Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 45(45)

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Publication Date

2023

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Abstract

Metaphor is central to human language and cognition. It has also been proposed to play an important role in language evolution. For these reasons, the evolution of metaphor and the cognitive processes supporting it are an important explanatory target for evolutionary accounts of human language. Here, we focus on the evolution of one particular capacity supporting metaphor, that of analogy. We integrate data from comparative psychology and cognitive archaeology to investigate the evolution of analogy as well as its evolutionary foundations. We present evidence that many aspects of analogy display evolutionary continuity between humans and non-human animals. In addition, we propose that analogical capacities can also be inferred from the archaeological record by looking at productional diversity in tool-making. Overall, we argue that analogy as an important cognitive process supporting metaphor has deep evolutionary roots.

Keywords: Metaphor; Analogy; Comparative Psychology Cognitive Archaeology; Language Evolution

Introduction

Metaphor has been shown to be a central process in human language and cognition (Lakoff & Johnson, 1980). What is more, metaphor has also been assigned an important functional role in the evolution of language both in diachronic change (Hopper & Traugott, 2003), and the emergence of linguistic properties such as grammatical structure (Smith & Höfler, 2015) and compositionality (Ellison & Reinöhl, 2022). Uncovering the evolution of metaphor and the cognitive processes supporting it, therefore, presents an important part of explaining the evolution of human language and cognition.

In metaphor, one thing is understood and experienced in terms of another on the basis of some perceived similarity (Lakoff & Johnson, 1980). More precisely, a conceptual target domain A is understood in terms of a conceptual target domain B by analogical mapping of elements of the source domain to elements of the target domain (Kövecses, 2010). In most cases, the source domain is more concrete and less clearly experientially delineated than the target domain, so that the structure of the source domain helps understanding the abstract target domain by imposing structure or by analogically resonating with elements of the structure of the target domain (Holyoak & Stamenkovic, 2018; Lakoff & Johnson, 1980). For example, in the metaphorical expression *writing a CogSci paper is quite the journey* there are a number of analogical correspondences, or mappings, between constituent elements of the source domain JOURNEY and the target domain WRITING A COGSCI PAPER. For example, the travelers in a journey correspond to the writers of a CogSci paper, the distance covered in a journey corresponds to the progress made in writing the paper, the events during the journey correspond to the events and steps taken (another metaphor) while writing the paper, and the reaching the destination of the journey corresponds to finish writing (and submitting) the paper (cf. Kövecses, 2010). Such a conceptual metaphor WRITING A COGSCI PAPER IS A JOURNEY then licenses many different metaphorical expressions based on these analogical relations, such as *we have to push forward with the paper*, *we have hit a roadblock while writing*, or *finally finishing the paper has been a long road*.

As argued for by Lakoff and Johnson (1980; 1999), such conceptual metaphors licensing different metaphorical expressions pervade human language and cognition, with many if not most of our concepts being metaphorical in nature, and conventionalized metaphorical expressions pervading everyday language. For example, we *defend our argument*, and *attack somebody else's indefensible position* (AN ARGUMENT IS WAR), say that *prices have gone up* (MORE IS UP), or *explode in anger* and *blow up* (ANGER IS A HOT FLUID IN A CONTAINER) (Köveces, 2010; Lakoff & Johnson, 1980). Given the pervasiveness and importance of metaphor in human language and cognition, as well as its potential driving role in language evolution and change, the evolution of metaphor and the cognitive processes that underlie it are central explanatory targets for evolutionary accounts of language.

In M. Goldwater, F. K. Anggoro, B. K. Hayes, & D. C. Ong (Eds.), *Proceedings of the 45th Annual Conference of the Cognitive Science Society*.

The Evolution of Metaphor

Two key sources of evidence when taking an evolutionary perspective on language and cognition are comparative psychological data, and archaeology, especially cognitive archaeology (Henley, Rossano & Kardas, 2020; Wynn & Coolidge, 2022). Comparative psychology investigates the cognitive abilities of animals in order to compare similarities and differences between different species, with a special focus on how the abilities of other animals relate to those of humans, and their implications for the evolution of human cognition. Cognitive archaeology traces the development of modern cognitive abilities by inferring the necessary underlying cognitive mechanisms for the creation of (types of) archeological artifacts from the material record (Henley et al., 2020; Wynn & Coolidge, 2022). However, direct evidence and direct conclusions that can be drawn regarding the evolutionary foundations of metaphor have been limited.

