ATTENTION FOCUS AND SELF-TOUCH IN TODDLERS:

THE MODERATING EFFECT OF ATTACHMENT SECURITY

by

Sachiyo Ito-Jäger

Bachelor of Arts, 2001
Whitworth University
Spokane, Washington

Master of Arts, 2006
Ball State University
Muncie, Indiana

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ATTENTION FOCUS AND SELF-TOUCH IN TODDLERS: THE MODERATING EFFECT OF ATTACHMENT SECURITY

Attachment refers to "a bond, tie, or enduring relationship between a young child and his mother" (Ainsworth, Blehar, Waters, & Wall, 1978, p. 17; Bowlby, 1969/1982). In attachment theory, touch is considered to be one of the core components. Touch is the largest sensory system of a body and the first sense to develop (Kandel, Schwartz, & Jessel, 2000; Montague, 1971). Touch has a variety of significant functions, including development promotion (Field, 1998), positive emotion and attention orientation enhancement (Clements & Tracy, 1977; Feldman, Weller, Sirota, & Eidelman, 2003), and attention focus and performance promotion (Clements & Tracy, 1977). By being touched by their caregiver, infants learn that the caregiver is present and they can be protected in times of threat (Main, 1990). Mother's touch, such as Kangaroo care (i.e., a method of holding an infant, which involves skin-to-skin contact), elevates infant's smiling and eye contact behaviors (Feldman et al., 2003; Stack & Muir, 1992).

The extent to which children *initiate* touch toward their caregiver, as opposed to passively receiving touch, is also important in attachment theory. In the Strange Situation, a well-established procedure to assess attachment style, an infant is placed in an increasingly stressful situation, where he or she is left alone in a room with and later without a stranger until he or she is reunited with the mother (Ainsworth et al., 1978). Attachment style is assessed based on four interactive behaviors that the infant exhibits during the reunions: proximity- and contact-seeking, contact maintaining, resistance, and avoidance. All four behaviors include touch as one component among other behaviors such as eye contact. Two of the four interactive behaviors, proximity- and *contact*-seeking and *contact* maintaining, are directly related to touch.

Infants who score high on these two behaviors seek touch with their caregivers and try to maintain touch with them during the reunions. The other two behaviors, resistance and avoidance, are negatively associated with touch. Infants who score high on these behaviors resist being touched by their caregivers and avoid touching.

Based on these interactive behaviors, infants are classified into one of the three attachment styles: secure, anxious-ambivalent, and anxious-avoidant (Ainsworth et al., 1978). Both anxious-ambivalent and anxious-avoidant are considered insecure attachment styles. Infants who actively seek proximity and contact with their mothers, maintain contact with them, and show little or no tendency to resist or avoid interaction with them are classified as securely attached to their mother. Infants classified as having an anxious-ambivalent attachment style also show strong proximity- and contact-seeking behavior and strong contact maintaining behavior. Anxious-ambivalent infants, however, tend to show ambivalent behaviors, such as the mixture of seeking and resisting contact with the mother. Infants with anxious-avoidant attachment style, on the other hand, tend to avoid their mother upon reunion. These infants do not seek proximity or contact with their mother, and as a result there is little or no touch, at least in the context of the Strange Situation.

With regard to attachment theory, it has also been studied how much a child touches their caregiver in less stressful, naturalistic settings. Ainsworth and colleagues (1978) found that 9- to 12-month-old children who are avoidant in a strange situation, in fact, exhibit some touch behaviors at home, such as patting, touching, and fingering, toward their mother as much as securely attached children do, although they show less affectionate touch, such as "sinking in," hugging, and kissing than do secure children. These results suggest that the likelihood of touch exhibited by children of different attachment styles may vary by context as well as type of touch.

Clarke-Stewart and Hevey (1981) conducted a short-term longitudinal study and observed the extent to which children touched their mothers at 12, 18, 24, and 30 months at home. It was found that for securely attached children, child-initiated touch gradually declines from age 18 to 30 months. The development of child-initiated touch for insecurely attached children, on the other hand, increases from 24 to 30 months. The authors argued that decreased touch shown by securely attached children could be an indicator of autonomy and maturity. These findings suggest that the likelihood of touch exhibited by children with different attachment styles may differ not only by context and type of touch but also by age.

Attachment and Self-Touch Behavior

Although touch is an important aspect of attachment theory, most of the studies have focused on its extrinsic forms (i.e., being touched by a caregiver, and touching a caregiver) and neglected its intrinsic form (i.e., self-touch). To our knowledge, there is only one published research examining the association of attachment style with self-touch behavior. Koulomzin, Beebe, Anderson, Jaffe, Feldstein, and Crown (2002) demonstrated that four-month-old infants later classified as anxious-avoidant attachment style exhibits more self-touch behaviors during face-to-face play with their mother than do infants later classified as securely attached. Koulomzin and colleagues argued that the increased use of self-touch by anxious-avoidant children might be an indicator of attempting to achieve self-comfort.

The association of self-touch with emotional distress has been widely explored in past research. The duration of self-touch is found to increase when children are under distress (e.g., Montague, 1971). Infants, for example, exhibit more self-touch when they encounter a stranger and when they are left alone in a room compared to being with or around familiar people (Trevarthen, 1977, 1979). Furthermore, 3-year-old children exhibit more self-touch during

storytelling with an "emotionally evocative picture book" than during storytelling with non-emotionally evocative toys (Landau, Shusel, Eshel, & Ben-Aaron, 2003). In this study, more self-touch during storytelling with the picture book was observed to reduce tension more so than self-touch during storytelling with the toys. Ruggieri, Celli, and Crescenzi (1982) also found that undergraduate students exhibit more self-touch when they talk about more emotional topics than less emotional topics.

The finding that anxious-avoidant children exhibit more self-touch than secure children, however, may not apply to different contexts or age groups. In fact, the greater self-regulation and attention-regulation capacity of securely attached children (e.g., Matas, Arend, & Sroufe, 1978) may allow them to exhibit more self-touch than insecurely attached children in a situation requiring attention focus.

Self-Touch Behavior and Attention Focus

Previous studies have shown that the duration of self-touch increases when people focus attention on a task. Barroso, Freedman, Grand, and van Meel (1978) found that 10-year-old children exhibit more self-touch, particularly bilateral self-touch (i.e., both hands moving onto each other or on the body, simultaneously), during a task requiring more attention focus (i.e., Stroop Color-Word test) than during a task requiring less attention focus (i.e., Stroop Color-Naming Test). The authors argued that self-touch behavior could be considered a manifestation of the extent to which one's attention was focused. As an alternative conclusion, the authors speculated that self-touch might function to help regulate attention focus.

In a subsequent study, Barroso, Freedman, and Grand (1980) found that the longer periods of bilateral self-touch are related to better performance during three different cognitive tasks: Stroop tests, memory task, and reasoning task. Specifically, 10-year-old children who

show larger increases in bilateral self-touch from the Stroop Color-Naming test (i.e., requiring less attention focus) to the Stroop Color-Word test (i.e., requiring more attention focus) have fewer insertions (i.e., repeating a correct response, correcting of errors in naming, or repeating previous responses). Additionally, longer periods of bilateral self-touch are associated with more numbers of items remembered during the memory task, and fewer requests for information being repeated during the reasoning task. Based on the assumption that performance in a task reflects attention processes, Barroso and his colleagues argued that self-touch, particularly bilateral self-touch, is related to improvements in attention focus.

The association between self-touch behavior and attention focus has also been demonstrated with adults (Barroso & Feld, 1986) and children as young as preschoolers (Rögels, Roelen, & van Meel, 1990). For instance, three- to six-year-old children engage in self-touch behavior when watching cartoons and retelling what they saw in the cartoons (Rögels et al, 1990). However, no study has investigated whether children younger than preschoolers would exhibit self-touch when they strive to focus their attention. Thus, before examining attachment style's relation to self-touch, we first attempt to examine whether the relationship between self-touch and attention focus emerges by toddlerhood (18-30 months).

Attention Systems

Attention consists of at least two systems (Ruff & Rothbart, 1996). The first attention system is the orienting system, which enables the orientation of attention toward specific objects or locations. Berlyne (1960) suggested that humans are more likely to orient attention toward certain stimuli than others. For instance, infants orient toward patterns with more elements, more angles, more information, and larger elements throughout 1- to 6-months of age (Fantz & Fagan, 1975). Infants are also reactive to novelty (Ruff & Rothbart, 1996). Due to habituation,

however, the orienting response decreases when the same object is presented repeatedly, particularly for older infants (Graham, Anthony, & Ziegler, 1983). The orienting system consists of not only orientation of attention toward objects but also disengagement of attention. Infants gradually become able to disengage attention from attractive objects. Johnson, Posner, and Rothbart (1991) found that 4-month-old infants, but not 2- or 3-month-old infants, are able to disengage from attractor stimuli. The orienting system becomes fully functional during the first year of life (Ruff & Rothbart, 1996). This system, however, is a primitive form of the attention system and is not yet sufficient for children to focus and sustain attention.

The second attention system is the higher form of attention system, and it enables children to focus attention. Focused attention is defined as "a state in which attention is directed more or less exclusively to one target or task and not divided or shared between targets or tasks" (Ruff & Rothbart, 1996, p. 110). Ruff and Rothbart (1996) also argued that, during focused attention "selectivity becomes narrower and restricted to fewer elements, and the degree of effort or energy directed at the target task is increased" (p. 110). This attention system, which gradually develops during toddlerhood (18-30 months old), is related to the first attention system because it controls the orienting system by intentions and not by novelty or physical features (Ruff & Rothbart, 1996).

This higher form of the attention system involves self-regulation in general and attention-regulation in particular. Self-regulation refers to one's capacity to control attention, emotion, and behavior in an adaptive manner across a variety of contexts (Saarni, 1997). Attention-regulation is defined as the ability to monitor and coordinate one's attention, by focusing and sustaining attention on a task and by inhibiting irrelevant stimuli (Ruff & Rothbart, 1996). During toddlerhood, along with the further development of the frontal cortex, which has executive control capacity, children increase their self-regulation and attention-regulation

capacity. Children improve their ability to monitor attention, leading to more sustained attention (Posner & Peterson, 1990; Ruff & Rothbart, 1996). For instance, sustained attention on complex visual displays, such as TV programs increases from 1 to 4 years of age both in a lab and at home (Anderson & Levin, 1976; Anderson, Lorch, Field, Collins, & Nathan, 1986). In addition, in free play with age-appropriate toys, the duration of focused attention increases between 1 and 3.5 years of age (Ruff & Lawson, 1990).

Child-Caregiver Interactions and Development of Self-Regulation and Attention-Regulation

Early interactions with a caregiver play an important role in the development of self-regulation as well as attention-regulation. Self-regulation is first learned during infancy through dyadic co-regulation with a caregiver (Sroufe, 1995). In the first half year of life, the caregiver responds to the infant by attending to his or her needs. Infants passively receive support from their caregiver with basic biological processes, such as sleeping and feeding, as well as regulating arousal (Brazelton, 2000; Sander, 2008). In the second half year of life, however, infants start actively seeking for their caregiver when in need. Infants initiate interactions with their caregiver and try to determine availability of their caregiver (Sander, 2008). During the second year of life, caregiver-guided self-regulation emerges. Since this is a transition stage to true self-regulation, toddlers still require the presence and guidance of their caregiver to regulate themselves.

