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ORIGINAL ARTICLE

Perspective: Early Development of Memory Schema of Closeness in Social Relationships

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Abstract

When, how, and why do humans come to distinguish between close, significant others and more casual social contacts? Although a healthy social life encompasses diverse relationship types, close relationships are consistently perceived as qualitatively distinct, characterized by frequent interactions, time spent together, predictability, long-term stability, and reciprocal emotional engagement. Cognitive social neuroscience specifies these features, yet key explanatory domains, including relationship cognition, attachment-based internal working models, and memory processes, remain in relative isolation. The current study proposes a novel perspective of how the foundational distinction between "close" and "casual" relationships may emerge. By integrating perspectives from cognitive social neuroscience, developmental psychology, and memory research, this framework advances a unifying account of relational categorization. We argue that early interactions with primary caregivers in infancy not only establish specific attachment bonds and, consequently, internal working models but also give rise to a highly abstract, domain-general memory schema of relational closeness. We suggest that this generalized schema constitutes a fundamental component of the knowledge systems supporting the formation and maintenance of our most important, close relationships throughout the lifespan.

Keywords Social-cognitive development · Primary caregiving · Attachment · Close relationships · Casual relationships · Memory processes · Abstraction · Memory schemas

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Introduction

Great things are done by a series of small things brought together.

Vincent van Gogh

Cognitive neuroscience, social neuroscience, and psychology actively explore the principles that govern how people relate to one another and why some individuals experience chronic interpersonal difficulties, such as loneliness or disruptive relationships with partners and children.

In our complex social life, close relationships are the most important to us. The literature describes them as enduring, emotionally significant interpersonal bonds marked by mutual interdependence, frequent interaction, and cognitive–affective involvement of the self and the other with long-term prediction. Whereas casual or instrumental relationships are relatively transient, they include low-intimacy interactions organized around specific goals, roles, or resources, with minimal emotional investment or mutual self-other involvement (Aron et al., 2004; Krienen et al., 2010; Lieberman, 2013).

Recent functional neuroimaging studies investigating the neurobiology of social closeness in adulthood further suggest that close relationships and more casual social ties may involve partly distinct neural and cognitive processes. Interactions involving close others appear to be processed more rapidly and are associated with stronger self-related processing, implicit knowledge, and intuitive judgments. In contrast, interactions with more casual social partners tend to rely more strongly on deliberate cognitive evaluation of social information (Roseman et al., 2022). These findings suggest that we also learn about and manage distinct categories of relationships differently.

Humans are not passive recipients of social skills; rather, research indicates that we are born with a natural inclination toward sociality and must actively learn to relate to others (Lieberman, 2010). Numerous studies have therefore focused on prenatal development and infancy to elucidate when and how people begin to relate to others. Both periods are associated with rapid brain growth, and infancy is also characterized by rapid social development. Moreover, a substantial body of research demonstrates that early experiences influence social functioning across the lifespan (Müller et al., 2019). Within this literature, the role of primary caregiving is understood to be central for the development of healthy social functioning (Tottenham, 2020). Empirical research has extensively examined the consequences of early adversity for socioemotional and relational functioning in later life. In particular, studies have investigated the effects of the absence of a consistent primary caregiver during infancy and early childhood (Champagne, 2010; Müller et al., 2019; Gunnar, 2020). For example, research on children who spent their first months or years in institutional settings without a stable caregiver has demonstrated alterations in neurobiological development and long-lasting impairments in the ability to form and maintain social relationships (Tarullo & Gunnar, 2005; Tottenham, 2012; Winnette, 2022).

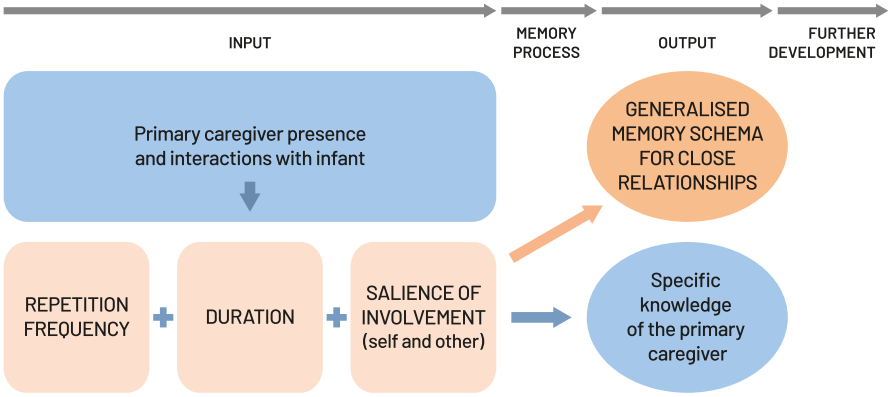


Fig. 1 Figure 1 Illustrates how the abstracted sense of closeness as a distinct characteristic of relationship with care givers during early socio-emotional and relational development may be encoded as a memory schema

Early social development's impact on our lives is most often discussed in the context of attachment theory, which emphasizes the importance of early attachment relationships for the development of internal working models. This framework highlights the role of the quality of maternal (primary caregiver) care, the experience of safety in attachment relationships, and the emotional regulation provided by the attachment. According to Bowlby, once the internal working model is established, it tends to remain relatively stable and influences how individuals perceive and manage their social relationships throughout life (Bell, 1970; Bowlby, 1951, 1958, 1960; Jones, 1970). Another influential framework is object relations theory, which proposes that infants organize their experiences of self and others into internal object representations that shape later interpersonal functioning. Development involves the gradual integration of initially split representations—for example, "good" and "bad" objects—into more coherent views of self and others. Those views serve as a "road map" for further social life. Disturbances in early relationships may therefore lead to unstable or fragmented representations of self and others, potentially contributing to difficulties in intimate relationships later in life (Kernberg, 1976; Klein, 1946, 1957; Teyber & Teyber, 2017; Winnicott, 1965).

At the same time, developments in memory research have introduced the concept of memory schemas. A memory schema, as conceptualized by Ghosh and Gilboa (2014), is a multidimensional, dynamic knowledge that emerges from the integration of multiple interrelated experiences. It encodes commonalities across episodes, enabling abstraction and generalization, and omits details of individual events. Such schemas are inherently associative and relational, linking perceptual, conceptual, and contextual elements, and can also incorporate affective components, such that emotions become embedded within and influence the structure and retrieval of the schema (Ghosh & Gilboa, 2014).

Problem Statement

Despite substantial research on early social development, an important conceptual gap remains. Existing theories primarily explain the emotional dynamics and expectations that emerge from early caregiver relationships, but they do not explicitly address how individuals acquire complex abstracted knowledge about different types of relationships. In particular, neither attachment theory nor object relations theory explains how individuals come to recognize and classify relationships as belonging to qualitatively different types of categories—for example, distinguishing close relationships from more casual or peripheral social ties. Although neuroscience research increasingly suggests that close relationships and casual social interactions involve distinct cognitive processes and brain structures, the developmental mechanisms underlying how and when individuals learn these relational categories remain insufficiently understood.

