Effects of Attachment-Related Scenario Simulation on Adult Attachment Security

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Abstract

The plasticity of attachment is an important theme in research on adult attachment, and exploring the plasticity of attachment first requires understanding how attachment security is obtained. The attachment control system model posits that individuals can access attachment security through internal representations. Existing research often employs the secure base script as this type of internal representation, but neglects another form of internal representation, namely attachment-related episodic simulation. Several previous studies have proposed and confirmed this new pathway to attachment security—attachment-related episodic simulation—but have yet to answer: What is the specificity of this new pathway compared to existing pathways? What is its mechanism of action? And how can attachment security interventions be developed based on this? This project will investigate these questions through three studies: Study 1 examines the influence of attachment-related episodic simulation on attachment security and its specificity; Study 2 investigates the mechanism through which attachment-related episodic simulation influences attachment security from the perspectives of its content and processing; Study 3 employs natural language processing techniques to develop a classification method for attachment-related episodic simulation and applies it to attachment security intervention. This project will supplement the content of the attachment control system model, can explain the situational flexibility of the attachment system, and provide insights for understanding the plasticity of attachment and conducting attachment security interventions.

Full Text

The Effect of Attachment-Relevant Episodic Simulation on Adult Attachment Security

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Abstract

The plasticity of attachment represents a crucial research theme in adult attachment studies, and exploring this plasticity first requires understanding how individuals attain attachment security. The control-systems model of attachment posits that individuals can access attachment security through internal representations. Existing research has frequently identified the secure-base script as this internal representational mechanism, yet it has overlooked another form of internal representation: attachment-relevant episodic simulation. Several previous studies have proposed and confirmed this novel pathway to attachment security, but critical questions remain unanswered: What is the specificity of this new pathway compared to existing ones? What are its underlying mechanisms? And how can attachment security interventions be developed based on it? This project will address these questions through three studies. Study 1 examines the effect of attachment-relevant episodic simulation on attachment security and its specificity. Study 2 investigates the mechanisms through which attachment-relevant episodic simulation influences attachment security, considering both its content and processing. Study 3 develops classification methods for attachment-relevant episodic simulation using natural language processing techniques and applies them to attachment security interventions. This project will supplement the control-systems model of attachment, explain the situational flexibility of the attachment system, and provide insights for understanding attachment plasticity and conducting attachment security interventions.

Keywords: adult attachment, episodic simulation, control-systems model of attachment, attachment security, internal working models

1. Problem Statement

Marital and family happiness constitutes an essential component of people' s well-being. The Ministry of Civil Affairs and the National Development and Reform Commission issued the "14th Five-Year Plan for Civil Affairs Development," prompting government departments at all levels to actively promote marital and family cultural education and counseling services to foster harmony and stability in marriages and families. Research indicates that attachment security is one of the most powerful factors explaining marital and family happiness (Feeney & Monin, 2008; Joel et al., 2020), and the attainment of attachment security is closely related to long-term intimate relationship quality and well-being (Mikulincer & Shaver, 2016). Therefore, understanding how individuals

attain attachment security and exploring methods for attachment security intervention holds significant value. This study focuses on the question of how adults attain attachment security.

Attachment was originally proposed to explain the special emotional bond formed between infants and caregivers (Bowlby, 1969). Subsequently, researchers noted that romantic relationships in adulthood can also be viewed as attachments (Hazan & Shaver, 1987). Individual differences in attachment originate from internal working models (IWMs), which are experience-based mental representations formed through repeated interactions with attachment figures (Bartholomew & Horowitz, 1991). Based on the positivity or degree of positivity of these internal working models, individuals can be classified into different attachment types or styles (Bartholomew & Horowitz, 1991), or described using continuous variables such as attachment security or attachment orientation (Brennan et al., 1998; Li Tonggui & Kato Kazuo, 2006). Adult attachment individual differences are closely associated with intimate relationship outcomes (Givertz et al., 2013; Waldinger et al., 2015), mental health (Wright & Perrone, 2010), and life adaptation (Mikulincer & Shaver, 2016; Li Caina et al., 2016). Attachment possesses dual characteristics: relative stability and situational sensitivity. The former corresponds to trait attachment (individual differences in attachment), while the latter corresponds to state attachment, which can be described as attachment security (Jia Chenglong et al., 2020).

