Chapter 10
Simulating Patagonian Territoriality in Prehistory: Space, Frontiers and Networks Among Hunter-Gatherers

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10.1 Introduction

"Ethnicity", "territoriality" and "culture" are still fashionable words in modern archaeological research. Maybe such popularity is a signal of an academic inertia that has kept some of the narrative of the old historical and cultural traditions, having varied the background of the narrative. Although the current effort to develop an archaeology of identity and ethnicity is impressive, there are still many questions to be solved and even asked regarding to the role of archaeology and archaeological data in dealing with such concepts.

The proper question is "*why* groups of people were the way they were in the past"—That means, *how* social aggregates emerged. The complex interplay of people and their social actions, and the consequences of those actions would explain ethnicity in terms of a vast network of interacting *actions* and *entities*. We assume that ethnogenesis and identity formation emerged among prehistoric hunter-gatherers as result of the contradiction between social inertia (knowledge

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inheritance) and cultural consensus (social similarity) built during cooperation and labor exchange.

In this paper we consider Patagonian historical trajectory as a case study. At the extreme south of South America, hunter-gatherers survived until European expansionism altered tragically 13,000 years of history. In the last 40 years, the very idea of a "Patagonian" ethnicity has evolved from a static and essentialist classification of human groups according to their very own *nature*, to a relational frame of reference used by a group of people considered to be *similar* and differentiated from others (Del Castillo et al. 2011). We have adopted here an analytical view of ethnicity based on the emergence of identity as a consequence of the very fact that some individuals interact more often than others, which means that people embedded in social networks interact with a subset of the population and define themselves in terms of their similarity (or *cultural likeness*) to the people with whom they interact.

In this paper we have computationally grown a surrogate of hypothetical ethno-genetic processes that may have occurred in prehistoric Patagonia, to explore their effects on the emergence of "cultural" differences, spatial mobility and diffusion of innovations. Our aim has been to simulate virtual social agents "living" in a virtual environment defined on the basis of social theory and/or historical data. In this preliminary and simplified computer simulation we are exploring the consequences that labor exchange and territorial mobility in an artificial unconstrained world had on identity formation and negotiation. We expect to be able to discern if cultural diversity emerged as a result of social decisions only, or if it was the result of constraints on mobility generated by geography and the irregular distribution of resources, both in space and time. By implementing social events as computational agents and their mutual influences as interactions, we seek to discover whether collective action may be described and explained as non-accidental and non-chaotic. It should be emphasized that the aim of such work is *not* to create the most "realistic" artificial society possible. The simulation is not intended to be an exact re-creation of the past but rather provide us with an understanding of how different circumstances might have affected people in the past.

An important aspect of this way of understanding historical causality is that it forces the analysis to pay attention to the flux of ongoing activities, to focus on the unfolding of real activity in a real historical setting.

10.2 From Ethnicity to Territoriality

What has traditionally been called "ethnic" differentiation is nothing more than a consequence of the diverse degrees of social interaction between human communities, and an emerging pattern of social "similarity". We want to explore social mechanisms and processes whose results may produce some similarity in social activity. Developing the definitions of D'Andrade (1987), Carley (1991), Axelrod (1997), Boyd and Richerson (2006), and others, we may define culture

as the distribution of information (ideas, beliefs, concepts, symbols, technical knowledge, etc.) capable of affecting individuals as a result of their interactions in the present. Cultural consensus is a measure of similarity in motives, actions, behavior and mediating artifacts that does not exist for ever, but is in the process of continuous building, influenced by many aspects of social life. Then, observed aggregations of activities and social practices may be good estimates of "culture", but the accuracy of that observation depends on the agreement among what people did, what they believed they did, and the number of observations on past actions (Romney 1999; Romney and Weller 1984; Romney et al. 1986; Garro 2000; Weller 2007; Sieck 2010; Borgatti and Halgin 2011).

If "culture" can be defined as the expected variance in a distribution of social values, goals and activities among synchronous human aggregates or populations, "ethnicity" can be approached as the degree of social inertia or resilience between different temporal states of the same aggregate or population, that is the ability of an aggregate of social agents to maintain a certain identity in the face of historical change and external perturbation (Stein 1997; Ramasco 2007; Castellano et al. 2009). Consequently, "culture" and "ethnicity" can also be understood as the propensity or tendency a human group has to practice or produce a distinct social goal, motivation, behavior or artifact. Both "culture" and "ethnicity" are quantitative properties of human aggregates and not features of individuals. Whereas "culture" expresses the degree of commonality in social activities between contemporaneous groups, "ethnicity" expresses the degree of similarity between social activities between different temporal stages of the same group. Therefore, we don't consider ethnic groups to be discontinuous isolates to which people naturally or "ideally" belong but a series of real related dichotomizations of inclusiveness and exclusiveness resulting from social reproduction, affecting the way people aggregated in the past and aggregate in the present into groups and adapted/adapt their social practices as a consequence. Ethnicity dos not presuppose the existence of discrete and particular "ethnia", nor does culture imply the existence of cultures. In other words, there is not a thing or a set of things called an "ethnic group", in the same way that there is not a set of things called "culture". The use of both terms should then be limited to the configuration of an instrument for measuring typified ideas, behaviors, actions and products that different human aggregates may have in common, in the present or across time.

Our starting point for the computer simulation of ethnogenetic processes is that the lesser the intensity and frequency of inter-group relationships, the greater the differences in ways of speaking and other *cultural features manifested by groups* (Del Castillo 2012; Del Castillo and Barceló in press). Commonalities in needs, motivations, goals, actions, operations, signs, tools, norms, cooperative ties, and in division of labor schemas are the consequences of the way some social agents interacted, aggregated in space and time as a consequence of some of these interactions, and reproduced the basis of such an aggregation. The formation of such diverse aggregates at diverse scales and with different degrees of similarly acting social agents is mediated by a perceived similarity both at the moment of the interaction, but also previously, as some inherited social inertia or resilience. As a

result: the greater the temporal depth of the social aggregation of agents, and the longer the transmission links between a greater number of generations, the more redundant the consensus, and the more stable it is.

The obvious result is that most people with the same history of interactions show a degree of similarity in their motivations, goals, actions behaviors and mediating artifacts which do not depend on their actual will, but on what they have received from the past (Dow et al. 1984; Eff 2004). Endogamy appears then as one of the main factors to classify some groups of similar subjects, needs, motivations, behaviors and/or artifacts as ethnic (Abruzzi 1982; Whitmeyer 1997). Human reproduction is not just a mere biological process, but a socially mediated mechanism. Reproductive mates are consciously chosen and many social, ideological and political constraints impose some directionality in social reproduction (Bernardi 2003; Bongaarts and Watkins 1996; Kalick and Hamilton 1986). For that reason we assume social reproduction, i.e., the historically variable forms of mating and marriage, and kinship topologies have a key importance for the definition and analysis of ethnically distinguishable populations. Similarity and difference, continuity and distinction among local populations emerge when unions among members of a same population occur more often than unions with members of other populations. Endogamy preserves the differential distribution of similar subjects, needs, behaviors and artifacts inside a community. Exogamy, on the other hand, may attenuate local distinctions when syncretic knowledge and norms are transmitted from a generation to the following one. The more institutionalized the mechanisms of reproductive isolation—as part of the explicit norms of a community, constituting the law, religious doctrine or ideology of government-, the greater the possibility that similarity emerges and is consciously sought after and maintained in the community, and transmitted to the following generation (Abruzzi 1982; Cavalli-Sforza et al. 1994; Giuliano et al. 2006).

When useful commonality and redundancy emerges into a social encoding scheme, members of the group produce the means whereby descendents will *predict* their own identity even before acting, augmenting the social group and cognitive resilience and hence generalizing what defines their own group. The obvious consequence is a higher probability of social aggregation, which in turn increases the probability of within group regularity. We suggest the probability of an interaction between two agents is based on the principle of homophily, i.e. the greater the amount of knowledge they share the more probable the interaction is. And the more similar the origins, the more commonalities the members of the same descent group share. But what comes from the past can be modified in the present. Within the group and between groups, social agents may interact for many reasons and in many ways: cooperating to acquire subsistence, cooperating to produce (Bjerck and Zangrando 2013; Borrero et al. 2009; Gómez Otero 2007; Orquera and Gómez Otero 2007) tools and instruments, cooperating to exchange subsistence and/or tools, cooperating for reproducing themselves, refusing such cooperation, or compelling other agents to work in their own benefit, etc. War and conflict are also another kind of interaction. In all those cases, interactions vary in intensity and frequency, defining a complex network of positive or negative

intergroup relationships. As a result, agents adopt similar activities, and their actions tend to generate similar results. Consequently, inter-action should be considered both positive (cooperation) and negative (conflict), in such a way that different kinds of social fusion, fission and friction develop a set of representations and values that set the terms from which social clustering and self-ascriptions are constructed. All these diverse sources of interaction modify similarity in social activities and any kind of perceivable regularity, in such a way that newly configured aggregates affect future mechanisms of social reproduction, and hence vary elements to be transmitted to the next generation. Social inertia changes constantly because social conditions in which reproduction takes place changes according to actual interactions. As a consequence, ethnicity, the degree of similarity product of social inertia may change constantly.

Our hypothesis is based on the idea in terms of agents' tendency to interact with agents with a similar "identity" which makes for a greater probability interactions between already connected people than unconnected ones (with dissimilar features). In addition, we also introduce the principle of social influence (i.e., the more people interact with similar people, the more similar they become) which runs at the level of communication and the formation of a socio-cognitive level.

10.3   Beginning of Times at the End of the World: Patagonia

How might those processes have acted in Patagonia before European colonization?

The antiquity of human settlement on the Patagonian steppe during the Pleistocene-Holocene transition is well established (Borrero 2008, 2012; Miotti and Salemme 2003; Mancini et al. 2013; Rivals et al. 2013). The beginning of human settlement in Patagonia has been reconstructed as a slow process of exploration and colonization, carried out by small groups, very mobile and dispersed, with approximate site-catchment areas of around 100 km in radius (Borrero and Barberena 2006; Barberena 2008). Sites may have been occupied intermittently, by few people and/or short periods of time, but repeatedly (Frank 2012). These foundational groups were characterized by low population density and the absence of specialized use of the ecosystem given the lack of competition among distant and dispersed groups (Barceló et al. 2009; Del Castillo 2012; Del Castillo and Barceló in press).

The growing number of sites identified as settlements and the greater rate of material deposition at those sites suggest a demographic increase during the Holocene (Borrero and Franco 1997; Borrero 2005; Martínez et al. 2013). It is from this time, around the seventh millennium B.P., that an increasing use of marine and littoral resources has been recorded (Bjerck and Zangrando 2013; Borrero et al. 2009; Gómez Otero 2007; Orquera and Gómez Otero 2007; L'Heureux and Franco 2002; Moreno et al. 2011). Many factors should be taken into account in understanding why different groups decided to manage differently diverse sets of resources from differentiated areas (Prates 2009). Among those factors, we can

mention: the quantity of available labour, the size of the group, the degree of technological investment, the complexity of labor operations, the organizational needs of labor, and the social relations of production.

Six thousand years ago economic variability would have been consolidated all over Patagonia, defining a differentiation between some communities specialized in the exploitation of marine resources, some specialized in terrestrial resources, and others without specialization but exploiting both terrestrial and littoral resources. In any case, such economic differentiation cannot be well understood without taking into consideration mobility across the territory. Human groups moved from place to place for social and political needs, in such a way that extremely long and complex interaction networks developed. Goods and information would have traveled more than people would (Bellelli et al. 2008; Barberena et al. 2011; Méndez et al. 2012; Silveira et al. 2010; López et al. 2010). Borrero et al. (2008) explain the circulation of goods associated with large partially overlapping ranges within a framework of inter-group visits, which would be related to economic and social factors that make the size and composition very fluid over time.

If economic variability was already configured some time around 6,000/5,000 B.P., it is possible that cultural and social variability were also configured at the same time. How many "distinct" populations existed then? Ethnologists have made reference to language differentiation to suggest the existence of differentiated populations, even in these remote times. Languages spoken by hunters exploiting the forests along the Andes Mountains, the steppe, and the Atlantic littoral resources historically derive from two different linguistic sources originating around the same time Campbell (1997); Adelaar and Muysken (2004); Fernandez Garay (1998, 2004); Fabre (2005); Viega Barros (2005); Brown et al. (2008); Müller et al. (2009). The first one would have been spoken by human groups at the western side of the Andes (*mapudungun* linguistic family) (Zúñiga 2006) and another for human groups at the eastern side (*günuna a iajüch* and *chon-tsoneka*,[1] different languages from a common linguistic family) (Casamiquela 1983; Fernandez Garay 1998; Viega Barros 2005; Orden 2010). Further south and notably southwest, on the Pacific coast, canoe fishers spoke languages from a totally different origin: *chono-kawescar-yamana/yaghan* (Aguilera Faúndez 2007).

Nevertheless, cultural variability cannot be limited to the level of linguistic differentiation. It is important to remark that the speakers of those languages in early colonial times did not have ethnonyms for self identification: the term "günuna-küna", where "küna" is the word for "people" has been translated as "people of the same blood, friends" (Harrington 1946; Casamiquela 1983); "aonik'kenk", where "kenk" is the word for "people" has been translated as "people from the south" (Fernandez Garay 2004). There are many ethnographic sources on the inter-ethnic relationships in early colonial times (Nacuzzi 1998; Vezub 2006, 2009, 2011).

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[1]Musters (1872–1873) wrote that "tsoneka" was the etnonym these people gave to themselves (Musters 1964 [1872–1873]). He was mistaken, because the work derives from *aónik'o ais* language: *tshontk' = ch'óon(e)k(e)* (Casamiquela 1965, p. 22).

There is also mention of mixed groups formed between coastal gatherers and interior hunters (*guaicurues* along the Magellan Strait, *cacaue* along the central western coast, cf., Viega Barros 2005 for linguistic and Martinic 1995 for historical evidence).

Modern paleobiological investigation reinforces this view of permeable frontiers and between group integration. Evidence of biological exchange between steppe hunters and southern canoe fishers, south and west of the Andes (Gonzalez-Jose 2003; Gonzalez-Jose et al. 2001) proves the inexistence of closed biological populations (see also Barrientos and Perez 2005 for the región North of Patagonia, and Morello et al. 2012 for the cross of Magellan Straits). Whether molecular markers (frequency of different haplogroups in the samples with the same geographical origin), or morphological and/or morphometric skull, variability can not be described in discrete units (or "types"), but as a continuum between more or less similar samples. Lalueza et al. (1997) argue that geographic distance (in a latitudinal sense) is the main factor that influenced the differentiation of the human groups from Tierra del Fuego and Patagonia. Recent studies at continental or subcontinental level in America prove that environment, diet and temperature, are the most important factor for understanding craniofacial and postcranial metric variation, explaining 50–80 % of morphological variation (Béguelin 2010; Beguelin and Barrientos 2006; Gonzalez et al. 2011; Fabra and DeMarchi 2011; Perez 2011). Therefore, the definition of biological "types" represents an incorrectly subjective assignment of affinities (Long and Kittles 2003; Gonzalez-José et al. 2008). Nevertheless, the alternating contraction and expansion processes of population (demographic and geographic), including events such as local extinction and recolonization of areas has important effects on the historical construction of cultural variability (Barrientos and Perez 2002).

According to our view, an isolation-by-distance model would predict that human groups reflected geographic separation in the pattern of their between-group distances. The eventual result would be a greater similarity between geographically proximal populations and increasing differences between groups that are further and further apart. The closest populations in space would have greater similarity in their biological characters than populations located further away. Biological differences observed among individuals who lived in Patagonia and those who lived in the rest of the subcontinent may be explained by a long history of divergence; current estimates range between 5,264 and 1,641 years of fissioning processes and isolation for the emergence of phenotypical differences from a single foundational population (García-Bour et al. 2003). Such a huge chronological range highlights the problems in the use of molecular clocks. Paleolinguistic research also suggests around 6,000 years for explaining the gap between *günuna a iajüch* and the languages from the *chon-tsoneka* family: *Chewache-iayich* (also called *teuschen*), *aónik'o ais* (also called *tehuelche*), *haush*, *selk'nam*, etc., assuming that both linguistic families come from a single foundational proto-language (Suárez 1970; Viega Barros 2005).

The historical trajectory can be tentatively reconstructed in the following terms. A relatively homogenous foundational population speaking a common language would have lived across the steppes to the east of the Andes with complex mobility

and interaction patterns around 6,000 B.P., or probably before. Between 6,000 and 5,000 BP a noticeable reduction in the archaeological visibility in the northernmost part of this area (between 34° and 42° South) may be due to differences in mobility patterns, location of settlements or, more likely, the reduction in population density and population shrinkage due to migration processes and/or local extinction (Barrientos and Perez 2002, 2005; Boschín and Andrade 2011; Neme et al. 2011; Perez 2011). This would be the period were an original foundational identity and language *proto-gününa-chon* began to fission and evolve. The transition towards semiarid clima seems to have created the conditions for a later recolonization of the area by people of the same metapopulation, expanding from a few refugee areas, or members of a different metapopulation through processes or migration (Boschín and Andrade 2011). From 3,500–2,000 BP on, population expansion may have been affected also by the adoption of new technologies: bow and arrow and pottery. Barrientos and Perez (2002, 2005) suggest the existence of a strong biological relationship between groups of hunter-gatherers who occupied the Pampas and North Patagonia during the late Holocene (see also Béguelin et al. 2006; Cobos et al. 2012). While not yet established, it is possible that these groups would have configured a series of local populations belonging to a single metapopulation at a supraregional scale, experiencing contractions and expansions at different moments (Barrientos and Perez 2002; Barrientos et al. 2008; Prates 2008). The problem is that differentiated groups that may have existed were annihilated as a result of European colonization, and we have very poor information of linguistic diversity during early colonial times in Northern Patagonia. *Günuna a iajüch* is the only language of which we have some knowledge (Casamiquela 1983; Orden 2010), but there were many others.

Nothing of this population shrinkage in the middle Holocene and posterior phenomena of contraction and expansion is observable further south, between the rivers Chubut and Santa Cruz (42°–50° South lat.) (Belardi et al. 2010). Mena (1997) has suggested that between 6,000 B.P. and 3,000 B.P. this was a "macro-cultural region". It can be suggested that this is the original area where a *proto-chon* language differentiated from the northern *proto-gününe*. The individuality of those *proto-chon* speakers coincides with some observable differentiation in the archaeological record, like the general distribution of rock-art paintings and engravings and the specificities of lithic technology, in such a way that they can be used to distinguish this region (Orquera 1987; Fiore 2006; Gómez Otero et al. 2009; Cardillo 2011; Charlin and Borrero 2012). The ritual practice of cranial deformation is an additional evidence for the differentiation of northern Patagonia. South of 48° Latitude South, the frequency of this social behavior is very low. It has been suggested that the intentional deformations would have reflected the effort to achieve a predetermined cranial form, used as an indicator of group identity, demarcator of social or territorial boundaries, or as a trait that reinforces and maintains the networks of exchange between groups (Bernal et al. 2008; Perez et al. 2009). Around 2,500 B.P., speakers of a *proto-chon* language, already differentiated from their northern relatives (Suárez 1970; Viega Barros 2005), would have began to differentiate themselves, emerging new languages strongly related between them

like *chewache-iayich*, *aónik'o ais*, *haush*, *selk'nam*, etc. It is interesting to note that the northernmost populations (not only speakers of *günuna a iajüch*, but also other unrelated linguistic groups) would be genetically and morphologically more similar to each other than to human populations further south, even though their supposed origin may have been different (Guichón 2002; Llop et al. 2002; Rothhammer and Llop 2004; García et al. 2006; Bernal et al. 2006; Pérez et al. 2007). This fact suggests a slower process of group fissioning in the south. This situation seems to agree, at least partially, with that suggested by Daniel Nettle for whom "the greater the problem of subsistence, the wider the social network necessary" (Nettle 1999). As a result, everything seems to indicate that "the greater the risk of not achieving the threshold of subsistence, the higher linguistic homogeneity exist in a geographical area of given size". However, this assumption should not lead us to uncritically affirm that the linguistic community was the basic social unit facing economic stress. Simply, contact with other groups must have been much more important in northern Patagonia than further south (Nettle 1999; Currie and Mace 2009). We may suggest that languages historically related as a result of the physical exchange of speakers are structurally and lexically more similar than those that were not connected and were also more geographically distant (Nichols 1997, 2008; Holman et al. 2007; Wichmann et al. 2008). The relationship that may exist between genetic distances, linguistic and "cultural" distances is the consequence of the fact that human populations (and therefore languages) "move" in a predictable way in some particular contexts. Therefore, the genetic distances between populations should be related in some way to the degree of statistical differentiation between the languages spoken by those people. The biological similarity among people and the existence of "cultural" differences in their motivations, behaviors and products should decrease as social interaction decreases as a result of an increase in geographical distance.

Both south and north, from the late Holocene onwards (ca. 1,000–800 B.P.), it has been suggested a reduction in mobility, the increase of population and a concomitant increase in the complexity of social interactions produced social instability, along with the emergence of a strong network of relationships between people culturally differentiated. In South Patagonia, this social and economic change has been related to the Medieval Climatic Anomaly, ca. 1,000 B.P. (Belardi and Goñi 2006; Goñi and Barrientos 2004; Goñi et al. 2007). Increasing aridity rates in this area would have caused the reduction of available fresh water sources, spatially constraining and concentrating animal movements and human settlements, and leading to greater social specialization in the use of physical space. This could have created conditions for habitat fragmentation, a local increase in population density and increased spatial coherence. The opening of social exchange networks would have compensated for the reduced mobility of residence patterns and the nucleation of human settlement. For instance, the radius of movement of rocks and raw materials would have extended to 800 km (Gómez Otero 2007). At this level of differentiation, kinship and political alliance constituted the only mechanisms for fixing the limits of social groups, which differed in size, language, culture, social structure, and probably also in the nature of their predominant economic activities. Archaeologically, the high

rates of burial area reuse would suggest that human groups were increasingly fixed to specific territories (Gómez Otero 2007; Borrero et al. 2008). The concentration of rock-art on the Stroebel Plateau would suggest the aggregation of different groups at specific places.

Although such a climatic phenomenon would have had different effects at different places (Favier Dubois 2004), a similar transition has been suggested for North Patagonia. There, strongly differentiated human groups would have shared the same process of economic and social intensification consolidating complex social-political networks that favored the movement of goods, people and ideas in a very large social space (Mazzanti 2006; Luna 2008). Precisely in this period, there is clear evidence of a more intensive occupation in some areas, and a significant variability in mortuary practices. By 1,000 BP, there was a transition to the current weather conditions and retraction of the main animal resources to the West and South of the Interserrana area, what probably implied the redistribution of the existing population and/or the expansion of another population(s) from northeastern Patagonia. In the latter part of the late Holocene (ca. 1,000–400 years BP), there is growing evidence of a population expansion from the lower basin of the Colorado and Negro Rivers and Atlantic coastlines, to the plains on both sides of the Ventania Sierra. The potential competition between the local population and the new immigrants would have favored the latter, which reached a dispersion range that included the aforementioned areas and at least part of the areas Tandilia Interserrana and Serrana (Barrientos and Perez 2002, 2005; Béguelin et al. 2006). Craniological studies by Barrientos and Pérez (2004) suggest the presence of expanding populations from northeastern Patagonia to Southeast and southern Pampas. Furthermore, the bioarchaeological record from the south-central La Pampa province seems to reflect two different populations in just north of Northern Patagonia (Berón 2005). Finally, Gonzalez-Jose (2003) has recognized morphological affinity between skull samples of the foothills of northern Patagonia, the Black River valley and northeast and the Pampas of Buenos Aires, probably due to interbreeding.

The later progressive homogenization of languages and cultures across eastern continental Patagonia was probably caused by an increase in the frequency and intensity of long-distance exchange mechanisms (Lazzari and Lenton 2000; Mandrini 1991; Palermo 2000; Villar and Jiménez 2003; Nacuzzi 2007, 2008; Carlón 2010). Archaeologically, this process can be inferred from the increase in population, more sedentary occupations, symbolic manifestations (rock art), technological innovation (ceramics and specialized instruments), formal burial areas, foreign exchanges, etc). The even greater complexity, intensity, and frequency of social interaction between groups determined the transformation of traditional means of social reproduction and political order. Mechanisms for collective decision-making began an ever-increasing hierarchization process, concomitant with the increased size and more diverse composition of human groups. Social relations of production began to acquire some characteristics related with domination. To sum up, we must avoid the traditional mistake made by the first European travelers in Patagonia and the early ethnographers who described indigenous groups as if they were Old World nations. According to all evidence, ethnic, linguistic, cultural, economic,

territorial frontiers were extremely permeable, suggesting a considerable degree of population mixture. Consequently, the apparent cultural unity recorded by modern ethnographers was just a phase in the changing nature of social exchange, and not a fixed cultural trait since the origin of those populations (Boschín 2001, 2002).

10.4   An Agent-Based Simulation Model for Understanding the Emergence of Patagonian Ethnicity and Territoriality

We have built a computer simulation (see Fig. 10.1) to explore how ethnogenesis and related process of territorialization could have occurred in the prehistoric past of Patagonia. The current implementation is a further development of previous, preliminary attempts, partially published in Barceló et al. (2013a,b), Barceló and Del Castillo (2012), Del Castillo (2012), and Del Castillo et al. (in press). The new computer program has some important advances in the way positive interaction has been modeled, and in the modelling of the mechanisms of social reproduction. The number of free parameters has been reduced and some important non-linearities have been taken into account. Programming code is implemented in Netlogo (Wilensky 1999) and provisionally available from http://www.openabm.org/model/ 4063. A full description of the algorithm appears in Barceló et al. (2013b).

   In the model, agents simulate "families" or households, defined in the following terms:

- *Labor* (l_i), a Poisson distributed parameter counting the aggregated quantity of labor from all family members).
- *Cultural identity*, a vector of 10 dimensions; each component is an ordinal number from 1—not important—to 6—very important. Such dimensions are weighted according to a fixed vector).
- *Technology* (β_i), a Gaussian distributed parameter for each agent affecting the efficiency of labor when obtaining resources.
- *Energy-conservation factor* (d_i) calculated as $\beta_i/2$ and expressing the efficiency of storing and preservation methods: the part of acquired energy that can be stored and transferred to the next time-step.
- *Survival threshold* ($\bar{e}_i$): Given that the survival of agents depends on the amount of energy acquired and transformed from the environment, and the number of members the household has (expressed in labor units), a survival threshold should be calculated in terms of the quantity of calories an agent (representing a group of individuals) needs to be able to live a season long. In the simulation the household size is equivalent to labor. Assuming an individual needs an average of 730 kilocalories per year (2,000 calories per day; based on estimations by the Institute of Medicine, 2002), and one time step (cycle or "tick") in the simulation roughly represents what an agent is able to do and move in six months, $\bar{e}_i = (730 \times$ the number of labor units at this agent)/2.
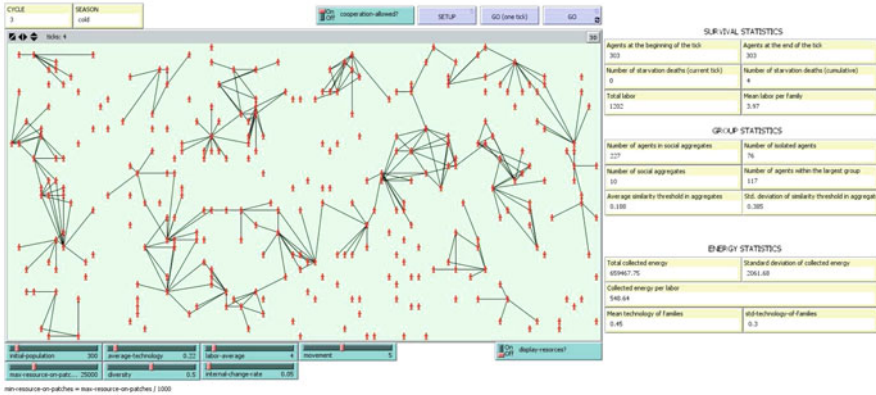
Fig. 10.1 A screenshot of the interface up front

The model's diversity index expresses the amount of variation between agents for reasons characteristic of the agent, and not of global demographic factors. We have assumed it is a global Gaussian parameter measuring the standard deviation of productive instruments (β_i) and storing means (d_i). We do not have precise estimates (but see Binford 2001), so we have fixed this parameter with a medium value (diversity = 0.5).

Physical space is modeled as a 40×80 grid, and it contains 3,200 environmental cells or "patches". We assume that each grid cell is a surrogate of a 100×100 km geographically homogenous area, interpreted as the total extension a virtual household can explore during a season of six months in its search for resources and people. Each path has a number of *resources* (r_i), a random distributed parameter, measured in kilocalories, diminishing at odd cycles ("cold" season) and reproducing the original value at even cycles ("hot" season) to reproduce seasonality. Resources at each patch have also a *difficulty* level (h_i) (another random distributed parameter). It counts the difficultness of resource acquisition (the more mobile the resource—animals—and the less abundant, the more labor or more technology is needed to obtain resources up to survival threshold. The availability and abundance of resources are assumed to variate randomly through the landscape; therefore we have used a uniform distribution of values between a minimum and a maximum value. From a theoretical minimum value of 100 kilocalories, we have explored different intervals: from 100 to 15,000 kilocalories (the "poor" world hypothesis), from 100 to 20,000 kilocalories, from 100 to 25,000 kilocalories, from 100 to 40,000 kilocalories, from 100 to 50,000 kilocalories (the "rich" world hypothesis). Such configuration intends to simulate the way edible resources were distributed in the Patagonian past. The main source of food was the locally evolved camelid *lama guanicoe* ("guanaco") and although very mobile, numerous herds dominated the landscape (L'Hereux 2006; Gómez Otero 2007; Papp 2002; Prates 2009; Politis et al. 2011; Rivals et al. 2013). The consequence is the existence of a source of subsistence that can be occasionally and locally abundant but spatially and

temporally variant and relatively unpredictable (Soriano et al. 1983; Paruelo et al. 1998; Schulze et al. 1996; Borrero et al. 2008; Mazia et al. 2012). The model implements a simplified seasonality: a hot season in which natural resources are initialized to its maximum value, and a cold and dry season in which resources do not regenerate naturally, and the amount of resources available in each cell is equal to the half of what was generated at the hot season minus what the agent extracted at the previous time-step. In any case, our simulated environment does not pretend to reproduce Patagonian ecology. It is obvious that landscape differences and topographic barriers would have affected hunter-gatherers subsistence and mobility. Instead, we want to investigate what could have happened if geography played no role in social dynamics.

The way in which Patagonian hunter-gatherers defined, conceived and behaved regarding resources and subsistence did not meet universal standards, but was mediated by a complex and unique system of practices and beliefs, influenced by the characteristics of the resource itself and the general environment for energy needs, and the social, ideational and historical trajectory of people (Prates 2009). Therefore, we have not considered the individuality of each resource, but the human results of the activity. Energy is obtained by agent i by means of labor ($l_i(t)$) with the contribution of its own technology, whose efficiency is estimated as $\beta_i(t)$. Both factors act upon the difficulty of acquiring and transforming resources, in such a way that:

$$f_i(t) = \frac{1}{1 + \frac{1}{h_i(t) \cdot l_i(t)^{\beta_i(t)}}} \qquad (10.1)$$

$f_i(t)$ measures the ability to obtain resources according to each agent's individual ability. Its maximum value is 1, indicating the amount of work available (l_i) and the effectiveness of current technology β_i to compensate the local difficulty (h_i) of obtaining the resources existing at that place. When the value of $f_i(t)$ is less than 1 (but greater than 0), we can deduce that the working capacity and technology available only allow obtaining a proportion of the available resources. We are not taking into account the precise energetic performance of each resource, vegetal or animal, but the probability of attaining full survival with an undetermined series of resources obtained locally.

We assume that the higher the technological level, if the amount of labor does not vary and local resources remain stable, the less cooperation and lesser chances of cultural diversity. That means, that hunter-gatherer groups with poor technology based on worked stones and transformed wood will manifest higher cultural homogeneity than groups with a technology that allows them to transform into subsistence all existing local resources. The *technology* parameter may range from 0.01 to 2. High efficiency indicates that all local resources can be managed independently of its difficulty of acquisition given the extreme performance of available technology. Low values are characteristic of human groups with hardly evolved instruments, in such a way that only a part of locally available resources

are effectively managed. The efficiency of food preservation techniques is another technological factor, related with the overall level of development of means of production. In the experiments we report here, we have fixed parameters related with technology and efficiency using data from our own research in Patagonia (Barceló et al. 2009, 2011; Del Castillo 2012): average-technology = 0.22 (low development); standard deviation (diversity among simulated households = 0.5); storing capability = 0.11 (very low). In the absence of efficient hunting equipment beyond "boleadoras" and spears (bow-and-arrow was a relatively late instrument in Patagonian archaeological record, and hardly adapted to the capture of local game).

