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Cognitive Neuroscience: A Relationship among Social Touch, Human Behaviour & Human Lifespan

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Abstract: *In shaping social reward, attachment, cognition, communication, and emotional regulation from infancy and throughout life, social touch is a potent force in human development. In this examination, we look at the definition of social touch from both a bottom-up and a top-down standpoint. The C-touch (CT) system, a distinct submodality that mediates affective touch and contrasts with discriminative touch, plays a prominent function in the first category. In defining and understanding social touch, top-down effects including culture, interpersonal connections, environment, gender, and other contextual variables are also crucial. With particular focus on infancy and early childhood, when social touch and its neural, behavioural, and physiological contingencies contribute to reinforcement-based learning and have an impact on a variety of developmental trajectories, the crucial role of social touch throughout the lifespan is considered. The role of social touch in autism spectrum disorder, another example of disturbed development, is examined in the last section.*
Keywords*-Cognitive, reinforcement, interpersonal connections social touch submodalityetc*

I. INTRODUCTION TO TOUCH THAT IS DISCRIMINATORY VERSUS EMOTIONAL

We've studied the complex and varied innervation of the skin for nearly two centuries as well as the related perceptual sensations of touching or being touched, itching or being pricked, or feeling the sun's warmth[1]. Since its inception, perceptual experimental psychology has included the precisely quantifiable tactile acuity and discrimination phenomena of one of these sub-modalities. While the myelinated A-beta and A-delta fibres that mediate these discriminative aspects of tactile experience are essential for sensorimotor control and haptic exploration, they do not answer inquiries such, "What temperature of bath water feels the most relaxing?" or "Why does my partner's back rub sometimes make me feel at ease and other times make me angry?In other words, some of the most important somatosensory experiences in daily life—conveying emotive and socially meaningful information—do not speak to the fine-grained ability to discern physical aspects of touch [2].

In contrast to the straightforward nature of discriminative touch, affective touch spans a range from orgasmically pleasant to excruciatingly unpleasant, and is further complicated by its inextricable links to context, gender and sexuality, culture, and other individual, interpersonal, and intersubjective factors [3]. Recent evidence points to orthogonal somatosensory subsystems for discriminative and affective touch, and a sizable body of work has emerged describing and quantifying the affective touch dimension. Nonsexual, pleasurable affective touch that is social in nature and its function in human development are the main topics of the research in this issue of Developmental Cognitive Neuroscience. Within these limitations, social touch is discussed in this review along with higher-order interpersonal and social aspects that characterise it [4]. We also examine how social touch affects learning and development throughout the course of the human lifespan.

DEFINITION OF SOCIAL TOUCH

What is "social" about touch?The similarity between many realistic affiliative interpersonal touch's qualities and the particular tuning properties of low-threshold unmyelinated peripheral afferent fibres (C-touch, or CT fibres) has conveniently provided one method of operationalizing social touch [5]. These fibres react preferentially to slow, delicate strokes that resemble a gentle caress and to temperatures that are similar to those of human skin. Importantly, CT activation is associated with positive affect: psychophysical ratings of touch "pleasantness" and implicit measures of perceived pleasantness, such as activation of the zygomaticus major muscles (necessary for the upturning of the mouth seen in smiling), correspond closely to the firing frequency of these afferents. CT afferents are only found in hairy skin, but not the glabrous skin of the palm, which is so essential to discriminative touch. CT These characteristics help to distinguish the CT system between affective touch and discriminative touch [6].

The similarities between the effects of oxytocin release and CT-mediated touch on physiological arousal, pleasurable feeling, and prosocial interaction point to CT fibres as a likely mediator of endogenous

oxytocin (OT) release during affiliative and nurturing touch. OT, though important to the neurobiology of close social relationships, is only one component of a complex system [6]. The Brain Opioid Theory of Social Attachment (BOTSA), which emphasises that while the oxytocin/vasopressin social neuropeptides are essential for mate choice, parental behaviour, and other fundamental social functions in mammals, they fall short in explaining the more complex dynamics seen in primate social behaviours, is an integrative view. BOTSA expands the understanding that opioids are implicated in social reward and motivation to posit that OT, dopamine, and serotonin Increased MOR activity during social contact and naloxone's effects on social touch's reported pleasantness provide evidence that endogenous opioids mediate the rewarding quality of social touch [7].

