Rethinking Human Cognition: A Comparative Framework Bridging Biological Roots and Social Complexity

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Abstract

Across cognitive science, psychology, and the social sciences, human cognition is often examined in isolation—treating capacities such as tool use, cooperation, fairness sensitivity, and political strategy as uniquely human or culturally constructed. However, decades of research in primatology and comparative cognition reveal that these abilities also appear in our closest living relatives—the chimpanzees—suggesting they are not human inventions, but structured extensions of shared cognitive functions. Here, we propose a comparative framework that bridges biological roots and social complexity by aligning core domains of human cognition—culture and learning, cooperation and joint action, social and goal inference, power and politics, morality and fairness, and species-general cognition—with functionally grounded mechanisms observed across species. This perspective reframes human cognition not as a set of isolated higher-order faculties, but as a structured continuum grounded in biologically grounded mechanisms. It offers a foundation for integrative modeling across cognitive science, social theory, and computational approaches to social behaviour.

Figure 1: Overview of the six-domain cognitive framework, aligning core human functions with observed chimpanzee capacities.

1 Introduction

Across cognitive science, psychology, and the social sciences, human cognition is often studied in isolation—treating capacities such as symbolic reasoning, moral judgment, political strategy, and cultural learning as uniquely human, culturally constructed, or emergent from abstract social

complexity. This framing reinforces the view that high-level cognition is built from abstract constructs, rather than from functional elaborations of shared biological capacities.

Yet decades of empirical work in primatology and comparative cognition suggest otherwise. Chimpanzees, our closest living relatives, demonstrate a wide range of cognitive behaviors long assumed to be uniquely human: they manufacture and use tools Goodall [1964], Boesch and Boesch [1990], Whiten et al. [1999], coordinate in cooperative hunts Boesch [1994], Mitani and Watts [2001], Boesch [2002], engage in tactical deception Woodruff and Premack [1979], Whiten and Byrne [1988], Hare et al. [2006], express fairness-related reactions Brosnan et al. [2005, 2010], and navigate dynamic social hierarchies with strategic coalition-building Manson et al. [1991], Wrangham and Glowacki [2012], Wilson et al. [2014]. These behaviors are not isolated anomalies—they are structured manifestations of cognitive capacities that form the substrate of human cognition.

Despite this growing body of evidence, the implications of primate cognition are rarely integrated into broader theoretical models of human cognition or social behavior. Instead, high-level domains such as morality, politics, or symbolic culture are often theorized independently of their biological roots, leaving a gap between empirical observation and the abstract constructs used to interpret it.

To address this gap, we propose a comparative framework that bridges biological roots and social complexity by aligning core domains of human cognition—culture and learning, cooperation and joint action, social and goal inference, power and politics, morality and fairness, and species-universal cognition—with functionally grounded mechanisms observed in chimpanzees. Rather than viewing these capacities as disconnected higher faculties, we frame them as structured elaborations of biologically continuous substrates.

Our contribution.

- **Cross-Disciplinary Synthesis:** We integrate long-term fieldwork, experimental findings, and theoretical insights to reconstruct a biologically grounded view of human cognition.
- **Comparative Functional Framework:** We propose a six-domain structure that identifies core human cognitive capacities as functional continuities of primate cognition, enabling systematic cross-species alignment.
- **Reframing Social Constructs:** We reinterpret capacities like symbolic culture, fairness, and political strategy as structured extensions of minimal cognitive functions—offering a testable and integrative alternative to symbolic or normative accounts.

Ethical Statement This work explicitly avoids biological determinism or simplistic evolutionary claims, instead emphasizing functional organization and empirical grounding over speculative adaptationist explanations.

2 Related Work

2.1 Human-Centered Assumptions in Cognitive and Social Sciences

Research in cognitive science and social sciences has traditionally examined human cognition in isolation, often treating capacities such as tool use, cooperation, fairness sensitivity, and political reasoning as uniquely human or culturally constructed Albert [2017], Geertz [2017]. Theory of mind Premack and Woodruff [1978], Tomasello [2009], moral reasoning Haidt [2001], Greene and Haidt [2002], and social institutions Albert [2017], Geertz [2017] are frequently modeled as symbolic, recursive, or normative frameworks disconnected from biological constraints. This has reinforced the assumption that many core cognitive functions are emergent properties of culture rather than grounded in shared cognitive mechanisms across species.

Our work challenges this species-isolated framing by proposing a cross-species perspective that situates human cognition within a continuum of biological functions. Rather than treating high-level cognition as an abstract or disembodied faculty, we argue it reflects structured elaborations of biologically grounded capacities.