Virtual households can be involved in two kinds of economic activities: gathering, which is an individual task, and hunting, which is only possible as a collective task. Ethnographical sources make manifest the difficulties of hunting guanacos, and the need to ask for the help of many people to encircle the game and be able to kill enough prey (Fitz-Roy 1932 [1833–1839]; de Orbigny 2002 [1833]; Cox 1999 [1862–1863]; Claraz 1988 [1865–1866]; Musters 1964 [1872–1873]; Spegazzini 1884). At the beginning of twentieth century, a witness described:

> Leaving early in the morning they rode out into the camp. They had already ascertained where several pregnant guanaco were feeding. The riders lined up in a huge, loosely knit circle about them, unnoticed, and at an appointed time all rode in towards the center. The game ran, only to meet other riders, ran from them, to meet others on the shrinking circle. If any broke through, a rider balled it, jumped quickly from his horse and killed it, mounted and was back in place in no time. Lions, ostrich, deer, and guanaco shared the same fate. The trapped animals fought to escape when the ring drew close about them, and the Indians, in a sort of ecstasy, caught and killed as many as they could. If there were riders enough, and good horses under them, few would escape, and at last the center would be a mass of dead animals or struggling live ones, killed or entangled by boleadoras. (Childs 1936, p. 160f)

In our simulation, "hunters" need the contribution of other hunters in the neighborhood. The aggregated productivity $[\Delta f_i(t)]$ of an agent member of a group $G_i(t)$ is calculated as:

$$\Delta f_i(t) = \cfrac{1}{1 + \cfrac{1}{\left[h_i(t) \cdot \left(\sum j \epsilon G_i(t) l_j(t)^{\delta \beta_j(t)} \right)^{\theta_i(t)} \right]}} \qquad (10.2)$$

where $G_i(t)$ is the total amount of labor the group of agents that cooperate with agent i and $\delta \beta_j(t)$ the maximum technology within the group. There is an additional parameter modifying the total effect of aggregated labor at the social aggregate $(\theta_i(t))$, illustrating the idea that cooperation is less needed when there are plenty of resources.

Agents cannot move to an occupied patch, so they never share their resources. What they share is labor, and not the products of that labor. Sharing labor and technology is a way to increase the chances of survival when the productivity of the patch (quantity of resources modulated by labor and technological efficiency) is below the survival threshold. By doing so, agent i receives cooperation in form of labor. There is no obligation to "return the favor": only the helped agent receives

help when its similarity threshold between the helper and the helped is low enough so that the helper "can afford" to help. There is no compensation for the excess of labor exchanged, or calculation of differential costs. This is not a limitation of the model, but a phenomenon that is well understood in the ethnography of hunter-gatherers. Given that labor attains its limit when survival is assured, there is no surplus. Consequently, there is always a remanent of "unused" labor. When hunter-gatherers aggregate, all members identify themselves as members of the same group, and all labor is put in common. We assume agents in the simulation do not use the fiskean logic of "Equity matching" but a form of "community sharing" (Fiske 1991). Ethnographic sources suggest that the decision to cooperate or refuse cooperation was far more complex in Patagonia than the simplified approach adopted in PSP 1.5 (Martinic 1995; Papp 2002). There are some common aspects, however: it seems that cooperation within the kinship network was far more frequent than with strangers, and that kinship ties were constantly negotiated even without marriage exchange (Musters 1964 [1872–1873]; Fernández Garay and Hernandez 2004). Our algorithm follows such kind of limited and changing parochialism.

Cooperation at work and the consequences of its restriction are at the core of the simulation. Agents decide to cooperate and work together when at least one of them needs the help of others to obtain enough resources for survival and there is someone in the neighborhood able to cooperate given the relative similarity of social values. That is to say, to decide if an agent cooperates with another, we imagine each one observing the immediate neighborhood and evaluating their respective identities to know if they are "sufficiently" common. Each agent has its own organized list of meanings, values and beliefs (*identity*), inherited at birth, learnt within the evolving group, modified all along the life of the agent and transmitted to the new generation. Agents rank the relevance of each value-dimension according to a fixed weight vector. Thus, they capture the agent values without explicitly identifying values as the topic of investigation. The simulation asks about similarity to another agent with particular goals and beliefs (values) rather than similarity to another agent with particular traits. Consequently, instead of *assuming* that agents have common identity traits based on membership to an already existing "ethnic" group, agents need to be queried as to the extent to which they "believe" they are similar to those of others in the neighborhood, and queried as to whether the outcomes of those values are perceived to be similar.

When cooperating and sharing labor capabilities, information and knowledge flow between agents. Therefore, the most effective technology proves its advantages and begins to be adopted by members of the same group. Technology should be updated in such a way that the next tick will increase its efficiency towards the level of the most efficient within the group. This is a process of convergence and not of imitation. An additional source of technological evolution is implemented in form of an *internal change rate* (hereafter ICR). This is a random value (from 0 to 1, usually very small) defined as a random factor that expresses the likelihood of internal change (invention, catastrophe, sudden change) affecting values and technology. The higher this value, the more important internal changes in the virtual "family", expressing the probability that each agent changes independently of the other agents.

Given the evidence of the Patagonian archaeological record and its 7,000 years of technological continuity, we have assumed a very low likelihood of internal change (0.05), according to the archaeological evidence of slow technical, linguistic and cultural transformations in Patagonia (Barceló et al. 2009; Del Castillo 2012).

With probability equal to ICR, the agents adopt a new technology value, whose average is calculated on the basis of the global parameters: average-technology and diversity. Technological involution has been an exception historically, and we do not take this into account in the model. Although technological change is mostly "rational" at the scale of the individual taking the decision to change, from an external perspective, such decisions at the local level may appear as internal shocks perturbing the apparent linearity of a given trajectory. Therefore, although technical evolution is not random at the level of each agent, it can be modeled as random at the level of the population.

As a result of interaction and information flow, cultural consensus emerges by combining the identities and values of interacting agents in an emergent group. Therefore, once the agent gets enough resource for its own survival (with or without the help from others), the identity vector used to define the possibilities of cooperation is updated towards the statistical mode of the group identity. With a fixed probability level (95 %) each agent copies the statistical mode of identities within the group. There is an additional source of identity change, also implemented in the form of the same ICR we have considered before. With every tick, and with a fixed probability level determined by the opposite of the identity weight vector, the identity vector mutates. In this way, we assume that the most "universal values" are the least prone to internal change (although they may change, but with lower probabilities). The most frequent internal changes appear in the less "universal" dimensions, which are also the less relevant to build cultural consensus. Therefore, what future generations arising in the aggregation will inherit is not the old identity, but the new commonality. We assume that the higher the cooperation between people, and the higher the cultural consensus among them, the higher the probability that reproductive couples will be formed within the group. The idea is that once the new social aggregation has emerged and survival of agents has been assured, hybridization mechanisms begin to act because inherited identities (ethnicity) should be modified to maintain the newly built consensus.

Because hunting is more productive, there are increasing returns to collective involvement. Survival is also affected by *diminishing* marginal returns relative to the social and technological impossibility to regenerate resources, and the need to wait for a minimum of one year for its natural regeneration. Agents lose one of its members (a labor unit) each time the total acquired energy is below the survival threshold. In the same way, every 30 ticks, a new member is born, and will live until the total acquired energy is below the survival threshold. In this way, we have implemented a determinist population growth mechanism opposed to stochastic mortality. When survival is possible and the number of members in an agent (expressed in labor units) is greater than 10, the current agent reproduces and gives birth to a new agent, with half the parent labor, the same technology and the same identity.

Agent actions are oriented to foraging and food gaining through mobility across a territory, conditioned by available technology and agent density, and the establishment of cooperation between agents when direct survival is not possible. However, what they have acquired as subsistence has a short temporal duration, and given the low degree of storing technology, agents should begin the process anew at the beginning of each time-step. In the model, the availability of resources is fixed as a global probability parameter ("rich world", "poor world"). Each agent has the possibility to move camp/settlement location and interact with other agents in order to decide whether to cooperate or not in survival or in reproduction. The agent has the goal of survival at least after T simulation steps. To do that the aim of each individual is to optimize the probability of survival and reproduction by gaining enough food (energy reserves) to meet a threshold of energy necessary for successful reproduction.

Agents should take the decision whether to move to another place with more resources, but where positive interaction with others may not be possible. According to that decision, each agent may remain in place interacting with the same agents it interacted with at a previous time step, or it can move to another patch. Agents move randomly because they can follow any direction within a restricted neighborhood. When moving, agents first determine who it can cooperate with from the group of agents in place (`my_group`). The process `identify-agents` is based on a calculation of the number of common identity traits perceived among agents within a neighborhood. An agent does not have information about all the agents in the world, but only those within a reasonable geographic distance (`my_neighborhood`). The extension of such a neighborhood simulates the precise territory agents arrive to know by themselves or by means of communication flows from linked agents. The size of the neighborhood changes as a consequence of the displacement of the center of the neighborhood, maintaining the same radius (a limit connected with the low efficiency and efficacy of transport technology). In this way, the model has an emphasis on local dynamics and bounded rationality. Whether cultural consensus is high enough, agents are listed into the newly emerging group, and the program characterizes such a group with a distinct color. Once within an aggregate (`my_group`), an agent's subsistence output can be enhanced adding to the agent's capacity to work, and the capacities of other agents within the group.

Identity traits have been modeled as adaptive behaviors, because in some sense they act to increase a measure of the virtual household success at meeting some goal (survival). In so saying, we assume some degree of "utility" for agents' identities: if they change and negotiate their identities they can obtain higher probabilities for success. Consequently, we assume each agent's goal is to maximize survival probabilities through increasing the probability to hunt with the help of labor from other agents. However, the only "rational" decision executed by an agent is the decision about whether it cooperates with a neighbor or not. Such a decision is carried out by computing the resemblance of identities, and using a changing decision rule for determining the degree of similarity in terms of the circumstantial needs and expectations from collective hunting. That is to say, our virtual Patagonian
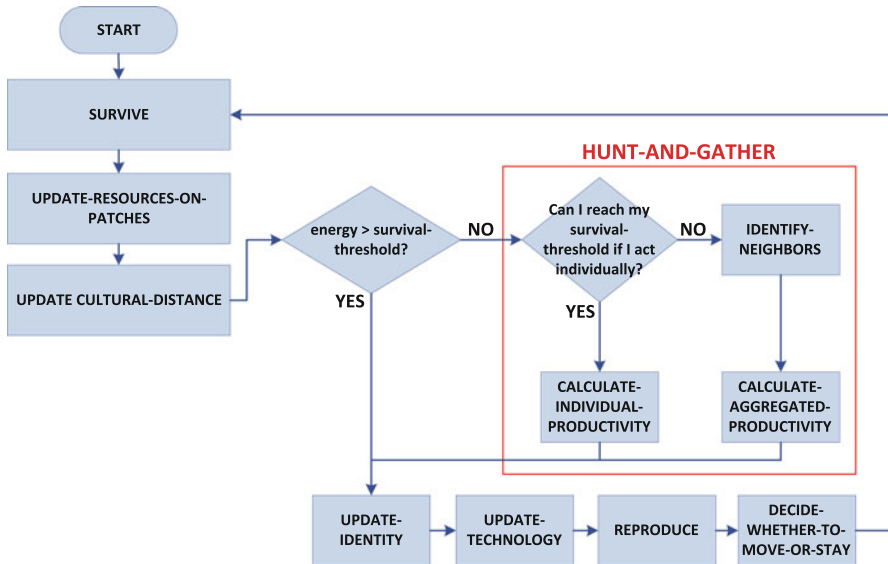
Fig. 10.2 The model's flow-chart

households are able to change the value of their tolerance to cultural and social diversity given the actual needs to enhance probabilities for survival when resources are spatially or temporally scarce.