Child-caregiver interaction is also studied specifically in the development of attention-regulation. In order to encourage children to engage in and complete a challenging task, caregivers use scaffolding. Bruner (1978) refers to scaffolding as a regulatory process, which caregivers or teachers use to promote children's cognitive development. Scaffolding is derived

from Vygotsky's (1978) socio-cultural theory of cognitive development, which emphasizes the important role of collaborative work with adults in the development of children's cognitive skills (Chaiklin, 2003). Through appropriate guidance from their caregiver, children gradually learn self-generated attention-regulation skills (Rogoff, Mistry, Goncu, & Mosier, 1993).

In one study by Wertsch, McNamee, McLane, and Budwig (1980), a child-mother dyad was instructed to solve a puzzle while referring to the completed model puzzle. The mother was asked to help the child whenever she felt the child needed assistance. Attention-regulation was coded as other-generated if the mother guided the child's gaze to the model puzzle, such as by pointing to the model or telling the child to look at the model. The results showed that other-generated attention-regulation is more frequent for younger children than older children (Wertsch et al., 1980). Mothers also assist directing attention of younger children verbally and non-verbally more often than older children (de la Ossa & Gauvain, 2001), suggesting development of self-regulation over time. Moreover, Freund (1990) demonstrated that mothers of younger children enhance regulation of children's attention during a more difficult task than mothers of older children. Other-generated attention-regulation, therefore, appears to be gradually replaced by self-generated attention-regulation during early development (Ruff & Rothbart, 1996).

The aforementioned evidence shows that (a) self-touch is observed when one focuses attention, (b) the ability to focus attention emerges by toddlerhood, and (c) caregiver-guided self-regulation emerges during toddlerhood. Based on these findings, we hypothesized that toddlers are more likely to exhibit self-touch when they are focusing on a task than when they are not focusing on a task in the presence of their caregiver (Hypothesis 1).

Attachment Style, Attention Focus, and Self-Touch Behavior

The superior self-regulation and attention-regulation ability of securely attached children has been demonstrated repeatedly. Securely attached children whose caregivers have been consistently responsive and caring learn that their caregivers would be available at a time of distress (Cassidy, 1994). This history of consistent care during infancy enables securely attached children to use their caregiver as a secure base, which leads them to explore environments, pursue autonomous activities, and achieve self-regulation and attention-regulation skills, including attention focus, during toddlerhood (Sroufe, 1995).

Anxious-ambivalent children whose caregivers have been inconsistently available, at times being responsive and at other times neglectful, during infancy develop extreme dependence on their caregiver and seek attention from their caregiver (Ainsworth et al., 1978; Cassidy, 1994). This intense dependency on their caregiver interferes with the development of autonomy, self-regulation, and attention-regulation, including attention focus, of these children (Cassidy, 1994).

Children who have a history of consistent rejection from their caregiver in times of need minimize the importance of their caregiver (Cassidy, 1994). By the end of the first year, they avoid contact with their caregiver when under stress. These anxious-avoidant children seem to be independent on a behavior level. However, the distress level, measured with cortisol, of anxious-avoidant children increases after participating in the Strange Situation, whereas it slightly decreases for securely attached children, suggesting an inappropriate coping strategy of anxious-avoidant children (Spangler & Grossmann, 1993).

In fact, anxious-avoidant children as well as anxious-ambivalent children are found to have poor self-regulation and attention-regulation skills, including attention focus. Matas and her colleagues (1978) found that, during a problem solving task, 24-month-old toddlers with

insecure attachment styles spend less time focusing on the task, show less positive affect and more negative affect, and exhibit more frustration behaviors than toddlers with a secure attachment style.

Main (1983) also demonstrated that 21-month-old toddlers with secure attachment style play with toys longer than insecurely attached toddlers when caregivers are prevented from initiating play. Securely attached toddlers are also rated to focus their attention on the toys more intensely and fully than insecure children. This association between attachment security and attention-regulation has also been observed at other ages. In primary school, securely attached children show higher levels of attention control (i.e., focusing and shifting attention) than insecure children (Muris & Dietvorst, 2006). In addition, adults with higher attachment anxiety tend to report having difficulty focusing and shifting attention than those with lower attachment anxiety (Skowron & Dendy, 2004).

Thus, for securely attached children, their caregiver functions as a secure base, which allows children to engage in challenging tasks and focused attention. Lack of this secure base, on the other hand, may cause more difficulty in attempting to focus attention for anxious-ambivalent and anxious-avoidant children. Therefore, we expect to replicate the past findings that securely attached children are more likely to focus attention on a task than children of the insecure attachment styles (Hypothesis 2).

The abovementioned findings indicate that (a) securely attached children are more likely to focus attention on a given task than anxious-avoidant and anxious-ambivalent children, and that (b) self-touch is observed when one focuses attention. These findings lead to the prediction that secure children are more likely to exhibit self-touch than insecurely attached children in a situation requiring attention focus, such as in a learning context (Hypothesis 3).

Moreover, in order to clarify the nature of the relationships among attachment style, attention focus, and self-touch, a moderation analysis was conducted. The first three hypotheses involved the associations between two variables at a time and were conducted to replicate and be compared to previous findings. Hypothesis 1 pertains to the association between self-touch and attention focus. Hypothesis 2 pertains to the association between attachment style and attention focus. Hypothesis 3 pertains to the association between attachment style and self-touch, neglecting the effect of attention focus. Therefore, the relationships among all three variables still require clarification. Thus, we explored the influence of attachment style on the association between self-touch and attention focus, using a moderation model (Hypothesis 4). Because past research has shown a distinctive relation between two types of self-touch (bilateral and lateral self-touch) to attention focus for older children (e.g., Barroso et al., 1978), they were explored separately for each hypothesis.

The Present Study

In order to clarify the associations among attention focus, self-touch, and attachment style, we examined behaviors of toddlers in mother-child interactions at 19 months and at 26 months of age. We determined attachment classification of the children using the Strange Situation. The instances of attention focus and self-touch behavior during a challenging task were coded second by second (microanalysis).

Method

Participants

Data of forty-nine mother-child dyads from middle-class families were used for the current study. These families were part of a longitudinal study conducted from 1987 to 1991 at

Texas Christian University. All families were recruited from the Bureau of Vital Statistics birth log including all births from ten Tarrant County hospitals. Families with a child turning 12 months of age between September, 1987 and December, 1987 were recruited. Criteria for participation included families that were Caucasian, English-speaking, and having a first-born child with no pre-, peri-, or post-natal complications. Additional criteria included parents having no auditory, visual, or motor problems. Of those recruited, 100 families met the criteria. For the current study, data of forty-nine families who participated in experiments both at 19 months and at 26 months of child's age and whose videotapes had sufficient quality for coders to score (e.g., a child's hands are not behind the book) were used.

Procedure

Data for this study were derived from two time points, at 19 months and at 26 months of child's age. At 19 months, the child-mother dyad participated in the Strange Situation to test attachment style of the child (Ainsworth et al., 1978). At 26 months, the child-mother dyad participated in a reading task to test self-touch and on-task behavior of the child (Knight, 1990).

Attachment Classifications. Children participated in the Strange Situation paradigm, a well-established procedure to test attachment style of a child at 19 months of age (Ainsworth et al., 1978). In the Strange Situation, a child was placed in an increasingly stressful situation, where he or she was left alone in a room with and later without a stranger before reunions with the mother (See Table 1). The Strange Situation was videotaped and four interactive behaviors of the child at the reunions with the mother were observed: proximity- and contact-seeking behavior, contact maintaining behavior, resistant behavior, and avoidant behavior. Based on these behaviors, children were classified into one of the three attachment styles: secure, anxious-avoidant, and anxious-ambivalent (see Table 2).

Table 1

Summary of Strange Situation Episodes

Episode	Persons Present	Brief Description of Action
1	Mother, baby, & experimenter	Experimenter introduces mother & baby to experimental room & then leaves.
2	Mother & baby	Mother is not participating while baby plays with toys.
3	Mother, baby, & stranger	Stranger enters. Min.1: Stranger silent. Min.2: Stranger interacts with mother. Min.3: Stranger interacts with baby.
4	Stranger & baby	First separation episode. Stranger follows baby's lead.
5	Mother & baby	First reunion episode. Mother greets, comforts, & settles baby. Stranger leaves unobtrusively. After 3 min. mother leaves.
6	Baby alone	Second separation episode.
7	Stranger & baby	Continuation of separation. Stranger follows baby's lead.
8	Mother & baby	Second reunion episode. Mother greets, comforts, & settles baby. Stranger leaves unobtrusively.

Note. Episodes last approximately 3 minutes with the exception of Episode 1, which lasts only 30 seconds.

Table 2

Criteria for Attachment Classification (Ainsworth et al., 1978, pages 59-62)

Secure Attachment
- The baby wants either proximity and contact with his mother or interaction with her, and he actively seeks it, especially in the reunion episodes. - If he achieves contact, he seeks to maintain it, and either resists release or at least protests if he is put down. - The baby responds to his mother's return in the reunion episodes with more than a casual greeting – either with a smile or a cry or a tendency to approach. - Little or no tendency to resist contact or interaction with his mother. - Little or no tendency to avoid his mother in the reunion episode. - He may or may not be friendly with the stranger, but he is clearly more interested in interaction and/or contact with his mother than with the stranger. - He may or may not be distressed during the separation episodes, but if he is distressed this is clearly related to his mother's absence and not merely to being along. He may be somewhat comforted by the stranger, but it is clear that he wants his mother.
Anxious-Avoidant Attachment
- Conspicuous avoidance of proximity to or interaction with the mother in the reunion episode. Either the baby ignores his mother on her return, greeting her casually if at all, or, if there is approach and/or a less casual greeting, the baby tends to mingle his welcome with avoidance responses – turning away, moving past, averting the gaze, and the like. - Little or no tendency to seek proximity to or interaction or contact with the mother, even in the reunion episodes. - If picked up, little or no tendency to cling or to resist being released. - On the other hand, little or no tendency toward active resistance to contact or interaction with the mother, except for probable squirming to get down if indeed the baby is picked up. - Tendency to treat the stranger much as the mother is treated, although perhaps with less avoidance. - Either the baby is not distressed during separation, or the distress seems to be due to being left alone rather than to his mother's absence. For most, distress does not occur when the stranger is present, and any distress upon being left alone tends to be alleviated when the stranger returns.

Anxious-Ambivalent Attachment
- The baby displays conspicuous contact- and interaction-resisting behavior, perhaps especially in Episode 8. - He also shows moderate-to-strong seeking of proximity and contact and seeking to maintain contact once gained, so that he gives the impression of being ambivalent to his mother. - He shows little or no tendency to ignore his mother in the reunion episodes, or to turn or move away from her, or to avert his gaze. - He may display generally "maladaptive" behavior in the strange situation. Either he tends to be more angry than infants in other groups, or he may be conspicuous passive.

Children who actively seek proximity and contact with their mothers, maintain contact with them, and show little or no tendency to resist or avoid interaction with them are classified as securely attached to their mother. Secure children are thought to exhibit those behaviors because the history of consistent care during infancy teaches them that their caregivers provide a secure base (Ainsworth et al., 1978).

Children classified as anxious-ambivalent attachment style also show strong proximity- and contact-seeking behavior and strong contact maintaining behavior. Anxious-ambivalent children, however, tend to show ambivalent behaviors, such as the mixture of seeking and resisting contact with the mother (Ainsworth et al., 1978). These behaviors are likely to develop because anxious-ambivalent children's caregivers have been inconsistently available during infancy. In consequence, children seek attention from their caregiver but, at the same time, are anxious that they may lose attention from them at any time.

Children with anxious-avoidant attachment style, on the other hand, tend to avoid their mothers upon reunion (Ainsworth et al., 1978). These children tend not to seek proximity or contact with their mothers. Children tend to develop these behaviors because a history of

consistent rejection from their caregivers in times of need make them minimize the importance of their caregivers.

