Grounding the Human Sciences: A Cross-Species Framework for Experimental Robustness

Abstract

Human research typically examines human phenomena without first clarifying the roots of the capacities that underlie them. As a result, researchers often move directly from partial observations to narrative accounts or loosely defined constructs that lack clear boundaries and stable empirical targets, making them difficult to falsify. This contributes to unstable findings and persistent replication failures. Yet decades of research in primatology and comparative cognition show that many capacities studied in the human sciences have functionally comparable counterparts in other primates. These comparisons reveal the shared biological and cognitive foundations of human capacities and provide an empirical basis for evaluating whether theories characterize them correctly. Here, we propose a cross-species framework that aligns major domains of human cognition with functionally comparable capacities observed across species. We also introduce a cross-species workflow for producing robust results by grounding human research in comparative evidence. Together, the framework and workflow ground the human sciences in observable capacities and comparative evidence, moving beyond loosely defined constructs and narrative interpretations toward a robust, mechanism-based science.

Keywords: Human Science, Cross-Species, Task Grounding, Experimental Robustness

1 Introduction

Human research often begins with partial observations of high-level phenomena without first clarifying the capacities that underlie them. Researchers may therefore move directly from these observations to narrative accounts or loosely defined constructs—such as symbolism, morality, culture, discourse, or social meaning—that lack clear boundaries and stable empirical targets. In the absence of a stable underlying phenomenon, evidence can always be selectively chosen or interpreted to support these accounts, making them difficult to falsify and contributing to unstable findings and persistent replication failures [1, 2].

Yet decades of empirical work in primatology and comparative cognition show that many capacities studied in the human sciences have functionally comparable counterparts in other primates. Chimpanzees, our closest living relatives, manufacture and

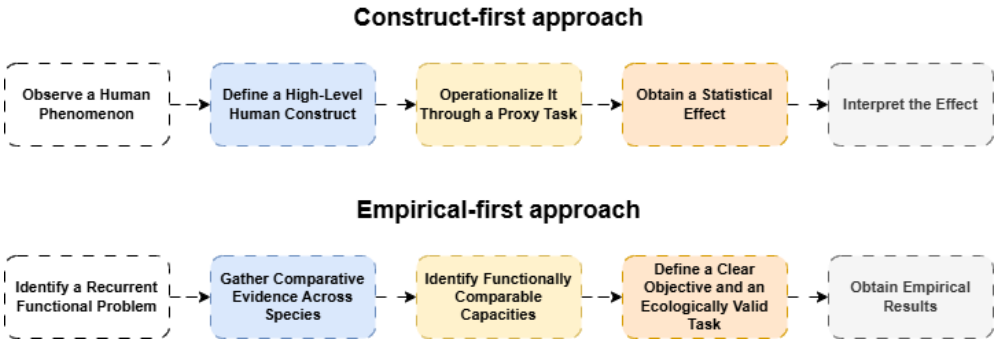

Fig. 1 Construct-first research operationalizes predefined high-level concepts through proxy tasks, leaving the resulting effects dependent on interpretation. The empirical-first approach uses comparative evidence to define capacities precisely and design ecologically grounded tasks, producing robust results.

use tools [3–5], coordinate in cooperative hunts [6–8], engage in tactical deception [9–11], express fairness-related reactions [12, 13], and navigate dynamic social hierarchies with strategic coalition-building [14–16].

Despite this growing body of evidence, comparative findings remain fragmented across separate research traditions and are often treated primarily as remarkable observations of nonhuman animal behavior. They have not been recognized as an empirical basis for grounding theories and experimental tasks in human research. Consequently, the human sciences often continue to explain phenomena such as morality, politics, and culture through top-down interpretations without first identifying the more basic and observable capacities from which they develop.

To address this gap, we propose a cross-species framework that aligns major domains of human cognition with functionally comparable capacities observed in chimpanzees. The framework reveals the shared biological and cognitive foundations of human capacities and provides an empirical basis for evaluating whether theories characterize them correctly. In addition, we introduce a cross-species workflow for producing robust results by grounding human research in comparative evidence. Together, the framework and workflow move the human sciences beyond loosely defined constructs and narrative interpretations toward a robust, mechanism-based science.

Our contributions.

This work makes three main contributions:

- **Replication failure.** It identifies the lack of stable and clearly defined capabilities as a fundamental source of replication failure in human research.
- **Cross-species framework.** It aligns six major domains of human cognition with functionally comparable capacities in chimpanzees, revealing their shared foundations.

