
The *Tool-Dependent* Behaviour, Environmental Element Changes, and Psychological Selection: The Origin of the Human Mind

Xiaoming Liu

Bureau of Agriculture, Taishan City, China

Email address:

kjsxg@163.com

To cite this article:

Xiaoming Liu. The *Tool-Dependent* Behaviour, Environmental Element Changes, and Psychological Selection: The Origin of the Human Mind. *American Journal of Life Sciences*. Vol. 11, No. 5, 2023, pp. 77-82. doi: 10.11648/j.ajls.20231105.12

Received: October 22, 2023; **Accepted:** November 15, 2023; **Published:** November 21, 2023

Abstract: This study elucidates the interplay between *tool-dependent* behavior, environmental dynamics, and the emergence of distinctive human traits during evolution. A breakthrough in the *tool-dependent* behavior of human ancestors was achieved through tool use in defense and predation, such as using stones and sticks as weapons, creating new survival elements from the environment. This study compares humans' *tool-dependent* behavior with other animals' use of tools: one is a unique, risk-taking, and irreversible behavior change, and the other is a universal and risk-averse behavior. We can distinguish the essential difference between the two behaviors from creating new environmental elements or not. Mainly, this creation determined the direction of tool, cultural, and social improvements, generating the essential differences between human and natural environments. It reveals the reasons for the emergence of special human traits: new elements and directional factors in the human environment, including tool and cultural and social improvements, leading to directional changes in human adaptation, such as gradual upright posture, increased brain capacity, and an acquired, complex language system. From an evolutionary psychology perspective, the adaptive relationship between distinctive psychological mechanisms and environmental factors has been confirmed, addressing the creation of our unique human mind: as environmental directional factors benefit specific psychological development, new psychological mechanisms emerge and shape the human mind. Therefore, unique human environmental changes result in the different selection of human characteristics, i.e., psychological selection. A unique and directional psychological evolution characterizes human history. This study explains the origin of the human mind emerging from the relationship between *tool-dependent* behaviour and environmental changes, which is of great significance for correcting existing significant flaws in evolutionary theory.

Keywords: Behavior Change, Tool-Dependent, Environmental Elements, Psychological Selection, Psychological Mechanisms

1. Introduction

The uniqueness of human evolution has long been a controversial issue. The theory of natural selection has been established, explaining the origins of humans and other animals. Humans and apes share a common ancestor. However, a controversy continues regarding the psychological continuity between humans and apes [1, 2]. In recent years, some scholars have proposed the viewpoint of the culture-gene co-evolution [3, 4], explaining mental development from a cultural perspective. However, only human cultures are different. The primary drivers of human

cultural change remain unclear. This study proposes a new model of evolution in which a breakthrough in the *tool-dependent* behavior of human ancestors accompanied the use of tools for defense and predation. This breakthrough emerged with new tools, cultural improvements, and the gradual predominance of upright posture and increased brain capacity [5].

Our ancestors depended on tools, representing unique tool behaviour changes. External objects, such as stones and sticks, were transformed into weapons or tools for human survival, creating new survival elements from the environment. This resulted in environmental and evolutionary differences.

Therefore, *tool-dependence* was both a behavioral change and a catalyst for new environmental survival elements, eventually becoming the linchpin of human evolution. This study compares humans' use of tools with other animals, elucidating the essential differences between human and natural environments based on tool behavior changes. Furthermore, this study confirms the relationship between human environmental changes and psychological selection mechanisms [6], explaining the origin of the human mind.

2. Human *Tool-Dependent* Behavior

Of all animals, humans are the only species that can defend and attack with tools. Being *tool-dependent* marked the boundary between the tool-related behavior of humans and other animals. Tool use has been observed in animals. For example, wild chimpanzees use and make stone tools [7]; capuchins use stone tools indistinguishable from those of early humans [8]; and chimpanzees, orangutans, gorillas, baboons, and capuchins have been observed to hurl branches and stones [9]. They can crack nuts open with stones or intimidate opponents by throwing stones and sticks. However, they cannot defend or attack more formidable opponents with tools or even approximate that behavior. The author defines *tool dependence* as their use in close defense and attack. This study highlights tool dependence using italics to indicate the difference between human and animal tool use.

