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Memories that touch deeply: Toward a neurobiological model of affective tactile memory

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Abstract

Affective touch has long been recognised as fundamental to bonding, emotional regulation, and social development, yet its role as a distinct form of memory has remained largely unexplored. This paper advances the concept of affective tactile memory, integrating neurobiological, developmental, and clinical perspectives. We propose a model in which bottom-up processes, partially mediated by C-tactile afferents, may converge with top-down modulation from prefrontal-limbic networks to support the encoding, consolidation, and retrieval of tactile experiences. These processes may generate both explicit memories, enabling conscious recall of specific episodes, and implicit traces, shaping emotional security, attachment, and interpersonal trust across the lifespan. We outline hypotheses on implicit memory formation, explicit recall, and the developmental trajectory of tactile memory, and consider moderators such as attachment style, interoceptive awareness, and imagery capacity. Finally, we discuss implications for clinical interventions and caregiving, where fostering or restoring nurturing tactile experiences may enhance resilience and well-being. Recognising affective touch as a potential distinct memory domain opens novel theoretical and empirical avenues across neuroscience, psychology, and clinical science.

Keywords affective touch; tactile memory; c-tactile afferents; emotional memory; interoception; attachment

Highlights

- Affective touch may form both explicit and implicit memory traces.
- CT afferents underpin bottom-up encoding.
- Top-down factors (context, attachment) modulate memory consolidation.
- Affective tactile memory could shape resilience and social bonding.

1. Introduction

Affective touch refers to a specific type of tactile stimulation that is typically slow, gentle, and perceived as pleasant and emotionally meaningful (McGlone et al., 2014) that has been shown to play a crucial role in early childhood attachment and emotional development, fostering safety and trust between caregivers and newborns (Croy et al., 2019; Crucianelli & Filippetti, 2020; La Rosa et al., 2024). Research has traditionally distinguished between discriminative touch, mediated by fast-conducting Aβ fibres and supporting the perception of texture, pressure, and vibration, and affective touch, elicited by slow, gentle stroking that preferentially activates unmyelinated C-tactile (CT) afferents and contributes to emotional and social processing, fostering well-being, bonding, and emotional regulation (Löken et al., 2009; McGlone et al., 2007, 2014; Walker et al., 2017).

However, this distinction is not absolute. Recent evidence demonstrates that Aβ fibres also contribute to the perceived pleasantness of touch (Case et al., 2023; Schirmer et al., 2023), and that affective significance extends beyond CT-optimal stimulation to encompass forms such as hugs, static pressure, and deep touch that do not primarily engage CT afferents. Throughout this article, we focus on CT-optimal touch as the prototypical and most extensively studied form of affective touch, while recognising that affective tactile experience is not reducible to CT-afferent activation alone.

Affective touch is characterised by its strong emotional component, which may activate specialised neural and physiological processes (Gallace & Spence, 2009; Meijer et al., 2022; Lange et al., 2024). Neurobiological models suggest that the processing of affective touch involves a set of interconnected regions: primary and secondary somatosensory cortices (S1, S2), which provide initial cortical representations of tactile input; the insula (Morrison, 2016), which integrates sensory and emotional information; the amygdala (Gothard & Fuglevand, 2021), which evaluates affective relevance and modulates encoding into memory; the hippocampus, which supports contextual binding of sensory and emotional features into coherent memory traces (Diana et al., 2007; Ranganath, 2010); subcortical reward-related structures including the striatum and nucleus accumbens (Rolls, 2023); and prefrontal-limbic structures such as the orbitofrontal cortex (OFC) and the anterior cingulate cortex (ACC), which represent the hedonic and motivational qualities of tactile experiences (Gordon et al., 2013; Rolls et al., 2003). It has been suggested that these neural and physiological mechanisms may contribute to the role that affective touch plays in physical and psychological well-being across the lifespan (Trevarthen & Aitken, 2001; Feldman, 2011; Cascio et al., 2019). This network-level processing could make affective touch particularly well-suited to support the encoding and consolidation of emotional experiences, not only into explicit but also into implicit memory traces, potentially enhancing both conscious and unconscious retrieval.

The tactile interactions between a caregiver and an infant, such as caressing or gentle stroking, have been associated with enhanced infant's physiological regulation and reduce stress reactivity, thereby reinforcing feelings of safety and security (Carozza & Leong, 2021; Kidd et al., 2023). Research indicates that affective touch is associated with enhanced emotional perception, particularly in the context of caregiver-child relationships, where the perceived quality of touch may be modulated by neurochemical responses such as oxytocin release, which is linked to positive emotional states and social bonding (Thrasher & Großmann, 2021; Scheele et al., 2014; Walker et al., 2017; Kidd, Devine, & Walker, 2023). Interestingly, research highlights the role of affective touch across different developmental stages, from enhancing facial expression recognition in infants as young as 4 months (Della Longa et al., 2021) to supporting attention to visual scenes in later infancy (Carnevali et al., 2024) and improving emotion perception in preschoolers (Della Longa et al., 2021, 2023).

Affective touch appears to be necessary for proper neurodevelopment and sociability (Huzard et al., 2022). Attachment theory posits that the quality of early interactions, especially those involving gentle tactile experiences, significantly influences emotional and social development (Ainsworth et al., 1978; Bowlby, 1969/1982; Boldt et al., 2020; Harlow, 1958). Moreover, childhood touch experiences are hypothesised to shape attachment styles, with the quality and availability of such experiences playing a key role in long-term emotional regulation (Keizer et al., 2022). Touch deprivation, for example, may modulate the link between attachment style and touch perception, highlighting how early tactile experiences may influence later processing of and responses to affective touch (Beltrán et al., 2020; Keizer et al., 2022; Spitoni et al., 2020). As a consequence, sensitivity to CT-optimal, affective touch, is influenced by adult attachment style, with insecure attachment and attachment anxiety associated with reduced discrimination of the pleasantness of CT-optimal versus non-CT-optimal touch (Krahé et al., 2018).
Here, we refer to the formative role of affective touch during infancy and childhood, rather than a de novo formation of attachment dispositions in adulthood. These findings suggest that affective touch is not only impactful in the moment but may also leave lasting traces (potentially via processes similar to those involved in memory), influencing attachment dynamics and tactile perception across the lifespan. This interplay between early tactile experiences and their enduring impact raises a critical question: Can affective touch, beyond its immediate sensory and emotional effects, be encoded in the brain as both implicit and explicit lasting memory traces? Could it serve as a cornerstone for emotional and cognitive well-being across the lifespan?

To explore these intriguing hypotheses, it is essential to consider the concept of body memory, a term that encompasses the cumulative imprint of all past bodily experiences stored in memory (Gentsch & Kühn, 2022; Parma et al., 2024). These include tactile, motor, proprioceptive, painful, and interoceptive experiences, along with their associated emotions. While the term remains theoretically contested and lacks a unified biological framework, recent work by Gentsch and Kühn has proposed a systematic account of body memory as both a conceptual and processual phenomenon. Such embodied memories may be stored explicitly, where they are consciously accessible, or implicitly, where they remain hidden yet profoundly influence physical states and behaviours, particularly during emotional experiences (Gentsch & Kühn, 2022).

