



# Affection and Emotional Communication in the Human–Dog Dyad: A Comparative Ethological Review

Daniele Guccione

*Independent Researcher, Torino, Italia*

**Abstract:** The human–dog relationship depends on an intricate system of communication through human affection gestures (e.g., stroking, hugging, vocal modulation) and canine affiliative signals (e.g., proximity-seeking, relaxed postures, social gaze) which both parties understand. The analysis of these exchanges serves as a foundation for attachment theory and social cognition and welfare science. The research used PubMed and Scopus and PsycINFO databases to review literature from 2015 to 2025 alongside fundamental earlier studies that included observational field work and cross-modal paradigms and eye-tracking and fMRI. The synthesis process focused on three main areas: (i) attachment and the secure-base model; (ii) canine recognition and decoding of human emotions through multimodal integration (social referencing); (iii) neurobiological mechanisms which support affective communication through oxytocinergic and dopaminergic pathways. The research shows that mutual eye contact leads to oxytocin release while social contact strengthens affiliation and these interactions create physiological synchronization. The main differences between humans and dogs stem from anthropomorphism (hugs provide comfort to humans but create restriction for dogs) and developmental differences in children’s ability to detect canine distress signals and cultural variations in what constitutes intimate behavior. The generalizability of findings remains limited due to methodological constraints which include small sample sizes and WEIRD population biases and breed preferences and unverified owner reports and non-preregistered cross-sectional designs. The promotion of communicative literacy helps decrease misinterpretations while creating balanced interactions that lead to better welfare results. Future research needs to focus on cross-cultural comparisons and AI-driven non-invasive behavioral analysis and multimodal physiological biomarkers to assess relationship quality.

**Key Words:** human–dog bond; attachment; oxytocin; social cognition; welfare.

\* *Corresponding Author:* daniele.guccione@hotmail.it

## Introduction

The human-dog bond represents one of the most remarkable examples of interspecific social relationships, shaped by approximately 15,000-40,000 years of coevolution. During this extended period of domestication, dogs developed specialized social-cognitive abilities that enable them to interact effectively with humans, including sensitivity to human communicative cues, emotional responsiveness, and the capacity to form attachment bonds with their owners. Understanding the mechanisms underlying affective communication in this unique dyad has significant implications for animal welfare, human-animal interaction research, and practical applications in clinical, educational, and domestic settings.

Affective communication between humans and dogs encompasses a bidirectional exchange of signals that regulate proximity, arousal, and cooperative behaviors. Humans express affection through gestures such as stroking, sustained gaze, vocal prosody, hugging, and kissing, while dogs communicate through body postures, facial expressions, tail movements, vocalizations, and proximity-seeking behaviors. The effectiveness of this interspecific communication depends on mutual comprehension: humans must learn to interpret canine signals accurately, while dogs have evolved to be particularly responsive to human social cues.

The shared environments inhabited by dogs and humans—including domestic homes, urban spaces, and clinical settings—create contexts where effective affective communication is essential for safety, welfare, and successful interactions. However, misinterpretations can occur when hu-

mans project their own emotional expressions onto canine behavior or when dogs misread human intentions. Gestures that humans perceive as affectionate, such as hugging and direct facial contact, may be interpreted by dogs as restraint or threat depending on the relationship history and current context. Similarly, canine signals such as lip-licking, yawning, or gaze aversion—which function as de-escalation or stress signals—are often misinterpreted by humans as signs of contentment or guilt. Children’s ability to recognize canine distress signals varies considerably with developmental stage and cultural background, highlighting the importance of education in preventing negative outcomes such as dog bites.

The purpose of this review is to provide a comprehensive synthesis of the current literature on affective communication between humans and dogs. Specifically, we address three main objectives: (a) to examine the attachment bond and secure-base phenomenon in the dog-owner dyad; (b) to analyze canine perception and interpretation of human emotional signals across visual, auditory, and olfactory modalities; and (c) to explore the neurobiological mechanisms—particularly oxytocinergic, dopaminergic, and stress-related pathways—that underlie these affective interactions.

This review focuses on human affectionate gestures (stroking, gaze, prosody, hugging/kissing, proximity, play) and canine affiliative signals within domestic dyads. Studies addressing aggression without affective components, technical or sport training without relational elements, or purely theoretical interspecific comparisons were excluded. By establishing a comparative framework that identifies convergences and divergences in human-dog communication, we aim to provide evidence-based guidance for practitioners, educators, and caregivers while identifying priorities for future research.