Apes repel or deter aggressors with *tool-dependent* behaviors. Recordings of chimpanzees confirm tool behaviors that resemble those of humans. In one such recording, a chimpanzee holds a stick and frantically chases another, after which an accomplice rushes toward them and snatches the stick. The unsuccessful chimpanzee quickly flees. In this scenario, the group thwarted an individual tool-based attack, indicating unacceptable behavior.

Non-human primates often imitate human behavior. For example, a monkey approaches the host and brandishes a sharp knife; dangerous movements of their "weapons" become a convincing coercion method while not causing injuries. Moreover, the host can confiscate the "weapons" safely (as the selling point of the show), or the monkeys can drop the "weapons" immediately if threatened. This performance indicates a significant difference in psychological mechanisms.

Gorillas often walk upright for brief periods; their forelimbs are suitable for grasping. Moreover, they outperform humans in flexibility, speed, and strength. They would undoubtedly win if they attacked or defended themselves with stones and sticks, yet they did not do so. Tool dependence requires an upright posture. However, the upright posture risks injury to vital body parts in duels and limits flexible movement and rapid escape. Thus, it is unsafe. These facts indicate that apes' use of tools is a universal and risk-averse behavior; they avoid *tool-dependent* behavior change.

Humans are the only species to exhibit *tool-dependent* behavior change. For example, humans use sticks to repel wolf and bear attacks. We can infer the following points from

these practices. First, human *tool dependence* is a high-risk behavior that entails firm psychological support. Second, *tool dependence* is a challenging behavioral breakthrough. This behavior change was a matter of life and death for early human ancestors. Only certain individuals with specific psychological and physical characteristics could pass the test. Therefore, only human ancestors made a breakthrough and changed their tool behavior, or a behavior deviating from natural selection [6]. Third, *tool dependence* is an irreversible and ongoing behavior change. Evolutionary changes, such as the upright posture of the human body, have led to decreased speed and flexibility. Thus, humans cannot survive without tools. In other words, humans and tools are an inseparable organic whole. This characteristic is an essential difference from other animals' tool use. It represents a critical turning point in human evolution.

3. Environmental Elements and Directionality Factors

Environmental elements (i.e., sunlight, water sources, and food) are critical for species' survival. The tool dependence of human ancestors led to breakthroughs. New environmental elements emerged following the adoption of weapons and tools used for survival; early humans used stones, sticks, and other objects in the surrounding environment to defend themselves or engage in predation. Thus, the indispensable materials or new elements for human survival emerged in the environment.

This change caused a new environment, differing from the natural one. If our human ancestors lived in the same regions as ancient apes, the external world of the two species would be the same. However, human survival opportunities were entirely different. For *tool-dependent* humans, the available stones and sticks became weapons or tools to repel predators, ensuring safety and food sources. Thus, the emergence of new survival elements for humans in the external world transformed the original hostile environment into a favorable one.

Changes in environmental elements led to the creation of tools and cultural and social improvements. Thus, human environmental directional factors emerged. *Tool-dependent* behavior entailed high risk. Nevertheless, it offered several survival benefits and promoted complex intellectual activities like predation. Humans had to continuously enhance their tools, culture, and society to improve their safety and efficiency. For example, tools and hunting culture were continuously improved by moving from unprocessed stones to manufactured stone implements. In addition, a wider society was established with increasingly complex social communication, division of labor, and cooperation. These factors enabled cultural and social development.

Thus, human environmental differences began with *tool-dependent* behavior changes. With changes in survival elements and psychological and physical adaptations, humans and tools became integrated into an inseparable organic whole.

This unity solved the fundamental problem of human survival. Therefore, our human ancestors' tool use enhanced their physical abilities [9], leading to a perceived change in environmental resource attributes. Stones, sticks, and other objects became indispensable materials or were endowed with the new attribute for maintaining human survival, creating new environmental elements and a safer external world.

In contrast, other animals' tool use merely extends their body functions, leaving environmental resource attributes unchanged. In the past and present, stones and sticks have been unnecessary for their existence, and accordingly, their use leaves the environment unchanged. Therefore, a breakthrough in tool behavior was critical in human history. It created new survival elements from the environment. This creation determined the direction of tool, cultural, and social improvements and the development of the human environment. In other words, as sticks and stones for defense were in the same category as the modern fence or house, our ancestors began living in the human environment, whereas ancient apes continued living naturally. They existed in different external worlds based on differences in tool behavior.

4. Discussion

4.1. Orientation Between Human and Natural Environments

Early human evolution has long been considered an adaptation to directional changes, mainly from forests to open habitats such as savannas, with interactions of ground-based life, use of tools, and creophagy favouring brain enlargement [10, 11]. However, paleoenvironmental evidence contradicts this directional environmental shift. As indicated by repeated habitat shifts, paleoenvironmental fluctuations in Africa during human evolution were more pronounced than earlier in the Cenozoic. Therefore, some scholars have proposed the environmental variation hypothesis, stating that human evolution responds to habitat and resource variability [12]. However, natural ecology includes environmental variability. The specific factors leading to human evolution's directionality must be empirically clarified.

Explaining the directionality of human evolution based on the natural environment is challenging. Natural selection produces a variety of structures or species that display universal or convergent characteristics, such as apes and monkeys living in forests and baboons in open habitats. All these species have fast and flexible motor structures such as limbs for walking and brachiating. However, humans are the only species that walk upright. Thus, humans move more slowly and less flexibly than apes. This difference suggests that the shift to upright locomotion did not represent an adaptation to the natural but rather to the human environment.

Tool dependence caused essential changes in the human environment. First, it changed natural resource attributes and added new survival elements to the human environment. To illustrate, people responded to wolf or bear attacks using

stones or sticks in the surrounding environment. These objects became weapons or new environmental elements that determined life and death for early human ancestors. Second, it led to the invention of more tools and cultural and social enhancements, providing directional factors for development in the human environment. When stones and sticks became weapons and tools for survival, humans inevitably continued making and improving tools. Continuous advances occurred in tools used for predation and hunting culture. Therefore, changes in *tool-dependent* behavior confirmed the essential environmental differences between human ancestors and ancient apes.

Thus, *tool-dependent* behavior introduced new survival elements into the human environment. The differences between the human and natural environments resulted in the different selection of human characteristics. This was psychological selection: the survival probability of individuals increased with stronger mental abilities, i.e., the individual variation, or adaptation of tool and cultural improvements, was selected [6]. The orientation of the human environment was more robust, stable, and precise than the fluctuations and variations of the natural one. For example, the human environment featured tool-related and cultural and social improvements, leading to a more adaptable, fully upright position, a larger brain, and a more complex language system. Thus, a human evolutionary pattern with *tool-dependent* behavior is a more persuasive argument.

4.2. Characteristic Structural Evolution in Humans

Directional factors such as tools, and cultural and social improvements in the human environment construct our distinct characteristics.

4.2.1. Fully Upright Position

Breakthroughs in *tool-dependent* behavior occurred in some ancient apes. Human ancestors began defending or attacking semi-uprightly, grasping stones and sticks, expelling predators, and occupying favorable territory. A completely upright position allowed more effective tool use and manufacture, ease of carrying food and tools, and facilitation of migration activities. Upright variation and individuals with better survival benefits were selected, gradually creating a fully upright body structure. Importantly, humans walked upright to adapt to the environment, leading to psychological adaptations. Whether human children can walk upright is related to external conditions [13], which demonstrates the existence of a psychological adaptation to the human environment.

4.2.2. A Large Brain

The human brain has been dramatically altered. Its volume has grown four times that of chimpanzees. Increased brain volume facilitates the processing of external input and better adaptation to directional factors such as cultural improvement. The cerebral cortex processes higher-level cognition, emotions, thinking, and language [14]. The invention of new tools for hunting and complex social life led to the

increasingly developed neocortex [15]. The human brain added new psychological adaptations (including new psychological mechanisms), and individuals acquired psychological ability by learning. Thus, humans became the most psychologically capable species.

4.2.3. A Complex Language System

Human language is designed to communicate information [16]. With the change in environmental elements, directional factors such as large-scale societies with complex structures appeared. Language fostered cooperation, communication, and cognitive efficiency, which led to language variation, individual selection, and an emerging formal system. The evolution of the human language system involved psychological adaptations because human languages could not be separated from learning. Similarities between the human and ape language systems are absent, including in the nervous system and sound organs [17]. Apes live in small, unstable groups (i.e., 20–50 chimpanzees) and can only develop a language suitable for such contexts.

In summary, the tool behavior of human ancestors changed, and consequently, tool, culture, and social improvements emerged. Adapted human features also emerged, enabling humans to keep solving new problems arising in the environment. For example, a fully upright position responds to new issues emerging from tool innovation, and a considerably larger brain manages new issues emerging from cultural development. In contrast, a complex language system addresses new issues emerging from social changes. Therefore, the interactive development of human feature constructions and directional environmental factors created evolutionary directionality.

Notably, all major human traits contribute to distinctive psychological mechanisms. These mechanisms correspond to the changes in environmental factors, such as cultural and social improvements. Thus, people acquire these abilities or adapt to their environment only through learning. Therefore, the human environment adapted to tool, and cultural and social improvements were fundamental, and led to the different selection of human characteristics, or psychological selection, which created new psychological mechanisms and human characteristics.

4.3. Evolutionary Psychology Analysis and Validation

Human tool behavior changed and adapted to the changing environment, mainly through directional factors, including tool use and cultural and social improvements. This progression led to changes in character constructs (including psychological mechanisms). Thus, evolutionary psychology has provided a conceptual toolkit to analyse changes in human mental processes [18]. Moreover, it supports the causes of human mental uniqueness.

4.3.1. Change in the Psychological Mechanisms Related to Tools

The differences between tool behaviors in humans and apes are based on psychological mechanisms. Psychology

comprises many specialized mechanisms, each solving a specific adaptive problem. Thus, psychological mechanisms may have addressed recurrent specific issues related to survival and reproduction across evolutionary time [18]. Animals such as apes have psychological mechanisms for using tools safely. They may exhibit risk-averse tool-related behaviors to avoid harm. In contrast, human ancestors exhibited risk-taking *tool-dependent* psychological mechanisms. They used tools successfully in close defense and attack and gained great benefits, such as safety and food.

The *tool-dependent* mental mechanisms and behavioral variations created different external worlds; humans viewed stones and sticks as survival weapons (i.e., iron armor, clubs, spears) used for self-defense, whereas apes lacked weapons. In other words, *tool-dependent* behavior broke through the constraints of psychological mechanisms. Consequently, humans gained the security necessary for survival and found new environmental elements. In contrast, apes' tool behavior was constrained by their psychological mechanisms, and consequently, their survival environment remained unchanged. Therefore, we can distinguish the essential differences between the ape and human behaviors by creating new environmental elements to reveal the causes of human evolution's directional modifications.

4.3.2. Change in Feature Adapters

The concept of an adapter is expounded in evolutionary psychology. An adapter is a specialized human mechanism solving a specific adaptation problem, such as complex organs (i.e., eyes, noses, and mental modules) [18]. Some adapters have complex structures and are associated with specific information input. Human feature adapters, for example, constitute the main differences between the apes and us.

Unlike apes, humans exhibit fully upright postures, large brains, and complex language systems. Such feature adapters are activated with specific inputs. For example, infants walk upright through imitation and learning, and human intelligence and language production are inseparable from society and education (i.e., learning activates them). This need for input indicates an associative role of human feature adapters with mental mechanisms; these mental mechanisms are activated through specific information [18]. Many psychological mechanisms appear to operate in human feature adapters, and people acquire them through learning.

Human feature adapters are central to our evolution. They can only be activated in the human environment. For example, feral human infants and children lose their distinct human characteristics. They crawl, have intellectual deficits, and lack language [13]. This phenomenon suggests that human feature adapters are inseparable from the human environment. These constructs (including psychological mechanisms) are adapted to directional factors such as using tools and cultural and social improvements or can only be activated in the human environmental factors. In other words, as specific psychological mechanisms corresponded or adapted to specific environmental factors (specific information), human evolution led to new mental mechanisms, determining

whether an individual's features could adapt to the human environmental changes. The above examples also confirm that human psychological mechanisms are critical. Losing them would lead to the decay of unique human characteristics.

Therefore, new psychological mechanisms can be inferred to determine human characteristics. These, in turn, correspond to the changes in environmental factors. As environmental directional factors benefited specific psychological development, new psychological mechanisms and their adaptive relationship with environmental factors became pivotal in the evolution of human characteristics. That is, new psychological mechanisms emerged and shaped our unique human characteristics.

In contrast, other animals lack specific or human-like psychological mechanisms. That is, they cannot acquire human characteristics simply through learning; whether in a natural environment or raised by humans, animals such as dogs and chimpanzees exhibit the essential characteristics of their species. They are different from humans because no similar environmental or evolutionary changes occurred in their history.

4.4. An Explanation for the Origin of the Human Mind

From the perspective of evolution, Darwin acknowledged that the problem of how the human mind developed was challenging to solve. He wrote, "...but neither my ability nor knowledge permit the attempt" [19]. Many previous reports concerning the cultural differences between humans and apes have been made, including learning, cooperation, teaching, and cultural accumulation [20-22]. Culture promotes the development of the human mind [4, 23]. However, cultures are inseparable from distinctive psychological mechanisms, and apes cannot master human cultures simply by learning.

The human environmental changes include tool, culture, and social improvements. The corresponding psychological mechanism has become crucial for human evolution since it determines our characteristics. Modern evolutionary psychology has made significant progress regarding psychological mechanisms, including its reasons for formation, principles of action, forms of expression, and scope [18]. Compared to general biological structures, psychological mechanisms may have more diverse and specialized functions, such that people acquire these abilities only through learning. Therefore, the unique human environmental changes created new psychological mechanisms, which was the origin of the human mind.

Our ancestors depended on tools for behavior change, creating new survival elements and an environment adapted for tool and cultural and social improvements. Environmental differences resulted in human psychological mechanisms and characteristics. This *tool-dependent* behavior explains why human intelligence is far more advanced than apes and why humans have developed complex language systems. A unique, directional psychological evolution characterizes human history. This study addresses the origins of the human mind emerging from the relationship between *tool-dependent* behavior and environmental changes, which is of great

significance for correcting existing major flaws in evolutionary theory.

5. Conclusion

Compared with other animals' use of tools, humans' *tool-dependent* behaviour is a unique, risk-taking, and irreversible behavior change. It led to changes in psychological and physical adaptations in humans, making humans and tools an inseparable organic whole. Thus, external objects, such as stones and sticks, transformed into weapons or tools for human survival, creating new survival elements from the environment. This creation determined the direction of tool, cultural, and social improvements, and the development of the human environment, generating the essential differences between human and natural environments.

Differences in human environment resulted in the different selection of human characteristics, which was psychological selection, wherein the survival probability of individuals increased with stronger mental abilities, or adaptation of tool, cultural, and social improvements was selected. It led to directional changes in human evolution, such as gradual uprightiness, increased brain capacity, and an acquired, complex language system.

All major human traits contribute to distinctive psychological mechanisms. These mechanisms correspond to the changes in environmental factors, such as cultural and social improvements. Thus, people acquire these abilities or adapt to the human environment through learning, indicating that psychological mechanisms determine human characteristics, or human environmental factors create new psychological mechanisms that determine human characteristics. This is the origin of the human mind.

Acknowledgments

I would like to thank Editage (www.editage.cn) for their assistance in English language editing.

References

- [1] P. J. Bowler, *Evolution: The History of an Idea*, 3rd ed., Oakland: University of California Press, 2003.
- [2] A. R. Wallace, "Sir Charles Lyell on Geological Climates and the Origin of Species," *Quarterly Review*, 1869, pp. 391-394.
- [3] T. J. H. Morgan, N. T. Uomini, L. E. Rendell, L. Chouinard-Thuly, S. E. Street, H. M. Lewis, C. P. Cross, C. Evans, R. Kearney, I. de la Torre, A. Whiten, and K. N. Laland, "Experimental evidence for the co-evolution of hominin tool-making teaching and language," *Nature Communications*, 2015, vol. 6, pp. 6029.
- [4] K. Laland, *Darwin's Unfinished Symphony: How Culture Made the Human Mind*, Princeton: Princeton University Press, 2017.

- [5] X. Liu, "New models of human evolution and psychological selection mechanisms," *Biol. Bull. Beijing*, 2016, vol. 51, pp. 3–7.
- [6] X. Liu, "Comparison of psychological selection and natural selection," *Biol. Bull. Beijing*, 2021, vol. 56, pp. 4–8.
- [7] C. Boesch, and H. Boesch, "Tool use and tool making in wild chimpanzees," *Folia Primatologica*, Basel, 1990, vol. 54, pp. 86–99.
- [8] M. Haslam, R. A. Hernandez-Aguilar, T. Proffitt, A. Arroyo, T. Falótico, D. Frigaszy, M. Gumert, J. W. K. Harris, M. A. Huffman, A. K. Kalan, S. Malaivijitnond, T. Matsuzawa, W. McGrew, E. B. Ottoni, A. Pascual-Garrido, A. Piel, J. Pruetz, C. Schuppli, F. Stewart, A. Tan, E. Visalberghi, and L. V. Luncz, "Primate archaeology evolves," *Nature Ecology & Evolution*, 2017, vol. 1, pp. 1431–1437.
- [9] Y. Shang, "Animal use tools," *Biol. Bull. Beijing*, 2001, vol. 36, pp. 7–9.
- [10] R. G. Klein, *The human career: Human Biological and Cultural Origins*, Chicago: University of Chicago Press, 1989, pp. 180–182.
- [11] M. H. Wolpoff, *Paleoanthropology*, New York: McGraw-Hill, 1980, pp. 98–102.
- [12] R. Potts, "Environmental variability and its effect on hominid evolution," *Acta Anthropologica Sinica*, Beijing, 1995, vol. 14, pp. 324–339.
- [13] G. Zhou, "Enlightenment of wolf children," *Fossils*, Beijing, 1977, 4, 16–17.
- [14] D. L. Schacter, D. T. Gilbert, and D. M. Wegner, *Psychology*, 2nd ed., New York: Worth Publishers, 2011.
- [15] M. V. Flinn, D. C. Geary, and C. V. Ward, "Ecological dominance, social competition, and coalitionary arms races," *Evolution and Human Behavior*, 2005, vol. 26, pp. 10–46.
- [16] S. Pinker and P. Bloom, "Natural language and natural selection," *Behavioral and Brain Sciences*, 1990, vol. 13, pp. 707–727.
- [17] W. T. Fitch, *The Evolution of Language*, Cambridge: Cambridge University Press, 2010.
- [18] D. M. Buss, *Evolutionary Psychology: The New Science of the Mind*, 5rd ed., London: Routledge, 2016.
- [19] C. R. Darwin, *The Descent of Man, and Selection in Relation to Sex*, 1rd ed., Princeton: Princeton University Press, 1981, pp. 160.
- [20] A. Whiten, J. Goodall, W. C. McGrew, T. Nishida, V. Reynolds, Y. Sugiyama, C. E. G. Tutin, R. W. Wrangham, and C. Boesch, "Cultures in chimpanzees," *Nature*, 1999, vol. 399, pp. 682–685.
- [21] C. Boesch, "Is culture a golden barrier between human and chimpanzee?," *Evolutionary Anthropology: Issues News and Reviews*, 2003, 12, 82–91.
- [22] W. C. McGrew, *Chimpanzee Material Culture: Implications for Human Evolution*, Cambridge: Cambridge University Press, 1992.
- [23] J. Henrich, *The Secret of Our Success: How Culture Is Driving Human Evolution, Domesticating Our Species, and Making Us Smarter*, Princeton: Princeton University Press, 2015.