

Experimental models for testing hypotheses about cumulative cultural evolution[☆]

Christine A. Caldwell*, Ailsa E. Millen

Department of Psychology, University of Stirling, FK9 4LA Stirling, UK

Initial receipt 14 September 2007; final revision received 11 December 2007

Abstract

The rapid appearance (over evolutionary time) of the cognitive skills and complex inventions of modern humans has been attributed to “cumulative cultural evolution” (CCE), the accumulation of knowledge and skills over generations. To date, researchers have only been able to speculate about the reasons for the apparent absence of this phenomenon in nonhumans, and it has not been possible to test hypotheses regarding the mechanisms underlying it. Here, we show that it is possible to demonstrate CCE under laboratory conditions by simulating generational succession through the repeated removal and replacement of human participants within experimental groups. We created “microsocieties” in which participants were instructed to complete simple tasks using everyday materials. In one of our procedures, participants were instructed to build a paper aeroplane which flew as far as possible, and in the other, they were instructed to construct a tower of spaghetti which was as tall as possible. We show that, in both cases, information accumulates within the groups such that later generations produce designs which are more successful than earlier ones. These methods offer researchers a window to understanding CCE, allowing for experimental manipulation and hypothesis testing.

© 2008 Elsevier Inc. All rights reserved.

Keywords: Cultural evolution; Cultural transmission; Culture; Ratchet effect; Social learning

1. Introduction

The rapid appearance (over evolutionary time) of the cognitive skills and complex inventions of modern humans has been attributed to “cumulative cultural evolution” (CCE) (Boyd & Richerson, 1996; Richerson & Boyd, 2005; Tomasello, 1999). The term *CCE* is used to describe the way that knowledge accumulates in human populations over time, such that each generation makes use of behaviours and artefacts invented by previous generations, which they would be unlikely to have been able to invent by themselves (Boyd & Richerson, 1996; Richerson & Boyd, 2005; Tomasello, 1999). It has been argued that, although social learning is relatively common in the animal kingdom, CCE is extremely rare, possibly restricted to humans (Boyd & Richerson, 1996; Galef, 1992; Tomasello, 1999). It has also been suggested that CCE may even be dependent on learning mechanisms which are unique to humans and is conse-

quently not possible in nonhumans (Tomasello, 1999), although this remains contentious (e.g., see Whiten, Horner, & Marshall-Pescini, 2003). Understanding CCE may therefore represent an important element in understanding human nature, particularly as it has allowed humans to develop powerful technologies, assemble complex societies, use symbolic forms of communication, and exploit an unusually wide range of habitats (Boyd & Richerson, 1996). However, to date, research on CCE has been restricted to historical approaches, such as those which classify and sequence human artefacts (Basalla, 1989; O’Brien, Darwent, & Lyman, 2001), and comparative approaches, which draw comparisons between human behaviour and that of other animals, such as chimpanzees (Boesch, 2003; Tomasello, Kruger, & Ratner, 1993; Tomasello, Savage-Rumbaugh, & Kruger, 1993; Whiten et al., 2003). Therefore, researchers have only been able to speculate about the reasons for its apparent absence (or at least its relative rarity, e.g., see Boesch, 2003) in other species and the abilities upon which it depends in humans.

This has led to considerable debate (Whiten, 2005) and little consensus. For example, Boyd and Richerson (1996) and Tomasello (Tomasello, 1999; Tomasello, Kruger, et al.,

[☆] This work was supported by a grant from the Economic and Social Research Council (ESRC) to C.A.C. (RES-061-23-0072).

* Corresponding author.

E-mail address: c.a.caldwell@stir.ac.uk (C.A. Caldwell).

1993; Tomasello, Savage-Rumbaugh, et al., 1993) have suggested that CCE may depend on specific social learning mechanisms, in particular, imitation and/or teaching. Since imitation and teaching have traditionally proven notoriously difficult to identify in animals (Caldwell & Whiten, 2002; Caro & Hauser, 1992), their arguments have provided a conveniently neat explanation for the apparent absence of CCE. However, this has not gone undisputed (Heyes, 1993; Laland & Hoppitt, 2003). Laland (2004) has suggested that CCE may instead depend on an ability to appraise the relative effectiveness of behavioural alternatives and that this could be beyond the capabilities of nonhumans. In contrast, Whiten (2005; Whiten et al., 2003) has proposed that the crucial factor may be the unusual complexity of human behaviours and that this accounts for CCE rather than particular social learning mechanisms.

Our aim was to demonstrate that CCE could be studied under laboratory conditions. Such a demonstration would allow this debate to move from theoretical speculation into the realms of empirical testability. We therefore wanted to show that improvement in performance on a task could be passed on within groups over miniaturised “generations” of learners. We used a micro-society design, in which generational succession is simulated through the repeated removal and replacement of participants within groups (e.g., Baum, Richerson, Efferson, & Paciotti, 2004; Jacobs & Campbell, 1961). This method also has similarities with the transmission chain method, originally pioneered by Bartlett (1932) and more recently applied by Mesoudi (e.g., Mesoudi, 2007; Mesoudi & Whiten, 2004; Mesoudi, Whiten & Dunbar, 2006). We presented groups of participants with challenges involving the construction of simple artefacts. In one of our tasks, groups of participants were asked to build a paper aeroplane from a sheet of paper that would fly as far as possible. In the other task, 10 groups of participants were asked to construct a tower from spaghetti and modelling clay, which was as high as possible. It was predicted that the performance of these chains of individuals would improve over successive generations. It was also predicted that the artefacts produced by participants would themselves show physical evidence of social learning in that structures would be more similar within chains than across them.

2. Methods

2.1. Participants

Participants were recruited on campus at the University of Stirling and from two local secondary schools. For the paper planes study, 10 chains of 10 participants took part. Their mean age was 20 years (S.D., 6.02, youngest=13, eldest=48), and the ratio of males to females was approximately 50:50 (53 males, 47 females). Ten chains of 10 participants also took part in the spaghetti towers study. Their mean age was 21 years (S.D., 7.14, youngest=11, eldest=47), and the ratio of males to females was approximately 40:60 (39 males,

61 females). As the participants for both studies were drawn from the same pool of participants (predominantly undergraduates from the University of Stirling), it is possible that some individuals took part in both parts. We did not consider it necessary to exclude individuals from participating in one study if they had already taken part in the other.

Ethical approval for this research was provided by the University of Stirling Department of Psychology Ethics Committee. The procedure was explained to all participants in advance, and they each gave written consent to participation.

2.2. Materials

Paper plane builders were provided with a single sheet of A4 paper, and spaghetti tower builders were provided with a standard 500-g packet of spaghetti and 78-g of modelling clay (Early Learning Centre “Modelling Material”).

2.3. Procedure

Participants were randomly assigned to the positions 1 to 10 in each chain. The participants were informed that they were about to take part in a team challenge and that they would be called in turn to engage in the task. In order to simulate generational succession, the participants’ start times were staggered, such that every 2.5 min, a new person entered the group (see Table 1 for information on group composition at any given time). While they were in the test group, each participant had 5 min of observation time, during which they could watch the previous participants building their artefact, followed by 5 min of building time, during which they had to construct their own artefact. Once their time was up, they left the test group. The staggered start and finish times had the effect that, at any given time (except at the very start and very end of any given chain), there were four individuals together in the group, two of whom were observing and two of whom were actually engaged in the

Table 1
Group composition over time in the micro-society design

Time (min)	Group composition (by participant number)	
	Observing	Constructing
0.00–2.30	2, 3	1
2.30–5.00	3, 4	1, 2
5.00–7.30	4, 5	2, 3
7.30–10.00	5, 6	3, 4
10.00–12.30	6, 7	4, 5
12.30–15.00	7, 8	5, 6
15.00–17.50	8, 9	6, 7
17.50–20.00	9, 10	7, 8
20.00–22.30	10	8, 9
22.30–25.00		9, 10
25.00–27.30		10

Note. Generational succession is simulated through the repeated removal of experienced participants and introduction of naïve participants. Each row of the table shows the group composition at any given time, made up of observing participants and participants actually engaged in the task (constructing).

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات