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Psychological Effects of Actual and Simulated Affectionate Touch

Mandy Tjew-A-Sin

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Chapter 1.

General Introduction

While writing this dissertation, I received a call from a journalist. She had just interviewed someone who provides "cuddle therapy" and wanted my scientific take on it. From a quick search, I learned that cuddle therapy is a novel service that blew over from the United States and Australia, and has been popping up all over Europe. In traditional psychotherapy, the therapist and client only talk to each other, and have no physical contact. This is different in cuddle therapy, where the—often self-proclaimed—therapist gently touches, hugs and caresses the client throughout the therapeutic session. According to the cuddle therapist, her clientele is diverse, and includes lonely elderly, people with a visible disability, deformity or birthmark, as well as young autistic men who wanted to practice touching other people.

People, it seems, spend a considerable amount of time, money, and effort in order to receive caring, affectionate touch form another human being. Affectionate touch can be defined as any form of direct physical contact between people that conveys affection (e.g., love, care, appreciation; Floyd, 2006). These behaviors are commonly be found in close relationships (i.e., child-parent, romantic): hugging, petting, stroking, and caressing. The success of cuddle therapy suggests that affectionate touch is valuable to people, valuable enough to seek out in the form of momentary encounters with strangers. What is special about this type of touch? And do some people desire it more than others? These questions do not appear to be trivial, and answering them will likely tell us more about how people use their body to influence their emotions. Such insights may be especially useful to people now that digitalization and technological advancements are changing how and whether people can access human touch.

This dissertation is about the psychological effects of affectionate touch, and about whether people can simulate touch experiences. How do both types of touch affect people's social, cognitive, and emotional functioning? Can simulated affectionate touch can be an alternative for people who are more apprehensive about touch from other people?

To understand discuss how affectionate touch affects people, and how touch may be simulated, I discuss three major landmarks in psychological theories about affectionate touch. These are: Bowlby's attachment theory, which first acknowledged the importance of physical contact, modern theoretical perspectives on embodied cognition, which gave the body a central role in cognition, and novel work from the social-cognitive and affective neuroscience that further cements the significance of affectionate touch for human well-being.

Attachment Theory

Attachment theory (Bowlby, 1969, 1973b, 1980) was developed by British psychiatrist John Bowlby, one of the first people to explicitly recognize the significance of affectionate touch, which fosters a sense of safety and security in young infants. Bowlby started developing his ideas in the 1930s, working as a psychiatrist in a Child Guidance Clinic in London, where he treated emotionally disturbed children. Bowlby saw that children were highly distressed when separated from their mother, even when they were in fed and comfortable. This observation discounted the then-dominant behaviorist theory (Dollard & Miller, 1950) which stated that a child becomes attached to its mother merely because she provided food. In contrast, Bowlby came to believe that early separation from the mother caused emotional disturbances in children. He concluded that the relationship with the mother had been overlooked as the basis for the child's social, emotional and cognitive development.

Around the same time, Mary Ainsworth was finishing her graduate degree on children's need for security before exploring unfamiliar situations. In 1950, Ainsworth took a position in Bowlby's research unit, and eventually co-founded attachment theory together with Bowlby. Through her elaborate observational studies of mother-infant interactions in Uganda and Baltimore, she provided the initial empirical evidence for attachment theory (Ainsworth, 1967, 1979; Ainsworth, Bell, & Stayton, 1972). In her studies, Ainsworth found that there were differences in how a child attached to its mother—reflecting three main "attachment styles"—and developed a method to discern them (Ainsworth, Blehar, Waters, & Wall, 1978) .

The method was the "Strange Situation Procedure": In the span of 21 minutes, this procedure exposed the child to different situations involving caregivers and strangers, which varied in how stressful they were. Some infants were visibly distressed when their caregiver left, but easily soothed upon their return, as their caregiver was sensitive to the child's needs. These children were considered secure in their attachment; they are confident that their caregiver will be available to meet their needs, and thus assuredly explore their environment, including interacting with strangers (Main & Solomon, 1990).

Other infants were highly distressed when their caregiver left, and difficult to sooth upon their return. Furthermore, these infants were highly fearful of strangers and spent little time exploring. These children were considered "anxious-resistant", a form of insecure

attachment. A last group of infants did not seem distressed when left by their caregiver, nor when a stranger approached them. In fact, they showed little interest in their caregiver's return and allowed comforting from caregiver and stranger alike. These children were believed to have an "avoidant" insecure attachment. A fourth attachment style, "disorganized", was added later on to describe children who showed odd, contradictory behavior toward their caregiver; this attachment pattern resulted from confusing and unpredictable caregiving from a traumatized parent (Main & Solomon, 1990).

Bowlby's attachment theory proposed an evolutionary framework to understand attachment. Over the course of evolutionary history, attachment to at least one primary caregiver greatly increased an infant's chance of survival. Therefore, infants go to extraordinary lengths (e.g., crying, clinging, frantically searching) to prevent separation from their caregiver. This highly coordinated effort of multiple instinctive systems had one goal: To maintain proximity to someone who could provide safety and care. Proximity to the caregiver is found most directly in the form of close physical contact, which most clearly signals to the infant that they are safe and secure (Ainsworth, 1979). From this evolutionary view-point, the quality of physical contact a that a child receives is central to its survival (Ainsworth et al., 1978; Bowlby, 1973b).

Bowlby's work had the important consequence of moving psychologists away from the "medical model" of child-rearing, an approach that was only focused on meeting the child's immediate needs for food and shelter, while overlooking an equally pressing but less obvious human need: physical touch. The medical model was applied in hundreds of Romanian orphanages, where orphaned children—who were fed and clothed—went hungry for something they did not know to ask for. In the understaffed but overpopulated orphanages, children were given the bare minimum of human interaction—with devastating results: Half the children died within the first 24 months after arriving at the orphanage, while children that survived had stunted growth, a low weight, impaired language ability, underdeveloped motor behavior, and a diminished intellect (Carlson & Earls, 1997). Desperate for any social interaction, the children tried to seek affection from anyone they met, including complete strangers. Many children were eventually adopted, but continued to experience serious social and emotional problems, including lashing out and harming others (Field, 2002). Despite years of nurturance and support in adoptive families, many children who missed out on caring touch at an early young age developed mental health disorders as teenagers or adults (Sonuga-Barke et al., 2017). The bleak fate of

thousands of Romanian orphans called much-needed attention to the vital importance of early nurturance and affection for health and well-being.

In the late 1980s, Cindy Hazan and Phillip Shaver applied attachment theory to adult relationships, expanding the influence of infant attachment to include its effects on adult romantic relationships (Hazan & Shaver, 1987). Although crucial in an obvious way to young children in their formative years, affectionate touch and care do not become less of a need in adulthood. Regular recipients of affectionate touch within adult close relationships have better relational, psychological, and physical well-being (Debrot, Schoebi, Perrez, & Horn, 2013; Jakubiak & Feeney, 2017). By emphasizing that affection and security are the foundation upon which healthy adult relationships are built, the beneficial effects of affectionate touch in later years are easily derived from the framework of attachment theory.

Attachment theory posits that early interactions with caregivers—specifically how responsive and available they were—lead people to develop "internal working models", which are internalized models of the world that guide the person's beliefs, expectations, and perceptions. The "model of others" informs the person whether others can generally be relied on for affection and care, while the "model of self" answers the question: "Am I *worthy* of love and support?" These working models are reflected in the four-prototype model of attachment in Figure 1., which conceptualizes individual differences in attachment based on Bowlby's (1969) proposal that two dimensions underlie internal working models: positivity of self-views and of views of others (Bartholomew & Horowitz, 1991).

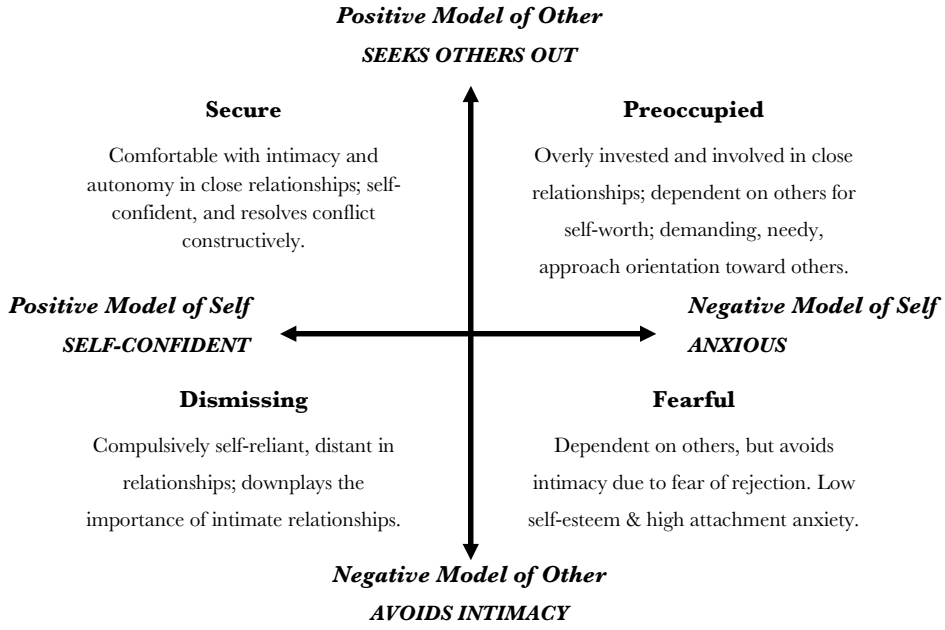


Figure 1. Bartholomew's Four-Prototype Model of Attachment

Among adults, attachment style has been associated with preferences and desire affectionate touch. Securely attached, and anxious-preoccupied individuals prefer the greatest frequencies of affectionate touch in their close relationships, while individuals with an avoidant attachment "dismissing" and "fearful" attachment types—prefer not to engage in touch, even though "fearful" individuals express a strong desire for it. Furthermore, the dismissing" type prefers to maintain relational distance, so they may even interpret touch as intrusive, overbearing, and uncomfortable (e.g., Mikulincer & Shaver, 2003; J. A. Simpson, 2007).

Not everyone is able to receive affectionate touch through their relationships (for reviews, see Mikulincer & Shaver, 2007a, 2012). Touch deprivation or an unfulfilled need for affectionate touch may undermine health and well-being (Jakubiak & Feeney, 2017; Mikulincer & Shaver, 2007b). Are there alternative ways for which touch-deprived people to attain some of the benefits of affectionate touch?

Increasing evidence suggests that people can use soft objects not only to comfort themselves, but also to feel more certain in the face of ambiguity and more included by others. when facing exclusion Among adults, touching a teddy bear reduced the impact of

social exclusion, while merely looking at a teddy bear did not provide any comfort (Tai, Zheng, & Narayanan, 2011). Touching soft (versus hard) objects has been shown to reduce uncertainty (Van Horen & Mussweiler, 2014). Lastly, blind-folded participants who received soft slow brush-strokes on the arm experienced reduced distress following social exclusion, while fast brush-strokes did not provide comfort (von Mohr, Kirsch, & Fotopoulou, 2017).

A possible explanation for the soothing effects of softness is provided by Bowlby's contemporary: Donald Winnicott. In the 1950s and 1960s, Winnicott was, much like Bowlby, developing influential ideas about how to promote psychological growth and well-being of children. His ideas, however, were based on a psychoanalytical perspective (Winnicott, 1951). He famously introduced the concept of the "transitional object", which is the first self-chosen object—often a blanket, teddy bear, pacifier, or doll—to which the child becomes highly attached. Winnicott believed that children relied on such objects only partly for its sensorial qualities—soft comforting sensations lessened the stress of being left alone—and mostly to symbolically "reunite" with their mother; attachments to objects are thus the result of a "spill-over" of the attachment to the mother (Mahler, 1975). Transitional objects have tremendous value for a child; they provide relief from stress that the child can control and therefore rely on. The object, however, remains based on a symbolic extension of the mother, and the child will be distressed when the object is missing.

Transitional objects appear to be a unique phenomenon of developed countries where early independence and separation from the parents is valued and encouraged (Gaddini, 1970; Hobara, 2003; Hong & Townes, 1976). In support of this idea, a recent investigation found that children who spent full days in center-based childcare at the age of 3 were more likely to develop attachments to inanimate objects compared to children who spent only half-days in daycare (Fortuna, Baor, Israel, Abadi, & Knafo, 2014).

The use of transitional objects has been explored in experimental settings, where security-providing objects were compared to the security provided by the mother. Passman and Weisberg (1975) found that security blankets were as effective as the child's mother in inhibiting distress and promoting play and exploration in a novel situation; merely familiar objects had no effect. These findings support Winnicot's idea that the transitional object functions much like an extended "safe base" based on the security provided by the mother.

Summary

Taken together, Bowlby's attachment theory provided an influential theoretical account for understanding why physical contact provided by the caregiver is crucial for child well-being. Furthermore, Cindy Hazan and Phillip Shaver's application of attachment theory to adult romantic relationships opened up avenues for studying affectionate touch in relation to differences in adult attachment. One possible explanation for the soothing effects of soft objects is based on Winnicott's notion that they may function as a low-level extension of the security provided by the primary caregiver. This does not explain, however, why people can feel more certain and more included by others after touching soft objects. An explanation that accounts for touch effects that go beyond mere soothing can be found in the movement within social psychology that focuses on embodied cognition.

Theories of Embodied Social Cognition

In the 1990s, a novel theoretical idea gained traction in philosophy, robotics, linguistics, and many other areas that dealt with (human) cognition (Lawrence W Barsalou, 1999; Brooks, 1991; Clark, 1998; Arthur M Glenberg & Robertson, 2000; Lakoff & Johnson, 1980; L. M. Parsons et al., 1995; E. R. Smith & Semin, 2007; Zwaan, Madden, Yaxley, & Aveyard, 2004). The field of psychology was no exception. The theoretical notion of *embodiment* implied that cognition is shaped by the body of an organism—and cannot be interpreted without it.

Within psychology, embodiment theories signaled a departure from traditional theories in their core assumptions about knowledge representation. Until that point, nearly all accounts of how people experience the world—and save these experiences—were based on abstract concepts, such as feature lists and semantic networks. Using such concepts to explain emotion and cognition is an "amodal" approach. This implies no similarity between the experience of the person and the "form" in which it is saved. When we see a car, neurons in the brain fire to produce a perceptual representation of a car, which is recognized as such only because features like the wheels and engine are recognized as attributes. In contrast, a "modal" approach suggests that a concept such as a car is based on perceptual representations that become stored during perception and action, and can be

reenacted in absence of the stimuli (the car) that originally produced it. Support for both approaches has been discussed in the literature (Dove, 2009).

In psychology, modern theories of embodied cognition represent knowledge as partial simulations of sensory, motor, and introspective states (Simmons & Barsalou, 2003). Whenever a person experiences an event for the first time, the underlying sensory, motor, and introspective states are partially stored. When knowledge of the event becomes relevant through memory, language, or thought, these original states are partially simulated in modality-specific systems. These systems include the sensory systems that underlie perception (e.g., vision, hearing, touch); the motor cortices (i.e., internal representations of bodily states); including the "mirror neuron system" (Gallese & Goldman, 1998; Rizzolatti, 2005), and introspective systems that underlie conscious experiences of emotion, motivation, and cognition.

Theories of embodied cognition also made the central claim that all cognition, including high-level conceptual processes, rely heavily on grounding in either the modalities or the body (Wilson, 2002). The explanation for this reliance varies: Some suggest that people's higher mental processes developed by reusing evolutionarily older programs (Anderson, 2010); others believe that early experiences in infancy helps people structure and understand more abstract or complex concepts at later ages. The latter is called scaffolding (Williams, Huang, & Bargh, 2009).

Embodiment theories provide a new way of thinking about the effects of affectionate behavior. Attachment theory suggests that physical contact between people — hugging, kissing, petting—are attachment behaviors guided by internalized models of responsivity and care provided by the caregiver (Bowlby, 1969, 1973b, 1980). From an embodied perspective, the early experiences of love, care, and safety encode neural links in the brain, which become partially reactivated whenever an aspect of those experiences is provided. For instance, when a child is tenderly embraced by her mother, any aspect of the sensorial experience—the soft sensations on the skin, the smell of the mother's hair, even the ticklish sensation of a strand of hair on the cheek—may trigger partial reactivation of the neural states caused by the embrace. Furthermore, an embodied approach to affectionate touch proposes that talking, and thinking about affection, close others, etc., may reactivate parts of the neural states that occurred when a specific affectionate touch was first experienced (Niedenthal, 2007).

In a recent study, researchers asked participants to imagine receiving supportive touch from their romantic partner, or supportive words. Those who thought about receiving touch were better able to withstand stressful events that followed (Jakubiak & Feeney, 2016a). In another study by the same group, participants who imagined receiving touch from their partner during a conflict felt more secure and closer to their partner compared to participants asked to imagine only the room where the conflict took place. These studies strongly suggest that mental simulations of receiving affectionate touch or support can at least partially lead to results similar to actual affectionate touch experiences.

However, not everyone has the kind of a childhood whereby soft sensations and affection become closely linked. For instance, Ainsworth (1979) reported that mothers of avoidant babies did not enjoy close bodily contact; as a result, they did not provide their children with close physical contact that would allow secure attachment. We can therefore expect the effect of sensations that are closely associated with affectionate experiences—soft, warm, comfortable sensations—vary by individual differences in attachment style. In other words: One's early experiences with caregivers are crucial for the appreciation of affectionate touch later in life.

That attachment style affects responses to simulations of touch is supported by a study that tested whether warm sensations could increase people's desire to affiliate. The researchers found that attachment style moderated the effect: only people low in avoidance or high in anxiety became more ready to connect (Fay & Maner, 2012). Also, in a study that investigated whether imagining affectionate touch from a partner increased attachment security, the effects were found only among those low in avoidant attachment (Jakubiak & Feeney, 2016b)

Does this mean that the benefits of affectionate touch are unattainable for those with an insecure attachment? People generally experience at least some form of love, care, and security, even if their initial attachment was not a secure one. Oddly enough, simulations of affectionate touch may not only be possible, but in some cases also more preferable for those who received less affection from close others.

Though embodied simulation may never compare to the richness of actual (physical) contact with another person, it offers certain advantages. In particular, embodied simulations remove any threat of potential rejection. Thus, people with a deep-seated fear of rejection or an unfulfilled desire for affection and closeness may prefer a simulation route to emotional comfort. Much like children who attach to an object to control their access to

security, people can use an embodied simulation to experience touch in a form that they can control; they could focus only on evoking pleasant and enjoyable experiences of interpersonal touch (Collins & Feeney, 2000). Mental simulations of receiving touch are also more helpful than receiving actual support when people get to simulate a touch experience that is most suited to their specific needs without having to feel self-conscious or uncomfortable (Bolger & Amarel, 2007; Jakubiak & Feeney, 2016a).

Summary

Modern theories of embodied cognition challenge traditional psychological theories that hold an amodal view of how knowledge is stored. By doing so, they opened up new avenues of research about how sensory-motor experiences and internal states are stored, and retrieved using embodied simulations. According to these theories, contact with sensory information or reminders of loved ones—both purposefully sought out and accidentally experienced—allows people to experience an embodied simulation closeness. Individual differences in attachment style may determine whether people can and are motivated to engage in such simulations. Theories that take into account all the different factors that can contribute to the outcome of touch can be found in neurobiology.

Neurobiological Theories of Affectionate Touch

It is clear by now that touch does more than provide sensory input to navigate one's surroundings, or to communicate comfort, sympathy, and support. But why does a person's touch have a unique soothing effect (Fairhurst, Löken, & Grossmann, 2014; Feldman, Singer, & Zagoory, 2010)? Why is touch uniquely pleasurable, depending on the softness (Ackerley et al., 2014; Essick et al., 2010; Rolls et al., 2003), temperature, force and velocity of the touch? And how can touch from another person remove physical and social pain (Coan, Schaefer, & Davidson, 2006; Mancini, Beaumont, Hu, Haggard, & Iannetti, 2015; Mancini, Nash, Iannetti, & Haggard, 2014)?

Recent breakthroughs in neurobiology provide new answers to many questions related to touch and deepen our understanding of its effects. A number of specialized physiological and neurobiological systems appear to mediate the effects of affectionate physical touch (Dölen, Darvishzadeh, Huang, & Malenka, 2013; Gordon et al., 2013; Walker & McGlone, 2013). Humans are hard-wired to detect and process touch from others; the hairy parts of the human skin has nerve receptors—called C tactile afferents—that respond specifically to slow stroking sensation (Ackerley et al., 2014; Walker & McGlone, 2013). C-tactile afferents are believed to take a sensory pathway that leads from the skin to the thalamus, which is the "air traffic controller" that sends incoming sensory information to the correct cerebral cortex (Andrew, 2010).

From there, touch signals are spread to sensory processing areas in the brain such as the insular and primary and secondary somatosensory areas (Björnsdotter, Löken, Olausson, Vallbo, & Wessberg, 2009; Gazzola et al., 2012; Francis McGlone et al., 2002). The pleasurable and rewarding sensations of affectionate touch are due to the activation of higher-order areas of the brain that process social and emotional information, and rewards. Subcortical areas that process affect and motivation, such as ventral striatum and amygdala, are also believed to be involved (Ellingsen et al., 2013; Perini & Olausson, 2015).

Before touch is consciously experienced by a person, higher-order brain areas process and modulate the original signals from the skin-receptors based on beliefs and expectations of all previous touch experiences (Kersten, Mamassian, & Yuille, 2004; Schmack et al., 2013). This takes into account current mood and motivation, perceived importance, relevance of the touch as well as the person doing the touching (Macaluso & Driver, 2001; Taylor-Clarke, Kennett, & Haggard, 2002), internal motivational state or

mood (Montoya & Sitges, 2006; Triscoli, Ackerley, & Sailer, 2014). All this happens within the split of a second.

The slow stroking that activates C-afferent skin receptors also stimulates release of the neuropeptide oxytocin. Oxytocin is known to play a central role in social affiliation and attachment in mammals (Feldman, 2012; Tops, Van Peer, Korf, Wijers, & Tucker, 2007). First-time fathers who touched their children in a supportive way had higher levels of oxytocin in their blood; the same was found among first-time mothers who touched her children affectionately (Gordon, Zagoory-Sharon, Leckman, & Feldman, 2010). Some

An intervention study assigned couples to a 4-week warm touch enhancement intervention—with daily practice of touch and massage on their partner's neck, shoulders, and hands—or to a control condition. Participants in the touch group had increased levels of oxytocin in their saliva, as well as lowered blood pressure, and cortisol levels compared to the control group (Holt-Lunstad, Birmingham, & Light, 2008).

Some researchers, however, question the validity and results of blood-based oxytocin measures (Christensen, Shiyanov, Estepp, & Schlager, 2014; McCullough, Churchland, & Mendez, 2013).

From a biological perspective, touch can be viewed as a necessary form of stimulation (Thayer, 1986) that does not lose its importance throughout life. However, in contrast to the well-established importance of nurturing touch for infant well-being, the significance of touch among adults remains largely unexplored. The discovery of the c-afferent receptors is a breakthrough that suggests that slow-moving touch has been essential for human survival (Olausson, Wessberg, Morrison, McGlone, & Vallbo, 2010). The social touch hypothesis posits that social, affective touch belongs to a distinct category of tactile experience, which has evolved in mammals to encourage physical contact in nurturing and social interactions. It is no coincidence that the speed of stroking that optimally activates C-tactile afferents is also the speed that people experience as most pleasant. In other words, nurturing touch is important not just for infant survival but for all bonding of human beings (Morrison, Björnsdotter, & Olausson, 2011).

In a recent review, Jakubiak and Feeney (2017) laid out a theoretical mechanistic model to explain why and how affectionate touch in adult close relationships may promote and long-term beneficial outcomes in three domains of well-being. These included relational well-being, which reflects relationship satisfaction and commitment, psychological well-being, which includes positive mood, and a lack of psychological distress, and physical

well-being, such as the absence of illness, and other indicators of physical functioning (B. C. Feeney & Collins, 2015). The Jakubiak-Feeney model is focused primarily on the benefits of receiving affectionate touch from a close other (e.g., romantic partner, best friend), but also describes beneficial effects of touch from strangers as well as touching soft material.

Jakubiak and Feeney focus on two immediate outcomes of affectionate touch receipt—relational-cognitive changes and neurobiological changes— as important mechanisms underlying the effects of affectionate touch on well-being. They highlight several mechanisms, such as stress-buffering effects, relational-cognitive increases in sense of inclusion and security, and direct neurobiological effects.

One broad mechanism that improves well-being is based on the stress-buffering hypothesis, which states that affectionate touch may promote health by both mitigating stress' negative impact on health and by promoting well-being independent of stress.

In one illustrative example of this mechanism, researchers recruited 16 married couples, and placed the women placed in an fMRI machine. They were told that they would receive electric shocks on their ankle; brain imaging showed that the women had threat-related responses in the right anterior insula, superior frontal gyrus, and hypothalamus. Then the men were allowed to hold the hand of their partner. All the threat-related activity decreased. The handholding was especially effective when the couple was more satisfied with their marriage. Holding the hand of a stranger also attenuated the neural threat response, but the effect was more limited (Coan et al., 2006).

In another study involving among couples, researchers used EEG to measure the synchronicity of brainwave activity while the couples were sitting together without touching, sitting together holding hands, and sitting in separate rooms (Goldstein, Weissman-Fogel, Dumas, & Shamay-Tsoory, 2018). Then the researchers repeated the measurements during these scenarios, but now subjected the woman to mild heat pain on her arm. The researchers found that sitting together while the woman was in pain led to brain wave synchronicity in the alpha mu band, a wavelength associated with focused attention. When the couple held hands, the brain synchrony was maximized. However, if the woman was in pain and her partner could not touch or be with her, the coupling of their brain waves diminished. The coupling of heart rate and respiration was similarly diminished when the man could not support his partner via touch (Goldstein, Weissman-Fogel, & Shamay-Tsoory, 2017).

Receiving affectionate touch from a partner has also been shown to speed recovery after a stressor has occurred (Robinson, Hoplock, & Cameron, 2015)

As a powerful indicator of physical and emotional closeness to another person, affectionate touch may generally convey a message of closeness and social inclusion (Ben-Ari & Lavee, 2007). Receiving affectionate touch also increases the salience of social inclusion more broadly, as memories of inclusion will become more accessible (e.g., Singer & Salovey, 1988). It may also increase feelings of security in adults.

Recently, guided visualizations of receiving touch from close others have been effective in increasing security as measured by an increase the accessibility of security-related words (e.g., calm, supported) compared to individuals who merely visualized the details of a room. Furthermore, individuals who received affectionate touch from a romantic partner experienced greater felt security after the task than participants whose partners refrained from providing touch (Jakubiak & Feeney, 2016b). These relational-cognitive effects may indirectly aid in buffering stress.