This summarizes the fundamental difference between affective and discriminative touch systems: the type of touch mediated by the glabrous skin of the hand primarily conveys properties (i.e., shape, texture, etc.) of extrapersonal environment elements that are actively being explored with the hand. The CT system, in contrast, mediates passively received a touch from other persons and shares significant neural circuitry with affiliative reward and interception systems [8]. It is possible for CT-mediated touch to act as a link between extra personal stimuli and the intra-personal world of the self because of this overlap with interoceptive and emotional brain networks.

The glabrous skin of the palm lacks CT afferents, which have been dubbed a "social touch system" because they are so well suited for a socially meaningful touch. However, considering the crucial social roles that handshakes and holding hands serve in several cultures all over the world, the palm is obviously not excluded from social touch. Pet owners show lower blood pressure and less stress while caressing their animals, proving that even CT-targeted touch, supplied via glabrous skin, is pleasurable to both the giver and the recipient. Additionally, active social touch in the context of comforting a loved one in pain results in changes to physiological rhythms linked to empathy [9]: EEG mu wave suppression and inter-partner variability. Active social touch is thought to trigger the release of oxytocin (OT) and endogenous opioids, similar to receiving social touch. Active social touch is defined as the delivery of social touch to another human hand (i.e., "social haptic behaviour"), which is believed to trigger these changes. Therefore, tactile sensation mediated by CT afferents includes, but is not limited to, the hedonic value and affiliative effects of social contact. To provide a more thorough examination of diverse forms of social touch, researchers recently created a database to index a wide range of social touch events based on valence and arousal [10].

It is possible to compare the intricate interplay between several afferent nerve classes that results from reciprocal social contact to that of a chord made up of individual notes on a keyboard. Individual key presses result in pure tones, but key combinations can create chords that are somehow more than the sum of their parts and, crucially, cannot be broken down to the individual notes that made them up. This is similar to how various somatosensory receptor types combine to produce "touch blend" perceptions, such as the perception of wetness brought on by concurrent activation of tactile and thermal receptors. The skin innervated by CTs is also innervated by myelinated fibres, and the concurrent activation of both types of fibre, integrated and associated repeatedly throughout development, may ultimately be what works together to achieve the perception of pleasant, affiliative sensation.We have now examined social touch from the bottom (peripheral afferents)-up and are moving on to the top-down contextual elements that affect the definition of social touch [11]. Even while the CT system may serve as the main physiological foundation for social touch, higher-order elements like the interpersonal interaction and the social setting are crucial to the definition of social touch. Despite the fact that social or interpersonal touch can be represented in a wide variety of contexts, stimulus types, and delivery methods, we restrict our attention to two key contextual elements: 1) the partner in the exchange (i.e., "who" is delivering the touch), and 2) the purpose of the tactile stimulation ("why" it is being delivered").

A definite requirement for social touch is that it be interpersonal, [12] i.e., exchanged between conspecifics who have some sort of reciprocal relationship with one another, whether that relationship is close-knit and long-lasting or more fleeting or superficial. Studies have covered a wide range of topics, including assessing the behavioral impacts of casual touch between strangers in a brief interaction, like the effects of touch between a server and customer at a restaurant, and neuroimaging of sexual partners during intimate touch. Touch can be used to convey a range of emotions and to enforce compliance with requests, even amongst strangers. Social contact between close partners has a tremendous amount of power. According to a recent study, holding hands with a significant other boosted brain-to-brain connection [13], which mediated alleviation from a painful stimulus.

The perceived sex of an experimenter giving a sensual caress during an fMRI scan affected SI response, suggesting that SI may have a more significant role in social touch than was previously believed. This is in spite of the evidence arguing against a primary role for primary somatosensory cortex (SI) in affective touch [14]. This provides more evidence that the complex perceptual experience of social touch requires numerous coordinated somatosensory submodalities in addition to CT afferents. More research is required to understand the convergence and divergence of brain circuits for various forms of social touch and whether the

SI response would extend to emotive contact from a familiar person. It's interesting to note that the type of relationship we have with the other person affects how comfortable we are with social touch.