2.2 Comparative Cognition and Primate Intelligence

Over the past three decades, primatology and comparative cognition have produced extensive evidence that non-human primates—especially chimpanzees—exhibit behaviors once thought to be uniquely human. These include cultural transmission of tools Whiten et al. [1999], strategic coalition building Waal [2007], sensitivity to inequity Brosnan and De Waal [2003], and coordination in cooperative tasks Melis et al. [2006a].

However, these findings are often siloed into specific behavioral domains. While existing work demonstrates individual capacities, it rarely integrates them into a broader cognitive framework. Our approach synthesizes these results into a functional comparative architecture that aligns key domains of human cognition with observed primate capacities, highlighting structured biological continuity rather than isolated parallels.

3 Framework Construction: Scope and Methodology

3.1 Empirical Basis

To construct a cross-species cognitive framework, we use human cognition as a reference point—given its relatively better documentation and conceptual organization. Our primary focus is on chimpanzees, whose cognitive capacities remain fragmented across domains and methodologies. By synthesizing decades of field and experimental data, we aim to reconstruct a functional organization of chimpanzee cognition that aligns with core features of human cognitive architecture.

This framework draws on empirical evidence from chimpanzee research, including both long-term field studies and controlled experiments. These sources capture behaviors expressed in ecologically valid and socially complex settings. Human studies are included as cognitive anchors where cross-species comparisons help clarify functional structure.

3.2 Source Criteria and Comparative Emphasis

Our goal is not comprehensive coverage, but selective inclusion of functionally informative studies that best illustrate specific cognitive capacities. Because chimpanzee research is fragmented across diverse observational and experimental literatures, we provide more detailed analysis for these findings. For capacities that resist controlled experimentation—such as coalition dynamics or intergroup hostility—we rely primarily on long-term ethological observations. Human data are included only when they help clarify domain-relevant mechanisms.

4 Functional Taxonomy Overview

Most theories in social science, psychology and cognitive science focus narrowly on humans—developing accounts of cooperation, morality, or political strategy without reference to other species. As a result, many capacities presumed to be uniquely human are theorized in isolation, despite long-standing evidence of similar behaviors in chimpanzees.

Tool use, deception, goal inference, social manipulation, and fairness preferences have all been documented in our closest relatives. Yet these findings remain fragmented across disciplines and are rarely integrated into broader cognitive theory. Without a unifying framework, the biological roots of human cognition remain obscured.

To address this, we introduce a cross-species functional taxonomy that aligns key domains of human cognition with structured capacities observed in chimpanzees. Rather than categorizing behavior by species or task, the taxonomy organizes cognition by underlying function—highlighting shared mechanisms that support complex social behavior. It comprises six domains:

1. **Culture and Learning**: How individuals acquire, retain, and transmit knowledge through observation, interaction, and group-specific traditions — enabling behaviors to persist across time and partners.
2. **Cooperation and Joint Action**: How individuals coordinate their actions with others — working toward shared goals, dividing roles, or synchronizing behavior in collective tasks.