The physical encoding or processing of touch experiences may affect a person despite that person's interpretation of the touch. (Jakubiak & Feeney, 2017). A direct neurobiological path is included to explain why receiving physical contact affects well-being when it is not provided by a close other. People may experience health benefits from being touched by strangers. In particular, the positive and calming effects of massages have been well-documented; a meta-analysis that included 144 studies found that receiving massages can reduce anxiety, state blood pressure, state heart rate, trait depression, and pain (Moyer, Rounds, & Hannum, 2004). These findings may at least partially be explained by direct biological effects of massage, such as the increase both serotonin and dopamine levels (Field, Diego, Hernandez-Reif, Schanberg, & Kuhn, 2004; Field, Hernandez-Reif, Diego, Schanberg, & Kuhn, 2005).

In a similar vein, therapeutic touch from nurses has been found to reduce anxiety, physiological stress, and pain among patients compared to those not receiving touch (Aghabati, Mohammadi, & Pour Esmaiel, 2010; Busch et al., 2012; Papathanassoglou & Mpouzika, 2012; Vannorsdall, Dahlquist, Shroff Pendley, & Power, 2004). A direct physiological effect of touch may provide an alternative explanation for why holding soft, inanimate objects may negate the impact of social exclusion (Tai et al., 2011), and reduce the experience of uncertainty (Van Horen & Mussweiler, 2014). It may also explain why blind-folded participants who received soft slow brush-strokes on the arm touch

experienced reduced distress, while fast strokes that did not simulate affectionate touch had no effect (von Mohr et al., 2017). It remains difficult, however, to tease apart purely biological effects from those influenced by mental processes.

Neurobiological theories do well by emphasizing the significance of the context in which touch is experienced; touch can be unpleasant if the recipient of touch does not like the intent or the person doing the touching (Gazzola et al., 2012). Individual differences in how touch is perceived, such as attachment orientation, may determine the outcome of a touch experience (Walker & McGlone, 2013). (e.g., Jakubiak & Feeney, 2017; Krahé, Drabek, Paloyelis, & Fotopoulou, 2016; Krahé et al., 2018).

Summary

A number of biological systems have been implicated in the processing of affectionate touch, including higher-order brain areas that are linked to social cognition, emotion-regulation, and motivation. Thus, the processing of the experience of touch happens largely outside of conscious awareness, well before the subjective experience of touch is formed, and determines much of the emotional and behavioral outcome. In the context of close relationships, a number of mechanisms may explain the beneficial effects of affectionate touch on adult well-being, including direct biological effects. Finally, context of touch experience and the individual differences in appreciation of affectionate touch are worth considering when explaining touch effects.

Conclusions and Outstanding Questions

The three perspectives addressing affectionate touch—attachment theory, embodiment theories, and social-cognitive and neurobiological theories—complement each other by highlighting different aspects of affectionate touch that in combination can explain its wide range of effects, as well as predict its impact in specific contexts, and for individuals who differ on critical dimensions.

First, attachment theory highlighted the instinctive, basic human need for affectionate touch for survival purposes. Theories of embodied cognition then emphasized how affectionate touch may influence higher-order cognition, which is embodied in modality-specific systems. Lastly, social-cognitive and affective neuroscience illuminates the cognitive, physiological and neurobiological "backbone" that underlies the effects of affectionate touch.

Against the backdrop of these perspectives, we ask a number of new questions about the psychological effects of affectionate touch. Does affectionate touch influence higher-order cognition—not only a feeling of pain, but a cognitive fear of one's mortality? Can embodied simulations of affectionate touch affect brain processes that reflect cognitive control and engagement? Can soft tactile experiences allow people with an insecure attachment or low self-esteem to simulate affectionate touch, and does the simulation help them deal with threat? These are the key research questions that I seek to answer in this dissertation.

Overview of Things to Come

The remainder of this dissertation is organized into five chapters. Each chapter was written as a paper that can be read separately. The chapters thus contain some overlap. Chapters 3-5 are empirical chapters that investigated effects of affectionate touch directly using various manipulations that were based on earlier work. Individual differences play a key role in all chapters. The data from the empirical chapters either have been or will be made publicly available through DANS (Data and Network Services) at https://dans.knaw.nl/ after publication in a scientific journal.

Chapter 2 provides a brief narrative review on the potential of human touch to influence emotional and social functioning. For human beings, as for many other mammals, touch plays a crucial role in the attachment process of infants, whose first sense of safety and security is found in the close proximity of the parents. This allows them to explore their surroundings and seek out new experiences and opportunities. Touch is further used by people to communicate feelings and emotions. The soothing effects of touch remain in adulthood, and further shape people's social and emotional lives by influencing their willingness to connect, share and cooperate.

Chapter 3 examines the effects of actual and simulated interpersonal touch in a novel domain of higher-order cognition, namely coping with existential concerns. People with low (rather than high) self-esteem often find it hard to suppress thoughts about death and struggle with death anxiety (Harmon-Jones et al., 1997b). One possible way to bypass the need for symbolic meaning (e.g., belief in an afterlife) may be to provide people with low self-esteem with a soothing experience of actual or simulated interpersonal touch, which rely more on physiological processes such as the bodily release of endorphins and hormones like oxytocin.

Chapter 4 examines whether simulated interpersonal touch, operationalized as holding a teddy bear, could improve error monitoring, an ability indicative of executive control. This would explain some of the motivational effects of touch that have been found in previous work. In the control condition, participants held a brown cardboard box. We predicted that holding a teddy bear would increase task engagement among people high on trait intrinsic motivation, who are sensitive to, and motivated by, interesting or novel aspects of a task. The level of task engagement can be measured using electroencephalography (EEG), a brain-imaging technique that measures brain activity as electrical impulses on the scalp, including the error-related negativity (ERN). The ERN is larger when people are more engaged during a task. We expected that holding the teddy bear would increase the size of the ERN, and especially among participants high in trait intrinsic motivation.

Chapter 5 investigates the effects of simulated interpersonal touch among insecurely attached people, who find it more difficult to maintain close relationships. As a result, they may not be able to benefit from frequent affectionate (Debrot et al., 2013; Jakubiak & Feeney, 2016b). One way in which insecurely attached people may attain the benefits of affective touch is by touching soft material that allows them to simulate sensory

aspects of affective touch (Cohen & Clark, 1984; Triebenbacher, 1997). Simulations of affective touch may be especially welcomed by and helpful to people with a fearful-avoidant attachment, who generally report the greatest fear of intimacy as well as the greatest unfulfilled desire for affectionate touch (Brennan, Wu, & Loev, 1998; Collins & Feeney, 2004).

Finally, Chapter 6 is an integrative chapter that reviews the main empirical findings from Chapters 3-5. It also discusses the theoretical implications of these findings, and reflects on applied, practical, and societal insights that this dissertation provides on the psychology of affectionate touch.

Chapter 2.

That Human Touch That Means So Much: Exploring the Tactile Dimensions of Social Life

This chapter is based on Tjew-A-Sin, M., & Koole, S. L. (2013). That human touch that means so much: Exploring the tactile dimension of social life. *In-Mind Magazine, 17*.

Abstract

Interpersonal touch is a fundamental but undervalued aspect of human nature. In this paper, we discuss the role of touch in regulating our emotions and strengthening our bonds with others. Given its significant beneficial effects, touch may be valuable as a therapeutic or health-promoting tool. Moreover, haptic technology may allow society to benefit more optimally from the power of touch.

Keywords: interpersonal touch, emotion regulation, social bonding, mediated touch

No one wants to live alone
Who wants to smile, laugh, or cry alone
Have we lost the touch that means so much
Have we lost the human touch
From *Human Touch*, performed by Nina Simone (written by Charles Reuben)

Whether we get a friendly slap on the back, a sensual caress, or a loving kiss—interpersonal touch has a powerful impact on our emotions. In fact, our skin contains receptors that directly elicit emotional responses, through stimulation of erogenous zones or nerve endings that respond to pain (Auvray, Myin, & Spence, 2008; Hertenstein & Campos, 2001). Furthermore, research by Matthew Hertenstein, director of the Touch and Emotion Lab at DePauw University, has shown that touch may communicate distinct emotions (Hertenstein, Keltner, App, Bulleit, & Jaskolka, 2006). Hertenstein and his associates asked pairs of participants to sit at a table with a curtain between them, so that they were unable to see one another. One of the participants, the encoder, was asked to communicate distinct emotions (e.g. anger, disgust, fear, sympathy) by touching the other person's arm. The person being touched, the decoder, was asked to identify the communicated emotion from a number of response options. Although they could neither see nor talk to each other, the participants were able to encode and decode distinct emotions such as anger, fear and disgust at above-chance levels.

The Emotional Power of Touch

The emotional impact of interpersonal touch is ingrained in our biology. Indeed, there is some direct evidence that, in mammalian species, touch triggers the release of oxytocin, a hormone that decreases stress-related responses. Researchers first tested this idea by stroking rats' abdomens for 30-45 seconds. They found that this type of soft touch raised rats' oxytocin levels (Agren, Lundeberg, Uvnäs-Moberg, & Sato, 1995). Interpersonal touch can also induce oxytocin release among humans. For instance, in one experiment, couples who engaged in a warm touch exercise, during which they touched each other's neck, shoulders, and hands, had more oxytocin in their saliva than couples who did not engage in this exercise (Holt-Lunstad et al., 2008). Likewise, women who report frequent

partner hugs display higher levels of oxytocin in their blood than women who report few partner hugs (Light, Grewen, & Amico, 2005). The oxytocin-enhancing effects of touch may reduce the discomfort that people experience from everyday stressors, such as family turmoil or conflict at work (Di Simplicio, Massey-Chase, Cowen, & Harmer, 2009).

In the early 1950s, American psychologist Harry Harlow provided a dramatic demonstration of the importance of touch in coping. Harlow set out to study the effect that separation from their mothers has on children by conducting a range of controversial experiments with baby Rhesus monkeys. Harlow raised the baby monkeys in isolation in a cage that contained two surrogate "mothers"— one made of metal wire and the other wrapped in terrycloth. Although the wire mother contained a bottle from which the monkeys could nurse, the monkeys would cling to the terrycloth mother when they were frightened, even when this led them to dehydrate and starve. Harlow's monkeys were apparently hungry for something other than food: They were literally starving for a warm, comforting touch. With these studies, Harlow was the first to show that intimate body contact, and not feeding, was the most important factor in mother-child bonding. He called this need for physical touch: "contact comfort".

Harlow conducted his ground breaking (and arguably cruel) experiments after reading a World Health Organization report on the detrimental effect of institutionalization. This report was written by the British psychiatrist John Bowlby, a pioneering researcher who developed attachment theory (Bowlby, 1973b). Attachment theory suggests that touch from sensitive caregivers allows infants to feel safe and secure, and thus forms the basis of securely attached relationships later in life. Developmental research has supported these notions. For instance, mothers' nurturing touch was found to foster more secure attachment in low birth weight infants nine months later (Weiss, Wilson, Hertenstein, & Campos, 2000). Furthermore, infants who were tenderly held by their mothers and for longer periods of time were more securely attached than infants who were held reluctantly or awkwardly (Ainsworth et al., 1978). Thus, early nurturing touch from caregivers plays a key role in shaping children's emotional security.

The soothing effects of touch likely remain important in adulthood. There is growing evidence that touch from a romantic partner buffers us against stress. For instance, happily married women who are holding their husband's hand have smaller threat-related neural responses than when they are holding the hand of a stranger or do not engage in hand holding (Coan et al., 2006). People may also obtain the comforting effects of touch

from non-romantic relationships, and even with non-human animals such as pets (McConnell, Brown, Buchanan, Stayton, & Martin, 2011). Even inanimate objects appear to have an effect. Some fascinating experiments have shown that people recover more quickly from social rejection when they are holding a teddy bear on their lap (Tai et al., 2011).

Soft touch does not always have comforting effects. Jonathan Levav of Columbia University and Jennifer Argo of the University of Alberta (2010) found that a female's light, comforting pat on the shoulder increased feelings of security. However, this calming effect did not occur when individuals were touched by a male and was weaker when the touch consisted of a handshake. This finding suggests that gentle touch by non-threatening individuals is most likely to have beneficial effects. Touch is also less likely to have beneficial effects when it violates cultural, social, or personal norms. For instance, uninvited touch from a stranger is often perceived as intrusive or threatening (Thayer, 1986). Likewise, touching the waist area is only appropriate in the context of a strong bond or close relationship (Lee & Guerrero, 2001). Finally, some people generally dislike being touched (Wilhelm, Kochar, Roth, & Gross, 2001).

The Social Power of Touch

Beyond regulating our emotions, interpersonal touch may also regulate our social relationships. Cultural anthropologist Alan Page Fiske (1991, 2004) has elaborated on the social significance of touch. According to Fiske, touch is a key element of a communal sharing relationship, a relationship that occurs in all cultures between mothers and their children, and among members of a group with a shared identity. When people engage in communal sharing, they implicitly assume that their bodies share a common substance, which could be real, imagined, or implied. Interpersonal touch (but also other activities like joint eating or dancing) indicates the presence of a communal sharing relationship by referring to the sharing of a common substance.

If Fiske is correct, touch may render people more willing to share resources. April Crusco of the University of Mississippi and Christopher Wetzel of Rhodes College (1984) conducted a famous test of this idea, in which they examined the effects of touch on tipping behavior. They conducted the research among diners of two restaurants in a small college

town in the American south, where one of three waitresses served the diners. After a waitress collected a diner's money, she went to get change (in the early 1980s, most people presumably paid in cash). At this point, the researchers instructed the waitresses to touch the diners briefly on the shoulder or the palm of the hand, or to not touch the diners at all. The results showed that diners who were touched by the waitress left between 18% and 36% more tips than diners who were not touched, a pronounced difference that was statistically reliable. These beneficial effects of a brief touch have since been observed for many other behaviors, such as signing a petition (Willis & Hamm, 1980), returning lost money (Kleinke, 1977), helping to pick up dropped items (N. Guéguen & Fischer-lokou, 2003), volunteering for charity (Goldman, Kiyohara, & Pfannensteil, 1985), and looking after a dog (N. Guéguen & Fischer-Lokou, 2002).

Some particularly provocative studies have examined the effects of touch on courtship behavior. One study (N. Guéguen, 2007, Experiment 1) took place in a French nightclub. During slow romantic songs, an attractive 20-year-old male went up to a young woman and said, "Hello. My name is Antoine. Do you want to dance?". When he made his request, the man either touched the woman lightly on her forearm or refrained from touching her. While 43% of the women who were not touched accepted the invitation, 65% of the women who were touched agreed to dance. In a parallel study, an attractive male tried to obtain phone numbers from young women on the street. Of the women who were not touched, 10% provided their phone number, compared to 19% of the women who were touched (N. Guéguen, 2007, Experiment 2). These findings suggest that touch can be a powerful catalyst of romantic liaisons.

Equally notable are findings that touch can motivate people to work harder on shared tasks (e.g., Nicolas Guéguen, 2004; Steward & Lupfer, 1987). One recent study on this topic examined touches exchanged between members of basketball teams (Kraus, Huang, & Keltner, 2010). The researchers observed touch behaviors of 294 players from all 30 National Basketball Association (NBA) teams during one game that was played within the first two months of the 2008-2009 season. The focus was on touches among two or more players who were celebrating a positive play that helped their team, including behaviors such as high fives, head slaps, or team huddles. The researchers then related the frequency of these touches to basketball performance during the subsequent NBA season. The results showed that early season touch predicted season performance. This relation held even when the researchers statistically controlled for player salary, preseason

expectations, and early season performance. Indeed, the only measure that could account for the relation between touch and performance was the amount of cooperation that was observed during the game. These findings suggest that touch among basketball players is a strong indicator of trusting and cooperative attitudes, which may facilitate team performance.

The prosocial tendencies induced by touch may sometimes have harmful effects. In cultures that encourage recklessness and irresponsibility, touch may amplify the destructive behavior. One study showed that customers in US public taverns who were briefly touched by a waitress ordered more drinks and consumed more alcohol than customers who were not touched (Kaufman & Mahoney, 1999). Another recent study showed that men playing an investment game made riskier decisions after a woman pat them lightly on the shoulder (J. Levav & J. Argo, 2010). Interpersonal touch may thus lead people to pursue riskier strategies, particularly when these strategies are socially sanctioned.

Although touch may smooth social interactions and help people bond with others, people may feel unnerved when others get too familiar with them in a purely professional setting (Leander, Chartrand, & Bargh, 2012). Thus, the social benefits of touch are likely to materialize only in appropriate situations.

Conclusions and Outlook

Although psychologists have learned a great deal about the significance of touch, the scientific inquiry of touch is still in its infancy. One important complexity that has yet to be addressed is that touch is inherently a multisensory experience. During interpersonal touch, we typically experience tactile stimulation, but also changes in warmth, along with changes in what we see, hear, and smell. Nevertheless, inputs from other senses can have independent effects. For instance, merely being in a warm room or holding a warm drink can make people feel closer to others compared to when they are in a cold room or holding a cold drink (IJzerman & Saddlemeyer, 2012; Williams et al., 2009). More research is needed to establish whether and how warmth and other sensory experiences like smell, sounds, and vision contribute to the effects of touch (see Paladino, Mazzurega, Pavani, & Schubert, 2010, for a pioneering study on this topic).

Other important questions relate to the role of culture. Culture regulates how easily we can access interpersonal touch, by determining who is allowed to be touched by whom, which parts of the body can be touched, what touch means, how touch is ritualized in greetings (e.g., whether we kiss or shake hands with our friends), and so on. However, it is unclear to what degree we can attribute the influence of touch to psychological factors. As we have seen, some of the effects of touch are physiological, such as the release of oxytocin, and they are part of our biological hardware. These physiological processes may be resistant to cultural constraints. For instance, one study showed that individuals who consider touch inappropriate may still show physiological benefits from touch (Wilhelm et al., 2001). However, evidence of this kind remains limited. More research is therefore needed before we can draw firm conclusions about the role of culture in determining the physiological effects of touch.

Despite these limitations, insights from touch research could have many real-world applications. For instance, touch-based therapies may be useful in treating deficiencies in perspective taking (i.e. perceiving someone else's thoughts and feelings), one of the core symptoms of autistic spectrum disorder (Baron-Cohen & Belmonte, 2005). Given that oxytocin (which is released upon touch) improves perspective-taking abilities among high-functioning autistics (Guastella et al., 2010; Hollander et al., 2007), touch-based interventions might be helpful to autistic individuals (see Escalona, Field, Singer-Strunck, Cullen, & Hartshorn, 2001). More broadly speaking, interpersonal touch may support health-promoting behaviors by enhancing compliance. Indeed, one study showed that when service staff at a home for the elderly touched the patients while verbally encouraging them to eat, these patients consumed more calories and protein up to five days after the touch (Eaton, Mitchell-Bonair, & Friedmann, 1986; for related findings, see N. Guéguen & Vion, 2009).

Incorporating interpersonal touch in educational and health systems may sometimes be difficult. Educators and health professionals may fear malpractice and abuse charges (Field, 2001). Moreover, some individuals may prefer not to be touched, even when they might derive benefits from it (Wilhelm et al., 2001). Consequently, it seems useful to look for technological substitutes for interpersonal touch. The emerging fields of mediated social touch (Haans & IJsselsteijn, 2006) and affective haptics (Tsetserukou, Neviarouskaya, Prendinger, Kawakami, & Tachi, 2009) study and design haptic devices and systems that can elicit, enhance, or influence people's emotions. These efforts have produced devices that

can mimic aspects of interpersonal touch, such as the "Huggy Pajama", a haptic jacket that gives wearers the tactile sensations of a hug whenever a sender hugs a doll-shaped device (Teh et al., 2009). Preliminary evidence suggests that at least some of the behavioral effects of mediated touch parallel the effects of interpersonal touch (Haans & IJsselsteijn, 2009).

French novelist Michel Houellebecq (1998) envisioned a future in which all contact between people is mediated by technology. As such, one might wonder if haptic technology can ever replace interpersonal touch. Is being hugged by a haptic jacket as valuable as being hugged by a human being? Will the ultimate high-tech society be completely devoid of human touch? Though provocative, these questions may be largely beside the point. In the foreseeable future, the main use of haptic technology lies not in replacing human touch. Rather, haptic technology provides touch experiences for individuals who will otherwise remain touch-deprived. For instance, individuals with social anxiety, who find it awkward to be touched by people, may find it acceptable to wear a haptic jacket. Likewise, haptic technology may allow parents to hug their children while at work or traveling. New technological developments may thus enable greater numbers of individuals to reap the social and emotional benefits of interpersonal touch.

Chapter 3.

Embodied Terror Management: (Simulated) Interpersonal Touch Alleviates Existential Concerns Among Individuals with Low Self-Esteem

This chapter is based on: Koole, S. L., Tjew-A-Sin, M., & Schneider, I. K. (2014). Embodied terror management: (Simulated) Interpersonal touch alleviates existential concerns among individuals with low self-esteem. *Psychological Science, 25*(1), 30-37.

Abstract

Individuals with low (rather than high) self-esteem often struggle with existential concerns. The present research examined whether these existential concerns may be alleviated by seemingly trivial experiences of (simulated) interpersonal touch. A brief touch on the shoulder by a female experimenter led individuals with low self-esteem to experience less death anxiety (Study 1) and more social connectedness after a death reminder (Study 2). Reminding individuals with low self-esteem of death increased their desire for touch, as indicated by higher value estimates of a teddy bear, a toy animal that simulates interpersonal touch (Study 3). Finally, holding a teddy bear (versus a cardboard box) led individuals with low self-esteem to respond to a death reminder with less defensive ethnocentrism (Study 4). Individuals with high self-esteem were unaffected by touch (Studies 1-4). These findings highlight the existential significance of embodied touch experiences, particularly for individuals with low self-esteem.

Keywords: touch, self-esteem, terror management, mortality salience, fear of death, social connectedness, ethnocentrism, death and dying

As human beings, we all live out our lives knowing that we are going to die, and that our death could happen at any time and for any number of reasons. Many of us handle this existential predicament fairly smoothly, by convincing ourselves that our individual lives, though finite, are endowed with meaning that lasts beyond the grave (Pyszczynski, Greenberg, Solomon, & Koole, 2010). However, not everyone is equally successful at this task. Particularly individuals with low (rather than high) self-esteem often find themselves struggling with existential concerns. For instance, individuals with low self-esteem find it hard to suppress death thoughts (Harmon-Jones et al., 1997a), and respond to death reminders with increased anxiety (Routledge et al., 2010b). Their greater existential concerns may put low self-esteem individuals at risk for psychological disturbances, such as depression or social anxiety. It is therefore important to learn how low self-esteem individuals might cope more constructively with the problem of death.

The psychological confrontation with death has traditionally been the province of poets, prophets, and philosophers. In recent years, however, psychologists have developed rigorous experimental approaches for studying people's existential struggles (Koole, Greenberg, & Pyszczynski, 2006). Most experimental-existential psychological research to date has been guided by Terror Management Theory (TMT; Greenberg, Solomon, & Pyszczynski, 1997). Inspired by cultural anthropologist Ernest Becker (1973), TMT proposes that people's awareness of the inevitability of death creates a potential for overwhelming anxiety, which people can manage by adopting cultural worldviews that assure people of their literal or symbolic immortality. Upholding cultural worldviews affirms self-esteem, which shields people psychologically against the notion that their lives are fleeting and insignificant. TMT has been supported by many experiments showing that death reminders lead to cultural worldview defense (e.g., ethnocentrism) and enhanced self-esteem strivings (e.g., seeking fame; (for a review, see Pyszczynski et al., 2010).

From TMT's perspective, individuals with low self-esteem lack a vital buffer against existential anxiety, because low self-esteem individuals have a lack of meaning in life (Harmon-Jones et al., 1997b; Routledge et al., 2010a). Low self-esteem individuals may therefore look for sources of existential security that do not rely on symbolic meaning. One such source may be interpersonal touch. The connection between touch and security develops during infancy, when caregivers' gentle touch assures children that they are safe from harm (Bowlby, 1973a; Hertenstein, Verkamp, Kerestes, & Holmes, 2006). The soothing effects of touch remain in adulthood (Grewen, Anderson, Girdler, & Light, 2003).

Among adults, even a brief pat on the shoulder by a stranger (Levav & Argo, 2010) or holding a teddy bear (Tai, Zheng, & Narayanan, 2011) can be psychologically comforting. Experiments indicate that people prefer more physical closeness when reminded of death (Wisman & Koole, 2003). Such observations suggest, albeit indirectly, that people may manage existential anxiety through interpersonal touch.

The comfort of touch derives, at least in part, from physiological processes such as the bodily release of endorphins and hormones like oxytocin (R. I. M. Dunbar, 2010). These physiological systems operate similarly across all mammalian species. Because most mammals lack the capacity for symbolic thought, the comforting effects of touch seem largely independent of symbolic meanings. Thus, the intriguing possibility arises that people may use tactile experiences with little or no cultural meaning to alleviate existential concerns that only arise because of people's capacity for meaningful thought. By bypassing symbolic meaning, the comfort of interpersonal touch may be especially welcome among individuals with low self-esteem, who struggle to find meaning in life.

The present research investigated whether interpersonal touch may help individuals with low (rather than high) self-esteem to deal with existential concerns. Studies 1 and 2 manipulated whether participants were briefly touched on the shoulder by an experimenter. We predicted that participants with low self-esteem would respond to touch with lower death anxiety (Study 1), and less social alienation in response to death reminders (Study 2). Studies 3 and 4 examined if even an object that simulates interpersonal touch could provide existential comfort to low self-esteem individuals. We predicted that a death reminder would lead participants with low self-esteem to evaluate a teddy bear, a toy animal that simulates interpersonal touch (Study 3). Finally, we predicted that holding a teddy bear would reduce defense of cultural worldviews among participants with low self-esteem (Study 4). Throughout our experiments, we expected few effects of touch among high self-esteem participants, whose positive self-views already provide psychological protection against existential concerns.

Study 1

Method

Participants and design. Sixty-one paid volunteers (26 women; average age 23) were randomly allocated to touch or no-touch conditions. No reliable effects of gender emerged throughout Studies 1-4, so gender is not further discussed.

Procedure and materials. Participants were approached on the campus site of the VU University Amsterdam by a female experimenter who asked participants to fill out some questionnaires. In the touch condition ($N = 30$), the experimenter accompanied the questionnaire with a light, open-palmed touch for about 1 s on the shoulder blade, right below the deltoid. In the no-touch condition ($N = 31$), the experimenter provided the questionnaire without any form of touch. This touch manipulation was based on Levav and Argo (2010).

