Journal of Human Evolution 80 (2015) 159–170

Contents lists available at ScienceDirect

Journal of Human Evolution

journal homepage: www.elsevier.com/locate/jhevol

Social learning and technological evolution during the Clovis colonization of the New World

Metin I. Eren [a, b, *], Briggs Buchanan [c], Michael J. O'Brien [a]

[a] Department of Anthropology, University of Missouri, Columbia, MO 65211, USA
[b] Department of Archaeology, Cleveland Museum of Natural History, Cleveland, OH 44106, USA
[c] Department of Anthropology, University of Tulsa, Tulsa, OK 74104, USA

ARTICLE INFO

Article history:
Received 2 October 2014
Accepted 12 January 2015
Available online 7 February 2015

Keywords:
Cultural transmission
Dispersals
Drift
Geometric morphometrics
Hunter-gatherers
Peopling of the Americas

ABSTRACT

A long-standing debate in Pleistocene archaeology concerns the sources of variation in the technology of colonizing hunter-gatherers. One prominent example of this debate is Clovis technology (13,350–12,500 calendar years before present), which represents the earliest widespread and currently recognizable remains of hunter-gatherers in North America. Clovis projectile points appear to have been made the same way regardless of region, but several studies have documented differences in shape that appear to be regional. Two processes have been proposed for shape variation: (1) stochastic mechanisms such as copy error (drift) and (2) Clovis groups adapting their hunting equipment to the characteristics of prey and local habitat. We used statistical analysis of Clovis-point flake-scar pattern and geometric morphometrics to examine whether drift alone could cause significant differences in the technology of Stone Age colonizing hunter-gatherers. Importantly, our analysis was intraregional to rule out a priori environmental adaptation. Our analysis confirmed that the production technique was the same across the sample, but we found significant shape differences in Clovis point populations made from distinct stone outcrops. Given that current archaeological evidence suggests stone outcrops were "hubs" of regional Clovis activity, our dichotomous, intraregional results quantitatively confirm that Clovis foragers engaged in two tiers of social learning. The lower, ancestral tier relates to point production and can be tied to conformist transmission of tool-making processes across the Clovis population. The upper, derived tier relates to point shape, which can be tied to drift that resulted from increased forager interaction at different stone-outcrop hubs and decreased forager interaction among groups using different outcrops. Given that Clovis artifacts represent the earliest widespread and currently recognizable remains of hunter-gatherers in North America, our results suggest that we need to alter our theoretical understanding of how quickly drift can occur within a colonizing population and create differences among socially learned technological characters.

Introduction

Clovis artifacts represent the earliest widespread and currently recognizable remains of hunter-gatherers in late Pleistocene North America (Anderson, 1990; Steele et al., 1998; Anderson and Gillam, 2000; Haynes, 2002; Barton et al., 2004; Meltzer, 2009; Bradley et al., 2010; Sholts et al., 2012; Smallwood, 2012; Holliday and Miller, 2013; Miller et al., 2013; Sanchez et al., 2014; Smallwood and Jennings, 2014). By far the most iconic artifacts of the Clovis culture are bifacially flaked stone projectile points that have parallel to slightly convex sides, concave bases, and a series of flake-removal scars—termed "flutes"—on one or both faces that extend from the base to about a third of the way to the tip (Wormington, 1957; Bradley, 1993; Bradley et al., 2010; Buchanan and Collard, 2010, Fig. 1). Clovis points have been found throughout the contiguous United States, northern Mexico, and southern Canada (Wormington, 1957; Haynes, 1964; Anderson and Faught, 2000; Sanchez, 2001; Anderson et al., 2005; Sanchez et al., 2014). Current estimates, based almost entirely on radiocarbon dating, are that the Clovis culture appeared in the American West and Southwest ca. 13,350–12,800 calendar years before present (calBP) and in the East ca. 12,800–12,500 calBP (Haynes et al., 1984; Levine, 1990; Holliday, 2000; Waters and Stafford, 2007; Gingerich, 2011).

* Corresponding author.
E-mail address: erenm@missouri.edu (M.I. Eren).

http://dx.doi.org/10.1016/j.jhevol.2015.01.002
0047-2484/

Figure 1. Clovis point (Williamson County, TN).