Given the positive developmental outcomes associated with secure attachment and the numerous beneficial effects of attachment security priming (Gillath & Karantzas, 2019; Gillath et al., 2022; Jia Chenglong et al., 2020), the plasticity of attachment has remained an important research topic. Investigations of attachment plasticity have primarily come from lifespan developmental studies and attachment priming research. These studies have found that attachment in adulthood maintains moderate stability (Girme et al., 2018; Mikulincer & Shaver, 2016), that brief attainment of attachment security produces many positive effects (Gillath et al., 2022), and that repeated security attainment has cumulative long-term effects (Carnelley & Rowe, 2007; Hudson & Fraley, 2018). Related research has proposed explanations based on life events (Fraley et al., 2021) and social-cognitive models (Baldwin et al., 1993; Wang Yan & Wang Dahua, 2012). Summarizing existing research and theory, attachment plasticity can be explained as the modification of internal working models resulting from repeated changes in attachment security, thereby producing enduring changes in trait attachment (Arriaga et al., 2018). Therefore, exploring attachment plasticity first requires understanding how attachment security is attained.

Existing research on adult attachment security attainment has primarily focused on accessing secure-base script representations (Mikulincer & Shaver, 2015; Waters & Waters, 2006), neglecting the role of episodic simulation as one of the attachment representational structures (Bowlby, 1980; Collins & Allard, 2004). Some studies have suggested that attachment-relevant episodic simulation can serve as a potential pathway to attachment security (Cao et al., 2020; Cao Xian-

cai et al., 2020). This project will build upon this foundation to further examine the specificity and mechanisms of this new attachment security pathway and develop attachment security intervention methods accordingly. The findings will supplement and enrich attachment theory, provide insights for attachment plasticity, and inspire attachment security interventions.

2.1 The Control-Systems Model of Attachment and Attachment Security Attainment

The control-systems model of attachment in adulthood addresses attachment security attainment (Mikulincer & Shaver, 2003, 2016) (see Figure 1 [Figure 1: see original paper]). This model divides the attachment system into three relatively independent components. The first component refers to the monitoring and appraisal of threat signals, which determines whether the attachment system is activated. When individuals perceive potential or actual threats, the attachment system is automatically activated, increasing the accessibility of attachment-related cognitions and promoting proximity-seeking behaviors toward internal or external attachment figures. The second component refers to the monitoring and appraisal of attachment figure availability and responsiveness. After attachment system activation, the evaluation of whether attachment figures are available and responsive directly determines whether individuals attain security. The third component refers to the monitoring and appraisal of whether proximity-seeking can resolve attachment insecurity. The insecurity and distress caused by unavailable or unresponsive attachment figures lead individuals to adopt secondary attachment control strategies, which in turn influence threat perception and judgments about attachment figure availability and responsiveness (Mikulincer & Shaver, 2016).

As shown by the control-systems model, accessing information about attachment figure availability and responsiveness is key to attachment security attainment. Individuals can attain attachment security by seeking proximity to internal or external attachment figures to access such information. Internal attachment figures refer to internal representations of attachment (Mikulincer & Shaver, 2016). This project focuses on the internal representational pathway to attachment security attainment.

2.2 Attachment Security Attainment: The Internal Representational Pathway

Research on secure attachment priming demonstrates that internal representations can access information about attachment figure availability and responsiveness to attain attachment security (Gillath & Karantzas, 2019; Gillath et al., 2022; Jia Chenglong et al., 2020). Based on explanations of priming effects and attachment theory, internal representational access to attachment security includes two approaches: accessing the secure-base script and retrieving attachment-relevant episodic memories.

2.2.1 Secure-Base Script and Attachment Security Attainment

Existing theory and research suggest that accessing the secure-base script represents the primary internal representational pathway for attaining attachment security (Mikulincer & Shaver, 2015; Waters & Waters, 2006). The secure-base script represents procedural knowledge about support-seeking, support availability, and distress alleviation, reflecting a highly structured approach to processing threats and restoring emotional balance (Waters & Waters, 2006). Generally, securely attached individuals more easily access this script and are more adept at using it to handle threatening situations and attain security (Köber et al., 2019; Mikulincer & Shaver, 2016; Mikulincer et al., 2009; Waters & Waters, 2006; Waters & Roisman, 2019). The effects of secure attachment priming are achieved by temporarily increasing the accessibility of the secure-base script (Mikulincer & Shaver, 2015; Jia Chenglong et al., 2020). However, priming effects vary across individuals with different attachment styles, particularly with attachment-avoidant individuals showing priming failure (Tang Qingting et al., 2020; Jia Chenglong et al., 2020), suggesting that accessing the secure-base script to attain attachment security is influenced by individual differences in attachment.

