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HUMAN EVOLUTION

Group size determines cultural complexity

Many animals use culture, the ability to learn from others, but only humans create complex culture. A laboratory experiment tests which characteristics of our social networks give us this capacity.

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Isaac Newton famously said that he saw further by standing on the shoulders of giants. A more apt image for most human culture is that we see further because we stand on the shoulders of a vast pyramid of mini-Newtons. Only a few people have invented even one word of the language they speak, for example, yet a native speaker of English knows tens of thousands of words. As early as the Stone Age, people spoke complex languages, interacted in diverse social systems and built exquisite and functional tools. So how do we create the wonderfully diverse cultural systems that sustain us in almost every terrestrial habitat in the world? Studies of cultural evolution point to two factors — accurate imitation[1] and large social networks[2]. Mathematical modelling suggests[3] that these two properties will support the fast, cumulative evolution of cultural systems. In a paper published on *Nature*'s website today, Derex *et al.*[4] present results from a laboratory experiment that support the role of network size (Fig. 1).

Accurate imitation allows humans, but not chimpanzees, to learn complex skills and ideas from others — much more complex ones than they can learn for themselves. Large social networks allow human learners to tap the knowledge of mentors skilled in any cultural domain, thereby rapidly spreading the best ideas throughout a society. Studies to test the effect of network size on cultural evolution have mainly used observations of small, isolated populations compared with larger neighbouring groups[5]. But such natural experiments are controversial: not all studies find the effect, perhaps because other factors also influence cultural complexity. Therefore, Derex *et al.* turned to the laboratory to investigate the issue.

Theory suggests[2] that if a too-small group attempts to make a too-complex tool, over time the tool will become simplified: small groups will often lack a tool-maker of sufficient skill to make the complex version of the tool and a simpler form will evolve. To study the effects of varying task complexity and the number of members in groups of learners, Derex *et al.* asked participants to draw either a stylized arrowhead or a fishing net on a computer screen. These designs were then used to earn the participants money from simulated hunting or fishing expeditions. The monetary yield of an arrowhead was a simple function of its shape, whereas that for nets was a complex function of net shape, the size of cord used in different parts of the net and the knots used to hold the cords together. The yield from a well-constructed net was considerably more than could be earned from an arrowhead, so participants were motivated to construct nets.

The participants were assigned to groups of 2, 4, 8 or 16. They received initial video demonstrations in how to make both tools and then had 15 trials to make their own — one tool per turn. At the end of each trial, participants could see the yield of each of the other people in their group, and by clicking on those scores, could see the step-by-step procedure by which the corresponding object had been made.

The authors' findings support the hypothesis that group size plays an important part in cultural evolution: the probability of a group maintaining the ability to construct the complex tool (the net) over the course of the experiment, the probability of maintaining the ability to construct both tools, and the quality of both tools all increased as a function of group size. Most participant attempts to copy a demonstration for making the fishing net resulted in nets worse than the original. Nevertheless, in large groups, the best nets were often better than the demonstration, and this drove the maintenance of net quality in those groups, as predicted by theory. By contrast, net quality deteriorated substantially in smaller groups. The quality of the arrowheads improved considerably over the course of the trials in the larger groups and was more or less maintained in smaller groups.

A noteworthy wrinkle in the findings is that the performance in groups of 8 and 16 participants hardly differed, perhaps because the extra information in groups of 16 was as distracting as it was helpful. Furthermore, participants were under time pressure in observing others' procedures and making their new tools.

Laboratory experiments have the obvious problem of drastically compressing the timescale of social learning and cultural evolution, and the size of populations. But despite the difficulties of capturing culture in the laboratory, the need to do so is overwhelming. Cultural transmission is much messier than genetic transmission. The extended duration

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Figure 1 | Net gain. Derex *et al.*[4] show that interacting in large groups helps people to maintain the ability to perform complex tasks, such as building nets.

of enculturation, and the involvement of ill-defined and interacting influences, make studying cultural transmission in almost all natural populations difficult compared with studying the discrete events and the one or two parents involved in genetic reproduction. In addition, learners' own preferences also influence what is transmitted, and this situation is without parallel in biological reproduction. Controlled experiments are the only way to understand many of these processes and, as in so many fields, the problem of laboratory artefacts must be considered part of the price.

Although proposals to conduct such experiments go back a long way[6], and some older attempts produced interesting results[7], culture researchers are only at the beginning of their experimental project — they are essentially a century behind geneticists working on a similar project. The field of cultural evolution has grown up at the intersection of disparate disciplines and initial progress was slow. Evolutionary biologists and economists furnished the formal theory; anthropologists, sociologists and historians contributed their interest in culture; and social and developmental psychologists brought a focus on individuals and methods for studying how individuals interact with their groups. But only recently have experiments like those of Derex and colleagues been appreciated by a broad audience.

Science itself is a cultural evolutionary phenomenon, and understanding it as such is an important project in itself. The polymath psychologist and pioneering contributor to the study of cultural evolution, Donald T. Campbell, proposed an applied cultural-evolution project designed to improve scientific practice[8]. Recently, an article[9] in *The Economist* was featured on the magazine's cover as 'How science goes wrong'. Campbell's rarely discussed idea seems worth pursuing as part of our continuing studies of cultural evolution. ■

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