Participants proceeded by rating their death anxiety on 7 items (e.g., "I am afraid of death, because it is so final") using 5-point scales (1= not at all; 5 = very much). The items were averaged into a single index (Cronbach's $\alpha = .69$). Next, participants answered the Rosenberg (1965) self-esteem scale (RSES). The RSES consisted of 10 items (e.g., "On the whole, I am satisfied with myself") that were answered on 4-point scales (1= not at all; 5 = very much). RSES items were averaged into a single index (Cronbach's $\alpha = .84$). A one-way analysis of variance (ANOVA) indicated that RSES scores in Studies 1-2 were not influenced by the touch manipulation, $F < 1$. Finally, participants answered some biographical questions, were debriefed and thanked.

Results and discussion. We coded touch condition (no-touch = -1, touch = 1), standardized self-esteem, computed an interaction term between these variables, and simultaneously entered these factors into a multiple regression analysis predicting self-reported death anxiety. Only an interaction between touch and self-esteem emerged, $\beta(1,57) = .39$, $t = 2.17$, $p = .034$. To interpret this interaction, we obtained predicted means for the four cells crossing self-esteem ($\pm$ 1 SD) with touch condition (Aiken & West, 1991). As shown in Figure 1, individuals with low self-esteem experienced less death anxiety after being touched, $\beta(1,57) = -.46$, $t = -2.60$, $p = .012$. This is consistent with the hypothesis that

touch provided low self-esteem individuals with a form of existential security. Touch had no effect among individuals with high self-esteem, $\beta(1,57) = .09$, $t = .49$, $p = .626$.

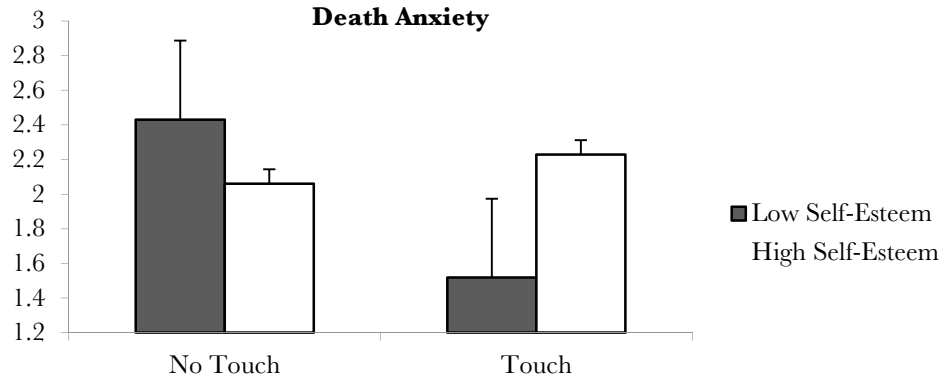


Figure 1. Death Anxiety as a Function of Touch and Self-Esteem (Study 1)

Study 2

Study 2 used the mortality salience (MS) paradigm, which examines people's responses to a subtle death reminder (Greenberg et al., 1997). Prior research has shown that MS promotes feelings of social alienation among individuals with low self-esteem (Routledge et al., 2010b, Study 8). We hypothesized that interpersonal touch would protect low self-esteem individuals against such socially alienating effects of MS.

Method

Participants and design. One hundred and twenty paid volunteers (53 women; average age 23) participated in the study. Four participants were discarded due to missing values. Participants were randomly allocated to experimental conditions. All participants of Study 1 also participated in the high MS condition of Study 1.

Procedure and materials. The setting, touch manipulation, and RSES (Cronbach's $\alpha = .81$) were similar to Study 1. However, Study 2 also manipulated MS. Under high MS ($N = 61$), participants answered 7 questions about their fear of death (see

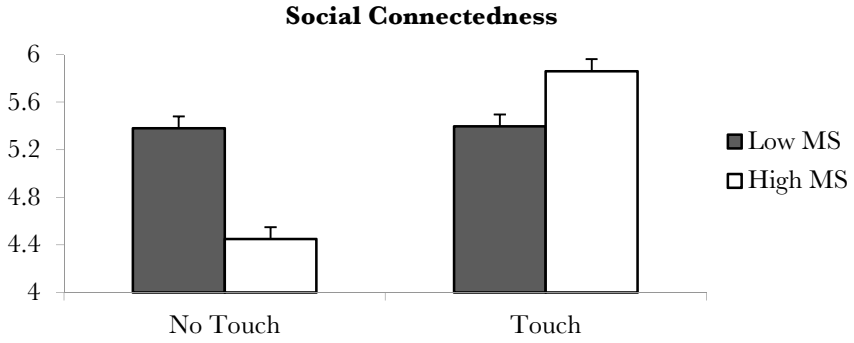
Study 1). Under low MS (N = 55), participants answered parallel questions about their fear of dentists. Next, participants completed word puzzles for 5 minutes, because MS effects are strongest after a brief distraction (Greenberg et al., 1997). Next, participants listed the names of 7 to 10 persons they knew[1] and rated how much they felt connected with them (1= not all; 9=very much). Ratings were averaged and combined into a social connectedness index.

Results and discussion. We first established whether, in the absence of interpersonal touch, MS weakened social connectedness among individuals with low (rather than high) self-esteem. Accordingly, we regressed the effects of MS and self-esteem, and their interaction (computed as in Study 1) on perceived social connectedness in the no-touch condition. This analysis yielded the expected interaction between MS and self-esteem, $\beta(1,107) = .27$, $t = 2.35$, $p = .021$. Simple slope analyses showed that MS weakened perceived social connectedness among participants with low self-esteem, $\beta(1,107) = -.47$, $t = -2.71$, $p = .008$, but not among participants with high self-esteem, $\beta(1,107) = .08$, $t = .49$, $p = .627$. We thus replicated the socially alienating influence of MS among low self-esteem individuals (Routledge et al., 2010b).

Proceeding with our main analysis, we coded MS condition (low MS = -1; high MS =1), and computed touch condition, standardized self-esteem, and their interaction terms as in Study 1. We simultaneously entered these factors into a multiple regression analysis predicting perceived social connectedness. The analysis yielded an effect of touch, $\beta(1,107) = .22$, $t = 2.53$, $p = .011$, and, the predicted interaction between MS, touch, and self-esteem, $\beta(1,107) = -.25$, $t = -2.87$, $p = .005$.

[1] A first group of participants (N = 61) listed and rated 10 persons Cronbach's a = .93). However, because participants commented that listing 10 persons was rather difficult, we asked subsequent participants to list only 7 persons (N = 54; Cronbach's $\alpha = .86$). Participants who generated 10 persons reported less connectedness than those who generated 7 persons, $F(1, 115) = 12.65$, $p < .001$ ($M = 6.27$ vs $M = 7.29$). We hence controlled for number of listed persons as a covariate in the regression analyses of Study 2. Without this covariate, the interaction between MS and self-esteem was $\beta(1,108) = -.36$, $t = -2.49$, $p = .014$.

A) Low Self-Esteem Individuals



B) High Self-Esteem Individuals

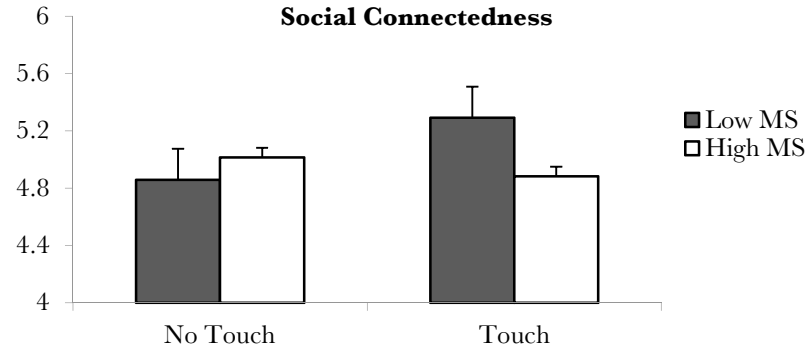


Figure 2. Social Connectedness as a Function of Mortality Salience (MS), Touch and Self-Esteem (Study 2)

To interpret these effects, we derived predicted means for the eight cells crossing self-esteem (± 1 SD) with MS and touch conditions (Aiken & West, 1991). As shown in Figure 2, there were no effects of MS and touch among participants with high self-esteem, *t*s <1.16, *p*s > .24. By contrast, among participants with low self-esteem, there was a main effect of touch, $\beta(1,107) = .36$, $t = 2.98$, $p = .004$, qualified by a MS by touch interaction, $\beta(1,107) = .35$, $t = 2.91$, $p = .004$. Simple slopes analyses showed that, under high MS,

touch increased social connectedness among individuals with low self-esteem, $\beta(1,107) = .71$, $t = 3.91$, $p < .001$. Under low MS, individuals with low self-esteem were not influenced by touch, $\beta(1,107) = .01$, $t = .05$, $p = .961$. Interpersonal touch thus buffered the socially alienating effects of MS among individuals with low self-esteem.

Study 3

If low self-esteem individuals gain existential security through interpersonal touch, then salient existential concerns may increase low self-esteem individuals' desire for touch. Study 3 tested this idea. Because participants might find it awkward to directly report their desire for touch, we devised an indirect method to assess this variable. People particularly value what matches their motivational orientation. Desire for touch should hence increase the value of touch-providing agents. We thus hypothesized that MS may lead low self-esteem individuals to exaggerate the value of a teddy bear, a toy animal that simulates interpersonal touch.

Method

Participants and design. Fifty paid volunteers (30 women, 20 men; average age 21) were randomly allocated to high versus low MS conditions.

Procedure and materials. Participants were received in a laboratory, and escorted to cubicles. Instructions were computer-administered. The investigation allegedly consisted of unrelated studies, administered together for efficiency reasons. Participants began by answering some questionnaires[2], which included the RSES (Cronbach's $\alpha = .89$).

[2] Prior research has shown that the effects of MS are not mediated by negative mood (Greenberg et al., 2007), but Levav and Argo (2010) did find an effect of negative mood. We therefore measured mood in our studies. In Study 3 the brief Profile of Mood Scales was completed at the start of the experiment (Cronbach's $\alpha = .89$) and after the touch manipulation. We found no significant effects of MS or touch on negative mood. Unexpectedly, pre-manipulation levels of negative mood varied by self-esteem level and

Next, MS was manipulated as in Study 2. Participants then moved on to a purported consumer test. Participants were asked to evaluate a 100 cm teddy bear in a cardboard box. Participants were instructed to look at the bear through a Plexiglas window for three minutes, and estimate the bear's retail value in Euros. Finally, participants answered some biographical questions, and were debriefed, rewarded, and thanked.

Results and discussion. We entered MS and self-esteem and their interaction terms (computed as in Study 1) into a multiple regression analysis predicting the average estimated Euro value of the teddy bear. The only significant effect was an interaction between MS and self-esteem, β (1,45) = -.31, t = 2.03, p = .048[2]. To investigate this interaction, we obtained predicted means for the four cells crossing self-esteem (± 1 SD) with MS condition (Aiken & West, 1991) displayed in Figure 3. Simple slope analyses indicated that for low self-esteem individuals, MS increased estimated teddy bear value, β(1,45) = .58, t = -2.65, p = .011. Participants with low self-esteem under high MS estimated the teddy bear's value around €23, whereas the other groups estimated its value around €13. MS had no effect on estimated teddy bear value among individuals with high self-esteem, β(1,45) = -.11, t <1. Study 3 thus shows that MS increased the desired for touch among low self-esteem individuals, as indicated by higher value estimates of a teddy bear.

MS, β(1,46) = -.38, t = -3.18, p = .003. We therefore included it as a covariate in the analyses of Study 3. Without this covariate, the interaction between MS and self-esteem was β(1,108) = -.25, t = -1.50, p = .142.

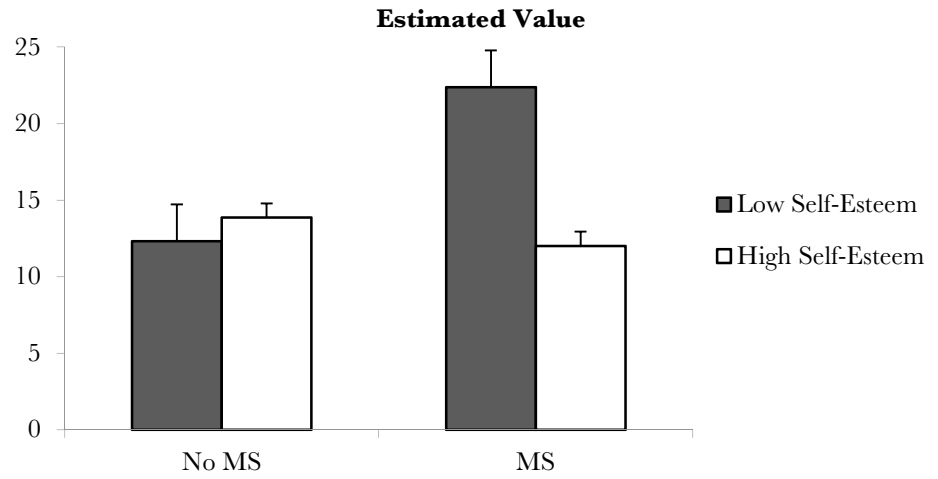


Figure 3. Estimated Value of Teddy Bear (in Euros) as a Function of Mortality Salience (MS) and Self-Esteem (Study 3).

Study 4

Were low self-esteem participants in Study 3 right to place more value on a teddy bear? After all, holding a teddy bear might provide them with existential comfort. To investigate this possibility, Study 4 varied whether participants held a teddy bear or a cardboard box. A robust TMT finding is that MS promotes claims of the superiority of one's own culture, especially among individuals with low self-esteem (Harmon-Jones et al., 1997b). Study 4 examined if holding a teddy bear might reduce low self-esteem individuals' need to engage in such cultural worldview defense under MS.

Method

Participants and design. Eighty paid volunteers (52 women; average age 20) were randomly allocated to high versus low MS and boxed versus unboxed bear conditions. Two non-Western participants were excluded because they were not expected to display Dutch ethnocentrism.

Procedure and materials. The setting and procedure, including the self-esteem measure Cronbach's α = .89) and MS manipulation were similar to Study 3. However, this time, we manipulated whether participants could touch the teddy bear (see Tai et al., 2011). To allow participants to hold the bear on their lap, we used a smaller bear of 34 cm. In the unboxed condition, participants were instructed to take the bear out of the box, place it on their lap and to touch the bear. In the boxed condition, participants were instructed to look at the bear through a Plexiglas window, while leaving the bear inside the box. After three minutes, participants answered some questions about the bear to bolster the cover story.

Participants proceeded by rating how much six negative emotions (e.g., pain, contempt) and six positive emotions (e.g., pleasure, hope) were applicable to a typical Dutch person and a typical Muslim (1 = not all to 9 = very much). We focused on Dutch and Muslims because this comparison elicits ethnocentrism among native Dutch (De Dreu, Greer, Van Kleef, Shalvi, & Handgraaf, 2011). Ratings were summed separately by valence for the Dutch and Muslim targets (.60 < Cronbach's αs < .81). Ethnocentrism was indicated when participants attributed a) more positive emotions and less negative emotions to Dutch persons, and/or b) less positive emotions and more negative emotions to Muslims. After the task, participants answered some biographical questions, and were debriefed, rewarded, and thanked.

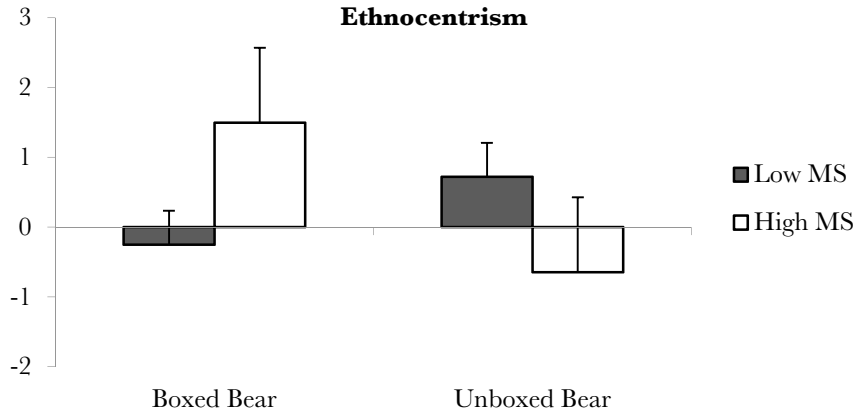
Results and discussion. We first checked whether, in the absence of touch, self-esteem buffered the effects of MS on ethnocentrism. Among participants with low self-esteem, MS led to more ethnocentrism $\beta(1,69) = .42$, $t = 1.64$, $p = .053$ (one-tailed). MS had no effect among participants with high self-esteem, $\beta(1,68) = -02$, $t = -.07$, $p = .944$. This pattern confirms prior findings that self-esteem buffers MS effects on cultural worldview defense (Harmon-Jones et al., 1997b).

We hypothesized that touching a teddy bear would reduce defensive ethnocentrism among participants with low self-esteem. To test this, we simultaneously entered the effects of MS, touch, self-esteem, and their interaction terms (computed as in Study 2) into a multiple regression analysis predicting ethnocentrism. The only significant effect was the

predicted interaction between MS, touch, and self-esteem, $\beta(1,68) = .28$, $t = 2.43$, $p = .018$[3]. To interpret this effect, we obtained predicted means for the eight cells crossing self-esteem (± 1 SD) with MS and touch conditions (Aiken & West, 1991). As Figure 4 shows, there were no effects among participants with high self-esteem. By contrast, among participants with low self-esteem, the predicted interaction between MS and touch was marginally significant, $\beta(1,68) = -.34$, $t = -1.96$, $p = .054$. Simple slopes analyses showed that, under low MS, ethnocentrism among individuals with low self-esteem was not influenced by touch, $\beta(1,68) = .21$, $t = .77$, $p = .443$. By contrast, under high MS, touch reduced ethnocentrism among individuals with low self-esteem, $\beta(1,68) = -.46$, $t = -2.16$, $p = .034$.

[3] Participants also rated their mood and arousal (Kuhl & Kazén,1997) before and after the touch manipulation. As in Study 3, we found no effects of the manipulations on negative mood. However, pre-manipulation arousal (assessed by Kuhl & Kazén, 1997 scales, Cronbach's $\alpha = .72$) interacted with touch, such that more aroused participants became more ethnocentric after touching the teddy bear, $\beta(1,68) = .38$, $t = 2.29$, $p = .025$. We therefore included arousal and its interaction with touch as covariates in the analyses of Study 4. Without these covariates, the interaction between MS, touch, and self-esteem was $\beta(1,70) = .24$, $t = 2.04$, $p = .045$.

A) Individuals with Low Self-Esteem



B) Individuals with High Self-Esteem

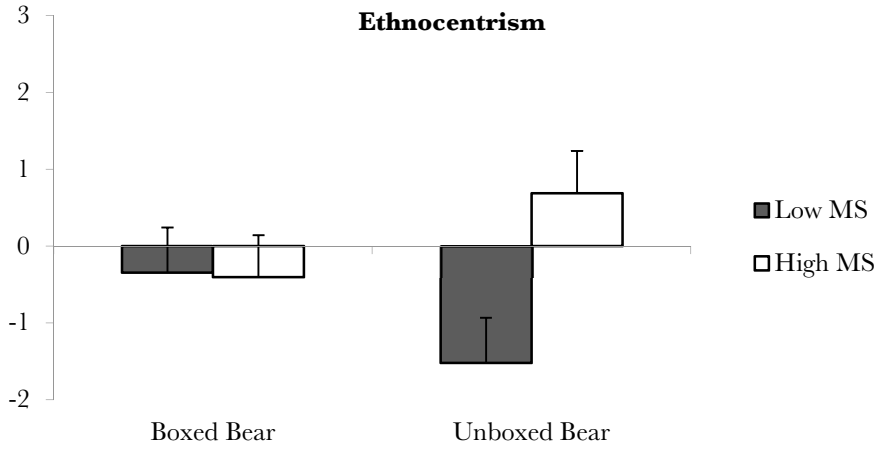


Figure 4. Ethnocentrism as a Function of Mortality Salience (MS), Touch, and Self-Esteem (Study 4).

General Discussion

The present research demonstrates that individuals with low self-esteem benefit from seemingly trivial instances of (simulated) interpersonal touch while coping with existential concerns. A brief touch on the shoulder by a female experimenter led low self-

esteem individuals to experience less death anxiety (Study 1) and more social connectedness when death concerns had been made salient (Study 2). A death reminder led low self-esteem individuals to experience a greater desire for touch, as indicated by higher estimated value of a teddy bear (Study 3). Finally, low self-esteem individuals responded with less ethnocentrism to a death reminder after holding a teddy bear (Study 4). Together, these findings indicate that individuals with low self-esteem derive important existential benefits from (simulated) interpersonal touch. Notably, individuals with high self-esteem were not significantly influenced by interpersonal touch manipulations throughout the present research.

The existential benefits of touch for low self-esteem individuals may be subject to important boundary conditions. For instance, touch might have less beneficial effects when people are touched by a potentially threatening person (see Levav & Argo, 2010) or someone of a stigmatized social group (though see Smith, 2008). Moreover, the existential comfort from touch may more fleeting than the security that people derive from adopting death-transcending worldviews. More research is needed to address these possibilities.

Though preliminary, the present findings could have important applied implications. Maladaptive coping with existential concerns among individuals with low self-esteem may contribute to the onset of depression and anxiety disorders (Routledge et al., 2010b). Consequently, by dampening existential concerns among individuals with low self-esteem, interpersonal touch could play an important role in preventing mental illness. Although legal and ethical restrictions may bar psychotherapists from touching clients, the present research suggests that simulated interpersonal touch may already have significant existential benefits for individuals with low self-esteem. Recent technological advances have yielded so-called 'haptic jackets' that can simulate an affectionate embrace (Tjew-A-Sin & Koole, 2013). These and other tactile interventions may supplement traditional psychotherapy, which has emphasized cognitive treatments for psychological disorders.

In sum, the present findings demonstrate that individuals with low self-esteem, who are struggling to find meaning in life, may derive considerable benefits from real or simulated interpersonal touch. By highlighting a tactile terror management tactic, these findings introduce an embodied dimension to existential psychology, a domain that has traditionally emphasized disembodied meanings in coping with existential issues (S. L. Koole, Greenberg, & Pyszczynski, 2006; Pyszczynski et al., 2010). Although the thought of the body's mortality fuels people's existential concerns (Goldenberg, Pyszczynski,

Greenberg, & Solomon, 2000), the body itself may help people come to terms with their deepest fears.

Chapter 4.

Caring About Errors: Effects of Simulated Interpersonal Touch and Trait Intrinsic Motivation On the Error-Related Negativity

This chapter is based on: Tjew-A-Sin, M., Tops, M., Heslenfeld, D.J., & Koole, S.L. (2016). Effects of simulated interpersonal touch and trait intrinsic motivation on the error-related negativity. *Neuroscience Letters, 617*, 134-138. doi: 10.1016/j.neulet.2016.01.044

Abstract

The error-related negativity (ERN or Ne) is a negative event-related brain potential that peaks about 20 to 100 ms after people perform an incorrect response in choice reaction time tasks. Prior research has shown that the ERN may be enhanced by situational and dispositional factors that promote intrinsic motivation. Building on and extending this work the authors hypothesized that simulated interpersonal touch may increase task engagement and thereby increase ERN amplitude. To test this notion, 20 participants performed a Go/No-Go task while holding a teddy bear or a same-sized cardboard box. As expected, the ERN was significantly larger when participants held a teddy bear rather than a cardboard box. This effect was most pronounced for people high (rather than low) in trait intrinsic motivation, who may depend more on intrinsically motivating task cues to maintain task engagement. These findings highlight the potential benefits of simulated interpersonal touch in stimulating attention to errors, especially among people who are intrinsically motivated.

Keywords: task engagement, touch, intrinsic motivation, error-related negativity, action versus state orientation, persistence

People inevitably make errors, no matter how skilled they are at a task. However, there is considerable variation in how much people care about errors. When people care little about a task, they are prone to ignore errors, but when people are motivated to perform well, they are likely to heed errors and to respond to them by increasing their efforts (C. B. Holroyd & Coles, 2002; Rabbitt, 1966). To understand how people respond to errors, it is therefore critical to examine the factors that influence people's motivation to do well at a task. In the present study, we consider how error processing is influenced by the interplay between a contextual factor that influences intrinsic task motivation, i.e., simulated interpersonal touch, and individual differences in intrinsic motivation.

An important neural correlate of error monitoring is the error-related negativity (ERN), a negative event-related potential that is elicited when people produce an incorrect response in choice reaction time tasks, peaking about 20 to 100 ms after the erroneous response with a fronto-central scalp distribution (Falkenstein, Hohnsbein, Hoormann, & Blanke, 1991; William J. Gehring, Goss, Coles, Meyer, & Donchin, 1993). One often-used paradigm to elicit the ERN is the Go/No-Go task (Falkenstein, Hoormann, & Hohnsbein, 1999; Kiefer, Marzinzik, Weisbrod, Scherg, & Spitzer, 1998). This task requires people to perform an action given certain stimuli, often pressing a button (e.g., the 'Go' response), and inhibit that action given different, less frequent, stimuli (e.g., 'No go'). The greater frequency of Go stimuli creates a tendency for people to respond on every trial, which leads them to commit errors when the less frequent No-Go stimulus appears. Such errors typically elicit the ERN.

Functional brain imaging studies have shown that the ERN reflects activity in a neural conflict monitoring system in the anterior cingulate cortex (Botvinick, Nystrom, Fissell, Carter, & Cohen, 1999; Dehaene, Posner, & Tucker, 1994). The size of the ERN depends on the person's motivation or task engagement. When people are striving for accurate performance, ERN amplitudes increase, while ERN amplitudes decrease when people respond with greater speed at the expense of accuracy (W. J Gehring, Coles, Meyer, & Donchin, 1990; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004). Moreover, the ERN varies as a function motivational states and traits (Hajcak, Moser, Yeung, & Simons, 2005; Tops & Boksem, 2010). For instance, the effects of motivational context on the ERN are moderated by aspects of trait persistence, such as intrinsic motivation, which reflects whether people are motivated by interesting or novel tasks (Tops & Boksem, 2010).