- **Cross-species workflow.** It translates comparative evidence into a systematic basis for defining constructs, designing tasks, and grounding empirical claims.

2 The Interpretive Inheritance of Human Science

The study of human behavior grew out of philosophy, where humans first organized their ideas about what humans were supposed to be. The apparent depth of this vocabulary often came not from empirical precision, but from conceptual openness, unstable boundaries, and the complexity produced through interpretation. Although many fields have since adopted more empirical methods, they often still lack a clear account of where human behavior comes from. As a result, empirical research often continues to begin from vague concepts inherited from this tradition, such as morality, culture, discourse, and institutions, before the origins of these behaviors have been clarified.

3 The Fundamental Problem of Replication

For more than two decades, the replication crisis[1, 2] in human science has been attributed to statistical power, methodological flexibility, and publication incentives. These explanations concern surface-level sources of instability rather than the most fundamental problem: whether the empirical target itself is stable and clearly defined.

Research in human science often begins from partial observations of people, from which a construct is proposed and operationalized through proxy tasks. Yet many of these constructs are vague, lacking clear boundaries and a precise account of what they refer to. A more fundamental problem is that what is treated as a single construct often does not correspond to a stable capability. The resulting effects are therefore often weak, context-dependent, or absent altogether.

4 Why Cross-Species Comparison

Cross-species comparison serves three methodological functions:

- It identifies the core mechanism shared across species, allowing research to begin from the underlying capacity rather than from a collection of proxy tasks.
- It establishes a stable empirical target from which precise definitions and ecologically grounded experimental tasks can be developed, rather than relying on vague constructs and unconstrained interpretations.
- It begins from observable capacities rather than human-specific interpretations, allowing empirical results to falsify theories rather than be absorbed through reinterpretation.

5 A Cross-Species Foundation for Human Science

We introduce a cross-species taxonomy that organizes human and chimpanzee capacities by shared function across 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.
3. **Social and Goal Inference**: How individuals interpret others' actions, goals, and social ties — adjusting behavior according to social situations and contexts.
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 fairness, helping, and repairing relationships.
6. **Shared Biological Substrates**: Common biological substrates—such as emotion, memory, and reproductive behavior—that are broadly observed across many species, not only in humans or great apes.

This taxonomy provides a functional map of primate cognition, integrating fragmented findings and establishing a comparative basis for grounding theories and experimental tasks in human research.

6 Overview of the Six Domains

In this section, we first identify the major vague constructs and conceptual problems in the humanities, and then present empirical evidence from primates to show how these constructs can be grounded in observable behavior rather than defined through abstract interpretation.

6.1 Culture and Learning

Traditional view.

Culture has long lacked a settled definition, having variously been framed through meanings, symbols, norms, values, and shared practices [62–65]. Because culture has been studied primarily through the human case, its study has remained largely interpretive, with no clear starting point for identifying the functional components from which it arises.

Cross-species view.

Chimpanzees exhibit several constituent features of culture and learning:

- **Tool Use.** Chimpanzees use sticks, leaves, and stones to extract food, collect water, crack nuts, and perform other tasks [3–5].
- **Social Learning.** They acquire tool-use and foraging skills by observing others, and can flexibly imitate actions or reproduce their outcomes [17–19].
- **Cultural Transmission.** Chimpanzees adopt and transmit newly introduced techniques and arbitrary behaviors, allowing them to spread through groups and persist over time [20, 21].

