Evolutionary Roots of Symbolic Thought

Evolutionary psychology theories strongly contribute to explaining symbolic representations by identifying biological substrates and adaptive advantages, though they work in conjunction with cultural processes.

Abstract

Evolutionary psychology theories account for key cognitive and social underpinnings of symbolic representation. Coolidge and Overmann (2012) argue that numerosity—a basic, widely shared cognitive capacity—provides the groundwork for the emergence of abstract symbols. Donald (1993) posits that the evolution of memory systems, progressing from mimetic skills to language and external symbols, forms a critical evolutionary pathway. Pinker (2010) emphasizes metaphorical abstraction and the "cognitive niche" as mechanisms by which symbolic thought emerged. Tomasello (2000) and Knight et al. (1995) stress the roles of shared attention, imitation, trust, and even self-domestication in fostering social environments where symbolic systems can thrive.

Among the 10 studies reviewed, evolutionary psychology appears in 9, often in tandem with cognitive developmental, enactive/constructivist, and comparative cognitive perspectives. The papers present a gradual transition from innate cognitive capacities to complex, culturally transmitted symbolic systems, noting that language and social interactions are pivotal in this evolution. In effect, evolutionary psychology offers a substantial, though not exclusive, explanation: it delineates the adaptive advantages and biological substrates that, when interwoven with cultural processes, give rise to abstract symbolic representations.

Paper search

Using your research question "To what degree do evolutionary psychology theories explain the creation of abstract or symbolic representations?", we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 50 papers most relevant to the query.

Screening

We screened in papers that met these criteria:

- **Evolutionary Psychology Focus**: Does the study examine evolutionary psychological mechanisms or theories related to symbolic or abstract representation?
- **Human Subjects**: Does the study include human subjects (either exclusively or in comparative analysis with non-human animals)?
- **Empirical Evidence**: Does the study present empirical evidence (experimental, observational, or comparative data)?
- **Symbolic Systems**: Does the study investigate the development or use of symbolic systems (e.g., language, art, mathematics, religious symbols)?
- **Research Perspective**: Does the study include evolutionary perspectives (rather than solely cultural or social constructivist approaches)?
- **Population Type**: Does the study examine typical (non-pathological) symbolic representation capabilities?
- **Study Type**: Is the study either primary research OR a systematic review/meta-analysis of evolutionary approaches to symbolic cognition?

- **Cultural Consideration**: Does the study consider cultural aspects or control for cultural variables in examining symbolic representation?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Theoretical Framework**:

  Identify the primary theoretical perspective used to explain symbolic representation. Look in the introduction, theoretical discussion, or conclusion sections. Categorize the approach as:

- Evolutionary psychology
- Cognitive developmental
- Enactive/constructivist
- Nativist
- Comparative cognitive If multiple frameworks are used, list all in order of prominence. If unclear, note "unclear" and provide a direct quote supporting the classification.

- **Research Methodology**:

  Describe the primary research methodology:

- Theoretical/conceptual analysis
- Empirical study (specify type: experimental, observational, comparative)
- Computational/modeling approach
- Archaeological/historical analysis
- Interdisciplinary synthesis

Provide specific details about the methodological approach from the methods or research design section. If multiple methods are used, list in order of primary focus.

- **Mechanisms of Symbolic Representation**:

  Extract the specific mechanisms proposed or investigated for symbolic representation creation. Look in results, discussion, and theoretical sections. Identify:

- Cognitive mechanisms
- Evolutionary pathways
- Social-cognitive processes
- Neurological foundations

Provide direct quotes or precise descriptions. If multiple mechanisms are proposed, list in order of significance to the study's argument.

- **Comparative Evidence**:

  Identify comparative evidence used to explain symbolic representation:

- Primate comparisons

- Cross-cultural evidence
- Developmental comparisons
- Archaeological evidence

Extract specific comparative data points or theoretical arguments. Note the source of comparison (e.g., specific primate species, archaeological period) and the key insights derived from the comparison.

- **Evolutionary Explanation**:

  Describe the evolutionary explanation for symbolic representation:

- Adaptive advantages proposed
- Hypothesized evolutionary stages
- Selection pressures identified
- Proposed timeline of development

Extract detailed explanations from theoretical discussions, focusing on how symbolic representation provided evolutionary advantages. If multiple explanations are provided, list in order of prominence.