Purpose of the Study

The purpose of this study is to propose a new integrative perspective on how categorical knowledge of relational closeness may emerge from very early social learning. Drawing on cognitive social neuroscience, developmental psychology, and memory research, it proposes that repeated, emotionally salient interactions with primary caregivers give rise not only to specific attachment bonds but also to a generalized memory schema of relational closeness. Through these interactions, infants' memory system may abstract recurring relational features—such as predictability, proximity, and affective attunement—forming a multidimensional, affectively laden template of what constitutes a "close" versus "casual" relationship category.

Building on this account, I propose that this specific memory schema subsequently guides how we form, maintain, categorize, interpret, and manage our diverse social relationships, especially close ones, which are a core component of mental health. The following section reviews key findings from social cognitive neuroscience, developmental psychology, and memory research that inform this perspective.

Literature Search and Selection Strategy

The present review adopts a targeted, interdisciplinary approach to identify literature relevant to the development of memory-based representations of close relationships. Studies were selected from three primary domains: (1) social cognitive neuroscience of relationships, (2) developmental psychology with a focus on early social experience and caregiver–infant interactions, and (3) memory research, including both adult and infant memory systems. The search strategy prioritized peer-reviewed empirical studies and influential theoretical contributions that address mechanisms of social cognition, early learning in caregiving relationships, and memory processes. Seminal works were included to provide conceptual grounding, alongside recent studies to reflect current advances in the field.

Studies were excluded if they were narrowly focused on domains not directly informative for the integration of relational and memory processes or if they lacked clear implications for early social developmental mechanisms and their impact on socio-emotional functioning later in life. Given the interdisciplinary scope, the review is inevitably not exhaustive but instead aims to provide a theoretically coherent synthesis of key findings that inform how generalized representations of close relationships may emerge in infancy.

Relationships

> *"A social relationship is an emergent quality from repeated interactions."* (https://dictionary.apa.org/social-relationship)

Hierarchical Social Lives and the Specific Role of Close Relationships

Our identity develops in the social world, especially with those closest to us (Lieberman, 2013). Anthropologist Robin Dunbar and his colleagues found that human groups naturally structure themselves into a hierarchy of interlinked social networks: families, bands, communities, and tribes or clans. These subgroups are arranged by and reflect the distance between self and others (Dunbar, 1998). According to these studies, we typically have a circle of 150–250 social ties, within which we have circles of more or less casual connections but only 3–5 unique, *close relationships* (Dunbar, 1998; Kelley et al., 1983; Shultz & Dunbar, 2014). Typically, these relationships involve parents, children, partners, and best friends (Shultz & Dunbar, 2014).

Research indicates that a large volume of the neocortex is involved in managing our relationships every minute of our lives (Dunbar, 1992; Kanwisher, 2017; Shultz & Dunbar, 2014). Historically, scientists assumed that the brain evolved by dealing with factual issues, developing tools, and responding to environmental demands. In his social brain hypothesis (1998), Robin Dunbar proposes that brain regions for social cognition evolved and expanded because it was adaptive to have the capacity to manage our social life within groups (Dunbar, 1998, 2008, 2009). He argues that group members must meet their needs and deal with others' behavior, which requires practical social skills (Dunbar & Shultz, 2007). However, it appears that most of the brain's capacity for social cognition may be devoted to managing our few closest relationships (Shultz & Dunbar, 2006). While the larger circle of casual social ties is involved in trading, defense, exploration, and use of resources (Alexander, 1974; Dunbar, 1998), the small number of intimate relationships we have are associated with closeness, strong self-involvement, emotional bonds, and frequent interaction (Andersen & Chen, 2002; Brown & Brown, 2006; Dainton et al., 2003; Kelley et al., 1983). Bonded relationships also involve a sense of belonging and stability over time and across changing contexts (Baumeister & Leary, 1995). They are recognized as unique and are not interchangeable with other ties (Ainsworth, 1989; Roberts et al., 2014). Forming and maintaining close relationships necessitates a significant mental and emotional investment. The literature shows that the more time social partners

invest in their relationship, the stronger their emotional bond may develop. Such frequent, affective interaction demands more neural activity and leads to specific changes in memory systems (Hill & Dunbar, 2003; Roberts & Dunbar, 2011; Sutcliffe et al., 2012).

A recent study by Roseman et al. (2022) examined how close and casual relationships are represented by distinct neural circuitry. In this study, participants compared how they felt about members of their social groups. The fMRI showed that brain areas activated for processing close relationships included the temporoparietal junction, middle temporal gyrus, precuneus and dorsomedial prefrontal cortex, and the default mode network A. Different brain parts, including the medial temporal lobe, retrosplenial cortex, ventromedial prefrontal cortex, and the default mode network C, were activated for casual social ties. Researchers also found a strong correlation between brain responses to close relationships and small spaces, such as a room or a household. Conversely, they found a strong correlation between brain responses to casual relationships and large spaces, such as a town or region. Moreover, reaction time was significantly shorter when people thought of their "close" people. These results indicate that maintaining relationships with a few close people is a different task for the brain than managing casual relationships. This finding suggests the unique and significant role that close relationships play in our lives (Roseman et al., 2022). For example, the absence or disruption of close relationships is a primary determinant of loneliness, defined as a perceived discrepancy between desired and actual relational closeness (Hawkley & Cacioppo, 2010; Perlman & Peplau, 1981). Loneliness and social isolation belong to major issues in mental health.

Early Social Development and Internal Working Model

> *"As the baby grows into the child and the child eventually into the adult, exploring and explaining what transforms as the individual develops from infancy to maturity and what remains stable and predicts the future person has constituted challenging tasks for philosophy, biology, and psychology."*
>
> *(*Bornstein, 2014*, p.122)*

Attachment Theory

Human brain development is exceptionally long and slow compared to our closest relatives, the non-human primates (Thompson & Nelson, 2011). Researchers hypothesize that prolonged development allows humans to learn how to function best in their environment, and a slower maturation process allows for better overall functioning in adulthood (Cahalane et al., 2012; Tottenham, 2013). Taken together with the social brain hypothesis, this means that about 25 years of human brain maturation are required to manage the environment and the complexities of social life within our network of relationships. This long maturation process requires unique long-term

support and assistance from caregivers in many areas, including nutrition, nurturing, and protection. Gaining the ability to relate to others requires extensive experience in social interaction. Some core qualities of social interaction in infancy are believed to develop further in childhood and adolescence, and to remain stable and predictable throughout the lifespan (Bornstein, 2014; Kontra et al., 2012; Piaget, 1952). The most salient social experiences for infants and children are interactions with their parents or primary caregivers and attachment to them.

Attachment theory has been one of the most influential models of the role of parenting (caregiving) in social development (for review, Rholes & Simpson, 2004). Bowlby emphasized that infants and young children are intrinsically motivated and genetically prepared to interact with their mothers and develop attachment ties. Furthermore, Bowlby believed that attachment requires the mother's presence and that disruption of maternal care through deprivation or loss severely impairs a child's development (Baker & Brandell, 2013; Waters et al., 2002). Infants feel distressed when separated from their caregivers and experience a sense of safety and comfort when reunited. Offspring thus follow the caregiver and seek safety when they feel threatened (Bowlby, 1951, 1958, 1960). He also argued that infants and young children learn about the quality of attachment relationships with their mothers from their close bonds and repeated interactions.