Despite the foundational role of tactile exchanges in shaping human interactions, the memory of affective tactile experiences remains relatively underexplored compared to other sensory modalities like vision or hearing (Gallace & Spence, 2009). Affective touch, as a distinct and emotionally charged subcategory of tactile perception, has, to our knowledge, received little attention in terms of its mnemonic impact. This includes both its potential to enhance the encoding of co-occurring emotional experiences, and the question of how memories of affective touch itself are formed, maintained, and recalled. The mechanisms through which affective touch might impact memory, especially in the context of early bonding and development, remain a largely unexplored area of research.

Here, we hypothesise that affective touch not only has immediate effects on the nervous system, such as activating CT afferents and associated pathways in the limbic-paralimbic networks introduced above (e.g., insula, amygdala, OFC, ACC; Lamm & Singer, 2010; Kirsch et al., 2020; Davidovic, Starck, & Olausson, 2019; Gothard & Fuglevand, 2021; Meijer et al., 2022), which are critical for processing emotional and social stimuli, but may also embed itself in episodic and semantic memory. In addition, affective touch has been shown to influence physiological regulation, for example by decreasing heart rate (HR) and increasing respiratory rate (RR) (Köteles et al., 2024; Triscoli et al., 2017), further underscoring its role in integrating emotional, physiological, and cognitive domains.

Under existing long-term memory frameworks, affective touch memories should most appropriately be categorised as episodic due to their contextual specificity, even though many of these experiences are not explicitly accessible. Episodic memory is traditionally understood as predominantly explicit, allowing for the conscious recall of specific events and their contextual details (Tulving, 1972; Renoult & Rugg, 2020). While explicit episodic memories of affective touch may align with this definition, referring to specific, temporally and spatially defined events involving affective tactile experiences, many of these experiences are likely to remain implicit. These implicit effects, presumably shaped by emotional salience, may influence behaviour, self-concept, or attachment-related regulatory processes without entering conscious awareness. Importantly, they do not fall within the classic procedural memory domain (typically linked to learned motor skills or habits; Hong et al., 2019) but may rather reflect affective-emotional traces not yet fully mapped onto existing distinctions within episodic vs. implicit/non-declarative memory frameworks.

Certain significant episodes, however, may remain available for conscious recall. Over time, aspects of such experiences may be abstracted and generalised, contributing to semantic memory (e.g., the generalised knowledge that "touch is comforting or uncomfortable"). This potential shift from episodic to semantic memory has been discussed in the context of systems consolidation and may involve hippocampal–cortical interactions within the medial temporal lobe during offline memory processing (see Gentry, Hunter & Buckner, 2024; Squire et al., 2015; Winocur & Moscovitch, 2011). This dynamic interaction between episodic and semantic systems may play a crucial role in encoding and storing affective touch. Such potential memories highlight the dual nature of affective touch, which serves as both an immediate sensory-emotional experience and a potential source of long-term memory that shapes emotional and social development. The complex interplay between explicit and implicit components, as well as the potential semantic abstraction of these experiences, reinforces the distinctive role of affective touch in influencing psychological processes over the lifespan.

While the connection to episodic and semantic memory remains an intriguing hypothesis, such memories could play a pivotal role in stress regulation, the development of resilience across the lifespan, and the capacity to build, experience, and sustain relationships. The specific properties of affective touch, the combination of sensory and emotional components (McGlone et al., 2014; Ackerley et al., 2014; Sailer & Leknes, 2022), may activate specific neural mechanisms (discussed below), potentially transforming early tactile experiences into long-term memory episodes and influencing self-concept, worldview, and the ability to engage meaningfully with others. Importantly, the consolidation of such memories is likely modulated by the individual's subjective appraisal, e.g., whether a touch is perceived as pleasant, neutral, or aversive, which in turn may shape the affective salience and accessibility of the memory trace.

Cross-modal research on other forms of tactile perception reveal that tactile memory encompasses a broad spectrum, from perceiving fine textures to processing spatial and emotional properties (Gallace & Spence, 2009). Affective touch, however, is particularly notable for its connection to reward related and stress-regulating mechanisms in the brain (Ellingsen et al., 2016). Rather than engaging only primary somatosensory regions, affective touch also recruits higher-order socio-emotional networks (see above), which integrate emotional and sensory information and may further enhance the likelihood of encoding tactile-affective experiences in episodic memory (Morales-Calva & Leal, 2025; Rolls, 2019; Tyng et al., 2017; Uncapher & Rugg, 2005).

In this paper, we examine how affective touch engages sensory, emotional, and cognitive processes relevant to memory formation. We hypothesise that affective touch, through its functional and developmental significance, contributes to the creation of episodic and semantic memories that support stress resilience, emotional regulation, and relationship dynamics. By discussing findings from behavioural research, developmental psychology, and memory studies, this article aims to provide a theoretical framework for future studies exploring how affective touch may serve as a critical element in shaping long-term emotional and cognitive well-being. A glossary of key terms used throughout this article is provided in Table 1.

2. Memory and affective sensory input

2.1 Memory processes: from sensory input to episodic representation

Memory enables humans to encode, consolidate, and retrieve information about past experiences, thereby shaping perception, decision-making, and future behaviour (Squire & Wixted, 2011; Tulving, 2000; Wixted & Squire, 2011; Zlotnik & Vasintjan, 2019). From a neurocognitive perspective, memory is not a unitary function but comprises multiple, interacting systems that operate over different timescales and levels of consciousness. Sensory memory captures raw, modality-specific input for a brief moment (milliseconds to seconds), while short-term and working memory systems allow for limited-duration storage and manipulation of information (Baddeley, 2000; Cowan, 2008). In contrast, long-term memory supports the enduring retention of information, including semantic knowledge and episodic representations of personally experienced events (Atkinson & Shiffrin, 1968; Tulving, 1972).

The formation of episodic memories depends on the successful encoding of perceptual input into a coherent spatiotemporal and emotional context, often requiring attentional focus and integration with prior knowledge (Craik & Lockhart, 1972; Moscovitch et al., 2016). Crucially, episodic memory formation is tightly linked to hippocampal and medial temporal lobe functioning, which support the binding - that is, the integration of spatially and temporally distributed sensory features into a single coherent representation – of features, including visual, tactile, and emotional cues, into unified memory traces (Diana et al., 2007; Ranganath, 2010). This binding process is especially relevant for affect-laden experiences, as emotion can enhance memory encoding by engaging limbic structures such as the amygdala, insula, and orbitofrontal cortex, which in turn modulate hippocampal activity (Tyng et al., 2017).

Moreover, emotionally salient stimuli not only receive prioritised attentional processing but are also more likely to undergo successful consolidation during sleep and offline replay, potentially contributing to the durability and vividness of such memories (Murty et al., 2010; Payne & Kensinger, 2018). This interplay between bottom-up salience signals and top-down modulation, shaped by individual goals, expectations, and social context, plays a key role in determining which experiences are remembered and how they are later reconstructed (Robin & Moscovitch, 2017; Shelton & Scullin, 2017).

