Neural Mechanisms of Insecure Attachment Plasticity

Authors: Ma Yuanxiao, Chen Xu, Chen Xu

Date: 2019-09-01T00:00:00+00:00

Abstract

Insecure attachment plasticity refers to the use of cognitive priming techniques (such as secure attachment priming) to place insecurely attached individuals in long-term sensitive and supportive environments, thereby activating individuals' positive attachment experiences, enabling them to form new cognitive schemas regarding attachment relationships, and ultimately achieving the reconstruction of internal working models in insecurely attached individuals. This project targets the cognitive processing deficits of insecurely attached individuals and employs secure attachment priming methods to explore the underlying mechanisms of insecure attachment plasticity and the corresponding neurophysiological basis. The project intends to conduct research on insecure attachment plasticity from three aspects: the ameliorative effects of single-session secure attachment priming on cognitive processing deficits in insecurely attached individuals, the examination of repeated secure priming effects under multi-task conditions, and longitudinal studies of repeated secure attachment priming effects; the research methodology adopts behavioral-physiological-neuroimaging techniques to systematically investigate the mechanisms and neural basis of insecure attachment plasticity from three dimensions: the nature, modality, and timing of secure attachment priming. Research on insecure attachment plasticity provides a new perspective for secure attachment research, the attachment schema reconstruction theory proposed in this study represents a validation and development of secure base schema theory, and the examination and longitudinal study of repeated secure priming effects attempt to construct a scientific and effective evaluation criterion for insecure attachment plasticity research. The research findings hold significant value for intervention training for insecurely attached populations, enhancing attachment security, and maintaining mental health.

Full Text

Neural Mechanisms of Insecure Attachment Plasticity

Ma Yuanxiao, Chen Xu
Faculty of Psychology, Southwest University, Chongqing 400715, China

Abstract

Insecure attachment plasticity refers to the process by which cognitive priming techniques (such as attachment security priming) place insecurely attached individuals in long-term sensitive and supportive environments, thereby activating positive attachment experiences and enabling the formation of new cognitive schemas about attachment relationships, ultimately reconstructing their internal working models. This project targets the cognitive processing deficits characteristic of insecurely attached individuals and employs attachment security priming methods to explore the mechanisms and neurophysiological foundations underlying insecure attachment plasticity. The research will investigate insecure attachment plasticity through three complementary approaches: (1) examining the ameliorative effects of single-session attachment security priming on cognitive processing deficits, (2) testing repeated priming effects under multitask conditions, and (3) conducting longitudinal tracking studies of repeated priming effects. Using an integrated behavioral-physiological-neuroimaging approach, this study systematically investigates the mechanisms and neural basis of insecure attachment plasticity across three dimensions: the nature, method, and temporal dynamics of attachment security priming. This research provides a novel perspective for attachment security studies, with the proposed attachment schema reconstruction theory extending and validating secure-base schema theory. The examination and tracking of repeated priming effects aim to establish a scientifically rigorous evaluation framework for insecure attachment plasticity research. These findings hold significant value for intervention training among insecurely attached populations, enhancing attachment security, and maintaining mental health.

Keywords: insecure attachment; cognitive processing deficits; plasticity; attachment security priming; neurophysiological mechanisms
Classification Code: B844

---

1 Problem Statement

Attachment styles formed through early interactions between individuals and their caregivers can influence cognitive processing biases toward external stimuli. Attachment-anxious individuals deny their own intrinsic value, tend to over-activate their attachment systems, and actively seek proximity to attachment figures, resulting in excessive cognitive processing of attachment-related information. Conversely, attachment-avoidant individuals deny the value of oth-

ers, suppress attachment system activation to avoid attachment relationships, and maintain emotional distance from attachment figures. These maladaptive cognitive processing patterns—characterized by excessive approach or avoidance —may reduce psychological resilience, impair interpersonal relationship management, and increase the likelihood of mental health problems. Securely attached individuals hold positive attitudes toward both self and others, enabling them to approach social information with openness and maintain emotional balance. Consequently, facilitating the transformation from insecure to secure attachment styles has become a critical and urgent issue in attachment research. Shaping secure attachment styles in insecure individuals not only helps correct their cognitive processing deficits but also enhances mental health and life satisfaction.

1.1 Cognitive Processing Deficits in Insecurely Attached Individuals

Attachment style, as an important personality trait, influences cognitive processing patterns. Attachment-anxious individuals employ hyperactivating strategies, showing heightened arousal to potential threat and rejection cues during early processing stages, which strengthens their motivation to seek proximity and support from attachment figures. Attachment-avoidant individuals adopt deactivating strategies, displaying a defensive posture characterized by high vigilance toward attachment-related information to avoid cues that might trigger attachment behaviors and prevent the internal conflict caused by potential rejection. These cognitive patterns manifest across various domains, including emotional processing, social cognition, and interpersonal interaction. Over the past two decades, research has primarily focused on how attachment styles influence attention to emotional information, making this project concentrate on emotional processing and selective attention deficits.