Behavior coding. The child-mother interaction during a reading task was videotaped at 26 months of child's age. In a laboratory, child and mother sat next to each other, and the mother was instructed to "read this book with your child as you would if you were at home." The assigned book was considered challenging for this age. The experimenter left the laboratory after he or she explained the task, leaving the child and the mother alone. The videotapes were timed for the instance of child's self-touch behavior and off-task-behavior to the nearest second with the DVD clock. Coders used the zoom function and the slow motion function when necessary in order to make the scoring as accurate as possible. Children were considered to be "in the task/room" from the time the book was open till it was closed.

Self-touch. Coders scored the instance (units of one second) of a child exhibiting self-touch in the task. Self-touch included behaviors such as rubbing, squeezing, or touching any part of the body. Each episode of self-touch was classified as one of two types based on a coding system adapted from Barroso and Feld (1986), Barroso et al. (1978), and Barroso et al. (1980): bilateral self-touch or lateral self-touch.

Bilateral self-touch refers to types of self-touch, in which both hands are moving onto each other or on the body, simultaneously. Lateral self-touch refers to types of self-touch, in which one hand is clearly moving on the other hand or on the body of the child. For each hypothesis, each type of self-touch was analyzed separately.

Each episode of self-touch was also scored whether it was incidental or non-incidental. Self-touch was considered incidental if the touch was a by-product of another behavior (e.g., a child touches himself or herself while trying to pick up a book). Only non-incidental touch was included for analysis.

Attention Focus. Coders scored the instance (units of one second) of a child *not* being fully engaged with the task of storybook reading based on the coding system adapted from Ruff and Lawson (1990). Off-task (i.e., *not* focusing on a task) included episodes such as the child talking to mother about irrelevant topics (e.g., what they ate for lunch or what time they were leaving). In order to control for the possibility that children might exhibit self-touch less frequently while walking, the seconds that children were walking in the room were not used for analyses. The episodes where children were in the task/room but not coded as off-task was considered on-task (i.e., focusing on a task).

Results

The R statistical software was used for model testing[1], model comparison analyses, as well as preliminary and primary analyses (R Development Core Team, 2009).

Inter-Rater Reliability

Self-Touch & On-Task Behavior. Two pairs of coders were trained together for two months, and later each pair independently scored bilateral self-touch, lateral self-touch, and on-task behavior on a sub-sample (20%) of videotapes, blind to attachment styles of each child. Cohen's (1960) kappa coefficients were .80 for bilateral self-touch, .91 for lateral self-touch, and .92 for on-task behavior. Each pair then independently scored the behaviors on the rest of the videotapes.

Attachment Styles. Two independent raters scored a sub-sample (20%) of the Strange Situation videotapes. Cohen's kappa coefficients were .90. A third rater scored any discrepancies to determine the attachment classification. Out of 49 children, 26 (53%) children were classified with a secure classification, 14 (29%) children as an anxious-avoidant classification, and 9 children (18%) with an anxious-ambivalent classification.

Preliminary Results: Bilateral Self-Touch vs. Lateral Self-Touch

Before examining the main hypotheses, which did not address differences between types of self-touch, possible differences in the likelihoods of lateral and bilateral self-touch were investigated. Examining the marginal likelihoods of self-touch, it was found that toddlers are significantly more likely to engage in lateral self-touch than bilateral self-touch, $OR = 2.61$, 95% CIs [.136, .149] and [.593, .681] for the proportions.

Examining the conditional likelihoods, conditioned on attention focus, it was found that toddlers are more likely to exhibit lateral self-touch ($OR = 2.38$) than bilateral self-touch ($OR = 1.76$) when they are focusing on a task, however, the difference did not reach statistical significance, 95% CIs [1.83, 3.08] and [1.25, 2.47].

Preliminary Results: Hypotheses 1, 2, and 3

Hypotheses 1, 2, and 3 addressed whether results from the current study were consistent with findings from previous studies. Specifically, Hypothesis 1a addressed whether the odds of exhibiting bilateral self-touch were greater when children were focusing on a task than when they were not, as was found with older children in a previous study (Barroso et al., 1978). Hypothesis 1b addressed whether the odds of exhibiting lateral self-touch were greater when children were focusing on a task than when they were not, although no significant differences were found for older children working alone in a previous study (Barroso et al., 1978). Hypotheses 2 addressed whether the odds of focusing on a task were greater for securely attached children than anxious-avoidant or anxious-ambivalent children, as previously found (Matas et al., 1978). Hypotheses 3a and 3b addressed whether the odds of exhibiting bilateral or lateral self-touch were greater for securely attached children than anxious-avoidant or anxious-ambivalent children.

For each hypothesis, model comparison using log-linear modeling was used to identify a unique adequate model, where "adequate" means the most parsimonious model having acceptable fit to the data. Two models, 2-way association model and independence model, were compared for bilateral and lateral self-touch in order to evaluate Hypothesis 1 (Table 3), Hypothesis 2 (Table 4), and Hypothesis 3 (Table 5). The 2-way association model was selected if the independence model fit the data poorly, whereas the independence model was selected if it fit the data well.

Table 3

Hypothesis 1: Parameters for 2-Way Association and Independence Models

Model	Parameters
2-way Association	$\log m_{ij} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_{ij}^{B/LO}$
Independence	$\log m_{ij} = \mu + \lambda_i^{B/L} + \lambda_j^{O}$

Note.
$\log m_{ij}$ = the log of the expected cell frequency for cell *ij* in the contingency table
μ = parameter indicating the overall mean of the natural log of the expected frequencies
λ = parameter indicating effects that the variables have on the cell frequencies
B = bilateral self-touch
L = lateral self-touch
O = on-task behavior
i = the categories within variable, bilateral or lateral self-touch
j = the categories within variable, on-task behavior
$\lambda_i^{B/L}$ = the marginal distribution of bilateral or lateral self-touch
λ_j^{O} = the marginal distribution of on-task behavior
$\lambda_{ij}^{B/LO}$ = the 2-way association between bilateral or lateral self-touch and on-task behavior

Table 4

Hypothesis 2: Parameters for 2-Way Association and Independence Models

Model	Parameters
2-way Association	$\log m_{jk} = \mu + \lambda_j^O + \lambda_k^A + \lambda_{jk}^{OA}$
Independence	$\log m_{jk} = \mu + \lambda_j^O + \lambda_k^A$

Note.
$\log m_{jk}$ = the log of the expected cell frequency for cell *jk* in the contingency table
μ = parameter indicating the overall mean of the natural log of the expected frequencies
λ = parameter indicating effects that the variables have on the cell frequencies
O = on-task behavior
A = attachment style
j = the categories within variable, on-task behavior
k = the categories within variable, attachment style
λ_j^O = the marginal distribution of on-task behavior
λ_k^A = the marginal distribution of attachment style
λ_{jk}^{OA} = the 2-way association between on-task behavior and attachment style

Table 5

Hypothesis 3: Parameters for 2-Way Association and Independence Models

Model	Parameters
2-way Association	$\log m_{ik} = \mu + \lambda_i^{B/L} + \lambda_k^{A} + \lambda_{ik}^{B/LA}$
Independence	$\log m_{ik} = \mu + \lambda_i^{B/L} + \lambda_k^{A}$

Note.
$\log m_{ik}$ = the log of the expected cell frequency for cell *ik* in the contingency table
μ = parameter indicating the overall mean of the natural log of the expected frequencies
λ = parameter indicating effects that the variables have on the cell frequencies
B = bilateral self-touch
L = lateral self-touch
A = attachment style
i = the categories within variable, bilateral or lateral self-touch
k = the categories within variable, attachment style
$\lambda_i^{B/L}$ = the marginal distribution of bilateral or lateral self-touch
λ_k^{A} = the marginal distribution of attachment style
$\lambda_{ik}^{B/LA}$ = the 2-way association between bilateral or lateral self-touch and attachment style

Hypothesis 1a: Bilateral Self-Touch & On-Task Behavior. As seen in Table 6, the odds ratio of children exhibiting bilateral self-touch during on-task in comparison to off-task was 1.76. A log-linear analysis showed poor fit for the independence model, $G^2(1) = 12.25$, $p < .05$, indicating that the odds ratio is significantly greater than 1. Thus, the results indicate that the odds of exhibiting bilateral self-touch are 1.76 times greater when children are focusing on a task than when they are not focusing on a task, which is consistent with previous findings (Barroso et al., 1978).

Table 6

Descriptive Statistics for Bilateral Self-Touch When Children Were On-Task versus Off-Task

	Bilateral touch	No bilateral touch	Marginal totals	Odds	Odds ratio
On-task	732	10,384	11,116	.07	1.76
Off-task	36	897	933	.04	
Column totals	768	11,281		.07	
Odds	20.33	11.58	11.91		

Note. Values are frequencies, odds, or odds ratio.

Hypothesis 1b: Lateral Self-Touch & On-Task. The odds ratio of children exhibiting lateral self-touch during on-task compared to off-task was 2.38 (see Table 7). A log-linear analysis revealed poor fit for the independence model, $G^2(1) = 53.86$, $p < .05$, again indicating that the odds ratio is significantly greater than 1. Thus, the odds of exhibiting lateral self-touch are 2.38 times greater when children are focusing on a task than when they are not focusing on a task, which is inconsistent from older children working alone in previous research (Barroso et al., 1978).

Table 7

Descriptive Statistics for Lateral Self-Touch When Children Were On-Task versus Off-Task

	Lateral touch	No lateral touch	Marginal totals	Odds	Odds ratio
On-task	1,656	9,460	11,116	.18	2.38
Off-task	64	869	933	.07	
Column totals	1,720	10,329		.17	
Odds	25.88	10.89	11.91		

Note. Values are frequencies, odds, or odds ratio.

Hypothesis 2: Attachment Style & On-Task Behavior. As seen in Tables 8 and 9, the odds of being on-task compared to off-task were 19.12 for securely attached children, 8.38 for anxious-avoidant children, and 8.48 for anxious-ambivalent children. A log-linear analysis showed poor fit for the independence model, $G^2(2) = 136.77$, $p < .05$. In order to identify the locus of attachment style differences, the three attachment styles were compared using three pair-wise comparisons. Pair-wise log-linear analyses comparing secure and anxious-avoidant children ($OR = 2.28$) as well as secure and anxious-ambivalent children ($OR = 2.25$) showed poor fit for the independence models, $G^2(1) = 107.94$, $p < .05$; and $G^2(1) = 77.96$, $p < .05$, respectively. A pair-wise analysis comparing anxious-avoidant and anxious-ambivalent children ($OR = .99$), however, revealed good fit for the independence model, $G^2(1) = .02$, $p = .89$. Therefore, the odds of focusing on a task are 2.28 times greater for secure children than anxious-avoidant and 2.25 times greater for secure children than anxious-ambivalent children. The odds of focusing on a task, however, do not significantly differ between anxious-avoidant and anxious-ambivalent children. These results are consistent with previous findings (e.g., Matas et al., 1978).

Table 8

Secure Attachment Style: Descriptive Statistics for Bilateral Self-Touch When Children Were On-Task versus Off-Task

	Bilateral touch	No bilateral touch	Marginal totals	Odds	Odds ratio
On-task	395	5,435	5,830	.07	1.16
Off-task	18	287	305	.06	
Column totals	413	5,722		.07	
Odds	21.94	18.94	19.12		

Note. Values are frequencies, odds, or odds ratio.