Comparative Evidence on the Evolution of Metaphor

In the domain of comparative psychology, only a few studies have investigated metaphorical competence in non-human animals. Dahl and Adachi (2013), for example, have shown that chimpanzees are faster to recognize high-ranking individuals when they appear in a higher position in a vertical display, and low-ranking individuals when they appear in a lower position in the display. Response latencies were longer if the position in the display was inconsistent with the social rank of the individual. They argue that this is evidence for conceptual mappings between social rank and high vs low vertical position, a conceptual metaphor found across many different languages and cultures, and expressed in English in such metaphorical expressions such as *high* vs *low status*, s*he's at the peak of her career*, or *she rose to the top*. Regarding spatial metaphoric mappings, Merrit, Cassasanto and Brannon (2010) showed that rhesus macaques — in contrast to humans, where *the past is behind us* and we take *short breaks* — do not process time in spatial terms. Specifically, they demonstrated that in humans, the length of a line display strongly influences judgements of how long the line display was displayed for, whereas the time a line display is displayed has a weaker effect on judgements of the length of the lines. In monkeys, on the other hand, spatial properties did not influence temporal judgements more strongly than the other way around. Instead, line length influenced temporal judgments to the same degree as display duration influenced judgements of the length of the line display. This suggests that rhesus macaques process both time and space in terms of a common magnitude system. Other studies on rhesus macaques (Drucker & Brannon, 2014), gorillas and orangutans (Gazes et al., 2017), as well as chimpanzees (Adachi, 2014), on the other hand, suggest that these non-human primates, just as humans, represent magnitude and serial order in terms of space (Gazes, Templer & Lazreva, 2022). This suggests that at least some conceptual metaphorical mappings have deep evolutionary roots. However, it does not shed light on the evolution of the cognitive mechanisms that support widespread analogical metaphorical mapping.

Archaeological Evidence on the Evolution of Metaphor

In cognitive archaeology, there is some evidence for metaphorical mappings in archaeological artifacts. However, these do not have a very long-time depth, limiting the conclusions we can draw from them as to the evolutionary foundations and emergence of metaphoric abilities. For example, Whitley (2008) analyzed North American rock engravings with a time-depth of around 11,000 years, and in combination with data from the ethnographic record interpreted them as representing a complex KILLING A BIGHORN conceptual metaphor that did not reference hunting, but metaphorically represented shamans entering a trance state. Another example is the widespread practice of 'pot burial' in which deceased humans were buried in ceramic pots. This practice could be found in a wide array of ancient cultures in Europe, South America, Africa, Asia and Oceania and was attested in Egypt from around 3500 BCE (Power & Tristant, 2016) and as early as the sixth millennium BCE in Southeast Europe (Bacvarov, 2008) and the Middle East (Orrelle, 2008). For these different cultures, it has been suggested that these ceramic pots reflect a metaphoric association with the womb or eggs, and were seen as representing a metaphoric relation to themes of rebirth and the transition to the afterlife (Power & Tristant, 2016; Orrelle, 2008). The potentially earliest archaeological evidence for the ability of metaphorical mapping is the Hohenstein-Stadel 'lion man', a 28cm high figurine carved from ivory about 40ka (Conard, 2003; see Figure 1).

Figure 1: The Hohlenstein-Stadel 'lion man' (40ka). Dagmar Hollmann/Wikimedia Commons. License: CC BY-SA 4.0

This figurine, with a human body and a lion's head, demonstrates the capacity for metaphorical mapping as it combines features from the conceptual domains of 'animal' and 'person' (Wynn, Coolidge & Bright, 2009). Whereas these examples demonstrate the long-term significance of conceptual metaphorical mappings for human cognitive systems and culture (Whitley, 2008), they do not provide insight into the evolutionary foundations and trajectory of metaphor and the cognitive processes supporting it.

In order to gain insight into the evolutionary foundations of metaphors and its cognitive underpinnings, we therefore focus on one central process supporting metaphor, that of analogy: "Analogy is a special kind of similarity [...]. Two situations are analogous if they share a common pattern of relationships among their constituent elements even though the elements themselves differ across the two situations" (Holyoak, 2005). Analogy has been argued to be a key mechanism underlying metaphor, as it represents the process of comparing a source and target domain in terms of potential correspondence relations among its constituent elements (Itkonen, 2005).

Metaphor makes use of a whole host of cognitive processes, and different types of metaphor might make use of different cognitive processes, with some types of metaphor even potentially not relying on analogy (see Holyoak & Stamenkovic, 2018 for a review). Regardless, especially from the view of conceptual metaphor theory, analogy seems to be one of the most central underlying operations supporting the mapping of constituent elements of source and target domain on the basis of perceived perceptual, functional, or relational similarities, which is why it represents the focus of our investigation. Specifically, we will integrate data from the two frameworks of comparative psychology and cognitive archaeology, to explore the evolutionary foundations of analogy. Regarding comparative evidence on analogical capacities we will discuss research on tool use, pretend play and relational reasoning. Regarding archaeological evidence we will discuss the role of analogy in prehistoric tool production.

Comparative Evidence on Analogical Capacities

Tool Using/Making in Nonhuman Animals

New Caledonian crows have been reported to use hooked-twig and stepped-cut tools for foraging in holes in living and dead wood (Hunt, 1996). This suggests that they might be capable of taking advantage of different methods to achieve the same purposes. Hunt & Gray (2003) observed that the crows manufactured the hooked tools in multiple steps including raw material selection, trimming and sculpting it three-dimensionally. Such a complex procedure shows that in order to make a hooked tool the crows are flexible in dealing with raw material to accomplish the final goal (Hunt & Gray, 2003), in the sense that the manufacturing process and the types of raw material can be varied (Klump et al., 2015). This indicates that the crows probably can identify the similarity between different raw materials and manufacturing processes to arrive at the final product, suggesting a possible analogical planning ability. Besides, New Caledonian crows were also observed to be able to use metatools, which require utilizing one tool to get another tool for solving the problem, which reflects the possibility of analogical reasoning of the function of a tool for reaching objects including another tool (Taylor et al., 2007). Furthermore, the crows were also showed to successfully transfer tool use in a tube-setting to a table-setting, again suggesting the possibility that they solve complex physical problems by causal reasoning analogically (Taylor et al., 2009) (see the section *Relational Reasoning* section), which in turn implies that the analogical ability could possibly date back to avian species, although New Caledonian crows might be one of the most intelligent species among birds.

As our close living relatives, nonhuman primates have been demonstrated to be able to use and make tools in the wild and in the laboratory. Wild chimpanzees have been observed to use leaves in two ways to drink rain water from tree holes: sponge-like leaves to absorb water and spoon-like folding leaves to collect water (Sousa, Biro & Matsuzawa, 2009). Moss was also reported to function as a sponge by chimpanzees in Tongo (Lanjouw, 2002) and bonobos in Lomako (Hohmann & Fruth, 2003). The Sonso chimpanzees community of Cudongo Forest, Uganda, use both leaves and moss (Hobaiter et al., 2014). Similarly, the simultaneous occurrence of using hands and folding leaves to scoop up water has been observed in chimpanzees and orangutans. These data suggest that they may know the similar relations between the tools and the goals they want to achieve, which is analogical between relations.

Tool using or nut-cracking has also been found in wild chimpanzees, capuchins and macaques. For example, wild chimpanzees use stones or wooden clubs as a hammer to crack the nuts on an anvil. They optimize their selection by considering multidimensional features of the tool, including its weight, material, distance to nuts and the anvil (Sirianni, Mundry & Boesch, 2015). This suggests that chimpanzees might make use of analogical tools, in the sense that they can transfer multidimensional features in a set to another (similar to Alex, see *Relational Reasoning* section) to tool manufacturing to achieve the final goal which is nut-cracking. Additionally, the oyster-cracking behavior in Burmese Long-Tailed Macaque shows that hammers can be from the same material but have different shapes combined with different actions to open the oysters (Tan et al., 2015), suggesting the possibility of an analogical reasoning across sensory-motor domains that A kind of shape combined with A kind of action is similar to B kind of shape combined with B kind of action.