The concept of the *internal working model*, consequently introduced by John Bowlby, refers to a set of cognitive–affective representations that individuals form about themselves, others, and relationships based on early attachment experiences. The internal working model develops through repeated interactions with primary caregivers and encodes expectations about the mother's (primary caregiver) availability, responsiveness, and self-worth. Once established, they function largely implicitly, guiding perception, emotion regulation, and behavior in later relationships. For example, consistently responsive caregiving tends to produce a model of the self as worthy and others as reliable (secure attachment), whereas inconsistent or neglectful care may yield expectations of rejection or unpredictability (insecure attachment). Importantly, these models are not fixed; they can be updated across development through new relational experiences, though they tend to show continuity over time (Bowlby, 1973; Fraley, 2019; Main et al., 1985; Pietromonaco & Barrett, 2000).

In developmental psychology, attachment to a caregiver is considered essential for relational development (see Dozier et al., 2012, for a review). For example, Myron A. Hofer describes attachment as an umbrella term for many interwoven processes that develop in parallel or separately and work together to serve a higher function, the generalized attachment behavior system (Hofer, 2006). Hofer also suggests that physiological regulatory systems, first developed in the interaction between infant and mother, are one of the traits that continue into adulthood (Polan & Hofer, 1999). Research in mental health shows that adults who learned in childhood that relationships are safe, communicate effectively, resolve conflicts and crises, discuss painful issues in a regulated way, and are less inclined to suffer from mental health issues (Gillath et al., 2016; Mikulincer & Shaver, 2017).

Object Relations Theory

Object relations theorists, Melanie Klein, Margaret Mahler, D. W. Winnicott, and Otto Kernberg emphasize that early interactions between infants and primary caregivers are internalized as enduring mental representations of the self and others. These internalized "object relations" function analogously to cognitive schemas, organizing affective and interpersonal expectations that guide subsequent relational patterns across development (Teyber & Teyber, 2017). Klein highlighted the infant's early phantasy life and splitting processes in structuring internal objects, whereas Mahler focused on the separation–individuation process through which a differentiated self emerges in relation to caregivers. Winnicott introduced the concept of the "good enough mother" and transitional phenomena, underscoring the facilitating environment necessary for healthy self-development, while Kernberg extended object relations theory to personality organization, particularly in the context of borderline pathology. Collectively, these theorists agree that early relational experiences crystallize into internal working models that provide implicit "road maps" for expectations, emotional regulation, and behavior in later relationships (Sroufe, 2005; Teyber & Teyber, 2017).

How the Proposed Concept Addresses a Gap in Existing Knowledge

A central point of divergence between the present proposal and both attachment theory and object relations theory, including the concept of internal working model, concerns the level of abstraction and functional role of the underlying mental representations.

In attachment theory and object relations concepts, internal representations are understood as relationship-specific models of the self and others, shaped through early interactions with the primary caregiver. These representations organize expectations, affect regulation, and interpersonal behavior. Both traditions emphasize the centrality of experienced safety, whether conceptualized as a secure base in attachment theory or as the internalization of reliable, containing objects in object relations, in shaping these models and guiding expectations of protection, responsiveness, and emotional regulation.

By contrast, the present perspective proposes that early experiences give rise to a generalized memory schema of relational closeness that operates at a higher level of abstraction.

This specific schema captures recurring structural and affective regularities across interactions between the infant and primary caregiver, including frequency, predictability, proximity, attunement, and emotional intensity. This abstraction enables the categorization of relationships into qualitatively distinct types (e.g., close versus casual ties). Thus, whereas attachment theory and object representations explain how individuals expect particular relationships to function, the proposed framework explains how individuals come to organize and classify relationships more broadly.

In this way, the proposed model complements existing theories by introducing cognitive-neuroscientific mechanisms of abstraction and generalization that link

early, repetitive interactions with primary caregivers to the formation of relational categories.

Next, I will review the literature on memory research and explain how the current knowledge of memory processes may support the current perspective.

Role of the Memory System

> *"We depend on memory for thinking, learning, decision-making, and interacting with other people. When memory is disrupted, these essential mental faculties suffer. Thus, memory is the glue that holds our mental life together." (*Kandel, 2018*, p.107).*

Brief Overview of the Memory System in Adulthood

We are who we are because our genetic program and learned experience combine in a flexible, complex memory system. Learning encodes information from experience and results in lasting changes in our neural system and behavior. Memory stores and retrieves this encoded information. Memory maintains our sense of self, personal identity, and relationships with others (Kandel, 2008; Winslow, 1886). Different brain structures manage different types of memory. Short-term (working) memory stores information for a few minutes for immediate use, while long-term memory stores information for days, months, or lifetimes (Goldstein, 2015). Long-term memory encodes and processes declarative (explicit) types of information and non-declarative (implicit) information (Squire & Wixted, 2011).

Declarative memory includes episodic memory, which involves personal memories about what happened, when, and where it happened (Moscovitch et al., 2016), and semantic memory, which involves meanings, generalized knowledge, and concepts.

Nondeclarative memory refers to several memory functions, including skills, habits, associations, conditioning, priming, habituation, sensitization, and perceptual and emotional learning. Nondeclarative memories are acquired through unconscious learning and do not require effortful retrieval (Squire & Wixted, 2011). They are central in orienting our response to the world: they drive our likes, dislikes, and preferences without conscious awareness. They convey events and social communication (Howieson, 1996). For example, the sound of a lullaby, which we repeatedly heard as children, evokes relaxation, the evening, and a good night's sleep.

Recent studies of memory reveal that remembering the past is necessary for predicting future events and for imagination. Neuroscientists have found that prediction involves activating the same neurons that were active when the original, relevant memories were encoded (Schacter et al., 2007). For example, when we think about seeing our mother next weekend, our memory automatically predicts how the upcoming experience may go based on our prior experience with her. These experiences may go deep into our history, including those from early childhood.

Here, I focus on two types of learning, as they represent systems that use information gained from repetitive experiences to create generalized knowledge.

Statistical Learning

Statistical learning is understood to be part of non-declarative memory processes in the hippocampus and neocortex. For example, when we regularly go fishing with our father, we encode that we go to the river together on Sundays (episodic memory). Over time, we learn that the river is near the railway station and how far it is from home (statistical learning) (Schapiro et al., 2017). Our brain identifies repetitive regularities in our experience and encodes these patterns. Statistical learning is essential for associative learning and for processing perceptual, motor, cognitive, and social skills on a daily basis. For example, learning a language requires recognition of patterns in speech. Research shows that statistical learning is intensely active in infancy and throughout life (Kuhl, 2004; Schapiro et al., 2014, 2017).

Memory Schema

One specific type of long-term declarative semantic memory is a memory schema. Ghosh and Giloba (for review Ghosh and Giloba, 2014) describe memory schemas as higher memory structures that develop over a long period through repetition and contain abstract generalizations distilled from many previous experiences. While the specific incidents that formed schemas may not be preserved, memory schemas capture the essence, the core meaning, of many similar experiences. Consolidated schemas function as a context that influences what we pay attention to, how we interpret the world, and how new memories will be encoded and retrieved (Sommer, 2017). In this way, they guide our choices and behavior (Ghosh & Gilboa, 2014). For example, after many visits to different swimming pools, we encode abstract qualities of swimming pools and our experiences there that apply to all of them, and our memory system creates a categorical memory schema of what a swimming pool is and of being at a swimming pool. This schema is multidimensional and dynamic. It encompasses smell, being in the water, taking a shower, and hearing typical sounds of splashing water. Then, when a friend invites us to go swimming at a pool together, even though we have never been to this particular pool, we know what it is like, how it feels, and what it looks like being in any swimming pool, and we can make a decision based on that schematic abstracted knowledge.

Brief Overview of Memory Systems in Infancy

> *"During early ontogeny, the rapid and cumulative acquisition of world knowledge contrasts with slower improvements in the ability to form detailed and long-lasting episodic memories. (...) During this period, recognizing regularities, forming stable representations of recurring episodes, predicting the struc-*

*ture of future events, and building up semantic knowledge may be prioritized over remembering specific episodes." (*Keresztes et al., 2018*, p.1).*

Declarative Memory in Infancy

Research suggests that learning in infancy involves acquiring fundamental knowledge that we will use throughout our lifetimes, such as speaking our mother tongue, walking, manipulating objects, approaching problems, and forming social bonds. We learn all this critical information and remember almost no episodic memories from infancy and early childhood (Ellis et al., 2021). Instead, infants encode and retrieve semantic memories, or "memory schemas" (Gilboa & Marlatte, 2017; Tulving, 1972).

According to many studies, declarative episodic memory is fairly limited at the beginning of life and increases significantly in childhood, around the age of seven to eight (Fivush, 2011; Ornstein & Haden, 2001). The absence of episodic memories from early childhood, known as infantile amnesia, has been widely studied and discussed; however, the reasons remain unclear. Josselyn and Frankland (2012) propose that rapid hippocampal neurogenesis in the early childhood of humans, nonhuman primates, and rodents correlates with the inability to form long-term episodic memories (Josselyn & Frankland, 2012; Ramsaran et al., 2019). Albernini and Travaglia (2017) suggest that the memory system is ready to encode only developmentally appropriate experiences. They propose that the hippocampal region is actively involved in processing and storing certain types of infantile memories and that these shape the further development of cognitive functions. This may explain the paradox that hippocampal learning is active in infancy, but episodic memories are unavailable later in life. I explore these hypotheses later in this section.

Non-Declarative Memory in Infancy

Several studies indicate that memory systems responsible for encoding and storing nondeclarative (implicit) memories are present from birth and do not significantly improve after the first three months of life (Schneider & Pressley, 2013). Implicit learning comprises multiple processes, such as priming, emotional learning, conditioning, statistical learning, and the development of mental categories about the changing world. For example, infants learn the phonemes of their mother tongue, how to move, and how to connect words with meaning and emotion with social interaction. These memories of early experience are available throughout life and influence our feelings, beliefs, and judgments (Bargh, 2013; Dunham et al., 2008). This learning shapes their behavior, affective functioning, and beliefs about the world, others, and themselves (Pinker, 1994). In this way, infants and young children quickly adapt to the place, cultural norms, and social environment where they live. John A. Bargh (2013) argues that early childhood experiences play a significant role in developing implicit or automatic relational processes, including self and self-regulation in interactions with others. It is interesting to note that intelligence does not influence implicit memory function (Lloyd & Newcombe, 2009).

Examples of the Composites of Early Declarative and Nondeclarative Learning

The Hippocampus is Active in Infancy and Supports Statistical Learning Before it Processes Episodic Memories

Recent studies show that the developing hippocampus processes two types of long-term memory. An fMRI study by Ellis et al. (2021) showed that activity in the hippocampus (especially the anterior hippocampus) is correlated with statistical learning processes from three months of age. This is consistent with findings that statistical learning is processed in the monosynaptic pathway, which is more active in the anterior hippocampus and develops earlier (Canada et al., 2021). In comparison, the trisynaptic pathway in the hippocampus, which is associated with episodic memory, develops later. The medial prefrontal cortex is also active in statistical learning and adult memory generalization. The authors conclude that some hippocampal-associated memory structures are active in early infancy and remain active throughout life. This suggests that early learning builds a complex, hierarchical structure of knowledge where generalized semantic and statistical learning precedes detailed episodic learning (Ellis et al., 2021). For example, infants quickly learn that their mother is often physically close; they learn her smell, tone of voice, and how she typically interacts with them (non-declarative memory). These memories later support the understanding and encoding of more specific and detailed episodic memories, such as mum playing with them in the sandbox (declarative memory).

Nondeclarative Schemas of Early Experience with Caregivers

Another example of nondeclarative learning is early affective learning. Nim Tottenham (2020) suggests that early affective experiences associated with the caregiver's behavior generalize over time, transforming into relatively stable affective meanings about relationships with primary caregivers. They may then be stored as memory schemas that provide an affective context and guide behavior in relationships from childhood through adulthood. In childhood, we encode positive, negative, and neutral affective experiences in close relationships.

Tottenham and her colleagues studied adverse childhood experiences and proposed that medial prefrontal-subcortical circuitry may encode affective memory schemas of early caregiving adversity. Although episodic memories of traumatic events from early childhood may not be available, implicit schemas encoding the effects of adverse experiences are maintained and alter behavior in relationships (incredibly close relationships) going forward (Tottenham, 2020). For example, if an infant repeatedly experiences hostile, cold interactions with their mother, they may encode these experiences in schematic generalizations that associate closeness in relationships with hostility and coldness. The child, and later the adult, may anticipate and re-experience hostility and coldness in relationships with, for example, their partner or children.

Emerging Models of Memory Development

Cristina M. Alberini and Alessio Travaglia outlined a novel model of memory development that emphasizes hippocampal learning. They propose that learning in the hippocampal area undergoes a cascade of critical periods, or developmental windows, during which certain experiences are necessary for the healthy development of specific functions (Alberini & Travaglia, 2017). Lack of those experiences during these developmental windows might fundamentally affect further functioning and development of the given area later in life (Knudsen, 2004). This model suggests that learning proceeds hierarchically. That is, when one competence is established, it provides the foundation for the following ones. More complex hippocampal learning proceeds only after a more straightforward learning phase is complete, and the brain area has matured. This is consistent with the findings of recent studies on early hippocampal learning. For example, Ellis et al. (2021) suggest that the anterior part of the hippocampus develops earlier and may support statistical learning in infancy and that episodic learning supported by the hippocampal area develops later. This implies a possible explanation for the phenomenon of infantile amnesia. Although early explicit episodic memories are not encoded or available later, according to Alberini and Travaglia's model of memory development, the memory system has already begun learning how to create episodic memories (Alberini & Travaglia, 2017). Thus, the development of episodic memory will be influenced by existing implicit generalized memories and schemas. Memories become more complex as new experiences are encoded in corresponding brain areas (Meredith, 2015).

How the Proposed Concept Integrates the Existing Knowledge of Memory Functions and the Development of Close Relationships

In summary, a growing body of research indicates that learning in infancy begins with the formation of generalized categories from repetitive experiences, and the encoding of detailed episodic memories occurs later (Parks et al., 2020). This hierarchical principle of memory development may shed light on how infants and young children learn about different qualitative categories of social relationships.

Regarding the literature, I propose that relational schemas laid down in infancy contain lasting, generalized knowledge about the basic principles and features of close relationships and how these affect how we form them throughout our lives. Infants learn to recognize their close primary caregiver and to connect with them by encoding general categorical knowledge: with this person, I experience frequent and predictable interactions, emotional intensity, and, when they come back, they are the same. Such processes establish a memory schema for a category of close relationships, which feature those qualities.

Consequently, young children extend encoding explicit, episodic memories of this relationship. If early experiences in close relationships are initially positive, this supports further episodic learning about how safe, close relationships work. If early experiences are adverse, this history may further incline one toward learning negative close relationship patterns. If an infant does not acquire enough knowledge about

close relationships with a constant primary caregiver, this may impair their ability to form and maintain close relationships throughout life.

However, what has to happen for infants to gain unique knowledge of closeness, intimacy, and shared emotion with another person? In the next section, I review several learning processes present in the earliest phases of life.

Interactive Learning with and about the Primary Caregiver in Infancy

> *"However, newborns show specific, highly specialized behavior that can be characterized as attachment or bonding influenced by learning and experience. This behavior begins in utero and adapts to accommodate the changing world as the infant matures." (*Sullivan et al., 2011*, p.1).*

Processes of Recognition, Attention, Perception, and Memory Generalisation

Recognition

Experiencing closeness and a special bond with another person in infancy would not be possible if the infant did not recognize the primary caregiver as a unique, familiar person different from any other. Recognition relies on two parallel processes (Mandler, 1980). The first is recollection; we retrieve specific, explicit details about an object, person, or situation. The second is familiarity. This is the feeling that we have experienced this object, person, or situation before, even if we do not retrieve any more specific information about it. Familiarity generates a sense of "being at home," an effortless, implicit connection with another person (Sacks, 2010, August 30). For example, we recognize our father in different contexts and do not confuse him with anyone else because, over time, we have experienced many variations in his behavior, appearance, and emotional expressions. Despite these changes, the rich knowledge we have compiled creates a deep sense of familiarity with him.

Research in cognitive psychology indicates that attention, perception, and memory are functionally connected and constitute specific interlinked processes. We pay attention to stimuli and perceive features that have meaning for us. This information is stored in memory, aligned with prior knowledge, and recalled in related contexts in the future (Kristjánsson & Campana, 2010; Styles, 2004). For example, seeing our father with an unusual haircut immediately catches our attention, and we compare his new image with the one we remember. The recognition process is currently viewed by neuroscience as a complex function of the memory system involving the hippocampus and the adjacent cortex (Wixted & Stretch, 2004).

Prenatal and Postnatal Perception of the Biological Mother are Salient Social Cues

Extensive research shows that infants enter the world with implicit memories of specific qualities of their biological mothers. They pay attention to and perceive sounds in their surroundings during the last trimester of prenatal development. They recognize

their mother right after birth using their knowledge of her sounds, smells, and tastes, which they learned in utero (Landers & Sullivan, 2012). Newborns can connect their mother's face with her voice, which they heard and learned during prenatal development (Coulon et al., 2011). Christine Moon (2011) proposes that prenatal learning of the mother's sounds may play a significant role in the early social development of attachment relationships. As a result of prenatal learning, implicit learning of social cues after birth is accomplished more quickly and efficiently. Newborns who are two to seven hours old distinguish their mother's face from a strange woman's (Bushnell, 2001). One of the most potent social stimuli is eye gaze. The ability to track eye gaze direction is essential for social learning and is among the most salient contributors to communication between individuals (Csibra & Gergely, 2009; Kampe et al., 2003). Neuroscience studies show that the superior temporal cortex and the medial prefrontal cortex (medial PFC) are active when adults and four-month-old infants process eye contact in social and affective communication (Kampe et al., 2003; Grossman et al., 2008). Smiling is another strong relational cue for infants. Research studies have had one-year-old infants watch videos of their mother smiling at them and videos of a stranger smiling at them. Infants showed increased medial PFC activity in both conditions; however, the medial PFC response was significantly greater when an infant responded to their mother (Minagawa-Kawai et al., 2009; Grossman, 2013).

It is widely agreed that infants' memory system uses encoded information about the mother's physical features as a cue for later physical and emotional connections with her (Landers & Sullivan, 2012; Schaal et al., 1995; Sullivan et al., 2011). Once the mother or primary caregiver (father, grandparent, adoptive parent) is familiar and recognized, the infant seeks closeness, safety, and biological and emotional regulation with this person (Hofer, 1994, 2006). These preferences are relatively stable (Dunham et al., 2008).

Perceptual Constancy

Prenatal and early postnatal learning depends on memory to encode sensory experiences, organize them, and transform them into a coherent, meaningful sense of events in the world. One of the cognitive properties involved in this process is perceptual constancy. To make sense of the ever-changing world, we must perceive objects, surfaces, and sounds as constant, even though they appear different under changing conditions (Encyclopaedia Britannica, 2023). For example, in daylight, we recognize our partner's face by the color of their hair, eyes, and skin tone. At dusk, we do not perceive these colors but nonetheless recognize our partner's face.

Experimental research shows that shape and size constancy may fully develop at birth, while other types of perceptual constancy develop during the first few years of life (for review (Granrud, 2006; Slater, 1992; Slater et al., 1990). For example, newborns show perceptual constancy for face recognition. Infants one to three days old match faces when presented with the image of the face rotated at 45° and with a 3/4 view (Turati et al., 2008). The initial memory trace is understood to be strengthened over time with further learning and experience (Bushnell, 2001). This also means constancy-based memories are necessary for thinking and further learning (Garrigan & Kellman, 2008).

Perceptual Learning Depends on Perceptual Constancy

Perceptual learning is a type of learning that improves our ability to respond to stimuli by using prior sensory knowledge. In this way, we build a lasting, improved sense of what we perceive through our senses. It helps us respond to the environment's unique and delicate aspects when needed (Gold & Watanabe, 2010). For example, wine experts have grown to recognize nuances in the flavor and appearance of a wine produced this year compared to older vintages.

In this case, the perceptual constancy process develops distinct categories for strong stimuli that we may experience under different circumstances but in which core qualities of the stimuli do not change. Because these categories are stable across different contexts, we can elaborate on them to generate more complex, nuanced perceptions and responses to fine details of the specific stimuli. Thus, perceptual learning depends on perceptual constancy (Garrigan & Kellman, 2008). We can only improve our knowledge of a stimulus when we have learned its core facets and then may use it to learn more. For example, we can read our best friend's mind (i.e., know what they are thinking and feeling without saying anything) because, with experience, we have learned to interpret even minute changes in their mood or expression and anticipate what comes next. Nevertheless, after spending a week together in the mountains, we may know our best friend better. For example, we have now learned how they respond to bad weather or a spectacular sunset.

Memory Generalization in Infancy

Memory generalization occurs when we recall core memories about stimuli even when details and circumstances have changed. It allows us to use learned information flexibly in situations different from the one in which we first learned it. This adaptive process helps us orient ourselves in new environments and situations, guiding our behavior before we learn enough about novelties to find corresponding links to our previous experience.

Research shows that memory selectively preserves information based on factors such as significance, intensity, and repetition. Less salient information is more likely to be transient. We could say that the memory system "decides" which information to store and then uses it to guide navigating the world around us (Richards & Frankland, 2017). Positive or negative emotions intensify the experience, thus making it more likely to be remembered (Ramsaran et al., 2019). For example, when our memories of stressful events experienced with our parents in the past are generalized, we may feel distressed when we imagine we will see them again next weekend. Although we do not know how the weekend will go, we may try to avoid visiting them. Alternatively, we may feel stressed by something our parents say because we anticipate conflict will follow.

Research indicates that memory generalization is present at birth and continues to develop over time (Keresztes et al., 2018). It is also understood that this memory function may have a powerful impact in infancy when most sensory and relational experiences are novel (Ramsaran et al., 2019).

How Those Memory Processes in Infancy May Contribute to the Recognition of the Primary Caregiver and Encoding Closeness

Research shows that infants are highly sensitive to regular, repetitive experiences across different contexts at birth. This includes speech and language, musical sounds, movement, and spatial patterns (for review, Saffran & Kirkham, 2018). Saffran (2020) suggests that statistical learning, a specialized memory process, generates higher knowledge about regular features of the environment and predictions about events based on prior experience. For instance, when infants are familiar with a regular sequence of sounds, they are better at segmenting words that use that sequence. Once they recognize sound patterns, they connect these patterns with meaning (Thiessen & Saffran, 2003). Saffran also hypothesizes that statistical learning may orient the infant to what to learn, rather than simply to recognize. Once the repetitive experience is stored as a higher category of knowledge, the infant can discriminate between known and unknown and then pay more attention to novelties and explore them to learn (Saffran, 2020).

Infants perceive a wide range of stimuli, but when they have consistently experienced a specific set of stimuli, the range of perception is reduced by a process called perceptual narrowing (Watson et al., 2014). As a result of this narrowing, infants are better able to distinguish familiar stimuli from the welter of stimuli that surround them. For example, while infants become experts at recognizing the phonemes of their native language and the faces of their primary caregivers, they gradually become less adept at distinguishing sounds from other languages and at recognizing the faces of strangers (Krasotkina, 2021).

These studies support the idea that perceptual narrowing and statistical learning are vital in infants' learning to recognize the primary caregiver as a unique, close person.

Summary of the Literature Review

The reviewed literature converges on several key themes regarding the development of close relationships and their developmental cognitive foundations. First, research in social neuroscience demonstrates that close relationships occupy a privileged position in human cognition and social life, supported by specialized neural systems and characterized by emotional salience, frequent interaction, and stability over time. Second, attachment and object relations theories explain how early interactions with primary caregivers are foundational for later social functioning, with repeated experiences contributing to relatively stable internal working models that encompass expectations about others and relationships with them. Third, memory research indicates that early learning is dominated by implicit, statistical, and schema-formation processes, whereas efficient long-term episodic memory develops later. Infants preferentially extract regularities across repeated experiences and form generalized representations that guide perception, prediction, and behavior.

Together, evidence from studies on statistical learning, perceptual narrowing, affective learning, and memory generalization indicates that infants rapidly develop

stable representations of familiar individuals, especially primary caregivers, based on recurring patterns of interaction and their individual-specific features and styles. These processes support the emergence of memory schemas that capture core features of relational experiences, such as familiarity, emotional intensity and valence, and predictability.

Despite these advances, important gaps remain. Existing research has largely examined social relationships (e.g., social brain hypothesis), attachment processes (e.g., internal working models), and memory development (e.g., schema formation) in relative isolation. As a result, there is limited theoretical integration explaining how domain-general memory mechanisms give rise to representations of close relationships as a distinct social category. In particular, the role of early-developing memory schemas in organizing relational knowledge prior to the emergence of episodic memory remains under-recognised. Furthermore, while attachment theory describes the outcomes of early relationships, it does not fully account for the underlying learning and memory processes that construct these representations.

The present study addresses these gaps by proposing an integrative account in which memory schema formation in infancy constitutes a foundational mechanism for representing the category of close relationships. Specifically, it argues that repeated, affectively salient interactions with primary caregivers are encoded through implicit and statistical learning processes, giving rise to generalized schemas that define what constitutes a "close" relationship. By linking research on social cognition, early development, and memory systems, this approach extends current knowledge by reframing close relationships as emerging from general memory-based categorization processes and being highly abstract knowledge foundations for further learning about complex social life.

Discussion

> *Infants' preference for self-relevant social stimuli may help them form relationships and may promote social convergence (*Kalashnikova et al., 2017*).*

Infants' preference for self-relevant social stimuli may help them form relationships and promote social convergence (Kalashnikova et al., 2017). Beyond facilitating bonding, this early sensitivity may also provide the foundation for learning how different types of relationships are structured and experienced. Importantly, Sullivan et al. (1986) showed that newborns rely on early sensory-based learning and implicit memory to recognize and prefer their mother even before attachment relationships are fully established.

Perceptual constancy, perceptual learning, statistical learning, and memory generalisation in infancy contribute to the accumulation of implicit knowledge about the caregiver's physical features, physiological states, and social behavior patterns. As infants are exposed to repeated social input, these experiences are gradually organized into more generalized representations of the social world (Bloom, 2013). Building on this, I propose that infancy is a critical period not only for forming attachment bonds,

but also for constructing higher-order memory structures that encode what constitutes a "close" relationship. This process appears to reach an important developmental milestone when infants actively seek proximity and safety from a primary caregiver. However, such behavior likely depends on prior phases of learning in which recurring relational features are detected, integrated, and abstracted.

In line with the purpose of this study, the following sections discuss forms of interactive social learning that may support the emergence of an abstract memory schema of relational closeness—one that enables infants to differentiate close relationships from more casual social interactions.

Interactive Social Learning in Infancy—The Role of the Medial PFC in Social Behavior

Recent cognitive neuroscience studies show that social interaction begins early, with infants actively initiating and exploring these interactions. They suggest that regions of the medial prefrontal cortex (medial PFC) are associated with how we relate to others, how we perceive others as similar or dissimilar, and how we perceive ourselves (Grossmann, 2013; Lieberman et al., 2019; Raz & Saxe, 2020). Regions of the lateral prefrontal cortex (lateral PFC) are active during social tasks that involve attention, exploration of new resources, reasoning, and goal-directed emotional regulation (Ochsner & Gross, 2005; for a review, Satpute & Lieberman, 2006). It is understood that the medial and lateral PFC are interconnected parts of a system that work together to support complex human behavior (Wood & Grafman, 2003).

The PFC is anatomically immature in infancy, and thus, many cognitive and executive functions associated with the mature PFC (for example, working memory and executive functioning) are still developing (Grossmann, 2013). However, research (for review by Raz & Saxe, 2020; Werchan & Amso, 2017) supports the view that the PFC is partially active in infancy and that some areas and connectivity responsible for social learning may already be in use. Raz and Saxe (2020) report that infants show a strong interest in social relationships and engage in social interactions, even when there is no potential for gaining new factual information. Research shows that the medial PFC supports relational behavior within the first year of life. Studies using fMRI show that infants four to six months old react to social stimuli that engage the infant's self (that is, self-related stimuli) (Deen et al., 2017). For example, infants look longer at faces that directly attend to them than at faces that gaze in another direction (Farroni et al., 2002). Another experiment showed that when the primary caregiver sensitively and affectionately touches a four-month-old infant, the infant is faster at recognizing the caregiver's face. When they experience neutral non-social stroking, it does not have the same effect. This suggests that social touch promotes recognizing the primary caregiver's face and identity (Della Longa et al., 2019). Studies of PFC activity when newborns react to auditory stimuli show that the PFC responds more when the mother reads the infant a story using "infant-directed speech" (which has a higher pitch) versus "adult-directed speech" (Fernald, 1992). This finding suggests that positive, emotionally charged speech affects the medial PFC in newborns (Grossmann, 2013). The findings reviewed here support the conclusion that infants distinguish social interaction involving repetitive connection with familiar others

from casual social exchanges with strangers. Moreover, these recent findings support the idea that social interactions start very early and that the recognition of close people relies on those intimate connections.

Together, these findings suggest that early medial PFC engagement in self-relevant and emotionally salient interactions may support not only the recognition of familiar individuals, but also the gradual abstraction of relational patterns characteristic of close social bonds, as PFC is thought to be involved in encoding and processing higher-order generalized knowledge.

Examples of Social Interactions in Infancy

The literature offers examples of interactive social learning and presents a variety of perspectives on how infants interact with social partners and what they learn from this.

Memory and Meaning of Imitation in Infancy

Children and adults learn many essential skills by imitating others (Heyes, 2016). Andrew Meltzoff and his colleagues found that infants aged 12 to 21 days imitate facial expressions and gestures (Meltzoff & Moore, 1977). Several subsequent studies confirmed that newborns imitate simple behaviors when observing them (Meltzoff, 2005). However, some researchers find the data unconvincing, and there have been problems replicating the results. The debate among researchers centers around whether infants imitate behavior or show arousal and random reactions (for review Jones, 2009). Among researchers who support the notion of imitation in infancy, it is widely believed that infants learn to imitate through active engagement in social exchange and that imitation is crucial for the development of social and cognitive skills (Heyes, 2016; Oostenbroek et al., 2016).

Meltzoff and Moore argue that specific developmental principles, including perception, coordination, and motor control, drive early imitation. They hypothesize that memory is involved since imitation is performed after some delay. They suggest infant imitation is possible because the behavior infants imitate is first encoded as a nonverbal implicit memory. Meltzoff and Moore propose that in this way, imitation supports the infant's ability to recognize familiar people and distinguish them from novel social contacts (Meltzoff & Moore, 1994). Infants expect the primary caregiver to provide consistent behavior they can experience repeatedly (Meltzoff & Moore, 1992). Moreover, imitation thus allows the infant to categorize people into relational categories and guides their behavior toward them, particularly when infants develop strong connections with primary caregivers. It is congruent with the notion that early interactions with others are categorized into general knowledge about the social world. I offer the idea that imitation in infancy plays a role in learning general schemas and distinguishing between close and casual social contact. When an infant imitates someone less familiar, imitation serves to learn about them and create a new interactive acquaintance. When an infant imitates the familiar primary caregiver, imitation enhances existing intimate knowledge and memory schemas of "this is a constant close person" and "we relate and belong to each other." Infants expect the

primary caregiver's unique, typical behavior and test it repeatedly. When they can rely on the knowledge of the primary caregiver, they also explore and encode the meanings of this behavior. For example, a family friend arrives and communicates with the family's eight-month-old infant. By imitating the friend, the infant experiences how they are perceived and responded to by the new person. On the other hand, when the infant imitates their mother, it strengthens their relationship. In this way, imitation deepens the special bond with the primary caregiver and fosters learning about relationships with others.

From this perspective, imitation may function not only as a mechanism for learning about specific individuals but also as a process through which infants extract regularities across interactions, contributing to the formation of a generalized schema that distinguishes familiar, stable partners from less-known, less predictable others.

Memory and Meaning of Synchrony Between Child and Parent

Synchrony is a temporal relation when things or activities happen simultaneously (Merriam-Webster's Medical Desk Dictionary, 2002). Synchrony as a concept in social psychology was coined by researchers in animal parenting (Rosenblatt, 1965). Ruth Feldman studies synchrony in human parenting (2007). She defines it as a special connection between a child and a parent, distinct from ordinary interactions in daily routine (Feldman, 2007). In her view, synchrony involves sharing affective states of mind, connection, rhythm, and biological tuning when the infant and parent are together, playing, or engaging in other joint activities. The child and parent become unified and feel joyful about experiencing togetherness. They recognize their faces and other features as familiar, but join each other's inner worlds through synchrony and stay within them over time and across activities. Feldman proposes that repeated mutual experiences of synchrony support the development of a bonded relationship between them (Feldman, 2007). Thus, it supports the notion that implicit memories of synchrony with another person provide another layer of generalized relational knowledge. The infant also learns on an implicit level how to regulate behavior and affects it through connecting with the primary caregiver (Feldman, 2012).

Repeated experiences of synchrony may therefore provide a structured, affectively rich context in which infants encode core features of closeness—such as mutual regulation, temporal coordination, and shared affect—supporting the development of an abstract representation of categorical qualities of close relationships.

Memory and Meaning of Intersubjectivity

Daniel Stern (2005) defines intersubjectivity as the ability to share another person's lived experience. This means that to connect with someone, we must simultaneously experience our own mental states and the other person's social cues and create meaning from those experiences. Intersubjective exchange is generally considered critical for learning about the social and cultural world around us (Trevarthen & Aitken, 2001).

In the field of social development, it is established that intersubjectivity is an innate program active in infancy (Trevarthen, 1993). Colwyn Trevarthen (1979) posits that intimate relationships involve understanding and sharing inner mental states at many levels. Multiple studies show that infants as young as a few months old can engage in face-to-face nonverbal communication, play, and the rhythm of relating with their caregivers (Cohn & Tronick, 1987; Trevarthen, 1979, 1993, 1998). When researchers studied the timing and facial expressions involved in this intersubjective communication, they found that it is statistically similar to an informal conversation between two adults. Daniel Stern (1974) studied three-month-old infants as they played with their mothers. He found that this shared play activity mutually regulates behavior and emotion and maintains a positive affective connection. Maternal activities and engagement with the infant were similar to adult interpersonal communication, modified only by the infant's natural behavior. An infant influences the exchange of facial expressions and vocalizations by redirecting their gaze (Stern, 1974). Research on intersubjective behavior between caregivers and infants indicates that infants are intrinsically motivated to initiate a social connection and develop companionship, collaboration, and meaning-sharing (Trevarthen et al., 1981). These findings support the notion that although we do not retain and retrieve explicit episodic memories of the tremendous amount of interactions with our primary caregivers and others from infancy, the memory system in infancy encodes essential information about ways of connecting and interacting with others and differences among them. Experiences with primary caregivers not only enrich infants' intimate, specific knowledge of those caregivers but are also necessary for learning schemas about how close relationships form, are experienced, and are maintained in general. This early social learning depends on the time spent together (duration), the frequency and repetition of experiences, and the interactive involvement of both the infant and the caregiver.

In this way, intersubjective exchanges may contribute to the formation of relational knowledge that extends beyond specific interactions, enabling infants to generalize how close relationships feel, function, and differ from less self-other-connected and engaged social encounters.

Taken together, the evidence reviewed in this section supports the central proposal of this study: that early social interactions with primary caregivers do more than establish attachment bonds—they provide the repeated, structured, and emotionally salient experiences necessary for the emergence of a generalized memory schema of relational closeness. Across imitation, synchrony, and intersubjectivity, infants are exposed to consistent relational patterns characterized by predictability, mutual responsiveness, and self-other emotional engagement. Through these processes, infants may abstract these core features of close relationships, forming a higher-order abstracted representation that allows them to distinguish close from more casual social ties. This schema offers a potential developmental mechanism linking early social experience to the later ability to categorize, interpret, and navigate diverse relationships across the lifespan.

Conclusions

Repetitio est mater studiorum

Practice makes a master

In conclusion, close relationships are essential for our emotional well-being. People feel lonely and isolated without them, even when they may have many casual social connections. For this reason, it is essential to understand how we gain the ability to have close relationships and what may hinder this crucial accomplishment.

Infants acquire knowledge about themselves and their caregivers through repeated interactions and salient affective experiences, forming early attachment bonds that serve as the foundation of social development. Beyond these specific bonds, the memory system extracts regularities across experiences and encodes them into generalized schemas that capture the defining features of close relationships as a distinct relational category.

These memory schemas are multidimensional and dynamic. They integrate affective valence, interactional patterns, and expectations about reciprocity, stability, and emotional significance. In doing so, they support the categorical distinction between close relationships and more casual social ties, as outlined in the present framework. Notably, variation in early caregiving experiences—ranging from consistent and supportive to unpredictable or adverse—shapes the qualitative properties of these schemas, leading to adaptive, maladaptive, or mixed relational expectations.

Once formed, schemas of relational closeness guide perception, interpretation, and behavior in social contexts. They influence how individuals identify, form, and maintain close relationships across the lifespan, providing a cognitive-affective template for navigating complex interpersonal environments. In this way, early attachment experiences do not merely inform specific relational expectations but contribute to a broader, generalized understanding of what constitutes a "close relationship."

The proposed account is consistent with contemporary research demonstrating that memory systems encode abstract, higher-order representations of social experience (Zhang & Scott, 2024) and differentiate between novel and repeated patterns to form generalized knowledge structures (Cockcroft et al., 2022; Roy et al., 2025). Extending this literature, the present framework emphasizes that such abstraction processes operate in the social domain to construct a category of relational closeness grounded in early experience.

Furthermore, emerging work in affective neuroscience highlights the role of early caregiving environments in shaping long-term socio-emotional functioning, including sensitivity to unmet needs and stress-related relational patterns (Tottenham & Vannucci, 2025). This perspective is reinforced by findings linking early social learning to later relationship quality, loneliness, and social isolation (Jalilian et al., 2023), as well as by clinical observations reflected in diagnostic frameworks such as ICD-11 C-PTSD, where disturbances in relational functioning are central.

In summary, by integrating insights from developmental psychology, neuroscience, and memory research, this framework proposes that, alongside forming specific attachment bonds with primary caregivers, infants encode a generalized memory schema of relational closeness that distinguishes close from casual social ties. This schema provides a foundational cognitive structure for understanding, organizing, and engaging in social relationships throughout the lifespan.

Limitations and Recommendations for Future Research

Limitations

The present study proposes a novel integrative account of a memory schema of relational closeness as a specific category; however, several limitations should be acknowledged.

First, the framework is not empirically tested, and the proposed construct has not yet been operationalized. This limits the ability to draw firm conclusions about its validity or predictive utility. Accordingly, the model should be interpreted as a conceptual framework that generates testable hypotheses rather than as a definitive account of underlying mechanisms.

Second, the model assumes relatively uniform processes of schema abstraction from early caregiving experiences, without fully accounting for individual differences, such as temperament, genetic predispositions, and environmental variability. This may constrain the explanatory scope of the framework and limit its generalizability across individuals.

Third, the emphasis on early developmental experiences may underrepresent the role of later-life social interactions in shaping and modifying relational schemas. As a result, the present account may overestimate the stability of early-formed schemas while underestimating their plasticity across the lifespan.

Finally, the distinction between close and casual relationships is treated as a categorical boundary, whereas real-world relationships likely exist along a continuum and are influenced by sociocultural context. This may limit the cross-cultural applicability and ecological validity of the proposed framework.

In Light of these Limitations, Several Directions for Future Research are Warranted

First, empirical work is needed to operationalize and measure schemas of relational closeness using behavioral, cognitive, and neurobiological methods. Longitudinal designs would be particularly valuable for examining how repeated early interactions contribute to the emergence of generalized relational knowledge. Future studies should test specific hypotheses derived from the present framework. For example:

(1) Individuals with more consistent and responsive early caregiving experiences will form more coherent and positively valenced schemas of relational closeness, which in turn predict greater stability and satisfaction in later close relationships.

(2) Exposure to inconsistent or adverse caregiving will be associated with more fragmented or negatively biased relational schemas, leading to altered perception and interpretation of closeness-related cues in adulthood;
(3) Individuals with a history of absent primary caregiving, such as institutional care where infants do not receive consistent, predictable, and emotionally intense individual care (Winnette, 2022), will show significant difficulties in recognition of close relationships and the ability to form and maintain them.
(4) Relational schemas of closeness will be detectable at the neurocognitive level, such that stimuli signaling close versus casual relationships differentially engage memory- and affect-related neural systems.

Second, research should investigate individual differences in schema formation by integrating biological, temperamental, and environmental factors, thereby providing a more comprehensive account of developmental variability. Additionally, examining the malleability of relational schemas—particularly in response to new social experiences or therapeutic interventions—would clarify the extent to which early-formed schemas can be updated.

Finally, cross-cultural studies are needed to determine whether the distinction between close and casual relationships reflects a universal cognitive category or varies across sociocultural contexts. Such work will be essential for refining the boundaries, mechanisms, and applicability of the proposed schema.

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