Anxious-Avoidant Attachment Style: Descriptive Statistics for Bilateral Self-Touch When Children Were On-Task versus Off-Task

	Bilateral touch	No bilateral touch	Marginal totals	Odds	Odds ratio
On-task	178	3,064	3,242	.06	3.69
Off-task	6	381	387	.02	
Column totals	184	3,445		.05	
Odds	29.67	8.04	8.38		

Note. Values are frequencies, odds, or odds ratio.

Anxious-Ambivalent Attachment Style: Descriptive Statistics for Bilateral Self-Touch When Children Were On-Task versus Off-Task

	Bilateral touch	No bilateral touch	Marginal totals	Odds	Odds ratio
On-task	159	1,885	2,044	.08	1.61
Off-task	12	229	241	.05	
Column totals	171	2,114		.08	
Odds	13.25	8.23	8.48		

Note. Values are frequencies, odds, or odds ratio.

Table 9

Secure Attachment Style: Descriptive Statistics for Lateral Self-Touch When Children Were On-Task versus Off-Task

	Lateral touch	No lateral touch	Marginal totals	Odds	Odds ratio
On-task	1,056	4,774	5,830	.22	2.85
Off-task	22	283	305	.08	
Column totals	1,078	5,057		.21	
Odds	48.00	16.87	19.12		

Note. Values are frequencies, odds, or odds ratio.

Anxious-Avoidant Attachment Style: Descriptive Statistics for Lateral Self-Touch When Children Were On-Task versus Off-Task

	Lateral touch	No Lateral Touch	Marginal totals	Odds	Odds ratio
On-task	326	2,916	3,242	.11	1.49
Off-task	27	360	387	.08	
Column totals	263	3,276		.08	
Odds	12.07	8.10	8.38		

Note. Values are frequencies, odds, or odds ratio.

Anxious-Ambivalent Attachment Style: Descriptive Statistics for Lateral Self-Touch When Children Were On-Task versus Off-Task

	Lateral touch	No lateral touch	Marginal totals	Odds	Odds ratio
On-task	274	1,770	2,044	.16	2.33
Off-task	15	226	241	.07	
Column totals	289	1,996		.15	
Odds	18.27	7.83	8.48		

Note. Values are frequencies, odds, or odds ratio.

Hypothesis 3a: Attachment Style & Bilateral Self-Touch. The odds of exhibiting bilateral self-touch compared to not exhibiting it were .07 for securely attached children, .05 for anxious-avoidant children, and .08 for anxious-ambivalent children (see Table 8). A log-linear analysis revealed poor fit for the independence model, $G^2(2) = 16.84$, $p < .05$. In order to identify the locus of attachment style differences, the three attachment styles were compared using three pair-wise comparisons. A pair-wise log-linear analysis comparing secure and anxious-avoidant children ($OR = 1.36$) showed poor fit for the independence model, $G^2(1) = 11.25$, $p < .05$. A comparison between secure and anxious-ambivalent children ($OR = .89$) revealed, however, good fit for the independence model, $G^2(1) = 1.44$, $p = .23$. A comparison between anxious-avoidant and anxious-ambivalent children ($OR = .65$) showed poor fit for the independence model, $G^2(1) = 14.16$, $p < .05$. Thus, the odds of exhibiting bilateral self-touch are greater for secure and anxious-ambivalent children than anxious-avoidant children. The odds of exhibiting bilateral self-touch, however, do not differ between secure and anxious-ambivalent children. The results are inconsistent with the only published study investigating the relationship

between attachment style and self-touch behavior, which revealed that anxious-avoidant infants exhibited more self-touch than secure children during a face-to-face interaction with mother (Koulomzin et al., 2002). However, there are a number of methodological differences between the present study and the previous study, which will be addressed in the discussion section.

Hypothesis 3b: Attachment Style & Lateral Self-Touch. The odds of exhibiting lateral self-touch in comparison to not exhibiting it were .21 for secure children, .08 for anxious-avoidant children, and .15 for anxious-ambivalent children (see Table 9). A log-linear analysis revealed poor fit for the independence model, $G^2(2) = 212.20$, $p < .05$. In order to identify the locus of attachment style differences, the three attachment styles were compared using three pair-wise comparisons. Pair-wise log-linear analyses comparing all three pairs of attachment style showed poor fit for the independence model, $G^2(1) = 209.85$, $p < .05$; $G^2(1) = 30.96$, $p < .05$; and $G^2(1) = 42.99$, $p < .05$ ($OR = 2.66$ for secure vs. anxious-avoidant; $OR = 1.47$ for secure vs. anxious-ambivalent; and $OR = .55$ for anxious-avoidant vs. anxious-ambivalent, respectively).

Therefore, the odds of exhibiting lateral self-touch are greater for secure children than anxious-avoidant or anxious-ambivalent children. Additionally, the odds of exhibiting lateral self-touch are greater for anxious-ambivalent children than anxious-avoidant children. The results are inconsistent with a previous finding that anxious-avoidant infants exhibited more self-touch than secure children (Koulomzin et al., 2002). Again, these inconsistencies will be addressed in the discussion section.

Model Comparison for Hypothesis 4

Model comparison using log-linear modeling was again used to identify a unique adequate model for Hypothesis 4. Three models were compared for each type of self-touch in

order to evaluate the relationships among on-task behavior, self-touch, and attachment (see Table 10).

Table 10

Parameters for 3-Way Association, 2-Way Association, and Independence Models

Model	Parameters
3-Way Association (Saturated)	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ij}^{B/LO} + \lambda_{ik}^{B/LA} + \lambda_{jk}^{OA} + \lambda_{ijk}^{B/LOA}$
All 2-way Associations (Three 2-Way Associations)	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ij}^{B/LO} + \lambda_{ik}^{B/LA} + \lambda_{jk}^{OA}$
Two 2-Way Associations	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ij}^{B/LO} + \lambda_{ik}^{B/LA}$
	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ij}^{B/LO} + \lambda_{jk}^{OA}$
	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ik}^{B/LA} + \lambda_{jk}^{OA}$
One 2-Way Association	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ij}^{B/LO}$
	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{ik}^{B/LA}$
	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A} + \lambda_{jk}^{OA}$
Independence	$\log m_{ijk} = \mu + \lambda_i^{B/L} + \lambda_j^{O} + \lambda_k^{A}$

Note.
$\log m_{ijk}$ = the log of the expected cell frequency for cell *ijk* in the contingency table
μ = parameter indicating the overall mean of the natural log of the expected frequencies
λ = parameter indicating effects that the variables have on the cell frequencies
B = bilateral self-touch
L = lateral self-touch
O = on-task behavior
A = attachment style
i = the categories within variable, bilateral or lateral self-touch
j = the categories within variable, on-task behavior
k = the categories within variable, attachment style

$\lambda_i^{B/L}$ = the marginal distribution of bilateral or lateral self-touch
λ_j^{O} = the marginal distribution of on-task behavior
λ_k^{A} = the marginal distribution of attachment style
$\lambda_{ij}^{B/LO}$ = the 2-way association between bilateral or lateral self-touch and on-task behavior
$\lambda_{ik}^{B/LA}$ = the 2-way association between bilateral or lateral self-touch and attachment style
λ_{jk}^{OA} = the 2-way association between on-task behavior and attachment style
$\lambda_{ijk}^{B/LOA}$= the 3-way association effect between bilateral or lateral self-touch, on-task behavior, and attachment style

The following sequential strategy was used to identify the unique adequate model for each type of self-touch:

1. The 3-way association model was adopted if the two-way association model fit poorly. No additional analysis was necessary.
2. The 2-way association model was selected if (i) the 2-way association model fit well and (ii) the comparison between the independence model and the 2-way association model was statistically significant. Additional analyses were conducted to select which of the following 2-way association models was adequate: (a) the three 2-way association model, consisting of all three 2-way association terms; (b) the two 2-way association models, consisting of only two 2-way association terms; or (c) the one 2-way association models, consisting of only one 2-way association term.
    (a) The three 2-way association model was adopted if (i) all three of the two 2-way association models fit poorly and (ii) comparisons between the three 2-way association model and all three of the two 2-way association models were statistically significant.
    (b) The two 2-way association model was selected if (i) two of the two 2-way association models fit poorly; (ii) both of the one 2-way association models, consisting of the poorly fit two-way association

term, fit poorly; and (iii) the comparison between the superordinate two 2-way association model, consisting of the poorly fit 2-way association terms, and both of the one 2-way association models showed statistical significance.

(c) The one 2-way association model was selected if (i) one of the two 2-way association models fit poorly; (ii) the one 2-way association model, consisting of the poorly fit term fit well; and (iii) the comparison between the one 2-way association model and both of the superordinate two 2-way association models, consisting of the poorly fit term, did not show statistical significance.

3. The independence model was selected if it fit the data well. No additional analysis was necessary.

Primary Results: Hypothesis 4

Hypotheses 4a and 4b addressed whether the association between being on-task and bilateral or lateral self-touch was moderated by attachment style.

Hypothesis 4a: A 3-Way Association between Bilateral Self-Touch, On-Task Behavior, and Attachment Style. Log-linear analyses showed poor fit for both the independence model, $G^2(7) = 171.37$, $p < .05$, and the 2-way association model, $G^2(2) = 6.53$, $p < .05$, indicating that the 3-way association model is the unique adequate model. Thus, the relationship between on-task and bilateral self-touch differs for at least one pair of attachment classifications. Three-way association models were fit for each pair of attachment classifications to determine which comparisons were statistically significant.

Secure vs. Anxious-Avoidant. Pair-wise log-linear analyses comparing secure and anxious-avoidant children showed poor fit for both the independence model, $G^2(4) = 134.24$, $p < .05$, and the 2-way association model, $G^2(1) = 6.46$, $p < .05$, demonstrating that the 3-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA} + \lambda_{jk}^{OA} + \lambda_{ijk}^{BOA}$ [Secure vs. Anxious-Avoidant], was necessary for this pair of attachment styles. Thus, the association between on-task and bilateral self-touch is moderated by attachment style for secure and anxious-avoidant children. Specifically, as shown in Table 8, the odds of exhibiting bilateral self-touch when on-task as compared with off-task were greater for anxious-avoidant children ($OR = 3.69$) than for secure children ($OR = 1.16$).

Posthoc analyses were conducted to investigate the bilateral self-touch by on-task association for the secure and anxious-avoidant attachment styles (see Figure 1). A pair-wise log-linear analysis examining secure children showed good fit for the independence model, $G^2(1) = .37$, $p = .55$, indicating that the odds of exhibiting bilateral self-touch did not differ between on-task (Odds = .07) and off-task (Odds = .06) for secure children (see Table 8 – the secure attachment sub-table). However, for anxious-avoidant children (see Table 8 – the anxious-avoidant sub-table), poor fit of the independence model, $G^2(1) = 14.68$, $p < .05$, shows that the odds of exhibiting bilateral self-touch were greater during on-task (Odds = .06) than off-task (Odds = .02). Thus, anxious-avoidant children are more likely to exhibit bilateral self-touch during on-task than off-task ($OR = 3.63$), whereas no difference exists for secure children ($OR = 1.16$).

Another set of posthoc analyses was conducted to investigate attachment differences in the odds of bilateral self-touch when on-task or when off-task (see Figure 1). A pair-wise log-linear analysis (see Table 8 – the first rows in the secure attachment sub-table and the anxious-avoidant sub-table) showed poor fit for the independence model, $G^2(1) = 5.93$, $p < .05$, indicating

that the odds of exhibiting bilateral self-touch were 1.26 times greater for secure children (Odds = .07) than for anxious-avoidant children (Odds = .06). The same results were found for the likelihood of children exhibiting bilateral self-touch when off-task (see Table 8 – the second rows in the secure attachment sub-table and the anxious-avoidant sub-table), $G^2(1) = 9.81$, $p < .05$ (Odds = .06 for secure children; Odds = .02 for anxious-avoidant children; $OR = 3.94$).