One long-standing debate in Pleistocene archaeology concerns the sources of lithic technological variation among colonizing populations of hunter-gatherers, namely by what means, and how quickly, the frequency of cultural traits change through time. Variation, of course, is a key element in any system of descent with modification (i.e., an evolutionary system; Darwin, 1859; Lyman and O'Brien, 1998; O'Brien and Lyman, 2000; Mesoudi et al., 2004; Eerkens and Lipo, 2005; Mesoudi, 2011; Schillinger et al., 2014a:129,b), and both heritable and non-heritable sources of variation contribute to the stone-tool forms observed in, and production techniques inferred from, the paleoanthropological record (O'Brien and Lyman, 2000; Lycett and von Cramon-Taubadel, 2015). For example, among Lower Paleolithic hominins presumably dispersing from sub-Saharan Africa into other regions such as the Near East, Europe, and the Indian subcontinent over a relatively longer period of time, cultural-evolutionary processes, raw material, and resharpening have all been found to contribute to technological variation in varying amounts on particular traits (Lycett and von Cramon-Taubadel, 2008, 2015; Lycett, 2008, 2009). Alternatively, on a relatively shorter time scale, during the *Homo sapiens* colonization of Europe between 60,000 and 30,000 years ago, recent work (Tostevin, 2012; Nigst, 2012) has examined whether independent innovation, cultural transmission, or a combination of these two factors were predominately responsible for lithic technological evolution in different geographic regions and archaeological cultures such as the Bohunician, Aurignacian, and Szeletian. Indeed, with respect to the Aurignacian in particular, there is wide agreement that in western and central parts of Europe, the appearance of Aurignacian technology reflects human dispersal (Mellars, 2009; Pettitt and White, 2012), which has led to questions involving how and why chronologically later Aurignacian technological variation in the west is similar to or different from that of potential "homelands" in southeastern Europe, the Levant, or even farther east (Olszewski and Dibble, 2006; Dinnis, 2012).

Variation in Clovis points represents a prominent example in this debate regarding the sources of lithic technological variation, especially in terms of shape. Numerous studies have documented differences—often subtle differences—in shape (plan-view form; Meltzer, 1988, 1993; Anderson, 1990; Storck and Spiess, 1994; Morrow and Morrow, 1999; Buchanan and Hamilton, 2009; Hamilton and Buchanan, 2009; Smallwood, 2010, 2012; Buchanan et al., 2014), but there is a lack of agreement over the cause(s) of the variation. Two principal processes have been proposed: (1) stochastic mechanisms such as copy error (drift; Bentley et al., 2004) introduced variation (Morrow and Morrow, 1999; Buchanan and Hamilton, 2009) and (2) Clovis groups adapted their hunting equipment to the characteristics of prey and local habitat, resulting in regionally distinct point shapes (Buchanan et al., 2014).

Other studies have focused not on the shape of Clovis points but rather on how they were manufactured. Several researchers have proposed that the points were made with similar production techniques, irrespective of geographic locality (Bradley, 1993; Morrow, 1995; Collins, 1999; Tankersley, 2004; Bradley et al., 2010), but only recently has the proposal been subjected to quantitative analysis. For example, Smallwood (2012) found shared aspects of Clovis technology across the southeastern United States. In a quantitative assessment, Sholts et al. (2012) used laser scanning and Fourier analysis to examine flake-scar patterns—relics of the tool-making process—on a sample of 34 Clovis points from sites in the Southwest, Southern Plains, and Northern Plains, and five points from a site in Maryland. Their analysis suggested that flaking patterns were similar across these regions, and they concluded that there was a continent-wide standardization of Clovis technology "without evidence for diversification, regional adaptation, or independent innovation" (Sholts et al., 2012:3024). If so, and regardless of which hypothesis might account for variation in shape, patterns of flake removal appear to have been less sensitive than point shape to either adaptive change driven by environmental conditions (selection) or the vagaries of cultural transmission (drift).

The two sources of variation in point shape—drift and selection—are not mutually exclusive and could both simultaneously contribute to interregional differences (O'Brien et al., 2014; see also Kuhn, 2012; Hiscock, 2014; Mackay et al., 2014; Lycett and von Cramon-Taubadel, 2015). Colonizing populations do not necessarily stay in constant contact with one another, especially as geographic distance between them increases, and thus over time point shapes can begin to drift. Similarly, colonizing populations may begin to adapt point shape to the environmental conditions they encounter, which are different from those encountered by other groups. But even granting some variation in shape, it is apparent that, with respect to Clovis groups, it occurred within fairly narrow bounds (Buchanan et al., 2014).

In terms of learning models for Clovis-point manufacture, a good case can be made for some kind of biased transmission across North America (Sholts et al., 2012; O'Brien et al., 2014), with "biased" referring to the various factors that can affect one's choice of whom or what to copy (e.g., copy the majority, copy the most successful model; Boyd and Richerson, 1985; Bettinger and Eerkens, 1999; Laland, 2004). Given that the manufacture of a Clovis point is a complex procedure that would have required a significant amount of investment both in terms of time and energy to learn effectively (Crabtree, 1966; Whittaker, 2004; Bradley et al., 2010), biased-learning strategies could have played a key role in fluted-point technologies (Hamilton, 2008; Hamilton and Buchanan, 2009). Sholts et al. (2012:3025) proposed that learning could have taken place at chert outcrops—quarry sites—where "Clovis knappers from different groups likely encountered each other [which] would have allowed knappers to observe the tools and techniques used by other artisans, thereby facilitating the