2.2.2 Episodic Memory and Attachment Security Attainment

Attachment theory and indirect research evidence suggest that retrieving attachment-relevant episodic memories represents another pathway to attachment security. Attachment-relevant episodic memories constitute one structure of attachment representations (Bowlby, 1973; Collins & Allard, 2004; Collins & Read, 1994; Dykas & Cassidy, 2011; Mikulincer & Shaver, 2016), and activation of the attachment system can enhance the accessibility of episodic memories in which attachment figures provided support (Mikulincer & Shaver, 2003; Wang Zhengyan et al., 2006). Some studies have indirectly supported the retrieval of episodic memories as a means to attain attachment security. For example, Alea and Bluck (2007) asked participants to recall autobiographical memory events with their partners and found that such recall increased perceived relationship intimacy. Additionally, in attachment priming research, an effective priming method involves having participants recall and visualize a close relationship that made them feel safe (Mikulincer et al., 2005; Rowe et al., 2012), thereby enhancing attachment security. Thus, attachment security attainment can be more precisely divided into the model shown in Figure 2 [Figure 2: see original paper].

Like accessing the secure-base script, retrieving attachment-relevant episodic memories is also influenced by individual differences in attachment (Dykas & Cassidy, 2011; Liu Chen & Chen Xu, 2018). Insecurely attached individuals experience difficulties retrieving attachment-relevant episodic memories (Sakaluk, 2013). This pathway particularly fails when individuals lack experience similar to the situation, making it difficult to attain security through episodic retrieval. This indicates that the episodic retrieval pathway to attachment security is con-

strained by both individual differences in attachment and attachment-related experience limitations.

2.3 Episodic Simulation and Attachment Security Attainment

Attachment theory indicates that attachment representations include not only the secure-base script and episodic memories but also future-oriented processing such as expectations (Collins & Allard, 2004; Thompson, 2008). Internal working models allow individuals to mentally simulate interactions with attachment figures (Mikulincer & Shaver, 2007). This prospective information processing is episodic simulation. Existing research has overlooked the role of episodic simulation in attachment security attainment and has not constructed a complete model of attachment security attainment.

Episodic simulation refers to the constructive process of mentally representing specific future autobiographical events (Szpunar et al., 2014). It belongs to the same episodic processing system as episodic memory and has the following characteristics: First, episodic simulation involves the self and constructs future scenarios in an autobiographical form. Second, similar to the re-experiencing quality of recalling past events, episodic simulation has a future-oriented pre-experiencing quality. Third, episodic simulation is highly adaptive and easier to construct than episodic memory (Gaesser & Schacter, 2014), allowing individuals to construct multiple possible future events without actual behavior, which benefits goal-directed behavior, prospective memory, intertemporal decision-making, and well-being (Schacter, 2012; Schacter et al., 2017).

Attachment theory mentions episodic simulation in several places. For example, internal working models store multiple "if-then" patterns that allow individuals to conduct "small-scale experiments" in their minds to simulate future attachment-related events (Bowlby, 1969). The function of internal working models resembles the process of episodic simulation of interactions with attachment figures (Bretherton & Munholland, 2008; Gallese, 2005). Mikulincer and Shaver (2007) also noted that when interacting with attachment figures, internal working models allow individuals to encode expectations about attachment figures, which can determine how individuals perceive and respond in specific situations. These various statements in attachment theory show that the attachment system depends on episodic simulation processes.

Can episodic simulation serve as a pathway to attachment security? Attachment theory posits that the attachment system is a mechanism for coping with threats or distress, comprising two different coping components: emotion-focused coping and problem-focused coping. The former involves identifying and expressing feelings and seeking emotional support, while the latter involves seeking instrumental support and problem-solving to alleviate distress (Mikulincer & Shaver, 2003). Theory and research on episodic simulation indicate that it has situational flexibility, allowing individuals to simulate possible coping meth-

ods based on specific stressful situations, thereby promoting problem-solving and emotion regulation. Both emotion-focused and problem-focused coping can benefit from episodic simulation (Jing et al., 2016, 2017). Accordingly, attachment-relevant episodic simulation can be defined as the psychological process by which individuals construct scenarios in which they resolve distress through proximity-seeking in difficult situations. We propose that constructing attachment-relevant episodic simulations can also serve as a pathway to help individuals attain attachment security (Figure 3 [Figure 3: see original paper]).

