

Future thinking: Children but not apes consider multiple possibilities in a new minimalist task

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The future is full of possibilities and, although we draw on our past experience to anticipate what is to come, we must take uncertainty into account. For example, while preparing for a trip, we might pack a raincoat and some sunglasses to be ready for multiple weather conditions. New research shows that the ability to plan for multiple future possibilities may be present in human children from as early 3-4 years of age, but lacking in non-human apes.

The mental construction of future episodes has drawn much attention over the past decade of research [1]. The ability to create future scenarios could offer a selective advantage in an uncertain world, and as adult humans we project ourselves forward using ‘mental time travel’ to anticipate what the future might bring. There has been speculation that this ability may be unique to our species and contribute to the definition of what it means to be human [2, 3]. Although previous comparative work has provided evidence for future planning in non-human animals [4, 5], it has been argued that preparatory actions in these studies can be explained by simpler mechanisms like associative learning and innate programming [6]. Part of the problem is that these examinations have fallen short of capturing the uncertain nature of the future. Subjects were first trained to expect a certain state of affairs, and then researchers investigated whether or not they could take steps to prepare for this predetermined environment. For example, a group of apes were trained to use a tool to obtain food from a baited apparatus that they learned would stay in a given location [7, 8]. In another location, the apes successfully chose the right tool to take with them, forgoing an immediate reward [8], and even retaining the tool overnight [7]. Children from the age of 3-4 years also succeed in this kind of task [9]. However, by training or explaining upcoming conditions to participants we remove the defining feature of the future itself, inherent uncertainty. When the to-be-planned-for future matches past experience, it might not require the kind of mental scenario building that can deal with an uncertain future [10]. A new study published in this issue of *Current Biology* [11] introduces a task that involves planning for multiple possibilities. It makes use of a simple and inherently-rewarding task, the kind of minimalist design that can be used across species.

The paradigm involves dropping a reward into a vertical tube which forks into two openings at the bottom. To pass, subjects must use two hands to prepare for the item possibly exiting either side. Children’s performance increased linearly with age: two-year-olds did not consistently cover both openings but most of the older children did. The developmental trajectory shown in this study is comparable to that in the wider literature on age-related changes in future-thinking capabilities [12]. Ape performance was similar to that of the two-year-olds. Some individuals were able to pass the task after some experience, but they did not maintain this behaviour over all trials, and always regressed to a one-handed strategy. The authors take this to indicate that despite possessing the requisite physical skills, the apes and two-year-olds lacked the ability to plan for multiple future possibilities. What

remains unclear from the current work is what is responsible for this difference in ability. What is missing in apes and younger children?

The authors suggest that the skill that makes the difference could be metarepresentation: the ability to reflect on representations themselves, for example, to reflect that one's prediction might be wrong [13]. This seems plausible, because by the age of four children begin to show evidence of other skills in which different representations of reality must be entertained, such as identifying the content of another individual's false belief [14]. However, responding to the uncertainty created by multiple possible outcomes need not entail an ability to metarepresent them as such [15]. Previous research has shown that great apes can take multiple courses of action in tasks where they are uncertain [16]. Suda and Call reported that apes faced with uncertainty about which of two cups contained the greater reward would use both hands and point to both cups. Conversely, an experiment by Beck and colleagues showed that children can represent alternative states of reality without spontaneously preparing for multiple possibilities [17]. Similar to the new study, in this experiment, a toy mouse could go down a forked slide, but here the task for children was to lay out mats to catch the mouse. Only a minority of 3- to 5-year-old children took the precaution of laying down two mats, but they were able to answer counterfactual questions about where the mouse would be if he had gone the other way. The nature of the relationship between representational and planning abilities remains an open and intriguing question.

The authors accept that there are other explanations for the difference that have not yet been ruled out. One possibility is background knowledge. In order to pass the task from the first trial, subjects must understand the causal mechanism in order to know that there can be multiple possible outcomes [18]. Problematically, there is some indication that apes and two-year-olds struggle with prediction on a task in which food travels through a bent tube, even when there is only one possible exit. Both young children and chimpanzees incorrectly expected food dropped into an opaque slanted or S-shaped tube to have fallen straight down [19, 20]. While the authors of this new study report that subjects did not place their hands where a gravity bias would predict (directly beneath where the food was dropped), it remains possible that weak object knowledge could account for poor performance.

Although there are multiple possible interpretations of the results, this study uses a clever minimalist paradigm to forge a new path for comparative research. Work of this kind is vital if we are to investigate what, if anything, is unique about human foresight [2]. Future research could shed more light on what causes success and failure on this task. Does anticipating multiple possible outcomes of a physical event that is about to unfold require the ability to project oneself into the future? To this end, it would be interesting to know how performance on this task relates to planning for a more distant future. The findings from the new study are likely to be of interest to both developmental and comparative researchers and provide a springboard for new research on future thinking.

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Figure 1: Imagining the future or learning from the past? Previous studies of future thinking in apes

involved teaching subjects how to use a tool to solve a puzzle, such as using a straw to drink juice [8]. In another room, apes successfully selected this tool and later transported it to the puzzle, but critics argue that this might be driven by past experience with the tool rather than genuine forethought [2]. Drawing by Leigh Wagner.