Behavioral studies reveal that attachment-anxious individuals show hyperactivated processing of attachment-related information, whereas avoidant individuals exhibit processing inhibition. Using an affective priming task, Suslow et al. (2010) found that high attachment avoidance predicted relatively low automatic emotional responses to sad faces. Additional research indicates that, compared to securely attached individuals, anxiously attached individuals show higher arousal to negative information such as fear and sadness, whereas positive emotions elicit lower arousal in avoidant individuals. Similarly, in selective attention tasks, avoidant individuals demonstrate greater processing costs for both positive and negative attachment-related information, suggesting they selectively inhibit attention to attachment-related material—consistent with the hypothesis that avoidant individuals defensively suppress potentially painful information. Domestic researchers Ma et al. (2011) also found that attachment avoidance negatively correlates with working memory performance for emotional words of different valences, reflecting avoidant attentional bias. Pain research further demonstrates that attachment-anxious individuals tend to exaggerate pain experiences, while avoidant individuals suppress them. For instance, using

the tourniquet task to measure pain thresholds in women, Wilson and Ruben (2011) found that anxiously attached women reported lower pain thresholds, greater subjective pain, and higher catastrophizing, whereas avoidant women showed better pain tolerance and lower psychological arousal.

Neurocognitive research corroborates these findings. Attachment-anxious individuals exhibit heightened emotional arousal during emotional information processing, evidenced by increased activation in the striatum, ventral tegmental area, left amygdala, prefrontal areas, globus pallidus, claustrum, and right cerebellum when processing facial expressions. DeWall et al. (2012) also found that social rejection elicited heightened neural activity in anxious individuals and reduced activity in avoidant individuals (dorsal anterior cingulate cortex, anterior insula). However, the heightened emotional arousal in anxious individuals consumes substantial cognitive resources, leading to inefficient emotion regulation. Gillath et al. (2005) found that recalling negative experiences elicited higher activation in the anterior temporal pole and lower activation in the orbitofrontal cortex in anxious individuals, reflecting both high arousal to negative information and poor emotion regulation. ERP studies show similar patterns, with anxious individuals exhibiting larger LPP amplitudes when processing emotional information.

The vigilance-avoidance model posits that avoidant individuals' early automatic vigilance enables rapid environmental responses, facilitating timely avoidance behavior. Lenzi et al. (2013) found that avoidant individuals show greater activation in motivational, mirror, and limbic systems when viewing, imitating, or empathizing. However, this defensive processing pattern results in low arousal to emotional information. Researchers have observed reduced activation in avoidant individuals during emotional processing in regions including the subcallosal cingulate cortex, lateral prefrontal cortex, primary somatosensory cortex, striatum, ventral tegmental area, medial orbitofrontal cortex, perigenual ACC, and left amygdala. ERP studies support these findings, with Dan and Raz (2012) reporting that angry faces elicited larger C1 and P1 amplitudes than neutral faces in avoidant individuals, reflecting vigilant processing, while facial expressions elicited lower N1, N2, and N400 amplitudes.

Securely attached individuals possess strong security, habitually employ secure-base strategies, and demonstrate attentiveness, warmth, and sensitivity in interpersonal relationships. Neurophysiological evidence supports these characteristics, with infant facial expressions eliciting weaker amygdala activation but stronger activation in reward-related regions such as the ventral striatum, oxytocin-related hypothalamus, and pituitary gland in secure individuals. Furthermore, compared to insecure mothers, secure mothers show smaller N170 amplitudes and larger P300 amplitudes in response to infant facial expressions.

1.2 Research on Attachment Security Priming Effects

Given the advantages of securely attached individuals in cognitive processing, interpersonal functioning, and mental health maintenance, numerous adult attachment studies aim to identify methods that promote adult security and secure-base strategy utilization—namely, attachment security priming. This technique involves contextually activating secure attachment representations, temporarily making individuals feel safe and protected, thereby increasing attachment security and promoting secure-base strategy use. Security priming provides a scientifically feasible approach to investigating insecure attachment plasticity. Recent studies using priming to contextually activate secure representations have enabled real-time dynamic examination of attachment system activity, reflecting developmental changes in attachment styles and environmental interactions.

First, attachment security priming can evoke positive emotions, eliminate negative impacts from threatening situations and psychological trauma, and enhance mental health. Research demonstrates that priming enables individuals to respond to relational threats more securely. Gillath and Shaver (2007) found that one week after completing nine priming sessions over three weeks, the priming group still reported higher self-esteem, positive emotions, and empathy compared to controls, indicating better durability of repeated priming effects. Neuroimaging studies show that presenting the name of a secure attachment figure reduces hypothalamic activation during social exclusion. Similarly, Norman et al. (2015) found that security priming attenuated amygdala activation in both anxious and avoidant individuals when processing threatening faces and words. Research on neurosis and personality disorders also reveals enhanced prefrontal activation in anorexic children and increased superior temporal sulcus activation with reduced parahippocampal activation in borderline personality disorder patients following security priming.

Second, security priming can enhance positive self-concept in insecure individuals, weaken defensive mechanisms, promote secure-base strategy use, and increase exploratory, self-actualizing, and authentic behaviors. Studies show that priming significantly reduces avoidant individuals' tendency to avoid traumatic memories and decreases intense negative emotions in anxious individuals when recalling such experiences. Additionally, priming increases authentic behavior in insecure individuals by eliminating self-defensive motivations. Huang and Murnighan (2010) found that subliminally presenting attachment figures' names enhanced trust toward strangers. Neurophysiological research indicates that viewing romantic partners' photos activates dopamine-rich reward and motivation systems and elicits larger LPP amplitudes.

Finally, regarding interpersonal relationships, security priming can improve insecure individuals' interpersonal expectations, help them form stable relationships, and enhance empathy and altruism. Multiple studies demonstrate that priming increases positive interpersonal expectations and behaviors toward attachment

figures. Repeated priming research shows that after three consecutive days of priming, participants reported lower attachment anxiety and more positive self and relationship evaluations, with positive expectations showing linear correlations with priming frequency. Furthermore, priming increases compassion toward others' needs.

1.3 Attachment Security Priming and Insecure Attachment Plasticity

Secure-base schema theory posits that memories of caregiving and support from attachment figures are stored as secure-base schemas. Due to consistent, responsive support during threat, securely attached individuals develop well-organized, accessible secure-base schemas, whereas insecure individuals'schemas remain disorganized and inaccessible due to inconsistent, absent, or ineffective caregiving. Although attachment styles are relatively stable, they remain developing structures. As new attachment experiences become internalized, individuals may alter their cognitive evaluations of past experiences, generating new schemas related to internal working models. Attachment security priming uses specific cognitive techniques to expose individuals to warm attachment environments, with positive effects influencing cognition, attention, and behavior. Mikulincer and Shaver (2007c) proposed a heuristic model suggesting that activating secure attachment representations spreads to related perceptual, self-representational, self-regulatory, and affective management processes. Therefore, although secure-base schemas originate from early interactions with primary caregivers, insecure individuals' schemas are not necessarily stable but can assimilate and accommodate new information.

Researchers propose that cognitive structures contain multiple attachment schemas, with both positive and negative attachment memories coexisting in the attachment system. In insecure individuals, negative schemas dominate. Security priming exposes insecure individuals to safe environments, awakening positive attachment experiences and activating secure attachment schemas. If these positive events recur repeatedly over time, secure schemas may become dominant, ultimately reconstructing insecure individuals' internal working models. Thus, attachment styles are not immutable but influenced by specific relationships and contexts. We hypothesize that long-term exposure to sensitive, supportive environments enables insecure individuals to form new cognitive schemas about attachment relationships, which then match and reorganize with old schemas to develop new attachment patterns. Consequently, attachment security priming, particularly repeated priming, provides theoretical feasibility and methodological direction for insecure attachment plasticity research.

1.4 Research Gaps and Directions

Previous research on insecure attachment plasticity has explored life events and social support, yielding valuable findings, but insecure attachment plasticity and its neural mechanisms have not been systematically investigated.

First, prior studies have neglected the role of conscious states in priming effects for insecure individuals. Although both conscious and unconscious priming produce positive effects, they represent fundamentally different cognitive states that may differentially influence priming outcomes. Indeed, researchers suggest that unconscious priming can reduce experimental demand effects and minimize defensive reactions in avoidant individuals.

Second, repeated priming effects and their neural mechanisms remain unexplored. While single-session priming temporarily enhances attachment security and improves threat coping, these state-level changes do not involve trait-level transformation. Gillath et al. (2008) argue that priming frequency affects outcomes, with Brown et al. (1996) suggesting that increased repetition produces stronger, more durable effects. Attachment theory posits that sustained interaction with attachment figures improves attachment system function in the short term and influences stable attachment schemas long-term. Although existing research demonstrates good persistence of repeated priming effects, studies suffer from insufficient frequency, discontinuity, and critically, lack of neural mechanism investigation.

Third, priming methods remain relatively singular and non-targeted. Priming approaches fall into two categories: active recall (imagining positive attachment experiences) and passive reception (semantic and affective priming). However, existing research employs monolithic methods without combining multiple approaches. Moreover, avoidant individuals hold negative other-models and view intimacy-seeking as dangerous due to fear of rejection. Current research fails to design targeted priming methods for avoidant individuals, potentially limiting effectiveness.

Finally, systematic testing of repeated priming effects is lacking. Repeated priming provides crucial theoretical direction for plasticity research, and testing these effects represents a key indicator of effectiveness. Current assessments primarily compare pre-post effects or use control groups, but given that attachment styles involve multiple cognitive domains, multidimensional systematic testing would provide stronger scientific evidence for insecure attachment plasticity.

2 Research Framework

Based on the above analysis, this research systematically investigates insecure attachment plasticity and its neural mechanisms from the perspective of attachment security priming. At the cross-sectional level, we examine priming effects and neural mechanisms in insecure individuals by investigating how conscious states and duration influence priming outcomes. At the longitudinal level, tracking studies assess the temporal persistence of repeated priming effects. Using a combined cross-sectional and longitudinal design with behavioral-physiological-neuroimaging techniques, this research systematically explores insecure attachment plasticity. The framework consists of three components, with a schematic overview presented in Figure 1 [Figure 1: see original paper].

2.1 Study 1: Effects of Conscious State on Attachment Security Priming in Insecure Individuals

Although both conscious and unconscious priming produce sustained positive effects, they represent fundamentally different cognitive states that may differentially influence priming outcomes. While conscious priming dominates current research, avoidant individuals' defensive reactions to intimate attachment information may render conscious priming ineffective for this population. As noted, unconscious priming can reduce experimental demand effects and minimize avoidant individuals' defensive responses, suggesting it may be more suitable for avoidant individuals. Therefore, the applicability of conscious versus unconscious priming may differ for anxious and avoidant individuals. Addressing the limitation of monolithic, non-targeted priming methods, Study 1 examines how conscious and unconscious priming ameliorate attention processing deficits in insecure individuals and compares their differential effectiveness. By clarifying the validity and applicability of both priming methods for anxious and avoidant individuals, this study deepens understanding of how priming nature influences effectiveness.

Specifically, Study 1 employs a modified cueing paradigm with two ERP experiments to examine the role of conscious state. Experiment 1 investigates the temporal dynamics of attention processing for attachment-related stimuli in anxious and avoidant individuals under conscious (supraliminal) priming conditions. The experiment manipulates three variables: attachment style (anxiety, avoidance), priming valence (neutral, secure), and facial emotion (neutral, negative), with attachment style as a between-subjects factor and priming type and facial emotion as within-subjects factors. Notably, this research uses attachment-relevant priming materials because previous studies demonstrate differential effects between attachment security priming and positive affect priming. For example, Mallinckrodt (2007) found that security priming produced stronger empathic responses than positive affect priming. We hypothesize that security priming will improve anxious individuals' hyperactivating attention patterns but not affect avoidant individuals. Specifically, compared to neutral priming, anxious individuals will show smaller N170 amplitudes and larger P300 amplitudes under security priming, while avoidant individuals will show no significant N170 or P300 differences.

To more systematically investigate conscious state effects, Experiment 2 uses ERP to examine attention processing under unconscious (subliminal) priming. The design mirrors Experiment 1, except priming stimuli are presented for 22 ms to achieve subliminal presentation. A forced-choice recognition test at the end verifies stimulus unawareness. We hypothesize that unconscious security priming will improve avoidant individuals' defensive attention patterns, manifested as smaller P100 amplitudes and larger P300 amplitudes compared to neutral priming, with no significant effects for anxious individuals.

2.2 Study 2: Examining Repeated Attachment Security Priming Effects Under Multi-Task Conditions

Although single-session priming can temporarily evoke positive emotions and increase attachment security, these state-level enhancements may not reflect trait-level change. Gillath et al. (2008) argue that priming frequency influences effects, and schema theory suggests that sustained enhancement of attachment security through experimental methods may facilitate secure schema formation in insecure individuals. Study 2 therefore implements 30 consecutive days of security priming training for anxious and avoidant individuals. Repeated priming effects should extend beyond cognitive processing, as attachment security is fundamental to other behavioral systems. The heuristic model of priming effects suggests that secure representation activation spreads to perception, self-representation, self-regulation, and affective management. Therefore, this study systematically tests repeated priming effects across multiple attachment-related cognitive and behavioral systems—a critical step for evaluating plasticity validity and reliability. Specifically, Study 2 examines changes in biochemical indices (oxytocin), empathy levels, and social rejection coping abilities, comparing insecure and secure individuals post-training to assess trait-level changes.

Training Procedure: Before training, participants complete the Experience in Close Relationships questionnaire and State Adult Attachment Scale. Participants imagine or recall positive attachment experiences in writing, view warm attachment scene images and videos, and record daily positive events in a diary before bedtime. Questionnaires are administered weekly. Control groups receive neutral, attachment-unrelated materials and record neutral daily events.

Notably, viewing instructions differ for anxious and avoidant participants during image training. Anxious individuals judge whether images convey warmth, while avoidant individuals count the number of people present. This manipulation intentionally diverts avoidant individuals' conscious attention from emotional valence, transforming the task into an implicit affective procedure.

Study 2 employs multiple neurophysiological techniques across three experiments to comprehensively examine repeated priming effects on caregiving, empathy, and psychological adjustment systems.

Experiment 3 examines oxytocin levels as an index of the caregiving system. The design manipulates attachment style (secure, anxious, avoidant), group (priming, control), and time point (pre-test, post-test). For endogenous oxytocin measurement, saliva samples are collected at baseline (after 10-minute rest), task condition (10 minutes after viewing a 5-minute infant video containing happy and crying segments), and recovery phases (10 minutes post-task). To avoid circadian rhythm effects, sessions occur between 14:00-17:00. We hypothesize that anxious and avoidant individuals will show significantly higher post-test oxytocin levels compared to pre-test, with secure individuals showing higher levels than insecure individuals at pre-test but no group differences at post-test.

Experiment 4 uses fMRI to assess repeated priming effects on empathy. The design manipulates attachment style, group, and time point. Materials consist of infant facial expressions with two tasks: emotional empathy (imitating expressions) and cognitive empathy (perspective-taking). We hypothesize that post-test neural activity in anxious and avoidant individuals will be significantly greater than pre-test in the subgenual cingulate and orbitofrontal cortex, with secure individuals showing higher activation than insecure individuals at pre-test but no group differences at post-test.

Experiment 5 examines psychological adjustment using fMRI and endogenous cortisol during social rejection. The design manipulates attachment style, group, and time point. The task is the classic Cyberball paradigm. Cortisol samples are collected at baseline (10 minutes post-arrival, pre-scan), task (10 minutes post-scan), and recovery phases. To avoid familiarization effects, daily training includes Cyberball tasks with random acceptance/rejection sequences. We hypothesize that post-test cortisol levels and dorsal ACC/anterior insula activation will be significantly lower than pre-test in anxious and avoidant individuals, with secure individuals showing higher levels than insecure individuals at pre-test but no group differences at post-test.

2.3 Study 3: Temporal Persistence of Repeated Priming Effects

Beyond multidimensional testing, temporal persistence represents another crucial indicator of repeated priming effectiveness. To verify whether repeated priming achieves plasticity goals, Study 3 conducts a 30-day follow-up after training completion. For consistency, follow-up assessments use identical tasks from Study 2, testing persistence across caregiving, empathy, and psychological adjustment systems, plus questionnaire measures. Participants return to the laboratory on days 7, 14, 21, and 28 post-training.

Experiment 6 assesses persistence in caregiving function by measuring endogenous oxytocin at weeks 1-4 post-training. The design manipulates attachment style (anxious, avoidant), group, and time point (0 [post-test], 1, 2, 3, 4 weeks). Procedures mirror Experiment 3. We hypothesize that oxytocin levels and attachment questionnaire scores will not differ significantly between post-test and weeks 1-4.

Experiment 7 assesses persistence in empathy function by measuring empathy task scores at weeks 1-4 post-training. The design mirrors Experiment 4. We hypothesize that empathy scores will not differ significantly between post-test and weeks 1-4.

Experiment 8 assesses persistence in psychological adjustment by measuring endogenous cortisol at weeks 1-4 post-training. The design mirrors Experiment 5, with participants completing Cyberball tasks on two random days per week to prevent familiarization. We hypothesize that cortisol levels will not differ significantly between post-test and weeks 1-4.

3 Theoretical Construction

Over the past two decades, research has extensively examined different attachment styles and their corresponding cognitive processing patterns. Insecure attachment involves excessive approach and avoidance deficits that may cause cognitive dissonance, hinder social relationship formation, and increase psychiatric risk. Transforming insecure into secure attachment styles has thus become a research priority. Given the advantages of secure attachment, numerous studies have sought methods to promote security and secure-base strategy use. While previous research has made valuable contributions, current priming studies remain relatively "coarse-grained,"lacking comprehensive exploration of priming effects. This research adopts a plasticity perspective to elucidate the mechanisms and neurophysiological foundations of insecure attachment plasticity through three avenues: examining priming applicability, systematically testing repeated priming effects, and tracking their persistence.

First, this research investigates the role of conscious states in priming effects. Although both conscious and unconscious priming produce positive effects, their differential effectiveness and applicability remain poorly understood. A prerequisite for priming research is that manipulations activate secure schemas and enhance attachment security. However, avoidant individuals view intimacy-seeking as dangerous due to painful rejection experiences. Given their defensive mechanisms against intimate information, conscious priming may be unsuitable for avoidant individuals. Indeed, unconscious priming can reduce experimental demands and avoidant defences. Recent meta-analyses show conscious priming fails to produce positive effects in avoidant individuals, likely due to cognitive-affective defences that unconscious priming may bypass. Therefore, clarifying the validity and applicability of both priming methods forms the foundation of plasticity research and suggests that future studies should design targeted approaches for specific insecure attachment types.

Second, this research implements security priming training and systematically tests repeated priming effects across multiple cognitive-behavioral systems—the core phase of plasticity research. Priming effects depend on both nature and duration. Secure-base schema theory suggests that memories of caregiving are stored as secure-base schemas. When new events repeat, they transition from unexpected occurrences to established schemas. Although internal working models are stable and attachment styles represent trait-level individual differences, they remain changeable under supportive conditions. Accordingly, this research proposes attachment schema reconstruction theory: when insecure individuals experience long-term sensitive and supportive environments, new attachment bonds match and update previous schemas, facilitating the transformation from insecure to secure attachment—i.e., insecure attachment plasticity. Before establishing plasticity, objective scientific assessment methods are essential. Since attachment security underpins other behavioral systems, and priming effects spread to multiple domains, multidimensional testing is necessary. This research systematically examines repeated priming effects across caregiving, empathy,

and psychological adjustment systems to establish reliable plasticity evidence.

Finally, this research longitudinally examines the temporal persistence of repeated priming effects. Persistence represents a crucial indicator of effectiveness, as established secure schemas should not decay like single-session effects. Assessing temporal persistence across multiple cognitive-behavioral systems provides another important measure of plasticity research validity. Through comprehensive testing across systems and time, this research aims to establish a reliable, thorough evaluation framework for insecure attachment plasticity.

Insecure attachment plasticity research offers new theoretical perspectives on the development and assessment of plasticity, contributing to attachment theory validation and extension. Moreover, shaping secure attachment styles enhances attachment security, interpersonal relationships, and mental health, with significant implications for improving well-being and quality of life.

References

Aron, A., Fisher, H., Mashek, D. J., Strong, G., Li, H. F., & Brown, L. L. (2005). Reward, motivation, and emotion systems associated with early-stage intense romantic love. *Journal of Neurophysiology, 94*(1), 327–337.

Baldwin, M. W., Keelan, J. P. R., Fehr, B., Enns, V., & Koh-Rangarajoo, E. (1996). Social-cognitive conceptualization of attachment working models: Availability and accessibility effects. *Journal of Personality and Social Psychology, 71*(1), 94–109.

Beckes, L., Simpson, J. A., & Erickson, A. (2010). Of snakes and succor: Learning secure attachment associations with novel faces via negative stimulus pairings. *Psychological Science, 21*(5), 721–728.

Bowlby, J. (1973). *Attachment and loss: Separation—anxiety and anger* (Vol. 2). New York, NY: Basic Books.

Bowlby, J. (1982). Attachment and loss: Retrospect and prospect. *American Journal of Orthopsychiatry, 52*(4), 664–678.

Bretherton, I., & Munholland, K. A. (1999). Internal working models in attachment relationships: A construct revisited. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (pp. 89–111). New York: Guilford Press.

Brown, A. S., Jones, T. C., & Mitchell, D. B. (1996). Single and multiple test repetition priming in implicit memory. *Memory, 4*(2), 159–173.

Buchheim, A., Erk, S., George, C., Kächele, H., Kircher, T., Martius, P., ···Walter, H. (2008). Neural correlates of attachment trauma in borderline personality disorder: A functional magnetic resonance imaging study. *Psychiatry Research: Neuroimaging, 163*(3), 223–235.

Canterberry, M., & Gillath, O. (2013). Neural evidence for a multifaceted model of attachment security. *International Journal of Psychophysiology, 88*(3), 232-240.

Carnelley, K. B., & Rowe, A. C. (2007). Repeated priming of attachment security influences later views of self and relationships. *Personal Relationships, 14*(2), 307-320.

Cassidy, J., Shaver, P. R., Mikulincer, M., & Lavy, S. (2009). Experimentally induced security influences responses to psychological pain. *Journal of Social and Clinical Psychology, 28*(4), 463-478.

Dan, O., & Raz, S. (2012). Adult attachment and emotional processing biases: An event-related potentials (ERPs) study. *Biological Psychology, 91*(2), 212-220.

Davies, K. A., Macfarlane, G. J., McBeth, J., Morriss, R., & Dickens, C. (2009). Insecure attachment style is associated with chronic widespread pain. *PAIN, 143*(3), 200-205.

Davila, J., Karney, B. R., & Bradbury, T. N. (1999). Attachment change processes in the early years of marriage. *Journal of Personality and Social Psychology, 76*(5), 783-802.

DeWall, C. N., Masten, C. L., Powell, C., Combs, D., Schurtz, D. R., & Eisenberger, N. I. (2012). Do neural responses to rejection depend on attachment style? An fMRI study. *Social Cognitive and Affective Neuroscience, 7*(2), 184-192.

Donges, U. S., Kugel, H., Stuhrmann, A., Grotegerd, D., Redlich, R., Lichev, V., ···Dannlowski, U. (2012). Adult attachment anxiety is associated with enhanced automatic neural response to positive facial expression. *Neuroscience, 220*, 149-157.

Donges, U. S., Zeitschel, F., Kersting, A., & Suslow, T. (2015). Adult attachment orientation and automatic processing of emotional information on a semantic level: A masked affective priming study. *Psychiatry Research, 229*(1-2), 174-180.

Dykas, M. J., & Cassidy, J. (2011). Attachment and the processing of social information across the life span: Theory and evidence. *Psychological Bulletin, 137*(1), 19-46.

Edelstein, R. S. (2006). Attachment and emotional memory: Investigating the source and extent of avoidant memory impairments. *Emotion, 6*(2), 340-345.

Edelstein, R. S., & Gillath, O. (2008). Avoiding interference: Adult attachment and emotional processing biases. *Personality and Social Psychology Bulletin, 34*(2), 171-181.

Fraedrich, E. M., Lakatos, K., & Spangler, G. (2010). Brain activity during emotion perception: The role of attachment representation. *Attachment & Human*

Development, 12(3), 231–248.

Gabriel, S., Kawakami, K., Bartak, C., Kang, S. J., & Mann, N. (2010). Negative self-synchronization: Will I change to be like you when it is bad for me? *Journal of Personality and Social Psychology, 98*(6), 857–871.

Gillath, O., Bunge, S. A., Shaver, P. R., Wendelken, C., & Mikulincer, M. (2005). Attachment-style differences in the ability to suppress negative thoughts: Exploring the neural correlates. *Neuroimage, 28*(4), 835–847.

Gillath, O., Giesbrecht, B., & Shaver, P. R. (2009). Attachment, attention, and cognitive control: Attachment style and performance on general attention tasks. *Journal of Experimental Social Psychology, 45*(4), 647–654.

Gillath, O., & Karantzas, G. (2019). Attachment security priming: A systematic review. *Current Opinion in Psychology, 25*, 86–95.

Gillath, O., Selcuk, E., & Shaver, P. R. (2008). Moving toward a secure attachment style: Can repeated security priming help? *Social and Personality Psychology Compass, 2*(4), 1651–1666.

Gillath, O., Sesko, A. K., Shaver, P. R., & Chun, D. S. (2010). Attachment, authenticity, and honesty: Dispositional and experimentally induced security can reduce self- and other-deception. *Journal of Personality and Social Psychology, 98*(5), 841–855.

Gillath, O., & Shaver, P. R. (2007). Long-term effects of repeated security priming. Unpublished manuscript, Department of Psychology, University of Kansas.

Guo, W., Chen, X., & Yang, N. (2011). Secure base priming and its neural mechanisms. *Psychological Development and Education, 27*(5), 553–560.

Huang, L., & Murnighan, J. K. (2010). What' s in a name? Subliminally activating trusting behavior. *Organizational Behavior and Human Decision Processes, 111*(1), 62–70.

Karremans, J. C., Heslenfeld, D. J., van Dillen, L. F., & van Lange, P. A. M. (2011). Secure attachment partners attenuate neural responses to social exclusion: An fMRI investigation. *International Journal of Psychophysiology, 81*(1), 44–50.

Keinänen, M. T., Johnson, J. G., Richards, E. S., & Courtney, E. A. (2012). A systematic review of the evidence-based psychosocial risk factors for understanding of borderline personality disorder. *Psychoanalytic Psychotherapy, 26*(1), 65–91.

Kouider, S., Dehaene, S., Jobert, A., & Le Bihan, D. (2007). Cerebral bases of subliminal and supraliminal priming during reading. *Cerebral Cortex, 17*(9), 2019–2029.

Langeslag, S. J. E., Jansma, B. M., Franken, I. H. A., & van Strien, J. W. (2007). Event-related potential responses to love-related facial stimuli. *Biological Psychology, 76*(1-2), 109–115.

Lenzi, D., Trentini, C., Pantano, P., Macaluso, E., Lenzi, G. L., & Ammaniti, M. (2013). Attachment models affect brain responses in areas related to emotions and empathy in nulliparous women. *Human Brain Mapping, 34*(6), 1399–1413.

Leyh, R., Heinisch, C., Behringer, J., Reiner, I., & Spangler, G. (2016). Maternal attachment representation and neurophysiological processing during the perception of infants' emotional expressions. *PloS One, 11*(2), e0147294.

Liu, Y., Ding, Y., Lu, L., & Chen, X. (2017). Attention bias of avoidant individuals to attachment emotion pictures. *Scientific Reports, 7*, 41631.

Lorenzini, N., & Fonagy, P. (2013). Attachment and personality disorders: A short review. *Focus, 11*(2), 155–166.

Ma, Y. X., Chen, X., Ran, G. M., Ma, H. J., Zhang, X., & Liu, G. Z. (2017). The processing of body expressions during emotional scenes: The modulation role of attachment styles. *Scientific Reports, 7*, 44740.

Ma, S. C., Xiao, Z. Z., Zhou, A. B., Yang, X. L., & Xiang, L. (2011). Avoidant attachment and attentional bias: Stimulus generality versus stimulus specificity. *Psychological Science, 34*(6), 1313–1319.

Main, M. (1981). Avoidance in the service of attachment: A working paper. In K. Immelmann, G. Barlow, M. Main, & L. Petrovich (Eds.), *Behavioral development: The Bielefeld Interdisciplinary Project* (pp. 651–693). New York, NY: Cambridge University Press.

Mallinckrodt, B. (2007). A call to broaden and build Mikulincer and Shaver' s work on the benefits of priming attachment security. *Psychological Inquiry, 18*(3), 168–172.

Mark, R. E., Geurdes, F. I. M., & Bekker, M. H. J. (2012). Attachment styles are related to ERPs elicited to angry faces in an oddball paradigm. *Journal of Behavioral & Brain Science, 2*(1), 128–140.

Martínez, M. P., Miró, E., Sánchez, A. I., Mundo, A., & Martínez, E. (2012). Understanding the relationship between attachment style, pain appraisal and illness behavior in women. *Scandinavian Journal of Psychology, 53*(1), 54–63.

Mikulincer, M., & Arad, D. (1999). Attachment working models and cognitive openness in close relationships: A test of chronic and temporary accessibility effects. *Journal of Personality and Social Psychology, 77*(4), 709–723.

Mikulincer, M., Gillath, O., Halevy, V., Avihou, N., Avidan, S., & Eshkoli, N. (2001). Attachment theory and reactions to others' needs: Evidence that activation of the sense of attachment security promotes empathic responses. *Journal of Personality and Social Psychology, 81*(6), 1205–1224.

Mikulincer, M., Gillath, O., & Shaver, P. R. (2002). Activation of the attachment system in adulthood: Threat-related primes increase the accessibility of mental representations of attachment figures. *Journal of Personality and Social Psychology, 83*(4), 881–895.

Mikulincer, M., & Shaver, P. R. (2003). The attachment behavioral system in adulthood: Activation, psychodynamics, and interpersonal processes. *Advances in Experimental Social Psychology, 35*, 53–152.

Mikulincer, M., & Shaver, P. R. (2007a). Boosting attachment security to promote mental health, prosocial values, and inter-group tolerance. *Psychological Inquiry, 18*(3), 139–156.

Mikulincer, M., & Shaver, P. R. (2007b). *Attachment in adulthood: Structure, dynamics, and change*. New York: Guilford Press.

Mikulincer, M., & Shaver, P. R. (2007c). Reflections on security dynamics: Core constructs, psychological mechanisms, relational contexts, and the need for an integrative theory. *Psychological Inquiry, 18*(3), 177–182.

Mikulincer, M., Shaver, P. R., Sapir-Lavid, Y., & Avihou-Kanza, N. (2009). What' s inside the minds of securely and insecurely attached people? The secure-base script and its associations with attachment-style dimensions. *Journal of Personality and Social Psychology, 97*(4), 615–633.