In this light, affectively charged sensory events such as interpersonal touch are particularly well suited to engage episodic memory systems. Yet how such tactile and affective inputs are encoded and maintained in memory remains underexplored. The following sections therefore examine how memory operates across different sensory modalities, including vision, audition, olfaction, gustation, and touch, to illuminate the potential mechanisms underlying the formation of memory for affective tactile experiences.

While much of the current memory research emphasises the reinstatement of sensory content during retrieval (Kang, Kang, & Lee, 2022; Rau et al., 2025), affective touch may involve the reactivation of both the tactile sensation and its emotional significance. This raises the question whether affective touch functions merely as a cue to retrieve abstract semantic associations (“touch is comforting”) or whether it reactivates rich, context-bound episodic memories. Understanding how emotional salience becomes integrated, and reinstated, in tactile memory traces is therefore key to elucidating the specific role of affective touch in memory systems.

2.2 Affective sensory memory across modalities: a comparative perspective

Insights from sensory modalities such as seeing, hearing, smelling, and tasting suggest that memory formation relies on an intricate interplay of emotional, sensory, and contextual factors. Among the diverse array of sensory modalities, visual and auditory memory have emerged as the most extensively researched areas (Bonetti et al.,2024; Gallace & Spence, 2009; Lange et al., 2024). This prominence can be attributed not only to the prevalence of visual and auditory stimuli in everyday experiences but also to the relative accessibility of these modalities for empirical investigation within experimental frameworks. The methodologies employed in studying visual and auditory memory often allow for precise manipulation and measurement, thereby yielding valuable insights into the underlying cognitive processes (Baddeley, 2000; Squire & Wixted, 2011).

Research on visual and auditory memory highlights the critical roles of attention and emotional salience (Opoku-Baah et al., 2021; Salsano et al., 2024). Emotionally significant visual stimuli are preferentially encoded, with the amygdala and hippocampus playing key roles in linking emotional signals to sensory memories (Kattner & Clausen, 2020; Rademaker et al., 2019). Similarly, auditory memory benefits from emotional and attentional engagement, as demonstrated by studies showing that emotionally relevant auditory cues enhance both short- and long-term memory processes (Gloede et al., 2017; Moradi et al., 2023). Iconic memory, a subtype of sensory memory in the visual domain, and auditory sensory memory provide rapid, specialized and efficient encoding systems that depend on attention for transfer into longer-term storage (Camina & Güell, 2017). These findings raise the possibility that affective touch, like emotionally salient visual or auditory stimuli, may recruit shared attentional and emotional mechanisms to support memory formation. This hypothesis awaits direct empirical testing in the tactile-affective domain.

The strong limbic connections associated with olfactory memory underline its specific ability to evoke vivid and emotionally charged memories. Olfactory stimuli, processed through the amygdala and hippocampus, are closely tied to past experiences, often triggering intense recollections that endure over time (Daniels & Vermetten, 2016; García-Ruiz et al., 2021). Similarly, gustatory memory emphasises the importance of contextual and emotional factors. Studies on conditioned taste aversion illustrate how negative associations with specific tastes lead to persistent aversive memories (Cruz et al., 2008). Additionally, the multisensory integration of taste and smell enhances the encoding and retrieval of gustatory experiences, demonstrating the role of environmental and relational dynamics in memory formation (Stevenson, 2001; Pardasani et al., 2021). These processes highlight potential parallels with affective touch, which may utilise similar mechanisms to create emotionally resonant and enduring memory traces.

The phenomenon of multisensory integration (Calvert, 2001; Murray & Wallace, 2012; Shams & Seitz, 2008; Thelen et al., 2012), evident in olfactory and gustatory memory, further supports the possibility that affective touch might interact with other sensory cues to facilitate memory retrieval rather than directly reinforcing memory itself. For instance, the robust configural memories formed through the combination of taste and smell suggest that affective touch, when paired with visual or auditory inputs, could enhance memory performance through multisensory pathways (Meyer-Gerspach et al., 2016). Importantly, this refers to the integration of distinct sensory modalities, which is conceptually different from the integration of affective (and interoceptive) dimensions within touch itself. Moreover, the emotional and relational contexts in which tactile experiences often occur may serve as crucial factors in embedding such memories deeply within the cognitive and emotional systems.

Together, these findings suggest that affective touch may engage not only emotional but also sensory and contextual pathways to create deeply embedded and emotionally charged memories. The influence of emotional salience and attentional engagement, coupled with multisensory integration, highlights the importance of further research into how affective touch contributes to memory formation. Having considered these cross-modal parallels, the following section turns to haptic and tactile memory, which share the most direct sensory overlap with affective touch and may therefore offer particularly relevant insights into its mnemonic properties.

2.3. Haptic and tactile memory

Haptic memories are based on active perception, integrating tactile and proprioceptive signals processed in neural networks such as the somatosensory and prefrontal cortex (Lawson et al., 2015). Hutmacher and Kuhbandner (2018) demonstrated that people could recognise objects they had only touched once with high accuracy, even after an extended period of one week. These findings highlight the durability of haptic memory traces and underscore the importance of active interactions for memory consolidation. The studies by Lawson et al. (2015) expanded this perspective by investigating the susceptibility of haptic memory processes to interference. Lawson et al. tested various types of interference, haptic, motor, spatial, and verbal, during the encoding and retention phases of objects. Their results indicated that haptic and spatial interference had the most consistent disruptive effects on performance. While familiarity of objects was not a primary variable, the authors proposed that familiar objects might be more resilient to non-haptic interference, suggesting a potential modulatory role of prior experience in haptic memory retention. Another experiment by Lawson et al. (2015) examined the effects of interference during the retention phase. Spatial interference had the strongest impact on memory performance, as it competed with specific processes of haptic memory. Motor and verbal interferences also impaired performance, though to a lesser extent. These results illustrate the modality-specificity of haptic memory processes and their vulnerability to disruptions.

In contrast to haptic memories, tactile memory traces arise from the passive perception of sensory stimuli, without requiring active interactions (Lawson et al., 2015). Lange et al. (2024) examined the robustness of tactile memory performance across the lifespan using a two-alternative forced-choice paradigm in which participants had to distinguish between previously presented and novel tactile dot patterns. Their findings showed that both younger and older adults were reliably able to discern subtle differences between tactile patterns. However, older adults did not achieve peak performance in simpler tasks, suggesting age-related changes in memory networks. Despite increased detection thresholds with age, the precision and durability of tactile memory traces remained intact, indicating remarkable stability in these mechanisms.

Research by Roe et al. (2017) explored the Ranschburg effect in tactile memory, a memory illusion where repeated items are harder to recall, revealing mechanisms of facilitation and inhibition similar to those found in verbal memory. In their paradigm, participants felt short sequences of tactile stimuli, and some items were deliberately repeated within the same sequence. These repeated items showed systematically lower recall accuracy, mirroring the Ranschburg effect known from verbal serial recall tasks. This makes clear that "repeated items" refers to the same tactile item appearing twice within the same sequence, not simply the same item across different trials. These findings align with the notion that tactile memory operates through shared mechanisms across sensory modalities, reinforcing a common cognitive architecture for memory processing. Although these findings primarily concern short-term tactile processing, they are relevant to the present framework insofar as working memory provides the initial representational basis from which long-term memory traces may be formed (Baddeley, 2000; Cowan, 2008). It should be noted that these working memory studies investigated generic tactile stimuli rather than affective touch specifically. They are discussed here as evidence that touch engages similar cognitive-mnemonic architecture to other sensory modalities, not as direct support for the neurobiological model proposed below. Roe et al. (2024) extended these findings by demonstrating that prioritisation effects, well-documented in visual and auditory working memory, also extend to the tactile domain, with modality-specific encoding mechanisms independent of verbal strategies.

Elshafei et al. (2024) added further evidence by showing that tactile working memory spans can last up to 20 seconds, significantly exceeding the 2.8-second span reported by Picard and Monnier (2009). These findings suggest that tactile memory is not only robust but also highly adaptive, supporting complex cognitive tasks such as spatial navigation and object recognition. While the preceding findings concern short-term working memory processes, the following evidence from Lange et al. (2024) reflects long-term memory mechanisms operating on a fundamentally different neural substrate. Building on this, Lange et al. (2024) demonstrated that tactile memory is shaped by cognitive biases, most notably a pattern completion bias, whereby incomplete tactile patterns are more likely to be reconstructed with previously known information. This bias was observed across age groups but was more pronounced in older adults, indicating that tactile memory involves active reconstruction processes that may change with age.

Finally, Gallace and Spence (2009) provided a comprehensive review demonstrating that tactile memory processes involve several distinct neurocognitive subsystems, ranging from short-lived peripheral to long-term central storage processes. Their work synthesised findings from studies on tactile change detection, numerosity judgements, and pattern recognition, revealing that tactile short-term memory has a severely limited capacity, estimated at approximately two to three items, and is highly susceptible to masking and interference from stimuli presented to other body locations. They further highlighted the role of multisensory networks, which often process tactile information in combination with visual, auditory, and kinaesthetic modalities. A key insight from their research is the differentiation between micro- and macrogeometry of tactile stimuli, texture and roughness (microgeometry) versus shape and size (macrogeometry), which are processed by distinct brain regions and integrated into spatial reference frames to form coherent memory traces. These findings underscore the multifaceted and highly interconnected nature of tactile memory.

2.4. Toward a model of affective tactile memory

Research in the fields of haptic and tactile memory can provide important insights to better understand the potential memory processes involved in affective touch. Both haptic and tactile modalities demonstrate the ability to create durable and precise memory traces, suggesting that touch engages both explicit and implicit memory systems. Affective touch, characterised by emotional and social salience, likely utilises these mechanisms to enhance the encoding, consolidation, and retrieval of emotionally significant experiences.

The remarkable stability of tactile memory, as highlighted by Elshafei et al. (2024) and Lange et al. (2024), provides an important analogy for affective touch. Despite age-related changes, tactile memories remain robust and precise, which suggests that emotional touch may similarly produce long-lasting memories. Additionally, the findings by Hutmacher and Kuhbandner (2018) demonstrate that haptic interactions are particularly well retained when associated with familiarity or repeated exposure. These aspects are especially relevant for affective touch in relational and social contexts, where repetition and emotional connections often play a central role.

Moreover, the prioritisation effects observed in tactile memory by Roe et al. (2024), who showed that items with higher mnemonic value in tactile sequences were recalled more accurately even under concurrent articulation, underline the strategic allocation of attentional resources to specific stimuli and suggest that modality-specific encoding mechanisms may operate independently of verbal strategies. This ability to prioritize certain tactile inputs could parallel how emotionally salient touches are encoded and remembered more effectively, emphasising the dynamic interplay between sensory and emotional processing in memory formation. Taken together, these findings suggest that potential memory of affective touch operates at the intersection of sensory, emotional, and cognitive pathways, harnessing the strengths of haptic and tactile memory mechanisms to create enduring, emotionally meaningful memory traces, potentially encompassing both explicit and implicit forms of memory.

Building on these insights, we propose a neurobiological model for the memory of affective touch, aiming to integrate the dynamic interplay of sensory, emotional, and cognitive pathways. This model seeks to explain how affective touch may leverage tactile memory mechanisms to form enduring and emotionally significant memory traces.

3. Neurobiological model for affective tactile memory

A neurobiological model for memory of affective touch is likely to encompass both bottom-up and top-down processes, which together facilitate the perception and emotional processing of tactile stimuli. Affective touch, characterised by its emotional significance, is associated with specific neural pathways that differentiate it from non-affective touch (McGlone et al., 2014) although, as noted above, the distinction between affective and discriminative processing is not absolute (Case et al., 2023; Schirmer et al., 2023).

3.1. Bottom-up processing of affective touch

The bottom-up processing of affective touch begins with sensory input from the skin, where specialised receptors, namely CT afferents, play a pivotal role (Vallbo et al., 1999; Olausson et al., 2010; Löken et al., 2009; Case et al., 2023). CT afferents are unmyelinated nerve fibres that are particularly responsive to gentle, caress-like touch, typically delivered at speeds of approximately 1-10 cm/s and at skin temperature (Ackerley et al., 2014; Pawling et al., 2017; Novembre et al., 2021). From an anatomical standpoint, the CT afferent pathway shows structural parallels with the neural routes for temperature and pain, and more broadly, with unmyelinated afferents passing through lamina I in the spinal cord, afferents that are implicated in interoceptive processing (Björnsdotter et al., 2010; Davidovic et al., 2017; Crucianelli & Morrison, 2023; Crucianelli & Ehrsson, 2023). These afferents are considered crucial for encoding the pleasantness of touch, as their activation correlates with the subjective hedonic experience of caresses (Löken et al., 2009; Mazza et al., 2023; Novembre et al., 2021; Voos et al., 2013). When the skin is stroked at these optimal speeds, CT afferents increase their firing rates, transmitting signals to the central nervous system that are interpreted as affectively positive (Löken et al., 2009; Davidovic et al., 2016; Perini et al., 2021). However, it should be noted that recent evidence suggests that CT-afferent activation alone may not be sufficient to enhance memory formation. Convertino et al. (2025) and Bregulla et al. (2025, preprint) found that affective touch delivered at CT-optimal velocities did not significantly enhance episodic memory encoding compared to control conditions, suggesting that the relationship between CT-mediated pleasantness and mnemonic benefit may be more complex than initially assumed. These null findings highlight the importance of considering additional factors, such as emotional context, relational meaning, and top-down appraisal, in determining whether affective touch translates into durable memory traces.