Pretend Play

Leslie (1987) proposed that pretend play in its simple form plays a leading role for metarepresentational abilities like theory of mind. Object substitution is included in pretending, by which the organism treats one object as another (Mitchell, 2002). For example, children will pretend a banana is a phone (Pleyer, 2020). This is closely related to the analogical mind, in the sense that the characteristics of a banana are analogous to those of a phone. Object substitution was early reported in apes raised by humans or in the laboratory. For instance, two human-reared female gorillas at 2.5 years old were found to hold objects as “dolls” between their arm and chest, which actually resemble their maternal behavior when they have babies (Mitchell, 2002). This can be explained by adopting such a behavior owing to living with humans.

However, object substitution has also been observed in the wild. Wild chimpanzees of Kanyawara community in Kibale National Park, Uganda were found to exhibit a behavior called ‘stick-carrying’, where juveniles held or cradled sticks with their hand or mouth or armpit, or tucked them between the abdomen and thigh, and they carried them for as long as four hours during daily life (Kahlenberg, Richard & Wrangham, 2010). It is of note that the stick doesn’t serve any immediate functions, which indicates a potential pretend play role due to its similarity in infant-directed behaviour. Indeed, there is evidence that these behaviours represent a form of “play-mothering” (Kahlenberg et al., 2010). For example, they report observations of an 8-year-old male chimpanzee who not only played with a log and carried it around for four hours, but also made a separate nest for the log in the group’s day-nest (Wrangham & Peterson, 1996). Matsuzawa (2020) also witnessed a similar episode. Ja, an 8-year-old female chimpanzee, took a log (about 50 cm long and 10 cm in diameter) with her which was broken off a dead branch. Ja put it on her shoulder and then shifted it to her armpit more securely when she followed her mother who took her sister on the back. When Ja took a rest on a horizontal branch, she slapped the log softly like mothers do when they slap the back of their infants. It was proposed that this maternal kind of behavior occurs out of female instinct, and a later study indeed showed a sex difference towards females (Kahlenberg, Richard & Wrangham, 2010). However, it doesn’t only happen in females, and the first (as far as we know) case of this behavior was observed in an 8-year-old male chimpanzee (Wrangham, 1995). These data suggest that beginnings of analogical capacities could have been already present in the common ancestor of humans and apes.

Beyond this, analogical reasoning could be another possible explanation of “dolls” playing in apes. Analogical reasoning focuses on the similarities between relations among entities instead of entities *per se* (Gentner, 1983). So, the log juveniles play with may not only be analogous to an infant in terms of entity similarities, but the pretend play of holding a log resembles mothers holding an infant that is, which exhibits mother-infant-caregiving relational similarity. We will discuss analogical, relational reasoning in the next sub-session in detail.

Relational Reasoning

High-level forms of relational reasoning have been regarded as human specific thinking (Penn, Holyoak & Povinelli, 2008). Relational reasoning goes beyond the comparison between entities, but is the ability to make inferences on the basis of relations between entities. In doing so, humans not only need to form explicit representations of such relations, but also make inferences from relations across domains. The same-different conceptualization serves as one of the central cases to study relational reasoning. Here as Hochmann, Wasserman and Carey (2021) emphasize, same-different conceptualization does not mean same or different in perception (first-order relation), but “representing the abstract relations themselves” (second-order relation). Specifically, one not only perceives A and A match and A and B do not, but also generalizes the relation of A and A to B and B. Analogical reasoning is the ability to recognize the sameness between relations. By reviewing studies on same-different conceptualization in nonhuman animals, we agree with the idea that analogical reasoning is an evolutionary continuity.