Figure 10.2 summarizes how the model runs. At start up, agents are placed randomly in the world. Each agent should occupy a single patch, and no two agents are allowed to occupy the same patch. If their energy level is below their survival threshold they look for resources (*hunt*-and-*gather*), constrained by the amount of work available at a single household (*labor*) and the current value of their technology. If acquired resources are not enough, they look for neighbors to cooperate with. If no one cooperates, and resources remain below survival threshold, the agent dies.

10.5   Running the Model: Preliminary Results

The current version of the model differs from Patagonian ethnoarchaeological data in some important ways.

We have implemented a single, homogenous founding population, although current paleobiological research seems to conclude the likelihood of a minimum of two or even three well differentiated founding populations (Gonzalez-José et al. 2008; Lewis et al. 2007; Pérez et al. 2007; Rothhammer and Llop 2004; Bodner et al. 2012). Miotti and Salemme (2003) have suggested that early settlers would

have belonged to a Patagonian megapopulation that would have split in northern South America, moving independently on both sides of the axis of the Andes, which would have acted as biogeographic filter. This would have led to processes of colonization and expansion-retraction differing between the two slopes. However, the hypothetical difference in founding biological populations is still under discussion and there is no hard evidence about it. Our simulation intends to explore what could have occurred in the case of a single population as it first colonized a previously unoccupied landscape and the increasing differences between groups emerged as households and grew further apart in their constant movement in the quest for resources. How do processes of convergence and divergence occur between groups of hunter-gatherers over the long-term?

The simulated environment has nothing to do with environmental conditions during the Holocene in Patagonia. We have not modelled a "virtual Patagonia", and we have explicitly avoided the representation of geographical details. We know that in prehistoric Patagonia, human groups aggregated where resources were more abundant, temporally frequent and easy to get, but we doubt that the environment was the only cause. What would have happened if the environment had no influence on spatial aggregation? We have imagined a cold and dry plain without any topographic features, where resources randomly varied from very scarce to very abundant. We have experimented with all possible scenarios, beginning with a very "poor" environment, and finishing with the "richest" imaginable one. If resources in the environment are scarce (below 15,000 kilocalories per patch), a small population (estimated at 300 "families" with an average of four members in each; based on estimations published in Papp 2002), with hardly efficient technology (both for producing and for storing), would never survive on their own (without any kind of cooperation with neighbors) beyond 100 simulated years. In this simulated scenario, the wealth of resources clearly influences survival in a linear way ($r^2 = 0.688$). However, when virtual households with similar identities exchange surplus labor and share the most efficient technology, mortality clearly reduces, and the influence of resources was clearly non-linear ($r^2 = 0.365$). In other words, when our simulated Patagonian hunter-gatherers interacted and worked together, the probability of their survival was higher than if they had worked only on their own.

Technological efficiency experienced changes and evolution, both in prehistoric Patagonia as in our simulation. Here computational results coincide with archaeological data: there is evidence of small but continuous changes, interpreted as local advances not related with interaction, but also a gradual convergence towards the most efficient, when innovations diffused. Figure 10.3 shows how in a cooperation scenario, average-technology quickly evolves towards more efficient values as a result of innovation-diffusion through conspicuous imitation and borrowing. The diagram shows interpolated curves, that although in their first part seems to have a lesser than average model, they correctly predict the temporal trajectories. The difference of means has been proved to be statistically relevant.

Cardillo (2011) has shown how both environment and geography account for a statistically significant part of the lithic technology variation. The archaeological pattern is much more detailed than in our model, suggesting a latitudinal gradient
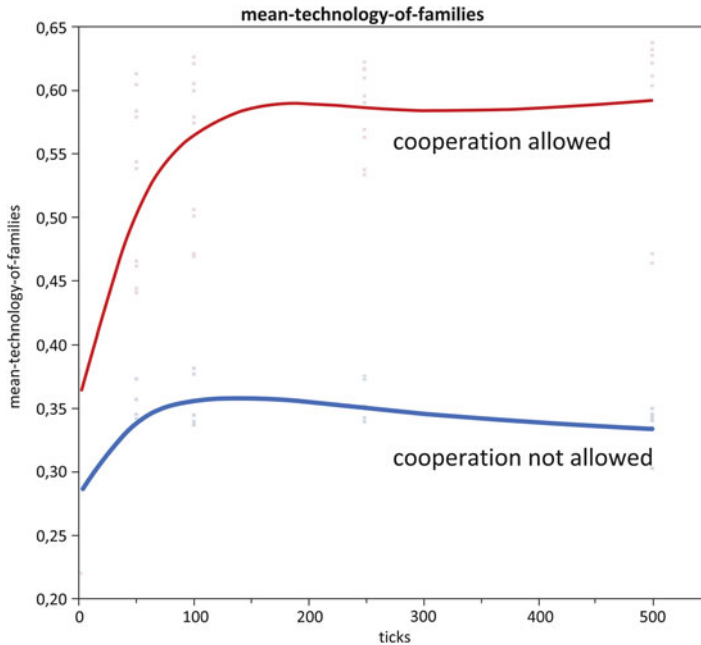
Fig. 10.3 The temporal evolution of average-technology after 500 runs (simulated 250 years). We have here averaged the different wealth scenarios: *grey dots* represent original data from which both curves have been interpolated. Graph computed using JMP 10 software (SAS, Inc.)

in diversity that might be explained as the result of restrictions of information borrowing within a culturally homogenous population (parochialism) as well as of selective mechanisms related to energy acquisition (see also Gómez Otero et al. 2009; Charlin and González-José 2012).

As a result of economic interaction, virtual households aggregate in space, configuring what we can consider social networks of cooperation. The model does not predict the formation of discrete groups with clearly defined borders and frontiers, but the emergence of changing networks of social relationships, with different possible topologies: in some contexts, closed groups may emerge, but when the intensity of interaction varied, or the circumstances in which the interaction took place were different, the nature of the social aggregation was also different, allowing the dissolution of any previously differentiated group into an undefined homology of social activities.

We have suggested that commonalities in needs, motivations, goals, actions, operations, signs, tools, norms, cooperative ties, and in division of labor schemas are the consequences of the way some social agents interacted, aggregated in space and time as a consequence of some of these interactions, and reproduced the basis of such an aggregation. Our model suggests that in prehistoric Patagonia, social aggregation and network formation may have been more frequent in the cold season,

Table 10.1 Parameters and results for the different scenarios shown in Fig. 10.4

Name	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5
Max. resources	15,000	20,000	25,000	40,000	50,000
Initial agents (founding households)	300	300	300	300	300
Total number of agents after 250 years	40	222	351	968	1,144
Number of social aggregates	3	14	12	2	1
Number of agents in social aggregates	8	116	220	709	868
Number of isolated agents	32	106	131	259	276
Number of agents within the largest group	3	29	45	690	868

given a higher frequency of aggregation. During the hot season the benefits of cooperation are less obvious and therefore the probability of any form of restricted territoriality is significantly lower. According to the Analysis of Variance (ANOVA) test on 100 examples of each wealth scenario, the probability of equal average number of social aggregates in the hot and cold season is less than 0.001 in all scenarios. Exactly the same is true for the size of the network—the number of agents in social aggregates. This result is compatible with ethnoarchaeological evidence in Patagonia: with bigger campsites in cold seasons and a general dispersal of households during the hot season (Moreno and Izeta 1999; Boschín and Del Castillo 2005).

Simulation results (refer to Table 10.1) correlate with J. Gómez-Otero's reflection on the need for "places of concentration and distribution" (Gómez Otero 2007): She cannot consider Patagonian human groups randomly wandering on foot, at any time of year, to find someone with whom to cooperate. No hunter-gatherer would invest so much energy in search times if there was no assurance for success in meeting and obtaining searched resources. Our simulation predicts that very few groups will keep moving again and again. Rather, some kind of "good-enough" scenario is found where groups stay in the neighborhood of other groups, keeping the connections among them.

Are such networks an initial form of ethnogenesis? We stressed at the beginning of this paper that *the lesser the intensity and frequency of inter-group relationships, the greater the differences in ways of speaking and other cultural features manifested by groups*. The same can be said in terms of network embeddedness. Network embeddedness means that everybody does not interact equally with everybody else, but is constrained by needs (expected benefits), geographical neighborhood and prior cultural consensus (common history). Agents within the network interact among themselves more often than with others out of the network, which means that a subset of the population may be excluded from positive interaction and hence the process of similar identity negotiation and innovation diffusion. How intense is the resulting segregation in the explored virtual scenarios? We have measured it in threesteps: fractionalization, generalized resemblance and demographic polarity.
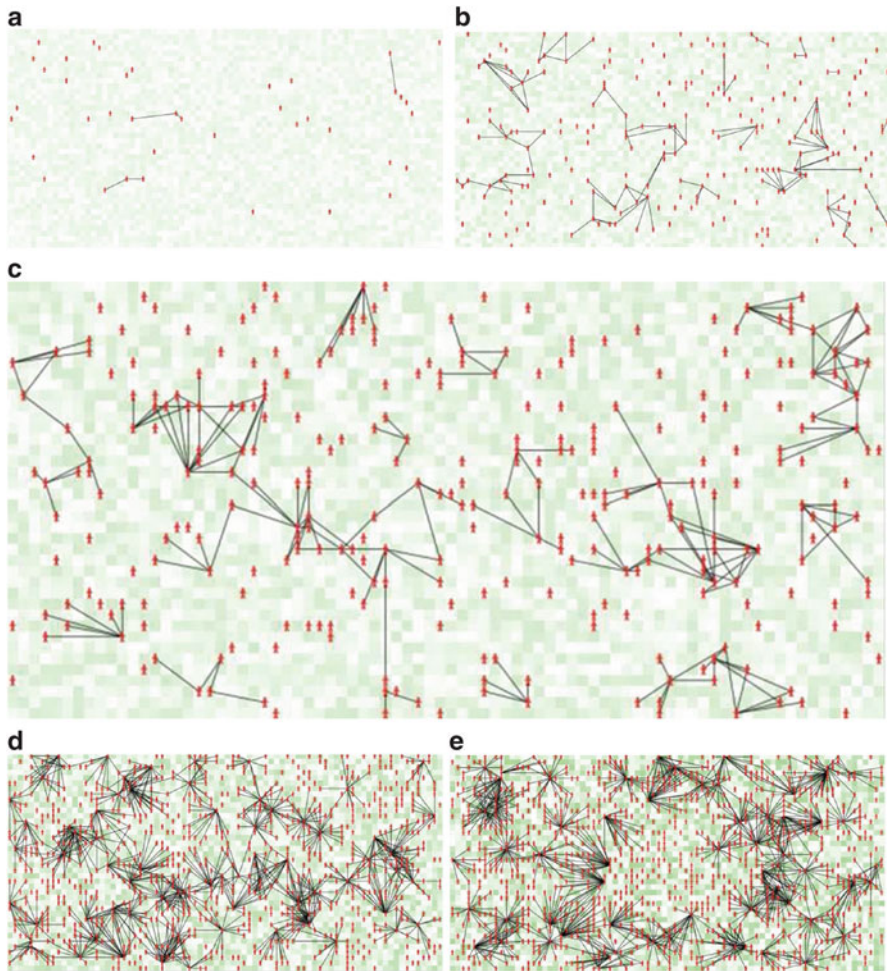
Fig. 10.4 Different scenarios of virtual Patagonia, variating the maximum resources at patch. Links visualize agents that cooperated (exchanged labor) at the current tick. Screen-shots of the simulation after 500 time steps (ca. 250 years). Parameter settings for all scenarios are given in Table 10.1. (**a**) Scenario 1. (**b**) Scenario 2. (**c**) Scenario 3. (**d**) Scenario 4. (**e**) Scenario 5

A traditional measure of social fractionalization can be calculated by dividing the population into ethnic groups, calculating each group's share of the population, summing the squared shares, and subtracting the sum from one. Such a measure was calculated by Taylor and Hudson (1972) as a decreasing transformation of the Herfindahl concentration index applied to population shares. In particular the index takes the form of

$$ELF_j = 1 - \sum_{i=1}^{I_j} \left(\frac{n_{ij}}{N_j} \right)^2 = 1 - \sum_{i=1}^{I_j} s_{ij}^2 \qquad (10.3)$$

where n_{ij} is the number of people that belong to ethnolinguistic group i in country j. N_j is the size of the population in country j and I_j is the total number of ethnic groups in country j. This formula requires the groups to be mutually exclusive (i.e., if an agent is in aggregate 1, then it is not in aggregates 2-n) and exhaustive. Given mutual exclusiveness and exhaustiveness, this index measures the probability that two randomly chosen individuals from a country's population belong to different groups. The measure scores zero where in a perfectly homogenous population (i.e. all individuals belong to the same group) and reaches its theoretical maximum value of 1 where an infinite population is divided into infinite groups of one member (Alesina et al. 2003).

In our case, we have simplified calculations which do not take into account isolated agents. In fact, each isolated agent would have constituted a differentiated group, so actual results should offer higher fractionalization indexes that those provisionally calculated here (see ELF score in Table 10.2).

Fractionalization increases when the number of small groups increases. In our case, the probability that two randomly drawn individuals from the population belong to two different groups increase when resources are low and survival may be at risk. The higher the value, the higher horizontal inequality in the total population. These results are very interesting for understand the consequences of the Medieval Climatic Anomaly, ca. 1,000 B.P., in some Patagonian areas. The reduction of available fresh water sources would have spatially constrained and concentrated resources and human groups, and created conditions for residential fragmentation. Our results clearly show that when the simulated world is comparatively poor (maximum resources less than 30,000 kilocalories for a complete season), as during the Medieval Climatic Anomaly, fractionalization scores are higher than in the case where resources are abundant and frequent. Following Vigdor (2002), estimated fragmentation effects can be interpreted also as the weighted-average of within-group affinity in the population. That is to say, a high value of fragmentation when resources were scarce and concentrated can be explained as the probability of an

Table 10.2 Further calculation results

	Scen. 1	Scen. 2	Scen. 3	Scen. 4	Scen. 5
ELF score	0.9863	0.92	0.97	0.423	0.431
Minimum Euclidean distance between households	0	0	0	0	0
Maximum Euclidean distance between households	7.0	7.5	7.34	9.94	6.70
$G(S_N)$	4.96	0.86	0.06	0.115	0.144
RQ	0.0511	0.14	0.09	0.56	0.56

individual's willingness to spend on available resources given the degree of affinity within its constrained neighborhood. The probabilities of successful economic interaction vary depending on how many members of the community share the same identity of that individual. It is important to take into account, however, that our results are not linked to a specific moment in Patagonian historical trajectory. To the extent that social aggregates are constantly changing, especially between the hot and cold seasons, ELF scores never remain constant. Calculated values only refer to a specific state of the simulation (500 "ticks", or 250 simulated years).

It is usual to explain the effects of the Medieval Climatic Anomaly in Patagonia in terms of the potential competition between the spatially differentiated populations, with the emergence of "territoriality". Different authors (Belardi and Goñi 2006; Goñi and Barrientos 2004; Goñi et al. 2007; Gómez Otero 2007) suggest that during the peak of greatest aridity, the presence of water in the environment may have become circumscribed to specific loci (e.g., relict lake and permanent watercourses) that would have had the potential to act as hubs for population aggregates. Human groups reduced their residential mobility, so that settlements were confined to locations with availability of critical resources (water, wood) and good condition (repair, mild winters). Parallel to this reduction in residential mobility, the ranges for logistic action would have expanded and extended. Among the consequences of these circumstances, a decrease in population density at a regional scale has been suggested, whereas density increased locally. Our results are congruent with these hypotheses. Our results also seem to coincide with those of J. Gómez-Otero (2007) which has suggested a "gradual" population growth at this period, with very localized moments of stress and competitive concurrence.

In our simulation, the index of fractionalization is just a measure of heterogeneity; such measure conveys no information about the depth of the divisions that separate members of one group from another, which is a necessary factor for inferring *social tension* (Fearon 2003; Posner 2004; Chandra and Wilkinson 2008; Brown and Langer 2010; Chakravarty and Maharaj 2011). The ELF index can at best be seen as a measure of cultural diversity but not a proxy for the effect of diversity as a whole. We may arrive at the depth of the "difference" in terms of the non-normalized Euclidean distances (see Table 10.2) between *cultural identity* vectors (see definition on page 227; note that in the rest of this chapter, we usually omit *cultural* and just talk of *identity* or *identity vector*). In our simulated world, at time-step 0, this value is 0 because the founding population is supposed to be homogenous. Two hundred and fifty simulated years after, the differences have clearly increased: although some households maintain their similarity (Distance = 0), many others have augmented their differences (maximum measured Euclidean distance is 9.94).

The reference value of Maximum Euclidean distance between identity vectors in our case is 18.97, which results when identity vectors (ranging from 0 to 6, as defined earlier) are totally different:

$$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0$$
$$6\ 6\ 6\ 6\ 6\ 6\ 6\ 6\ 6\ 6$$

Bossert et al. (2011) and Kolo (2012) have introduced a more flexible version of the ELF, the generalized ethno-linguistic fractionalization index. Based on the specific characteristics, a mutual similarity matrix between individuals takes the distance between them into account. Hereby the groups emerge 'endogenously' from the matrix. The similarity value between two individuals i and j for all $i, j \in 1, \ldots, N$ is given through s_{ij}. For a society with N individuals, all s_{ij} are contained in a $N \times N$ matrix, labelled similarity matrix S_N, which is the main building block of this measure. Based on this matrix, the corresponding generalized resemblance value for a population with N individuals is given through:

$$G(S_N) = 1 - \frac{1}{N^2} \sum_{i=1}^{N} \sum_{j=1}^{N} s_{ij} \tag{10.4}$$

In calculating $G(S_N)$, each individual counts in two capacities. Through its membership in its own group, an individual contributes to the population share of the group. In addition, there is a secondary contribution via the similarities to individuals of other groups. In our case, and considering the state of the agents' identity similarity after 500 ticks, we get the results given under $G(S_N)$ in Table 10.2.

Those results should be interpreted as the expected dissimilarity (in Euclidean distance terms) between two randomly drawn individuals. In our case, the poorer the world, the higher the expected dissimilarity. When the world seems rich enough and fractionalization is less conspicuous, expected similarity is far greater. These results seem to be concordant with the process of cultural hybridization at the end of the Holocene. What was fractionalized when resources were scarce and concentrated became homogenized when technology increased suddenly its efficiency (imported colonial items, horse domestication) and resources increased by foreign factors (horse domestication, acquisition of colonial cattle and new technologies) (Mandrini 1991; Mandrini 1992; Palermo 2000; Villar and Jiménez 2003; Nacuzzi 2007, 2008; Carlón 2010). The idea of the "tehuelche complex" (Escalada 1949; Casamiquela 1965; Martinic 1995; Papp 2002), an integration and hybridization of a plurality of previous identities into a new syncretism would also relate with such results.

Generalized resemblance does not solve our problem about the emergence of segregation and territoriality when group fractionalization increases. Obviously, if dissimilarity is great and fractionalization is intense, the probability of competition should be higher. But the number of groups and the degree of difference on their own are not enough to conclude social tension and violence. "Polarization" is needed to transform difference into competition. Theoretically, polarization should be calculated in terms of the "distance" between two groups, i and j, corrected by the sizes of each group in proportion to the total population (Esteban and Ray 1994; Duclos et al. 2004). The assumption behind this alternative measure is that whilst the generalized fractionalization matrix rightly attributes a low chance of ethnic conflict to an homogenous population, highly fractionalized populations are not conflictual as no group has the "critical mass" necessary for conflict. Conflict will

be more likely the more a population is polarized into two large groups, well beyond a specific critical mass. Montalvo and Reynal-Querol (2002, 2005; Chakravarty and Maharaj 2011) have developed an index of demographic polarization

$$RQ = 4 \sum_{i=1}^{k} \sum_{j \neq i} p_i^2 p_j = 4 \sum_{i=1}^{k} p_i^2 (1 - p_i) = 1 - \sum_{i=1}^{k} \left(\frac{0.5 - p_i}{0.5} \right)^2 p_i \quad (10.5)$$

p_i in the equation is the proportion of people who belongs to ethnic group i. RQ employs a weighted sum of population shares. The weights employed in RQ capture the deviation of each group from the maximum polarization share 1/2 as a proportion of 1/2. Analogously to the index of fractionalization, underlying the formula for RQ is the implicit assumption that any two groups are either completely similar or completely dissimilar, and thus the weights depend on population shares only. This index tends towards zero for very homogeneous and non-conflictive populations, i.e., with only one relevant group. However, with increasing group numbers, ELF and RQ show clearly different results. While ELF is an increasing function of the number of groups, RQ reaches its maximum with two equally sized groups (i.e. $i = 2$, $p_1 = 0.5$, $p_2 = 0.5$) and decreases afterwards. It is the same to say that social heterogeneity and social conflict is not one and the same. Initially, one could think that the increase in diversity increases the likelihood of social conflicts. However, this does not have to be the case. In fact, many researchers agree that the increase in ethnic heterogeneity initially increases potential conflict but, after some point, more diversity implies inferior probabilities for potential conflict.