Adult neuroimaging research has indicated that slow, affective stroking is processed by several brain areas, including the insular cortex and its operculum, the secondary somatosensory cortex (S2), the temporoparietal junction, the superior temporal sulcus (STS), the amygdala, the striatum, the OFC, and the pregenual ACC (Olausson et al., 2002; Lindgren et al., 2012; Gordon et al., 2013; Voos et al., 2013; Bennett et al., 2014; Kaiser et al., 2016; Perini et al., 2015; Case et al., 2016). Research suggests that the afferent signals can also travel to the insula directly through the thalamus, circumventing the primary somatosensory cortex (Olausson et al., 2002). Insular processing of unmyelinated afferent input is suggested to follow a posterior-middle-anterior progression, from the posterior insula through the middle insula to the anterior insular cortex (aIC), where higher-level integration of multisensory information ultimately contributes to a unified percept of subjective awareness (Craig, 2002; Davidovic et al., 2017). The amygdala, a key structure in emotional processing, further helps encode the affective value of touch, potentially facilitating the formation of enduring memories associated with emotionally significant tactile experiences (Gothard & Fuglevand, 2021).

3.2. Top-down modulation of affective touch

Top-down processes also significantly influence how affective touch is perceived (Ellingsen et al., 2016; Crucianelli et al., 2021), and likely remembered. These processes involve higher-order cognitive functions, such as expectations, prior experiences, and emotional states, which can modulate the perception of touch. For example, the context in which touch occurs, whether it is in a supportive or threatening environment, can alter the emotional response to that touch (Björnsdotter et al., 2014; Saarinen et al., 2021; Sailer & Leknes, 2022), thereby possibly affecting memory consolidation. For instance, such emotional context may modulate hippocampal and amygdala engagement during encoding, which in turn facilitates or disrupts memory consolidation (Takashima et al., 2016; Qasim et al., 2023).

Crucially, regions like the posterior superior temporal sulcus (pSTS) contribute to evaluating the affective quality of touch, integrating emotional and contextual factors that modulate neural responses to tactile stimuli (Davidovic et al., 2016; Perini et al., 2021). This integration of sensory signals with prior experiences underscores how top-down influences shape affective touch perception and its potential memory encoding. This integration may support encoding into long-term memory via mechanisms that first stabilize perceptual representations in working memory, consistent with multistage memory models (Baddeley, 2000; Cowan, 2008).

Research indicates that the prefrontal cortex plays a crucial role in top-down modulation, influencing how sensory information is interpreted based on contextual cues and individual differences (Sikkens et al., 2019; Kida & Shinohara, 2013; Ellingsen et al., 2016). The OFC, for instance, embeds sensory input within an emotional framework, modulating the perceived pleasantness of touch (Frey et al., 2008; Rolls, 2004). Studies suggest that oxytocin can enhance the perceived pleasantness of affective touch, which in turn increases OFC activation (Chen et al., 2020; Ellingsen et al., 2014; 2016). The ACC, closely linked to the OFC, integrates emotional responses with decision-making processes, contextualising tactile experiences within broader situational contexts (Rolls, 2019; Koga et al., 2024; Lindgren et al., 2012). These modulations may enhance or diminish the perceived pleasantness of touch, with implications for how memories of touch are formed and recalled. Although attachment style develops over time via relational experiences, including the quality and availability of touch in early caregiving, in this context it functions as an existing interpersonal schema that modulates how affective touch is encoded in adulthood, rather than being created by the touch itself. For instance, individuals with secure attachment styles may exhibit stronger neural responses to affective touch, which has been interpreted as reflecting a more positive emotional memory associated with such experiences (Zuckermann et al., 2023; Spitoni et al., 2020; Krahé et al., 2018). Conversely, individuals with insecure attachment styles may be more likely to encode affective touch within a negative emotional framework, potentially leading to more persistent or intrusive memories of such experiences.

3.3. Affective tactile memory encoding, consolidation, and retrieval

The consolidation of memories related to affective touch might involve the integration of sensory and emotional information into long-term memory. This process is thought to be facilitated by the hippocampus, which plays a key role in the formation of new memories and the integration of contextual information (Bird & Burgess, 2008; Chen et al., 2020). The emotional significance of touch enhances the likelihood that these memories will be retained and recalled in the future (Ritchey et al., 2008; McGaugh, 2004; Hermans et al., 2014). Importantly, this hippocampus-dependent consolidation pathway is most relevant to explicit memory formation. Implicit memory traces, by contrast, may form through hippocampus-independent mechanisms, including amygdala-mediated emotional conditioning and cortico-striatal learning, which can operate without conscious awareness (Squire, 2004; Squire & Wixted, 2011, Henke, 2010). Notably, Ballesteros and Reales (2004) demonstrated intact haptic priming in patients with Alzheimer's disease despite severely impaired explicit recognition, providing direct evidence for a dissociation between implicit and explicit tactile memory systems. This distinction is critical for the present framework, as it suggests that many affective touch experiences may leave lasting implicit traces even when they are not consciously recalled, not because they are forgotten, but because they were encoded through pathways that do not support explicit retrieval.

Moreover, the interplay between bottom-up and top-down processes is crucial for the flexibility of memory retrieval (Shelton & Scullin, 2017; Zheng et al., 2024). The ability to recall specific memories of affective touch might be influenced by the current emotional state of the individual, highlighting the dynamic nature of memory consolidation (Buchanan, 2007; Tyng et al., 2017). This suggests that memories of affective touch, like other emotional memories, are not static but can be reshaped by ongoing experiences and emotional contexts.

In summary, the memory of affective touch could arise through a complex process that links various neural mechanisms (*Figure 1*). Initially, sensory encoding plays a key role, where gentle touch activates CT afferents. These receptors transmit sensory signals to the posterior insula and other relevant brain regions, leading to the perception of the touch as pleasant and meaningful. However, as noted above, sensory encoding via CT afferents alone does not appear sufficient to guarantee memory formation (Convertino et al., 2025; Bregulla et al., 2025, preprint). Rather, it is the subsequent integration with affective and contextual processing that may determine whether a tactile experience becomes a lasting memory trace. In affective processing, the amygdala and OFC evaluate the emotional significance of the touch and determine whether it is perceived as positive or negative. This emotional evaluation might enhance the affective quality of the touch and contribute to its long-term storage in memory.

The next step could involve contextual integration, where the ACC and hippocampus link sensory inputs with environmental and relational contexts. This process would ensure that the touch is not perceived in isolation, but instead placed into a larger, situational framework, enhancing its meaning and relevance. During consolidation, the emotional salience of the touch could increase the likelihood of its storage in long-term memory, making the memory more stable and enduring. Finally, the flexible (implicit) retrieval of this memory could be influenced by current emotional and social contexts, allowing the memory of the touch to be dynamically shaped and modified according to the present circumstances. Such retrieval may trigger a process known as reconsolidation, the reactivation-dependent restabilisation of an existing memory trace, during which its content can be updated or modified based on the current emotional or relational context (Nader & Einarsson, 2010). This process, initial consolidation and later reconsolidation during retrieval, could explain how affective touch, when integrated with emotional and contextual meaning, becomes a deeply rooted and personally meaningful memory. We further note that contextual modulation, encompassing factors such as expectations, attachment style, interoceptive awareness, imagery capacity, and neurochemical milieu (e.g., oxytocin), is proposed to operate across all stages of this model, from initial encoding through reconsolidation, rather than at a single discrete processing step (see Figure 1).