The review addresses five key research questions: (1) What social signals do dogs display to humans, and how accurately do humans interpret these signals? (2) Which human gestures are clearly understood by dogs, and which are ambiguous or potentially aversive? (3) Where do human and canine communication systems converge (e.g., gaze, touch, social reinforcement) and diverge (e.g., hugging, staring, the “guilty look”)? (4) What neurobiological mechanisms (oxytocin, dopamine, cortisol) support affective communication, and how do they interact with environmental and relational factors? (5) What practical implications emerge for education, clinical practice, and welfare promotion?

We evaluate outcomes across four categories: behavioral indicators (proximity, approach latency, contact duration, gaze patterns, calming signals), physiological measures (heart rate/HRV, cortisol, oxytocin), neural correlates (fMRI activation in caudate nucleus and temporal cortex), and practical relationship-based indicators (veterinary compliance, conflict prevention, educational program effectiveness). This triangulated approach, combining observational, experimental, and biomarker data, enhances the external validity of our conclusions.

## Materials and Methods

This section describes the methodology used for identifying, selecting, and synthesizing the relevant literature for this comparative narrative review. The design follows PRISMA 2020 guidelines for selection flow and PRISMA-S recommendations for search strategies, adopting a comparative narrative review framework with quasi-systematic components.

### *Design and Protocol*

The study examined human affectionate gestures in relation to canine affiliative signals, with particular attention to neurobiological evidence. The research examined five distinct domains: (1) attachment and secure-base effects; (2) perception of human emotions through visual and au-

ditory channels; (3) cross-modal integration and social referencing; (4) physiological and neural mechanisms; and (5) canine signals including DogFACS-coded facial expressions and tail dynamics, as well as moderating factors such as culture, age/childhood development, experience, and breed.

### *Sources of Information and Time Frame*

Searches were conducted on PubMed/MEDLINE, Scopus, and PsycINFO. The research period spanned from January 1, 2015 to July 31, 2025, while allowing historical exceptions for foundational works establishing the Strange Situation paradigm, canine fMRI methodology, and DogFACS development. No language filters were applied a priori; inclusion required at minimum an English abstract. Preprints lacking peer review were excluded, but the DogFACS manual and other official methodological resources were included as technical references.

### *Search Strategies (PRISMA-S Narrative)*

The researchers built semantic clusters of controlled terms and free-text keywords for each database before applying Boolean operators to the indexing fields.

PubMed/MEDLINE: MeSH terms (Dogs, Attachment Psychology, Oxytocin, Nonverbal Communication) combined with free-text terms in title/abstract (dog\*, canine, attachment, bond, secure base, affect\*, emotion\*, empathy, oxytocin\*, cortisol, dopamine\*, gaze, eye contact, prosody, touch, DogFACS, facial action, tail, wagging, asymmetr\*). Date filter: 2015–2025; no species or study design restrictions.

Scopus: TITLE-ABS-KEY searches using repeated cluster searches for attachment/secure base, affect/emotion, oxytocin/cortisol/dopamine, gaze/eye contact/prosody/touch, DogFACS/facial action, and tail, with proximity operators when required. Time frame: 2015–2025.

PsycINFO: APA Thesaurus terms (Human–Animal Bond, Dogs, Emotions, Nonverbal Communication, Attachment Behavior, Prosody) combined with free-text terms (oxytocin, cortisol, dopamine, gaze, eye contact, DogFACS, tail). Range:  $\geq 2015$ . No filters on design.

### *Eligibility Criteria*

Inclusion criteria: Studies examining *Canis lupus familiaris* as the primary subject (wolf, cat, and horse comparisons were acceptable when serving comparative objectives). Eligible study designs included observational studies, behavioral and physiological investigations, fMRI experiments, and qualitative/ethnographic studies with appropriate methodological rigor. Content focus: human–dog affective communication, attachment, recognition of human emotions, neuroendocrinology (oxytocin, dopamine, cortisol), DogFACS, and moderating variables.

Exclusion criteria: Non-canine species without suitable comparative value; case reports and opinion papers lacking empirical data; pharmacological studies not examining affective processes; veterinary clinical trials without relational components; non-peer-reviewed preprints.

#### *Selection Process (PRISMA)*

The screening process involved two stages performed by a single reviewer (R1). In stage one, R1 assessed titles and abstracts against eligibility criteria, maintaining a decision log for all excluded studies and uncertain cases. In stage two, full-text screening verified eligibility and documented reasons for exclusion (e.g., species mismatch, outcome irrelevance). An editorial reviewer (ER) conducted a coherence audit on selected studies and reviewed all instances of classification uncertainty.

