Security Enhances Auditory Sensitivity: Activating Attachment Security Enhances Auditory Perceptual Ability

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Abstract

Background: Attachment theory posits that attachment security promotes environmental exploration, openness, and mindful attention. However, it remains unclear whether attachment security influences basic sensory perception. This study aims to investigate whether activating attachment security enhances auditory sensitivity and the moderating role of attachment orientation in this process.

Methods: This study consists of two experiments in which undergraduate participants completed an autobiographical recall writing (ARW) task to prime either attachment security or control conditions. In Experiment 1 (N = 37), four priming conditions were compared: attachment security, positive emotion, neutral person, and neutral scene. Experiment 2 (N = 61) replicated the design of Experiment 1 while further examining whether attachment orientation moderates the priming effect.

Results: Compared to control conditions, participants' auditory thresholds significantly decreased after attachment security priming, indicating enhanced auditory sensitivity. This effect was replicated in Experiment 2 and was moderated by attachment anxiety. Specifically, the perceptual advantage brought by security priming primarily occurred in individuals with lower levels of attachment anxiety, while individuals with high attachment anxiety showed almost no improvement. Attachment avoidance influenced overall frequency-related sensitivity but did not significantly moderate the priming effect.

Conclusion: The findings suggest that activating attachment security can influence early sensory processing, indicating that a fundamental socio-emotional resource acts not only on cognition and emotion but may also extend to basic perceptual sensitivity.

Full Text

Preamble

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Background

Attachment theory suggests that a sense of attachment security promotes exploration, openness, and mindful attention to the environment. However, little is known about whether attachment security can influence basic sensory perception. The present research examined whether activating attachment security enhances auditory sensitivity and the moderative effects of attachment orientation.

Methods: Under experiments, undergraduate participants completed autobiographical recall writing (ARW) designed to prime attachment security or control conditions. In Experiment 1 (N = 37), four priming conditions were compared: attachment security, positive otion, neutral person, and neutral scene primes.

Experiment 2 (N = 61) replicated the design and additionally examined whether attachment orientation moderated the priming effect.

Results: Participants exhibited significantly lower hearing thresholds following the attachment security prime than in the control conditions, indicating enhanced auditory sensitivity. This effect was replicated in Experiment 2 and was moderated by attachment anxiety. Specifically, the perceptual benefit of security priming emerged primarily among individuals low in attachment anxiety, whereas those high in attachment anxiety showed little improvem ttachment avoidance influenced overall frequency relat ed sensitivity but did not significantly moderate the priming effect.

Conclusion

These findings suggest that activating attachment security can influence early sensory processing, highlighting that a fundamental social emotional resource may extend its impact beyond cognition and emotion to basic perceptual sensitivity

Keywords

Attachment Security; Experimental Prime; Pure Tone Audiometric Thresholds ; Attachment Orientation

Introduction

Auditory sensitivity, the ability to detect and discriminate sounds, plays a critical role in enabling individuals to perceive and adapt to their surrounding environment.

One of the most widely used indicators of auditory sensitivity is the pure tone hearing threshold, which refers to the lowest sound intensity that an individual can reliably detect (Aguilar et al., 2015 Kuiper et al., 2019). Previous research has primarily focused on how environmental conditions, audiometric equipment, and listener charac teristics (e.g., age, degree of hearing impairment) influence pure tone thresholds (Zekveld et al., 2011). However, emerging evidence suggests that psychological characteristics may also influence auditory sensitivity. In particular, previous work has begun to explore whether attachment security , a fundamental social emotional resource, can influence hearing thresholds Nagar et al. (2022) examined auditory sensitivity using standardized pure tone hearing tests under different priming conditions. In their tudy, images of security enhancing figures served as primes in the security condition, whereas images of strangers or geometric shapes served as neutral controls. The results showed that participants exhibited lower hearing thresholds in the security primi condition than in the neutral conditions across age groups. This pioneering finding suggests that attachment security may extend its influence beyond higher order cognition to basic sensory perception.