So far, research on error processing has mainly studied the role of motivation in a direct, explicit, manner, by instructing participants to be concerned about errors or by providing rewards based on task performance (Boksem, Tops, Kostermans, & De Cremer, 2008; Boksem, Tops, Wester, Meijman, & Lorist, 2006). However, how much people care about errors may also be influenced by subtle contextual factors. One such factor may be brief, non-threatening experiences of actual or simulated interpersonal touch, which can have a motivating or encouraging effect. For instance, students who were touched twice on the arm during an interview after a first examination improved their performance on later examinations compared to students who were not touched (Steward & Lupfer, 1987), and elderly people who were stroked by an anthropomorphic robot performed more working actions and spent more time working on the task (Nakagawa et al., 2011). In view of these and similar findings (e.g., Nicolas Guéguen, 2004; Howard, 1988; Legg & Wilson, 2013), we hypothesized that simulated interpersonal touch may increase people's task motivation, and hence increase error processing.

To test this hypothesis, we conducted an experiment in which we manipulated simulated interpersonal touch, by asking participants to hold either a teddy bear (see S. L. Koole, Tjew-A-Sin, & Schneider, 2014; Tai et al., 2011) or a cardboard box during a Go/No-Go task. We predicted that simulated interpersonal touch (i.e., holding a teddy bear) would lead our participants to care more about errors, leading to larger ERN amplitudes (relative to holding a cardboard box). In line with prior research (e.g., Kanfer, Dugdale, & McDonald, 1994; Keller & Bless, 2008) we also expected that simulated interpersonal touch would be more effective among people high in trait intrinsic motivation, because they are more motivated by interesting tasks than people low in trait intrinsic motivation.

Method

Participants and design. Twenty-three right-handed students from VU University, Amsterdam, participated voluntarily in a 2-hour session for course credit or €15. None of the participants had a history of neurological or psychiatric disease. The study was conducted in accordance with the Code of Ethics of the World Medical Association. All participants gave written informed consent. Three participants were excluded: one

participant showed excessive noise in EEG recording; a second participant committed more than 35% errors on Go trials; and a third participant committed too few errors in the No-Go trials (less than 10%). Thus, the final dataset consisted of 20 participants (16 women, 4 men; average age: 20). The study had a within-subjects factorial design in which participants completed two sessions of a Go/No-Go task, one while holding a teddy bear and one while holding a same-sized cardboard box (order was counterbalanced). The main outcome measures were performance and ERNs during the Go/No-Go task. We also measured individual differences such as trait intrinsic motivation.

Procedure and materials. We ran the experiment in a soundproof chamber that was equipped with a computer. Participants were told that the study investigated the effects of distracting objects on task performance. Participants first completed questionnaires including the Action Control Scales (Diefendorff, Hall, Lord, & Strean, 2000) with the Persistence subscale (Cronbach's $\alpha = .63$) that we use to measure trait intrinsic motivation. The Persistence subscale has been linked consistently to intrinsic motivation and task engagement in work settings (Diefendorff et al., 2000; Kanfer et al., 1994) and in laboratory tasks (Keller & Bless, 2008; Marguc, Forster, & Van Kleef, 2011). It measures the degree to which a person becomes caught up in interesting tasks. An illustrative item is "When I am trying to learn something new that I want to learn: A. "I'll keep at it for a long time", B. "I often feel like I need to take a break and go do something else for a while". In this example, option A reflects a high and option B reflects a low intrinsic motivation response. We summed participants' number of action-oriented responses to provide an index of trait intrinsic motivation.

We continuously measured EEG while participants completed a Go/No-Go task. Participants started with practice trials, after which they completed two sessions in counterbalanced order, one while holding an 80 cm teddy bear and one while holding a cardboard box. Finally, participants were asked for some biographical information and debriefed.

Dependent variables.

Go/no-go task. Participants completed a version of the Go/No-Go task that was specifically designed to elicit frequent errors (Inzlicht & Al-Khindi, 2012). Participants were told that they would see a fixation cross on the screen, followed by either the letter M or the letter W. They were instructed to press the space bar if they saw the letter M (the Go stimulus), and to refrain from pressing when they saw the letter W (the No-Go stimulus). Participants were told to do the task quickly but accurately. The fixation cross was presented between 300 to 700 ms, and the stimulus letter was shown for 100 ms. Participants were given 500 ms to respond to the stimulus letter before moving to the next trial. Participants started with 20 slower practice trials with feedback to familiarize them with the task. For the actual task, participants completed two sessions without feedback (one per object to hold), each consisting of six experimental blocks of 100 trials. The first six participants were erroneously presented with only 5 experimental blocks per session. Of every 100 trials, 80 Go and 20 No-Go trials were presented randomly. We measured average reaction time on correct and incorrect trials, and the number of omission (not pressing during a Go trial) and commission (pressing during a No-Go trial) errors.

Neurophysiological recordings. Recording sites on the face and mastoids were lightly abraded and cleaned with alcohol. Bipolar leads were placed to record horizontal electrooculogram (HEOG) from the left and right temple, and vertical electrooculogram (VEOG) from above and below the left eye. Continuous EEG during the Go/No-Go task was recorded using a stretch ECI cap embedded with 62 sintered Ag/AgCl electrodes. Recordings were digitized at 500 Hz using Neuroscan acquisition software (Compumedics Neuroscan, Hamburg, Germany) with average-ear reference and ground on the left cheek. EEG was corrected for vertical electrooculogram artifacts (Gratton, Coles, & Donchin, 1983).

We used Brain Vision Analyzer software (Brain Products, Gliching, Germany) to digitally filter the EEG offline between 0.1 and 30 Hz (FFT implemented, 12dB zero phase-shift Butterworth filter). The 200 ms period before button press was used for baseline correction. An epoch was defined as 200 ms before and 400 ms after the response. Epochs containing EEG artifacts exceeding 80 μV were excluded. Data for these epochs were averaged within participants independently for correct trials (correct related negativity; CRN) and incorrect trials (ERN), and then grand-averaged within the respective conditions. The ERN was defined as the most negative peak on error trials in the 100 ms following the

response at the central midline electrode Cz, where visual inspection showed that this component was maximal. For statistical analyses, we used the average amplitude of the ERN in a time window starting 25 ms before the peak until 25 ms after the peak. For correct trials, on which no negative peak was present in the 100 ms following the response, the average amplitude was obtained for each subject and condition from the same time window as on error trials. ERN calculations were based on no fewer than eighteen artifact-free error trials.

Statistical analyses. We created two separate variables with the average ERN amplitudes in the teddy bear condition and in the box condition. To test for effects of simulated interpersonal touch on ERN amplitudes, we performed a two-way repeated measures analysis of variance (ANOVA) with correctness of response and condition as within-subject factors. When a significant interaction was found, we analyzed correct and error trials separately with one-way repeated measures ANOVAs. To investigate the role of trait intrinsic motivation, we included it as a covariate in a one-way repeated measures ANOVA on amplitudes on error trials with condition as within-subject factor.

Results. The mean score for trait intrinsic motivation was 9.35 (*SD* = 2.21). The mean percentage of omission errors and commission errors was 8.8% (*SD* = 5.27) and 51.7% (*SD* = 12.60) respectively. The mean reaction time was 322.10 (*SD* = 34.90) for correct Go trials and 274.23 (*SD* = 26.79) for incorrect No-Go trials. We did not find effects of condition on performance. Table 1 shows the estimated marginal means per condition and the Pearson correlations between trait intrinsic motivation and performance.

Table 1

Estimated Marginal Means (SD) Per Condition and Pearson Correlations of Trait Intrinsic Motivation with Performance.

Condition	*Performance measure*	*Estimated marginal means*		*Pearson correlations*				
				1	*2*	*3*	*4*	*Trait intrinsic motivation*
Teddy	1 ERN	-2.31	(.48)					.11
bear	2 Commission errors	50.2	(3.9)	.38				.08
	3 Omission errors	8.7	(1.0)	.28	.43†			.40†
	4 RT Go	326	(9)	-.19	-.74**	-.48*		-.19
	5 RT No-Go	278	(7)	-.17	-.54*	-.62*	.86**	-.38†
Box	1 ERN	-1.00	(.48)					.64**
	2 Commission errors	53.3	(2.5)	.45*				.43†
	3 Omission errors	9.0	(1.5)	.35	.05			.06
	4 RT Go	318	(8)	-.45*	-.41†	-.42†		-.57**
	5 RT No-Go	271	(7)	.65**	-.15	-.29	.89**	-.51*

$^{\dagger}p < .10$; *p < .05; **p < .01; ***p < .001. The percentage of commission and omission errors was used for the correlations.

ERN. We performed a two-way repeated measures ANOVA on ERN amplitudes with correctness of response (error or correct) and condition (teddy bear or box) as within-subject factors. Consistent with an ERN effect, there was a main effect of correctness of response, $F(1,19) = 83.78$, $p < .00001$, $\eta_p^2 = .815$, such that ERN amplitudes were more negative on error trials ($M = -1.66$, $SD = 1.63$) than on correct trials ($M = 4.15$, $SD = 2.04$), and an interaction between correctness and condition, $F(1,19) = 5.38$, $p = .032$, $\eta_p^2 = .221$.

We further interpreted the interaction effect by analyzing correct and error amplitudes separately with one-way repeated measures ANOVAs. These analyses showed an effect of condition on error trials, $F(1,19) = 4.35$, $p = .051$, $\eta_p^2 = .186$, but not on correct trials ($p = .812$). As can be seen in Figure 1, the ERN amplitude was more negative on error trials in the teddy bear condition ($M = -2.31$, $SD = 2.14$) than in the box condition ($M = -1.00$, $SD = 2.16$).

The response-locked ERPs in the time interval of the ERN may be influenced by the P3 response to the stimulus, which is sensitive to motivation (Carrillo-de-la-Pena &

Cadaveira, 2000) and may be responsible for the positive peak that is visible around 80 ms after correct responses (see Figure 1). To control for potential P3 effects in the response-locked ERPs, we performed the same analyses including the effect of condition on amplitude (i.e. bear minus box) from correct trials averaged over CPz and Cz as a covariate. These analyses yielded comparable results: condition had an effect on error trials $F(1,18) = 5.29$, $p = .034$, $\eta_p^2 = .23$.

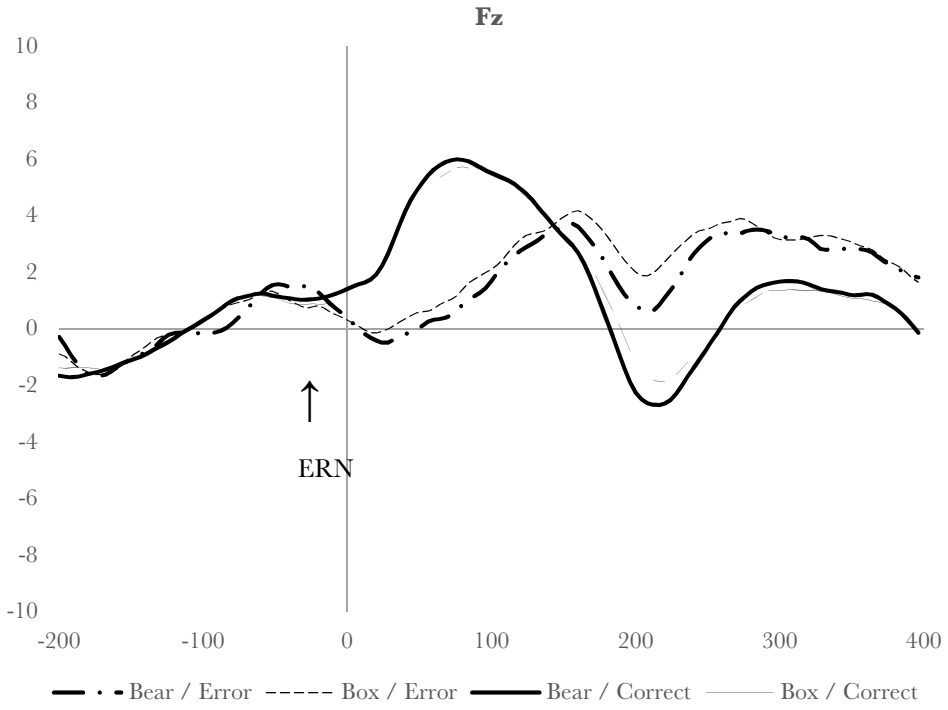


Figure 1a. Response-locked event-related potentials in μV over time (ms) from electrodes Fz as a function of correct (solid line) versus error (dashed line) response and bear (thick line) versus box (thin line) condition.

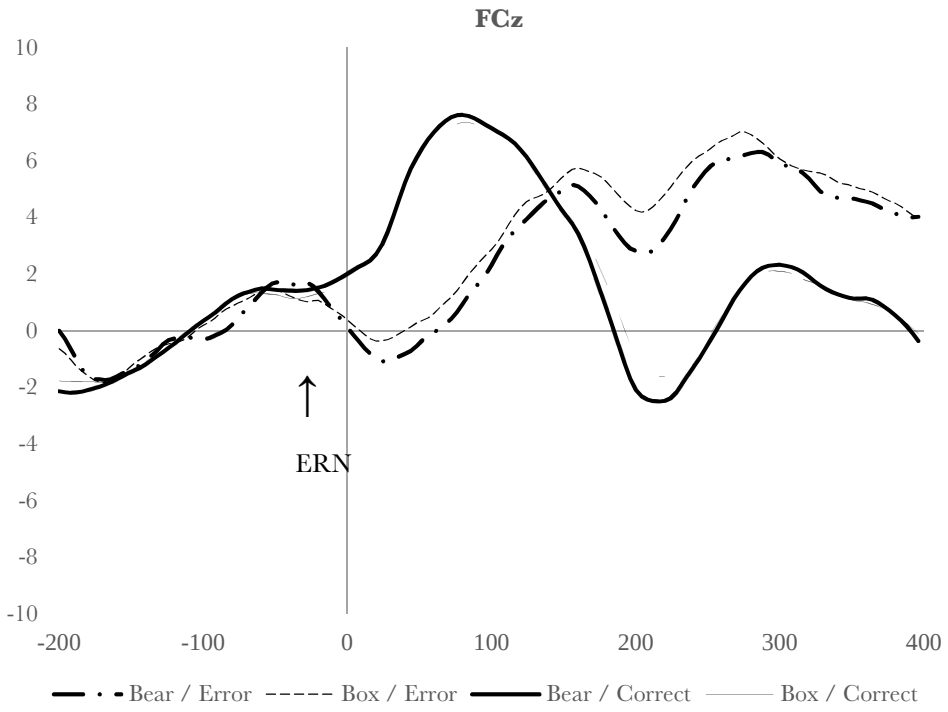


Figure 1b. Response-locked event-related potentials in μV over time (ms) from electrodes FCz as a function of correct (solid line) versus error (dashed line) response and bear (thick line) versus box (thin line) condition.

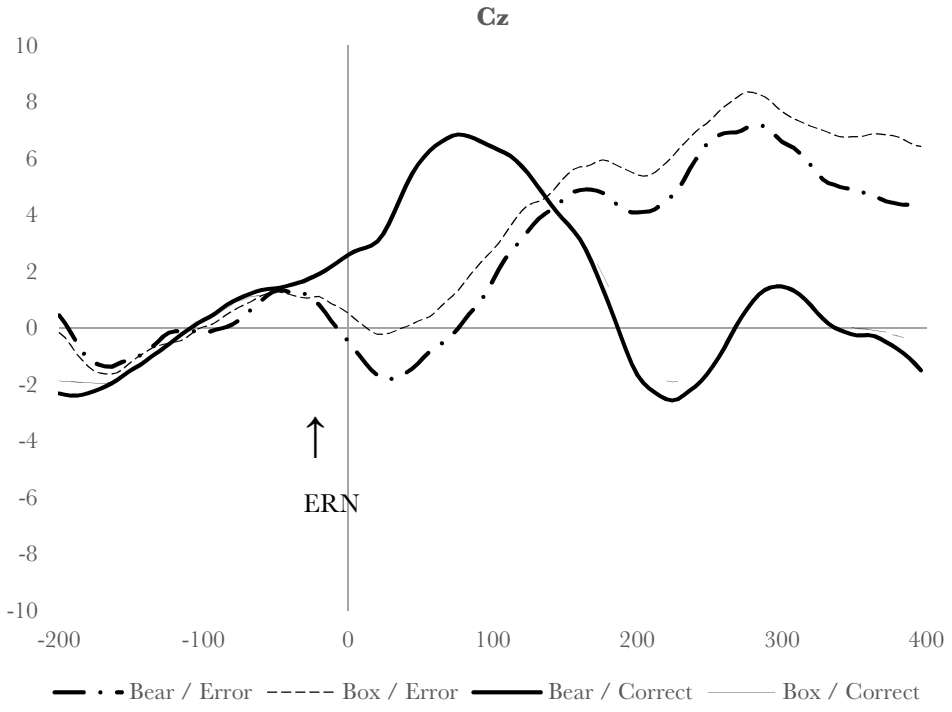


Figure 1c. Response-locked event-related potentials in μV over time (ms) from electrodes Cz as a function of correct (solid line) versus error (dashed line) response and bear (thick line) versus box (thin line) condition.

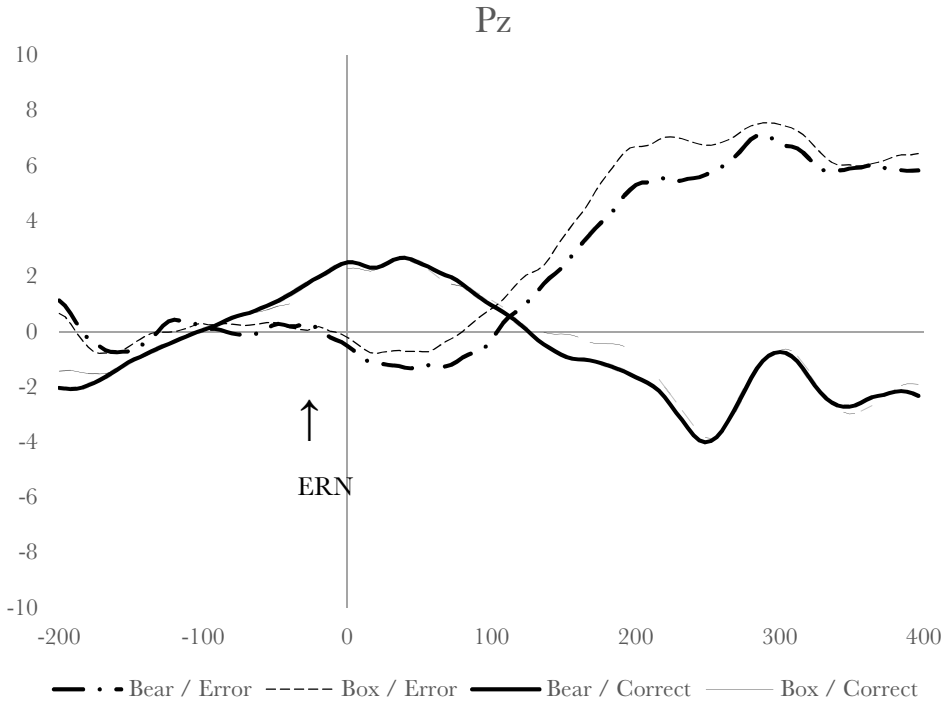


Figure 1d. Response-locked event-related potentials in μV over time (ms) from electrodes Pz as a function of correct (solid line) versus error (dashed line) response and bear (thick line) versus box (thin line) condition.

Trait intrinsic motivation. Next, we performed a one-way repeated measures ANOVA on amplitudes on error trials with condition as within-subject factor and trait intrinsic motivation as a covariate. The analysis revealed a main effect of trait intrinsic motivation, $F(1,18) = 5.90$, $p = .026$, $\eta_p^2 = .247$, and a marginal interaction between condition and trait intrinsic motivation, $F(1,17) = 3.70$, $p = .070$, $\eta_p^2 = .171$. After controlling for potential P3 effects, we still found a main effect of trait intrinsic motivation, $F(1,17) = 6.50$, $p = .021$, $\eta_p^2 = .276$, and an interaction between condition and trait intrinsic motivation, $F(1,17) = 4.47$, $p = .050$, $\eta_p^2 = .208$. As can be seen in Figure 2, only participants high in trait intrinsic motivation displayed less negative ERN amplitudes, a pattern consistent with lower task engagement, in the box compared to the teddy bear condition.

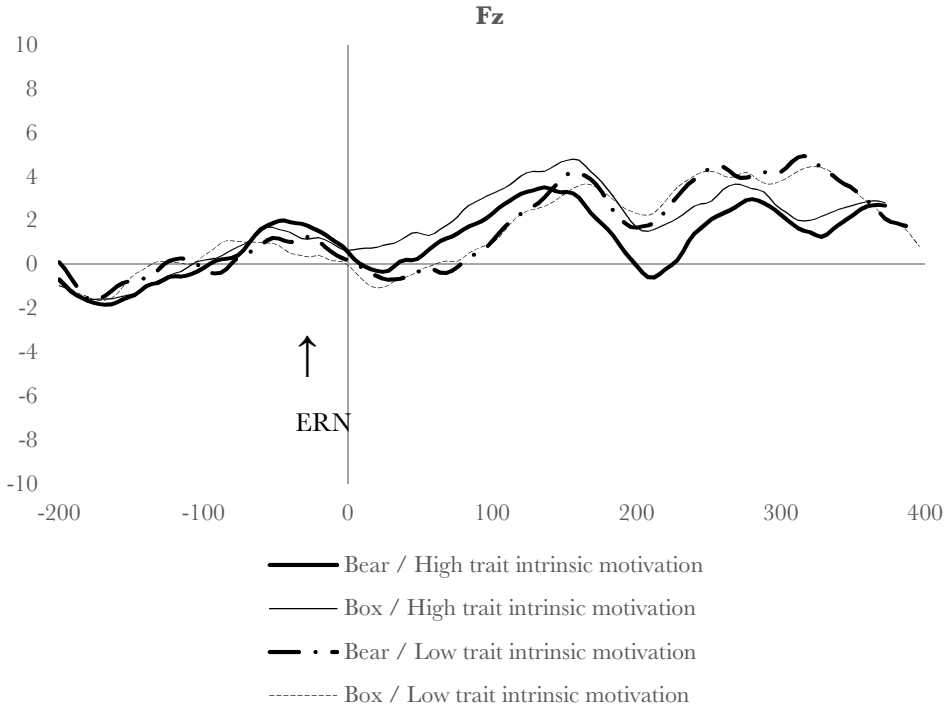


Figure 2a. Response-locked event-related potentials from error trials in μV over time (ms) from electrode Fz as a function of holding a teddy bear (thick line) versus box (thin line) and high (solid line) versus low (dashed line) trait intrinsic motivation. For presentational purposes, we created high- and low-scoring groups on the basis of median split.

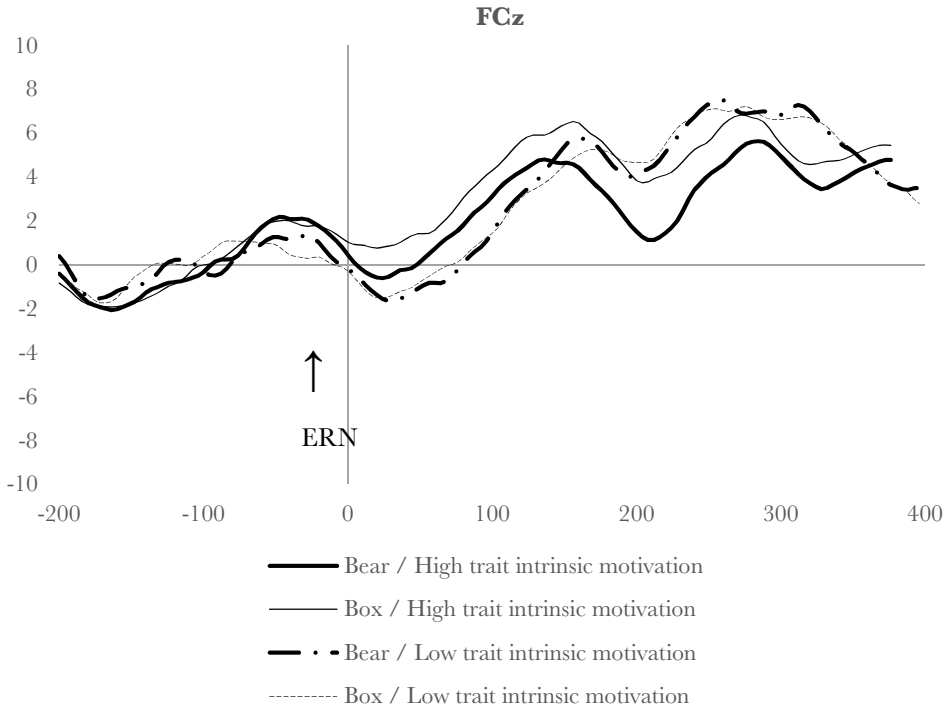


Figure 2b. Response-locked event-related potentials from error trials in μV over time (ms) from electrodes FCz as a function of holding a teddy bear (thick line) versus box (thin line) and high (solid line) versus low (dashed line) trait intrinsic motivation. For presentational purposes, we created high- and low-scoring groups on the basis of median split.

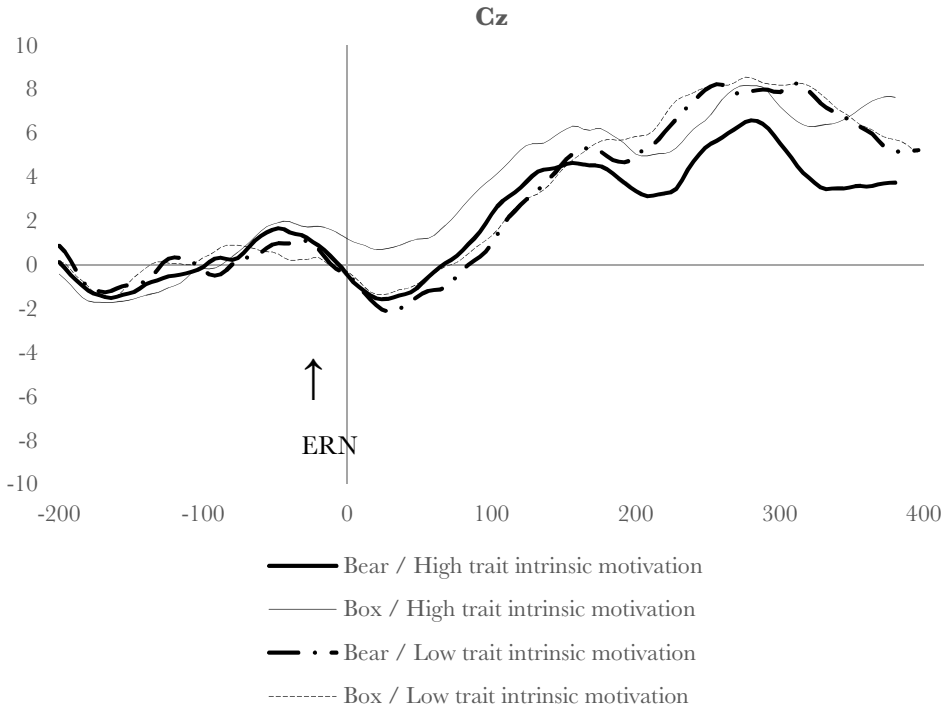


Figure 2c. Response-locked event-related potentials from error trials in μV over time (ms) from electrodes Cz as a function of holding a teddy bear (thick line) versus box (thin line) and high (solid line) versus low (dashed line) trait intrinsic motivation. For presentational purposes, we created high- and low-scoring groups on the basis of median split.