This hypothesis has received preliminary support from two previous studies. A cross-sectional study showed that expected partner responsiveness in attachment-relevant episodic simulation could predict individuals' relationship satisfaction and subjective well-being (Cao et al., 2020). These findings align with the theoretical account of long-term positive effects of attachment security attainment, indirectly indicating that attachment-relevant episodic simulation can serve as a potential pathway to attachment security. Another experimental study demonstrated that engaging in attachment-relevant episodic simulation can increase expected partner responsiveness and attachment security, with increases in expected partner responsiveness closely related to increases in attachment security (Cao Xiancai et al., 2020). However, this effect requires replication, and a series of related issues remain unexamined.

2.4 Brief Review

In summary, existing research on adult attachment security attainment has concentrated on accessing secure script representations (Mikulincer & Shaver, 2015; Waters & Waters, 2006), neglecting the role of episodic simulation as a structure of attachment representation. Only two studies have examined this issue, leaving unanswered questions: What is the specificity of attachment-relevant episodic simulation compared to other attachment security pathways? What are its mechanisms of influence on attachment security? And how can attachment security interventions be conducted based on attachment-relevant episodic simulation? Investigating these questions is valuable.

On one hand, episodic simulation is easier to construct (Gaesser & Schacter, 2014; Schacter et al., 2017). The constructive episodic simulation hypothesis posits that the content of episodic memory serves as material for constructing episodic simulation, allowing individuals to flexibly recombine episodic details to form simulation content (Schacter & Addis, 2007; Schacter et al., 2017). We therefore speculate that in specific situations, attachment-relevant episodic memories are not the only source material for attachment-relevant episodic simulation; episodic memory content unrelated to attachment can also serve as material for attachment-relevant episodic simulation, and this content is less affected by individual differences in attachment. This suggests that compared to accessing the secure-base script and episodic retrieval, the role of attachment-relevant episodic simulation is less influenced by individual differences in attachment and attachment-related experience. Even individuals with insecure attachment

styles or lacking situation-relevant experience can simulate scenarios for the situation. Therefore, episodic simulation offers advantages in attachment security attainment. No research has yet examined this.

On the other hand, both accessing the secure-base script and retrieving attachment-relevant episodic memories to attain attachment security are based on the assumption of the attachment system' s situational sensitivity—that situations can induce mental representation activation and exert bottom-up influence on the attachment system (Mikulincer & Shaver, 2016; Jia Chenglong et al., 2020). However, the attachment system also possesses situational flexibility: attachment theory posits that the attachment system is a goal-directed system whose primary goal is to attain attachment security. In specific threatening situations, individuals need to flexibly adjust based on the current situation and actively construct proximity-seeking methods to cope with specific threats and achieve the goal (Mikulincer & Shaver, 2016). Thus, the function of the attachment system should not only involve passively accepting mental representation activation triggered by environmental information but should also involve actively constructing the current situation to guide toward attachment goals. Existing attachment security pathways and corresponding attachment priming research have only focused on attachment representation activation, and attachment security interventions based on this have limited effectiveness (Arriaga et al., 2018). In contrast, attachment-relevant episodic simulation emphasizes active construction of problem situations in specific contexts, simulating the most suitable proximity-seeking methods for the situation to guide toward attachment goals, which aligns more closely with the situational flexibility emphasized by the attachment system. Therefore, examining attachment-relevant episodic simulation as a pathway to attachment security and its mechanisms can not only expand explanations of attachment security attainment and construct a more complete control-systems model of attachment but also provide a more flexible and effective perspective for secure attachment intervention, offering insights for attachment plasticity.

In summary, this project focuses on the control-systems model of attachment and, based on proposing that attachment-relevant episodic simulation can serve as a pathway to attachment security, further examines the specificity and mechanisms of this new pathway and develops attachment security intervention methods accordingly.

3. Research Proposal

Existing research on attachment security pathways has neglected the role of attachment-relevant episodic simulation. Previous studies have proposed and confirmed that attachment-relevant episodic simulation can also serve as a pathway to attachment security. Building on this foundation, this project further examines the specificity and mechanisms of attachment-relevant episodic simulation in attaining attachment security and designs attachment security intervention methods accordingly.

The project comprises three parts: Study 1 compares different attachment security pathways to examine the specificity of attachment-relevant episodic simulation in terms of usage frequency, advantages, and conditions of use. Study 2 investigates the mechanisms through which attachment-relevant episodic simulation influences attachment security from the perspectives of its content and processing. Study 3 will use natural language processing techniques to develop classification methods for attachment-relevant episodic simulation and apply them to attachment security intervention.

3.1 Study 1: The Effect of Attachment-Relevant Episodic Simulation on Adult Attachment Security

Previous research has preliminarily verified that attachment-relevant episodic simulation can serve as a potential pathway to attachment security (Cao et al., 2020; Cao Xiancai et al., 2020). Study 1 further examines, based on replicating this finding: What is the specificity of this new attachment security pathway compared to other pathways? This research examines this question from three aspects: usage frequency, usage advantages, and usage conditions.

First, regarding usage frequency, does the frequency of using attachment-relevant episodic simulation to attain attachment security differ from other attachment security pathways in daily life scenarios? Previous cross-sectional research has indirectly examined this from the perspective of long-term effects of attachment security attainment (Cao et al., 2020). Another laboratory study required participants to actively engage in attachment-relevant episodic simulation, which does not reflect individuals' natural responses in real-life situations. Therefore, do individuals use attachment-relevant episodic simulation to attain attachment security in daily life contexts? How does its usage frequency compare to other attachment security pathways? To address this, Study 1.1 uses the experience sampling method to examine the effect of attachment-relevant episodic simulation on attachment security. The study focuses on two questions: (1) In daily life contexts, can attachment-relevant episodic simulation access attachment figure availability and responsiveness to help individuals attain attachment security? (2) Do different attachment security pathways differ in usage frequency?

Individuals frequently engage in episodic simulation in daily life, and most content relates to intimate relationships (Barsics et al., 2016; D' Argembeau et al., 2011). Research also indicates that episodic simulation is easier to construct than episodic retrieval (Gaesser & Schacter, 2014). Accordingly, Study 1.1 hypothesizes that: (1) In daily contexts, attachment-relevant episodic simulation can access attachment figure availability and responsiveness to help individuals attain attachment security; (2) In terms of usage frequency, this new attachment security pathway is used more frequently than other attachment security pathways.

Second, regarding usage advantages, what advantages does attachment-relevant

episodic simulation have in attaining attachment security compared to other pathways? We propose that the advantages of attachment-relevant episodic simulation mainly manifest in being less affected by individual differences in attachment and easier to access. Both attachment-relevant script processing and episodic retrieval may be influenced by individual differences in attachment. Based on the constructive episodic simulation hypothesis (Schacter & Addis, 2007; Schacter et al., 2017), we speculate that in specific situations, attachment-relevant episodic memories are not the only source material for attachment-relevant episodic simulation; episodic memory content unrelated to attachment can also serve as material for attachment-relevant episodic simulation. Therefore, the effect of attachment-relevant episodic simulation is less influenced by individual differences in attachment (Figure 4 [Figure 4: see original paper]). Additionally, combined with the characteristic that episodic simulation is easier to construct (Gaesser & Schacter, 2014), this new attachment security pathway should also be faster to access. To test this, Study 1.2 uses experimental methods to compare the accessibility and effectiveness of attachment-relevant episodic simulation with other attachment security pathways and examines how different attachment security pathways are affected by individual differences in attachment. This study focuses on two questions: Compared to other attachment security pathways, does attachment-relevant episodic simulation (1) show less influence from individual differences in attachment and easier accessibility? (2) have different effects on attachment security?

Study 1.2 hypothesizes that attachment-relevant episodic simulation is easier to access, its effect is less influenced by individual differences in attachment, and it shows interaction effects between individual differences in attachment and pathways in terms of accessibility and effectiveness.