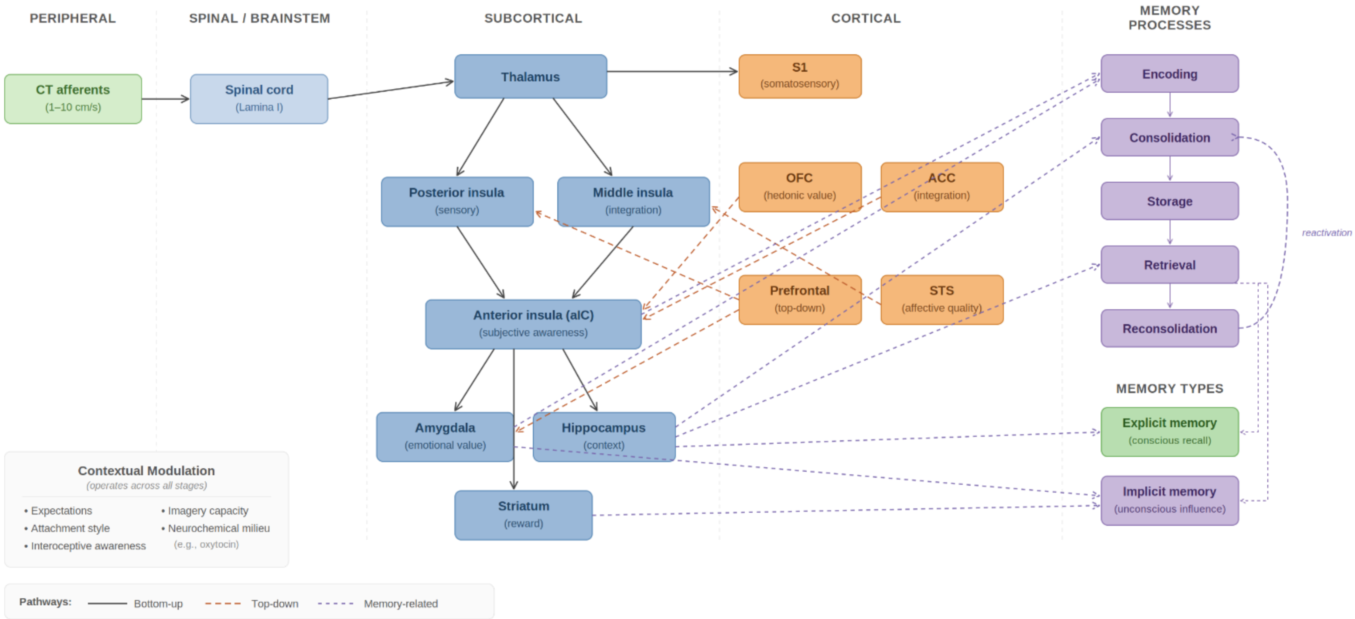

***Figure 1.* Neurobiological model for affective tactile memory.**

In this figure, solid lines indicate bottom-up pathways (peripheral → cortical), orange dashed lines indicate top-down modulation (cortical → subcortical/peripheral), and purple dashed lines indicate memory-related pathways linking neural structures to memory processes and memory types. The line style reflects pathway directionality, not evidence strength. Gentle, CT-optimal touch (1-10 cm/s) is encoded peripherally by CT afferents and transmitted via lamina I of the spinal cord to subcortical and cortical regions. Bottom-up pathways converge on posterior, middle, and anterior insula, as well as amygdala, hippocampus, and striatum, supporting the integration of sensory and affective signals into subjective awareness. However, CT-afferent activation alone does not appear sufficient to drive memory formation (Convertino et al., 2025; Bregulla et al., 2025, preprint); rather, contextual modulation is proposed as a critical determinant of whether tactile input becomes a lasting memory trace. Top-down modulation arises from cortical regions (OFC, ACC, prefrontal cortex, STS), shaped by a set of contextual factors, termed Contextual Modulation in the figure, encompassing expectations, attachment style, interoceptive awareness, imagery capacity, and neurochemical milieu (e.g., oxytocin). These processes interact across all stages of memory formation: encoding, consolidation, storage, retrieval, and reconsolidation, that is, the reactivation-dependent restabilisation of a memory trace, represented by the feedback arrow from reconsolidation to consolidation. Together, they may transform affective touch into both explicit memories (conscious recall of touch experiences), dependent on hippocampal consolidation, and implicit memories (emotional security, unconscious influence), which may form through hippocampus-independent pathways such as amygdala-mediated conditioning.

4. Working hypotheses and outstanding questions

4.1. Hypotheses

Based on the previous considerations, we formulate the following hypotheses:

H1: Affective touch may give rise to implicit memory traces that primarily promote emotional security and well-being. These memory traces may promote the feeling of safety and comfort in social and interpersonal contexts.

Research has shown that affective touch is closely linked to CT afferents, which are associated with the perception of pleasantness and emotional regulation (Ackerley et al., 2014; Björnsdotter et al., 2010). CT afferents play a role in interoceptive processes that may enhance feelings of safety and well-being (Morrison et al., 2010; Crucianelli & Morrison, 2023). Importantly, affective touch is not limited to dyadic, interpersonal contexts. Self-soothing touch behaviours, such as self-stroking or hand-over-heart gestures, have also been shown to activate similar physiological calming responses, suggesting that implicit tactile-affective traces may be formed and reactivated outside of social interactions as well (Dreisoerner et al., 2021; Maier et al., 2026; Uvnäs-Moberg et al., 2015).

To test this hypothesis, future studies could examine whether repeated exposure to CT-optimal touch produces measurable changes in implicit markers of emotional security, such as attenuated cortisol reactivity, increased approach behaviour, or shifts in implicit association tasks, compared to non-affective tactile control conditions.

Outstanding questions

Could affective touch create implicit memory traces that support emotional security and well-being by embedding tactile experiences within neural and emotional systems? The exact pathways through which such potential implicit memory traces are formed and maintained remain unclear. For instance, does repeated exposure to affective touch reinforce unconscious associations with safety and comfort, such as automatic physiological stress responses (e.g., cortisol reactivity), nonverbal proximity behaviours, or pre-reflective attachment strategies shaped through early touch experiences (e.g., Schore, 2001; Sroufe, 2005)? To what extent do these traces influence unconscious behaviours and experiences, such as attachment patterns or stress responses, in the long term? A related question concerns the encoding threshold: what determines whether a given affective touch experience is encoded as a lasting trace rather than merely processed in the moment? Factors such as emotional salience, relational context, repetition, and the individual's current physiological and psychological state may jointly determine this threshold, but the relative contribution of each remains unknown. Indeed, the apparent 'forgetting' of most everyday affective touch experiences may reflect not a failure of encoding but rather the predominance of implicit, hippocampus-independent memory pathways: tactile-affective traces may be formed and maintained without ever becoming consciously accessible (Squire, 2004).

These memory traces may not be consciously accessible or verbally reportable but instead resemble affective schemas or implicit emotional memories shaped by repeated affective experiences (Damasio, 1999; LeDoux, 2003), influencing future social perception and behaviour without requiring conscious recall. Such traces could also involve emotionally toned episodic memories or generalised semantic schemas of touch in safe contexts, which contribute to future approach tendencies (Rubin et al., 2003; Rubin, 2014; 2022; Schacter et al., 2007).