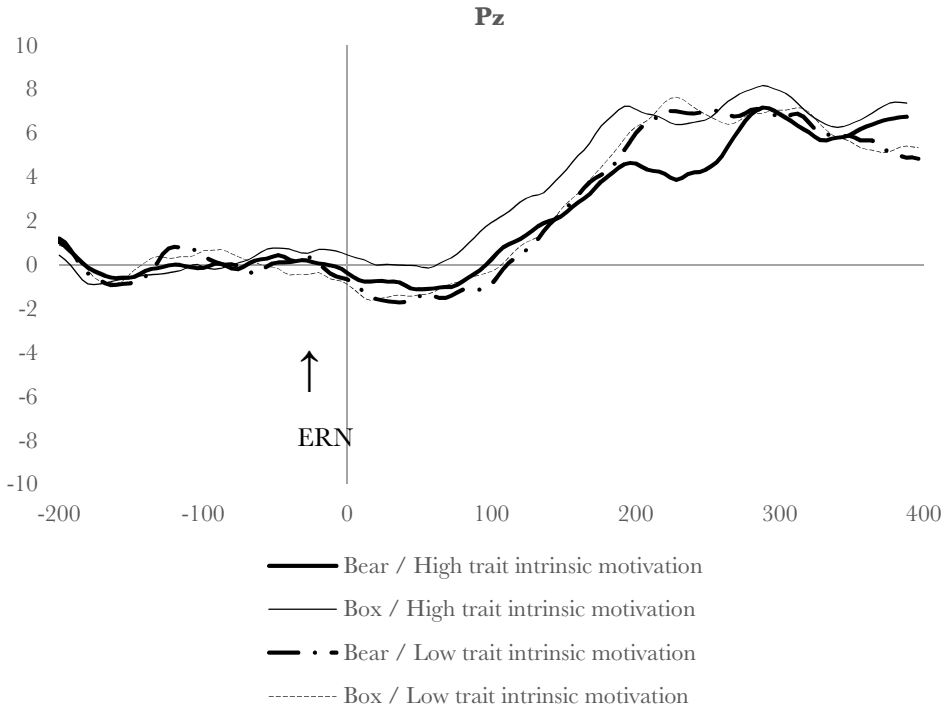


Figure 2d. Response-locked event-related potentials from error trials in μV over time (ms) from electrodes Pz as a function of holding a teddy bear (thick line) versus box (thin line) and high (solid line) versus low (dashed line) trait intrinsic motivation. For presentational purposes, we created high- and low-scoring groups on the basis of median split.

Discussion

In the present study, we observed that simulated interpersonal touch, e.g., holding a teddy bear, led to larger ERN amplitudes when making errors than holding a cardboard box. This effect emerged even after we corrected for the P3 motivational response to the stimulus. We also found that trait intrinsic motivation moderated the effect of simulated interpersonal touch. Whereas participants low in trait intrinsic motivation had similar ERN amplitudes across both conditions, participants high in trait intrinsic motivation displayed greater ERN amplitudes in the teddy bear compared to the box condition. This pattern of findings is consistent with the idea that simulated interpersonal touch allowed participants sensitive to cues of intrinsic motivation to maintain higher levels of motivation during the task.

The present results mesh will with earlier findings regarding trait intrinsic motivation and the ERN. Specifically, in a previous study, we found that a different questionnaire marker of trait intrinsic motivation, i.e. absorption, predicted larger ERN/Ne amplitudes only during the first 20 minutes of performance, after which absorption was associated with a sharp decline in ERN amplitudes (Tops & Boksem, 2010). Presumably, the latter pattern reflects the responsiveness of intrinsically motivated people to interesting and novel aspects of the task. As long as the task is interesting and engaging, people high (rather than low) in trait intrinsic motivation are more motivated to perform the task. However, when the task becomes less interesting, they become increasingly less motivated.

It is notable that items of the absorption questionnaire (e.g., "Becoming extremely involved in a good book or movie is somewhat rare for me [reverse-coded]") show substantive overlap with items of our present questionnaire of trait intrinsic motivation (e.g., "When I'm watching a really good movie, I get so involved in the film that I don't even think of doing anything else" [vs. "I often want to get something else to do while I'm watching the movie"]) Thus, the present results converge with earlier findings showing that trait intrinsic motivation predicts smaller ERN amplitudes under less motivating conditions.

The present study leaves several questions to be addressed in future work. First, the present study only included a teddy bear and a box condition, so we cannot definitively conclude to what extent either condition drove the observed effects on the ERN. Future research is needed to replicate the present study with an additional condition in which participants do not hold anything. Second, touch did not affect performance in the present

study. This is consistent with many studies showing an ERN effect in the absence of performance effects (William J. Gehring et al., 1993; Inzlicht & Al-Khindi, 2012; Tops & Boksem, 2010). Nevertheless, other studies have shown that interpersonal touch can improve performance (Nakagawa et al., 2011; Steward & Lupfer, 1987). More research is therefore needed to specify the conditions under which (simulated) interpersonal touch enhances the ERN and/or performance.

Another fruitful avenue for future research would be to investigate what specific qualities of the teddy bear increase task engagement. Recent studies have shown that careful task performance can be increased by inducing an embodied state of care: carefulness (Nittono, Fukushima, Yano, & Moriya, 2012; Sherman, Haidt, & Coan, 2009). Cute features of infants do not only elicit feelings of tenderness and nurturance in adults (Konrad Lorenz & Martin, 1971), but may also translate into careful motor behavior appropriate for caring for a small, vulnerable child (Nittono et al., 2012). Thus, cute objects such as teddy bears may elicit careful behavior. Other studies suggest that it is the softness of the teddy bear that helps buffer people against the effects of social exclusion (Tai et al., 2011) and mortality salience (S. L. Koole et al., 2014). Because we did not measure perceived qualities of the teddy bear (e.g., cuteness, softness, anthropomorphism), more research is needed to determine the relative contribution of each of these qualities in influencing the ERN.

In conclusion, whereas previous studies have shown an encouraging effect of interpersonal touch in educational and health settings, the present study is one of the first to show that simulated interpersonal touch may have a similar effect, especially among people who are sensitive to triggers of intrinsic motivation. These findings suggest that touch can be utilized as a motivating and health-promoting tool (Tjew-A-Sin & Koole, 2013). In recent times, interpersonal touch has been increasingly perceived as an ethical or risk management issue to be avoided, and educational and healthcare professionals may fear that their use of touch is misinterpreted or considered inappropriate. In light of these developments, simulated interpersonal touch may form an important alternative way to allow people to benefit from the encouraging effects of touch.

Chapter 5.

Soothing Softness: Touching a Soft Fabric May Increase Security Among People with Insecure Attachment Styles

This chapter is based on: Tjew-A-Sin, M. & Koole, S.L. (2020). Manuscript in preparation.

Abstract

The tactile sensations associated with touching soft material may simulate part of the experience of receiving affectionate interpersonal touch, and thus provide social connectedness and security without the risk of rejection. Such experiences may especially appeal to people who experience a lack of affectionate touch from others but find intimacy to threatening, such as people with a fearful-avoidant attachment. To test this idea, two experiments examined the effects of touching a soft fabric or a control fabric among participants with varying attachment styles. In Study 1 (N = 279), touching a soft (versus control) fabric led to increased feelings of connectedness with close others among participants high on fearful-avoidant attachment and participants low on secure attachment. In Study 2 (N = 173, partially from the same sample as Study 1), touching a soft (versus control) fabric led to an increase fabric in felt security among insecurely attached participants, as did visualizing an accepting relationship (versus distant relationship). Furthermore, touching a soft fabric insulated participants low on secure attachment from the negative consequences of visualizing a distant relationship on felt security. These findings suggest that touching soft materials can provide a form of embodied emotion regulation particularly to individuals with fearful and low secure attachment.

Keywords: touch, softness, haptic sensations, security, adult attachment

Affectionate touch is any form of direct physical contact between people that conveys affection (e.g., love, care, appreciation; Floyd, 2006), and includes such behaviors as hugging, patting, stroking, and caressing. People commonly receive regular affectionate touch within close relationships, which leads to better relational, psychological, and physical well-being (Debrot et al., 2013; R. I. Dunbar, 2010; Field, 2001, 2014; Jakubiak & Feeney, 2017; Tjew-A-Sin & Koole, 2013). Many of the benefits of frequent affectionate touch for well-being can be attributed to its soothing or calming effects, particularly in the event of threat (Jakubiak & Feeney, 2017).

Insecurely attached people may be less willing or able to maintain close relationships (see Mikulincer & Shaver, 2007a; Mikulincer & Shaver, 2012) and are hence less likely to receive regular affectionate touch (Ainsworth et al., 1978; Bowlby, 1969). Although people with an insecure attachment indicate a lack of touch in their lives (Brennan, Wu, et al., 1998), they nonetheless have difficulty with intimacy because of uncomfortable or negative experiences in the past (Jakubiak & Feeney, 2016b; Mikulincer & Shaver, 2007b). Compared to the securely attached, people with an insecure attachment have less satisfying romantic relationships (Bookwala & Zdaniuk, 1998; Collins & Read, 1990), lower levels of self-esteem (J. Feeney & Noller, 1990) , and more difficulty regulating emotions (Brennan, Wu, et al., 1998). They are also less likely to seek and receive emotional support from relationship partners when stressed (Simpson, Rholes, & Nelligan, 1992) (J. A. Simpson, Rholes, & Nelligan, 1992). How can insecurely attached people attain some of the security that affectionate touch provides?

One way may be via alternative sources of soft tactile stimulation. This strategy commonly used by young children, who sooth themselves with a stuffed toy animal or a soft blanket (Cohen & Clark, 1984; Triebenbacher, 1997). The basic physiological apparatus that allows children to feel comforted by soft sensations is the same in adults (e.g., Jakubiak & Feeney, 2017; Löken & Olausson, 2010; Löken, Wessberg, McGlone, & Olausson, 2009). Seeking security from soft tactile simulation as an alternative to affectionate touch may be particularly attractive to insecurely attached people who experience a lack of affectionate touch, but are fearful of trusting another person.

Soothing Effects of Affectionate Touch

Among infants, appropriate nurturing touch from one's caregivers is the most tangible, concrete indicator of safety, security, and of being cared for (Bowlby, 1969). This is no different for adults. Humans have a dedicated neurophysiological system for processing gentle, caress-like bodily contact between individuals (Löken et al., 2009; F. McGlone et al., 2012; Walker & McGlone, 2013). This system likely evolved to promote and facilitate bonding. For instance, affectionate touch between people is encouraged by a distinct increase in in the sensation of softness when touching another person's skin, thus making it more rewarding to touch others affectionately (Gentsch, Panagiotopoulou, & Fotopoulou, 2015). Through such physiological systems, affectionate provides calming and bonding effects throughout the human lifespan.

Nonetheless, affective responses to touch can also occur without activation of a person's neurophysiology (Essick et al., 2010; Krahé et al., 2018). For instance, children who were patted on the arm were less anxious during a dental visit than children who received no touch (Greenbaum, Lumley, Turner, & Melamed, 1993). Similarly, adult participants who were gently patted on the shoulder report a greater sense of security and were more willing to take financial risks compared to participants who were not touched (J. Levav & J. Argo, 2010). Furthermore, gentle touches by nurses reduce anxiety, stress, and pain in patients compared to those not touched (Aghabati et al., 2010; Busch et al., 2012; Papathanassoglou & Mpouzika, 2012; Vannorsdall et al., 2004).

Thus, even seemingly trivial interpersonal touches that do not directly engage neurophysiological systems can provide security. Nevertheless, there may be significant individual differences in the effects of affectionate touch depending attachment style, which captures people's early touch experiences (e.g., Ainsworth et al., 1978; Mikulincer & Shaver, 2007b).

Attachment Style May Moderate the Effects of Affectionate Touch

Differences in the early use of nurturing, affectionate touch by caretakers lead to individual differences in attachment (Ainsworth et al., 1978; Bowlby, 1973b; Collins & Read, 1990; Egeland & Farber, 1984). For instance, observational studies revealed that

mothers of avoidant babies showed more frequent signs of an aversion to close bodily contact. Thus, avoidant mothers were unlikely to have provided the close physical contact that leads to secure attachment (Ainsworth, 1979).

Furthermore, an experimental study by Anisfeld, Casper, Nozyce, and Cunningham (1990) used different types of baby carriers that varied the amount of physical contact between mothers and their infants. They found that infants carried on their mother's chest in soft carriers were more likely to be rated by independent observers as secure compared to infants who were transported in hard seats. The results suggest that early experiences with soft touch promotes attachment security among infants.

In a related vein, Weiss et al. (2000) investigated maternal touch effects on attachment security among low-birth-weight infants. Infants of mothers who used nurturing touch as 75% or more of their total touching of the infant were more likely to have developed secure attachments 9 months later compared to infants whose mothers used either moderate or minimal amounts of nurturing touch. Similar results were found by Gathwala, Singh, and Balhara (2008).

Once established, one's attachment style reflects internalized relational models, which contain beliefs about whether they deserve affection and care, and whether they can trust and rely on others to provide such care (Bowlby, 2008). These models guide expectations, perception, and behavior in all new relationships and remain relatively stable across the lifespan (Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). Various studies have linked adult attachment patterns to self-reports of early experiences with attachment figures (e.g., Collins & Read, 1990; Hazan & Shaver, 1987; Levy, Blatt, & Shaver, 1998; Rothbard & Shaver, 1994). Studies have also related adult attachment styles to self-report measures concerning the desire for and availability of affectionate touch (Brennan, Wu, et al., 1998; Collins & Feeney, 2004).

Secure attachment is generally associated with optimal relational outcomes in terms of frequency of affectionate touch, intimacy, closeness and support. They are comfortable seeking intimacy and closeness with their partners and are believe that they are worthy of care and affection (Bartholomew, 1990; Bartholomew & Horowitz, 1991; Collins & Feeney, 2004). They both frequently desire and receive affectionate touch (Brennan, Wu, et al., 1998).

Anxious-preoccupied people tend to be comfortable with closeness and intimacy, but tend to doubt their self-worth and whether they deserve affection (Bartholomew &

Horowitz, 1991). Nonetheless, they both frequently desire and receive affectionate touch. Experimental research has shown that they tend to resemble securely attached people in neutral situations; only in threatening situations do they desire somewhat high levels of intimacy in order to feel loved and supported (Campbell & Marshall, 2011; Collins & Feeney, 2004).

Dismissive-avoidant adults tend to be compulsively self-reliant and dismissive of their need for intimacy and closeness (Bartholomew, 1990; Bartholomew & Horowitz, 1991). They tend to have a positive view of self, but have trouble trusting others. Dismissive-avoidant individuals perceive touch as aversive (Brennan, Clark, & Shaver, 1998; Brennan, Wu, et al., 1998; Chopik et al., 2014) and are thus unlikely to seek affectionate touch.

Finally, fearful-avoidant people have a painful personal history of rejection, resulting in feelings of unworthiness, and distrust of others. Although they often crave closeness and intimacy, they are highly fearful of seeking care and affection from others (Bartholomew, 1990; Bartholomew & Horowitz, 1991), and hesitate to form close relationships (Collins & Feeney, 2004). Fear of intimacy and rejection appears to harm the fearful-avoidant more than other insecure groups.

For instance, in their close relationships, fearful-avoidant people provide care that lacks close physical contact and sensitivity. In observational studies of their interactions with romantic partners, fearful-avoidant people score very low on trust and receptivity, gaze, attentiveness and pleasantness of voice and facial expression. Tellingly, they sit farthest from their partners and are the least comfortable talking to them (Guerrero, 1996).

The fearful-avoidant are more troubled than other insecure people and experience frequent psychological distress (Feeney, 1999 (J. A. Feeney, 1999)). They are also most likely to become depressed and lonely compared to other insecurely attached (Murphy & Bates, 1997; Pincus & Wilson, 2001). The avoidance of intimacy for fear of rejection even impedes successful psychotherapy and treatment (Reis & Grenyer, 2004). Only when rejection is least likely will their behavior be guided by their emotional desire for intimate contact (J. A. Simpson & Steven Rholes, 2017).

People with a fearful-avoidant could greatly benefit from the security that affectionate touch provides. However, their high sensitivity to rejection prevents them from seeking physical contact and support. An alternative way for them to gain the benefits of interpersonal touch may be through bodily cues that simulate gentle, caring touch.

The Substitution Route: Simulated Interpersonal Touch

People with an unfulfilled desire for affectionate touch are likely to look for alternative ways of obtaining emotional comfort. Consequently, such people may be particularly receptive to alternative sources of soft tactile stimulation, such as touching soft inanimate objects, which may act as a substitute for interpersonal touch. To be sure, interacting with a soft animate object can never provide the full riches of an actual interpersonal exchange. Nevertheless, interacting with a soft animate object may offer certain advantages over actual interpersonal exchanges. In particular, interacting with soft inanimate objects removes any threat of potential rejection. The latter is may be especially attractive for whom the risk of rejection is of paramount concern, such as people with a fearful-avoidant attachment style.

The strategy of resorting to inanimate sources of comforting touch is akin to the classic psychoanalytic notion of "transitional objects" (Clark, 1998; Triebenbacher, 1997). The latter refers to objects, which often have comforting tactile properties that allow the child to symbolically reunite with the mother. Experimental studies support the idea that the presence of such objects reduces distress much like the presence of the parent (e.g., Passman & Weisberg, 1975). In a similar manner, pleasant touch sensations may consciously or unconsciously evoke part of the sensory experience of comforting, affectionate interpersonal touch.

Consistent with this, the sensory experience of softness has been shown to facilitate the categorization of sex-ambiguous faces as female, suggesting that softness may trigger simulations of stereotypically feminine traits such as tenderness (Slepian, Weisbuch, Rule, & Ambady, 2011).

Furthermore, holding a soft teddy bear has been shown to buffer against feelings of social exclusion (Tai et al., 2011), presumably by allowing a simulation of affectionate touch. And in a recent study, blind-folded participants who received soft slow brush-strokes on the arm touch were buffered against distress following social exclusion, while fast strokes that did not simulate affectionate touch had no effect (von Mohr et al., 2017).

Lastly, participants low in avoidant attachment have been found to derive a sense of security by recalling experiences in which they received affectionate touch from a friend or romantic partner (Jakubiak & Feeney, 2016a; Kim, Feeney, & Jakubiak, 2018). The

latter findings suggest that not just actual affectionate touch, but also mental simulations of an interpersonal touch experience alone may increase sense of security.

Few studies have examined the notion that people—especially with insecure attachment styles—may derive important emotional benefits from soft tactile experiences. One study found that anxious children are more likely to depend on transitional objects for longer than developmentally appropriate (Bachar, Canetti, Galilee-Weisstub, Kaplan-DeNour, & Shalev, 1998) Among adolescents, the use of a transitional or comfort object has been related to anxious and fearful attachments (Bachar et al., 1998; Stagg & Li, 2019).

In another line of research, participants were led to hold either a soft or a control fabric for one minute, ostensibly as part of a consumer test (Van Horen & Mussweiler, 2014). Participants who touched a soft fabric (rather than a control fabric) reported experiencing more certainty and higher tolerance of uncertainty. The latter experiments did not consider individual differences in attachment style. However, feelings of uncertainty are more prevalent among insecurely attached people (especially the anxious-preoccupied and fearful-avoidant subtypes) than among securely attached people (Mikulincer & Shaver, 2003).

Another set of studies examined the effects of holding a teddy bear on coping with existential threat (S. L. Koole et al., 2014). One study showed that soft touch by a female experimenter lowered death anxiety, especially among participants with low (rather than high) self-esteem (S. L. Koole et al., 2014, Study 1). Furthermore, an experimental reminder of death led low self-esteem participants to attribute a greater monetary value to a teddy bear (S. L. Koole et al., 2014, Study 3), an effect that did not occur among participants with high self-esteem. Low self-esteem is correlated with insecure attachment, especially with its anxious-preoccupied and fearful-avoidant subtypes (Bartholomew & Horowitz, 1991).

Finally, a recent study has found that touching a warm object led to increased desire to affiliate, especially among participants low in attachment avoidance and high in attachment anxiety (Fay & Maner, 2012). Given that affectionate touch is associated with warmth (Williams et al., 2009), these findings are consistent with the idea that simulated interpersonal touch has special value for insecurely attached people. Although warmth cannot be equated with soft tactile stimulation, the evidence supports the more general idea that insecurely attached people may benefit more than people with other attachment styles

from tactical sensations that simulate important embodied aspects of affectionate interpersonal touch.

Several strands of evidence thus suggest that simulated interpersonal touch may provide emotional security, especially among people with anxious and fearful attachment styles. However, some of the available evidence is indirect given that relevant studies did not assess individual differences (Van Horen & Mussweiler, 2014), assessed self-esteem rather than attachment style (S. L. Koole et al., 2014), or examined the effects of warmth rather than touch (Fay & Maner, 2012). It is therefore desirable to directly investigate the effects of soft tactile experiences among people with varying attachment styles.

The Present Research and Hypotheses

In the present research, we investigated the potentially security-providing effects of soft touch among people with secure and insecure attachment styles. To this end, we led participants with varying attachment styles to touch a piece of fabric that was cut either from a soft fleece blanket or a cotton kitchen towel. Our experimental manipulation was based on Van Horen and Mussweiler (2014). Unlike the latter researchers, however, we did not use a rough fabric as a control condition. Instead, we provided our participants with pieces of cloth that differed only in their relative softness, which is a more rigorous test the soothing effects of softness.

Our main hypothesis was that touching the soft fabric, rather than the control fabric, would function as a proxy for affectionate interpersonal touch and thus provide security to insecurely attached participants. More specifically, we predicted that especially participants with a fearful-avoidant attachment style should respond favorably to soft touch, given that these participants have the greatest unfulfilled need for affectionate touch. We do not expect anxious-preoccupied individuals to respond favorably to touching the fabric, as we do not provide an explicit threat in our studies (Campbell & Marshall, 2011; Collins & Feeney, 2004).

Felt security, a notion derived from attachment theory, has conceptualized this construct as comprising feelings of care, esteem, love, and safety (Bowlby, 1969; Holmes & Rempel, 1989; Mikulincer & Shaver, 2007b; Murray, Holmes, & Griffin, 2000) and describes the perceived sense of security received from, and the availability of, close

attachment figures. In Study 1, we measured felt security indirectly by asking participants to report their sense of connection to close others from their daily lives. We hypothesized that touching a soft fabric would increase feelings of connectedness with close others among fearful-avoidant participants.

In Study 2, which used part of the same sample as Study 1, we compared the effects of touching a soft fabric with a common, linguistic way of priming security. Specifically, we asked people to visualize and write about a supportive and accepting relationship (Mikulincer & Shaver, 2007b). Previous studies have shown that such linguistic security primes activate corresponding interpersonal perceptions, expectations, and behaviors (M. Baldwin, Keelan, Fehr, Enns, & Koh-Rangarajoo, 1996; M. W. Baldwin, 1994). We therefore predicted that priming an accepting relationship and touching a soft fabric would have similar effects on felt security. Finally, we explored whether touching a soft fabric could buffer insecurely attached individuals against the psychological threat of priming a distant relationship.

Study 1

Method

Participants and design. The sample consisted of 279 paid volunteers (212 women, 67 men; M_{age} = 20.43, SD_{age} = 3.21) at the Vrije Universiteit Amsterdam. We aimed to collect roughly 40 participants per experimental condition. Participants were recruited in two subsamples. The first subsample was recruited March-May, 2015, and consisted of 106 volunteers (78 women, 28 men; M_{age} = 20.80, SD_{age} = 2.62). The second subsample was recruited October-December, 2015, and consisted of 173 volunteers (134 women, 39 men; M_{age} = 20.21, SD_{age} = 3.52), and also participated in Study 2. One-hundred-and-sixty-two participants were native Dutch (58.1%), 114 participants had a nonnative background (40.9%), and three participants did not indicate their background (1.1%). Participants were randomly assigned to either the soft touch (n = 137) versus control touch (n = 142) conditions. Individual differences in attachment were measured. The main dependent variable was participants' sense of connection to close others. All measures, manipulations, and exclusions are reported in this paper.

Procedure. Participants were greeted by the experimenter and escorted to a private cubicle. All instructions were computer-administered. Participants were informed that they were taking part in a study that pretested materials for future studies. Informed consent was obtained using a check box on the information page. On top of the desk, there was an envelope in the far end corner that contained the material for either the soft touch or control touch condition. The experimenters who ran the study were blind to condition and study hypotheses.

Participants first filled out a set of questionnaires, which included measures of adult attachment style, self-esteem, and mood (only measured among subsample 1). Results pertaining to self-esteem were of exploratory interest and are described elsewhere. (Briefly, we found a trend of a moderation effect of touch similar to the pattern of effects among participants low on secure attachment in both Study 1 and Study 2. This trend effect of self-esteem is not surprising considering the low levels of threat compared to previous studies (see S. L. Koole et al., 2014). In Study 2, we indeed found that soft touch had a buffering effect among people with low self-esteem under conditions of threat, conceptually replicating, S. L. Koole et al. (2014, Study 4).

Subsequently, our manipulation of soft tactile sensations was introduced, which was based on a validated paradigm (Van Horen & Mussweiler, 2014). Participants were asked to open the envelope on the desk at which they were seated, and to take out a piece of fabric, which they were requested to evaluate as a supposed pretest for a future study.