Third, regarding usage conditions, when or under what conditions do individuals rely more on attachment-relevant episodic simulation to attain attachment security? We propose that situational novelty influences the use and effectiveness of attachment-relevant episodic simulation. In novel situations, individuals lack similar experiences and, constrained by individual differences in attachment, find it difficult to respond to situations and attain security through direct episodic memory retrieval or accessing the secure-base script. Episodic simulation demonstrates its advantage here, as even without similar experience, individuals can construct scenarios for the situation, showing situational flexibility (Szpunar, 2010). Accordingly, we propose that situational novelty is an important factor influencing the selection of attachment security pathways. To test this, Study 1.3 examines the effect of attachment-relevant episodic simulation on attachment security under conditions of varying situational novelty. The main research question is: Does situational novelty influence the selection of attachment security pathways?

Study 1.3 hypothesizes that when situational novelty is high, individuals are more inclined to use attachment-relevant episodic simulation to attain attachment security.

3.2 Study 2: Mechanisms of Attachment-Relevant Episodic Simulation' s Effect on Adult Attachment Security

If attachment-relevant episodic simulation can serve as an independent attachment security pathway, what are its underlying mechanisms? Study 2 examines the mechanisms through which attachment-relevant episodic simulation influences attachment security from the perspectives of its content and processing.

First, regarding content, we examine how the content of attachment-relevant episodic simulation influences attachment security. Attachment-relevant episodic simulation content contains various components that may influence security attainment, so we need to exclude the influence of other potential factors to test whether the effect of attachment-relevant episodic simulation on attachment security stems from constructed, situation-corresponding attachment scenarios. To this end, Study 2.1 examines semantic information, attachment relevance, positivity, and situational relevance of simulation content. Considering the replicability of episodic simulation effects and to provide a test dataset for Study 3, this study designs four experiments: Experiment a compares attachment-relevant episodic simulation with attachment-relevant semantic thinking to test the role of situational semantic information in simulation content; Experiment b compares attachment-relevant episodic simulation with attachment-irrelevant episodic simulation to test the role of attachment relevance in simulation content; Experiment c compares attachment-relevant episodic simulation with positive emotion induction to test the role of emotional valence in simulation content; Experiment d compares situation-relevant attachment-relevant episodic simulation with situation-irrelevant attachment-relevant episodic simulation to test the role of situational relevance in simulation content.

Based on theory and research on episodic simulation, we hypothesize that the effectiveness of attachment-relevant episodic simulation is superior to other comparison conditions, and its effect originates from constructed, situation-corresponding attachment scenarios that cannot be independently explained by other factors.

Second, regarding processing, we examine how the processing of attachment-relevant episodic simulation influences attachment security. According to the constructive episodic simulation hypothesis, individuals need to extract details from episodic memory and flexibly recombine them to construct episodic simulations (Schacter & Addis, 2007). Thus, episodic simulation comprises two processing stages: episodic retrieval and episodic construction. On one hand, research on episodic simulation indicates that its effect depends on the number of details retrieved from episodic memory (Madore & Schacter, 2014). On the other hand, research using the Adult Attachment Interview shows that more securely attached individuals exhibit higher coherence in autobiographical memory, meaning their narratives are more thematically focused and follow a clearer event sequence (Hesse, 2008; Waters et al., 2017). Episodic simulation research

also indicates that higher simulation coherence is closely related to actual behavioral intentions (Madore & Schacter, 2014). This suggests that the richness of details in the retrieval stage and the coherence in the construction stage influence the effectiveness of attachment-relevant episodic simulation. Accordingly, Study 2.2 focuses on the processing stages of attachment-relevant episodic simulation and explores their influence on attachment security by manipulating key features at different stages. Specifically, two experiments examine the roles of detail richness in the retrieval stage and scenario coherence in the construction stage: Experiment a uses a detail induction method to manipulate the richness of details in the retrieval stage and examines its effect on expected partner responsiveness and attachment security; Experiment b uses a coherence induction method to manipulate the coherence of scenario construction and examines its effect on expected partner responsiveness and attachment security.

We hypothesize that the richness of details in the retrieval stage and the coherence in the construction stage influence the effectiveness of attachment-relevant episodic simulation.

3.3 Study 3: Natural Language Processing-Based Classification of Attachment-Relevant Episodic Simulation and Its Application in Attachment Intervention

Study 3 will develop classification methods for attachment-relevant episodic simulation using natural language processing techniques and apply them to attachment security intervention. If episodic simulation can serve as a pathway to attachment security, then because it is less affected by individual differences and possesses situational flexibility and easy accessibility, it is particularly suitable as a target for attachment security intervention. How can appropriate attachment security intervention methods be developed based on research into the mechanisms of attachment-relevant episodic simulation? The third part of this research addresses this question. It uses natural language processing (NLP) techniques to provide real-time feedback on the effectiveness of individuals' episodic simulations and conducts targeted training on simulation content or processing to improve trait attachment security.