Therefore, secure children are more likely to exhibit bilateral self-touch than anxious-avoidant children both when on-task and off-task. Anxious-avoidant children are likely to exhibit *less* bilateral self-touch when *off*-task than on-task, but there is no difference during on-task and off-task for secure children. Thus, although significant differences exist both when being on-task and off-task, it is the difference in off-task that contributes to the differences in the odds ratio.

Secure vs. Anxious-Ambivalent. A pair-wise log-linear analysis comparing secure and anxious-ambivalent children showed good fit for the 2-way association model, $G^2(1) = .70$, $p = .40$. In addition, the comparison between the independence model and the 2-way association model for secure and anxious-ambivalent children was statistically significant, $G^2(3) = 81.77$, $p < .05$. Taken together, these two results indicate at least one of the two-way association terms, but not the 3-way association term, is necessary for an adequate model.

Further analyses compared the three 2-way association model (i.e., $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA} + \lambda_{jk}^{OA}$) and the two 2-way association models, consisting of only two 2-way association terms (i.e., $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA}$; $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{jk}^{OA}$; or $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{BA} + \lambda_{jk}^{OA}$). The results showed that the model without λ_{jk}^{OA} fit poorly, $G^2(2) = 79.03$, $p < .05$, whereas the model without λ_{ij}^{BO} or λ_{ik}^{BA} fit well ($G^2(2) = 3.07$, $p = .21$; and $G^2(2) = 2.51$, $p = .29$, respectively), suggesting that at least λ_{jk}^{OA} is necessary for an adequate model.

The one 2-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{jk}^{OA}$, had good fit, $G^2(3) = 4.51$, $p = .21$. Additionally, the comparison between this one 2-way association model and the superordinate two 2-way association models, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{jk}^{OA}$ and $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{BA} + \lambda_{jk}^{OA}$, did not show statistical significance ($G^2(1) = 2.00$, $p = .16$; and $G^2(1) = 1.44$, $p = .23$, respectively). Thus, the one 2-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{jk}^{OA}$ [Secure vs. Anxious-Ambivalent], is adequate when comparing secure and anxious-ambivalent attachment styles, which demonstrates that the association between on-task and bilateral self-touch is not moderated by attachment style for secure ($OR = 1.16$) and ambivalent ($OR = 1.61$) children.

The adequate model shows that the odds of focusing on a task are greater for secure children than ambivalent children ($OR = 2.25$) even when bilateral self-touch is taken into consideration. On the other hand, the odds of exhibiting bilateral self-touch did not differ either between secure and anxious-ambivalent children ($OR = .89$), or between during on-task and during off-task ($OR = 1.30$) for the combination of secure and anxious-ambivalent children.

Posthoc analyses revealed that the odds of exhibiting bilateral self-touch are not significantly different between when on-task (Odds = .08) and when off-task (Odds = .05) for anxious-ambivalent children, $G^2(1) = 2.71$, $p = .10$, (see Table 8 –the anxious-ambivalent sub-table) and also not for secure children as shown in the previous section.

Another set of posthoc analyses was conducted to investigate attachment differences in the odds of bilateral self-touch when on-task and when off-task. A pair-wise log-linear analysis examining on-task behavior (see Table 8 – the first rows in the secure attachment sub-table and the anxious-ambivalent sub-table) showed good fit for the independence model, $G^2(1) = 2.28$, $p = .13$, indicating that the odds of exhibiting bilateral self-touch do not differ between secure children (Odds = .07) and anxious-ambivalent children (Odds = .08) when they are focusing on a

task (*OR* = .87; see Figure 1). There was also no significant difference between secure children (Odds = .06) and anxious-ambivalent children (Odds = .05) when they were not focusing on a task (*OR* = 1.21; see Table 8 – the first rows in the secure attachment sub-table and the anxious-ambivalent sub-table).

Thus, both securely attached children and anxious-ambivalent children do not differ in the likelihood of exhibiting bilateral self-touch when they are focusing on a task and when they are not. The likelihood of exhibiting bilateral self-touch do not differ between secure and anxious-ambivalent children both when they are on-task and off-task.

Anxious-Avoidant vs. Anxious-Ambivalent. A pair-wise log-linear analysis comparing anxious-avoidant and anxious-ambivalent children revealed good fit for the 2-way association model, $G^2(1) = 2.70$, $p = .10$, and the model comparison between the independence model and the 2-way association model was statistically significant, $G^2(3) = 28.87$, $p < .05$, indicating at least one of the 2-way association terms is necessary.

Further analyses were conducted to compare the three 2-way association model with each of the two 2-way association models (see Table 10). The model without λ_{ij}^{BO} or λ_{ik}^{BA} fit poorly ($G^2(2) = 17.39$, $p < .05$; and $G^2(2) = 16.84$, $p < .05$, respectively), suggesting that at least λ_{ij}^{BO} or λ_{ik}^{BA} is necessary for an adequate model. One of the one 2-way association models, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO}$, had poor fit, $G^2(3) = 16.86$, $p < .05$, and also the comparison to the superordinate two 2-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA}$, showed statistical significance, $G^2(1) = 14.16$, $p < .05$. Additionally, the other one 2-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{BA}$, had poor fit, $G^2(3) = 17.41$, $p < .05$, and also the comparison to the superordinate two 2 way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA}$ showed statistical significance, $G^2(1) = 14.71$, $p < .05$.

Therefore, the two 2-way association model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA}$ [Anxious-Avoidant vs. Anxious-Ambivalent], is adequate for comparing anxious-avoidant and anxious-ambivalent attachment styles. Thus, there is a significant association between being on-task and bilateral self-touch, but this association is not moderated by attachment style for anxious-avoidant (OR = 3.69) and anxious-ambivalent (OR = 1.61) children.

In addition, because the model consisted of two 2-way association terms, both involving the variable bilateral-self-touch, a possible mediation effect (i.e., bilateral self-touch mediates the association between attachment and on-task behavior) was explored. One of the criteria for a mediation effect is that there is a relationship to be mediated, in this case between attachment and on-task behavior. Thus, the model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{AO}$, was compared against the independence model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A$. The comparison analysis revealed no statistical difference, $G^2(1) = .02$, $p = .89$, indicating that anxious-avoidant and anxious-ambivalent children did not differ in on-task behavior. Therefore, bilateral self-touch cannot mediate the association between attachment and on-task behavior when comparing children with anxious-avoidant and anxious-ambivalent styles because there is no association to mediate.

The adequate model, $\log m_{ijk} = \mu + \lambda_i^B + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{BO} + \lambda_{ik}^{BA}$, shows that the odds of exhibiting bilateral self-touch are greater for anxious-ambivalent children than anxious-avoidant children (OR = 1.51), even when controlling for the effect of on-task. In addition, the odds of exhibiting bilateral self-touch are greater during on-task than off-task (OR = 2.31) for the combination of anxious-avoidant and anxious-ambivalent children, even when controlling for the effect of bilateral self-touch. The odds of being on-task, however, did not differ between anxious-avoidant and anxious-ambivalent children (OR = .99).

Posthoc analyses were conducted to investigate attachment differences in the odds of bilateral self-touch when on-task (see Table 8 – the first rows in the anxious-avoidant attachment

sub-table and the anxious-ambivalent sub-table) and off-task (see Table 8 – the second rows in the secure attachment sub-table and the anxious-ambivalent sub-table). Pair-wise log-linear analyses showed poor fit for the independence model both when they were on-task, $G^2(1) = 10.78$, $p < .05$, and off-task, $G^2(1) = 6.06$, $p < .05$. More specifically, as Figure 1 shows, the odds of exhibiting bilateral self-touch are greater for anxious-ambivalent than for anxious-avoidant children both when they are focusing on a task (Odds = .08 for anxious-ambivalent; Odds = .06 for anxious-avoidant; *OR* = 1.45) and when they are *not* focusing on a task (Odds = .05 for anxious-ambivalent; Odds = .02 for anxious-avoidant; *OR* = 3.25).

Therefore, anxious-avoidant children, but not anxious-ambivalent children, are more likely to exhibit bilateral self-touch when they are focusing on a task than when they are not focusing on a task. Also, anxious-ambivalent children are likely to exhibit bilateral self-touch than anxious-avoidant children both when they are on-task and off-task.

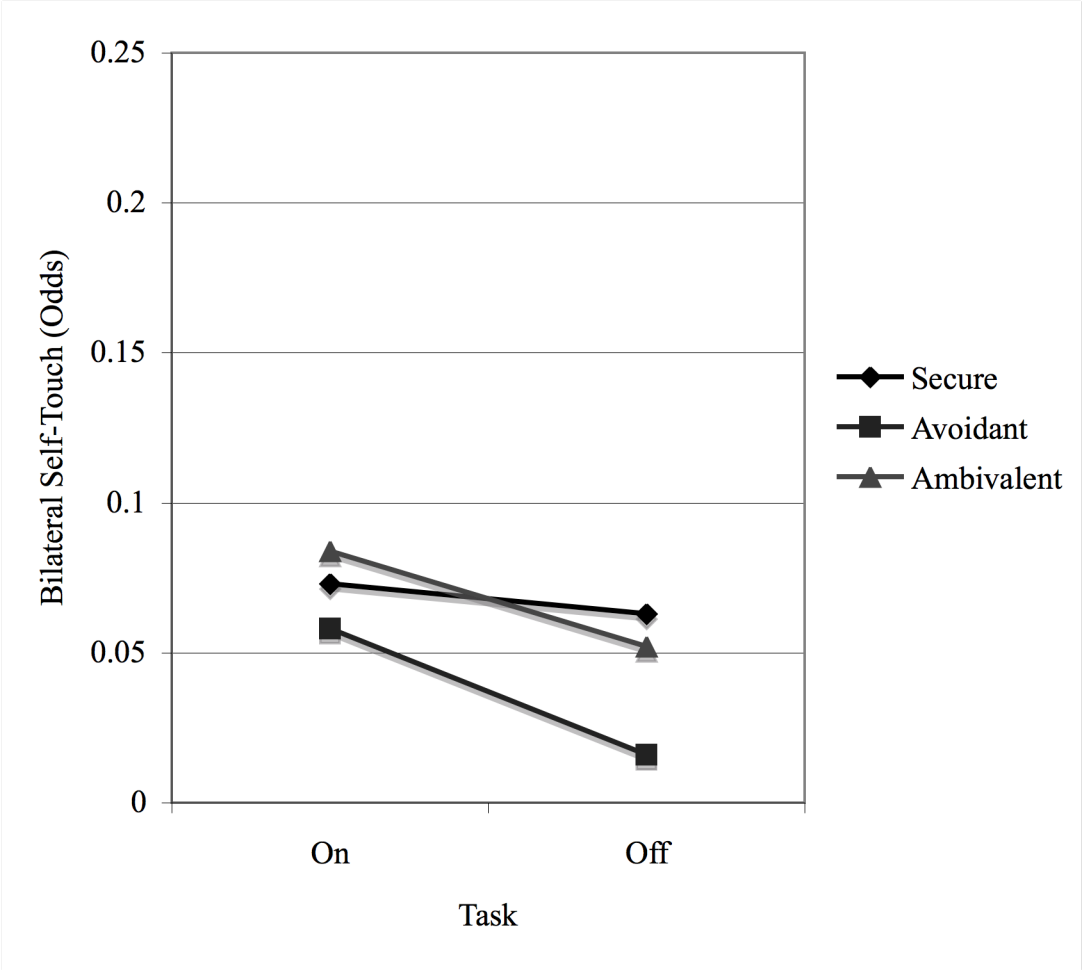

Figure 1. The Odds of Bilateral Self-Touch During On-Task and Off-Task for Secure, Anxious-Avoidant, and Anxious-Ambivalent Children.

