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Exploring tool innovation: A comparison of Western and Bushman children



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ABSTRACT

A capacity for constructing new tools, or using old tools in new ways, to solve novel problems is a core feature of what it means to be human. Yet current evidence suggests that young children are surprisingly poor at innovating tools. However, all studies of tool innovation to date have been conducted with children from comparatively privileged Western backgrounds. This raises questions as to whether or not previously documented tool innovation failure is culturally and economically specific. In the current study, thus, we explored the innovation capacities of children from Westernized urban backgrounds and from remote communities of South African Bushmen. Consistent with past research, we found tool innovation to occur at extremely low rates and that cultural background had no bearing on this. The current study is the first to empirically test tool innovation in children from non-Western backgrounds, with our data being consistent with the view that despite its key role in human evolution, a capacity for innovation in tool making remains remarkably undeveloped during early childhood.

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Introduction

In 1908, the world's first production car, the Model-T Ford, rolled off the assembly line. It could muster a top speed of just over 60 km/h. Less than 100 years later, the Bugatti Veyron, one of the world's fastest street-legal production cars, could get to 60 km/h in 2.6 s on its way to a top speed of over 400 km/h. On the other hand, 100 years before the Model T, the only reliable way to reach 60 km/h was to climb onto the back of a fast horse. The advances in technology that underpin these shifts, and the innovative ideas behind them, are remarkable. Since Jane Goodall reported that chimpanzees use twigs to fish for termites, we as humans could no longer lay claim to the title of the planet's only tool-making animals (Goodall, 1964). Yet we remain without peers when one considers the depth, breadth, and inventiveness of our technology (Vaesen, 2012). There is every reason to expect that chimpanzees living 200 years ago stripped leaves from twigs, much like they do today. During the same period, we have gone from building buggies for our horses to vehicles with power roughly equivalent to that of 1000 horses. Underpinning such remarkable examples of cumulative cultural progress are our propensities for both innovation and learning to use tools and objects by watching and copying what others do with them (i.e., by imitating).

The capacity for imitation is an achievement established very early in development. From 6 months of age onward, infants show an ability to acquire the skills needed to use novel objects by copying others (Barr, Dowden, & Hayne, 1996; Meltzoff, 1988). Moreover, a spate of recent studies has shown that from the second year of life onward, children are increasingly prone to copy others so inclusively that they will incorporate visibly causally irrelevant actions (for recent summaries, see Over & Carpenter, 2012; Wood, Kendal, & Flynn, 2013). For example, if an adult deliberately wipes a stick along the top of a box before opening it, children will do the same even if they are familiar with the box and know it can be opened more simply by opening a door located on the front of the box (Nielsen, Moore, & Mohamedally, 2012). Such precise copying has become known as overimitation, and limited evidence to date suggests that it occurs cross-culturally in humans (Nielsen, Cucchiaro, & Mohamedally, 2012; Nielsen, Mushin, Tomaselli, & Whiten, *in press*; Nielsen & Tomaselli, 2010) but is not present in our closest primate relatives (Horner & Whiten, 2005).

Given that our children develop in environments profusely furnished with both simple and complex tools and other mysterious technological artifacts, overimitation appears to be highly adaptive (Herrmann, Legare, Harris, & Whitehouse, 2013; Whiten, Hinde, Laland, & Stringer, 2011). The skills needed to use and operate tools whose functions are often initially opaque can be rapidly acquired by directly and comprehensively copying "expert" adults. However, high-fidelity copying of others' tool use was not sufficient to get us from a buggy to a Bugatti. It was tool innovation—the construction of new tools, or use of old tools in new ways, to solve new problems—that proved to be critical in making this happen. And although young children's ability to learn how to use tools through observation is well documented and analyzed, current evidence suggests that their capacities for tool innovation are much more limited.

In one of the few studies to have investigated emerging tool innovation capacities, using a task originally developed to test New Caledonian crows (Weir, Chappell, & Kacenic, 2002), Beck, Apperly, Chappell, Guthrie, and Cutting (2011) presented children with a narrow vertical tube containing a bucket with a hooped handle (see also Chappell, Cutting, Apperly, & Beck, 2013; Cutting, Apperly, & Beck, 2011). The task was to get the bucket out of the tube in order to retrieve a sticker. When given a choice between a straight pipe cleaner and a hooked one, 4-year-olds chose the hooked one above chance. However, when given a choice among a straight pipe cleaner, a long piece of string, and some small matchsticks, children up to 5 years of age rarely bent the pipe cleaner into a hook or made any other functional tool. Fewer than half of even 7-year-olds succeeded, with children not performing at high levels until 9 or 10 years of age. In marked contrast, children in all age groups succeeded at high rates once shown by an adult what to do (i.e., by imitating). In an analogous study, 4-year-olds were tested on a task where water could be poured from a bottle into a tube in order to float a toy to the top so that it could be retrieved (Nielsen, 2013). Unlike the task of Beck and colleagues, this task does not require children to construct a new tool, but they do need to use an old tool (i.e., the water bottle) in a new way. Children were unable to do this, failing to recognize the solution on their own. They did,

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