Natural language processing is an important direction in computer science and artificial intelligence that has recently been applied in psychological research to investigate human psychological and cognitive processes (Jackson et al., 2022). Some studies have used NLP techniques to identify depression (Takano et al., 2018) and to code autobiographical memory specificity (van Genugten & Schacter, 2022). In this project, the investigation of attachment-relevant episodic simulation adopts an autobiographical interview paradigm, generating substantial language material from participants. Key linguistic information extracted from this material can be used to determine whether individuals' episodic simulations are effective and to identify deficiencies in simulation content and processing. Study 3 comprises two specific sub-studies.

First, Study 3.1 uses natural language processing techniques to develop methods for rapidly classifying attachment-relevant episodic simulation. The study collects a large sample to form a training dataset, identifies key linguistic features that distinguish between texts of attachment-relevant episodic simulations that increase attachment security and those that do not, and then trains classifiers using support vector machines (SVM) in machine learning to quickly identify whether attachment-relevant episodic simulations can increase individuals' attachment security. Using the same method, it trains classifiers to quickly determine whether simulation content corresponds to situation-relevant attachment scenario construction and whether the simulation processing has high detail richness and coherence. Finally, it tests the effectiveness and transferability of the classifiers using two test datasets.

Second, based on the classification methods from Study 3.1, Study 3.2 designs an attachment security intervention method based on attachment-relevant episodic simulation and examines its short-term and long-term effects on trait attachment security. Drawing on research showing that repeated secure attachment priming can reduce trait attachment anxiety (Hudson & Fraley, 2018), this study uses repeated attachment-relevant episodic simulation for trait attachment security intervention. Combining results from Study 2 and Study 3.1, it designs the attachment-relevant episodic simulation training method shown in Figure 5 [Figure 5: see original paper], examining its short-term and long-term effects on trait attachment through a two-week training program and a two-month follow-up. The study assumes that this method will be superior to repeated attachment priming and will have significant short-term and long-term effects on increasing trait attachment security.

4. Theoretical Construction and Innovation

The theoretical construction process has been systematically elaborated in the research questions and content sections. As shown in the above analysis, this project' s theoretical construction focuses on the attachment security attainment component of the control-systems model of attachment. Existing theory and research on internal representational pathways have concentrated on accessing the secure-base script (Mikulincer & Shaver, 2015; Waters & Waters, 2006), neglecting that attachment-relevant episodic simulation can also serve as a pathway to attachment security. This project expands the control-systems model' s explanation of security attainment pathways, innovatively proposing attachment-relevant episodic simulation as a new pathway and further examining its specificity and mechanisms to construct a more complete control-systems model of attachment.

In summary, this project's expansion of the control-systems model of attachment and attachment research is reflected in the following points:

First, it provides a more detailed decomposition of the internal representational pathway to attachment security attainment and proposes attachment-relevant

episodic simulation as a new pathway (Figure 3). Existing discussions of attachment security attainment have mainly focused on secure script access, forming the basis for numerous attachment priming studies that have yielded rich findings (Gillath & Karantzas, 2019; Gillath et al., 2022; Jia Chenglong et al., 2020). However, research and theory have relatively neglected episodic processing as a structure of attachment representation, especially the role of episodic simulation. Although attachment theory contains discussions about episodic processing or simulation (Bowlby, 1973; Collins & Allard, 2004; Collins & Read, 1994; Dykas & Cassidy, 2011; Mikulincer & Shaver, 2016; Thompson, 2008), these discussions have not been conceptualized as scientific research questions. With advances in research paradigms on episodic simulation in cognitive processing, relevant paradigms can be borrowed and applied to attachment research. Based on this, we propose attachment-relevant episodic simulation as a new pathway to attachment security attainment. This new pathway is valuable: it can explain the situational flexibility of the attachment system and further enrich explanations of the attachment system' s situational sensitivity. Situational flexibility refers to the need for individuals to flexibly adjust based on current threatening situations, actively constructing proximity-seeking methods to cope with specific threats and achieve attachment goals (Mikulincer & Shaver, 2016). Attachment-relevant episodic simulation emphasizes active construction of problem situations in specific contexts, simulating the most suitable proximity-seeking methods for the situation to guide toward attachment goals, which is fundamentally different from secure script representation' s emphasis on passive situational activation.