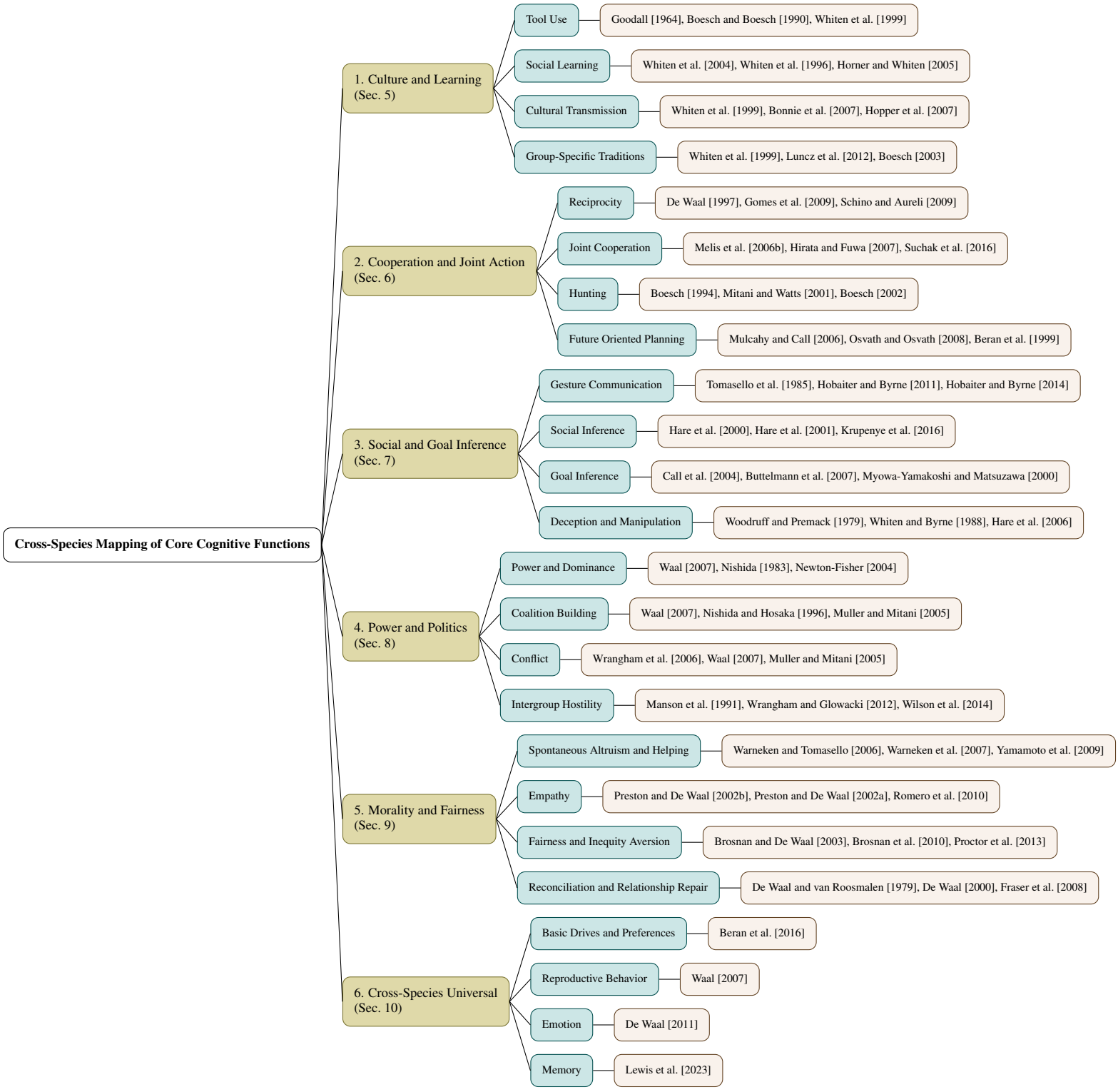

Figure 2: Cross-species cognitive taxonomy aligning six core domains of human cognition with observed chimpanzee behaviors. Each branch includes representative subfunctions and supporting studies, illustrating the structured continuity between human and primate cognition.

3. **Social and Goal Inference**: How individuals interpret others' actions, intentions, and social ties — adjusting behavior based on goals, attention, or affiliative context.
4. **Power and Politics**: How individuals navigate dominance, alliances, and group tensions — shaping access to resources, influence, and long-term social position.
5. **Morality and Fairness**: How individuals respond to unequal treatment, unsolicited harm, or social disruption — including preferences for fairness, helping, and repairing relationships.
6. **Species-Universal Cognition**: Cognitive capacities—such as emotion, memory, and motivation—that are broadly observed across many species, and thus not unique to humans or great apes.

This taxonomy offers a functional map of primate cognition—bridging fragmented findings and reframing high-level human functions as structured extensions of biologically grounded capacities.

5 Culture and Learning

5.1 Evidence from Human Behavior

Humans are highly flexible learners. They acquire skills through exploration, trial-and-error, and by observing and interacting with others. From an early age, people learn how to use tools, complete tasks, and follow routines by watching how others behave and engaging in shared activities Bandura and Walters [1963], Albert [2017].

A defining feature of social species is the emergence of group-specific ways of doing things—patterns that are shared within a community and stable over time. These stable, transmissible behaviors are commonly described as "culture." In humans, culture can be seen in practices like tool use, food preparation, and social rituals, which differ across populations and persist across generations Boyd and Richerson [2005].

5.2 Behavioral Evidence from Chimpanzees

5.2.1 Tool Use

Tool use was long seen as a defining line between humans and other animals—a sign of intelligence and culture. But decades of field research have overturned that idea. Wild chimpanzees have been observed using sticks to fish for termites, stones to crack nuts, and even sharpened branches to hunt small animals.

This shift began with Goodall's groundbreaking observations Goodall [1964], which revealed that chimpanzees in the wild also use sticks to extract insects, leaves to drink water and clean themselves, and stones as deliberate projectiles. Building on this, Boesch and Boesch Boesch and Boesch [1990] found that such behaviors vary across chimpanzee groups—not just due to environmental differences, but also based on how individuals learn from one another. Their findings suggested that some tool-use patterns are socially transmitted, much like human cultural traditions. Whiten et al. Whiten et al. [1999] later compared chimpanzee behavior across seven field sites and identified 39 distinct group-specific behaviors—many involving tools. They argued that differences like termite fishing and nut cracking are best explained by cultural learning, rather than ecological necessity.

5.2.2 Social Learning

Chimpanzees don't just figure things out on their own—they learn by watching others. Young individuals often acquire tool use and foraging skills through years of observing their mothers. Many group-specific behaviors are passed down this way, making social learning essential to how chimpanzee communities maintain their own traditions.

Whiten et al. Whiten et al. [2004] provided a detailed classification of social learning strategies in apes—from basic attention cues to structured imitation—and argued that chimpanzees can replicate not just individual actions but also the sequence and organization of behavior. This capacity underpins the transmission of complex traditions. In a now-classic study, Whiten et al. Whiten et al. [1996] showed that while both chimpanzees and children can imitate, only children tend to copy unnecessary steps—a phenomenon later termed overimitation. Horner and Whiten Horner and Whiten

[2005] further demonstrated that chimpanzees switch between imitation and emulation depending on whether they understand a task's causal structure, suggesting that their learning is goal-directed and flexible—not mere mimicry.

5.2.3 Cultural Transmission

Many chimpanzee behaviors—like nut cracking or hand-clasp grooming—are passed down across individuals and persist over generations. These group-specific traditions, which cannot be fully explained by genetics or ecology, point to cultural transmission through social learning.

Whiten et al.Whiten et al. [1999] first provided systematic field evidence for this idea, showing that behaviors such as termite fishing and nut cracking vary between groups in ways best explained by social transmission. Hopper et al.Hopper et al. [2007] later confirmed this experimentally, demonstrating that chimpanzees can acquire and retain group-specific behaviors purely through observation. Bonnie et al. Bonnie et al. [2007] extended these findings by showing that even arbitrary habits—when introduced by a model—can spread and persist, suggesting that chimpanzees follow group conventions even when there is no functional advantage.

5.2.4 Group-Specific Traditions

Group-specific traditions are behavioral patterns that differ across chimpanzee communities and are passed down over time—not through genes or environment, but through shared routines. These include local variations in tool use, foraging methods, and social gestures—like nut cracking, water sponging, or hand-clasp grooming—that cannot be explained by ecology or genetics alone. Such stable, socially learned behaviors form the foundation of chimpanzee culture.

Whiten et al.Whiten et al. [1999] provided the first systematic field evidence for this cultural transmission, identifying 39 distinct traditions across seven wild populations. These ranged from tool techniques to social practices, and were best explained by group-specific learning. Luncz et al.Luncz et al. [2012] built on this by comparing neighboring groups in similar environments, showing that even subtle differences—like tool preferences or grooming styles—persist through social learning. Boesch Boesch [2003] argued that these findings challenge the idea of culture as uniquely human, suggesting instead a cognitive and cultural continuity between humans and chimpanzees.

6 Cooperation and Joint Action

6.1 Evidence from Human Behavior

Humans cooperate in all kinds of situations—helping one another, building things together, making plans, or solving problems as a team. Even young children can figure out what someone else is trying to do and join in. What makes human cooperation special is that it doesn't stop at small tasks. People can work together across time, across roles, and across entire communities. This ability to cooperate at scale is what allows human societies to grow, organize, and build everything from shared knowledge to complex civilizations Henrich [2016].

6.2 Behavioral Evidence from Chimpanzees

6.2.1 Reciprocity

Reciprocity refers to the tendency to return benefits over time based on past interactions. In chimpanzees, this often takes the form of grooming, food sharing, or coalition support. These behaviors are not driven by emotional bonds alone, but by a memory of past partners and an expectation of future return. Such partner-specific tracking enables individuals to maintain stable cooperation even without immediate payoff.

Several studies support this view. De Waal De Waal [1997] was the first to propose, based on long-term field observations, that chimpanzee social life functions as a "service economy"—where grooming, alliance support, and mating access are exchanged over time. Gomes and Boesch Gomes et al. [2009] provided empirical evidence that grooming is often reciprocated after delays spanning days or weeks, indicating that individuals keep track of past interactions. Schino and Aureli Schino and Aureli [2009] further argued that primates sustain long-term cooperation not through exact

scorekeeping, but by forming stable bonds—built on memory, partner preference, and emotional regulation.

6.2.2 Joint Cooperation

Joint cooperation occurs when chimpanzees coordinate their actions in real time to achieve a shared goal—such as pulling ropes together or hunting in pairs. This goes beyond helping, requiring mutual monitoring and shared intent.

Studies show that chimpanzees are not only capable of such coordination, but also selective in how they do it. Melis et al.Melis et al. [2006a] found that individuals actively recruit the most effective partners in cooperative tasks, based on competence. In follow-up experimentsMelis et al. [2006b], chimpanzees demonstrated an understanding of coordination demands and chose collaborators strategically. Extending this to more natural settings, Suchak et al. Suchak et al. [2016] showed that chimpanzees spontaneously form alliances even in competitive contexts, selecting partners based on both skill and social tolerance. These findings suggest that joint cooperation in apes is flexible, partner-sensitive, and guided by social evaluation—not rule-following.

6.2.3 Hunting

Hunting in chimpanzees is a coordinated group activity that often involves role differentiation. Unlike opportunistic foraging, successful hunts—particularly of agile prey like monkeys—require individuals to anticipate each other's actions and take on complementary roles, such as drivers, blockers, or ambushers. These behaviors suggest that chimpanzees can intentionally align their actions toward shared goals.

Chimpanzee hunting displays clear signs of intentional coordination and social complexity. Boesch Boesch [2002] found that wild Taï chimpanzees adopt distinct roles during hunts—such as drivers, blockers, and ambushers—acting in sync without explicit signals. Boesch Boesch [1994] showed that group hunting is more stable when meat is broadly shared and collective success is high, emphasizing the role of local social context. Mitani and Watts Mitani and Watts [2001] observed that chimpanzees hunt more frequently when in the company of other males and share meat selectively, often in ways that support alliance formation, rather than as direct exchanges for food or mating.

6.2.4 Future Oriented Planning

Future-oriented planning is the ability to act in the present to meet a future need. It requires anticipating upcoming situations and selecting actions accordingly, even when there is no immediate reward or external cue.

Chimpanzees have demonstrated several capacities consistent with future planning. Beran et al. [1999] showed that individuals can delay gratification, choosing larger delayed rewards over smaller immediate ones. Osvath and Osvath [2008] found that apes can forgo immediately attractive items in favor of tools needed for a task occurring an hour later, suggesting both inhibitory control and the ability to anticipate future contexts. Mulcahy and Call [2006] further demonstrated that apes can select and retain tools for future use after delays of up to 14 hours, providing strong evidence for future-oriented planning in the absence of present-moment reinforcement.

7 Social and Goal Inference

7.1 Evidence from Human Behavior

Humans are intensely social primates Dunbar [1998]. Like other great apes, we rely on relationships to survive and learn—but on a scale no other species approaches. Modern life revolves around anticipating, responding to, and influencing the behavior of others. From parenting to politics, from casual talk to digital feeds, daily behavior is shaped by what others do, want, or expect.

This constant exposure makes social skill a primary driver of human cognition. People learn how to interact, cooperate, and compete not by theorizing, but by engaging—through repetition, adjustment, and memory across lived experience Vygotsky and Cole [1978].

7.2 Behavioral Evidence from Chimpanzees

7.2.1 Gesture Communication

Gestural communication refers to the use of intentional, flexible bodily signals—such as hand movements, postures, or facial expressions—to influence the behavior of others. Unlike reflexive or fixed signals, gestures are often produced with a specific goal, adjusted based on social context, and used selectively, making them a key window into intentional and referential communication.

Chimpanzees use gestures across a range of social situations with clear signs of intentionality and flexibility. Tomasello et al. [1985] found that young individuals adjust their gestures based on context and recipient response, suggesting that these signals are learned and goal-directed. Hobaiter and Byrne [2011] catalogued 66 gesture types in wild chimpanzees, many of which were modulated in real time according to the social environment. Hobaiter and Byrne [2014] identified over 60 gesture types and demonstrated that most consistently elicited specific responses, indicating a structured gestural repertoire with semantic properties.

7.2.2 Social Inference

Social inference refers to the ability to pattern-match across various interaction signals—such as perceptual access, past encounters, and situational regularities—to anticipate how others are likely to act. These capacities facilitate smoother coordination and strategic behavior in group-living animals.

Chimpanzees exhibit multiple components of this ability. Hare et al. [2000] showed that they distinguish what others can and cannot see, indicating sensitivity to visual perspective. Hare et al. [2001] demonstrated that they track what others have previously encountered, using memory of past access to predict competitive choices. Krupenye et al. [2016] found that great apes forecast actions even when another individual holds outdated or incomplete information, suggesting an ability to integrate others' informational history into behavioral predictions.

7.2.3 Goal Inference

Goal inference refers to the ability to interpret others' actions as directed toward specific outcomes. It involves extracting intentional structure from behavior—inferring what another agent is trying to achieve, even when the goal is not explicitly stated. This capacity supports both social prediction and cooperative interaction.

An early study by Myowa-Yamakoshi and Matsuzawa [2000] explored whether chimpanzees imitate purposeful object-manipulation, but results were inconclusive—partly due to high baseline performance that made it hard to isolate imitation or infer goal understanding. Later work provided more direct evidence that chimpanzees infer goals from both contextual cues and action structure. Call et al. [2004] showed that they distinguish between intentional and accidental failures, responding differently when an experimenter was unwilling versus unable to act. Buttelmann et al. [2007] found that chimpanzees selectively imitate actions when the demonstrator had a choice, suggesting sensitivity to goal rationality.