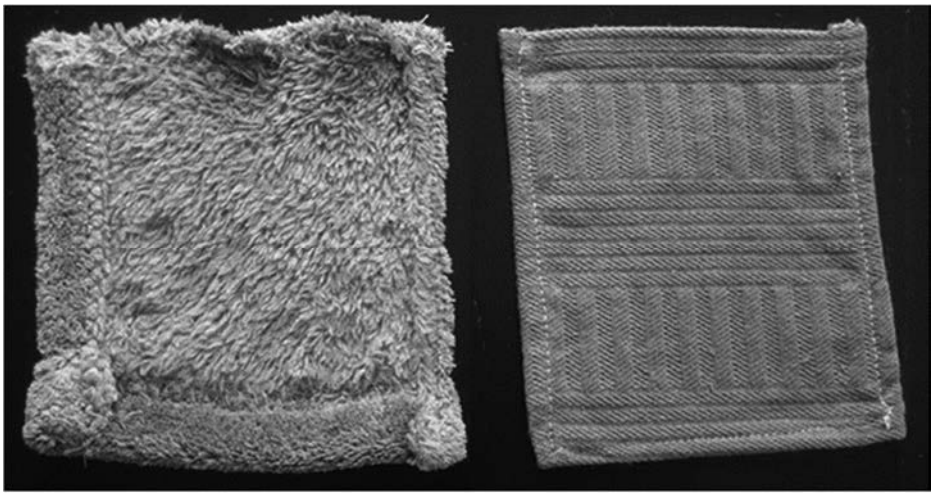


Figure 1. The soft and control fabrics used in the present studies.

In the soft touch condition, participants touched a piece of fabric cut from a soft gray throw blanket made of polyester. In the control touch condition, participants touched fabric cut from a flat gray dish towel made of cotton. The control condition was based on Van Van Horen and Mussweiler (2014). It should be noted, however, that the control fabric was not experienced by participants as rough or hard in absolute terms. Indeed, participants rated the control cloth as "less soft" instead of "hard". Our touch manipulation thus appears to be more subtle than the one used by (Van Horen & Mussweiler, 2014).

Both types of fabric measured 12 cm broad by 12 cm wide, and had been purchased a Dutch discount store-chain. Participants were asked to hold the fabric in their hand and to rate it on how soft, pretty, and nice it is to hold as manipulation checks. After rating the fabric, participants were asked to place it back in the envelope. We then measured mood for a second time. To measure participants' sense of connection to close others, they were asked to name seven people they knew from their daily lives, and to rate how connected they felt to each of them at the moment, followed by a questionnaire measuring loneliness. Results pertaining to loneliness were of secondary, exploratory interest and are described elsewhere. The rest of the procedure and results of Sample 2 are discussed in Study 2.

Materials and measures.

Attachment. Participants rated their attachment on the Attachment Style Questionnaire (ASQ; Van Oudenhoven, Hofstra, & Bakker, 2003), which was developed to measure non-relationship specific attachment styles of adults. It was translated into Dutch and validated in samples of Dutch students (Hofstra, van Oudenhoven, & Buunk, 2005). Brennan, Clark, et al. (1998) found four distinguishable dimensions in the ASQ. Secure attachment was assessed with seven items that described an ease and preference of forming close relationships e.g., "I feel at ease in intimate relationships". Fearful-avoidant attachment was assessed with five items that described a desire to get close to others, impeded by a fear of betrayal and hurt e.g., "I would like to have close relationships with other people but I find it difficult to fully trust them"; I am afraid I will be deceived when I get too close with others". Anxious-preoccupied attachment was measured with seven items that described a preoccupation and fear of being disliked by others e.g., "I often wonder whether people like me". Lastly, dismissing-avoidant attachment was measured with five items that described a preference for emotional distance from others e.g., "I prefer that others are independent of me and I am independent of them"). Cronbach's αs were .82, .85, .83 and .60 for each of the respective dimensions. Participants rated the items on 7-point scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). We used continuous dimensions following research showing that adult attachment is best measured and conceptualized in terms of dimensions, not as a categorical variable (Fraley, Waller, & Brennan, 2000). The Pearson inter-correlations of the four attachment dimensions are shown in Table 1.

Table 1

Pearson Inter-Correlations of the Four Attachment Dimensions (N = 279)

	Secure	Anxious	Dismissing
Secure subscale			
Anxious-preoccupied subscale	-.13*		
Dismissing-avoidant subscale	-.29*	-.21*	
Fearful-avoidant subscale	-.60*	-.28*	-.23*

*$p < .05$; **$p < .01$

Mood. Participants rated their moods on a brief version of the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971) by rating on 32 emotional descriptors from 1 (*not feeling the emotion at all*) to 7 (*strongly feeling the emotion*). These descriptors fell under five subscales that described affective states: tension, depression, vigor, anger, and fatigue. Cronbach's α was .95 for the first measurement and .95 for the second measurement.

Touch manipulation check. Participants rated the piece of fabric on how soft, pretty and how nice it was to hold on a sliding scale from 1 (*not at all*) to 100 (*very much*).

Connectedness to close others. Participants were asked to first list the names or initials of seven people from their daily lives. On the next screen, they rated how connected they felt to each person on a sliding scale from 1 (*not at all*) to 100 (*very much*). Ratings were averaged and combined into a single index representing participants' sense of connection to close others. Cronbach's α for this measure was .77.

Results

Manipulation checks. We first checked whether any of the participants guessed the purpose of our study. None of them did. We then conducted independent samples t-tests to check the effectiveness of the touch manipulation. Participants rated the soft fabric as softer (M = 86.42, SD = 11.64) than the control fabric (M = 39.23, SD = 19.83), $t(229.400) = 24.34$, $p < .001$, 95% CI [43.37, .51.01]. Furthermore, participants rated the soft fabric as nicer to hold (M = 77.20, SD = 23.10) than the control fabric (M = 51.96, SD = 23.91), $t(277) = 8.97$, $p < .001$, 95% CI [19.70, 30.78]. Participants also rated the soft fabric as prettier (M = 51.82, SD = 25.03) than the control fabric (M = 42.80, SD = 23.46), $t(277) = 3.11$, $p = .002$, 95% CI [3.31, 14.74]. However, the latter effect was no longer significant after controlling for experienced softness as a covariate, $F = 1.217$. Overall, the manipulation checks indicate that the soft fabric instilled softer, more pleasant tactile sensations than the control fabric.

Mood. We analyzed participants' mood changes using a repeated-measures ANOVA with mood as within-subject factor and the different attachment style as covariates to make sure that insecurely attached individuals did not have a more negative mood in our study (e.g., Wei, Vogel, Ku, & Zakalik, 2005). There was a main effect of time on mood, $F(1, 105) = 9.20$, $p = .003$, $\eta^2 = .08$, such that participants reported less negative mood after touching and rating one of the two fabrics (M = 2.52, SD = .86) compared to before touching the fabric (M = 2.61, SD = .88). There was no interaction effect between time and

touch on mood. There was also no interaction effect between touch and attachment dimension on mood changes, Fs < 1.77. Attachment dimensions also had no significant effects on mood changes, Fs < 1.94.

Attachment style x touch effects on connectedness. We conducted multiple linear regression analyses to test whether participants who scored high on fearful-avoidant attachment would report more connectedness in the soft touch (versus control touch) condition. We standardized the four attachment dimensions, computed interaction terms between them and touch, and entered each of the attachment dimensions and interaction term combinations in separate multiple regression analyses predicting connectedness.

There was a main effect of fearful-avoidant attachment, β = -.19, $t(274)$ = -3.38, p = .001, 95% CI [-3.91, -1.03], and a two-way interaction between touch and fearful-avoidant attachment, β = .19, $t(274)$ = 3.26, p = .001, 95% CI [.95, 3.83]. The latter effects are graphically displayed in Figure 2. Simple-slopes analyses (Aiken & West, 1991) showed that touching the soft fabric (versus the control fabric) led participants who scored high on fearful-avoidant attachment to feel more socially connected, β = .22, $t(274)$ = 2.60, p = .010, 95% CI [.65, 4.72]. Unexpectedly, participants who scored low on fearful-avoidant attachment felt less socially connected after touching the soft fabric rather than the control fabric, β = -.17, $t(274)$ = -2.02, p = .044, 95% CI [-4.13, -.06]. These effects were not a priori predicted, so we are reluctant to interpret in here. Nevertheless, it may be that people low on fearful-avoidance do not simulate close relationship experiences based on an impoverished approximation of affectionate touch, and it may even adversely affect their normally high levels of connectedness. Indeed, securely attached people are more discriminate in the type of touch, closeness and affection that they prefer (Brennan, Wu, et al., 1998; Krahé et al., 2018).

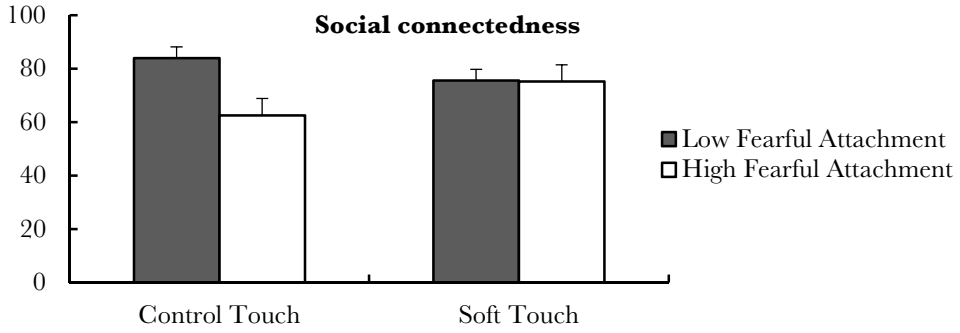


Figure 2. Connectedness with close others (0-100) as a function of fearful-avoidant attachment (coded 1 *SD* below and above the mean) and touch in Study 1. Standard errors are shown as error bars attached to each column.

Unexpectedly, we also found an interaction effect between touch and secure attachment. For the secure subscale (see Figure 3), there was a main effect of secure attachment, $\beta = .43$, $t(274) = 7.95$, $p < .001$, 95% CI [4.11, 6.81], and a two-way interaction between touch and secure attachment, $\beta = .-13$, $t(274) = -2.34$, $p = .020$, 95% CI [-2.96, -.25]. Simple-slopes analyses showed that touching soft fabric (versus control fabric) led low securely participants to feel more connected, $\beta = .15$, $t(274) = 1.97$, $p = .049$, 95% CI [.01, 3.82]. For high securely attached participants, touch had no effect, $\beta = -.10$, $t(274) = -1.36$, $p = .176$, 95% CI [-3.18, .59].

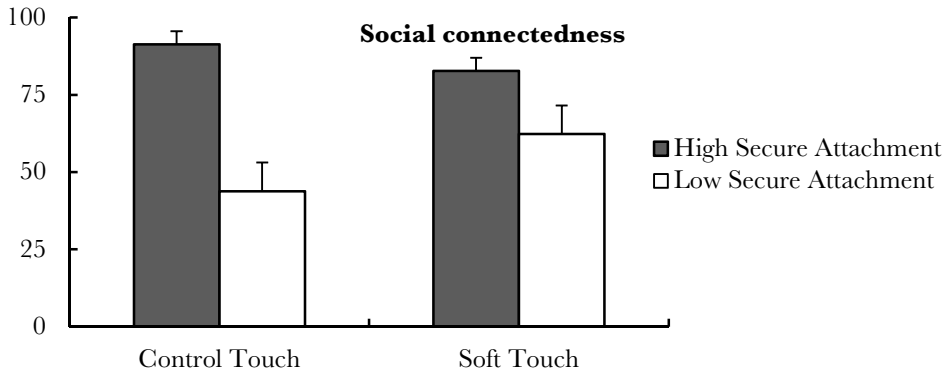


Figure 3. Connectedness with close others (0-100) as a function of secure attachment (coded 1 *SD* below and above the mean) and touch in Study 1. Standard errors are shown as error bars attached to each column.

There were no effects involving touch and anxious-preoccupied and dismissing-avoidant attachment styles.

Discussion

The results of Study 1 showed that touching a soft (versus control) fabric interacted with fearful-avoidant attachment style to predict participants' sense of connection to close others. Fearful-avoidant participants reported more connectedness with people in their daily lives after touching a soft fabric than after touching a non-soft control fabric. This finding supports our hypothesis that soft tactile experiences may be a proxy for affectionate touch and can thus increase a sense of social connectedness among fearful-avoidant people.

Unexpectedly, touching the soft (rather than control) fabric led participants who were low on fearful-avoidance to report somewhat fewer close relationships. One possibility is that people low on fearful-avoidance are more discriminate in the type of touch, closeness and affection that they prefer (Brennan, Wu, et al., 1998). In particular, low fearful-avoidant people may view interpersonal touch primarily as a means of communicating affection to another person and may be less likely to derive feelings of connectedness from an impoverished simulation of interpersonal touch. This interpretation is supported by the finding that securely attached individuals are much more discriminate regarding the quality

of affectionate touch, preferring affectionate touch that optimally activates touch sensors in the skin as opposed to touch that is suboptimal, such as the touch provided here. In contrast, insecurely attached individuals are far less discriminative, and find suboptimal touch experiences just as enjoyable and meaningful (Krahé et al., 2018).

The touch manipulation also showed an unexpected interaction with secure attachment in predicting social connectedness. The shape of this interaction paralleled the interaction that was observed for fearful-avoidant attachment: Soft touch increased social connectedness among participants low on secure attachment, but not among participants high on secure attachment. Although this interaction was not a priori predicted, it seems compatible with our theoretical analysis when we examine the scale items. Specifically, low secure attachment is indicated by discomfort with relationships when they become too close or intimate, i.e., "I feel uncomfortable when relationships with other people become close", but not a dismissal of their need for connection. This suggests that they may not be frequent recipients of affectionate touch in their relationships. They may therefore also be receptive to tactile experiences that simulate interpersonal touch.

Although the theoretical explanation for both effects may be similar, it remains nonetheless important to point out a crucial distinction between these two types of insecure attachment. Whereas people low on secure attachment mainly indicate discomfort with fully relying on and trusting others, those with a fearful-avoidant attachment express such concerns clearly in relation to a fear of being hurt and deceived by others. This fits well with the theoretical perspective on fearful-avoidant attachment, which describes a history of rejection experiences (Bartholomew & Horowitz, 1991). Unsurprisingly, fearful avoidant attachment and secure attachment were strongly negatively correlated, $r(277) = .60$, $p < .01$.

Study 2

In Study 2, we investigated whether soft touch would lead to an increase of felt security, which was based on a validated measure by Luke, Sedikides, and Carnelley (2012). We were further interested in learning whether touching the soft fabric would be similar to the effect of linguistically priming an accepting relationship (e.g., Mikulincer & Shaver, 2007b). We compared the priming of an accepting relationship to priming a distant

relationship, which we predicted would only threaten the people most sensitive to interpersonal rejection, namely fearful-avoidant individuals. Finally, we examined potential interaction effects between soft touch and visualizing relationships. Although this aspect of our research was exploratory, we suspected that touching the soft fabric might buffer fearful-avoidant individuals against a decrease in felt security from visualizing a distant relationship.

Method

Participants and Design. Participants were 173 volunteers (134 women, 39 men; M_{age} = 20.21, SD_{age} = 3.52) from the Vrije Universiteit, Amsterdam who participated for two to two-and-a-half euros or partial course credit. Hundred-and-five participants were native Dutch (60.7%), 66 participants had a nonnative background (38.2%), and two participants did not indicate their background (1.2%). They were randomly assigned to the soft touch (n = 84) versus control touch (n = 89) condition, and to the attachment (n = 87) and distant (n = 86) visualization conditions. Individual differences in self-esteem and attachment were measured. Results pertaining to exploration were of secondary, exploratory interest and are described elsewhere. Felt security was the main dependent variable.

Procedure. The participants in Study 2 were part of the larger sample recruited for Study 1. The first part of the procedure was discussed in Study 1. Following the measure of connectedness to close others, participants filled out questionnaires measuring exploration and felt security. Participants were then randomly assigned to the accepting visualization or distant visualization condition. In the accepting relationship visualization condition, they were asked to first think of an accepting, security-providing relationship with someone meaningful and important to them. They were then asked to visualize this person and to type for several minutes what it is like to be around this person:

"Please think about a relationship you have had in which you have found that it was relatively easy to get close to the other person and you felt comfortable depending on the other person. In this relationship, you didn't often worry about being abandoned by the other person and you didn't worry about the other person getting too close to you. It is crucial that the nominated relationship is (or was) important and meaningful to you.

Now, take a moment and try to get a visual image in your mind of this person. What does this person look like? What is it like being with this person? You may want to remember a time when you were actually with this person. What would he or she say to you? What would you say in return? What does this person mean to you? How do you feel when you are with this person? How would you feel if this person was here with you now?"

In the distant relationship visualization condition, participants thought and wrote about a distant person in their lives with whom they did not have a close but rather a distant relationship. Importantly, participants were not asked to visualize or write about anything threatening or negative about the relationship:

"Please think of a current relationship that you have. Think of a distant relationship. Think of a person with whom you have had a truly neutral relationship. Think of a person that you don't know very well, and whom you neither like nor dislike."

All participants answered a few questions on the visualization exercise. Participants then filled out a second measurement of felt security and mood. Finally, participants were asked for some biographical information and thanked for their participation.

Materials and measures.

Felt security. Our measure of felt security was modeled after Luke et al., (2012). We measured felt security immediately after the touch manipulation before the visualization task ($\alpha = .86$) and afterwards ($\alpha = .90$). To this end, we created two semi-equivalent measures containing five items each with scales from 1 (*not at all*) to 7 (*very much*). For the first set, participants rated to what extent they felt "comforted", "looked after", "protected", "good about themselves", "loved by others". For the second set, participants rated to what extent they felt "supported", "cared for", "safe", "that they like themselves", and "cherished by others". The order in which the participants rated first one set or the other was randomized. We measured felt security twice in order to specifically look at an increase in felt security. We decided on this measurement because participants had previously filled out the connectedness measure of Study 1, which could make any subsequent security effects more challenging to gauge without a difference measure.

Visualization. Participants were asked to rate the ease of choosing the person to visualize, the ease of visualizing the person and the importance of the relationship to them as manipulation checks. They also rated their visualization of their chosen person on the following: "unpleasant", "distant", "unfriendly", "calming", "familiar" and "warm". Of these latter questions, we reverse-scored the first three items and calculated an average from all six items ($\alpha = .90$) that indicated the overall security provided by the visualized relationship. All items about the visualization task were rated on sliding scales ranging from 1 (*not at all*) to 100 (*very much*).

Results

Manipulation checks. As in Study 1, no participants correctly guessed any of our study hypotheses. We also conducted a MANOVA to check for potential differences in attachment styles across our four experimental conditions and found no significant differences, $F(169) > 2.25$, $p < .135$.

Visualization manipulation checks. Four participants mentioned after the study that they had skipped the specific visualization instructions by mistake and then assumed that they were supposed to write about accepting relationship. Our results reported remained unchanged when these participants were included in the accepting visualization condition. Nonetheless, we excluded them from our analyses. Thus, there were 87 participants in the accepting and 82 participants in the distant visualization condition. The participants in the accepting visualization condition visualized a friend (39.1%), romantic partner (34.5%), parent (14.9%), or other close relationships (11.5%). In the distant visualization condition, participants visualized a classmate (61.0%), colleague (14.6%), acquaintance (12.2%), or other distant relationships (12.2%).

We conducted independent samples t-tests to check whether participants experienced the visualization conditions differently. As expected, participants in the accepting person visualization condition found it easier to choose a person ($M = 79.86$, $SD = 22.82$) than participants in the distant relationship visualization condition ($M = 49.73$, $SD = 26.34$), $t(160.49) = 7.96$, $p = .022$, 95% CI [22.66, 37.60]. Participants in the accepting relationship visualization condition also found the person easier to visualize clearly ($M = 87.74$, $SD = 13.77$) than people in the distant relationship visualization condition ($M =$

64.57, *SD* = 25.55), *t*(122.73) = 7.27, *p* < .001, 95% CI [-29.23, -16.78]. And participants in the accepting relationship visualization condition rated the person as more important to them (*M* = 91.21, *SD* = 12.13) than people in the distant relationship visualization condition (*M* = 23.17, *SD* = 22.83), *t*(121.71) = 23.00, *p* < .001, 95% CI [62.42, 73.65].

Overall, participants who visualized an accepting relationship rated their visualization more positively on the six descriptors (*M* = 88.12, *SD* = 11.60) than people who visualized a distant relationship (*M* = 57.52, *SD* = 17.00), *t*(1141,92) = 13.60, *p* < .001, 95% CI [-34.85, -25.89]. We tested with two-way ANOVAs whether touch and visualization conditions interacted to affect the ease of choosing the person, the ease of visualizing the person, how important the chosen person was and the positivity of visualization. We found no effects, *F*s < .668, *p*s > .415.

Mood. We conducted a repeated-measures ANOVA with mood as within-subject factor and visualization as between-subject factor. There was a main effect of time on mood, *F*(1, 167) = 37.03, *p* < .000000001, η^2 = .18, qualified by an interaction between time and visualization, such that participants reported a somewhat greater reduction in negative mood in the accepting relationship visualization condition (*M* = 2.60, *SD* = .93; *M* = 2.34, *SD* = .88) compared to the distant relationship visualization condition (*M* = 2.67, *SD* = .96; *M* = 2.54, *SD* = .95)

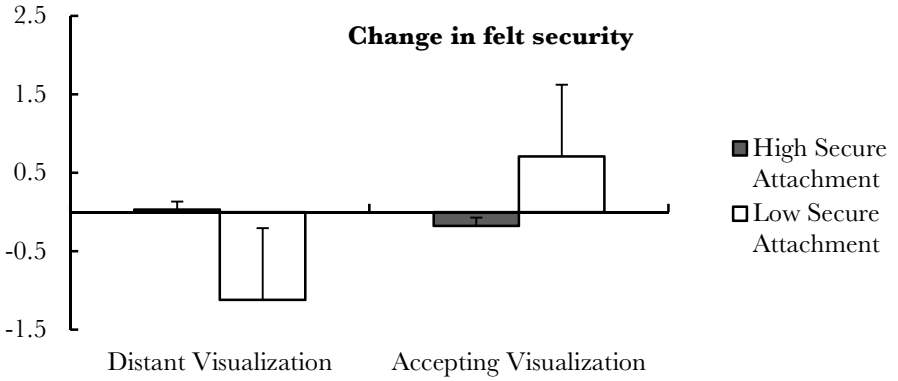
Effects of visualization and touch condition on felt security. As indicated by an independent samples t-test: *t*(167) = -1.11, *p* = .270, soft touch did not directly increase felt security, even though it increased awareness of one's close connections. We next looked at change in felt security using difference scores. An independent samples t-test confirmed that visualizing an accepting relationship led to a greater increase in felt security (*M* = .24, *SD* = .73) than visualizing a distant relationship (*M* = -.30, *SD* = .76), *t*(167) = 4.75, *p* < .001, 95% CI [.32, .77]. Importantly, in this test, soft touch also led to a higher increase in felt security (*M* = .10, *SD* = .74) compared to the control touch (*M* = -.14, *SD* = .81), *t*(167) = -1.98, *p* = .049, 95% CI [.001, -.48]. However, we found no interaction between touch and visualization on increases in felt security, *F*(167) = .015, *p* = .902.

Attachment style as a moderator of touch and visualization effects on felt security. For the secure attachment subscale (see Figure 4), we found a three-way interaction between touch, secure attachment and visualization, β = .15, *t*(161) = 2.01, *p* = .042, 95% CI [.004, .23]. Simple slopes showed that in the control touch condition, there

was a main effect of visualization, $\beta = .32$, $t(161) = 3.08$, $p = .002$, 95% CI, [.09, .41], and an interaction between visualization and secure attachment, $\beta = -.29$, $t(161) = -2.87$, $p = .005$, 95% CI [-.37, -.07]. Specifically, in the control touch condition, low secure attachment was associated with a decrease in felt security after visualizing a distant relationship, $\beta = .31$, $t(161) = 2.22$, $p = .028$, 95% CI [.03, .45]. In the control condition, low secure attachment was also associated with a nonsignificant increase in felt security after visualizing an accepting relationship, $\beta = -.25$, $t(161) = -1.83$, $p = .069$, 95% CI [.-.41, .02]. We found the opposite visualization effect at high levels of secure attachment, $\beta = .60$, $t(161) = 4.39$, $p = .0002$, 95% CI [.26, .68], such that securely attached individuals showed a decrease in felt security in the accepting relationship visualization condition. We return to the latter effect in the discussion.

In the soft touch condition, the two-way interaction between visualization and secure attachment was not significant, $\beta = .03$, $t(161) = .23$, $p = .821$. Overall, the pattern of findings suggests that soft touch helped participants that were low on secure attachment maintain a sense of security while visualizing a distant relationship.

a. Control fabric touch condition



b. Soft fabric touch condition

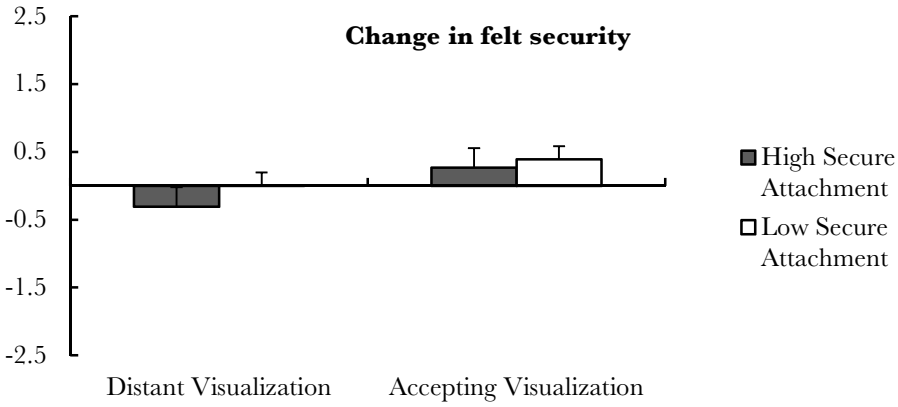


Figure 4. Changes in felt security as a function of secure attachment (coded 1 *SD* below and above the mean), touch condition, and visualization condition. Change in felt security was calculated by taking the difference in standardized scores of felt security before and after the visualization exercise. Standard errors are shown as error bars attached to each column.

We found no significant three-way interaction for the three other subscales, *t*s < 1.61, *p*s > .109. Nonetheless, for the fearful-avoidant subscale (see Figure 4) we found a main effect of visualization on increase in felt security, $\beta = .35$, $t(165) = 4.88$, $p < .001$, 95% CI [.16, .38], and a highly significant two-way interaction between visualization and fearful-avoidant attachment, $\beta = .24$, $t(165) = 3.35$, $p < .001$, 95% CI [.08, .30]. Simple-slopes analyses showed that among the highly fearful-avoidant participants, visualizing an accepting relationship led to an increase in felt security compared to visualizing a distant

relationship, $\beta = .58$, $t(165) = 5.82$, $p < .0000001$, 95% CI [.30, .62]. Among low fearful-avoidant attached participants, we found no effect of visualization, $\beta = .11$, $t(165) = 1.05$, $p = .295$, 95% CI [-.07, .24].

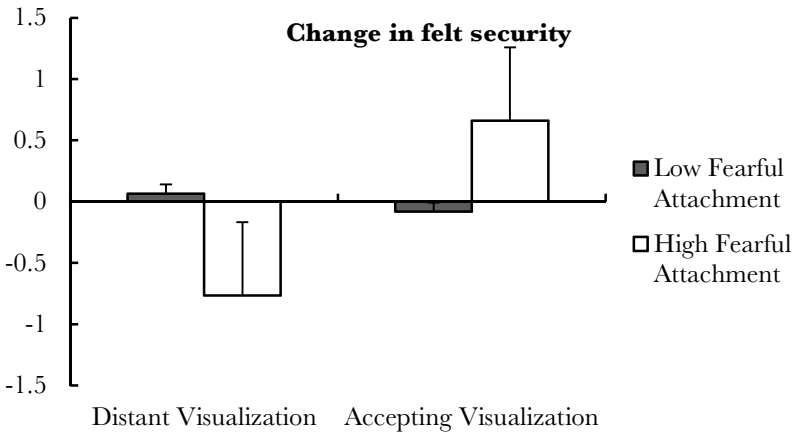


Figure 5. Standardized changes in felt security as a function of fearful-avoidant attachment (coded 1 *SD* below and above the mean) and visualization condition. Standard errors are shown as error bars attached to each column.

Discussion

The results of Study 2 suggest that touching the soft fabric led to an overall increase in felt security among participants. Moreover, visualizing a close, accepting relationship reliably increased felt security. In contrast, visualizing a distant relationship led to a decrease in felt security especially among participants with a fearful-avoidant attachment and a low secure attachment. The latter findings are consistent with prior research showing that people who are less securely attached and less able to trust and rely on others are more vulnerable to cues that signify potential rejection (Bartholomew, 1990; J. A. Feeney, 1999). There was no overall interaction between the two manipulations.

We did not observe the predicted buffering effect of touching the soft fabric among fearful-avoidant people. For fearful-avoidant people, who are the most troubled in their interpersonal relationships compared to other insecure attachment dimensions (Brennan, Clark, et al., 1998), thinking of a distant relationship may have been too threatening to be

compensated by interacting with the soft fabric. They showed a large reduction in their security after visualizing a distant person, which was not devised to be highly threatening.

However, we did find a buffering pattern among low securely attached people who touched the soft fabric. Thus, for less securely attached people, soft tactile experiences may be able to replace some of the feelings of security provided by thinking about one's' attachment relationships under mild threats to their felt security. However, given the exploratory nature of this finding, and the absence of this pattern among fearful-avoidant people, it should be replicated in future research.

Paralleling our finding in Study 1 that more secure participants responded to soft tactile touch with less perceived social connectedness, we also found that visualizing an accepting relationship led to a decrease in their felt security. Because the visualization was with an actual accepting relationship, the negative response of securely attached participants to this visualization cannot be explained by their greater selectivity (Keelan, Dion, & Dion, 1998). Instead, we speculate that this pattern may be related to counter-regulation processes (Rothermund, Voss, & Wentura, 2008). Counter-regulation is an automatic process that promotes affective stability by leading people to attend to the opposite emotional-motivational tendency that is activated by the situation. Counter-regulation tends to be stronger among securely attached people than among insecurely attached people (Koranyi & Rothermund, 2012). Under positive conditions, counter-regulation leads people to attend more to negative information (e.g., Rothermund, Gast, & Wentura, 2011) . The latter tendency theoretically prevents the development of overly intense positive emotional states, and thereby contributes to flexibility in self-regulation (Manes & Rothermund, 2013). Supporting this interpretation, a recent study found that people with high self-esteem, and low attachment anxiety were better able to down-regulate positive emotions (Zou, Plaks, & Peterson, 2019). Although more research is needed on this matter, the considerations suggest that he tendency of securely attached people to lower felt security in response to positive relationship primes could be an adaptive pattern.

General Discussion

In the present research, we proposed and tested the idea that soft touch could provide emotional security to people with a fearful-avoidant attachment style. To this end, we conducted two studies in which participants with varying attachment styles interacted briefly with either a soft fabric or a control fabric and then rated their emotional security. We found that soft tactile touch indeed benefitted fearful-avoidant participants, both by increasing a sense of connectedness to close others from their daily lives (Study 1), and by increasing felt security (Study 2). These effects were not observed among participants low on fearful-avoidant attachment style.

Our findings are consistent with the idea that people with a fearful-avoidant attachment style have an unfulfilled need for soft affectionate touch. This may lead them to be highly receptive to soft tactile experiences that mimic the effects of affectionate interpersonal touch. Indeed, we observed in Study 2 that the comforting effects of soft touch among fearful-avoidant are similar to the effects of thinking about an accepting relationship partner. Soft tactile experiences may thus serve as an important emotion-regulatory resource for people with a fearful-avoidant attachment style. As such, the present findings provide an important complement to prior findings that soft tactile experiences may reduce feelings of uncertainty (Van Horen & Mussweiler, 2014) and reduce existential concerns (S. L. Koole et al., 2014), especially among people with emotional vulnerabilities, such as low self-esteem.

However, the positive responsiveness for soft tactile experiences was not specific to participants with a fearful-avoidant attachment style. Participants with low secure attachment style also displayed such positive responsiveness. These individuals may desire touch and closeness, but also indicate difficulties fully trusting and relying on others, In contrast to fearful-avoidant individuals, they do not have a deep-seated fear of rejection based on painful past experiences (Bartholomew & Horowitz, 1991). This may explain why they were able to derive security from touching the soft fabric that buffered them against a mild threat. Although unexpected, these results suggest that less securely attached people, who may be touch-deprived because they struggle with trusting others, may also use soft tactile sensations to simulate affectionate touch. Moreover, these individuals may be better be able to benefit from using simulations of affectionate touch than individuals whose are highly sensitive to (potentially) threatening cues.

Positive responsiveness to soft touch was unrelated to anxious-preoccupied and dismissive-avoidant attachment styles. The lack of effects for the latter two attachment styles is consistent with the prior literature, which indicates that anxious-preoccupied people are typically able to access social support (Collins & Feeney, 2000; Ognibene & Collins, 1998), and that dismissive-avoidant people tend to inhibit their needs for closeness (Collins & Feeney, 2004; Fraley & Shaver, 1997; Jakubiak & Feeney, 2016a). This means that types should not have an elevated need for affectionate interpersonal touch.

Our soft touch manipulation could have soothed fearful-avoidant people through various pathways. One potential pathway is purely physiological, through activation of tactile nerve fibers in the human skin that are dedicated to signaling gentle, caress-like bodily contact between individuals (Löken et al., 2009; Olausson et al., 2010). The specific receptors for soft touch, however, have not been found in the glabrous (e.g., the thicker, non-hairy) skin on the palms. Nonetheless, the hands are one of the most sensitive areas to all manner of touch, and soft stroking of the hands has a direct pleasant feeling (Gordon et al., 2013; Liljencrantz & Olausson, 2014) which may, perhaps partially, explain our findings.

A recent study investigated the activation of the dedicated tactile nerve fibers that are associated with optimal affectionate touch among people with varying attachment styles. They found that despite activating the same fibers across participants, insecurely attached people are less able to detect to optimally soothing touch. In other words, they have trouble discriminating between optimal and suboptimal affectionate touch experiences. Securely attached people do not have such a problem (Krahé et al., 2018).

This finding is fully in line with the notion that attachment representations originate in early caregiving experiences involving touch (Bowlby, 2008; Field, 2002, 2014). Thus, a physiological pathway may partially account for the observed individual differences in the benefits from touching soft fabric. We therefore suggest that participants who desired affectionate touch seized on the soft cloth to evoke the sensory aspects of genuine experiences of affective interpersonal touch. This interpretation is supported by the increased ability to call to mind to close others, by those who are fearful-avoidant and low on secure attachment, after touching the soft fabric, while dismissing-avoidant individuals, who do not report a desire for affectionate touch, were unlikely to use the soft fabric to simulate close touch experiences (see S. L. Koole et al., 2014).

From an applied point of view, the present findings may be used in a therapeutic context. For instance, soft, comforting material, which can be incorporated in the furniture of a therapist's office, such as the seat-cushions and armchair covers, may help buffer some insecurely attached patients against the experience of threat when they are asked to recall experiences of rejection. In non-threatening contexts, fearful-avoidant individuals may especially benefit from the social connecting and security-enhancing effects of soft sensations, as they report high levels of psychopathology (Whiffen, Kallos-Lilly, & MacDonald, 2001), high levels of distrust (Cyranowski et al., 2002; Reis & Grenyer, 2004), and frequent negative therapeutic outcomes (Murphy & Bates, 1997; Pincus & Wilson, 2001).

Consistent with these ideas, other research indicates that emotionally vulnerable individuals may indeed benefit from a soft touch experiences during therapy. For instance, patients who receive Animal-Assisted Therapy (AAT; Kruger & Serpell, 2006) are encouraged to form a secure attachment bond with a pet during therapy, which functions as a transitional object, and promotes a more secure relationship with the therapist and other people (Granger & Kogan, 2006; Zilcha-Mano, Mikulincer, & Shaver, 2011). Patients who received AAT (versus other activities) initiated more social behavior, such as starting and engaging in longer conversations and initiating more touch behavior (Bernstein, Friedmann, & Malaspina, 2000). Moreover, a recent meta-analysis reported improved therapeutic outcomes among depressed individuals who were assisted by a therapeutic pet (Souter & Miller, 2007). From our perspective, touching pets may be especially able to provide such security because they are unlikely to be a source of rejection, and likely to provide soft, comforting sensations, which may allow some patients to simulate close interpersonal contact.

Limitations and Future Directions

The present study inevitably has limitations. First, we only examined the effects of soft touch among Western university students. Future research should investigate people from more diverse cultural backgrounds. Second, our Study 2 only tested whether first touching the soft fabric buffers against a loss of security when visualizing a distant relationship. To provide more insight into the relative strength of the effects of soft touch, future studies should counterbalance the order of the touch and visualization manipulations or use a within-subjects design. Third, future studies should consider including an additional neutral condition, which would allow a baseline against which to compare the effects of touch and visualization. Lastly, it makes sense to establish whether insecurely attached people also respond more favorably to non-human sources of security more readily in their daily lives. We therefore recommend that follow-up research will examine the use of simulated interpersonal touch in more ecologically valid settings, for instance, using ecological momentary assessments (Shiffman, Stone, & Hufford, 2008).

Concluding Remarks

Affectionate interpersonal touch plays a vital role in maintaining social and emotional well-being (Gallace & Spence, 2008; Hertenstein, Keltner, et al., 2006). In the present paper, we found that even a minimal simulation of affectionate interpersonal touch, namely touching a soft, abstract piece of fabric, may provide emotional security to fearful-avoidant people as well as people low on secure attachment. We hope our findings will stimulate further research on embodied sources of emotion regulation and how it may be helpful to people.

Chapter 6.

Conclusions and Outlook

Affectionate touch has broad and substantial effects on human psychology, as described in the narrative review about why touch means so much and shown with experimental investigations that use various cognitive, emotional, and motivational outcomes. Taken together, the present work has implications for the three major theories that were discussed in Chapter 1: Adult attachment theory, theories of embodied social cognition, and neurobiological theories of affectionate touch. This work also has practical implications for implications for the practical use of touch in clinical settings, education, and everyday life.

Theoretical Implications

Chapter 1 discussed three major theories of interpersonal touch: 1) Attachment theory, 2) theories of embodied social cognition, and 3) neurobiological theories of affectionate touch. In what follows, I relate how each of these theories is informed by the findings and conclusions of Chapters 2-5.

Implications for Attachment Theory

Chapter 3 found that actual and simulated interpersonal touch affect existential anxiety, a highly cognitive fear. These findings make intuitive sense when we think of physical contact as the primary indicator of security, which is exactly what the defensive processes in Attachment Theory aim to maintain.

Researchers from Attachment theory and Terror Management Theory have, in collaboration, proposed an integration in the form of a Tripartite Security System (J. Hart, Shaver, & Goldenberg, 2005). This model suggests that three defensive processes operate to maintain security: attachment, self-esteem, and cultural worldviews. Threats to one these processes triggers defensive reactions in other components. Satisfying or calming the attachment system using touch manipulations has been shown to reduce worldview defense (Mikulincer & Shaver, 2001). Conversely, threatening the attachment system has been shown to increase death-related thoughts (Mikulincer, Florian, & Hirschberger, 2003).

Further integrating both theories, Mikulincer, Dolev, and Shaver (2004); Mikulincer et al. (2003) have suggested that people may pursue close relationships because

they provide protection against existential concerns through attachment (Bowlby, 1982). Supporting this view, reminders of death have been shown increase desire for intimacy and commitment in romantic relationships (Florian, Mikulincer, & Hirschberger, 2002). Conversely, death-related primes increased the accessibility of attachment constructs (Mikulincer, Gillath, & Shaver, 2002).

Models that integrate both theories provide insight in why touch is such a potent remedy for existential angst. Future work may explore further how actual or simulated touch may help people manage the full range of existential fears, including abandonment, loss of meaning, loss of autonomy, and loss of self.

Besides the anxiety-buffering effects of touching a teddy bear reported in Chapter 3, holding a stuffed animal also had cognitive motivational effects in Chapter 4. The motivational benefits of touch in Chapter 4 emerged especially among emotionally less vulnerable people, which seems contrary to the socio-emotional effects of touch in Chapters 3 and 5.

However, recently published findings shine new light on this matter. A study by Saunders, Riesel, Klawohn, and Inzlicht (2018) tested the effects of interpersonal touch on cognitive control among 45 couples, using the same error task. They, however, manipulated touch by having the romantic partner hold the hand of the participant during half the trials. Similar to our results, they found that hand holding increased the size of the ERN, indicating increased engagement and cognitive control.

The researchers concluded that touch might facilitate task performance by enhancing neural monitoring processes. In their paper, they noted the conceptual similarity between their touch manipulation and the simulated supportive touch used in our study. Their use of a more salient manipulation of touch may explain why they found an increase in the size of the ERN across participants instead of an increase mainly among those more intrinsically motivated.

This additional finding supports our original idea that simulated interpersonal touch leads to an increase in neural monitoring processes, a general effect does not specifically apply to less secure people. The effects of holding a teddy bear were not moderated by self-esteem or attachment style. Thus, these motivational effects seem to be driven by a different mechanism than the anxiety-buffering effects of simulated interpersonal touch.

Recent findings in the literature support the idea that maternal touch leads to the development of cognitive control (Feldman, Rosenthal, & Eidelman, 2014; von der Lippe, Eilertsen, Hartmann, & Killèn, 2010). Among adults, touch has been shown to increase cognitive control in one other study (Saunders et al., 2018), and there is a direct connection between adult attachment security and cognitive control (Gillath, Bunge, Shaver, Wendelken, & Mikulincer, 2005; Gillath, Giesbrecht, & Shaver, 2009; Warren et al., 2010).

Thus, considering findings in the broader context of the literature, the specific motivational effect in Chapter 4 could have been the result of simulated affectionate touch. By telling participants to dismiss the objects they were asked to hold as a "distraction", rather than as a meaningful part of the task (i.e., Saunders et al. (2018), we may have isolated the effect to those more motivated by intrinsic interest. To investigate this possibility, follow-up studies could manipulate simulated touch in a more explicitly supportive manner when investigating its effects on neural processes.

An alternative explanation for the motivational effects of holding a stuffed animal may be the captivating nature of the teddy bear, whose anthropomorphic features have evolved to become more exaggerated and childlike over the years (Hinde & Barden, 1985). According to (Konrad Lorenz, 1943), the Kindchenschema or baby schema has evolved to draw human attention to infants and trigger nurturing responses. Such responses play a crucial role in facilitating secure attachment (Ainsworth et al., 1978). Studies among adults have found an attentional bias and preference for human faces that fit the baby schema (Brosch, Sander, & Scherer, 2007) (Hahn, Xiao, Sprengelmeyer, & Perrett, 2013; C. E. Parsons, Young, Kumari, Stein, & Kringelbach, 2011).

The teddy bear that we used was an infant-sized humanoid object that was designed to attract positive attention; its attention-grabbing features could have contributed to the increase in task engagement among those especially sensitive to such features. In line with this possibility, follow-up research could investigate whether other biologically significant positive stimuli that evoke attention can have similar motivational effects.

Chapter 5 found that touching a soft cloth may allow insecurely attached people to simulate affectionate touch to experience connectedness and security. For these individuals, touch in a low-threat setting has likely become a potent emotion-regulatory resource, such that mere simulations of affectionate touch can have meaningful effects. This is the case whenever simulated touch helps remind people of their close contact with others. People with a fearful-avoidant attachment named more people they were close to after touching

something soft. Moreover, visualizing a close relationship increased how much they felt loved by close others. These findings suggest that simulations of touch may increase or boost people's attachment security.

One concern in regards to simulated forms of interpersonal touch is that providing substitutions for genuine affection could prevent people from seeking close intimate attachments altogether. Initial evidence suggests, however, that the experience of simulated touch has the potential to encourage behavior that will allow access to desired touch experiences in the future.

A recent study showed that mentally simulating receiving touch from a loved one increased the willingness to embrace challenges and new experiences (Jakubiak & Feeney, 2016a). Affectionate touch and simulations of it thus seem to function less like a drug that numbs pain, and more like a secure gateway to seek connection with people and explore new activities and surroundings. In other words, taking small first steps to attain security may create an upward spiral that promotes and encourages reaching out and bonding in one's interpersonal relationships.

Implications for Theories of Embodied Social Cognition

Embodied theories of social cognition proposed that early sensorimotor experiences serve as the foundation for the later development of more abstract concepts and goals, such as love and trust (Williams et al., 2009). This idea has only begun to be tested in contemporary psychology (L. W. Barsalou, 2008; IJzerman & Koole, 2011; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005).

Chapter 3 found suggestive evidence that a simple touch on the shoulder from a complete stranger can lead to an increased sense of social connection. Whereas traditional theories about the representation of knowledge would require an elaborate network of linked mental concepts to explain this finding, a parsimonious explanation is found in the embodied perspective. Theories of embodied cognition would propose that a direct touch on the shoulder evokes embodied simulations of previous experiences during which such comforting touches were received in the past (L. W. Barsalou, 2008; IJzerman & Koole, 2011). These neural simulations may have involved touch receipt from close, trusted others.

Therefore, seemingly innocuous touch experiences can lead to the (re-)experience of feelings of closeness, safety, security, trust, and so on.

Although the studies described here provide no direct evidence for embodied processes, and they suggest that comforting interpersonal touch at the very least seems to be associated with close, supporting others. In two studies mentioned in the introduction, people who imagined receiving affectionate touch from their partners were better able to withstand, and feel more secure during stressful events (Jakubiak & Feeney, 2016a, 2019).

An embodied perspective would explain parsimoniously that such vivid guided simulations of being supported by others conjures feelings of closeness and security that they have had in the past, which are effective buffers against setbacks. A simulation account would also help explain the value ascribed to the teddy bear in Study 3. Although participants could not touch the teddy bear, past sensory-motor experiences would allow them to simulate the soft and pleasant tactile sensations it provides, which in turn allow simulation of past affectionate touch experiences. This could have made the teddy bear more attractive to those experiencing threat. Overall, an embodied interpretation explains straightforwardly how concrete, momentary touch experiences impacts higher-order, abstract concepts such as existential angst.

In Chapter 4, manipulation of simulated affectionate touch affected the cognitive performance of people who were more intrinsically oriented. In light of the findings of Saunders et al. (2018), who found that supportive touch from a close other increased cognitive control, a straightforward interpretation of the motivational effect is through embodied simulation of close supportive touch. Previous work has shown that secure attachment and cognitive control are linked (e.g., Gillath et al., 2009). We can thus expect that providing people with a simulation of sensitive, supportive affectionate touch could encourage task engagement and monitoring of mistakes.

Procedural differences between the studies in Chapter 3 and Chapter 4 may explain why the intrinsically motivated participants benefitted in this study. In performance settings, supportive touches are interpreted differently than touches without a performance context (e.g., Ellingsen, Leknes, Løseth, Wessberg, & Olausson, 2016; Jakubiak & Feeney, 2017). In contrast to Study 3, we did not induce threat. This decreased the likelihood that the teddy bear would be interpreted as supportive by those with low self-esteem or an insecure attachment. As a result of the experimental context, which emphasized task

performance, the individuals susceptible to motivational cues such as novelty may have particularly benefited from the simulation of supportive interpersonal touch.

I suspect that a supportive touch on the shoulder before the error-monitoring task would likely also have increased motivation through an embodied simulation route as in Chapter 3, Study 1 and 2. I therefore encourage more studies on touch in relation to cognitive performance.

In Chapter 5, we went a step further in testing the embodied simulation account by asking participants to interact with a piece of soft cloth that was devoid of symbolic meaning and anthropomorphic qualities. Nonetheless, insecurely attached people with diminished access to affectionate experiences reported feeling more connected, secure, loved, supported etc., after touching the soft cloth compared to a hard cloth. These findings are the most difficult to explain using traditional theories of cognition, while an embodied account can easily predict and explain these results.

According to an embodied simulation account, insecurely attached individuals were able to use the sensory qualities of the soft cloth to simulate previous experiences during which they received soft, gentle touch. The resulting experience of closeness and security further suggests that the simulations involved close others who provided such sensory comfort in the past. These effects occurred without an explicit threat, although it can be argued that sensitivity to rejection may be associated with the experience of chronic threat (e.g., Berenson et al., 2009). Furthermore, fearful-avoidant attachment is commonly associated with psychological distress (Collins & Feeney, 2004). Moreover, the results suggest that embodied cues of affection may indeed be grounded in internalized working models, thereby allowing moderation by individual differences in attachment style.

Although preliminary, these findings are in line with recent studies showing that the effects of embodiment cues are moderated by individual differences in attachment (Fay & Maner, 2012; IJzerman, Karremans, Thomsen, & Schubert, 2013; Kim et al., 2018; Krahé et al., 2016; Krahé et al., 2018) providing some further support for the idea that the body plays a role in social cognition.

Individual differences have been somewhat neglected in embodied cognition research. Our findings suggest that this neglect represents a missed opportunity. Individual differences in embodied experiences are captured by concepts such as attachment style, and self-esteem. Acknowledging the influence of critical differences in prior life experience are likely to provide enrichment to current theories of embodied cognition.

Taken together, the findings in this dissertation are compatible with the theoretical notion of embodied simulations. Nevertheless, we have no definitive proof that such simulations indeed occurred, or that they mediated our results. In the literature, there is evidence and general support for the existence of mental simulations of concrete concepts, namely objects (Pecher, Zeelenberg, & Barsalou, 2003) and actions (Arthur M Glenberg & Kaschak, 2002); the evidence thus supports effects of concrete sensorimotor input on conceptual thought. The existence of embodied representations of more abstract concepts is more questionable, as they have no grounding in concrete experience (e.g., Arthur M Glenberg, 2010; Pecher & Zwaan, 2005).

It is possible, of course, to interpret the results of this dissertation without using the idea of embodied simulations. Such an interpretation could emphasize the direct neurobiological effects of touch, which may be physiologically comforting, but this would be equally, or even more, speculative. However, an explanation including simulations provides the most straightforward and integrative account for all the effects of soft sensory touch experience that we found.

More research is needed to explicitly test the role of embodied simulations in the psychological effects of interpersonal touch. For instance, researchers could compare the effects of guided mental simulations of receiving affectionate touch to incidental touch of soft material without prompting participants to use mental simulation.

Implications for Neurobiological Theories of Affectionate Touch

Apart from one chapter, the research in this dissertation focused on the psychological rather than the physiological or biological effects of touch. This means that we cannot address specific neurobiological mechanisms. Nevertheless, the present findings can be integrated with neurobiological theories of affectionate touch. To promote this integration, I relate the main findings of this dissertation to the neurobiological model of interpersonal touch by Jakubiak and Feeney (2017).

Chapter 3's findings concerning existential concerns fit well with how affectionate touch is proposed to affect stress to promote well-being (Jakubiak & Feeney, 2017). Touch can directly reduce the implicit threat of death anxiety and provide a buffer via relational-cognitive changes, such as an increased sense of closeness or connection. That people with low self-esteem benefit from touch fits well with the idea that self-esteem indicates one's social connectedness (Leary & Baumeister, 2000). Low self-esteem hence motivates attempts to restore or create new connections; one effective way to do so may be through affectionate touch. The beneficial outcomes of touch may also be partly explained by the direct neurobiological pathway that buffers stress, for instance, via the release of oxytocin (e.g., Holt-Lunstad et al., 2008).

Chapter 4 investigated the neurological effects of simulated touch, showing that it can increase cognitive control. This idea fits well with Jakubiak and Feeney (2017) discussion of direct neurobiological effects of touch, which includes the benefits of touching soft objects. The results also fit with their proposed pathway that involves moderators that affect the interpretation of affectionate touch; when people are presented with a supportive touch, they may not interpret it as such because of the context of the study.

Several factors that may have affected the interpretation of touch: type of touch, an interpersonal difference, and the situational context. We provided a salient object and told participants it was merely a distraction from a demanding task. As mentioned before, this likely reduced the possibility that the teddy bear would be experienced as supportive, which nonetheless motivated those susceptible to salient and interesting stimuli.

Chapter 5 further supports the stress-buffering effects of affectionate touch to promote well-being among insecurely attached people. A previous study found that people can name more security-related words after imagining being touched by their loved ones (Jakubiak & Feeney, 2016b). In line with this, we found that, among rejection-sensitive

people, the tactile sensation of softness increased how close they felt to others and how much they felt loves and cared for (Ben-Ari & Lavee, 2007). Soft tactile sensations may be cues that can signal social closeness and thereby reduce discomfort.

For people with a fearful-avoidant attachment, who are highly sensitive to rejection, the soft sensations that signal connection lose its effect when they think of someone distant. People low on attachment security were, however, better able to hold on to their secure feelings during a mild threat.

These responses could be explained by a "reactive control" system that underlies insecure attachment. Following recent theorizing, there are two types of brain systems that control behavior, a reactive and a predictive control system (Tops, Boksem, Luu, & Tucker, 2010; Tucker & Luu, 2007). In predictable environments, the processing of information is guided by predictive internal models, such as the "internal working models" (Bowlby, 1988). In contrast, the reactive control system is dominant in unpredictable environments, and is specialized in processing novel, urgent stimuli using reactive (e.g., feedback-guided) control of behavior (Tops & Boksem, 2011).

According to this model, attachment security was developed in predictable, stable attachment relationships, and this guides behavior whenever distress levels are low. But insecure attachment is the result of less stable parenting, and therefore largely reactive (Beckes, Ijzerman, & Tops, 2015; J. Simpson & Rholes, 2012). Therefore, people may be seen as unpredictable and threatening, and thinking about a distant person activates reactive control (Tops et al., 2010).

People with a secure attachment do not experience threat because their internal working models do not detect any. Those with a lack of attachment security were in reactive mode, and felt secure from holding a soft fabric, even when later thinking of a distant person, suggesting that threat levels were not that high (Beckes et al., 2015). The fearful-avoidant people, however, were not able to use the soft tactile sensory experience to withstand mild threat, suggesting that their experiences of rejection were likely more severe or their positive experiences with others lacking.

In general, a direct neurobiological path alone cannot explain our findings. Across studies, participants' responses were affected by context (e.g., lab setting, touch manipulation) and individual differences (e.g., self-esteem, attachment style, trait intrinsic motivation). Our studies used highly standardized settings in order to minimize differences in interpretation, while in everyday life, the complexity of settings and room for different

interpretations is presumably much larger. It is likely that the effects of touch outside the lab are more variable and complex. Future studies could perhaps use a combination of objective context monitoring, (neuro-)biological methods, as well as subjective (self-report) measures to more thoroughly investigate touch effects.

Implications for Applied Settings and Everyday Life

The main focus of the present dissertation was to increase our scientific understanding of the psychology of affectionate touch. Nonetheless, insights from this dissertation seem relevant for various real-life domains. These include: 1) Counseling and psychotherapy; 2) Educational settings; and 3) New touch cultures and technologies.

Counseling and Psychotherapy

Several findings in the present dissertation suggest that the interpersonal touch is relevant for psychotherapy and counseling. For instance, in Chapter 3, we found that (simulated) interpersonal touch may alleviate existential concerns. Existential concerns are believed to underlie the development, maintenance, and course of many forms of psychopathology (Iverach, Menzies, & Menzies, 2014). Likewise, in Chapter 5, we observed that (simulated) interpersonal touch may alleviate attachment insecurity, a transdiagnostic factor in many psychological disorders (Ein-Dor & Doron, 2015). The psychological benefits of touch were pronounced among people with low self-esteem (Chapter 3) and people low in attachment security (Chapter 5), groups that have an increased vulnerability for developing psychological disorders. These findings together suggest that (simulated) interpersonal touch could help patients suffering from psychological disorders.

The use of interpersonal touch in psychotherapy is controversial (Hunter & Struve, 1998; Phelan, 2009). Advocates of physical contact in psychotherapy note that various touch behaviors can be safely applied. Touch can be used to communicate empathy, sympathy, safety, and comfort, and affirms that the client is being heard. Touch can also be used to orient or ground patients who might otherwise become anxious and dissociate (Hunter & Struve, 1998). Therapists can also model or practice appropriate touch behavior with their patients.

Perhaps most crucially, touch increases connection and trust between a therapist and a client (Phelan, 2009; E. W. Smith, 1998), which helps to establish the therapeutic alliance, one of the most well-established predictors of therapeutic success (Horvath, Del Re, Flückiger, & Symonds, 2011). Therapeutic touches are not trivial, and apprehension about using touch in therapy may mean a significant loss to the well-being of patients and clients (Westland, 2011, 2015).

Nonetheless, many psychotherapists remain wary of touching their patients. In a national sample of 470 practicing psychologists, close to 90% of respondents never or rarely offered touch to clients during a session. A handshake during greeting or parting was the only form of touch that occurred with some frequency (Stenzel & Rupert, 2004). Although the latter study was conducted some time ago, there is little reason to assume that psychotherapists have used more touch in their treatments in subsequent years.

The reluctance of practitioners to use physical contact stems from concerns that touch can be perceived as sexual or be confusing to vulnerable clients. Practitioners also run the risk of legal complaints, and may thus refrain from touching clients to avoid accusations of malpractice.

Nevertheless, when therapists were confidentially interviewed, many reported applying touch as an effective part of their clinical practice (e.g., J. C. Holroyd & Brodsky, 1977; Pope, Tabachnick, & Keith-Spiegel, 1987; Tirnauer, Smith, & Foster, 1996). Similarly, almost all social workers who were surveyed indicated they had used touch with clients at least some of the time (Strozier, Krizek, & Sale, 2003). The practice of therapeutic touch may thus be more prevalent and valued by practitioners than they openly admit.

These findings highlight the need for more open discussion about the role touch in therapy, including how to educate, formalize and regulate its application. Professionals in care, and healthcare more broadly, frequently face no-touch policies in the workplace. Various healthcare professionals have expressed concern about loss of interpersonal contact, including nurses (Benner, 2004; Paterson & Dodge, 2012), and doctors (Kelly, Tink, Nixon, & Dornan, 2015; Verghese, 2009). In recent years, authors have pleaded for education about the use of touch in health profession's curricula (Grant, Giddings, & Beale, 2005; O'Lynn & Krautscheid, 2011; Roger et al., 2002; Schifter, Bogert, & Boston, 1999; Tuohy, 2003; Verghese, 2009).

A partial solution to counter the movement against interpersonal touch may be to provide information about the value of human touch. This includes informing the public

about the science on the importance of affectionate touch for human well-being, having fact-based discussions about the current and desired role of touch in society, as well as informing would-be practitioners, about the importance of touch throughout the life-span, and the detrimental effects of touch deprivation.

Another part of the solution may be removing obstacles that prevent people who have difficulty establishing secure long-term relationships from seeking treatment. People may fear the stigma or taboo of going into therapy or the lack money for mental care. Many of the people who now seek temporary fulfillment of a deep-seated need for closeness and connection through touch services like "cuddle therapy" may be better served in counseling, where they can uncover the root of their touch deprivation, and start long-term strategies to achieve a more fulfilling emotional life.

Educational Settings

Our findings on the motivational effects of simulated interpersonal touch seem relevant for educational settings and schooling. In particular, Chapter 4 suggests that of simulated interpersonal touch may support goal-directed behavior via increases in cognitive control. Our interpretation of the Chapter 4 results was further informed by the study of (Saunders et al., 2018) who found a similar increase when participants held the hand of their partner. These findings fit with evidence connecting early maternal touch to the development of cognitive control (Feldman et al., 2014; von der Lippe et al., 2010). For instance, preschoolers who received 15-minute massages have shown an increase in their cognitive performance of (S. Hart, Field, Hernandez-Reif, & Lundy, 1998).

These findings do not imply that touch directly improves cognitive ability. Instead, interpersonal touch may improve cognitive control by making activities more intrinsically rewarding (Saunders et al., 2018). This meshes well with our finding that the intrinsically motivated individuals responded more to simulated interpersonal touch. In line with this interpretation, induced intrinsic motivation has been shown to enhance ERN amplitudes (Legault & Inzlicht, 2013).

Previous work has shown that touch can have a motivational or encouraging effect in goal-directed settings. Interpersonal touch can increase enjoyment and achievement of effortful performance of persons (Legg & Wilson, 2013; Steward & Lupfer, 1987), and

sports teams (Kraus et al., 2010). Kids who are touched by their teachers volunteer more during class, are more task-focused (Nicolas Guéguen, 2004; Khilnani, Field, Hernandez-Reif, & Schanberg, 2003; Wheldall, Bevan, & Shortall, 1986), and have increased delays of gratification (Leonard, Berkowitz, & Shusterman, 2014). In general, touch encourages cognitive development and control (Caldji, Diorio, & Meaney, 2000; Feldman et al., 2014; Saunders et al., 2018; von der Lippe et al., 2010).

Despite the beneficial effects of interpersonal touch, its practice in educational settings is increasingly rare. Educators seem especially hesitant to touch young children, who, much like therapeutic patients, are considered more vulnerable to negative consequences of touch. Proponents of touch in educational settings cite evidence that young children need to be touched for optimal security, growth, and development (Blackwell, 2000). By withholding touch, both children and adults are deprived of physical touch and its associated benefits, including the promotion of positive social interactions and behavior (Dobson, Upadhyaya, Conyers, & Raghavan, 2002), and closer, healthier relationships between teachers and students (Diego et al., 2002; Field, 1999a, 1999b, 2005).

In a recent survey among 65 primary school teachers, almost all of them indicated that they believed that touching enhances emotional development, communicates care, improves mood, and reduces stress (Owen & Gillentine, 2011). Most teachers also believed that touch improves general behavior and promotes cognitive development. In practice, however, only a fifth of teachers hugged children who were hurt, and less than half hugged children who were upset. Teachers were even less likely to hold and stroke children. Most children spent the day untouched by teachers. The teachers admitted that fear of accusations of abuse was their primary reason for withholding touch.

The fear of the teachers and parents is largely misplaced; actual abuse cases by teachers are exceedingly rare (Field, 2001; Tobin, 1997; Zirkel, 2000). Some of the reluctance to touch children and students may be removed by having fact-based discussions to correct such misgivings. The true danger to children's well-being may well be a form of institutional abuse via touch deprivation and emotional neglect that is quickly becoming commonplace (Owen & Gillentine, 2011; Tobin, 1997).

New Touch Cultures and Technologies

In Western societies, interpersonal touch has become increasingly regulated and scarce. In response, people have sought to develop new cultural practices and new technologies for improving people's access to the benefits of interpersonal touch.

One striking cultural trend is the rise of organized touch activities in Europe, Australia, Canada and the US. These activities consist of cuddle and massage workshops, cuddle conventions, large-scale hug sessions, and one-to-one cuddle sessions to meet the needs of the touch-deprived. Meanwhile, animal cafes have sprung up all over the globe, where people drink a beverage in the company of friendly, furry cats and rabbits. Similarly, paying professionals for massages, manicures, pedicures and waxes may also reflect, to an extent, a lack of casual interpersonal touch in society. A growing number of people seem willing to pay for non-sexual touch and companionship with a stranger, or brief interactions that simulate the affectionate touch of close relationships. It is remarkable that fleeting and less spontaneous interactions are so valued in our time, as they provide little meaning compared to frequent affectionate touch experienced in the context of long-term romantic relationships.

Another societal trend is the advance of technologies that facilitate simulated interpersonal touch. At the center of this trend is the newly emerging field of affective haptics (Tsetserukou et al., 2009), which aims to create devices can simulate interpersonal touch to provide people with valuable emotional experiences. For instance, a new wearable device on the market allows people to send a simulated form of touch (using haptic feedback) over a long distance, which may help them feel connected to distant loved ones (Jewitt, Price, Mackley, Yiannoutsou, & Atkinson, 2020).

Japanese developers have introduced a number of social robots to the world that allow tactile interaction, such as Paro, a cuddly a therapeutic interactive robot seal that has been used in hospitals and care homes (e.g., Kidd, Taggart, & Turkle, 2006; Šabanović, Bennett, Chang, & Huber, 2013). A more recent addition is Pepper, a humanoid robot that can shake hands, follow gaze, use gestures, hold conversations, and read and express emotion. Pepper has been deployed in care homes, hospitals, and by service providers around the world (e,g., Chu, Khosla, Khaksar, & Nguyen, 2017; Foster et al., 2016; Niemelä, Heikkilä, & Lammi, 2017).

Targeting the consumer market, full-body haptic feedback suits are being developed to enrich gaming experiences, allowing players to experience being touched in a game by other players or game characters. Incorporating haptic feedback in lightweight portable gloves has even made it possible to touch and manipulate virtual objects that "feel" as hard as a coffee cup or as soft as a sponge (Hinchet, Vechev, Shea, & Hilliges, 2018). It will soon be possible to touch virtual characters and human beings online.

Can technology ever provide satisfying substitutes for human relationships? Will robot touch someday replace the nurturing touch of a mother? Are people losing their human touch? Perhaps not. Although technological developments happen quickly, people change very slowly. A mother who gently strokes her child may seem to engage in a mundane, trivial action, yet the mother is acting out a script that was laid down by evolution some 30 million years ago, a script that prescribes the exact velocity with which human beings are meant to touch, caress and hug one another. Recent cultural and technological trends involving (simulated) interpersonal touch in the last decade are thus more likely to complement, rather than replace, more direct, traditional and time-honored ways of providing and receiving affectionate touch.

Concluding Remarks

The present dissertation has documented some of the psychological benefits that affectionate touch may provide, when people are likely to benefit from it, and which kinds of people may benefit more (or less) from simulations of affectionate touch. Our intellectual journey has led us to consider attachment theory, embodiment theory, and neurobiological theories that offer insights into why affectionate touch is of central importance to human well-being. We discussed new empirical studies showing that the seemingly trivial bodily sensations, thoughts and feelings that are related to affectionate touch, have pronounced psychological effects. The present dissertation thus highlights why affectionate touch is vitally important for people.

Chapter 7.

Summary

People from all walks of life engage in physical contact that conveys affection, such as hugs, strokes, and gentle caresses. Those who are deprived of such experiences, spend time, money, and effort on touch services that seem to mimic or simulate affectionate touch. What is special about affectionate touch? And what benefits can we derive from it? Do simulations of affectionate touch have similar effects? These questions become more urgent now that digital and technological advancements are changing people's access to (simulated) touch. This dissertation examines the psychological effects of affectionate touch—and by extension—what may be lost in modern societies as casual interpersonal touch continues to decline.

Chapter 2 starts with a review of past findings on the emotional and social effects of brief interpersonal touch. Brief touch allow non-verbal communication of emotions between strangers and reduces emotional distress of close others. Much of the psychological research on touch was first performed on animals, including Harlow's iconic studies with baby rhesus monkeys, who repeatedly chose soothing physical contact ("contact comfort") over access to food. Echoing his finding, touching pets and soft objects has been found to provide emotional comfort. Seemingly trivial touches also affect people's social functioning, perhaps by suggesting a communal sharing relationship; this would explain why waitresses who touch customers receive larger tips, and why teammates who touch each other frequently during game-time score more points. Social touch, however, can just as easily be used to encourage and condone reckless behavior. Cultural context further complicates the interpretation and therefore the effect of touch. Nonetheless, much can be gained by applying touch appropriately, and technological advancements seem to increase the possibilities of doing so.

Chapter 3 investigates whether actual and simulated interpersonal touch can reduce existential concerns among people with low self-esteem, who are generally more anxious about the prospect of death. In four experiments, we manipulated touch in various ways before measuring our outcomes of interest. We found that participants with low self-esteem who were touched briefly on the shoulder reported less death anxiety, and more social connectedness after being reminded of death. Participants with low self-esteem who were reminded of death also ascribed more monetary value to a teddy bear that simulates affectionate touch, and holding it prevented an increase in ethnocentrism, a common defensive response to a reminder about death. Across all studies, participants with high self-

esteem were unaffected by touch. These findings together suggest that embodied touch experiences hold existential significance for people with low self-esteem.

Chapter 4 examines whether simulated interpersonal touch could affect a brain potential that indicates cognitive control, which can be measured on the scalp using EEG. The error-related negativity (ERN or Ne) occurs when people make an incorrect response, and its size indicates how much they care about the mistake. We predicted that the size of the ERN would be larger when participants held a teddy bear on their lap during a demanding Go/No-Go decision task, as simulated affectionate touch was expected to increase task engagement. We compared this condition to a neutral condition during which participants held a cardboard box of similar size. We indeed found a larger ERN when participants held the teddy bear during the task, but especially among those participants who scored high on trait intrinsic motivation; such individuals are more susceptible to cues of intrinsic motivation, such as interesting or novel task aspects. This study thus supports the idea that simulated interpersonal touch can help people maintain higher levels of engagement during a demanding task.

Chapter 5 focuses on the potentially soothing effects of touching material which may allow people with an insecure attachment to simulate affectionate touch. In two studies, we examined the effect of a brief soft touch manipulation, while focusing differences in attachment style. We asked participants to touch a piece of fabric that was either soft or not soft. We found that participants who scored high on fearful-avoidant attachment or low on secure attachment reported feeling more socially connected after touching the soft fabric. Study 2 continued after Study 1 with a visualization exercise. Participants thought about someone with whom they had a close or distant relationship. We found that touching the soft fabric increased felt security among participants with an insecure attachment, similar in effect to thinking of a close relationship. Thinking of a distant relationship made all insecurely attached people feel less secure, except for those low on secure attachment who held the soft fabric. These findings suggest that soft tactile sensations can increase a sense of connectedness and security among insecurely attached individuals and perhaps buffer less secure people against mild threat.

Chapter 6 reviews the main findings and conclusions of this dissertation. The chapter discusses the implications of these findings for three major theories on affectionate touch—attachment theory, theories of embodied cognition, and neurobiological theories—and addresses practical implications for clinical and educational settings. Lastly, this chapter

offers some reflections on recent cultural trends and technological developments that seem related to a lack of casual interpersonal touch in modern society. Taken together, the work in this dissertation underscores the significance of affectionate touch for psychological well-being.

Chapter 8.

Dutch Summary

Mensen raken aan om affectie te tonen. Dit doen we door te knuffelen, te aaien en zachtjes te strelen. Er zijn ook mensen die weinig met affectie worden aangeraakt, maar hun tijd en geld besteden aan diensten die affectieve aanraking nabootsen, oftewel simuleren. Wat is er eigenlijk bijzonder aan affectieve aanraking? En welke voordelen biedt dit soort lichamelijk contact? Heeft gesimuleerde affectieve aanraking een vergelijkbaar effect? Deze vragen worden steeds belangrijker naarmate technologische vooruitgang vergaande simulaties van menselijke aanraking mogelijk maakt. Dit proefschrift gaat over de psychologische effecten van affectieve aanraking en het belang daarvan in moderne samenlevingen waar aanraking steeds minder voorkomt.

Hoofdstuk 1 biedt een overzicht van de effecten van aanraking op de mens. Zelfs kortdurende aanrakingen hebben invloed op hoe iemand zich voelt. Met vluchtige aanrakingen kunnen mensen hun emoties aan elkaar kenbaar maken en binnen een hechte relatie verzacht een zorgzame aanraking angst en verdriet. Een belangrijk deel van het psychologisch onderzoek naar aanraking werd eerst uitgevoerd bij dieren, zoals de studies van Harlow met jonge Rhesus aapjes. De aapjes waren angstig en hongerig, maar verkozen herhaaldelijk de geruststelling van zacht lichamelijk contact boven toegang tot voedsel. Harlow noemde dit fenomeen: “contact comfort”. Ook het aanraken van huisdieren en zachte objecten werkt geruststellend. Aanrakingen hebben ook invloed op maatschappelijk vlak. Ze kunnen namelijk de suggestie wekken dat men iets gemeenschappelijks deelt met een ander. Dit verklaart wellicht waarom serveersters meer fooi krijgen als ze klanten aanraken en waarom teamgenoten meer punten scoren als ze elkaar vaker een high-five geven. Aanraking kan echter ook gebruikt worden om probleemgedrag aan te moedigen. De effecten van aanraking worden moeilijker te interpreteren naarmate culturele en andere individuele factoren een rol spelen. Aanraking is belangrijk voor de mens en ontwikkelingen in de technologie lijken vooralsnog ervoor te zorgen dat meer mensen kunnen profiteren van de voordelen van aanraking.

Hoofdstuk 3 onderzoekt of affectieve aanraking doodsangsten kan verzachten bij mensen met een laag zelfvertrouwen; zij zijn gemiddeld genomen angstiger zijn over hun sterfelijkheid. In vier experimenten hebben we aanraking op diverse manieren gemanipuleerd. We vonden dat deelnemers met een laag zelfvertrouwen minder angstig waren als ze kort op de schouder waren aangeraakt. Als ze werden herinnerd aan de dood, zorgde een aanraking op de schouder ervoor dat ze zich toch nog sociaal verbonden voelden. Deelnemers met een laag zelfvertrouwen die herinnerd werden aan de dood waren

ook bereid meer geld neer te tellen voor een teddybeer die zachte, affectieve aanraking kan simuleren. Het vasthouden van de teddybeer verminderde defensieve reacties jegens andere culturen, wat een afname van doodsangst suggereert. We geen invloed van aanraking op op deelnemers met een hoog zelfvertrouwen. Deze bevindingen suggereren dat het omgaan met existentiële zorgen voor een deel belichaamd is. Aanraking heeft met name voor mensen met een negatief zelfbeeld existentiële waarde.

Hoofdstuk 4 toetst of gesimuleerde affectieve aanraking invloed heeft op een bekend elektrofysiologisch fenomeen die aangeeft of mensen bewust zijn van fouten of "errors" die ze maken. De elektrische activiteit van de hersenen kan op het hoofdhuid gemeten worden door middel van elektro-encefalografie (EEG). De error-related negativity (ERN of Ne) is een negatieve piek van hersenactiviteit die ontstaat als een persoon een fout maakt, waarvan de grootte van de piek aangeeft hoe erg ze dat vinden. We voorspelden dat deelnemers een grotere ERN zouden laten zien wanneer ze een teddybeer op hun schoot houden tijdens een moeilijke Go/No-Go beslissingstaak. Dit zou betekenen dat gesimuleerde aanraking mensen meer betrokken maakt bij de taak. We vergeleken deze conditie met een neutrale conditie waarbij deelnemers een kartonnen doos vasthielden. We vonden inderdaad dat de ERN groter was wanneer deelnemers de beer vasthielden tijdens de taak, maar vooral bij degenen die hoog scoorden op de persoonlijkheidstrek intrinsieke motivatie. Mensen met deze persoonlijkheidstrek zijn gevoeliger voor interessante of verrassende taakaspecten. Deze studie laat zien dat gesimuleerde affectieve aanraking de mentale betrokkenheid van mensen kan vergroten.

Hoofdstuk 5 onderzoekt de geruststellende werking van het aanraken van zacht materiaal, waarmee mensen met een onveilige hechting mogelijk affectieve aanraking kunnen simuleren. We voorspelden een geruststellend effect bij mensen met een angstig-vermijdende hechtingsstijl die een behoefte hadden aan aanraking. We vroegen deelnemers om een stuk stof aan te raken; deze was zo zacht als een wollen dekentje of zo hard als een theedoek. We vonden dat deelnemers die hoog scoorden op de angstig-vermijdende hechtingsstijl zich meer verbonden voelden met dierbaren na het aanraken van de zachte stof. Onverwachts vonden we hetzelfde effect bij deelnemers die laag scoorden op veilige hechting. Studie 2 volgde direct na Studie 1 met een visualisatie oefening waarbij deelnemers moesten denken aan een hechte relatie, of juist een afstandelijke. Het aanraken van de zachte stof leidde, net als het inbeelden van een hechte relatie, tot een toename in gevoelens van geborgenheid bij deelnemers met een onveilige hechting, terwijl de

afstandelijke visualisatie leidde tot een afname van geborgenheid. Degenen die laag scoorden op veilige hechting waren echter in staat om zich geborgen te blijven voelen als ze de de zachte stof hadden aangeraakt. De bevindingen suggereren dat zachte tactiele sensaties een gevoel van verbondenheid en veiligheid kan oproepen, waarmee minder veilig gehechte mensen lichte dreigingen kunnen weerstaan.

Hoofdstuk 6 biedt een overzicht van de belangrijkste bevindingen en conclusies van dit proefschrift. Dit hoofdstuk bespreekt de implicaties van de bevindingen voor drie invloedrijke theorieën over affectieve aanraking, namelijk hechtingstheorie (attachment theory), theorieën van belichaamde cognitie (theories of embodied cognition) en neurobiologische theorieën. Dit hoofdstuk bespreekt ook praktische implicaties voor de klinische praktijk en het onderwijs. Tot slot biedt dit hoofdstuk nog enkele reflecties op recente cultural trends en technologische ontwikkelingen die suggereren dat er een tekort aan menselijk contact is in de moderne samenleving. Samengevat benadrukt dit proefschrift het belang van affectieve aanraking voor het psychologisch welbevinden van de mens.

Chapter 9.

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Chapter 10.

Publications and Presentations

Peer reviewed publications

Tjew-A-Sin, M & Koole, S. L. (2018). Data from Paper 'Terror Management in a Multicultural Society: Effects of Mortality Salience on Attitudes to Multiculturalism Are Moderated by National Identification and Self-Esteem Among Native Dutch People' *Journal of Open Psychology Data 3*(1):e2, doi: 10.5334/jopd.39

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Presentations

Tjew-A-Sin, M., Schneider, I. K., & Koole, S. L. (March 2015). Embodied terror management: Interpersonal touch alleviates existential concerns among individuals with low self-esteem. Paper presented at the NIAS-Lorentz workshop "Social Support TAT; Theory, Applications, and Technology", Leiden, The Netherlands.

Tjew-A-Sin, M., Schneider, I. K., & Koole, S. L. (March 2015). Loneliness moderates the Association between Vulnerable Personality and Mental Health. Poster presented at the 1st International Convention of Psychological Science, Amsterdam, The Netherlands.

Tjew-A-Sin, M., Schneider, I. K., & Koole, S. L. (July 2014). Embodied terror management: Interpersonal touch alleviates existential concerns among individuals with low self-esteem. Paper presented at the 17th European Association of Social Psychology (EASP) General Meeting, Amsterdam, The Netherlands.

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Tjew-A-Sin, M., Schneider, I. K., & Koole, S. L. (May 2013). Simulated interpersonal touch alleviates existential concerns among individuals with low self-esteem. Poster presented at the 25th APS annual convention, Washington DC, United States.

Chapter 11.

Kurt Lewin Institute Dissertation Series

The "Kurt Lewin Institute Dissertation Series" started in 1997. Since 2016, the following dissertations have been published in this series:

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Chapter 12.

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Mandy Tjew-A-Sin was born in The Hague on the 11th of March 1989. After finishing her secondary education (Gymnasium; cum laude) in The Hague in 2007, she started her Psychology bachelor studies at Leiden University, while minoring in Philosophy. She received her Bachelor's degree in Psychology and Minor in Philosophy in 2010, and was selected for the Psychology Research Master program at Leiden University.

She graduated cum laude in August 2012 with a dual Master's degree in Social and Organizational Psychology and Cognitive Neuroscience. She worked as a research assistant during her Master studies, first at Leiden University and later at the Vrije Universiteit Amsterdam to work on an NWO grant proposal with Prof. dr. Sander Koole.

She was awarded the grant in 2012 and started her PhD research project at the Vrije Universiteit Amsterdam. Under the supervision of Prof. dr. Sander Koole, her research focused on embodied pathways to obtain the benefits of affectionate touch, using both behavioral and neuroimaging techniques. In the final stages of her PhD, she conducted a hyperscanning study in collaboration with Prof. dr. Ann-Christine Ehlis, Director of the Psychophysiology & Optical Imaging research group at the University of Tübingen. To analyze this data, she collaborated with Prof. dr. Emily Butler, Director of the Health & Interpersonal Systems (HIS) research group at the University of Arizona.

Mandy Tjew-A-Sin continued her interest in embodied emotion-regulation with a post-doc on ambulatory measurements of self-regulation among youth at the Biological Psychology department of the VU. On her website www.touchingresearch.com, she frequently writes about affectionate touch and self-regulation, both having become permanent intellectual interests.

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