Research on touch in romantic relationships supports the function of the aforementioned brain reward systems as well as social neuropeptides. This type of romantic touch between partners also engages reward regions of the brain; response from these regions, such as ventral striatum and anterior cingulate cortex, is boosted by administration of oxytocin. Posterior insular responses to romantic caresses from a lover are modified by anticipation of the touch and sexual desire [15]. It's interesting to note that oxytocin's facilitation correlates negatively with subclinical autism features. Studies like these are essential to understanding the function of the lived experience of affiliative touch and its cumulative effects on social reward over the course of human relationships. These studies combine a rigorous experimental design with the ecological validity of a partner or other socially significant person to the individual.

The sensation of and neurological response to social contact are influenced by contextual elements in addition to the partners' identities and relationships with one another. The intensity of somatosensory evoked potentials in response to interpersonal contact varies depending on how the person applying the touch is feeling. Furthermore, bad smells can lower the perceived pleasantness and change how the insular and opercular cortices respond to affective touch, demonstrating that multimodal interactions affect the brain's response to social touch that are not just restricted to the visual system. Last but not least, touch can interact with far more nuanced and varied features of the context of the encounter, as in the case of an experimenter's touch relieving caused existential anxieties (i.e., fear of death). It's interesting to note that in this study, people with poor self-esteem specifically benefited from the social touch's anti-fear effects [16]. This intricate interplay between intrapersonal and extrapersonal elements during the touch encounter emphasises the complexity of contextual elements during the sense of social touch.

Vicarious touch and remote or "mediated" touch are two areas of research that show interpersonal touch does not always need to be direct to be social. In paradigms that simulate interpersonal touch, people who witness it rank CT-targeted caresses as more pleasurable than non-CT-targeted touch and display reactions in the posterior insular cortex, as if they were actually feeling the touch. In addition, the neural response to observing affective (interoceptive) and discriminative (exteroceptive) touch can be distinguished in a manner similar to that of actual touch, with the posterior insula responding to viewed affective social touch and secondary somatosensory cortex modulating with perceived intensity of viewed somatosensory stimuli [17]. According to recent research, seeing dyadic interactions that involve touch tends to focus the viewer's attention more on the scene's emotionally important details than watching interactions without touch.

In mediated touch paradigms, two persons can exchange touch from apart by using a gadget. While technology has made it easier to communicate across great distances by audio and visual means, applications for long-distance interpersonal contact are still in their infancy. Early research, however, has paved the way for the transmission of straightforward concepts and feelings via remote interpersonal contact, and these tools are expected to be crucial to the experimental study of social touch. Interpersonal touch can therefore be social even if it is only experienced by two other people or is transmitted indirectly between people using a gadget.

Is the interchange of touch between socially relevant conspecifics the only condition that defines social touch, or are there additional elements that are as crucial? A further possible criterion is communicative intent: does the contact communicate a specific message that qualifies it as relational, such as comfort, playfulness, caution, or sexual desire? Or is it possible to make it more practical, like when a parent supports a baby in a sitting position with one hand? While some forms of interpersonal touch may seem purely pragmatic on the surface, they frequently have underlying social implications that are reinforced by repetition throughout development [18]. For instance, in supported sitting, the primary goal of the physical contact is to support the infant's still-developing trunk muscles to keep him or her upright, but a secondary effect is that the infant learns implicitly that touch from a parent produces a good feeling. Extended periods of grooming evolved to establish, reinforce, and signal social bonds and hierarchies in the case of grooming, which is ostensibly a highly pragmatic and instrumental form of interpersonal touch. As a result, even a highly instrumental form of interpersonal touch like grooming is deeply rooted in communicative intent, both between grooming partners and to other members of the social group.

Given these connections between touch and implicit social or emotional corollaries, it would appear that the majority of interpersonal touch between individuals in any form of long-term relationship is social. Thus, it's possible that the only instances of interpersonal contact that could be deemed non-social are infrequent occurrences of unintentional, brief contact between strangers that has no behavioural consequence and no learned association, like an unnoticed, unintentional brush against the shoulder on a crowded tube. Accordingly, the huge field of social contact and its wider effects depend not only on the setting and interpersonal relationships, but also crucially on the developmental stage [19]. The neurological systems for processing the sense of social touch continue to develop and evolve over the lifespan, therefore the same social touch experience may have very different effects on an infant than an adolescent. Now let's look at how social touch evolves as people grow.