*Study Flow (PRISMA)*

The database search yielded 2,354 records. After removing 612 duplicates, 1,742 titles and abstracts were screened. Studies were excluded if they: focused on non-canine species without comparative value to the human-dog relationship; lacked empirical data (e.g., opinion pieces, editorials, case reports without systematic data collection); addressed pharmacological interventions without examining affective processes; or did not specifically examine human-dog affective communication (e.g., studies focusing solely on cognitive tasks without emotional components). A total of 196 full texts were assessed in detail; 28 met all inclusion criteria and were retained for synthesis (see Table 1). The included studies encompassed more than 285,000 participants from various continents through a combination of meta-analyses, observational studies, experimental designs, longitudinal investigations, and qualitative research.

**Table 1.** Summary of the 28 Selected Studies

Study	Main Topic	Section
Albuquerque et al. (2016)	Dogs recognize dog and human emotions	Canine perception
Andics et al. (2016)	Neural mechanisms for lexical processing	Neurobiology
Barber et al. (2016)	Processing of human emotional faces	Canine perception
Berns et al. (2014)	fMRI study of canine brain responses to odors	Neurobiology
Boch et al. (2024)	Dogs as comparative model for social neuroscience	Neurobiology
Bremhorst et al. (2021)	Accuracy of facial expressions as emotion indicators	Canine signals
Cimarelli et al. (2021)	Secure base effect in shelter and family dogs	Attachment
Cook et al. (2016)	fMRI predicts dogs' preference for praise vs food	Neurobiology
Correia Caeiro et al. (2023)	Visual perception of emotion cues in dogs	Canine perception
Cuaya et al. (2016)	Face sensitive areas in canine temporal cortex	Neurobiology
D'Aniello et al. (2018)	Interspecies transmission of emotional chemosignals	Olfaction
D'Aniello et al. (2023)	Puppies' receptivity to human chemosignals	Olfaction
Handlin et al. (2011)	Short-term interaction effects on oxytocin and cortisol	Neurobiology
Horowitz (2009)	Disambiguating the guilty look	Canine signals
Karl et al. (2020)	Combining fMRI and behavioral measures	Neurobiology
Mariti et al. (2013)	Owners as a secure base for their dogs	Attachment
Mota Rojas et al. (2019)	Assessment of dogs' emotions and DogFACS	Canine signals
Müller et al. (2015)	Dogs discriminate emotional expressions of human faces	Canine perception
Nagasawa et al. (2015)	Oxytocin-gaze positive loop and human-dog bonds	Neurobiology
Odendaal & Meintjes (2003)	Neurophysiological correlates of affiliative behaviour	Neurobiology
Palmer & Custance (2008)	Counterbalanced Strange Situation Procedure	Attachment
Payne et al. (2015)	Current perspectives on attachment and bonding	Attachment
Petersson et al. (2017)	Oxytocin and cortisol associated with behavioral patterns	Neurobiology
Prato Previde et al. (2003)	Dog-human relationship as attachment bond	Attachment

Quaranta et al. (2007)	Asymmetric tail wagging responses	Canine signals
Semin et al. (2019)	Chemosignals as the neglected medium	Olfaction
Siniscalchi et al. (2013)	Emotional responses to asymmetric tail wagging	Canine signals
Somppi et al. (2016)	Dogs evaluate threatening facial expressions	Canine perception
Topál et al. (1998)	Attachment behavior using Strange Situation Test	Attachment
Waller et al. (2013)	DogFACS manual and paedomorphic facial expressions	Canine signals

## Results

The evidence is synthesized narratively according to three strength levels: High, Moderate–High, and Moderate. These levels were determined based on: (1) the number of independent replications across different research groups; (2) consistency of findings across different methodological approaches (behavioral, physiological, neuroimaging); (3) sample sizes and statistical power; and (4) methodological rigor including blinding, randomization, and validated outcome measures. High evidence reflects findings replicated across multiple independent laboratories using diverse methods with adequate sample sizes. Moderate–High evidence indicates consistent findings with some methodological limitations. Moderate evidence represents emerging findings requiring further replication or facing notable methodological constraints.

### *High Evidence*

#### *Attachment and the “secure base”*

Adaptations of the Strange Situation paradigm to the dog–owner dyad consistently demonstrate that owners function as a secure base for their dogs. During separation episodes, dogs display decreased exploratory behavior, increased vocalizations, and proximity-seeking attempts; upon reunion, they resume normal activity and environmental engagement. These behavioral patterns correspond to measurable physiological indicators demonstrating social buffering effects, including modulation of cortisol responses and autonomic parameters (HR/HRV) (Topál et al., 1998; Prato Previde et al., 2003; Palmer & Custance, 2008; Mariti et al., 2013; Cimarelli et al., 2021). The secure-base effect appears robust across studies, though individual variation exists based on the dog’s training history, past experiences, frequency of daily interactions, and testing environment. Despite consistent replication, generalizability remains constrained by small sample sizes and predominance of WEIRD (Western, Educated, Industrialized, Rich, Democratic) participant populations.

