Standing on the shoulders of giants: an archaeological perspective on cultural transmission

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How and why did humans learn to learn? A variety of disciplines have recently provided significant insights into the basic mechanisms behind cultural transmission – archaeology is now beginning to place these into a chronological framework that will help us understand when and why they evolved among our ancestors.

The extent to which human behaviours and knowledge are culturally transmitted within and between generations has long been considered a defining feature of our species. Parts of the behavioural repertoires of many other animals - from ants to dolphins - are neither determined by genetics nor individually acquired but learned from members of the same species. For example, the manufacture and/or use of material objects among some of our closest primate relatives are group-specific and persist between generations[1,2]. However, the diversity and complexity of learned behaviours among humans by far outstrip anything known in other species; in addition, human culture is cumulative in a way that other species' socially learned repertoires are not[3,4].

A basic capacity for motor imitation – the mirror neuron system, which automatically maps the observed actions of others onto one's own motor system – is part of our primate heritage[5]. But although other species may learn behaviours, and even act in such a way as to facilitate their offspring's learning, only humans are known to teach, which involves actively correcting learners [4,6]. Furthermore, although primates are capable of complex interactions with one another or with objects, they do not seem to engage in relations with objects *and* other individuals at the same time[6]. The suggestion is that the human mirror neuron system may allow us to go beyond imitating the observed motor acts of others to infer their intentions and perhaps even their states of mind[5] - perhaps the prerequisite for true imitation and cumulative cultural transmission.

However, neither humans nor primates are born fully-fledged imitators or mind-readers; the necessary cognitive and motor systems take time to mature. The fossil record documents an extension of the hominin developmental period relative to that of primates: estimates of brain size at birth, coupled with analysis of the relative development of teeth and bones of juveniles, demonstrate the birth of less developed infants and longer, slower growth of both brains and bodies[7]. Stone tools appear in the archaeological record from at least 2.5 million years ago[8], roughly at the same time as the earliest known specimens of *Homo*, documenting sufficient social and technical skills for the habitual targeting of higher-quality foods requiring more processing to extract, such as meat. This dietary shift in turn made it easier to provide for the longer developmental period, which required the involvement of more than one adult - an indication of more complex and longer-lasting social relationships.

This expanded period of development and maturation of the brain thus occurred in increasingly rich social and cultural environments, with longer-lived social relations facilitating the transmission of more and more complex cultural skills – many craft skills practiced by modern humans take several years of intensive teaching to master, often in childhood (see the first photo). Neuroimaging studies of the acquisition of tool-making skills[9] and modelling of early hominin social systems based on those of extant primates[10] are fleshing out our understandings of the basic cognitive mechanisms for motor imitation, learning, and sociality. Their social and cognitive flexibility that allowed hominins to colonize new and unfamiliar ecosystems and to develop the bewildering diversity of cultural traits visible today and in the archaeological record as they spread across the globe.

Makuri beadmaking; photo courtesy Clive Gamble

Archaeology can add to the debate by investigating specific patterns of cultural transmission among and between prehistoric populations. The patterns formed by the geographic and temporal distribution of material culture in the archaeological record results from the dissemination of the relevant behaviors between individuals. Thus, the process can be modelled (much as epidemiologists model the transmission of disease) to investigate the social and demographic factors that influence how learned skills spread into population-wide distributions[3]. Application of such models to the archaeological record has provided insights into such puzzles as the loss of various technologies in Holocene Tasmania. Rising sea levels cut the island off from the Australian mainland in the early Holocene, resulting in a sharp drop in effective population size that reduced the pool of social learners, resulting in these cultural losses[11].

Furthermore, because cultural transmission occurs vertically, from parents to children[12], dual inheritance theory considers cultural transmission as analogous to - but distinct from

– genetic transmission[3]. The use of methodologies better known for dealing with genetic data, such as cladistics and phylogenetic analysis, is beginning to yield valuable new information on the rates, timings and directions of such processes as the colonization of the Pacific Islands, the spread of agriculture across Europe from its Near Eastern origins and the changing compositions of pottery assemblages during the later stone age[13].

However, cultural transmission is always first and foremost social transmission, firmly embedded in networks of social relations between individuals. Thus, large-scale models can be enhanced by considering the small-scale processes revealed by ethnography. For example, among Micronesian sailors the traditional skills of navigation are indeed passed down between generations, often from father to son. From a very young age, children are immersed in discussion of canoes and navigation, and from the age of perhaps five upwards, teaching becomes more explicit. Knowledge is acquired through rote learning, the rehearsal of drills, chants and stories and the construction of "star charts" and "stick maps" that transmit the details of voyages covering more than 1400 miles of ocean (see the second photo). But this data is only part of the package; over more than 10 years, children are educated into a practical, physical understanding of how to use stars, ocean swells, currents, and wildlife in the actual performance of navigation[14].

Pa'afu lesson; photo courtesy Steve Thomas and the University of Hawaii's Traditional Micronesian Seafaring Collection.

In this case, the "maps" are deliberately designed to be ephemeral, and thus leave no trace in the archaeological record. Nevertheless, the social expertise and relationships that underpin the transmission of navigational skills are fundamental to the negotiation and maintenance of wider social networks. These networks connect islands through practices such as gifting, trade, and exchange, leaving material traces that could be found in the archaeological record. Thus, the entanglement of cultural transmission with social relationships creates the patterns visible in the archaeological record. The adoption of social network models to investigate their interrelations is therefore an exciting new development in archaeology that has been used to model interactions of another island group – the Aegean Cyclades – in the Bronze Age[15].

How and why human cultural transmission differs from that documented in other species is therefore a fundamental question. As the only discipline with the temporal scope to investigate patterns and processes of cultural transmission from the first hominins to the modern day, archaeology is well-placed to integrate the insights of the many disparate disciplines whose work informs on the question. We must learn to tack between the large scales of cultural transmission and the small scale of social relations to gain the best possible understanding of cultural transmission past and present.

Figure 1: Learning traditional Micronesian navigation skills (courtesy Steven Thomas/University of Hawaii at Manoa).

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