Results (see RQ in Table 10.2) capture how far the distribution of social aggregates in Virtual Patagonia is from the bipolar case. The idea is simple: polarization is related to the alienation that individuals and groups feel from one another, but such alienation may be fuelled by notions of within-group identity. There is intuitively a much greater risk of social tension and competition if a 5 % minority group is concentrated in one particular region of the country than if it were dispersed evenly across the country. In the Virtual Patagonia case study, demographic polarization attains higher values when the world has the more abundant resources, and when fractionalization has low values because most agents belong to group 1 or group 2. These results are different then to the expected increased territoriality as a consequence of resource scarcity and spatial concentration. From the Late Holocene onwards, the social aggregation in Patagonia was too differentiated, and their size was too reduced to allow for the emergence of social tension, segregation and hence exclusive territoriality. Part of the explanation lies in the high degree of homogenization of the founding population. When we introduce two founding populations in the simulation, for instance *mapudungun* speakers and *gününa-chon* speakers, the results of demographic polarization are completely different.

On the other hand, when social networks were high enough to integrate a big number of previously isolated agents, social tension emerged between network embedded individuals and people without any ascription. In any case, demographic

polarization values were comparatively lower in Patagonia than in other parts of the world, even when the horse complex and "tehuelchization" were at their maximum. These results can be related with the low degree of between-group violence in Patagonia inferred from physical anthropology analysis. The analysis of 100 traumatic injuries in male skulls from lower valleys of Chubut and Black rivers proved showed statistically significant temporal variations in the frequency of injuries resulting from interpersonal violence in times of decreasing resources (Barrientos and Gordón 2004; Gordón 2009; Berón 2010; Flensborg 2011). The likely competition and conflict situations that could have been generated with an alleged increase in population density in some areas "do not seem to have been resolved in a violent way beyond usual levels of violence in these societies" (Barrientos and Gordón 2004, p. 64; similar results have been obtained by Flensborg 2011). The highest frequency of injuries is detected once weapons of European origin appeared in historical times, indicating the later date of inter-group violence and the relevance of exogenous factors.

There is a correlation between the low degree of territorial competition and inter-group violence in our Virtual Patagonia, as well as in the actual historical Patagonian, where human groups never configured territories with clear-cut Euclidean boundaries and explicit segregation. Our results stress the role of 'territoriality' in terms of network embeddedness (Kim 2010); a "fractal metaphor" would help us to recognize that social aggregates overlapped (Appadurai 1996, p. 46). There was no place for delimited spaces conceived in geopolitical terms, because households aggregated in groups which had no "natural" limits. This is another factor stressing the low levels of polarization in Patagonia before European colonization. Therefore, because there is reason to suppose that the way in which groups were geographically concentrated may have important ramifications for ethnic politics, including conflict and economic development, we have spatially analysed the pattern of cultural diversity emerging from economic interaction (collective hunting), technological diffusion and cultural consensus.

We have carried out different experiments assuming the same five scenarios as before, and we have calculated hierarchical clustering of identity vectors based on a standard Ward method (refer to Fig. 10.5 for a graphical view of the clusters, and Table 10.3 for a summary of the results). The number of clusters for each scenario and each experiment has been normalized using the same Clustering Cubic Criterion. The number of "groups" does not refer to emerging networks of economic interaction, but to the clustering of agents in terms of their respective identities. We want to know whether the complexity of the configurated social networks has any correlation with the emergence of a global identity and the configuration of "culturally" homogenous territories.

The number of clusters, that is, the number of differentiated cultural consensuses that may emerge after 250 simulated years of communal hunting and technological borrowing is not as important as the spatialization of the differences in identity vectors. Note that such vectors represent the commonality in goals, motivations and believes. They constrain cooperation and interaction, but they are also the result of interaction networks. Therefore, it is obvious that the higher the number of
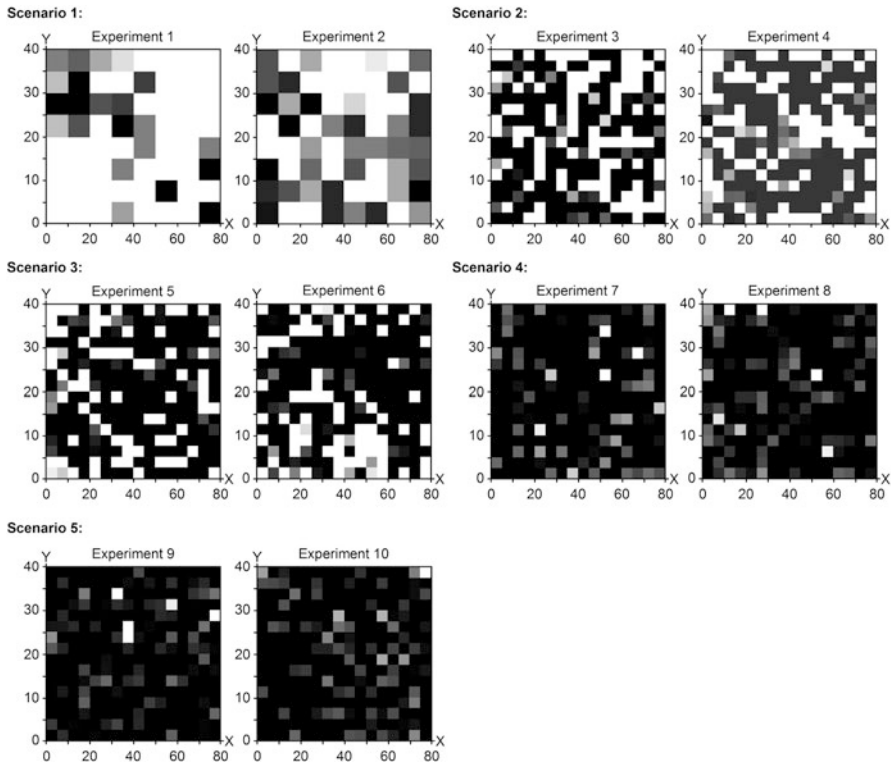
Fig. 10.5 Different scenarios of virtual Patagonia, varying the maximum resources at each patch. We have generated two different random experiments from each environmental scenario. Graphs show the spatial location of the agents after 500 time steps (ca. 250 years). *Grey* levels refer to similarity degree between agents, in such a way that each particular level reflects a similarity cluster. Clusters have been calculated using Wards method and Euclidean Distances between identity vectors (using JMP 10 Software, SAS, Inc). Table 10.3 furthermore gives the results for the above experiments in quantitative form

Table 10.3 Experimental results for the different scenarios shown in Fig. 10.5

Scenario	1		2		3		4		5	
Experiment	1	2	3	4	5	6	7	8	9	10
Max. resources	15,000	15,000	20,000	20,000	25,000	25,000	40,000	25,000	40,000	25,000
Initial agents (founding households)	300	300	300	300	300	300	300	300	300	300
Total number of agents after 250 years	41	63	246	246	323	329	956	1,018	1,162	1,184
Number of clusters	5	7	15	14	16	16	12	18	20	17

connected agents, the higher the global similarity. When resources are poor and spatially constrained (Scenario 1), population is low, and the number of networks is also very low. Consequently, there is no emergence of a common identity, but rather spatially homogenous but different identities randomly spread across the geographical area. This may have happened in Patagonia during the increased residential spatial constriction from 1,000 AD onwards. When resources become more abundant and therefore less spatially constrained (Scenarios 4 and 5) the population increases and there are more opportunities for interacting economically. As a consequence networks increase in size and in spatial extension, and a trend towards cultural homogeneity begins. That may have happened in Patagonia when new imported technology from European colonization modified drastically the chances of survival and the economic interaction among groups.

In other words, the probability of a common identity emerging within a social network decreases as the number of social networks, and the number of networked agents also decrease. The higher the number of households connected, the lesser the number of differentiated identities, and hence the more permeable seem the cultural frontiers.

To sum up, differentiated *etnia* do not emerge in 250 simulated years because of the very low temporal stability we have measured and the lack of clear segregation patterns. Preliminary results show that no aggregate has a duration of greater than a generation (50 ticks or 250 simulated years), so the fact of aggregation does not influence cultural transmission to the next generation. Identity and technological knowledge flows from parents to children, but the new generation changes and adapts its identity and knowledge constantly, according to their need for cooperation at work and the consequent flows of identity and information. Similarity clusters appear to have had more extended temporal durations than aggregates and social networks of cooperation. Evidence of exclusion and segregation are conspicuously lacking. In our case, parochialism does not emerge (Bowles and Gintis 2004; Kim 2010), because network embeddedness is in the process of being created and recreated constantly, and the average threshold of social similarity aggregates is very low in most simulated cases, indicating very high levels of tolerance to the differences of others.

Those results are what we expected. Strong ethnic differentiation based on spatial segregation should be linked to the rise of a social inequality system, and this is an aspect that we have not yet included in our model. When introducing the possibilities of "leadership" and conditioning the behavior of the next step on the behavior that a "leader" will adopt, social inertia emerges, and social aggregates increase stability and temporal duration. We think that this is what happened in Patagonia.

Historical documents from the time of European contact mention diverse forms of social and political hierarchy, notably a "chief" or "cacique" (Tomé Hernández 1587, quoted after Barros 1978). Mascardi (1963 [1670]) mentions the grouping of families around a leader with prestige. In 1784, Antonio de Viedma (cited after his *diario* published in 1836) described large groups under the leadership of a high

level chief with the authority to wage war and manage most tasks that required the activity of the entire group. These large groups would subdivide into smaller groups under the leadership of their own chiefs, with a recognized independence. Each chief or leader had control of a specific territory, and the members of the group could not enter into the territory of another chief without permission. Groups generally had to pay to pass through or for the right to use the resources of another territory (Musters 1964 [1872–1873]). Other travellers mention that chiefs became poor because they distributed what they had to their followers in order to satisfy them and to be celebrated as generous (Cox 1999 [1862–1863]). Given that people could choose the leader they wanted, without this distributive behavior many chiefs would have run the risk of undermining their support.

We have interpreted nineteenth century descriptions in terms of a configuration of social order with two top hierarchical levels, usually held by men, but also by women. The highest level was more irregular in time and geographical extent, but it predominated in groups of more than 1,000 people. Immediately below, a second hierarchical level where a minor leader had some degree of authority over small groups was more usual. In some cases, especially in northern Patagonia, this second hierarchical level was subdivided into lower level hierarchical ranks. The lowest social level was that of captives reduced to slavery, whose possibilities for social mobility were extremely low. The majority of group members had no access to dominance and leadership, but they were economically and politically self-sufficient, with the possibility of freely choosing the group to which they wished to belong.

In southern and central Patagonia, the authority of chiefs was probably not very great, being limited to leading the territorial mobility of the group. Chiefs were explicitly not liberated from work (Musters 1964 [1872–1873]). However, a chief's pre-eminence was well recognized by his/her followers and neighbors during their lifetime and it was even remembered after his/her death. Only in case of war would they acquire more authority, restricting the individual freedom of group members. As a result of war, captives were integrated into indigenous family groups as servants or as a kind of slave. At the end of eighteenth century, in some parts of northern Patagonia where European contact and inter-group conflict were stronger, chiefdoms were strongly consolidated, with evident hierarchical differences and elite families with succession rights (Mandrini 1992). In the nineteenth century, but probably even before, some of the chiefdoms had an important hereditary character (Vezub 2006, 2009, 2011), although we cannot easily conclude that political power and leadership were always transmitted from father or mother to son or daughter. Some families maintained the prestige and social influence of their main members for more than two or even three generations.