H2: Affective touch may support explicit memories, particularly the recall of touch experiences with attachment figures, such as parents or close caregivers. These explicit memories are conscious and may influence later behaviour and relationship dynamics.

While there is evidence that early tactile experiences, such as caregiving touch, are associated with emotional bonding and attachment (Croy et al., 2019; Crucianelli & Filippetti, 2020; La Rosa et al., 2024), it remains unclear how explicitly these experiences are stored in memory. Emotional events in general are known to engage the hippocampus and amygdala during memory consolidation (Kattner & Clausen, 2020; Rademaker et al., 2019). Notably, the few existing studies on touch and memory have examined whether affective touch enhances the encoding of co-occurring non-tactile stimuli, such as faces (Bregulla et al., 2025, preprint) or emotional images (Convertino et al., 2025), rather than whether the touch experience itself is stored as an explicit memory trace. Their largely null findings regarding recognition accuracy therefore do not directly address the present hypothesis but highlight that the mnemonic role of affective touch may operate through different mechanisms than simple encoding enhancement, potentially involving relational meaning, emotional context, and the subjective significance of the tactile experience itself.

To test this hypothesis directly, future studies could present participants with distinct affective touch experiences varying in relational context (e.g., delivered by a partner versus a stranger) and subsequently assess explicit recall of the touch itself, including its perceived quality, emotional valence, and contextual details, rather than recall of stimuli merely co-occurring with touch.

Outstanding questions

It is not yet understood how touch-related explicit memories are encoded and stored differently from memories associated with other sensory modalities. Furthermore, the long-term influence of specific early tactile experiences on adult attachment styles and relationship dynamics remains an open question. Another key unresolved issue concerns the distinction between explicit and implicit affective touch memories. While explicit recollection of touch experiences may rely on episodic memory systems, implicit affective traces could be encoded through interoceptive and emotional pathways, and how these two forms of memory interact remains unknown.

H3: Affective touch may have lifelong effects on emotional processing and social interactions. Touch experiences in childhood and adolescence may significantly impact the ability to empathise, cope with stress, and the quality of social interactions in adulthood.

Research suggests that early touch experiences are associated with the development of social and emotional skills, including empathy and stress regulation (Field, 2010; Della Longa et al., 2021, 2023; Carnevali et al., 2024). Studies have shown that individuals who report higher levels of nurturing touch in childhood exhibit greater social competence and emotional resilience (Narvaez et al., 2019; Svinth, 2018). Additionally, touch deprivation in early life is associated with social difficulties and heightened stress responses (Harlow, 1958; Hofer, 2006). Emerging evidence further highlights the role of touch during adolescence, a period characterised by heightened sensitivity to social evaluation and ongoing maturation of socio-affective neural circuits. Recent work suggests that affective touch continues to shape emotional processing during this developmental window, with adolescents showing distinct patterns in how touch influences facial emotion recognition (Della Longa & Farroni, 2025) and in how gender-specific touch preferences within peer relationships emerge and evolve from adolescence into adulthood (Valori et al., 2026, preprint). Importantly, this hypothesis extends beyond dyadic contexts:

self-initiated touch behaviours may also play a regulatory role across the lifespan (Dreisoerner et al., 2021; Maier et al., 2026).

To test this hypothesis, longitudinal designs tracking early touch experiences (e.g., via parental report or observational coding) and their associations with later socio-emotional outcomes would be particularly informative. Cross-sectional studies comparing individuals with varying histories of nurturing versus deprived touch could complement such designs.

Outstanding questions

How do specific types of touch experiences in childhood and adolescence (e.g., frequency, duration, context) differentially affect social and emotional outcomes? Are there critical periods during which touch has the greatest impact?

4.2 Conclusions and future directions

In this article, we suggest that affective touch may give rise to a distinctive form of memory, characterised by differences in both its neural underpinnings and its phenomenological texture. To fully appreciate its relevance, it is useful to contrast this emerging category with more established memory modalities.

While visual and olfactory memory systems have long been acknowledged for their evocative power and sensory richness (e.g., Herz & Schooler, 2002, Knez et al., 2017; Masaoka et al., 2021; Sheldon et al., 2016; Willander & Larsson, 2006), their mnemonic functions are typically examined in terms of perceptual specificity and associative cueing. Similarly, emotional memory research has emphasised the modulatory role of arousal and valence in enhancing memory consolidation (Costanzi et al., 2019; Gao et al., 2024; McIntyre et al., 2012), with a strong focus on amygdala-hippocampal interactions (Costa et al., 2022; Roesler et al., 2021). However, these frameworks rarely capture the relational, embodied, and intersubjective dimensions of sensory memory that characterise affective touch.

Affective touch, as partially mediated by CT afferents, is notable in several respects. First, it is often dyadic and relational, requiring not just a stimulus but an intending other (Ciaunica & Fotopoulou, 2017; Fotopoulou & Tsakiris, 2017; Ciaunica & Crucianelli, 2019), although self-directed touch may also carry affective significance (Dreisoerner et al., 2021; Maier et al., 2026). Second, its neural processing recruits a distinct affective-interoceptive network (including pIC and aIC, posterior cingulate cortex, and orbitofrontal regions), rather than the modality-specific sensory cortices alone (Björnsdotter et al., 2010; Morrison, 2016; Meijer et al., 2022). Third, its memory potential may be less dependent on discrete perceptual features and more grounded in implicit bodily associations, emotional safety, and social trust (Crucianelli et al., 2013; Fotopoulou et al., 2022; McGlone et al., 2014).

These characteristics suggest that affective touch memory may constitute a qualitatively differentiated memory category, less about recognising specific tactile patterns, and more about encoding the feeling of being safely held or rejected. This renders it particularly relevant in contexts of attachment, trauma, and early caregiving, where traditional sensory or emotion-focused memory paradigms may fail to capture the depth and texture of embodied relational experience.

The aforementioned hypotheses should be investigated in future studies to better understand the role of affective touch in the memory process and its long-term effects on emotional and social development. For example, future research should prioritize understanding whether and how memories of affective touch can be explicitly recalled and how these memories evolve over time. This investigation would address two critical aspects: the explicit retrieval of touch-related memories and the potential for such memories to become implicit or fade with time.

Explicit retrieval of affective touch memories

Neuroimaging studies could explore which brain regions are activated during the conscious retrieval of these memories, focusing on areas like the hippocampus, amygdala, and prefrontal cortex. Such research could help determine whether these memories remain explicitly accessible or transition into a more implicit form over time.

Experimental paradigms might involve presenting participants with affective tactile stimuli similar to those employed in previous CT-afferent studies (e.g., gentle stroking at 1-10 cm/s, Löken et al., 2009; Crucianelli, Chancel and Ehrsson, 2022) to examine whether such stimuli can be consciously memorised. Experimental designs could also include guided mental imagery or fMRI-based pattern analysis to trace reactivation patterns linked to prior tactile experiences. Additionally, researchers could investigate the role of emotional salience in enhancing or impairing the long-term recall of touch-related events.