According to attachment theory (Bowlby), repeated interactions with supportive caregivers foster a sense of attachment security, defined as confidence that support will be available when needed. In adulthood, reminders of attachment figures can activate mental representations of security, ofte n referred to as the secure script (Mikulincer & Shaver, 2016) . Activation of this script promotes positive beliefs about the self and others and biases information processing toward supportive and non eatening aspects of the environment. Consequently, individuals experience reduced distress, greater emotional stability, and increased availability of self regulatory resources that would be allocated to threat monitoring. This shift toward a calmer and more open cognitive affective state is associated with enhanced attentional engagement and more efficient information processing (e.g., sensory input Melen et al., 2017; Mikulincer et al., 2011 . However, when attachment figures are not supportive, individ uals may develop insecure attachment orientations characterized by persistent concerns about one s own value or others intentions (Bowlby, 1973). Adult attachment orientations are typically conceptualized along two continuous dimensions: attachment anxiety and attachment avoidance (Brennan et al., 1998; Mikulincer & Shaver, 2020).

Attachment anxiety reflects the extent to which individuals worry about rejection and seek excessive reassurance, whereas attachment avoidance reflects the extent to which indivi duals distrust others and strive to maintain emotional independence.

Importantly, research has shown that attachment security can be situationally activated in laboratory settings through a procedure known as security priming Mikulincer & Shaver, 2007). Security priming temporarily enhances individuals sense of security and influences a wide range of cognitive and behavioral processes (Mikulincer & Shaver, 2007; 2020) . For example, merely presenting a supportive figure induce a momentary sense of security even among chronically insecure individuals, leading them to think and behave in ways similar to securely attached individuals (Gillath & Karantzas, 2019) . Attachment security priming can be implemented using either subliminal or supraliminal procedures, depending on the level of conscious processing involved Marks & Vicary, Mikulincer et al., 2011). Although both approaches can enhance attachment security, supraliminal priming has been shown to produce more stab le and robust effects (Sakaluk, 2014) . Among supraliminal techniques , ARW tasks have been widely used to activate attachment security, which reliably increases feelings of security (Carnelley et al., 2016; Hudson & Fraley, 2018 However, several methodological issues remain in Nagar et al. (2022) . First, Nagar et al. (2022) did not include a manipulation check to verify whether the priming procedure successfully increased participants sense of attachment security. Without such verification, it is difficult to determine whether the observed improvements in auditory sensitivity were specifically driven by heightened attachment security. Second, the security prime consisted of images of a ttachment figures, which may have elicited onger positive affect than the control stimuli. Although previous research suggests that security priming has unique effects beyond general positive affect (Gillath & Karantzas, 2019), the possibility that positive emotional responses contributed to the served auditory effects cannot be fully ruled out. Finally, the authors themselves emphasized the need to replicate these findings using different security priming techniques and alternative control primes. Additionally, although stable individual differen ces in attachment orientations may also influence the effects of security priming, Nagar et al. (2022) did not assess participants attachment orientations. For example, et al. (2016) indicate that attachment anxiety can moderate the effect of security priming on interpersonal trust, which suggests that individual differences in attachment orientation may influence how people respond to security related cues. Addressing these issues would help clarify whether attachment security reliably influences auditory sensitivity and would provide deeper insight into how social emotional states shape basic sensory perception.

The present study aimed to address these issues and further examine the relationship between attachment security and auditory sensitivity. Because ARW tasks are simple, immersive, and effective in activating attachment security (Karremans et al., 2011) , the present study employed this method to prime attachment security. In addition, three comparison primes (positive emotion prime

neutral person prime neutral scene prime) were included to examine whether attachment security specifically enhances audit ory sensitivity beyond general positive affect. In addition to improving the priming procedure and including manipulation checks, we also assessed participants attachment orientations to examine whether attachment anxiety and avoidance moderate the effects of security priming on auditory sensitivity. Individuals high in

attachment anxiety may remain hypervigilant to potential threats, whereas highly avoidant individuals may suppress attachment related processing. These tendencies may influence how security related cues affect perceptual sensitivity. Building on Nagar et a l. (2022), the present study extends evidence for attachment security effects from initial demonstrations to a more rigorous test by isolating effects beyond general positive affect and examining moderation by attachment orientations. In doing so, it advan ces understanding of how attachment security shape early perceptual processing and clarifies individual differences in these effects.

Experiment 1 Participants A prior power analysis using G*Power 3.1 (Faul et al., 2009) indicated that a sample size of 23 participants would be sufficient to detect a medium effect size (.25) at an level of 0.05 with a power of 0.95. We initially recruited 44 undergraduates, and seven were excluded (4 failed the lie detection items and 3 showed 1000 Hz retest thresholds outside the ± 5 dB HL criterion). 37 participants were included in l analysis (56.76% female; aged 18 24 years, = 20.24 ± 2.10). All participants wer right handed, had normal or corrected normal vision, normal hearing, and no history of psychiatric or neurological disorders. The study was approved by the Ethics Committee of the School of Psychology, South China Normal University (SCNU . Written informed consent was obtained from all participants.