Hypothesis 4b: A 3-Way Association between Lateral Self-touch, On-Task Behavior, and Attachment Style. Log-linear analyses showed marginally good fit for the 2-way association model, $G^2(2) = 4.62$, $p = .10$, and the model comparison between the independence model and the 2-way association model was statistically significant, $G^2(5) = 301.38$, $p < .05$, suggesting that the 2-way association model or 3-way association model is adequate for lateral self-touch. Because the fit was only marginally good for the 2-way association model, the relationship between lateral self-touch and on-task may be moderated by attachment style for at

least one pair of attachment classifications. A 3-way association model was fit for each pair of attachment classifications to determine which comparisons were statistically significant.

Secure vs. Anxious-Avoidant. Pair-wise log-linear analyses comparing secure and anxious-avoidant children showed poor fit for both the independence model, $G^2(4) = 259.07$, $p < .05$, and the 2-way association model, $G^2(1) = 4.50$, $p < .05$, suggesting that the 3-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA} + \lambda_{jk}^{OA} + \lambda_{ijk}^{LOA}$ [Secure vs. Anxious-Avoidant], was necessary for this pair of attachment styles in terms of lateral self-touch. Therefore, the association between on-task and lateral self-touch is moderated by attachment style for secure and anxious-avoidant children. Specifically, as shown in Table 9, the odds ratio of exhibiting lateral self-touch when they are focusing on a task compared to when they are not focusing on a task are greater for secure children ($OR = 2.85$) than anxious-avoidant children ($OR = 1.49$).

Posthoc analyses were conducted to examine the lateral self-touch by on-task association for each attachment style (see Figure 2). A pair-wise log-linear analysis showed poor fit for the independence model for both secure children, $G^2(1) = 28.99$, $p < .05$ (see Table 9 – the secure attachment sub-table) and anxious-avoidant children, $G^2(1) = 4.06$, $p < .05$ (see Table 9 – the anxious-avoidant sub-table). The results indicate that the odds of lateral self-touch are greater when on-task than when off-task for both attachment styles (Odds = .22 when on-task and .08 when off-task for secure children; Odds = .11 when on-task and .08 when off-task for anxious-avoidant children).

Another set of posthoc analyses was conducted to investigate attachment differences in the odds of lateral self-touch when on-task and when off-task (see Figure 2). A pair-wise log-linear analysis revealed poor fit for the independence model when on-task, $G^2(1) = 110.64$, $p < .05$, suggesting that the odds of exhibiting lateral self-touch are greater for secure children (Odds

= .22) than for anxious-avoidant children (Odds = .11) when they are focusing on a task (*OR* = 1.97; see Table 9 – the first rows in the secure attachment sub-table and the anxious-avoidant sub-table). In contrast, a good fit for the independence model was found when off-task, $G^2(1) = .01$, $p = .90$, indicating that the odds of exhibiting lateral self-touch do not differ between secure (Odds = .08) and anxious-avoidant (Odds = .08) children when they are *not* focusing on a task (*OR* = 1.04; see Table 9 – the second rows in the secure attachment sub-table and the anxious-avoidant sub-table).

Thus, locus of moderation is not in children's off-task behavior, but in their on-task behavior. Both secure and anxious-avoidant children are more likely to exhibit lateral self-touch when they are focusing on a task than when they are *not* focusing on a task, but secure children are more likely to exhibit lateral self-touch than anxious-avoidant children when they are focused on a task.

Secure vs. Anxious-Ambivalent. A pair-wise log-linear analysis comparing secure and anxious-ambivalent children showed good fit for the 2-way association model, $G^2(1) = .31$, $p = .58$, and also the model comparison between the independence model and the 2-way association model was statistically significant, $G^2(3) = 149.45$, $p < .05$. These two results indicate at least one of the 2-way association terms, but not the 3-way association term, is necessary for an adequate model.

Further analyses were conducted to compare the three 2-way association model (i.e., $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA} + \lambda_{jk}^{OA}$), and each of the two 2-way association models (i.e., $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$; $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{jk}^{OA}$; or $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{LA} + \lambda_{jk}^{OA}$). All of the two 2-way association models showed poor fit: $G^2(2) = 72.08$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$; $G^2(2) = 40.84$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{LA} + \lambda_{jk}^{OA}$; and $G^2(2) = 25.08$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L +$

$\lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{jk}^{OA}$. In addition, the comparison between each of the two 2-way association models and the three 2-way association model was statistically significant: $G^2(1) = 71.77$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$; $G^2(1) = 40.53$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{LA} + \lambda_{jk}^{OA}$; and $G^2(1) = 24.77$, $p < .05$ for $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{jk}^{OA}$. These results indicate that the three 2-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA} + \lambda_{jk}^{OA}$ [Secure vs. Anxious-Ambivalent], is adequate when comparing secure and anxious-ambivalent children. Thus, the association between on-task and lateral self-touch is not moderated by attachment style for secure (*OR* = 2.85) and anxious-ambivalent (*OR* = 2.33) children.

The adequate model, however, shows that these two groups differed in proportions of the time focusing on a task and also exhibiting lateral self-touch. Specifically, the odds of focusing on a task are greater for secure children than anxious-ambivalent children (*OR* = 2.18), even when controlling for the effect of lateral self-touch. In addition, the odds of exhibiting lateral self-touch are greater for secure children than anxious-ambivalent children (*OR* = 1.42), even when controlling for the effect of on-task behavior. Also, the odds of exhibiting lateral self-touch are greater during on-task than off-task for the combination of secure and anxious-ambivalent children (*OR* = 2.64), even when controlling for the effect of attachment style.

Posthoc analyses examining attachment differences in the odds of lateral self-touch showed poor fit for the independence model when children are on-task, $G^2(1) = 24.87$, $p < .05$, and good fit for the independence model when children are off-task, $G^2(1) = .21$, $p = .65$ (see Figure 2). The results indicate that the odds of exhibiting lateral self-touch are greater for secure children (Odds = .22) than for anxious-ambivalent children (Odds = .16) when they are focusing on a task (*OR* = 1.43; see Table 9 – the first rows in the secure attachment sub-table and the anxious-ambivalent sub-table). In contrast, the odds of lateral self-touch do not differ for secure

(Odds = .08) and anxious-ambivalent (Odds = .07) children when they are *not* focusing on a task (*OR* = 1.18; see Table 9 – the second rows in the secure attachment sub-table and the anxious-ambivalent sub-table).

Another set of posthoc analysis showed that the odds of exhibiting lateral self-touch were greater during on-task (Odds = .16) than off-task (Odds = .07) for anxious-ambivalent children, $G^2(1) = 11.85$, $p < .05$ (*OR* = 2.33; see Table 9 – the anxious-ambivalent sub-table). Therefore, both secure and anxious-ambivalent children are more likely to exhibit lateral self-touch when they are focusing on a task than when they are not, but secure children are more likely to exhibit lateral self-touch than anxious-ambivalent children when they are on task (see Figure 2).

Anxious-Avoidant vs. Anxious-Ambivalent. A pair-wise log-linear analysis comparing anxious-avoidant and anxious-ambivalent children revealed good fit for the 2-way association model, $G^2(1) = 1.74$, $p = .19$, and the model comparison between the independence model and the 2-way association model was statistically significant, $G^2(3) = 26.36$, $p < .05$, indicating that at least one of the 2-way association terms, but not the 3-way association term, was necessary.

Further analyses were conducted to compare the three 2-way association model, and the two 2-way association models (see Table 10). The model without λ_{ij}^{LO} or λ_{ik}^{LA} fit poorly ($G^2(2) = 15.90$, $p < .05$; and $G^2(2) = 13.89$, $p < .05$, respectively), suggesting that at least λ_{ij}^{LO} or λ_{ik}^{LA} are necessary for an adequate model.

The one 2-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO}$, had poor fit, $G^2(3) = 13.91$, $p < .05$, and the comparison to the superordinate two 2-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$, showed statistical significance, $G^2(1) = 12.17$, $p < .05$. Additionally, the other one 2-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ik}^{LA}$, had poor fit, $G^2(3) = 15.92$, $p < .05$, and the comparison to the superordinate two 2-way association model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$, showed statistical significance, $G^2(1) = 14.18$,

$p < .05$. This pattern of result indicates that the model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{LO} + \lambda_{ik}^{LA}$ [Anxious-Avoidant vs. Anxious-Ambivalent], is adequate for comparing anxious-avoidant and anxious-ambivalent attachment styles. Thus, the association between on-task and lateral self-touch is not moderated by attachment style for anxious-avoidant ($OR = 1.49$) and anxious-ambivalent ($OR = 2.33$) children.

In addition, because the model consisted of two 2-way association terms, a possible mediation effect (i.e., lateral self-touch mediates the association between attachment and on-task behavior) was explored. Again, the model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A + \lambda_{ij}^{AO}$, was compared against the independence model, $\log m_{ijk} = \mu + \lambda_i^L + \lambda_j^O + \lambda_k^A$. The comparison analysis revealed no statistical difference, $G^2(1) = .02$, $p = .89$, indicating that anxious-avoidant and anxious-ambivalent children did not differ in on-task behavior. Therefore, lateral self-touch cannot mediate the association between attachment and on-task behavior for the sample of anxious-avoidant and anxious-ambivalent because there is no association to mediate.

The adequate model shows, however, that the odds of exhibiting lateral self-touch are greater for anxious-ambivalent children than anxious-avoidant children ($OR = 1.34$), even when controlling for the effect of on-task behavior. Additionally, the odds of exhibiting lateral self-touch are greater during on-task than off-task ($OR = 1.79$) for the combination of anxious-avoidant and anxious-ambivalent children, even when controlling the effect of attachment style. The odds of being on-task, however, did not differ between anxious-avoidant and anxious-ambivalent children ($OR = .99$).

Posthoc analyses examining attachment style differences in the odds of lateral self-touch showed poor fit for the independence model when children are on-task, $G^2(1) = 13.75$, $p < .05$ (see Table 9 – the first rows in the anxious-avoidant attachment sub-table and the anxious-ambivalent sub-table), and good fit for the independence model when children are off-task, $G^2(1)$

= .14, p = .71 (see Table 9 – the second rows in the anxious-avoidant attachment sub-table and the anxious-ambivalent sub-table). The results indicate that the odds of exhibiting lateral self-touch are greater for anxious-ambivalent children (Odds = .16) than for anxious-ambivalent children (Odds = .11) when they are focusing on a task (OR = 1.38). In contrast, the odds of lateral self-touch do not differ for anxious-ambivalent (Odds = .07) and anxious-avoidant (Odds = .08) children when they are not focusing on a task (OR = .88).

Based on the results above, anxious-avoidant and anxious-ambivalent children are both more likely to exhibit lateral self-touch when they are focusing on a task than when they are not. However, this association is stronger for anxious-ambivalent children than for anxious-avoidant children.