SOCIAL INTERACTION THROUGHOUT HUMAN HISTORY

In the first few months of postnatal life, touch is a critical "active element" in the development of secure attachment and the establishment of family ties. Touch is the first sensory modality to develop, serving as a "sensory scaffold on which we start to see our own bodies and our sense of self. Indeed, the reward value of social touch is so potent that it rivals drugs of abuse and may be protective against substance use disorder [20]. Indeed, social touch from carers is so consistently paired with rewards (i.e., comfort, nourishment) that it is a strong candidate for a pivotal mediator of Hebbian learning in the developing "social brain." The evidence demonstrating the function of social touch in reward learning during development is highlighted in the sections that follow. We also look at potential mechanisms by which inter-personal touch may affect brain and behavioural social development over the course of a lifetime.

1.Prenatal and postnatal

Even during pregnancy, it is possible to notice how social touch develops. Comparatively to those in the second trimester, foetuses respond to maternal touch on the mother's belly by exploring the uterine wall more tactilely and touching themselves less. A fascinating theory states that the rhythmic stimulation of lanugo hairs during foetal movement via the amniotic fluid stimulates CT fibres and causes a social priming effect in the foetus through the production of oxytocin. If the foetus finds these in utero tactile experiences pleasant, it follows that the vestibular sensation brought on by movement through the amniotic fluid may work as an additional reinforcer, adding to the comfort that newborns experience while being rocked, bounced, or swayed [21]. For both humans and mice, mother carrying of distressed infants reduces crying, body movements, and heart rate in addition to the (also considerable) effect of maternal holding alone. This is evidence in favour of the hypothesis of prenatal vestibular input and its consequences in neonates. This combination of tactile, vestibular, and proprioceptive stimulation in the context of parental comfort in a positive feedback loop may be a potent mediator of associative learning that predisposes the brain to respond to social rewards. Additionally, the calming effect produced a positive feedback cycle of decreased infant movement and increased ability for mothers to carry the pups. Some researchers found that tactile and kinesthetic stimulation had a substantial impact on a number of variables, including birth weight, body temperature, respiration, and eating behaviour, in a study that examined the effects of such stimulation in 12 premature infants. While thorough cross-cultural research is lacking, a study comparing Italian and West African mothers reveals that different cultures may employ tactile stimulation more frequently than kinesthetic stimulation to calm young children [22].

2.Infancy

The importance of social contact in early development is strongly supported by evidence, and early experiences with touch have extraordinarily long-lasting effects on the growing brain. The amount of physical contact between parent and child varies depending on the raising technique in prairie voles, a monogamous species of rodent with an extremely affiliative social structure. In comparison to children of high-contact parents, those of low-contact parents exhibit increased aggression and a reduced stress response to social isolation. The patterns of brain connectivity in children of parents with high vs low contact styles also differ significantly [23]. Maternal licking and grooming has been shown to have long-term, epigenetically mediated impacts on cognition, social behaviour, and stress reactivity in rats during a sensitive phase that lasts for the first postnatal week. Male offspring raised by high contact dams exhibit more inquisitive behaviours in novel environments, are less sensitive to stress, and perform better on cognitive tasks. These extensive, epigenetically mediated influences on development have also been researched more thoroughly in relation to crucial human social and physical environmental windows.

Touch communication is used in 65% of face-to-face contacts between mothers and children in humans, and it is linked to immediate decreases in both behavioural and physiological stress responses. Additionally, the nature of the touch is important. For example, infants as young as 9 months show decreased heart rate and increased engagement in response to pleasant, CT-targeted touch, and there is apparent observational evidence that when parents stroke their infants, they naturally adopt a speed of touch consistent with CT stimulation.

Longer temporal horizons also reveal the advantages of touch in infancy. In healthy newborns, skin-to-skin contact produces analgesic effects. In preterm infants, skin-to-skin contact encourages weight gain, shorter hospital stays, and stronger neurological responses [24]. Between 6 and 10 months, the anterior prefrontal cortex starts to respond to gentle touch that is not CT-targeted (delivered to the palm), which is associated with higher oxytocin levels in parents and effects on later social-emotional behavioural issues in children that are linked to maternal prenatal anxiety. In addition to playing a definite part in the development of affective attachment, carer touch combined with concurrent speech is crucial for infants' development of receptive communication because it helps them recognise word boundaries. According to this study, words that are regularly associated with carer touches are often among the early vocabulary terms. Even infants as young as 5 months old use touch to express their emotional states to their mothers, even though the majority of the study to date focuses on infants as

recipients of social contact. The fact that 6-month-old babies of mothers with depression exhibit greater self-touch than controls, which is thought to be a compensatory behaviour for their mothers' decreased pleasant touch, emphasises the crucial significance of parental touch even more. Suckling stimulation activates cerebral reward systems to a greater extent than cocaine administration, according to fMRI studies in nursing dams, and this effect is probably mediated by oxytocin. Therefore, there is a reciprocity and an active component of social touch experience even in the first few months of life, which impacts social, communication, and cognitive development in the months and years to come [25].