Measures ARW tasks Participants completed four ARW tasks designed to activate attachment related or attachment unrelated mental representations. Depending on the assigned condition, they recalled (a) someone they have close and supportive relationship with (attachment securi ty prime), (b) a personally meaningful achievement eliciting positive emotion (positive emotion prime), (c) someone they knew but were not close to (neutral person prime), or (d) an everyday scene such as grocery shopping (neutral scene prime). In order to facilitate vivid recollection, participants first visualized the person or scene with eyes closed and then wrote for approximately 10 minutes in response to several prompts (e.g., describing the imagined person' s facial features or indicating when the alled event occurred). These written responses were used solely to ensure engagement and were not included in the data analysis.

Emotional state measures State anxiety was assessed using the Visual Analogue Mood Scale (VAMS;

McCormack et al., 1988), in which participants rated their current level of anxiety from 0 to 100 "How anxious you feel at this moment?" . Based on the needs of the study, the "anxiety" item was adapted to assess state pleasantness.

Participants rated their current level of pleasantness on the same 0 100 scale.

Attachment security Attachment security was assessed using the Security subscale of the Chinese version of the State Adult Attachment Scale (SAAM; Ma et al., 2012), which consists of 9 items (e.g., "I feel that others care about me"). Responses were made on a 7 point Likert s cale (1 = strongly disagree to 7 = strongly agree). In the present study, Cronbach' s 0.91 (pre test) and 0.94 (post test). tone hearing thresholds tone hearing thresholds were measured using a MA51 audiometer (MAICO, Germany). The test signals include pure tones, pulsed tones, and warble tones. The frequency range spans 0.125 8 kHz. Intensity step sizes of 5 dB, 2 dB, and 1 dB are available. Air conduction thresholds can be assessed across an intensity range of −10 to 120 dB HL, adjusted using separate controls for the left and right ears. The audiometer supports assessments of hearing thresholds, uncomfortable loudness levels, and aided threshol ds. Its integrated high brightness color LCD screen provides a clear display of audiograms, intensity levels, frequencies, and signal types, allowing the experimenter to record results after testing. In this study, only pure tone air conduction audiometry was used, covering frequencies from 125 to 8000 Hz.

Procedures The study was conducted in a sound attenuated laboratory (ambient noise $<$ 25 dB) and consisted of four sessions, with one to two week intervals between sessions.

Before the first session, participants provided informed consent, completed demographic and a uditory history questionnaires, and received instructions on the pure tone audiometry procedure. During each session, participants first completed pre measures of emotional state (i.e., anxiety and pleasantness) and attachment security.

They were then randomly assigned to one of four priming conditions and completed the corresponding ARW task. Immediately afterward, participants completed post measures of emotional state and attachment security.

Following the emotional assessments, participants underwent pure audiometry using air conduction headphones (MA51, MAICO Diagnostics, Eden Prairie, MN) (Nagar et al., 2022). Testing was conducted sequentially for the right and left ears across eight f requencies presented in the following order: 1000 Hz, 2000 Hz, 4000 Hz, 6000 Hz, 8000 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz. he 1000 Hz frequency was presented twice to assess test retest reliability within each session. Participants indicated tone detectio n via a handheld response button, and thresholds were determined using the standard staircase procedure (ascending 4 dB, descending 2 dB).

All audiometry procedures were conducted by trained experimenters, who manually recorded and verified participants' data. Each participant completed four sessions in total. The order of the four priming conditions was counterbalanced across participants ing a Latin square design, ensuring that each condition appeared equally often in each session position. The entire experiment spanned approximately 30 35 days (See Fig. 1 [Figure 1: see original paper]).

Statistical Analyses All analyses were performed in 4.4.3 with packages such as BruceR (Bao, 2021).

To evaluate the effectiveness of the priming manipulation and examine differences across priming conditions, a 2 (time: pre test, post test) × 4 (prime condition: attachment security, positive emotion, neutral person, neutral scene) repeated measures ANOVA was conducted separately for each dependent variable: state anxiety, state pleasantness, and attachment security. Next, to assess whether the priming conditions differentially influenced auditory sensitivity, a repeated measures ANOVA was co nducted with priming condition and frequency band as independent variables, including ear side (left and right) and gender as control variables. tone frequencies were grouped into low (125, 250, 500 Hz), mid (1000, 2000 Hz), and high (4000, 6000,

8000 Hz) frequency bands

to enable a more fine grained analysis of how attachment security influences auditory sensitivity . Hearing threshold served as the dependent variable, with gender and test ear included as covariates. Effect sizes were reported using pa rtial for ANOVA, and the Greenhouse Geisser correction was applied when the sphericity assumption was not met.

Results

Manipulation Check To evaluate the effectiveness of the priming manipulation, repeated measures ANOVAs were conducted on state anxiety, state pleasantness, and attachment security

(see Fig. 2 [Figure 2: see original paper]). Across measures, significant main effects of time were observed, indicating reduced state anxiety, increased pleasantness, and attachment security from pre to post test (s $<$ 0.010). Importantly, significant interaction between time and prime condition emerged for all three measures (state anxiety: (2.03, 73.14) = 4.73, = 0.011, 0.12; state pleasantness: (2.60, 93.66) = 7.13, $<$ 0.001, = 0.17; attachment security: (1.94, 69.77) = 10.32, $<$ 0.001, = 0.22), suggesting differential priming effects across conditions. Follow up analyses revealed that both the attachment security and positive emotion primes led to greater reductions in anxiety and increases in pleasantness compared with the neutral perso n prime. For attachment security, the attachment security prime condition produced the largest post test increase, exceeding all other conditions (s $<$ 0.010).

Together, these findings demonstrate the effectiveness of the priming manipulation, showing that positive emotion and attachment security primes can significantly reduce anxiety and enhance positive affect, with the attachment security prime yielding the argest post test increase of attachment security.

Effectiveness of the priming manipulation in Experiment 1. ASP = attachment security prime; PEP = positive emotion prime; NPP = neutral person prime;

NSP = neutral scene prime.

Priming Effects on Hearing Sensitivity To assess whether the priming conditions differentially influenced auditory sensitivity, the present study conducted a repeated measures ANOVA on hearing thresholds, with frequency (low, mid, and high) and priming condition as within subject factors, ear s ide, and gender included as control variables. The results indicated a significant main effect of frequency, (1.74, 123.86) = 5.96, = 0.005, = 0.08.

Hearing thresholds were higher for low and mid frequencies compared to high frequency (s < 0.05), s uggesting higher auditory sensitivity for high frequency.

Additionally, although marginally significant (= 0.051), thresholds for mid frequency = 2.98 ± 0.48) were higher than those for low frequency (= 1.90 ± 0.31),

indicating reduced sensitivity at mid frequency. This study further observed the interaction between prime condition and frequency (See Fig. 3 [Figure 3: see original paper]), (4.72, 335.30) = 2.30, = 0.049, = 0.03. Specifically, at the high frequency range, participants exposed to the attachment security prime demonstrated significantly lower thresholds than those in the positive emotion and neutral person primes (s < 0.01). Under the mid frequency situations, participants in the attachment security prime showed significantly lower thresholds than those in the neutral scene ime (< 0.001). Importantly, when facing low frequency stimuli, the attachment security prime elicited significantly lower thresholds compared to all other priming conditions (s < 0.05).

Interaction effects between prime condition and frequency. ASP = attachment security prime; PEP = positive emotion prime; NPP = neutral person prime; NSP = neutral scene prime.

Summary

Experiment 1 examined whether activating attachment security influences auditory sensitivity. The manipulation checks confirmed that the priming procedures were effective: both attachment security and positive emotion primes reduced anxiety and increased p leasantness, whereas the attachment security prime produced the largest increase in perceived attachment security. More importantly, participants exposed to the attachment security prime show lower hearing thresholds than those in other priming conditions, indicating enhanced auditory sensitivity . These findings are consistent with attachment theory, which proposes that reminders of supportive attachment figures activate a sense of safety and reduce defensive concerns (Bowlby Mikulincer & Shaver, 2016). When individuals experience temporary attachment security, attentional resources may be less occupied by threat monitoring and more available for processing environmental input (Melen et al., 2017; Mikulincer et al.,

). Such a shift toward outward oriented attention may facilitate the detection of faint sensory signals, thereby enhancing perceptual sensitivity.

Notably, the effect cannot be attributed solely to general positive emotion.

Although the positive emotion prime produced comparable improvements in mood, it did not yield similar gains in auditory sensitivity. This dissociation suggests that attachment se curity involves regulatory processes beyond positive affect that may promote greater openness to external stimuli (Gillath & Karantzas, 2019). The facilitative effect of attachment security priming appeared particularly evident for low frequency tones, whe detection may be relatively demanding. Together, these findings provide initial evidence that activating attachment security can modulate basic perceptual sensitivity . Experiment 2 further examined whether this effect varies as a function of individual differences in attachment orientation.

Experiment 2 Participants The participants in Experiment 2 were independent from those in Experiment 1. A prior power analysis using G*Power 3.1 (Faul et al., 2009) indicated that a sample of 52 participants was needed to detect a medium effect size (.25) at an level of 0.05 with a power of 0.95. We initially recruited 67 undergraduates, of whom six were excluded (1 failed the lie detection items, 1 was excluded due to otitis media, and 4 were excluded due to laboratory renovation). 61 participants w ere included in later analysis (59.02% female; aged 18 25 years, = 20.06 $\pm$ 2.36). All participants were right handed, had normal or corrected normal vision, normal hearing, and no history of psychiatric or neurological disorders. Written informed c onsent was obtained from all participants.

Measures and Experimental Apparatus The measures and apparatus were mostly identical to those used in Experiment 1, with some differences. Only two prime conditions (i.e., attachment security prime and neutral person prime) were included, based on findings from Experiment 1 showing that atta chment security prime was most effective in increasing pleasantness and attachment security while reducing anxiety. As in Experiment 1, the VAMS and SAAM (Cronbach' s at pre test and .91 at post test) were used in Experiment 2.

In addition, attachment anxiety and avoidance were measured using the Chinese version of the Experiences in Close Relationship Inventory (ECR, Brennan et al., 1998; Li & Kato, 2006) in Experiment 2. The 36 item scale was assessed on a 7 point Likert scale (1 = strongly disagree, 7 = strongly agree), with higher scores indicating higher levels of each dimension. For undergraduates, references to "romantic partner"were replaced with "close person", and responses were anchored to the participants' current mary attachment figure (e.g., close friend, parents). In the current study, Cronbach' s values were 0.88 for the total scale, 0.90 for attachment anxiety, 0.90 for attachment avoidance. tone hearing thresholds were also measured using the MA51 audiometer (MAICO, Germany), following the same procedure as in Experiment 1.

Procedures The study consisted of two sessions separated by a 1 week interval and was conducted in a sound attenuated laboratory (ambient noise $<$ 25 dB), following the same procedure as in Experiment 1. Participants then provided

informed consent, completed ECR , demographic, and auditory history questionnaires, and received instructions for the pure tone audiometry procedure. In the second session, participants first completed pre test assessments of emotional state (state anxiety and pleasantness) and attachmen t security. They were then randomly assigned to one of two priming conditions and completed the corresponding ARW task under a double blind design.

Immediately afterward, post test assessments of emotional state and attachment security were administered. F inally, participants underwent pure tone audiometry using conduction headphones (MA51, MAICO Diagnostics, Eden Prairie, MN; Nagar et al., 2022) (see Fig. 4 [Figure 4: see original paper]).

Results

Manipulation Check To evaluate the effectiveness of the priming manipulation, repeated measures ANOVAs were also conducted on state anxiety, state pleasantness, and attachment security, as the same as Experiment 1 (see Fig. 5 [Figure 5: see original paper]). Across all three measures, significant main eff ects of time were observed, indicating decreased state anxiety and increased pleasantness and attachment security from pre to post test (s $<$ 0.010). Although the main effect of prime condition was not significant for anxiety, significant main effects prime condition were observed for state pleasantness and attachment security, with the attachment security prime yielding higher levels on both measures.

Importantly, significant interaction between time and prime condition emerged for all three measures (s $<$ 0.001). Follow up analyses revealed a consistent pattern across measures: only the attachment security prime produced significant changes from pre to post test. Specifically, under attachment security prime condition, participants showed a significant reduction in anxiety as well as significant increases in pleasantness and attachment security (s $<$ 0.001). Moreover, at post test, compared to the neut person prime condition, participants exhibited lower anxiety and higher pleasantness and attachment security under the attachment security prime condition (s $<$ 0.010).

Together, these findings demonstrate that the priming manipulation in Experiment 2 was effective, specifically indicating that attachment security prime reliably reduced anxiety and enhanced pleasantness and attachment security, whereas the neutral person prime did not induce comparable changes. This pattern further confirms the robustness and specificity of the attachment security priming effect observed in Experiment 1.