7.2.4 Deception and Manipulation

Deception and manipulation involve using an understanding of others' minds to influence them in misleading ways. These behaviors depend on tracking what others know or attend to, and adjusting one's actions to shape that information. Rather than coordinating minds, the goal is to create a gap between what is real and what others believe.

Woodruff and Premack [1979] showed that chimpanzees selectively convey or withhold information depending on whether a human partner is cooperative or competitive, providing early evidence of context-sensitive deception. Whiten and Byrne [1988] introduced the concept of tactical deception as the strategic misuse of typically honest signals, positioning primates as key models for studying flexible social cognition. Hare et al. [2006] found that chimpanzees avoid a competitor's line of sight when retrieving food, demonstrating visual perspective-taking and strategic behavioral adjustment.

8 Power and Politics

8.1 Evidence from Human Behavior

Power is a central feature of human social life. People form alliances, compete for status, and influence others' behavior—but human power goes far beyond dominance. Politics, in this context, refers to the strategic use of power to navigate social relationships and influence group outcomes. This ability enables humans to coordinate collective action, manage conflict, and maintain stability as communities grow in size and complexity Keltner et al. [2003].

8.2 Behavioral Evidence from Chimpanzees

8.2.1 Power and Dominance

Chimpanzees live in hierarchical groups, where rank directly affects their access to food, mating opportunities, and the ability to manage conflicts. But chimpanzee dominance isn't just about physical strength—it also involves sophisticated social tactics like building alliances, using intimidation, or choosing the right timing. High-ranking chimpanzees must continuously navigate complex relationships and potential threats to maintain their power.

The most famous description of chimpanzee dominance comes from Frans de Waal's Chimpanzee Politics [Waal, 2007], which highlights how alpha males rise and fall not by aggression alone, but through strategic alliances and social maneuvers. Field studies have also confirmed this complexity. For example, Nishida [1983] observed the dramatic overthrow of an alpha male, showing how dominance strongly predicts mating opportunities, especially during unstable transitions. Meanwhile, research by Newton-Fisher [2004] found that stable alpha males often maintain power through social control rather than frequent fighting, suggesting that true dominance involves managing relationships more than winning physical conflicts.

8.2.2 Coalition Building

Chimpanzees form coalitions to gain advantage in conflicts, challenge dominant individuals, or support allies. These alliances are typically short-term, built on mutual interest rather than kinship, and require recognizing the right partners, timing, and social context to shift the balance of power.

Coalition formation is a central feature of male chimpanzee social life. In Chimpanzee Politics, de Waal [Waal, 2007] showed that such alliances are fluid and strategic—used to suppress challengers, support dominant partners, or preempt emerging threats. Long-term fieldwork by Nishida and Hosaka [1996] confirmed that coalitions are selectively maintained and play a key role in reshaping dominance hierarchies. Muller and Mitani [2005] further emphasized that these coalitions often form between non-relatives and require sophisticated social tracking, enabling coordination not only in rank contests but also in collective actions like territorial patrols.

8.2.3 Conflict

Chimpanzees engage in aggressive interactions for a variety of reasons—including competition over dominance, mating, food, or shifts in social dynamics. But their conflicts are rarely indiscriminate. Individuals assess their chances, decide whether to escalate or withdraw, and sometimes recruit allies—depending on the social context, the audience, and the potential stakes involved.

These patterns of conflict are neither impulsive nor chaotic. Wrangham et al. [2006] found that lethal aggression, especially in intergroup contexts, often takes the form of low-risk, coordinated raids that resemble human-style coalitional violence. Within groups, de Waal [Waal, 2007] observed that male confrontations frequently involve calculated aggression, staged intimidation, and social maneuvering rather than direct harm. Muller and Mitani [2005] further showed that aggression typically arises from status competition and mating disputes, and is often followed by reconciliation or third-party intervention—highlighting the strategic management of conflict in chimpanzee societies.

8.2.4 Intergroup Hostility

Chimpanzees were the first nonhuman species observed to engage in war-like intergroup violence. Jane Goodall's fieldwork in Gombe [Goodall, 2011] revealed that chimpanzees carry out deliberate,

coordinated attacks on members of neighboring groups—often targeting isolated individuals during territorial patrols. This discovery challenged the long-standing view that organized, strategic violence was uniquely human, suggesting instead that coalitionary aggression may arise under shared social and ecological conditions.

Subsequent research has shown that group-level aggression in chimpanzees follows structured, low-risk strategies. Manson et al. [1991] found that such attacks typically take the form of surprise raids, launched when attackers outnumber a vulnerable target. Wrangham and Glowacki [2012] argued that these behaviors emerge under predictable conditions—clear group boundaries, numerical asymmetry, and potential material or reproductive gain—closely mirroring patterns of warfare in small-scale human societies. Long-term observations by Mitani et al. [2010] further demonstrated that coalitionary violence can yield lasting territorial expansion, highlighting its strategic and calculated nature.

9 Morality and Fairness

9.1 Evidence from Human Behavior

Humans are sensitive to fairness, rule violations, and moral transgressions—even when they are not directly affected. Children as young as three protest unequal treatment or reject partners who break rules. These responses are not limited to personal gain or loss, and often reflect an expectation that others should follow shared standards of behavior Turiel [1983].

9.2 Behavioral Evidence from Chimpanzees

9.2.1 Spontaneous Altruism and Helping

Spontaneous altruism refers to unprompted behaviors that benefit others, carried out without external pressure, solicitation, or immediate reward. One key form is instrumental helping—actions that assist others in achieving their goals. Such behavior suggests an ability to recognize another's needs and respond in the moment.

Warneken and Tomasello [2006], Warneken et al. [2007] found that human infants spontaneously help unfamiliar adults across a range of situations. Chimpanzees also help without prompting, but typically only in simple, low-effort tasks. Yamamoto et al. [2009] further showed that chimpanzees help more reliably when directly requested, suggesting their helping behavior depends more on overt cues than on spontaneous goal inference.

9.2.2 Empathy

Empathy refers to the ability to detect another's emotional state and adjust one's behavior accordingly. It supports behaviors such as offering comfort, responding to distress, or modifying actions based on how others feel—without requiring explicit signals.

Empathy spans a range of processes from basic affective matching to more complex social responses. Preston and De Waal [2002b] proposed that it unfolds along a continuum—from automatic responses like emotional contagion to higher-level skills such as perspective-taking—reflecting layered mechanisms across species. Preston and De Waal [2002a] highlighted the role of emotional expression in allowing individuals to map others' feelings onto their own internal states. Romero et al. [2010] found that chimpanzees engage in post-conflict consolation, with bystanders selectively comforting distressed partners, suggesting a capacity for sympathetic concern.

9.2.3 Fairness and Inequity Aversion

Inequity aversion refers to the ability to detect and evaluate unequal outcomes in reward, effort, or treatment between oneself and others. Rather than responding only to low personal gain, individuals may react to perceived unfairness relative to others—affecting decisions about cooperation, sharing, or withdrawal from social interactions.

Brosnan and De Waal [2003] first demonstrated inequity aversion in nonhuman primates, showing that capuchin monkeys often reject lower-value rewards when a peer receives a better one for the

same task. Follow-up research in chimpanzees [Brosnan et al., 2010] confirmed that such reactions reflect a sensitivity to relative outcomes, not just dissatisfaction. In a modified ultimatum game, Proctor et al. [2013] found that chimpanzees tended to offer and accept equitable splits, suggesting a basic but context-sensitive understanding of fairness in social exchanges.

9.2.4 Reconciliation and Relationship Repair

Chimpanzees are often portrayed as aggressive and competitive, but long-term research has revealed a surprising counterbalance: after serious conflicts, former opponents frequently reconcile through gestures like embracing, kissing, or gentle touching. These post-conflict interactions reduce tension and help repair damaged relationships, playing a critical role in preserving cohesion within socially complex and dominance-driven groups.

De Waal and van Roosmalen [1979] first systematized the study of these behaviors, distinguishing reconciliation—friendly contact between former opponents—from consolation—comforting interactions offered by bystanders. Both serve to restore social stability after conflict. Building on this, De Waal [2000] showed that such behaviors are widespread among primates and especially common between close partners, reflecting a broader strategy for maintaining group cohesion. Fraser et al. [2008] further demonstrated that consolation reduces visible stress in victims, suggesting that these responses involve not just social coordination, but also emotional regulation.

10 Species-Universal Cognition

Basic Drives and Preferences. Chimpanzees display consistent preferences that reflect learned associations and value assessment. In a controlled study, Beran et al. [2016] showed that chimpanzees could associate food quality with visual cues and selectively choose previously rewarding options, even in the absence of immediate taste. This indicates a stable preference system grounded in memory and evaluation rather than reflex or habit.

Reproductive Behavior. Chimpanzee mating strategies are deeply embedded within social hierarchies and power dynamics. Waal [2007] documented how high-ranking males h could further establish these themes as valid empirical phenomena within cognitive science, bridging the conceptual gap between cultural and biological understandings of complex social behaviors.

Emotion. Emotions are often treated as impulsive reactions or black-box labels with little explanatory value. De Waal De Waal [2011] argues instead that they serve as internal states that help animals adjust their behavior in flexible and socially responsive ways—such as hesitating, avoiding conflict, or reconciling after fights.

Memory. Chimpanzees exhibit robust long-term memory capacities that support extended social tracking. For example, Lewis et al. [2023] found that chimpanzees and bonobos can distinguish familiar individuals they had not seen for over a decade, solely based on facial cues. Such findings highlight stable, domain-general memory systems that persist across time and social context.

11 Limitations and Scope

This framework offers a conceptual synthesis of core cognitive functions observed in chimpanzees, grounded in functionally significant cognitive mechanisms rather than exhaustive literature coverage. Our aim is not to catalog every reported behavior, but to extract and organize functionally coherent patterns that support cross-domain cognition and enable species-level comparison.

Given the fragmented nature of primate research—spanning diverse methodologies and field conditions—some nuances are necessarily simplified or excluded. The framework prioritizes structural clarity and cross-species alignment over completeness. It should be read as a principled mapping of core capacities, not a comprehensive record of all empirical variation.

12 Implications and Future Directions

12.1 Cognitive Science: From Cultural Constructs to Cognitive Continuity

Concepts such as morality, political behavior, and culture have traditionally been framed as social constructs. This survey suggests they can instead be viewed as natural extensions of biological cognition, rooted in broadly conserved cognitive capacities rather than solely invented through cultural or social conventions. Future research could further establish these themes as valid empirical phenomena within cognitive science, bridging the conceptual gap between cultural and biological understandings of complex social behaviors.

12.2 Psychology: From Abstract Constructs to Comparative Mechanisms

Mainstream psychological research often isolates narrow cognitive tasks—such as false-belief attribution, prosocial choice, or imitation—within highly specific experimental setups applied only to humans. As a result, the field accumulates disconnected findings with limited generalizability, and lacks a coherent framework for organizing these behaviors into functional cognitive units. Without such structure, it becomes difficult to determine what each task actually reveals about underlying mechanisms, or to assess the conditions under which a given function appears. A more structured approach requires defining cognitive functions in terms of observable behavioral units and comparing them across species and developmental stages. Cross-species and infant comparisons are not peripheral but essential, as they help identify the boundaries, prerequisites, and scope of specific cognitive functions beyond isolated task performance.

12.3 Social Science: Reframing the Foundations

This functional survey of primate cognition opens new possibilities for revisiting foundational assumptions in fields such as sociology, anthropology, and political science. Instead of viewing phenomena like morality, culture, or power as purely institutional or normative constructs, these patterns can be reinterpreted as grounded in general cognitive mechanisms. This perspective offers a pathway to redefine core social science concepts in terms of biologically plausible and cognitively interpretable units—bringing greater empirical clarity, conceptual coherence, and testability to longstanding theoretical debates.

12.4 Social Simulation: From Empirical Cognition to Mechanistic Modeling

Empirical studies of chimpanzee behavior provide unique insights into the fundamental cognitive mechanisms underlying social interactions. By systematically characterizing and formalizing these mechanisms, future research can transform previously abstract social concepts into explicit, operationally defined units suitable for simulation. This methodological shift enables bottom-up, mechanism-driven modeling approaches, facilitating rigorous exploration of how complex social patterns can spontaneously emerge from minimal cognitive constraints, independent of linguistic or institutional assumptions.

12.5 Intelligence Research: From Abstract Ideals to Functional Definitions

The term "intelligence" is often used as a catch-all label for any behavior that appears complex. But not all such behaviors reflect high-level cognitive integration. Some are better understood as structured extensions of basic biological functions, while others may be task-specific strategies or simple reactive mechanisms. Without clearly defining what intelligence refers to, and distinguishing it from general cognitive operations, the label becomes uninformative. A meaningful framework should clarify which behaviors genuinely warrant the term "intelligence," and which should be understood through other, more precise functional categories.

13 Conclusion

Human cognition is often portrayed as an abstract, high-level domain—defined by constructs like morality, politics, and symbolic culture, and assumed to emerge uniquely from human social envi-

ronments. Yet when examined through a cross-species functional lens, these capacities reveal deep structural continuity with mechanisms already present in chimpanzees.

This paper reframes human cognition not as a discontinuous leap, but as a structured extension of biologically grounded functions. Our comparative framework aligns six core domains of human behavior with robust patterns in primate cognition, offering a taxonomy that bridges fragmented literatures across cognitive science, primatology, and social theory.

By grounding social complexity in generalizable biological functions, this perspective invites more interpretable, testable, and integrated models of human cognition—shifting the focus from what makes us unique to how complexity builds from continuity.

Declaration of LLM Usage

The authors used OpenAI's ChatGPT to assist in refining phrasing and improving clarity. All theoretical arguments and interpretations are original and authored by the researchers.

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