Temporal dynamics and implicit transition

Affective touch memories are unlikely to remain in explicit awareness indefinitely. While explicit and implicit memory systems are distinct, emotional episodes may, over time, give rise to affective schemas that operate without conscious access (Gilboa & Marlatte, 2017). This transformation does not reflect a direct conversion but rather an experience-driven abstraction process. Future research could examine the temporal dynamics of this process, exploring how and when touch-related memories become less consciously accessible and how they continue to influence behaviour and emotional responses implicitly. To capture such dynamics, behavioural, neural, and psychophysiological methods should be combined.

Developmental designs may further help uncover whether and how memory for affective touch changes with age or relational context, especially during sensitive phases such as adolescence. Dyadic settings, such as naturalistic parent-child interactions (e.g., Crucianelli et al., 2019), could be particularly informative in tracing how touch-related experiences are encoded and retained over time. Longitudinal studies could track participants across different life stages to assess how early touch experiences shape emotional security and relational behaviours over time. This would provide insights into whether the effects of affective touch are retained implicitly and how they manifest in various social and emotional contexts.

Finally, individual differences such as attachment style, interoceptive awareness, or imagery capacity may play a critical role in modulating how affective touch is remembered and re-experienced. Investigating such moderators could help refine the theoretical framework proposed here and identify conditions under which affective touch exerts its long-term effects.

By investigating the explicit retrieval and potential implicit transition of affective touch memories, future studies can clarify the role of touch in memory processes and its impact on emotional and social development. This research could uncover fundamental mechanisms underlying how touch shapes long-term emotional well-being and interpersonal dynamics.

Practical implications

The potential memories formed through affective touch could have meaningful implications for clinical practice and parenting. In therapeutic contexts, not only could reconnecting with positive affective tactile experiences from the past foster emotional resilience and well-being, but recognising the absence of such memories might also provide valuable insights into current emotional and relational difficulties. For individuals facing attachment-related challenges or trauma, understanding how a lack of nurturing touch in early life may have contributed to present struggles could help inform tailored therapeutic strategies (Cascio et al., 2019; Carozza & Leong, 2021; Field, 2010; Morrison, 2016; Walker et al., 2017).

Clinicians might use this understanding to explore solutions that address these gaps in emotional development (Durana, 1998; Jakubiak & Feeney, 2017; Phelan, 2009; Tanzer et al., 2025). For example, interventions could include creating new positive tactile experiences within therapy or guided exercises to help clients build trust and safety in relational contexts. Such interventions might promote new associative links between tactile experiences and emotional safety, potentially reshaping existing memory traces through mechanisms akin to emotional reconsolidation or therapeutic reappraisal. By that, individuals may develop alternative emotional coping mechanisms and improve their capacity for intimacy and connection.

In parenting, affective touch is vital for fostering emotional security and resilience in children (Fotopoulou et al., 2022). Sensitising parents to the importance of nurturing tactile interactions could help them recognise how their caregiving practices shape their child's emotional development. Practical guidance might focus on integrating consistent, gentle touch into daily routines, such as during comforting or bonding moments, to establish a foundation for long-term well-being. Helping parents understand the potential long-term effects of both the presence and absence of nurturing touch could empower them to create environments that promote emotional health. Importantly, research suggests that the affective state of the caregiver may modulate the impact of touch. Mutual emotional attunement, rather than mere tactile input, appears to enhance the efficacy of nurturing touch (e.g., Crucianelli et al., 2019), possibly via dyadic regulation processes and oxytocin-mediated bonding (Uvnäs-Moberg et al., 2015).

Beyond caregiving and therapy, affective touch may also hold particular relevance for ageing populations and individuals experiencing social isolation or loneliness. Older adults often face reduced opportunities for interpersonal touch due to bereavement, institutional care, or diminished social networks. If affective touch memories contribute to emotional resilience and well-being, then targeted interventions, such as structured touch programmes in residential care settings, or training in self-soothing touch techniques, could represent a meaningful avenue for improving quality of life in these populations. Future research should explore whether the mnemonic properties of affective touch remain accessible across the lifespan and whether they can be therapeutically leveraged in contexts of social deprivation.

Final remarks

Affective touch has long been considered a fundamental component of early bonding, emotional regulation, and social development, yet its potential as a distinctive memory category has remained largely overlooked. By foregrounding the relational, embodied, and interoceptive dimensions of tactile experience, we argue that affective touch challenges dominant models of memory rooted in visual, verbal, or emotional salience. At the same time, recent null findings regarding the direct mnemonic benefit of CT-optimal stimulation (Convertino et al., 2025; Bregulla et al., 2025, preprint) caution against assuming a straightforward link between affective touch and memory enhancement, and instead underscore the importance of contextual, relational, and individual-difference factors in shaping whether and how tactile experiences become lasting memories.

Recognising affective touch as a meaningful and potentially long-lasting memory trace opens new theoretical and empirical avenues across neuroscience, developmental psychology, and clinical science. It invites a rethinking of how we conceptualise memory, not merely as the recollection of events, but as the enduring imprint of being felt, held, or emotionally met. Future research that takes this perspective into account may uncover new mechanisms of emotional development, resilience, and even therapeutic change, grounded not in language or images, but in the quiet memory of safe, embodied connection.

Table 1. Glossary of key terms

Term	Definition
Affective touch	Tactile stimulation that is typically slow, gentle, and perceived as pleasant and emotionally meaningful, most extensively studied in the context of CT-optimal stroking but also encompassing forms such as hugs, static pressure, and deep touch (McGlone et al., 2014).
Body memory	The cumulative imprint of past bodily experiences, including tactile, motor, proprioceptive, painful, and interoceptive traces, stored in memory (Gentsch & Kühn, 2022; Parma et al., 2024).
Bottom-up processing	Sensory-driven neural processing originating from peripheral receptors and ascending through subcortical and cortical pathways, here referring primarily to the CT-afferent pathway from skin to insular cortex.
CT afferents (C-tactile afferents)	A class of unmyelinated, low-threshold mechanoreceptors found in hairy skin that respond optimally to slow, gentle stroking at approximately 1–10 cm/s and project to the posterior insular cortex via lamina I of the spinal cord (Vallbo et al., 1999; Olausson et al., 2002).
CT-optimal stimulation	Tactile stimulation delivered at the velocity and pressure range that maximally activates CT afferents, typically slow stroking at 1–10 cm/s.
Episodic memory	A long-term memory system supporting the conscious recall of specific past events together with their spatiotemporal and emotional context (Tulving, 2002).
Interoception	The perception of the body's internal physiological state, including signals related to cardiac, respiratory, and autonomic functioning, processed primarily via insular cortex (Craig, 2002; Khalsa et al., 2018).
Pattern completion	A memory reconstruction process in which partial cues elicit retrieval of a full stored representation, supported by hippocampal recurrent networks.
Reconsolidation	The reactivation-dependent restabilisation of an existing memory trace, during which its content can be updated or modified before being re-stored (Nader et al., 2000).
Top-down processing	Cortically driven modulation of sensory processing by higher-order cognitive factors such as attention, expectation, prior knowledge, and emotional appraisal, mediated primarily by prefrontal-limbic networks.

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