Effectiveness of the priming manipulation in Experiment 2. ASP = attachment security prime; NPP = neutral person prime.

Attachment Anxiety and Avoidance as Moderators of Priming Effects on Hearing Sensitivity To assess whether the priming effects on hearing sensitivity were moderated by attachment anxiety and avoidance, the present study conducted

a repeated measures ANOVA on hearing thresholds, with frequency and priming condition as within subject factors, at tachment anxiety/avoidance (high and low) as between subject factors, with ear side and gender included as control variables.

When attachment anxiety was entered as a moderator, significant main effects of attachment anxiety ((1, 118) = 7.30, = 0.008, = 0.06) and frequency ((1.89, 223.24) = 5.75, = 0.004, = 0.05) emerged. Participants with high attachment anxiety exhibited higher auditory thresholds than those with low attachment anxiety (= 0.008). In addition, low frequency stimuli elicited higher auditory thresholds than middle or high frequency stimuli (s < 0.010). Importantly, a significant three interaction among attachment anxiety, frequency, and prime condition was observed (1.73, 203.62) = 4.00, = 0.025, = 0.03; see Fig. 6 [Figure 6: see original paper]). Follow up analyses revealed that among participants with hig h attachment anxiety, auditory thresholds at low frequency were significantly higher than those at high frequency in the attachment security prime condition. In contrast, among participants with low attachment anxiety, auditory thresholds at low frequency were significantly lower in the attachment security prime condition than in the neutral person prime condition.

ASP = attachment security prime; NPP = neutral person prime.

When attachment avoidance was entered as a moderator, a significant main effect of frequency was observed ((1.89, 223.52) = 6.17, = 0.003, = 0.05). Low frequency stimuli elicited higher auditory thresholds than middle or high frequency stimuli (s < 0.050). Notably, a significant interaction between attachment avoidance and frequency was observed ((1.89, 223.52) = 3.65, = 0.030, = 0.03; see Fig. 7 [Figure 7: see original paper]).

Specifically, among participants with high attachment avoidance, auditory thresholds at low frequency were significantly higher than those at middle and high frequency (< 0.010). However, auditory thresholds at high frequency were significantly lower than those at low and middle frequency among participants with low attachment avoidance s < 0.010).

Interaction effects between attachment avoidance and frequency.

Summary

Experiment 2 aimed to replicate the perceptual effect observed in Experiment 1 and to examine whether individual differences in attachment orientation moderate this effect. The manipulation checks again confirmed the effectiveness of the attachment securit y prime, which significantly reduced anxiety and increased pleasantness and attachment security relative to the neutral condition. These results replicate the emotional regulatory effects of attachment security priming observed in Experiment 1.

More import antly, individual differences in attachment anxiety moderated the influence of attachment security priming on auditory sensitivity. Participants

with higher attachment anxiety generally exhibited higher hearing thresholds, indicating reduced auditory sensi tivity. Furthermore, the facilitative effect of attachment security priming emerged primarily among individuals low in attachment anxiety, particularly for low frequency stimuli. However, individuals high in attachment anxiety showed no comparable perceptu al benefit from the security prime. Attachment avoidance, in contrast, primarily influenced the general pattern of auditory sensitivity across frequencies but did not significantly moderate the priming effect.

These findings are consistent with attachment theory, which suggests that individuals high in attachment anxiety remain chronically vigilant to potential relational threats and have difficulty fully internalizing temporary cues of safety (Brennan et al., 1998; Mikulincer & Shaver, 2020) . As a result, security priming may be less

effective in releasing attentional resources for processing environmental input among these individuals. By contrast, individuals low in attachment anxiety may more readily experience the regulatory benefits of security activation, allowing attentional resources to shift toward external sensory signals. Together, these findings suggest that the perceptual consequences of attachment security activation depend in part on individuals attachment orientations, highlighting the role of attachment related regulat ory processes in shaping basic sensory sensitivity

Discussion

The present study examined whether activating a sense of attachment security could influence auditory sensitivity, as indexed by pure tone hearing thresholds. Across two experiments, several consistent findings emerged. First, attachment security priming s ignificantly lowered hearing thresholds, indicating enhanced auditory sensitivity. Second, this perceptual improvement could not be explained by general positive emotion, as the positive emotion prime produced comparable changes in affect but did not lead to similar improvements in hearing thresholds. Third, Experiment 2 further showed that individual differences in attachment orientation moderated this effect, with the enhancement of auditory sensitivity primarily observed among individuals with lower atta chment anxiety. Together, these findings provide converging evidence that a fundamental social emotional resource (e.g., attachment security) can shape even basic sensory perception.

A Secure Mind Hears Better The results of both experiments indicate that attachment security priming temporarily improves tone hearing sensitivity. This finding is consistent with previous research demonstrating that experimentally activating a sense of attachment security can lower audiometric thresholds (Nagar et al., 2022). The present study extends this evidence by employing a different priming procedure (i.e., ARW) which successfully induced a sense of attachment security and produced comparable perceptual benefits. The conver-

gence of findings across different priming methods and cultural samples further strengthen s the reliability and generalizability of the security priming effect on auditory perception. Crucially, prior research indicates that attachment security is associated with maternal neural sensitivity to infants cries, involving brain regions linked to emotion processing and attention (Laurent & Ablow,). The present findings resonate with this line of research, suggesting that attachment security may function as a general mechanism that enhances perceptual attunement to environmental signals, potenti ally contributing to maternal sensitivity to infants cries.

From the perspective of attachment theory, reminders of supportive figures activate secure base script , which provides individuals with a temporary sense of protection and emotion stability (Mikulincer & Shaver, 2016) . This psychological state reduces

distress and promotes a calm and confident mental platform, allowing individuals to allocate attentional resources more effectiv ely towards incoming sensory information Melen et al., 2017; Mikulincer et al., 2011 . Consistent with this account, previous research has suggested a bidirectional relationship between attachment security and mindfulness, with security related cues increasing mindful awareness and present moment attention (Ryan et al., 2007; Stevenson et al., 2021). Such a mindful state may encou rage individuals to focus more fully on ongoing perceptual tasks and external stimuli. In the context of the present study, this attentional orientation may have increased sensitivity to faint auditory signals, resulting in lower hearing thresholds.

Additi onally, from a developmental perspective, auditory signals, such as caregivers voices, play an important role in early attachment related interactions (Johnston et al., 2007). Over time, these repeated interactions may contribute to the formation of associations between attachment related cues and sensory processing systems.

Activat ion of attachment security may therefore partially reactivate these pathways, further facilitating sensitivity to auditory input.

Importantly, the present findings suggest that the observed improvement in auditory sensitivity cannot be attributed solely to general positive emotion. In Experiment 1, both the attachment security and positive emotion primes produced comparable reduction s in anxiety and increases in pleasantness. However, only the security prime led to lower hearing thresholds. This dissociation indicates that the perceptual enhancement observed in the present study is not simply a byproduct of improved mood. Instead, att achment security likely involves additional cognitive affective processes, such as trust in external support, reduced vigilance toward threat, and a general sense of psychological safety, that uniquely facilitate attentional engagement with environmental s timuli. The present findings also revealed frequency dependent patterns in auditory sensitivity. Specifically, the improvement associated with attachment security priming appeared to be most pronounced in the low frequency range (i.e., 125, 250, and

500 Hz). One possible explanation is that frequencies within the lower range are particularly relevant for speech perception and social communication (e.g., Aguilar et al., 2015), which may make them more sensitive to socio emotional contextual influence (Otani et al., 2014).

Security Helps Some Ears More Than Others The present study further revealed that the perceptual benefits of attachment security priming were moderated by individual differences in attachment orientations, especially attachment anxiety. Specifically, individuals with lower attachment anxiety showe d a clear security priming effect, exhibiting significantly lower pure tone hearing thresholds following the security prime. In contrast, highly anxious individuals showed little or no comparable benefit. This pattern is consistent with previous findings uggesting that the beneficial effects of security priming are often attenuated among individuals high in attachment anxiety (Li et al., 2016; Mikulincer et al., 2011).