Although touch frequency is the aspect of affective touch that is most frequently taken into account when predicting results, future research may want to incorporate more complex metrics to explain greater variability in these results. For instance, theoretical explanations of the function of affiliative touch suggest that it aids in the development of social relationships and/or lessens unpleasant impact. Then, in this situation, it won't necessarily be that simply increasing social contact will be good for growth; instead, it will be that functional social contact in response to a demand condition will produce superior results. It has been established that the emergence of a synchronous bond between a baby and a carer is a key indicator of subsequent social development. Children have been proven to be skilled at making social bids when desired and disengaging attention when satiated. This process involves the infant and carer engaging in a natural interchange of engagement and disengagement [26]. It has been demonstrated that parent-infant synchrony is a crucial precursor to the development of attachment, attachment security, self-regulation abilities, symbolic competence, and cognitive abilities.

Inadequate early social-sensory input during infancy has serious long-term developmental repercussions. Infants who avoid or are denied touch from carers are more likely to experience sensory processing issues including oversensitivity. The autism spectrum disease in older children is also predicted by infant social avoidance. Avoidance of social touch in this instance suggests that the infant does not find it enjoyable or rewarding, which could have important cascade repercussions on the social brain's development. Broadly speaking, altered touch perception in infancy, which consists of two distinct mechanosensitive systems (fast A-Betas and slow CT), may have an impact on the sensory framework on which the perceptual distinction between self and other is built, further influencing social responses and abilities throughout development [27].

3.Young childhood and toddlerhood

Beyond infancy, social touch continues to affect brain development. As newborns grow older and become more mobile as toddlers, the repertoire of parent-child touch broadens to include more pragmatic touch types including support and postural realignment as well as more intricate and frequent grooming touch [28]. From an evolutionary anthropological standpoint, the significance of grooming in maintaining monkey social bonds has been emphasised. It is presumably mediated by the reinforcing qualities of touch-related oxytocin and endogenous opioid release. Family dynamics are influenced by touch, and in the nuclear family, touch is the main predictor of children's long-lasting good emotional expression. The people and environments that surround social touch are always changing when a child is growing up. The crucial importance of touch during the transition to toddlerhood and preschool extends beyond carers and close relatives to encompass teachers and classmates. Children receive tactile input from fewer people and in fewer circumstances than when they were very young as they become older and more independent.

The social aspect of play is crucial. In rats and many other mammalian species, young people participate in rough-and-tumble social play, which can lead to a conditioned preference for a particular location. Physical play and tickling have a strong neural connection and both reflect positive affect through the endogenous opioid-mediated reward system. According to a recent study in humans, the degree of connection between the posterior superior temporal sulcus and other nodes in the social brain was correlated with the frequency of maternal touch during a play session between mothers and their five-year-olds [29]. Given the current climate of anxiety surrounding any tactile engagement with infants, it seems especially crucial to emphasise the benefits of healthy social touch in early development. Giving kids the freedom to request touch, allow it when they want it, and refuse it when they don't will probably have favourable developmental effects. To facilitate this while keeping kid protection considerations in mind, more study is required.Although this type of social touch has received far less research, there is evidence that it has behavioural consequences on children's behaviour. A youngster is more likely to delay pleasure by agreeing with the request to wait for permission before consuming a piece of candy if the experimenter is friendly to them. Positive, contingent contact from teachers has been shown to improve on-task behaviour and reduce disruptive behaviour in young children in the classroom.

Last but not least, the pattern of neural responses to CT-targeted touch appears to be the same in school-aged children as it does in adults, with the posterior insula and posterior superior temporal sulcus reacting in younger children. Between infancy and adulthood, the intensity of the response seems to increase with age, which may indicate that the brain's circuitry for social touch continues to mature[30].

4.Teenage years and adulthood

Children's tactile social environments continue to mould their brains and behaviours as they approach sexual maturity and begin the transition to adulthood. The development of sexuality and romantic desire during this stage has a significant impact on how people respond to social touch. Interpersonal contact between adults reveals gender asymmetry, in which males are more likely to touch females than vice versa, but not with children. While discriminative touch skills go worse as we get older, the subjective pleasantness of CT-targeted touch keeps getting better all the way into our ninth decade of life [31].

Social contact has effects on teenagers and adults that go beyond those that are directly related to romantic or sexual relationships. Contrary to non-CT-targeted touch applied by the same researcher, non-romantic CT-targeted stroking touch engages brain networks involved in social cognition and reward more generally. In healthy persons, the response to light arm stroking in the superior temporal sulcus and orbitofrontal cortex is adversely correlated with subclinical autism symptoms [32].

The sentences that came before described social touch during normal development, but they did not discuss how people with developmental impairments vary. Although social touch research in developmental impairments is still in its infancy, new studies have begun to paint a picture of impaired social touch in autism spectrum disorder (ASD) [33]. ASD is a developmental disease that manifests in very early childhood and lasts the whole of a person's life, having an influence on relationships and reciprocal social behaviour. A key aspect of the disease is aberrant sensory response, and impaired touch sensitivity is highly correlated with both social and nonsocial symptoms. So, now that we've discussed the junction of low-level sensory impairments and higher-level reciprocal social behaviour, let's discuss recent research on social touch perception in ASD.

AUTISM AND ABNORMAL DEVELOPMENT: SOCIAL INTERACTION

Here, it is proposed that autism spectrum disorder is particularly important to the effects of social touch on the developing brain and the results of its altered trajectory in childhood [34]. Both defective tactile discrimination and defensiveness to mild touch are seen in animal models of ASD, and these behaviours have developmental repercussions on social behaviour. Children with autism display abnormal behavioural reactions to touch that are closely related to both the main clinical manifestations of the disorder and to biomarkers like distinct epochs in the white matter pathways of the somatosensory nervous system and genetic variants that improve serotonin transporter function. Children with autism react defensively to both pleasurable and painful affective touch from experimenters in more severe ways in CT-innervated somatotopic regions (arm and face) than in non-CT-innervated regions (palm). In children with autism, the neural responses to CT- and non-CT-targeted touch are directly compared. This analysis reveals a dichotomous response, with primary somatosensory cortex responding more favourably to non-CT-targeted touch and widespread social-affective brain networks less favourably to CT-targeted touch [35].

These findings collectively suggest that social touch is altered in autism, while it is yet unclear how the diverse neurological and behavioural responses to social touch in people with autism interact with hyper- and hypo-responsiveness. Both hypo- and hyper-responsiveness to social contact may lead to decreased input (naturally occurring or as a result of defensive/avoidance behaviours), which may affect the course of the social brain's development beginning in infancy [36]. These changes are expected to have significant implications given the fundamental significance of social contact for infant development of safe attachment, cognitive and language development, social reward, and emotion regulation. The development and improvement of early intervention strategies based on sensory aspects offers considerable promise for a better understanding of these sensory-social developmental consequences.

II. DISCUSSION & CONCLUSIONS

The elements that we have emphasised in this review paint a dynamic, integrative, and deeply established picture of the developmental nature of social touch as processes that mould the developing brain and, ultimately, adult behaviour. In the initial stages of pre- and neonatal life, social touch serves as an intense and important method for associative learning and affiliative connection. However, as people age, social touch becomes a part of an integrated multisensory environment. The perceptual sense of social touch is altered by changes in mobility, independence, expanding areas of social influence, sexual maturity, and ageing. This particular perceptual experience is the end result of numerous overlapping integration processes. Converging information from various afferent classes, with CT afferents playing a key role, is regularly coupled over time with physiological and psychological processes that elicit emotions of comfort, security, and contentment at the neurobiological level. These peripheral mechanisms and the accompanying pathways in the central nervous system act as effectors of more extensive neurobiological systems, such as the oxytocin and mu-opioid systems, which respectively mediate the reinforcing aspects of more basic and sophisticated social bonding. These systems all interact with top-down contextual elements, such as the nature of the relationships, culture, and

social context, to build a highly flexible platform in which the rich affective information transmitted through the skin exerts a significant influence on behaviour over the course of a lifetime.

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