The next implementation of our simulation (called PSP 1.7) will include procedures for simulating leadership and political ties to analyze the way mobility and reproduction was mediated by social decisions.

10.6   Conclusions

"Ethnicity does not explain anything, it needs to be explained" (Doornbos 1991, p. 19). The same can be said about "territoriality". This is what we have tried to explore with our computer simulation of what may have happened in Patagonian history.

Our computer model of Patagonian hunter-gatherers explores the consequences of positive interaction as an adaptive advantage. Hunter-gatherers die less and survive better when they unite to hunt together. But such economic interaction had some important effects on innovation-diffusion and on cultural diversity. Survival in our virtual world is not an adaptive process, but a probabilistic one. That is to say, households do not modify their behavior to maximize survival. However, there are higher chances for surviving when agents cooperate looking for resources and sharing labor. Given that the probabilities of cooperation are conditioned on the existence of some cultural consensus, agents should be able to adapt their identity in response to the identity of agents with whom they have successful economic interactions. Identity is then under constant negotiation, and it evolves conditioned by the number and nature of agents involved in positive interaction. Given that social aggregates constantly change their internal organization, collective identity is constantly adapting. The apparent abundance, continuity, and easy access to resources all along the humanly exploitable area would have prevented human groups from increasing their productive capacity as a consequence of competition with other groups sharing the same environment. The absence (or insignificance) among Patagonian hunters of food reserves to be used during seasons of minimal economic activity is another fact that points in this direction. The mobile nature of the dispersed population was conducive to a very low level of political elaboration and hence of social stratification.

Our simulation shows that ethnicity can be understood in terms of the tendency of people with connected (or similar) traits (including physical, cultural, and attitudinal characteristics) to interact with one another more than with people with whom they have no connection (or similar features). In addition to the principle of ethnicity choice at the level of local rules of interaction, we have also introduced the principle of social influence (i.e., the more that people interact with one another, the more similar they become) which runs at the level of communication and the formation of a socio-cognitive level. This influence process produces induced ethnicity, in which the disproportionate interaction of likes with likes may not be the result of a psychological tendency but rather the result of continuous interaction.

Preliminary results clearly suggest that it is not the geographical space, and not only the distribution of resources that explains the emergence of territoriality, social aggregation and cultural differentiation phenomena, but social interaction (cooperation) and political constraints acting on social reproduction that explains both aggregation and the constant flux of identity negotiation and rebuilding. In the model, positive interaction depends on:

- the expected benefits of identity similarity,
- the expected benefits of help from others (in terms of labor),
- the expected benefits of more efficient techniques adopted from culturally similar neighbours,
- the expected benefits of mobility (the chance of finding someone in the neighborhood able to cooperate).

References

Abruzzi W (1982) Ecological theory and ethnic differentiation among human populations. Curr Anthropol 23(1):13–35

Adelaar WFH, Muysken PC (2004) The Languages of the Andes, revised edition. Cambridge University Press, Cambridge

Aguilera Faúndez O (2007) Fueguian Languages. In: Miyaoka O, Sakiyama O, Krauss ME (eds) The Vanishing Languages of the Pacific Rim. Part II: Areal Surveys. Oxford University Press, New York, pp 206–220

Alesina A, Devleeschauwer A, Easterly W, Kurlat S, Wacziarg R (2003) Fractionalization. J Econ Growth 8(2):155–194

Appadurai A (1996) Modernity at Large: Cultural Dimensions of Globalization. University of Minnesota Press, Minneapolis

Axelrod R (1997) The dissemination of culture: a model with local convergence and global polarization. J Conflict Resolut 41(2):203–226

Barberena R (2008) Arqueología y biogeografía humana en Patagonia Meridional. Publicaciones Sociedad Argentina de Antropología, Buenos Aires

Barberena R, Hajduk A, Gil AF, Neme GA, Durán V, Glascock MD, Rughini AA (2011) Obsidian in the south-central Andes: geological, geochemical, and archaeological assessment of north Patagonian sources (Argentina). Quat Int 245(1):25–36

Barceló J, Del Castillo F (2012) Why Hunter and Gatherers Did Not Die More Often? Simulating Prehistoric Decision Making. In: Proceedings of the 40th Conference on Computer Applications and Quantitative Methods in Archaeology, Southampthon

Barceló J, Del Castillo F, Mameli L, Moreno E, Videla B (2009) Where does the south begin? social variability at the southern top of the world. Arctic Anthropol 45(2):46–71

Barceló J, Del Castillo F, Mameli L, Moreno E, Sáez A (2011) Patagonia: Del presente etnográfico al pasado arqueológico. Rev Arqueología Iberoam 9(1):6–39

Barceló J, Cuesta J, Del Castillo F, Galán J, Mameli L, Miguel F, Santos J, Vila X (2013a) Simulating Prehistoric Ethnicity: The Case of Patagonian Hunter-Gatherers. In: Contreras F, Melero FJ (eds) CAA '2010: Fusion of Cultures, BAR International Series, vol S2494. ArcheoPress, Oxford, pp 137–144

Barceló J, Del Castillo F, Del Olmo R, Mameli L, Miguel F, Poza D, Vila X (2013b) Social interaction in hunter-gatherer societies: simulating the consequences of cooperation and social aggregation. Soc Sci Comput Rev. doi:10.1177/0894439313511943. Preprint, published online

Barrientos G, Gordón F (2004) Explorando la relación entre nucleamiento poblacional y violencia interpersonal durante el Holoceno tardío en el noreste de Patagonia (república argentina). Magallania 32:53–69

Barrientos G, Perez SI (2002) La dinámica del poblamiento humano del sudeste de la región pampeana. Intersecciones Antropol 3:41–54

Barrientos G, Pérez I (2004) La expansión y dispersión de poblaciones del norte de Patagonia durante el Holoceno tardío: evidencia arqueológica y modelo explicativo. In: Civalero M, Fernández P, Guráieb G (eds) Contra viento y marea: Arqueología de la Patagonia, INAPL-SAA, pp 179–196

Barrientos G, Perez SI (2005) Was there a population replacement during the Late mid-Holocene in the southeastern Pampas of Argentina? archaeological evidence and paleoecological basis. Quat Int 132(1):95–105

Barrientos G, Perez SI, Bernal V, González P, Béguelin M, Del Papa M (2008) El poblamiento holocénico del sudeste de la Región Pampeana: una discusión bioarqueológica. Apuntes del Centro de Estudios Arqueol Regionales, Universidad Nacional de Rosario, vol 2, pp 97–111

Barros JM (1978) Primer testimonio de Tomé Hernández sobre las fundaciones hispánicas del Estrecho de Magallanes. In: Anales del Instituto de la Patagonia, vol 9, Universidad de Magallanes, Punta Arenas, Chile, pp 65–76

Béguelin M (2010) Tamaño corporal y temperatura ambiental en poblaciones cazadoras recolectoras del Holoceno tardio de Pampa y Patagonia. Rev Argent Antropol Biol 12(1):27–36

Beguelin M, Barrientos G (2006) Variación morfométrica postcraneal en muestras tardías de restos humanos de patagonia: una aproximación biogeográfica. Intersecciones Antropol 7:49–62

Béguelin M, Bernal V, Del Papa M, Novellino P, Barrientos G (2006) El poblamiento humano tardío del sur de Mendoza y su relación con el norte de Patagonia: una discusión bioarqueológica. An Arqueol Etnol Vol Especial 61:6–25

Belardi J, Goñi R (2006) Representaciones rupestres y convergencia poblacional durante momentos tardíos en Santa Cruz. el caso de la meseta del Stroebel. In: Fiore D, Podestá M (eds) Tramas en la Piedra. Producción y uso del arte rupestre, Sociedad Argentina de Antropología, Buenos Aires, pp 85–94

Belardi J, Espinosa S, Carballo Marina F, Barrientos G, Goñi R, Súnico A, Bourlot T, Pallo C, Tessone A, García Guraieb S, Re A, Campan P (2010) Las cuencas de los lagos Tar y San Martín (Santa Cruz, Argentina) y la dinámica del poblamiento humano del sur de patagonia: integración de los primeros resultados. Magallania 38(2):165–188

Bellelli C, Scheinsohn V, Podestá M (2008) Arqueología de pasos cordilleranos: un caso de estudio en Patagonia Norte durante el Holoceno tardío. Bol Mus Chil Precolombino 13(2):37–55

Bernal V, Pérez I, González P (2006) Variation and causal factors of craniofacial robusticity in Patagonian hunter-gatherers from the Late Holocene. Am J Hum Biol 18:748–765

Bernal V, González P, Pérez I, Pucciarelli HM (2008) Entierros humanos del noreste de Patagonia: nuevos fechados radiocarbónicos. Magallania 36(2):175–183

Bernardi L (2003) Channels of social influence on reproduction. Popul Res Policy Rev 22(5–6):527–555

Berón M (2005) Integración de evidencias para evaluar dinámica y circulación de poblaciones en las fronteras del río Colorado. Programa y Resúmenes de las VI Jornadas de Arqueología de la Patagonia. Universidad de Magallanes, Punta Arenas

Berón M (2010) Circuitos Regionales y conflictos intergrupales prehispánicos. evidencias arqueológicas de violencia y guerra en la pampa occidental Argentina. In: Actas del XVII Congreso Nacional de Arqueología Chilena, vol 1, pp 493–503

Binford L (2001) Constructing Frames of Reference. An Analytical Method for Archaeological Theory Building Using Ethnographic and Environmental Data Sets. University of California Press, Berkeley

Bjerck H, Zangrando A (2013) Marine ventures: comparative perspectives on the dynamics of early human approaches to the seascapes of Tierra del Fuego and Norway. J I Coast Archaeol 8(1):79–90

Bodner M, Perego UA, Huber G, Fendt L, Röck AW, Zimmermann B, Olivieri A, Gómez-Carballa A, Lancioni H, Angerhofer N, Bobillo M, Corach D, Woodward S, Salas A, Achilli A, Torroni A, Bandelt H, Parson W (2012) Rapid coastal spread of first Americans: novel insights from South America's Southern Cone mitochondrial genomes. Genome Res 22(5):811–820

Bongaarts J, Watkins S (1996) Social interactions and contemporary fertility transitions. Popul Dev Rev 22(3):639–682

Borgatti S, Halgin D (2011) Mapping Culture: Freelists, Pilesorting, Triads and Consensus Analysis. In: Schensul J, LeCompte M (eds) The Ethnographer's Toolkit, vol 3. Altamira Press, Walnut Creek

Borrero L (2005) The Archaeology of Patagonian Deserts: Hunter-Gatherers in a Cold Desert. In: Veth P, Smith M, Hiscock P (eds) Desert Peoples. