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Did humans evolve to innovate with a social rather than technical orientation?

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ABSTRACT

The quality and frequency of human technical innovation differentiates us from all other species, and has played a primary role in creating the cognitive niche that we occupy. Yet, despite the centrality of technical innovation to human culture and our daily lives, most people rarely if ever innovate new products. To address this discrepancy we consider our evolutionary history, and how it might have created a species whose members are both highly innovative and highly unlikely to invent new products. We propose the *social innovation hypothesis,* which suggests that our minds evolved to innovate, but with a social rather than a technical orientation. Because people find social relations rewarding, they gravitate toward social rather than technical solutions to their problems. Thus, it may primarily be people who are less socially oriented who innovate technically. Consistent with this possibility, 1) engineers and physical scientists are less socially oriented and more likely to innovate new products than people in the humanities and social sciences, and 2) men are less socially oriented and more likely to innovate new products than women.

The quality and frequency of human *technical innovation* clearly differentiates us from all other species on this planet (Dong, Collier-Baker, & Suddendorf, 2015; Reader, Moran-Ferron, & Flynn, 2016). Technical innovation has permeated all aspects of our existence, and is involved in the processes by which we satisfy our basic needs as well as our desires for comfort and entertainment. Technical innovation also played a critical role in our evolution, as the creation of sophisticated tools enabled us to rise to the top of the food chain in the absence of outstanding biological weaponry beyond our large brain. Yet despite the fact that technical innovation is a defining quality of our species, most people rarely if ever innovate new products. For example, in a representative sample of the UK, people were asked if they had modified or created any new products to use for themselves, such as tools, toys, sporting equipment, cars, or household equipment. Six percent of the respondents indicated that they had modified or innovated new products in the last three years, listing a wide variety of household, garden, hobby, medical, child- and pet-related innovations (von Hippel, de Jong, & Flowers, 2012). Similar rates of user innovation have been documented in the U.S. (5.2%; Ogawa & Pongtanalert, 2011), Finland (5.4%, De Jong, von Hippel, Gault, Kuusisto, & Raasch, 2014), and Japan (3.7%; Ogawa & Pongtanalert, 2011). Such survey data are subject to all the flaws inherent in self-report, but they suggest that people rarely innovate new products for their own use.

There are at least three ways to interpret this discrepancy between our species as a whole and its individual members. First, perhaps all obvious inventions have already been made. This argument is centuries old but continuously disconfirmed.[1] Second, perhaps most people are ill-suited to innovate but a few geniuses among us have the talent to make important new things. Extraordinary innovations like the telephone, light bulb, or jet engine would support such a possibility, as the insights underlying them seem out of reach for ordinary minds. According to this possibility, technical innovations are like genetic mutations in that they are mostly worthless or trivial, but the occasional breakthrough sweeps through the population and can have an enormous impact on the species (Coward & Grove, 2011).

Third, it is also possible that most people are capable of innovating, but are simply disinclined to direct their problem-solving efforts toward product innovation. Strikingly ordinary technical solutions like wheels on suitcases would support such a possibility, as people lugged ungainly baggage on their journeys for generations before someone finally arrived at the simple and now ubiquitous solution of putting wheels on them (Sharkey, 2010). According to this possibility, *technical innovations do not necessarily demand genius and are only rare because people focus their innovative efforts elsewhere*. The goal of this paper is to address this latter possibility by considering how our particular evolutionary pathway might have created a species whose members are both highly

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[1] http://www.boredpanda.com/useful-creative-inventions/ provides examples of 25 recent and simple inventions, retrieved June 1, 2017.

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innovative and highly unlikely to invent new products.

Before delving into these issues, we need to clarify exactly what we mean by innovation. New ideas, products, and methods are typically regarded as innovations. However, innovation requires more than novelty and problem solving. From a psychological perspective, we propose that the critical features of *innovation* are the recognition that (1) a solution has been found and (2) the solution has future utility. For example, Fleming's discovery in 1928 that the unintended mould in his petrie dish had killed the staphylococci bacteria (Diggins, 1999) was an innovation because he recognized that he had found (1) something that killed bacteria, (2) which would be useful in the future. According to this view, a novel solution to a problem, whether it is arrived at deliberatively or serendipitously, qualifies as an innovation *only if its future utility has been recognized.* After all, it is recognition of future utility that motivates retention of the solution so that it can be used again, and often leads to attempts to refine and improve it.

Because people often imitate behaviors they do not completely understand (Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009), new solutions to problems can also be enacted and spread through a population in a less thoughtful fashion. Much like the mindlessness of natural selection, better tools and techniques can be stumbled upon and can spread to others (e.g. Dennett, 2017). Nonetheless, we would not label such improvements in tools or techniques as innovations unless (or until) someone identifies their current and future utility, at which point they are no longer just luck or happenstance.

From this perspective, foresight is an integral part of innovation, which might explain why innovation appears to be such a distinctly human capacity. When innovation is defined as "the first occurrence in a population" or "the process that generates in an individual a novel learned behavior that is not simply a consequence of social learning or environmental induction" (Ramsey, Bastian & van Schaik, 2007), then many species can be said to engage in innovative behaviors (e.g., Reader & Laland, 2001; van Schaik, van Noordwijk, & Wich, 2006). Research in this tradition has found considerable evidence for associations between frequency of innovative behavior and other variables such as brain size (e.g. Arbilly & Laland, 2017; Lefebvre, Reader & Sol, 2004; Reader & Laland, 2002; Street, Navarrete, Reader, & Laland, 2017). However, from our perspective, these studies are not tracking innovation, as there is no assessment of foresight. To the best of our knowledge, only humans can simulate novel future scenarios in a manner that enables weighting of possibilities and evaluation of their likelihood and desirability (Redshaw & Bulley, 2017; Seed & Dickerson, 2016; Suddendorf & Corballis, 2007). These capabilities allow assessment and comparison of novel circumstances and recognition of the future value of a new tool or idea.

Although innovators may choose to simulate the utility of a solution solely in terms of their own future self, recognition of future utility is often expressed by sharing an innovation with others who may also benefit from it. Indeed, innovations are frequently made available for adoption by family and friends (as is typically the case with user innovation; von Hippel, 2017), and by being introduced to the market. Thus, *retaining*, *sharing*, and *refining* are critical expressions of the recognition that a novel solution has future utility, and hence qualifies as an innovation (Suddendorf, Bulley & Milloyan, in press). The process of sharing enables the spreading of benefits and can bring rewards to the inventor.

Due to the enormous advantages of cumulative culture, humans solve most of their problems using products, techniques, and ideas that others have discovered. People ask others for advice and culturally inherit an enormous number of solutions that continue to accrue over time. Indeed, the cumulative scaffolding of innovation across individuals and generations is at the heart of human cultural evolution (Boyd, Richerson, & Henrich, 2011; Legare & Nielsen, 2015; Tomasello, 2016). The examples provided earlier of the telephone, light bulb, and jet engine were not created *de novo*, but rather relied heavily on the social transmission of prior innovations. This scaffolding process may be as old as our species, or considerably older, although the first hard evidence for such cultural capacities emerges many millennia after the advent of anatomically modern humans in the archeological record in the Middle Stone Age (e.g. d'Errico et al., 2017; Jacobs & Roberts, 2009; Shipton, 2013). Regardless of the timeline, cumulative culture eventually enabled us to dominate the planet, and our collective wit provides us with tried-and-true solutions to most of the problems we encounter (Sterelny, 2016; Suddendorf, 2013; Tomasello, 2014).

Nonetheless, both change and progress demand new solutions, and all humans occasionally encounter problems for which they have no off-the-shelf solution. The current paper focusses on problems such as these – for which we have no readily available solutions – and on our capacity to address such problems through technical innovation. By *technical innovation* we mean the creation of new physical products from scratch, or modifications to existing products or objects to change or enhance their function or production (von Hippel, 2017).

1. Sociality and early hominin evolution

The oldest remnants of hominin innovation are stone tools. Early stone tool technologies such as simple Lomekwi and Oldowan tools (from 3.3 to 2.6 million years ago, respectively; Harmand et al., 2015; Semaw, 2000) and more complex bifacial Acheulian tools (from 1.8 million years ago; Lepre et al., 2011; Putt, Wijeakumar, Franciscus, & Spencer, in press) seem innovative, but they remained in use for many hundreds of thousands of years without major improvements (Hopkinson, Nowell, & White, 2013; Mithen, 1999; Stout, 2011). This apparent paucity of technical innovation over many millenia suggests that our ancestors' success may be attributed to capabilities other than rapid technical advances. Instead, their evolving capacity for *cooperation* and *social coordination* was probably a key element that enabled our ancestors to survive and thrive on the savannah (Bingham, 2000). The reliable social transmission of powerful techniques, such as how to make a bifacial handaxe or how to coordinate activities, appears to have been more important than further technical invention (Morgan et al., 2015; Shipton & Nielsen, 2015).

On the grasslands our ancestors were much more susceptible to predation than they had been in the forests, as lions, saber tooth tigers, and hyenas are much faster and more powerful than bipedal hominins (Hart & Sussman, 2005). Although modern chimpanzees are only occasional cooperators (Boesch, 1994; Gilby, 2006; Hare & Tomasello, 2004), reliable cooperation would have been essential for our ancestors to protect themselves from these predators once they were away from the safety of trees. For example, one solution to the increased risk of predation might have been collectively throwing stones (Calvin, 1982; Isaac, 1987). Support for this possibility can be seen in changes to the hands of *Australopithecus afarensis*, which enable better throwing and clubbing than the hands of chimpanzees (Marzke, 1983; Napier, 1993; Young, 2003). Evidence for *Homo sapiens'* cooperative nature can also be seen in the whites of our eyes, which are much better at advertising gaze direction than the brown eyes of other apes, suggesting that it was to our ancestors' advantage to broadcast their intentions (Tomasello, Hare, Lehmann, & Call, 2007).

The mental challenges associated with cooperation and social coordination appear to have played an important role in the evolution of our large brains (Dunbar & Shultz, 2007; Frith & Frith, 2010). According to the *social brain hypothesis*, the evolution of primate intelligence was driven largely by social rather than physical challenges (e.g., Byrne & Whiten, 1988; Humphrey, 1976; Jolly, 1966; Whiten & Byrne, 1988). Consistent with this possibility, behavioral flexibility is associated with brain size across different species of primates (Reader & Laland, 2002; Street et al., 2017). In hominins, this trend may have accelerated as our ancestors increasingly relied on complex forms of cooperation, social coordination, and social transmission. The *cultural intelligence hypothesis* further suggests that humans evolved special skills of social cognition that enabled better social learning (e.g., Hermann