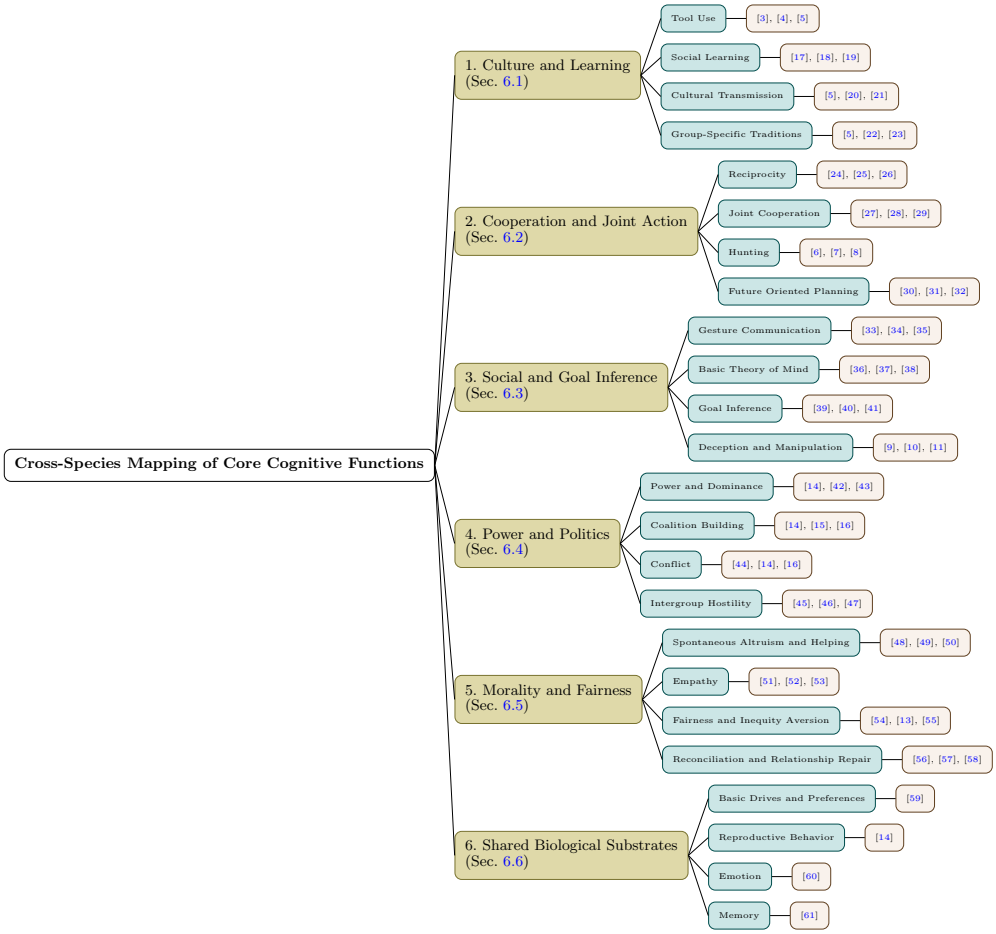

Fig. 2 Cross-species cognitive taxonomy aligning six core domains of human cognition with observed chimpanzee behaviors. Each branch includes representative subfunctions and supporting studies, illustrating the structured continuity between human and primate cognition.

- **Group-Specific Traditions.** Different communities maintain stable differences in tool use, foraging, and social practices, including among neighboring populations [5, 22, 23].

6.2 Cooperation and Joint Action

Traditional view.

Human cooperation has been explained through moral sentiments, social norms, reciprocal incentives, and institutions [66–69]. Because these accounts typically begin from the human case alone, their concepts often remain interpretive, leaving unclear what concrete processes they describe or at which level of explanation they operate.

Cross-species view.

Chimpanzees exhibit several constituent features of cooperation and joint action:

- **Reciprocity.** Chimpanzees exchange grooming, food, and coalition support over time, with patterns shaped by previous interactions and stable social relationships [24–26].
- **Joint Cooperation.** They recruit effective partners and coordinate their actions according to partner competence and social tolerance [27, 29, 70].
- **Hunting.** During group hunts, chimpanzees coordinate complementary roles and share meat in ways associated with collective success and alliance relationships [6–8].
- **Future-Oriented Planning.** Chimpanzees and other great apes delay gratification and retain tools for future use in the absence of immediate rewards or task cues [30–32].

6.3 Social and Goal Inference

Traditional view.

Social and goal inference have often been treated as uniquely human because they appear to involve understanding hidden intentions, meanings, and mental states [71, 72]. Since these states are not directly observable, however, such accounts often overstate what humans can actually know, turning inference from limited evidence into an apparent capacity for mind reading.

Cross-species view.

Chimpanzees exhibit several constituent features of social and goal inference:

- **Gesture Communication.** Chimpanzees use a flexible repertoire of gestures, adjusting their signals according to social context and recipient responses [33–35].
- **Social Inference.** They track what others can see and have previously encountered, using this information to anticipate subsequent behavior [36–38].
- **Goal Inference.** They distinguish unwilling from unable actors and respond to actions according to the demonstrator's apparent goal and available choices [39, 40].
- **Deception and Manipulation.** Chimpanzees selectively reveal or withhold information and adjust their actions according to what competitors can perceive [9–11].

6.4 Power and Politics

Traditional view.

Power is often inferred from its visible effects, such as dominance, status, authority, influence, and control [73–75], resulting in fragmented accounts rather than a clear understanding of power itself. More broadly, animals, particularly primates, are often intuitively portrayed as brutish and impulsive, overlooking the strategic and interactive nature of their social behavior [14]. Even attacks on neighboring groups reflect sensitivity to potential costs, benefits, and relative advantage [76].

Cross-species view.

Chimpanzees exhibit several constituent features of power and political behavior:

- **Power and Dominance.** Chimpanzee dominance depends not only on physical strength but also on alliances, intimidation, timing, and the management of social relationships [14, 42, 43].
- **Coalition Building.** They form fluid coalitions to support allies, challenge rivals, and reshape dominance hierarchies, often among non-relatives [14–16].
- **Conflict.** Chimpanzees adjust aggression according to status, allies, audience, and risk, and conflicts may be followed by reconciliation or third-party intervention [14, 16, 44].
- **Intergroup Hostility.** Chimpanzee communities conduct coordinated territorial patrols and attacks under numerical advantage, sometimes producing lasting territorial expansion [45, 46, 77, 78].

6.5 Morality and Fairness

Traditional view.

Morality is a strongly positive concept and has accumulated diverse meanings involving right and wrong, virtue, duty, justice, and obligation [79–81]. Its positive status also makes it easy to treat morality as uniquely human, leading to the assumption that animals lack it rather than considering whether more basic forms may exist in other primates [82].

Cross-species view.

Chimpanzees and other primates exhibit several constituent features associated with morality and fairness:

- **Spontaneous Altruism and Helping.** Chimpanzees provide instrumental help in simple, low-cost situations, particularly when recipients clearly signal their needs [48–50].
- **Empathy.** They engage in post-conflict consolation, with bystanders selectively comforting distressed partners [51–53].
- **Fairness and Inequity Aversion.** Primates respond to unequal rewards, while chimpanzees show context-sensitive reactions to relative outcomes and equitable divisions [13, 54, 55].
- **Reconciliation and Relationship Repair.** Former opponents restore affiliative contact after conflicts, while bystanders may console victims and reduce their stress [56–58].

6.6 Shared Biological Substrates

This section examines capacities found in chimpanzees that are also shared across other species:

- **Basic Drives and Preferences.** Chimpanzees form stable preferences from learned associations and select cues linked to previously rewarding outcomes [59].

- **Reproductive Behavior.** Their mating behavior is shaped by dominance, coalition support, mate guarding, social tolerance, and changing group relationships [14].
- **Emotion.** Chimpanzees display emotional responses that support flexible behavioral adjustment, including hesitation, conflict avoidance, and reconciliation [60].
- **Memory.** Chimpanzees and bonobos recognize familiar individuals after separations of more than a decade, demonstrating durable long-term social memory [61].

7 A Cross-Species Workflow for Empirically Grounded Human Science

The comparative framework can be translated into an empirical-first workflow for human research. Conventional research often defines a high-level construct from an observed human phenomenon, operationalizes it through a proxy task, and interprets the resulting statistical effect as evidence about that phenomenon. Without first identifying a stable underlying capacity, however, the task lacks a stable empirical target, producing unstable findings and persistent replication failures.

The empirical-first workflow reverses this order. It begins by identifying a recurrent functional problem rather than defining a high-level human construct in advance. Researchers then gather comparative evidence across species to identify functionally comparable capacities, develop a precise definition of the target capacity, and design an ecologically valid task.

This process specifies the target capacity precisely and provides a clear criterion for evaluating the results. When the observed behavior is inconsistent with that criterion, researchers can determine whether the discrepancy arises from the theoretical claim or the experimental design. The resulting evidence therefore provides a direct basis for testing and falsifying theoretical claims.

8 Conclusion

Cross-species comparison changes the starting point of human research. Rather than beginning with high-level constructs and then building proxy tasks from them, it begins with recurrent functional problems and observable capacities shared across species. This makes it possible to specify the empirical target in advance, allowing results to directly evaluate theories and reveal failures in theory or task design rather than depending on interpretation.

By organizing comparative evidence across major domains of human cognition and translating it into an empirical-first workflow, this paper provides a systematic basis for developing human research from empirically identified capacities. Stable empirical targets can provide precise foundations for definitions and experimental tasks, as well as explicit criteria for evaluating theoretical claims. In this way, the framework supports cumulative, falsifiable, and mechanism-based human research.

Supplementary information. The Supplementary Information provides detailed descriptions and supporting evidence for the chimpanzee behaviors discussed in this article.

Declarations

Competing interests

The author declares no competing interests.

Ethics approval and consent to participate

Not applicable. This article does not report new research involving human participants or animals.

Data availability

No new data were generated or analyzed in this study.

Author contributions

The author is solely responsible for all aspects of this work.

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