Compound Tool Use and the Evolution of Language

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1 Introduction

The origins of language function in humans is a widely debated and obscure area of evolution. Notably, various theories explore the connection between motor function (such as gestures) and linguistic operations, suggesting that there might be overlap in the brain regions responsible for these behaviours. More specifically, a select school of theories, such as Mithen (1993) suggest tool-use as the root function that language manipulation sprouted from. Combinational manufacture of compound tools is explored as the potential evolutionary origin of the Chomskian 'merge' function, a cognitive manoeuvre underlying recursion in modern human language (Chomsky, 1992). The current thesis outlines an evolutionary turning-point where the cognitive mechanism responsible for traversing hierarchically embedded structures (present both in manufacture of compound tools and recursive syntax parsing) is adapted from previously available cognitive mechanisms. This is hypothesised as a key pivot-point in human evolution toward the sophisticated cooperative life-form we are today.

The second, empirical part of the thesis explores the emergence of such an adaptation in an animal that does not use recursive language: the Goffin's Cockatoo. Compound tool-use is the behaviour of using a tool as an extension of the body to achieve a specific goal, where the tool consists of two or more separate elements. Constructing a compound tool requires intricate object-object interaction representations, beyond the level of complexity that is required for regular tool-use. Perhaps not surprisingly, our closest relative great apes have been known to engage in this type of tool-use under artificial conditions. More surprising is the discovery of this type of tool-use in non-mammalian species, such as the ever-more demonstrably intelligent New Caledonian Crow. Goffin's Cockatoo is another tool-using bird, engaging in various types of tool manufacture behaviours (Auersperg et al., 2018). Goffins are already known to engage in sequential tool-use (the use of a tool to access another tool needed for a goal), and they are thought to be able to model the object-object interactions needed to understand the combination of two items. However, whether they can apply such understanding to construct lasting compound tools is not known. The current study explores their ability to combine two objects into a single compound tool in order to achieve a goal: a piece of cashew.

2 Methods

The two subjects were be presented with two distinct tools, which can be combined into a compound tool longer than either of its sub-components, and a cashew piece just out of the reach of either object. If the subjects succeed in combining the tools into a compound tool, they could reach the reward. Subjects were tested through a Test Phase and a Transfer Phase. In the Test Phase, their ability to recognise the object-object interactions needed to solve the puzzle were put to a test. In the Transfer Phase where they were required to demonstrate transferral of their acquired knowledge to a novel problem. A Plexiglas puzzle box was used and two unique, 3D printed plastic tools were used in the experiment.

3 Results

Both birds reached the success condition in all ten of the test, and all ten of the transferral sessions by utilising two distinct strategies to combine the compound tool subcomponents. Both strategies are detailed in the results section of the text.

4 Discussion

The empirical section of the thesis adds to the body of research showcasing the presence of compound tool manufacture without complex language use in some animals. This suggests that the merge function required for recursive parsing in modern human tool use can be present without complex linguistic abilities in a form used to represent the object-object interactions present in compound tool manufacture.

References

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