According to attachment theory, individuals high in attachment anxiety tend to remain chronically vigilant to potential rejection or abandonment and therefore , are

more likely to allocate cognitive resources to monitoring interpersonal threats (Brennan et al., 1998; Mikulincer & Shaver, 2020). Such hypervigilance may make it difficult for them to fully internalize the temporary sense of safety induced by security priming. In addition, attachment anxious individuals often possess ambivalent attach related representations that include both positive memories of closeness and negative experiences of rejection (Mikulincer & Shaver, 2007). When exposed to security relat ed cues, these conflicting representations may be activated simultaneously, potentially generating psycho logical ambivalence and limiting the beneficial effects of the prime. Although derived from a different cognitive domain, previous research has shown that subliminal security priming can facilitate creative problem solving regardless of individuals attachment insecurity, whereas supraliminal security priming tends to benefit primarily those with lower attachment anxiety (Mikulincer et al., 2011 This p attern may provide indirect support for the present findings since subliminal primes operate outside conscious awareness and they may bypass ruminative processes and avoid activating conflicting attachment related memories.

Interestingly, attachment avoidance, in contrast, primarily influenced the general pattern of auditory sensitivity across frequencies but did not significantly moderate priming effect. Individuals high in attachment avoidance showed particularly elevated hearing thresholds for low frequency tones, whereas individuals low in avoidance demonstrated relatively lower thresholds for higher frequency stimuli. This pattern suggests that attachment avoidance may shape the frequency specific profile of auditory sensitivity rather than the overall magnitude of the security priming effect.

One possible explanation is that individuals low in avoidance tend to be more attentive socially relevant auditory cues, such as speech, which primarily occu-

pies the middle high frequency range (e.g., Aguilar et al., 2015). In contrast, avoidant individuals deactivating strategies may reduce attentional engagement with external signals, potentially limiting perceptual sensitivity, particularly for more difficult detect low frequency sounds.

Limitations and Future Directions Several limitations of the present study should be acknowledged. First, the sample consisted exclusively of university students, which may limit the generalizability of the findings. Future research should examine whether the observed effects extend to mor diverse populations, especially adolescents. Expanding the age range of participants may also help clarify potential developmental mechanisms. For example, given the central role of caregivers voices in early attachment interactions (Johnston et al., 20 activating attachment representations may reactivate pathways supporting sensitivity to socially relevant signals. Investigating these possibilities across different developmental stages may provide deeper insight into the origins of the observed eptual effects.

Second, although the present findings suggest that attachment security can enhance auditory sensitivity, the psychological mechanisms underlying this effect remain unclear. One possible pathway involves changes in attentional orientation. Previous

research has suggested a bidirectional relationship between attachment security and mindfulness, with security related cues increasing present moment awareness and attentional engagement (Ryan et al., 2007; Stevenson et al., 2021). Such attentional states may facilitate the detection of faint sensory signals. Future studies could directly test this possibility by incorporating measures of mindfulness, attentional allocation, or cognitive load to determine whether these processes mediate the relationship bet attachment security and perceptual sensitivity.

Finally, the present study employed only supraliminal attachment security priming (i.e., ARW). Future research could examine whether subliminal security priming produces similar or even stronger perceptual effects by minimizing conscious reflection on attachment related experiences. In addition, the current work focused exclusively auditory sensitivity. Because security priming is not specific to a single sensory modality, it would be valuable to investigate whether similar effects emerge in other percep tual domains, such as visual sensitivity or multisensory integration.

Neuroimaging methods may also help clarify the neural mechanisms underlying these effects. Attachment security may be associated with activation in brain regions involved in cognitive co ntrol and perceptual attention, such as the prefrontal cortex and parietal lobe (Canterberry & Gillath, 2013). Future studies combing attachment priming with neuroimaging techniques may therefore help elucidate how socio emotional states influence early se nsory processing.

Conclusions

present study provides novel evidence that activating attachment security can influence basic sensory perception. Across two experiments, attachment security priming consistently lowered pure tone hearing thresholds, indicating enhanced auditory sensitivity . This effect could not be explained by general positive emotion and was moderated by individual differences in attachment orientation, emerging primarily among individuals low in attachment anxiety.

Availability All data generated for this study are available in the Open Science Framework (OSF) The relevant code can be obtained from the corresponding author upon reasonable request.

Author Contributions Wenbin Pan: Conceptualization, methodology, software, formal analysis, writing original draft preparation, writing review and editing, visualization.

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Li: Conceptualization, writing review and editing, supervision, funding acquisition Fundings This work was supported by the Research Center for Brain Cognition and Human Development, Guangdong, China (No. 2024B0303390003), the National Natural Science Foundation of China (32400906), The MOE (Ministry of Education in China) Project of Humanities and Social Sciences (23YJC190013), and the Striving for the First Class, Improving Weak Links and Highlighting Features (SIH) Key Di scipline for Psychology in South China Normal University.

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