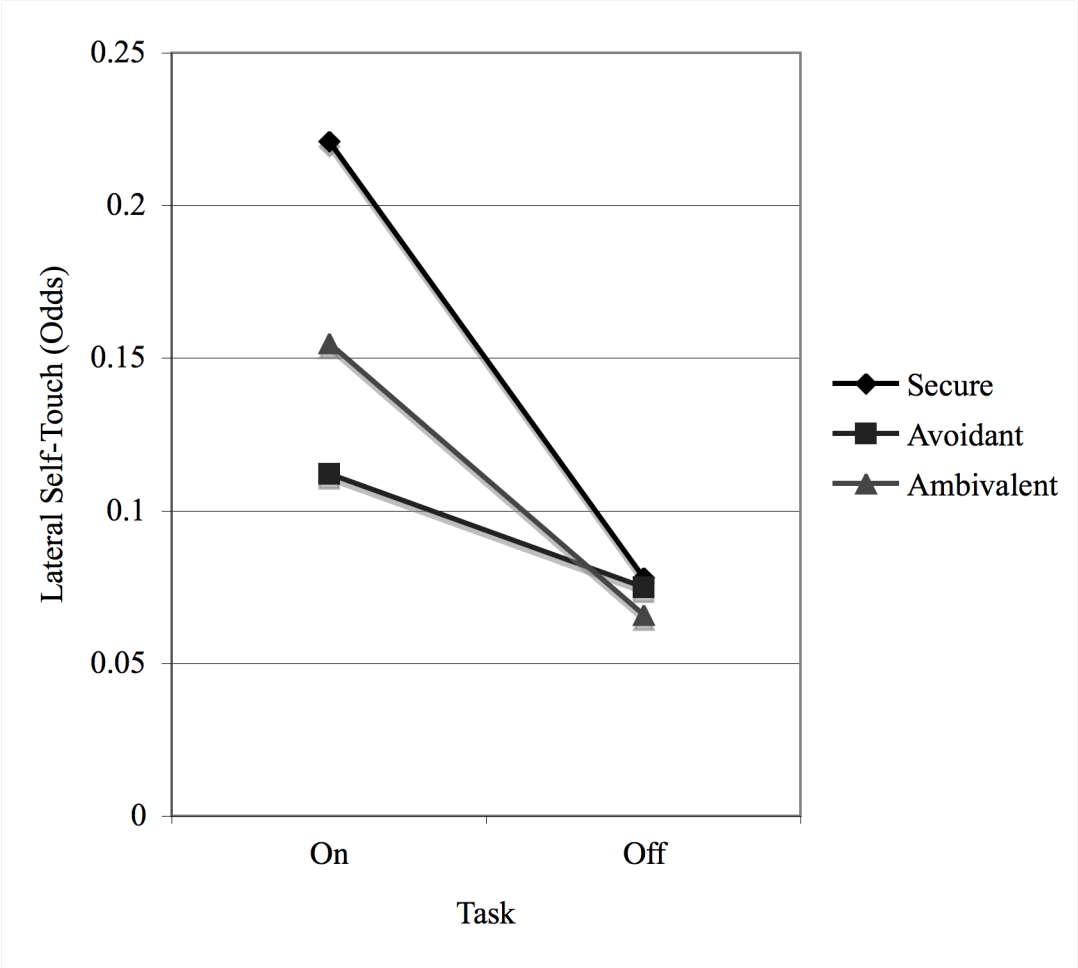

Figure 2. The Odds of Lateral Self-Touch During On-Task and Off-Task for Secure, Anxious-Avoidant, and Anxious-Ambivalent Children.

Hypotheses 4: Summary. The results regarding Hypothesis 4 revealed two statistically significant moderation effects, both when secure and anxious-avoidant children were compared. First, attention focus (i.e., on-task vs. off-task) has a stronger relationship with bilateral self-touch for anxious-avoidant children than for securely attached children. Particularly, as Figure 1 shows, anxious-avoidant children are *less* likely to engage in bilateral self-touch when they are *not* focusing on a task than when they are focusing on a task. In contrast, the likelihood of exhibiting bilateral self-touch does not vary between on-task and off-task for secure children.

Additionally, secure children are more likely to exhibit bilateral self-touch than anxious-avoidant children both when on-task and off-task although this difference is stronger when *off-task* than on-task.

Second, attention focus has a stronger association with lateral self-touch for securely attached children than anxious-avoidant children (see Figure 2). Both secure and anxious-avoidant children are more likely to exhibit lateral self-touch when they are focusing on a task than whey they are not. In addition, the likelihood of engaging in lateral self-touch does not differ between those two attachment classifications when they are *not* focusing on a task. However, when they are focusing on a task, secure children are more likely to exhibit lateral self-touch than anxious-avoidant children. Therefore, it is the difference when children are focusing on a task that creates the interaction in the likelihood of secure and anxious-avoidant children exhibiting lateral self-touch.

The results regarding Hypothesis 4 also revealed more refined results than Hypothesis 1, 2, and 3 (as well as previous studies) because the association between two variables was examined by taking the third variable taken into account in Hypothesis 4. Hypothesis 1a demonstrated that the odds of engaging in bilateral self-touch are greater when children are focusing on a task than when they are *not* focusing on a task. Hypothesis 4a, however, showed that this likelihood applies only to anxious-avoidant but not to secure children and anxious-ambivalent children. In terms of lateral self-touch, however, consistent with findings from Hypothesis 1b, the odds of exhibiting lateral self-touch are greater when on-task than off-task for children of all attachment classification (Hypothesis 4b).

Consistent with Hypothesis 2 and previous studies (Matas et al., 1978), the results regarding Hypothesis 4 showed that the odds of focusing on a task are greater for securely

attached children than anxious-avoidant or anxious-ambivalent children, even when controlling for the effect of bilateral or lateral self-touch.

The results regarding Hypothesis 3a revealed that the odds of exhibiting bilateral self-touch are greater for secure or anxious-ambivalent children than anxious-avoidant children. The findings are consistent even when on-task behavior is taken into account in Hypothesis 4a. The results regarding Hypothesis 3b showed that the odds of exhibiting lateral self-touch are greater for secure children than anxious-avoidant and anxious-ambivalent children. Hypothesis 4b revealed similar findings when task was taken into account. Specifically, the odds of exhibiting lateral self-touch are greater for secure children than anxious-ambivalent or anxious-avoidant children, and also greater for anxious-ambivalent children than anxious-avoidant children, when on-task behavior is taken into account.

Furthermore, in Hypothesis 4, post-hoc investigations of the data – differences in self-touch by on-task association for each attachment style, as well as pair-wise analyses of the three attachment classifications when being on-task or when off-task – were done for both bilateral self-touch and lateral self-touch. Regarding bilateral self-touch, anxious-avoidant, but not secure children and anxious-ambivalent children, are more likely to exhibit bilateral self-touch when being on task than when off task. Also, secure and anxious-ambivalent children are more likely to exhibit bilateral self-touch than anxious-avoidant children both when children are focusing on a task and when they are *not* focusing on a task.

In terms of lateral self-touch, children of *all* attachment styles are more likely to exhibit lateral self-touch when being on-task than when off-task. When children are *not* focusing on a task, children of all attachment styles exhibit lateral self-touch for similar proportions of time. When children are focusing on a task, however, secure children are more likely to exhibit lateral

self-touch than anxious-avoidant or anxious-ambivalent children, and anxious-ambivalent children are more likely to exhibit lateral self-touch than anxious-avoidant children.

Discussion

The primary objectives of the present study were to first (1) examine whether the association between self-touch and attention focus emerges by toddlerhood in the presence of a caregiver, then (2) investigate whether the likelihood of self-touch varies by attachment style in a situation requiring attention focus, and finally (3) examine whether the association between self-touch and attention focus varies by attachment style.

Self-Touch and Attention Focus: Developmental Aspect

The present study revealed that, toddlers are, in general, more likely to exhibit self-touch while they are focusing on a task than when they are not focusing on a task in the presence of their mothers. This finding is consistent with past research with preschoolers (Rögels et al, 1990) and adults (Barroso & Feld, 1986), who worked independently. The capacity for focused attention, which involves attention-regulation, gradually develops with the presence of and guidance by a caregiver during toddlerhood (Ruff & Rothbart, 1996; Sroufe, 1995). The present study showed that the higher likelihood of self-touch when focusing on a task than when not focusing on a task emerges by toddlerhood (18-30 months), at least when a caregiver is present.

The current study also demonstrated that toddlers are, in general, more likely to exhibit not only bilateral self-touch (i.e., both hands moving onto each other or on the body, simultaneously) but also lateral self-touch (i.e., one hand is moving on the other hand or on the body) when they are focusing on a task than when they are not. This finding is inconsistent with Barroso and colleagues' findings (1978 & 1980), which showed that bilateral self-touch, but not lateral self-touch, was related to attention focus for older children. In fact, the present study

showed that, for toddlers, the relation to attention focus is stronger for lateral self-touch than bilateral self-touch although the difference did not reach statistical significance. Additionally, overall, toddlers are more likely to exhibit lateral self-touch than bilateral self-touch. Thus, it appears that there is a developmental transition from a predominance of lateral self-touch in toddlerhood to a predominance of bilateral self-touch in childhood.

The first movements that infants exhibit are lateral (Cobb, Goodwin, & Saelens, 1966). Although infants and toddlers begin showing some bilateral movements, such as raising their arms and clasping their hands at the body midline (White, Castle, & Held, 1964), the development of bilateral motor coordination continues throughout childhood. Fagard (1990) found that even when infants start moving two hands at the same time, one hand touches an object first. Fagard, Morioka, and Wolff (1985) also showed that fine bilateral movements are first observed at 5 years of age. Even for adults, bilateral movements are slower than lateral movements (Wyke, 1971), suggesting that bilateral movements are a more sophisticated form of motor coordination than lateral movements. Therefore, the relation between attention focus and lateral self-touch may be stronger than bilateral self-touch for toddlers because bilateral coordination is still an emerging development. However, few studies have investigated distinctive relations of lateral and bilateral self-touch to attention focus (Barroso et al., 1978; Barroso et al, 1980). Thus, these relationships need to be further explored in different age groups in order to clarify the developmental trajectories.

Self-Touch and Attachment Style in a Situation Requiring Attention Focus

The only published study which investigated the relationship between self-touch and attachment style showed that anxious-avoidant children are more likely to exhibit self-touch than securely attached children when interacting with their mother (Koulomzin et al., 2002).

However, the present study revealed that securely attached children are more likely than anxious-avoidant children to engage in self-touch (both bilateral and lateral self-touch). This inconsistent finding can be explained by methodological differences between the two studies. First, these two studies differed in the age of the participants. In Koulomzin and colleagues' study (2002), participants were 4-month-old infants, whereas in the present study, participants were 26-month-old toddlers. Second, the studies varied in the context where children performed the task. In Koulomzin and colleagues' study, infants participated in a face-to-face interaction, where children interacted with their mother. In contrast, in the present study, toddlers participated in a reading task, which required them not only to interact with their mother but also to focus on a task. Thus, anxious-avoidant children in Koulomzin and colleagues' study might have exhibited self-touch because interactions with their mother, who tends not to be sensitive, produce emotional distress (De Wolff & van IJzendoorn, 1997; Smith & Pederson, 1988). On the other hand, self-touch (lateral self-touch) employed by securely attached children in the present study was associated with attention focus, which is further discussed in the next section. These studies suggest that the likelihood of self-touch may vary by attachment style, and furthermore, children with the same attachment style may exhibit self-touch more or less depending on the age as well as the context.

Similarly, in investigations of child-initiated touch toward a caregiver, the likelihood of touch exhibited by securely and insecurely attached children differs by age as well as by context (Clarke-Stewart & Hevey, 1981; Ainsworth et al., 1978). Specifically, during toddlerhood, child-initiated touch gradually declines for securely attached children but increases for insecurely attached children (Clarke-Stewart & Hevey, 1981). In addition, the frequency of child-initiated touch toward the mother differs significantly between secure children and anxious-avoidant children in a stressful situation, but not in a less stressful situation (Ainsworth et al., 1978).

These findings again suggest that contexts and age need to be taken into account when researchers investigate the likelihood of touch exhibited by children with different attachment styles.

Self-Touch and Attention Focus by Attachment Classification

Attachment classifications contributed to variations in both the association between bilateral self-touch and attention focus, as well as the association between lateral self-touch and attention focus.

Bilateral Self-Touch and Attention Focus by Attachment Classification. Anxious-avoidant children are *less* likely to exhibit bilateral self-touch when they are *not* focusing on a task than when they are focusing on a task. On the other hand, there is no difference in the likelihood of bilateral self-touch when focusing on a task and when not focusing on a task for securely attached children and anxious-ambivalent children. The pattern of the anxious-avoidant children's bilateral self-touch behavior is the same as that of older children in previous research (Barroso et al., 1978; Barroso et al., 1980). The data suggest that, only for anxious-avoidant children, bilateral self-touch may function either as a *manifestation* of the extent to which attention is focused or to *regulate* attention focus, as argued by Barroso and colleagues (1978).

However, closer observations of the children's behavior revealed that anxious-avoidant children are *less* likely to exhibit bilateral self-touch when they are not focusing on a task *because* they engage in behaviors that prevent them from exhibiting self-touch. More specifically, when they are not focusing on a task, anxious-avoidant children exhibit behaviors such as throwing away a book and trying to take a book away from their mother. In contrast, securely attached children and anxious-ambivalent children exhibit different types of off-task behaviors, such as talking about another task (e.g., crayon) or another event (e.g., visiting their

father), which allows them to exhibit self-touch. Thus, although anxious-avoidant children are *less* likely to exhibit bilateral self-touch when they are *not* focused, the pattern of this behavior does not necessary indicate that bilateral self-touch functions as a manifestation of the extent to which attention is focused or to regulate attention focus in toddlers. As discussed, lateral rather than bilateral self-touch may be related to attention focus in this period.

Lateral Self-Touch and Attention Focus by Attachment Classification. Children of all attachment classifications are more likely to exhibit lateral self-touch when they are focusing on a task than when they are not focusing on a task. The association between lateral self-touch and attention focus is, however, stronger for securely attached children than for children with either insecure attachment style (i.e., anxious-ambivalent or anxious-avoidant).

There are two possible reasons why securely attached children are more likely to engage in lateral self-touch when they are focusing on a task than children with insecure attachment styles. First, as Barroso and colleagues (1978) discussed in terms of the relationship between self-touch in general and attention focus, lateral self-touch may be a *manifestation* of the extent to which children's attention is focused. According to this hypothesis, securely attached children are more likely to exhibit lateral self-touch than anxious-ambivalent or anxious-avoidant children because they are focusing on a task more than the other two groups. Second, as Barroso and his colleagues (1978) argued as an alternative explanation, lateral self-touch may function to *self-regulate* attention. Thus, one reason why securely attached children are more likely to focus attention may be because they use lateral self-touch to regulate attention.

Because of the observational nature of the current study, we cannot conclude whether lateral self-touch functions merely as a manifestation of the extent to which attention is focused, or if, in fact, it functions as a self-regulation tool to focus attention. However, the strong association between lateral self-touch and attention focus for securely attached children suggests

that, at a minimum, children's self-touch is an indicator of secure attachment as well as a higher capacity of attention focus in certain environments; environments such as learning contexts, where focused attention is required. This finding is particularly important because self-touch is generally perceived negatively because of its association to emotional distress (e.g., Remland, 2008).

The present study suggests that a secure attachment relationship and an insecure attachment relationship create different types of context, and accordingly children may experience anxiety from different sources. A secure attachment relationship creates a safe environment for children, produces little anxiety, and allows them to engage in learning activities (Schore, 2000). However, securely attached children may still experience task-related anxiety from trying to focus attention on a challenging activity. Because anxiety influences attention focus (Das, Naglieri, & Kirby, 1994), in that a moderate level of anxiety is optimal for attention performance (Easterbrook, 1959), securely attached children may exhibit self-touch either as a manifestation of anxiety level or in order to regulate anxiety.

On the other hand, an insecure attachment relationship fails to create a safe environment for children, produces high anxiety, and prevents them from engaging in learning activities (Schore, 2000). Consequently, because these children are not fully focusing attention on an activity, they may experience less anxiety *due to the activity*. Thus, insecurely attached children may be less likely to exhibit self-touch in a learning context.

If self-touch functions as a self-regulation tool, an important question for future research is *how* securely attached children, in contrast to insecurely attached children, develop the ability to engage in self-touch in order to focus attention. A secure relationship with a caregiver may create the context for development of self-touch in relation to attention focus by multiple mechanisms. First, securely attached children may experience the effect of touch on attention

focus through their caregiver's touch. Adults' touch has been found to promote attention focus and performance in a problem-solving task of children (Clements & Tracy, 1977). Because mothers of securely attached children tend to be more sensitive with their children than mothers of insecurely attached children during infancy (De Wolff & van IJzendoorn, 1997; Smith & Pederson, 1988), mothers of securely attached children may touch their child more when their children have difficulty focusing on a task. Additionally, mothers' unaffectionate touch and aversion to touch with their child predicted child's attachment insecurity (Ainsworth et al., 1978), suggesting that securely attached children are, in general, more experienced than insecurely attached children to receive touch from their caregivers. Therefore, it is possible that, through touch by their caregivers, securely attached children learn to engage in self-touch when attention focus is required.

Second, securely attached children may learn the relation between self-touch and attention focus by observing their caregivers. Children can acquire behavior through the observing of and *modeling* of other individuals (Schunk, 2001), and adults are also more likely to engage in self-touch when they focus attention than when they do not (Barroso & Feld, 1986). Although no published studies have examined whether caregivers of securely attached children tend to exhibit more self-touch than those of insecurely attached children during attention focus, other studies suggest that this may be the case. First, there is a strong relationship between child attachment style and their parent attachment style (van IJzendoorn, 1995), indicating that parents of securely attached children also tend to be securely attached, whereas parents of insecurely attached children tend to be insecurely attached. Second, securely attached adults display a greater ability to self-regulate than insecurely attached adults (Bouthillier, Julien, Dubé, Bélanger, & Hamelin, 2002; Kobak, Cole, Ferenz-Gillies, Fleming, & Gamble, 1993). These findings suggest that caregivers of securely attached children may exhibit more self-touch than

those of insecurely attached children during attention focus. Therefore, securely attached children may learn the relation between self-touch and attention focus by observing their caregivers.

Third, securely attached children may learn self-touch as related to attention focus by experiencing themselves that they are better able to focus attention when they engage in self-touch. In other words, self-touch may be reinforced by successful attention focus, and consequently children may exhibit self-touch when attention focus is required. Because securely attached children have caregivers who are sensitive to their needs, they can use their caregiver as a secure base and are better able to develop autonomy than insecurely attached children (Cassidy, 1994). Consequently, by toddlerhood, securely attached children may be able to engage in self-touch behavior, which then leads to their own learning of its connection to attention focus.

Limitations and Future Research

One limitation of the present study is that attention focus and self-touch behaviors were observed only during toddlerhood. Future research should examine different age groups, particularly in order to explore the development of lateral and bilateral self-touch in relation to attention focus. The present study found that, although the difference was not statistically significant, lateral self-touch has a stronger relation to attention focus than bilateral self-touch for toddlers, a finding that is contrary to past studies with older children (Barroso et al., 1978, Barroso et al, 1980). As discussed above, these differences may be derived from the developmental transition in motor coordination during childhood, changing from a predominance of lateral movement in toddlerhood to bilateral movement in childhood. Future research should,

therefore, examine preschoolers in order to clarify developmental trajectories, in which laterality of self-touch changes in relation to attention focus and age.

Another limitation of this study is that the behavioral observations were limited to children. As discussed in the previous section, self-touch behavior of not only children but also mothers both in infancy and toddlerhood should be examined. Development of self-regulation has, for example, been studied in relation to mother-child affect synchrony (e.g., Feldman, Greenbaum, & Yirmiya, 1999). The close investigation of the mother-child interaction may help us clarify how securely attached toddlers, more than insecurely attached toddlers, develop to engage in self-touch when attention focus is required.

Finally, future research should investigate whether self-touch is merely a manifestation of the extent to which attention is focused, or self-touch functions as regulating attention. Because of the observational nature of the present study, we cannot conclude which function self-touch has from the present data. Future research should investigate these mechanisms using controlled experiments. For instance, future researchers may employ an intervention to train children to engage in self-touch in a learning context.

Footnotes

[1] Generalized Estimating Equations (GEE) were first considered for analyzing the current categorical data set. GEE are appropriate when observations within a category are correlated (Liang & Zeger, 1986). In the current data set, observations on self-touch form a time series over the duration of the observation period, which raises the possibility of autocorrelation. So, at first glance, it would appear that GEE should be used with the current data. However, further reflection suggests that this approach would be counterproductive, since one of the contextual variables, attention focus (i.e., on-task behavior), has such a strong temporal structure. In any autoregressive scheme, such as that used by GEE, the previous time point acts essentially as a covariate. However, since on-task behavior is so strongly temporal, the ultimate effect would be to covary out the effect of not only time, but also the effect of being on- or off-task. GEE would be suitable if the only contextual variable was attachment style, which is not temporally structured, or if there were another contextual variable unrelated to time. As it stands, we are forced to use the standard log-linear model to gauge the effects of attachment style and task focus on self-touch, an approach which violates the assumption of independent observations in the data.

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VITA

Personal Background	Sachiyo Ito-Jäger Kuwana, Mie, Japan Daughter of Kanemitsu and Mitsuko Ito Married Nils Jäger, August 7, 2010
Education	Diploma, Kuwana High School, Kuwana, Mie, 1996 Bachelor of Arts, Psychology, Whitworth University, Spokane, Washington, 2001 Master of Arts, Cognitive & Social Psychology, Ball State University, Muncie, Indiana, 2006
Experience	Statistical Consultant, Center for Academic Services, Texas Christian University, 2009-present Graduate Teaching Assistantship, Department of Psychology, Texas Christian University, 2006-present Graduate Research Assistantship, Department of Psychological Sciences, Ball State University, 2003-2005
Professional Memberships	Society for Research in Human Development American Psychological Associations Phi Kappa Phi, National Honor Society for Academic Excellence Psi Chi

ABSTRACT

ATTENTION FOCUS AND SELF-TOUCH IN TODDLERS:
THE MODERATING EFFECT OF ATTACHMENT SECURITY

By Sachiyo Ito-Jäger, Ph.D., 2011
Department of Psychology
Texas Christian University

Dissertation Advisor: David R. Cross, Professor of Psychology

Although touch is an important component of attachment theory, most of the existing studies have focused on its extrinsic forms (i.e., being touched by a caregiver, and touching a caregiver) and neglected its intrinsic form (i.e., self-touch). The primary objectives of the present study were to first (1) examine whether the association between self-touch and attention focus emerges by toddlerhood in the presence of a caregiver, then (2) investigate whether the likelihood of self-touch varies by attachment style in a situation requiring attention focus, and finally (3) examine whether the association between self-touch and attention focus varies by attachment style. Data from forty-nine mother-child dyads were employed for analyses. The attachment classification of the children was determined using the Strange Situation. The instance of attention focus and self-touch behavior during a challenging task were coded by second. First, self-touch as related to attention focus was found to emerge by toddlerhood. Second, securely attached children were found to be more likely than insecurely attached children to exhibit self-touch in a situation requiring attention focus. Third, an association between lateral self-touch and attention focus was found for children of all attachment classifications. This association was particularly strong for securely attached children, who also displayed higher levels of attention focus. The present study found that self-touch is associated with attention focus during toddlerhood, and that this association is strongest for the toddlers who were securely attached as infants.