Nagamitsu, S., Yamashita, F., Araki, Y., Iizuka, C., Ozono, S., Komatsu, H., ···Matsuishi, T. (2010). Characteristic prefrontal blood volume patterns when imaging body type, high-calorie food, and mother-child attachment in childhood anorexia nervosa: A near infrared spectroscopy study. *Brain and Development, 32*(2), 162–167.

Norman, L., Lawrence, N., Iles, A., Benattayallah, A., & Karl, A. (2015). Attachment-security priming attenuates amygdala activation to social and linguistic threat. *Social Cognitive and Affective Neuroscience, 10*(6), 854–861.

Pierce, T., & Lydon, J. E. (2001). Global and specific relational models in the experience of social interactions. *Journal of Personality and Social Psychology, 80*(4), 613–631.

Riem, M. M. E., Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Out, D., & Rombouts, S. A. R. B. (2012). Attachment in the brain: Adult attachment representations predict amygdala and behavioral responses to infant crying. *Attachment & Human Development, 14*(6), 533–551.

Rigon, A., Duff, M. C., & Voss, M. W. (2016). Structural and functional neural correlates of self-reported attachment in healthy adults: Evidence for an amygdalar involvement. *Brain Imaging & Behavior, 10*(4), 1189–1197.

Rognoni, E., Galati, D., Costa, T., & Crini, M. (2008). Relationship between adult attachment patterns, emotional experience and EEG frontal asymmetry. *Personality and Individual Differences, 44*(4), 909–920.

Rowe, A., & Carnelley, K. B. (2003). Attachment style differences in the processing of attachment-relevant information: Primed-style effects on recall, interpersonal expectations, and affect. *Personal Relationships, 10*(1), 59–75.

Shaver, P. R., Mikulincer, M., Lavy, S., & Cassidy, J. (2009). Understanding and altering hurt feelings: An attachment-theoretical perspective on the generation and regulation of emotions. In A. L. Vangelisti (Ed.), *Feeling hurt in close relationships* (pp. 92–119). New York, NY: Cambridge University Press.

Sibley, C. G., & Overall, N. C. (2010). Modeling the hierarchical structure of personality-attachment associations: Domain diffusion versus domain differentiation. *Journal of Social and Personal Relationships, 27*(1), 47–70.

Steele, R. D., Waters, T. E. A., Bost, K. K., Vaughn, B. E., Truitt, W., Waters, H. S., ···Roisman, G. I. (2014). Caregiving antecedents of secure base script knowledge: A comparative analysis of young adult attachment representations. *Developmental Psychology, 50*(11), 2526–2538.

Strathearn, L., Fonagy, P., Amico, J., & Montague, P. R. (2009). Adult attachment predicts maternal brain and oxytocin response to infant cues. *Neuropsychopharmacology, 34*(13), 2655–2666.

Suslow, T., Dannlowski, U., Arolt, V., & Ohrmann, P. (2010). Adult attachment avoidance and automatic affective response to sad facial expressions. *Australian Journal of Psychology, 62*(4), 181–187.

Tremblay, I., & Sullivan, M. J. L. (2010). Attachment and pain outcomes in adolescents: The mediating role of pain catastrophizing and anxiety. *The Journal of Pain, 11*(2), 160–171.

Vrtička, P., Andersson, F., Grandjean, D., Sander, D., & Vuilleumier, P. (2008). Individual attachment style modulates human amygdala and striatum activation during social appraisal. *PLoS One, 3*(8), e2868.

Vrtička, P., & Vuilleumier, P. (2012). Neuroscience of human social interactions and adult attachment style. *Frontiers in Human Neuroscience, 6*, 212.

Waters, H. S., & Waters, E. (2006). The attachment working models concept: Among other things, we build script-like representations of secure base experiences. *Attachment & Human Development, 8*(3), 185–197.

Wilson, C. L., & Ruben, M. A. (2011). A pain in her arm: Romantic attachment orientations and the tourniquet task. *Personal Relationships, 18*(2), 242–265.

Woodhouse, S., Ayers, S., & Field, A. P. (2015). The relationship between adult attachment style and post-traumatic stress symptoms: A meta-analysis. *Journal of Anxiety Disorders, 35*, 103–117.

Wyman, P. A., Cowen, E. L., Work, W. C., Hoyt-Meyers, L., Magnus, K. B., & Fagen, D. B. (1999). Caregiving and developmental factors differentiating young at-risk urban children showing resilient versus stress-affected outcomes: A replication and extension. *Child Development, 70*(3), 645–659.

Zhai, J., Chen, X., Ma, J. L., Yang, Q. Q., & Liu, Y. (2016). The vigilance-avoidance model of avoidant recognition: An ERP study under threat priming. *Psychiatry Research, 246*, 379–386.

Zhang, X., Li, T. G., & Zhou, X. L. (2008). Brain responses to facial expressions by adults with different attachment-orientations. *Neuroreport, 19*(4), 437–441.

Zilber, A., Goldstein, A., & Mikulincer, M. (2007). Adult attachment orientations and the processing of emotional pictures—ERP correlates. *Personality and Individual Differences, 43*(7), 1898–1907.

Note: Figure translations are in progress. See original paper for figures.