Results

Characteristics of Included Studies

Study	Study Type	Primary Focus	Theoretical Framework	Evidence Type	Full text retrieved
Coolidge and Overmann, 2012	Theoretical analysis	Numerosity as basis for symbolic thinking	Nativist, Evolutionary psychology, Cognitive developmental, Enactive/constructivist, Comparative cognitive	Theoretical/conceptual analysis; Interdisciplinary synthesis	Yes
Donald, 1993	Theoretical framework	Cognitive evolution and symbolic representation	Evolutionary psychology, Cognitive developmental, Comparative cognitive	Theoretical/conceptual analysis with interdisciplinary synthesis	Yes
Fernando et al., 2024	Theoretical framework	External representations and symbolic communication	Enactive/constructivist	Theoretical/conceptual analysis; Interdisciplinary synthesis	Yes

Study	Study Type	Primary Focus	Theoretical Framework	Evidence Type	Full text retrieved
Knight et al., 1995	Theoretical analysis	Symbolic revolution and neo-Darwinian theory	Evolutionary psychology, Comparative cognitive, Nativist, Enactive/constructivist	Interdisciplinary synthesis with theoretical/conceptual analysis and archaeological/historical analysis	Yes
Lock and Peters, 1998	Edited book	Human symbolic evolution	Cognitive developmental, Comparative cognitive, Evolutionary psychology	Interdisciplinary synthesis	No
Mühlenbeck and Jacobsen, 2020	Review	Origin of visual symbols	Evolutionary psychology	Interdisciplinary synthesis with theoretical/conceptual analysis	Yes
Pinker, 2010	Theoretical framework	Cognitive niche and symbolic representation	Evolutionary psychology	Theoretical/conceptual analysis	Yes
Saito, 2021	Review	Cognitive foundations of artistic expression	Evolutionary psychology, Cognitive developmental, Comparative cognitive, Enactive/constructivist	Empirical study (comparative), Theoretical/conceptual analysis, Interdisciplinary synthesis	Yes
Seghers, 2015	Critical review	Evolutionary psychological studies of art	Evolutionary psychology	Theoretical/conceptual analysis	No
Tomasello, 2000	Theoretical framework	Cultural origins of human cognition	Evolutionary psychology, Cognitive developmental, Enactive/constructivist, Comparative cognitive	Theoretical/conceptual analysis	Yes

Analysis of the included studies:

- Study Types:
  - 4 studies that proposed or utilized comprehensive theoretical frameworks to explain symbolic representation
  - 2 theoretical analyses
  - 2 reviews
  - 1 critical review
  - 1 edited book
- Primary Focus:
  - Diverse range of primary focuses, with no single focus appearing in more than one study
  - Topics included numerosity, cognitive evolution, symbolic revolution, visual symbols, artistic expression, and cultural origins of cognition
- Theoretical Frameworks:
  - Evolutionary psychology was the most common framework, found in 9 studies
  - Comparative cognitive approaches were found in 6 studies
  - Cognitive developmental and enactive/constructivist approaches were each found in 5 studies
  - Nativist approaches were found in 2 studies
- Evidence Types:
  - Theoretical/conceptual analysis was the most common, found in 9 studies
  - Interdisciplinary synthesis was found in 7 studies
  - We found 1 empirical study (comparative) and 1 study using archaeological/historical analysis

Many studies in the table are associated with multiple theoretical frameworks and evidence types, suggesting a multidisciplinary approach in this field.

Thematic Analysis

Cognitive Foundations of Symbolic Representation

The reviewed studies present various perspectives on the cognitive foundations of symbolic representation:

1. Numerosity as a Precursor : Coolidge and Overmann (2012) propose that numerosity, the ability to understand numbers, serves as a foundational cognitive basis for symbolic thinking. They argue that numerosity is both innate and shared across species, suggesting an ancient evolutionary origin. This perspective links basic quantitative cognition to more complex symbolic representations.
2. Memory Systems : Donald (1993) outlines three systems of memory representation that have evolved in humans: mimetic skill, language, and external symbols. These systems are proposed to underpin our capacity for symbolic thought and culture.
3. Metaphorical Abstraction : Pinker (2010) emphasizes the role of metaphorical abstraction in symbolic representation. This cognitive mechanism allows humans to apply reasoning developed for physical and social domains to abstract concepts, facilitating the creation and understanding of symbols.
4. Social Cognition : Several studies highlight the importance of social cognitive abilities in the development of symbolic representation. Tomasello (2000) identifies specific cognitive capacities such as

shared attention, understanding others' intentions, and advanced imitation as foundational for symbolic culture.

5. Language and Symbolism : The role of language in the evolution of symbolic thinking is a recurring theme. Donald (1993) and Pinker (2010) both emphasize the importance of linguistic adaptations in enabling complex symbolic representation.

The papers present diverse perspectives on the cognitive foundations of symbolic representation, with different studies emphasizing various cognitive capacities.

Evolutionary Adaptations vs. Cultural Development

1. Evolutionary Adaptations : Several studies emphasize the role of evolutionary adaptations in shaping our capacity for symbolic thought. Pinker (2010) proposes the "cognitive niche" theory, suggesting that humans evolved to manipulate their environment through reasoning and social cooperation, which provided a foundation for symbolic representation. Similarly, Coolidge and Overmann (2012) argue for the evolutionary basis of numerosity as a precursor to symbolic thinking.

2. Cultural Evolution : Other studies place greater emphasis on cultural evolution and social learning. Tomasello (2000) highlights the "ratchet effect," where each generation builds upon the cultural knowledge of previous generations, facilitating the development of symbolic systems. Fernando et al. (2024) propose a constructivist enactive view, emphasizing the role of dynamic interaction with the environment in the development of symbolic capabilities.

3. Interaction of Biology and Culture : Several studies suggest an interplay between biological evolution and cultural development. Saito (2021) applies niche construction theory to art evolution, proposing that artistic behaviors influence cognitive and genetic evolution through a feedback loop among neural, cognitive, and environmental niches.

4. Self-Domestication : Knight et al. (1995) introduce the concept of self-domestication as a key factor in the evolution of symbolic communication. They argue that reduced aggression and increased trust created a social environment conducive to the development of symbolic systems.

These perspectives highlight the complex relationship between biological and cultural factors in the emergence of symbolic representation as presented in the reviewed papers.

Social-Cognitive Mechanisms

The reviewed studies emphasize several social-cognitive mechanisms as crucial in the development of symbolic representation:

- Shared Attention and Intention Understanding : Tomasello (2000) identifies the capacity for shared attention and understanding others' intentions as key social-cognitive mechanisms underlying symbolic culture. These abilities facilitate the creation and transmission of shared symbolic systems.

- Imitation and Social Learning : Multiple studies highlight the importance of imitation and social learning in the development and transmission of symbolic representations. Tomasello (2000) emphasizes advanced imitation as a foundational capacity for symbolic culture, while Fernando et al. (2024) discuss the role of social learning mechanisms in the evolution of symbolic communication.

- Trust and Cooperation : Knight et al. (1995) propose that the evolution of trust and cooperation, facilitated by self-domestication, was crucial for the development of stable symbolic communication. This perspective emphasizes the social foundations of symbolic systems.
- Cultural Transmission : Several studies, including Donald (1993) and Tomasello (2000), emphasize the role of cultural transmission in the development and maintenance of symbolic systems. This process allows for the accumulation and refinement of symbolic knowledge across generations.
- Social Signaling : Mühlenbeck and Jacobsen (2020) discuss the role of social signaling in the evolution of visual symbols, suggesting that symbolic representations may have evolved partly as a means of social differentiation and communication.

These social-cognitive mechanisms highlight the deeply social nature of symbolic representation as presented in the reviewed papers.

Synthesis of Explanatory Power

Convergent Evidence

Despite the diversity of approaches and focuses among the reviewed studies, several areas of convergence emerge:

1. Gradual Evolution : Most studies support the idea of a gradual evolution of symbolic capabilities, rather than a sudden emergence. This is evident in the proposed evolutionary stages from basic cognitive abilities to complex symbolic systems.
2. Cognitive-Social Interplay : There is a general agreement on the importance of both cognitive and social factors in the development of symbolic representation. Studies consistently emphasize the interplay between individual cognitive abilities and social interaction.
3. Language as a Key Factor : Many studies highlight the crucial role of language in the evolution of symbolic thinking, suggesting a close relationship between linguistic and symbolic capabilities.
4. Cultural Transmission : The importance of cultural transmission and social learning in the development and maintenance of symbolic systems is a recurring theme across multiple studies.
5. Adaptive Advantages : While the specific proposed advantages vary, there is a consensus that symbolic representation provided significant adaptive benefits, particularly in terms of enhanced communication and social coordination.

The reviewed papers present various perspectives on the creation of abstract or symbolic representations, with many incorporating insights from evolutionary psychology, cognitive science, cultural evolution, and social cognition.

Competing Explanations

Despite areas of convergence, several competing explanations and emphases are evident across the studies:

1. Innate vs. Learned : There is variation in the emphasis placed on innate cognitive capacities versus learned behaviors. While some studies, like Coolidge and Overmann (2012), emphasize innate abilities such as numerosity, others, like Fernando et al. (2024), focus more on learned and culturally transmitted aspects of symbolic representation.

2. Biological vs. Cultural Evolution : The relative importance of biological evolution versus cultural evolution in shaping symbolic capabilities is debated. Some studies, like Pinker (2010), emphasize evolutionary adaptations, while others, like Tomasello (2000), place more emphasis on cultural processes.
3. Primary Driving Forces : There is disagreement on the primary driving forces behind the evolution of symbolic representation. Proposed factors include cognitive adaptations, social pressures, cultural evolution, and environmental challenges.
4. Timelines : The proposed timelines for the emergence of symbolic thinking vary across studies, with some suggesting very early origins tied to basic cognitive abilities, and others focusing on more recent developments in human evolution.

These competing explanations highlight the complexity of the topic as presented in the reviewed papers.

Integration of Perspectives

The diversity of approaches and explanations presented in the reviewed studies suggests that a comprehensive understanding of the creation of abstract or symbolic representations requires an integration of multiple perspectives:

- Cognitive Foundations and Social Processes : An integrated view would recognize both the cognitive foundations (such as numerosity, memory systems, and metaphorical abstraction) and the social processes (like shared attention, imitation, and cultural transmission) that contribute to symbolic representation.
- Evolutionary and Cultural Dynamics : A comprehensive explanation would account for both evolutionary adaptations that provide the cognitive basis for symbolism and the cultural dynamics that shape and expand symbolic systems.
- Multiple Timescales : An integrated perspective would consider multiple timescales, from the evolutionary history of cognitive capacities to the more recent cultural evolution of complex symbolic systems.
- Interdisciplinary Approach : Given the complex nature of symbolic representation, an integration of insights from evolutionary psychology, cognitive science, neuroscience, anthropology, and cultural studies is necessary for a comprehensive understanding.

The reviewed papers present a multifaceted view of symbolic representations, incorporating explanations at multiple levels, from neural substrates to cultural dynamics.

References

A. Lock, and C. R. Peters. “Handbook of Human Symbolic Evolution,” 1998.

A. Saito. “ARCHAEOLOGY OF THE ARTISTIC MIND: FROM EVOLUTIONARY AND DEVELOPMENTAL PERSPECTIVES.” *PSYCHOLOGIA*, 2021.

C. Knight, Camilla Power, and Ian Watts. “The Human Symbolic Revolution: A Darwinian Account.” *Cambridge Archaeological Journal*, 1995.

Chrisantha Fernando, Simon Osindero, and Dylan Banarse. “The Origin and Function of External Representations.” *Adaptive Behavior*, 2024.

Cordelia Mühlenbeck, and T. Jacobsen. "On the Origin of Visual Symbols." *Journal of Comparative Psychology*, 2020.

Eveline Seghers. "The Artful Mind: A Critical Review of the Evolutionary Psychological Study of Art," 2015.

F. Coolidge, and Karenleigh A. Overmann. "Numerosity, Abstraction, and the Emergence of Symbolic Thinking." *Current Anthropology*, 2012.

M. Donald. "Précis of Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition." *Behavioral and Brain Sciences*, 1993.

M. Tomasello. "The Cultural Origins of Human Cognition," 2000.

S. Pinker. "The Cognitive Niche: Coevolution of Intelligence, Sociality, and Language." *Proceedings of the National Academy of Sciences of the United States of America*, 2010.