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Persisting technological boundaries: Social interactions, cognitive correlations and polarization

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1. Introduction

In archaeology, the study of technological changes has two sides: the adoption (invention and spreading) of new techniques and the non-diffusion of techniques (or non-borrowing whether considering the actor or the technique). Diffusion participates in homogenization of technical traits, whereas non-diffusion maintains technical diversity. The understanding that technical features can diffuse across geographical or social boundaries (as shown in history, geography, sociology, anthropology) makes the persistence of diversity problematic because movements of people, objects, ideas will tend to homogenize material culture, in particular when substantial benefits are at stake. One salient example of this problematic is the non-diffusion of the potter's wheel in the Mediterranean for hundreds of years and still today in several parts of the globe even in highly competitive situations and despite the advantage of the wheel in terms of time manufacturing (Roux, 2013; Roux and Jeffra, 2016).

Non-diffusion of cultural traits is particular visible at boundaries between cultural clusters distributed in geographical space. Ethnoarchaeological and anthropological studies have investigated the social dimension of these boundaries (e.g. Dietler and Herbich, 1998; Gosselain, 2002, 2000; Hodder, 1985; Latour and Lemonnier, 1994; Lemonnier, 1993, 1992; Stark, 1998; Stark et al., 2008; Wiessner, 1983). They have highlighted that technological traditions have a tendency to superimpose on social boundaries and to be more resistant to change than easily transmissible traits such as style (shapes and decor of objects) (Gallay, 2007; Gelbert, 2003; Gosselain, 2000; Hegmon, 1998; Mayor, 2010; Roux, 2015; Stark et al., 2000). This difference between the two cultural traits has been explained in terms of learning modalities. Techniques are socially learned and culturally transmitted (e.g. Kuhn, 2004; O'Brien and Bentley, 2011). Their mastery requires learning through long lasting contacts, generally with socially close relatives (e.g. Bril, 2002; Gosselain, 2000; Shennan, 2013; Shennan and Steele, 1999). As a result, the generated population level pattern links technological traditions with producers' social group and are strong identity markers. Stylistic patterns relate not only to producers', but also to object and consumers' history. Stylistic boundaries are therefore more fluctuating and their link with social boundaries, less marked (David and Kramer, 2001). Since the mechanisms underlying the diffusion and persistence of cultural traits may vary according to the nature of these traits, each trait should be considered separately; in this article, only the persistence of technical traits is examined.

In anthropology and sociology, the co-existence of distinct technological systems, without exchange of traits, has been mainly explicated in terms of social affiliation/ differentiation. Under the 'technological choice' approach, at the group level, technical practices are considered as social facts, made in accordance with social strategies and meanings, their underlying and embedded representations fitting into a wider symbolic system (Dobres, 2000; Latour and Lemonnier, 1994; Lemonnier, 1992, 1993). Consequently, at boundaries, they resist the homogenizing effects of interactions through the process of affiliation/ differentiation. At the individual level, affiliation with the group practicing the same way has been shown to be the result of social learning which implies a learner and a tutor, with the outcome of learners practicing the same way than the tutors (Bril, 2002; Dietler and Herbich, 1998; Tehrani and Riede, 2008), having preferentially close ties with them and therefore developing a sense of affiliation with the tutor's group (Gosselain, 2011). These studies partially draw on Lave and Wenger's work (Lave and Wenger, 1991) on communities of practice. The latter are made up of individuals who exert or have exerted together their craft, given or not family relationships; shared learning process acts as a mechanism of affiliation to the group. Under the evolutionary approach, affiliation has been explained by the psychological bias according to which, in marked groups (here technologically), individuals feel close to individuals who are marked the same way (McElreath et al., 2003, p. 128). As a consequence of affiliation, individuals tend to conform to the norms of the group, while conformism exacerbates differentiation (Henrich and Boyd, 1998; Moscovici, 1984). This combined effect of conformism/ differentiation would favor non-borrowing of techniques.

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Addressing cultural boundaries, the affiliation/differentiation process is thus recognized as particularly cogent to explain why non-diffusion of cultural traits may persist and why it should be stronger at boundary region as suggested for ethnic differentiation (McElreath et al., 2003). In the cultural evolution approach, assumptions are made using evidence from analytical sociology. Simulation models have tested the conditions of preservation of cultural diversity. As a first step, diversity has been shown to be preserved when differences between cultural groups are too large; in these cases there is a preference to interact with those who are similar, called homophily (Axelrod, 1997). Going one step further, Flache and Macy (Flache and Macy, 2011) have recently proposed that diversity and differentiation between groups is a result of polarization through the combined effect of long-range and short-range ties, the former connecting "local clusters in the network that are not directly linked otherwise" (Flache and Macy, 2011, p. 147), the latter describing frequently activated relationships (such as family/kin ties) (Collar et al., 2015, p. 23). Polarization is defined as the division of population "into a small number of factions with high internal consensus and sharp disagreement between them" (Flache and Macy, 2011, p. 149). Simulation with an agent-based model shows that, in a small connected world, polarization occurs when "actors who are connected with a long-range tie are more likely to differ sharply from each other than are actors connected with a short-range tie" (Flache and Macy, 2011, p. 172). More precisely, long-range ties bridging otherwise disconnected clusters can promote cultural integration. However, these long-range ties can have the opposite effect when homophily is combined with differentiation. In this case long-range ties foster cultural polarization rather than integration. In other words, in well-connected networks, inter-group interactions can promote cultural integration but not when the differences between these groups are higher than the differences within the group. In this latter case, the combination of intra- and inter-group interactions promotes affiliation/differentiation and polarization.

This sociological model could well explain persistence of technological boundaries in the past, technological clusters supposedly correlating with social clusters and therefore technological boundaries with social boundaries. In these conditions, interactions between technologically marked groups would favor polarization.

In order to test the assumptions and predictions generated by this theoretical model, we propose to use field studies and examine the micro-processes at stake in the non-diffusion of techniques: to which extent techniques contributes to a sharp disagreement between groups and promote polarization? It will be dealt with following a multilevel analytical framework aimed at relating the individual level (micro-level, i.e. the role of techniques in differentiation), the group level (meso-level, i.e. the polarization phenomenon), and the cultural historical specifics emerging from the later (macro-level, i.e. the persistence of technological boundaries) (e.g. Manzo, 2007; Mesoudi, 2007). The ultimate goal is to provide archaeologists with an empirically tested model to explain spatial distribution of technological clusters and maintenance of technological boundaries.

The present research examines ethnographic situations in four countries (Ethiopia, Cameroon, Ecuador and India) where different social groups live in close geographical proximity and use different ceramic techniques for making utilitarian vessels. Two situations will enable us to examine the context under which technological boundaries persist, while two others will enable us to analyze, through a boundary-making perspective (Wimmer, 2013), how differences in craft techniques contribute to polarization. In the four cases, the boundary ceramic techniques present advantages over each other, thus seriously begging the question of the non-integrative effect of contacts.

As we shall see, interactions between groups living in close proximity and using different technological standards favor polarization given "negative" influence, namely influence reinforcing differentiation rather than integration. Technological standards are here defined as specific ways of making specific ranges of vessels and whose transmission over several generations makes them traditions. A cognitive bias makes that they contribute directly to a sharp differentiation between groups. The main consequence of technological polarization is the failure of technical traits to spread between technologically marked groups, even when these groups belong to the same social community as is the case in Ecuador.

2. Technological boundaries

Analysis of the persistence of technological boundaries first implies understanding how they are generated and how they may be superimposed on social boundaries. Two case studies are examined. They report on situations where ceramic production is in the hands of different groups of potters living in close geographical proximity and having contact with each other. Two questionnaires were designed. The first one aimed at mapping the pottery traditions (questionnaire on manufacturing process and range of vessels) of the region, and at recording the identity of the potters, their numbers, the distribution of the potters' villages, their interactions, their knowledge of each other's techniques, as well as the organization of the production and the distribution of ceramic crafts. The second questionnaire focused on the learning and transmission process. Full details are not here reported systematically, only those related to the issue addressed.

2.1. Transmission and technological boundaries

This section examines how the learning and transmission process of technological standards participate to their reproduction within one's social group, and as a result, create technologically marked clusters that superimpose on social boundaries.

Two situations of different degrees of complexity are considered in order to assess the role of matrimonial alliances in the contour of the technological boundaries:

- One simple situation which involves two ethnic groups and the transmission of technological standards through women only; it takes place in Ethiopia.
- One complex situation which involves four ethnic groups and the transmission of technological standards through men and women; it takes place in Cameroon.

2.1.1. A "simple" situation: Ethiopia

The Ethiopian case study shows that the learning and transmission process participates to the superimposition of technological boundaries on social boundaries despite variability in the modalities of learning.

The investigations have taken place in the Rift Valley, in the Oromiya region (Fig. 1). This region is inhabited by different ethnic groups (which include the Oromo, Woloyta, Gurage, Sidama, Amhara, Kambata, and Tigrayan) due to movements of populations in the past (Freeman and Pankhurst, 2003). Nowadays, pottery is practiced mainly by two ethnolinguistic groups: the Oromo who speak Afaan Oromo, the vehicular language in the region, and the Woloyta who, apart from the vehicular language, speak Woloytania and are migrants having arrived in the region forty years ago.

The Woloyta and the Oromo are patrilineal (ethnic affiliation depends on patrilineal filiation), virilocal (living at husband's village) and exogamous communities although in the potter community studied, inter-ethnic marriages are rare. Pottery production is a specialized activity conducted by women exclusively on a domestic scale. It is still a dynamic activity. It represents the main source of income for the Woloyta. Their rates of production depend on the season: around 200 vessels per month during the dry season against 80 during the wet season. Among the Oromo, the rates are more variable because pottery is not their sole economic revenue, though they are generally high, particularly among divorced women relying mainly on this revenue.

Two places have been investigated. One is Goljoota, a town