Introduced by David Premack (1983), relational matching-to-sample (RMTS) tasks have been widely used for investigating same/different relations. It modified the simple match-to-sample (MTS) procedure with substitution of single into paired stimuli, so that the relations of same/different can be revealed. Sarah, a chimpanzee who had been trained with language, managed to do both the selection task in which a judgment of same or different needs to be given, and the completion task in which an analogical element needs to be filled in the blank (Gillan, Premack & Woodruff, 1981). This let Premack (1983) hypothesize that only primates have abstract code, in the sense that such abstraction makes analogical reasoning possible. But can only language trained chimpanzees solve relational reasoning problems? Subsequent studies have shown that it is not a necessary condition. For example, bonobos and chimpanzees — who haven’t been trained with language — are able to select relational matches with a high percentage of accuracy (Christie, Gentner, Call & Haun 2016). It could also be the experience with arbitrary tokens instead of language itself (Thompson, Oden & Boyson, 1997). In contrast to ‘analogical’ great apes, monkeys were characterized as ‘paleologicians’ by Thompson & Oden (2000). However, some studies also show that old world monkeys, such as Guinea Baboons, and new world monkeys, such as capuchin monkeys, both display successful transfer to new relational stimuli on same/different in relation matching-to-sample tasks (Fagot & Thompson, 2011; Truppa et al., 2011), albeit only after very extensive training.

Then what about birds? Studies on parrots and crows also reveal that they show relational reasoning. For example, the famous Alex, a grey parrot, had a lot of verbally symbolic training. Like Sarah, he displayed relational reasoning in transferring relations of sets of features of objects to new stimuli (Pepperberg, 1987). This is a different method to evaluate relational reasoning in nonhuman animals which involves verbal description. In addition, on the basis of Identity matching-to-sample (IMTS) training, in which the birds were trained to learn the sameness relations by the perception of color, shape and number, crows and amazons performed highly accurate on both identity and relational trails in RMTS tasks, suggesting relational training is not necessary for birds to pass RMTS tests (Smirnova, Obozova, Zorina & Wasserman, 2021).

Relational reasoning has also been found in invertebrates. Delayed matching to sample (DMTS) and delayed non-matching to sample (DNMTS) protocols have been used for investigating same/different relations in bees. Subjects are given a complex visual pattern or patterns. After a short period of delay, they are asked to choose which pattern or patterns match in the DMTS and do not match in the DNMTS procedure the previous pattern or patterns. Honey bees have been shown to succeed in mastering the same and different relation between horizontal & vertical stripes and yellow & blue colors (Giurfa, 2021).

Collectively, the reviewed data suggest that relational reasoning does not present a discrepancy between human and nonhuman cognition. Rather, it supports the idea of evolutionary continuity.

Archaeological Evidence

The Role of Analogical Reasoning in Tool Production

The importance of analogical reasoning for tool production has been discussed in numerous publications (e.g., de Beaune, 2004; de Beaune, Hilaire-Pérez & Vermeir, 2017; Osiurak & Reynaud, 2020; Wadley, 2001). Indeed, it helps to acquire new knowledge and diversify a toolkit by transposing old information into a new context. Osiurak and Reynaud (2020) propose the concept of technical reasoning, which is defined as "the ability to reason about physical object properties" and is supposed to help humans to develop new technologies. They state that technical reasoning is analogical and underline that it "must not be confounded with other forms of non-verbal analogical reasoning, particularly fluid cognition". Although technical reasoning should be separated from fluid cognition, analogy, as the capacity to transfer existing knowledge onto new things on the basis of shared relations, can be assumed to serve as a common pool for both types of reasoning.

As part of technological reasoning, analogy is supposed to play a key role in the process of invention. Indeed, its role is often highlighted by researchers (de Beaune, 2004, 2009; Osiurak & Reynaud, 2020; Krumnack, Kühnberger, Schwering & Besold, 2020), especially in the generalization process, which allows to identify common elements in both entities ignoring unimportant details (Krumnack et al., 2020: 57). Osiurak and Reynaud (2020) also highlight the importance of generalization, which is crucial for learning new techniques. There seems to be an agreement that invention is rather a product of recombination and doesn't appear out of nowhere (de Beaune, 2004; Stout, 2004; Krumnack et al., 2020). Moreover, Osiurak and Reynaud (2020) emphasize that technical-reasoning skills, which rely heavily on analogy, play an even bigger role in the invention process than creativity. Not yet fully developed analogical reasoning may, among others, be a factor restricting children's ability to innovate (Burdett & Ronfard, 2020). In a more restrictive way, Osiurak and Reynaud (2020) propose that the "innovative component" of cumulative technical culture develops in adults and not in children.

The development of analogical capacities is not only a question of ontogeny but also of phylogeny. Were any extinct *Homo* species capable of analogical reasoning? Can we somehow attest and measure these capacities? One way is to turn to the archaeological remains.

How to Look for Analogical Capacities in Archaeological Artifacts

Despite its major role in tool production, however, no detailed methodology for inferring analogical capacities from archaeological material has been developed. De Beaune (2004) proposes a model of the "phylotechnical" evolution of stone tool production techniques. She links the breakthroughs presented in her model with problem-solving capacities, especially analogical reasoning. The model is diachronic, i.e., it presents the changes that occurred from the Lower Palaeolithic (2-0.3 Ma) until the Upper Palaeolithic (40-9.6 ka) and covers a large geographic area. It is thus quite general and compares different populations. The question that remains unanswered is how we can attest the presence of analogical capacities in prehistoric humans in synchrony on a local level. To our best knowledge such methodology has not been discussed yet, and we will thus propose a potential method here.

We propose that one way to look for analogical capacities in an archaeological collection is to look at its productional diversity, that is, different ways to achieve production goals. If we find different means to achieve the same production goal, we can assume analogical capacities for a given population. Different means to produce the same goal presuppose different situations; however, since the same goal is achieved, it also presupposes some similarities among those means, at least in their relationship with the goal.

Therefore, to make a meaningful comparison, it is important to consider productional goals by using, for example, the technofunctional method (Boëda, 1997, 2001, 2013, 2021; Lepot, 1993). When comparing different *chaînes opératoires* leading to the same productional goal, we can determine obligatory steps that are unavoidable for the production of this type of tool and other steps that may have variations. These variations are the points where a knapper should make a choice and it is here that we can look for analogical capacities, because at this point variations in means are possible.

As an example, we can look at the Collection de la Pointe aux Oies, Wimereux, France (Tuffreau, 1971). This collection dates between 600 and 450 ka (Dubois, 2019) and consists of flint flakes and cores. The study of negatives of removals has shown that the produced flakes were normalized in their proportions and lateral cutting edges, for example (Kuleshova, 2022). At the same time, it was found that two types of core preparation were used to produce the flakes. A prehistoric knapper could either open a striking platform by producing one or several preliminary flakes (usually larger ones), or they could choose a core with a natural striking platform. The second way would mean that the knapper would invest more time and effort in selecting the right core that would meet all technical criteria needed to produce a desired flake. Importantly, the flakes produced from both types of cores (with prepared or natural striking platform) have the same parameters and structure. To produce normalized flakes a knapper must know what technical criteria they need on their core in addition or in place of basic ones (plane and convex surfaces with an angle <90°). In the case of the Collection de la Pointe aux Oies that would be lateral convexities, and an angle between 65 and 90° among others. This means that a knapper should have a sort of mental template of a future flake, but also of a core or rather of a useful volume with all technical criteria needed. We can suppose that this mental template can come from a knapper's *constellation of knowledge*, which is knowledge about raw material, techniques and instruments (Sinclair, 2000).

As stated above, a mental template with technical criteria is needed for producing normalized flakes. Following Holyoak (2012) we can take this mental template as a source for analogical comparison, as a 'retrieval cue'. All potential cores then will be compared with the template: we will look for 'systematic correspondences' between the template and a potential core. In the case of the Collection de la Pointe aux Oies a knapper could either have a core with all technical criteria naturally present or a core with only partial natural technical criteria, and the potential to create the rest of them by core preparation. We can suppose that in the case of an all-natural useful volume, it's rather an example of comparison because a knapper would just verify their mental "checklist". However, in the instance of a core requiring a preparation step, we can suppose an analogy, because the knapper will have to identify aspects of the technical criteria in order to map them on a core that initially doesn't look like an ideal one. Although a knapper would look for the same criteria in the useful volume (part of the core that is actually knapped: striking platform + flaked surface), the collection presents three different strategies of the striking platform preparation which shows that a knapper would adapt to each particular core in order to get the desired result. This allows us to suppose that they were not just looking for a variant A or a variant B, but for the potential to create a useful volume in which the striking platform will be in such relation with the flaked surface that they would be able to produce the desired flake. In other words, in this case it is not enough to verify a mental "checklist", but the inferences about the suitability of a core should be made based on mapped correspondences from a more concrete source, previous knowledge (Holyoak, 2012; see Figure 2). It is important to underline the role of experience in this process: The more a knapper sees different cores, the easier the process of identifying the suitable cores will be. Following Gentner & Smith (2012: 136), who suggest analogical reasoning might be implicit and "structure everyday experiences, and form abstract schemas over similar experiences", we can suppose that this was an implicit process since the knapping was part of everyday life for prehistoric people.

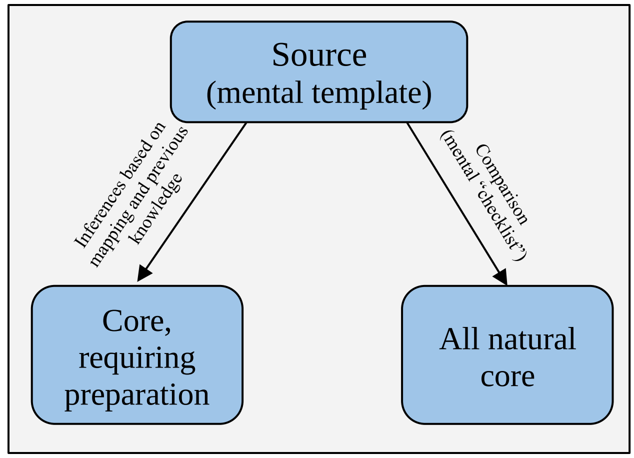

Figure 2: Possible analogy in core selection, based on Holyoak (2012)

Conclusion

In this paper, we have investigated the evolution of metaphor focusing on analogy from two perspectives: comparative psychology and cognitive archaeology.

Metaphor plays an important role in language and cognition, and thus presents a central explanatory target for an evolutionary account of language. However, direct evidence for metaphor in prehistory as well as in other animals is limited. Therefore, this paper focuses on analogy, a key cognitive process supporting metaphor, to gain insights into the evolution of the cognitive foundations of metaphor. We integrate interdisciplinary research from comparative psychology and cognitive archaeology. In comparative psychology, we looked at the domains of tool use, pretend play and relational reasoning in nonhuman animals. Evidence in all three domains suggests that analogy exhibits evolutionary continuity between humans and nonhuman animals. In cognitive archaeology, we proposed a methodology to study analogical capacities in the production process of prehistoric material artifacts. Specifically we investigated how productional diversity of an archaeological collection can help us to estimate analogical capacities of prehistoric people.

In conclusion, we argue that analogical capacities might be evolutionary deep-rooted, and proposed a method to find evidence for analogical capacities in prehistory. Such an interdisciplinary and integrative approach can, therefore, shed light on one of the most central cognitive processes underlying metaphor and thereby forms part of an evolutionary account of metaphor.

Acknowledgements

Michael Pleyer was supported by project No. 2021/43/P/HS2/02729 co-funded by the National Science Centre and the European Union Framework Programme for

Research and Innovation Horizon 2020 under the Marie Skłodowska-Curie grant agreement No. 945339. For the purpose of Open Access, the authors have applied a CC-BY public copyright licence to any Author Accepted Manuscript (AAM) version arising from this submission. We thank Monika Pleyer for discussion, Klaudia Karkowska and Darya Namednikava for help with editing the manuscript and Sławomir Wacewicz for helpful comments.

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