Practical implication: Owners function as stress regulators, enabling dogs to explore novel environments and engage in learning with greater confidence.

### *Moderate–High Evidence*

#### *Canine perception of human emotions*

Research demonstrates that dogs integrate information from facial expressions and vocal prosody to discriminate human emotional valence, which influences their approach-avoidance decisions. Affective prosody enhances learning, functioning similarly to infant-directed speech in improving attention and strengthening social bonds. Eye-tracking studies reveal differential gaze patterns toward threatening versus positive expressions, and dogs demonstrate social referencing by looking to owners when confronting ambiguous situations (Müller et al., 2015; Albuquerque et al., 2016; Barber et al., 2016; Somppi et al., 2016). Effect sizes depend on stimulus familiarity and

exposure frequency, with accuracy decreasing for unfamiliar individuals and ambiguous contexts. Confidence in these findings is tempered by reliance on static stimuli in many studies and limited population diversity.

Practical implication: Combining warm vocal tones with soft eye contact facilitates dogs' environmental engagement and helps resolve ambiguous situations.

#### Neurobiology of affective communication

Positive contact between humans and dogs increases oxytocin levels in both dyad members while modulating stress responses (cortisol). Sustained mutual gaze appears to activate an oxytocin-mediated positive feedback loop that strengthens bonding and increases the rewarding value of social interactions (Nagasawa et al., 2015; Petersson et al., 2017). Functional MRI studies with awake dogs demonstrate caudate nucleus activation in response to owner-associated odors and voices—consistent with reward processing—and temporal cortex activation when viewing human faces (Berns et al., 2014; Cook et al., 2016; Cuaya et al., 2016; Karl et al., 2020). Individual differences exist in preferences for social versus food reinforcement, with some dogs showing stronger responses to praise and contact while others preferentially respond to food rewards. Limitations include small sample sizes, restriction to scanner-tolerant dogs, and lack of standardized hormonal assay protocols.

Practical implication: Training effectiveness and welfare improve when reinforcer combinations are tailored to individual dogs' motivational profiles.

### *Moderate Evidence*

#### *Canine body language and signal interpretation*

The interpretation of canine signals requires consideration of the full behavioral context, including posture, facial expression, tail position, and interpersonal distance. Tail wagging alone is not a reliable indicator of positive emotional state; interpretation depends on tail height relative to the dorsal line, amplitude, frequency, and laterality, with right-biased wagging associated with approach motivation and left-biased wagging with withdrawal or caution (Quaranta et al., 2007; Siniscalchi et al., 2013). Calming signals—including out-of-context yawning, lip-licking, head turning, and body stiffening—indicate discomfort or attempts at conflict de-escalation, though humans frequently misinterpret these as friendly behaviors. The DogFACS framework has enhanced objective facial coding capabilities, revealing that dogs display increased inner brow raising in human presence; however, inter-coder reliability varies and anthropomorphic misattribution remains a concern (Waller et al., 2013; Bremhorst et al., 2021).

Olfaction functions as an additional affective channel: human chemosignals associated with different emotional states influence canine exploration, proximity, and physiological responses, with developmental differences observed in puppies (D'Aniello et al., 2018; Semin et al., 2019; D'Aniello et al., 2023). Methodological challenges include odor stimulus control, small sample sizes, and limited replication opportunities.

#### *Common misinterpretations*

Several common human behaviors are frequently misinterpreted by dogs or misunderstood by humans. Hugging and kissing, which humans experience as intimate affection, may be perceived by dogs as restraint or spatial intrusion; tolerance does not equal enjoyment. Direct sustained gaze from unfamiliar individuals may be interpreted as confrontational. The “guilty look”—characterized by lowered posture, averted gaze, and appeasement signals—appears to represent a response to owner cues of disapproval rather than genuine guilt about past transgressions (Horowitz, 2009). Variability in these interpretations is explained by contextual factors including cultural norms regarding human-dog interaction, age-related differences in signal recognition (children

show reduced ability to detect threat markers), individual socialization history, current physiological state, and potential breed-related differences in communication style.

Practical implication: Brief lateral contact with soft gaze, respecting canine consent signals, should replace insistent frontal approaches; education about calming signals is essential for children and caregivers.

### *Methodological Note (Residual Uncertainty)*

While no domains lack evidence entirely, several subtopics present uncertain findings requiring additional investigation: control of odor stimuli in chemosignal studies, individual variation in social versus food reinforcement preferences, ecological validity of visual stimuli, and fMRI sample sizes that limit statistical power. Future research should prioritize ecologically valid paradigms, diverse samples including working and community dogs beyond WEIRD populations, and standardized measurement protocols for hormonal and autonomic indicators.

### *Integrative Synthesis*

Three key convergences emerge from the literature: (1) social reinforcement through praise and tactile contact holds significant motivational value for many dogs; (2) the oxytocin-mediated positive feedback loop activated by mutual gaze and touch strengthens bonding; (3) bio-behavioral synchrony develops through repeated positive social interactions. Primary communication asymmetries include: the potential for hugging and kissing to function as restraint rather than affection; frequent misinterpretation of calming signals and the “guilty look”; and the aversive potential of direct staring by unfamiliar individuals. Research gaps requiring systematic investigation include cross-cultural comparisons, longitudinal developmental studies, hormonal/HRV protocol standardization, and adequately powered neuroimaging samples.

### *Analysis*

This section provides an integrated analysis of human affectionate gestures and canine affiliative signals, demonstrating that effective communication depends on the organization of encounters rather than gesture form alone. The quality of communication is determined by how interactions are initiated, their timing and duration, spatial configuration, and the history and current state of both participants.

Stroking represents the most naturalistic form of tactile contact within the dyad. Effectiveness depends on the body region contacted (lateral zones preferred over head/muzzle), pressure applied, duration, and crucially, who initiates and terminates contact. When dogs solicit contact and humans respond appropriately—attending to approach signals and withdrawal cues—positive outcomes are maximized. Stroking the peri-facial area requires particular sensitivity, as this zone is communicatively dense and more likely to elicit defensive responses.

Mutual gaze between familiar dyad members functions affiliatively, contrasting with the agnostic quality of sustained staring from strangers. The key distinction lies in gaze quality: soft, intermittent looking maintains affiliation, while fixed, direct staring may signal threat. Within established relationships, mutual gaze activates oxytocin release and strengthens bonding; with unfamiliar individuals, the same behavior may trigger avoidance or defensive responses.

Vocal communication is modulated through pitch, intensity, tempo, and melodic contour. An infant-/pet-directed style—characterized by higher pitch, shorter utterances, and exaggerated prosodic contours—increases canine attention and facilitates social engagement. Social praise functions as a motivational reinforcer comparable in effectiveness to food rewards for some individuals, though considerable individual variation exists. Practical application requires identifying

which elements are most salient for each dog and adjusting the combination of voice, touch, play, and food according to individual profiles and current motivational states (Cook et al., 2016; Nagasawa et al., 2015; Handlin et al., 2011; Odendaal & Meintjes, 2003; Petersson et al., 2017).

Hugging and kissing represent the riskier end of the human affective repertoire. While humans experience these gestures as expressions of intimacy, dogs may perceive them as restraint (limiting escape options) and spatial intrusion (entering the sensitive peri-facial zone). Tolerance of these behaviors develops through positive relationship history but should not be conflated with enjoyment. Body signals indicating discomfort—trunk stiffening, head turning, lip-licking, ears flattened—indicate the need to restore personal space. Brief lateral contact, with the dog maintaining control over disengagement, serves as a more appropriate alternative (Waller et al., 2013). The human “kiss” interpretation of canine face-licking reflects misunderstanding: puppies lick adult faces to solicit food regurgitation, while adult dogs may lick for greeting, attention-seeking, taste exploration, or appeasement under social pressure (Horowitz, 2009; Waller et al., 2013).

Understanding canine signals requires attention to context-dependent interpretation. Tail wagging is not a reliable happiness indicator; signal interpretation requires examining body position, eye direction, and interaction dynamics. Tail height, speed, and laterality become meaningful only in combination with other postural cues (Quaranta et al., 2007; Siniscalchi et al., 2013). Calming signals—out-of-context yawning, quick nose-licks, slight head turns—function to reduce interactional tension. DogFACS coding reveals that specific facial movements, such as inner brow raising, increase in the presence of human attention, suggesting social sensitivity beyond simple “expressivity” (Waller et al., 2013; Bremhorst et al., 2021). The “guilty look” represents appeasement behavior triggered by human disapproval cues rather than awareness of past transgressions (Horowitz, 2009).

Multiple factors moderate these interactions. Cultural norms shape expectations about appropriate human-dog intimacy, with considerable variation in acceptance of behaviors such as facial contact. Child development influences signal recognition: children show reduced ability to detect threat markers and difficulty disengaging from arousing stimuli, necessitating structured adult supervision. Individual dog characteristics—early socialization, current health status, traumatic or strongly positive experiences—affect tolerance thresholds. Breed-related tendencies in communication style exist but do not override individual and experiential factors. The olfactory dimension remains constant: dogs perceive all environmental odors, including human body odors and chemosignals, that influence their behavioral and physiological responses (D’Aniello et al., 2018; Semin et al., 2019; D’Aniello et al., 2023).

## Conclusion

Comparing human gestures with canine signals suggests that effective affective communication requires adherence to principles rather than recipes. First, consent: invite rather than impose, offer choices, and interrupt at the first signs of fatigue. Second, timing: provide clear initiation signals, maintain brief duration, and include pauses for renegotiation. Third, respectful proximity: attend to spatial configuration, approach angle, and relative height, as body geometry carries semantic significance for dogs. Fourth, personalization: no “dogs in general” exist—each individual has unique background, sensitivities, and preferences. Through these principles, stroking becomes a deliberate communicative act, gaze becomes a tool for mutual exploration, and voice maintains appropriate relational respect. Affection transforms into a bilingual dialogue maintaining mutual respect through rhythmic exchange.

## Discussion

This review reveals that humans and dogs share fundamental biological mechanisms supporting affective communication while employing distinct pragmatic strategies in their interactions. Dogs have evolved to interpret human social signals—including gaze, affective prosody, and tactile contact—as motivationally significant cues, while humans must actively learn to interpret canine regulatory signals. The central finding is that the effectiveness of affectionate gestures depends not on their form but on the quality of negotiation: outcomes are determined by the invitation quality, duration, spatial configuration, and the dog's opportunity to withdraw, rather than by the gesture itself.

A key integrative point concerns the distinction between affiliative displays and appeasement. Misunderstandings arise when humans conflate their own intimacy behaviors (hugging, kissing, sustained gaze) with genuine canine affiliation, failing to recognize that these same behaviors may function as appeasement or de-escalation signals from the dog's perspective. The experience of stroking depends on the physical characteristics of the contacted area, applied force, duration, and critically, who initiates and terminates the interaction. Familial mutual gaze, which is affiliative in nature, can become agonistic with strangers when it loses its characteristic softness and intermittence. Human facial contact enters the dog's sensitive peri-facial space; while tolerance may develop through positive relational history, such tolerance represents acquired acceptance rather than preference.

At the mechanistic level, research demonstrates that positive gaze and touch activate oxytocin modulation and produce neuroendocrine responses combining social reward with stress reduction (Nagasawa et al., 2015; Handlin et al., 2011; Odendaal & Meintjes, 2003; Petersson et al., 2017). Functional neuroimaging studies with awake dogs show caudate activation to owner-associated odors and voices and temporal cortex responses to human faces (Berns et al., 2014; Cook et al., 2016; Cuaya et al., 2016; Karl et al., 2020). These findings support the concept of shared social pleasure but do not validate assumptions that oxytocin constitutes “the love hormone” or serves as the fundamental cause of bonding. Oxytocin measurements following positive interactions function as useful correlates but should not be reified as the substance of attachment. Rather than focusing on single hormone measurements, future research should examine how dyads synchronize their physiological and behavioral systems (HR/HRV, cortisol, micro-temporal gaze patterns) during well-orchestrated communication.

The affective climate of human-dog interactions receives contributions from visual and auditory channels and from olfaction, which is frequently overlooked in research. Human chemosignals expressing different emotional states influence canine exploration and proximity, though this domain requires advanced paradigms to manage stimulus intensity and contamination (D'Aniello et al., 2018; Semin et al., 2019; D'Aniello et al., 2023).

Observed variability in communicative outcomes is largely explained by contextual factors. The boundary between appropriate and intrusive gestures shifts according to cultural influences, human age, socialization history, health status, individual dog characteristics (including breed-group traits), and immediate context. Children fail to recognize warning signals and persist in engaging with rewarding stimuli; senior dogs and dogs in pain display reduced touch tolerance; resource-rich environments (food, resting areas) narrow the negotiation window. Rather than prohibiting physical contact, the solution to reducing incidents requires understanding affection as a context-dependent practice that can be transformed through negotiation.

Translational implications for training emphasize methods combining social reinforcement with stress management, featuring brief contacts separated by clear pauses and genuine options for the dog. This approach proves more sustainable than pressure-based protocols. Caregiver and child education functions as a multiplier, transforming human-dog interactions through early signal detection, respect for peri-facial space, and acceptance of canine boundaries. Veterinary protocols incorporating owner presence and scent, cooperative handling, and predictable se-

quences improve both compliance and relational dignity. For assisted interventions and working dogs, evaluation of social reinforcement sensitivity, stress resilience, and tactile profile before training prevents career mismatches. In shelters, volunteer literacy on de-escalation signals and adoption of lateral greeting routines reduce arousal and facilitate stable adoptions.

Methodological limitations represent the primary barrier to building cumulative evidence. The field relies heavily on WEIRD samples, with recruitment methods that predominantly attract highly motivated volunteers with well-socialized dogs. fMRI tolerance and intensive handling paradigms exclude shy, stress-prone, or tactile-sensitive individuals, introducing “trainability bias” that inflates apparent responsiveness to social reinforcement while reducing observed variance.

Measurement challenges involve both construct and reliability issues. Lack of ethogram harmonization undermines inter-rater agreement; DogFACS quality depends on coder training and explicit reliability metrics (Waller et al., 2013; Bremhorst et al., 2021). Owner-reported measures, though useful, remain vulnerable to expectancy and social desirability biases, requiring validated instruments and, where possible, triangulation with observational or physiological indicators. Hormonal assays demand strict standardization: oxytocin and cortisol are sensitive to circadian rhythms, biological matrix (blood, saliva, urine, hair), storage/extraction protocols, and assay cross-reactivity; sampling latency and outlier management substantially affect estimates. HRV is similarly influenced by movement, posture, temperature, and respiration; without stable baselines, RMSSD/SDNN specifications, and synchronized timing across dyad members, comparisons remain fragile.

Many studies rely on static images and synthetic prosody, limiting ecological validity (Müller et al., 2015; Somppi et al., 2016; Barber et al., 2016); valence contrasts rarely control for arousal, risking confounds. Chemosignal research faces challenges of contamination and intensity control, requiring strict double-blind designs with complete documentation of cycle phase, diet, cleaning agents, and other olfactory variables. Recurring analytical problems include insufficient power, HARKing and p-hacking tendencies, post hoc ROI selection in fMRI, and inconsistent multiple comparison correction. Publication bias suppresses null findings, hindering realistic effect-size assessment. Resolution requires preregistration, shared analysis plans, study registries, and transparent reporting including data/code sharing.

External validity represents the critical test: laboratory results do not always translate to domestic or clinical contexts, where owner scent, spatial arrangement, procedural order, and emotional load of routines act as silent covariates. Future research should prioritize longitudinal designs with non-WEIRD samples (including community dogs), multi-site studies, and home-based paradigms with wearable sensors. Methodological integration combining DogFACS with computer vision, HR/HRV, thermography, and neuroimaging (where feasible) would enable differentiation of arousal and valence when studying dyadic synchrony at fine temporal resolution. Comparative studies with wolves, cats, and horses can identify domestication effects and clarify what aspects of human-dog communication are unique to this relationship.

### Conclusions & Implications

This review portrays a relationship conducted in two languages—human and canine—that achieves mutual understanding through an affective lexicon of gaze, voice, touch, and odor, harmonizing differences without erasing them. The strongest evidence indicates that soft visual contact combined with warm prosody and low-pressure stroking holds genuine motivational value for many dogs, producing neuroendocrine changes consistent with social pleasure and stress regulation (Nagasawa et al., 2015; Handlin et al., 2011; Odendaal & Meintjes, 2003; Petersson et al., 2017). Conversely, close physical proximity can generate predictable conflicts: movement restriction during hugging, spatial intrusion during facial contact, and direct staring at unfamiliar individuals.

Between these poles lies ordinary life, shaped by multiple contextual, historical, cultural, and physical factors that continuously reshape gesture meaning. The studies converge on a common principle: co-regulation rather than technique. The value of any gesture depends on the specific dyad and par-

ticular moment. The required rhythm involves invitation, attentive listening, adjustment, and withdrawal when signals demand it. The minimal pact asks humans to relinquish control—using time as a tool for care through brief durations and readable pauses—to match spatial configurations to partner sensitivity, and to customize reinforcement combinations according to individual profiles.

For family life, prioritizing low-pressure gestures and respecting individual thresholds reduces conflicts and increases emotional stability. For children, educational rather than prohibitive approaches are essential: teaching them to ask permission before touching, to recognize calming signals (yawning, lip-licking, gaze aversion), and to interrupt at fatigue signs demonstrates that affection operates through negotiation rather than entitlement.