Second, it examines the specificity of this new attachment security attainment pathway, understanding its usage in daily life situations, when it functions, and what advantages it has compared to other pathways. Based on theory and related research, we assume that attachment-relevant episodic simulation is very common in daily life, manifesting as higher frequency and faster access. More importantly, when situations are novel, individuals will prioritize attachment-relevant episodic simulation to attain attachment security. Simultaneously, this attachment security attainment pathway is less affected by individual differences in attachment and relationship experience, making it more suitable as a target for attachment intervention and more valuable for long-term attachment security intervention. The current project no longer adopts the unchangeable perspective of focusing on insecurely attached individuals' negative attachment strategies (Mikulincer & Shaver, 2003, 2016) but instead takes a more flexible and changeable relationship perspective. This means that even insecurely attached individuals can cope effectively with situational threats and develop secure attachment relationships if they construct appropriate attachment scenarios and strategies for specific situations.

Finally, understanding the mechanisms of this attachment security attainment pathway and designing a new attachment security intervention based on it can provide a new perspective for understanding attachment plasticity. Based on theory and research on episodic simulation, the effectiveness of attachment-

relevant episodic simulation depends on key features of its content and processing. Regarding content, attachment-relevant episodic simulation must align with the goal-directed nature of the attachment system. The attachment system posits that after encountering threatening situations, individuals automatically activate the attachment system, generate internal or external proximity-seeking behaviors, and rely on proximity-seeking to cope with distress and achieve attachment goals (Mikulincer & Shaver, 2003, 2016). Attachment-relevant episodic simulation content must meet the condition that the scenario involves individuals relying on proximity-seeking to resolve corresponding distress. Regarding processing, episodic simulation comprises retrieval and construction stages (Schacter & Addis, 2007; Schacter et al., 2017). The richness of details in the retrieval stage and coherence in the construction stage are key determinants of simulation effectiveness. First, rich details in the retrieval stage provide sufficient material for scenario construction, allowing individuals to flexibly combine details according to situational characteristics to build coping strategies and scenarios (Schacter & Addis, 2007; Schacter et al., 2017). This also means the material source is diversified; individuals can use episodic content from other situations or interactions with other close relationship figures as construction material. Second, coherence in the construction stage is also important. Coherence in attachment representation refers to whether the narrative follows the continuous steps of proximity-seeking, partner support, and distress resolution, and coherent attachment representation is a core characteristic of securely attached individuals (Hesse, 2008; Waters et al., 2017). This project borrows this concept for the scenario construction process, proposing that high coherence in construction indicates that the built scenario better matches the proximity-seeking distress-coping scenario.

Since attachment-relevant episodic simulation is common in daily life, has advantages over other attachment security attainment pathways, and is intervenable and changeable in terms of both content and processing, it is highly suitable for attachment security intervention. Returning to the control-systems model of attachment, threats from internal and external environments constantly exist in daily life situations. How individuals rely on proximity-seeking to actively adapt to the environment is a problem that all attachment types or orientations must face. Combined with results from the first two studies, the intervention proposed in this project does not teach individuals to achieve potentially unrealistic "psychological comfort" by "imagining a partner' s goodness" but rather enables individuals to actively construct proximity-seeking coping strategies in these situations to achieve problem resolution and thereby attain the goal of attachment system security.

In addition to the obvious theoretical innovation of constructing a more complete control-systems model of attachment, this project' s innovation is also reflected in research paradigms and methods. In summary, this project is the first to apply episodic simulation research paradigms to attachment research. The most representative experimental paradigm is the episodic coherence induction paradigm, adapted from detail induction methods in episodic simulation

research combined with coherence indicators from the attachment autobiographical interview. In addition to conventional psychological research methods, the third part of this project uses natural language processing techniques to train multiple text classifiers using machine learning and designs attachment security intervention methods based on them. Natural language processing can handle large amounts of language material and extract key features for text classification. The autobiographical imagination interviews in this study generate substantial language material, making this technique highly suitable for identifying the effectiveness of episodic simulation and detecting deficiencies in simulation content and processing, thereby designing real-time feedback-based attachment security intervention methods.

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