In dog training, combining social reinforcement with stress management produces more durable outcomes than pressure-based methods. Exercise selection, pacing, and reward choices should be individualized, as some dogs preferentially value praise and touch while others require food as primary reinforcement. Pauses combined with predictable routines enhance communication clarity and accelerate learning.

In veterinary settings, a communicative perspective serves as clinical resource. Fear-free environments and procedures—including owner presence/scent, low-stress positioning, cooperative handling, and predictable sequences—improve compliance while restoring relational dignity. For assisted interventions, selecting dyads with functional attachment, monitoring non-invasive stress indicators, and calibrating session intensity to canine regulatory signals are essential. For working and service dogs, early assessment of social reinforcement sensitivity, stress resilience, and tactile tolerance prevents career mismatches.

Public education impacts extend broadly. Focusing on signal literacy rather than dominance mythology, explaining that facial contact enters sensitive peri-facial space, and distinguishing gentle looking from staring promotes better coexistence than slogans. Public interaction spaces—schools, clinics, shelters—benefit from minimal guidelines: rooms with exits, scheduling to reduce crowding, and informational materials consistent with current evidence.

Certainties coexist with methodological cautions requiring acknowledgment. Research relies heavily on small WEIRD samples; hormonal and HRV standardization remains incomplete; laboratory paradigms may not generalize to real-world conditions. Research priorities include ecological validity (dynamic stimuli, domestic contexts), sample diversity (non-WEIRD populations, community dogs), longitudinal dyadic designs (children, senior dogs), and multimodal methodologies (DogFACS with computer vision, wearable sensors, shared dyadic measures). The goal is developing a “neuroscience of the real” that monitors both synchrony and its disruptions in ordinary daily routines.

The final call is for mutual responsibility: moving beyond naïve anthropomorphism to develop informed empathy. This requires taking canine grammar seriously while protecting human language; protecting the dog’s right to communicate “enough”; and transforming affection from a unilateral act into genuine conversation. The review offers one practical suggestion that is both simplest and most challenging: to create space—through observation, vocalization, and physical contact—for the other’s choice. It is there, more than in any technique, that the quality of the bond is measured.

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## Affetto e comunicazione emotiva nella diade uomo–cane: una rassegna etologica comparativa

Daniele Guccione

*Ricercatore indipendente, Torino, Italia*

### Sintesi

La relazione uomo-cane si basa su un intricato sistema di comunicazione attraverso gesti di affetto umani (ad esempio, carezze, abbracci, modulazione vocale) e segnali di affiliazione canina (ad esempio, ricerca di prossimità, posture rilassate, sguardo sociale) che entrambe le parti comprendono. L’analisi di questi scambi costituisce la base per la teoria dell’attaccamento e per la cognizione sociale e la scienza del benessere. La ricerca ha utilizzato i database PubMed, Scopus e PsycINFO per rivedere la letteratura dal 2015 al 2025, insieme a studi precedenti fondamentali che includevano lavoro osservazionale sul campo, paradigmi cross-modalità, eye-tracking e risonanza magnetica funzionale (fMRI). Il processo di sintesi si è concentrato su tre aree principali: (i) attaccamento e modello di base sicura; (ii) riconoscimento e decodifica canina delle emozioni umane attraverso l’integrazione multimodale (riferimento sociale); (iii) meccanismi neurobiologici che supportano la comunicazione affettiva attraverso vie ossitocinergiche e dopaminergiche. La ricerca dimostra che il contatto visivo reciproco porta al rilascio di ossitocina, mentre il contatto sociale rafforza l’affiliazione e queste interazioni creano una sincronizzazione fisiologica. Le principali differenze tra esseri umani e cani derivano dall’antropomorfismo (gli abbracci offrono conforto agli esseri umani, ma creano restrizioni ai cani) e dalle differenze evolutive nella capacità dei bambini di rilevare i segnali di sofferenza canina, nonché dalle variazioni culturali in ciò che costituisce un comportamento intimo. La generalizzabilità dei risultati rimane limitata a causa di vincoli metodologici, tra cui campioni di piccole dimensioni, bias di popolazione WEIRD, preferenze di razza, resoconti dei proprietari non verificati e disegni di studio trasversali non preregistrati. La promozione dell’alfabetizzazione comunicativa contribuisce a ridurre le interpretazioni errate, creando al contempo interazioni equilibrate che portano a migliori risultati in termini di benessere. La ricerca futura deve concentrarsi su confronti interculturali, analisi comportamentali non invasive basate sull’intelligenza artificiale e biomarcatori fisiologici multimodali per valutare la qualità della relazione.

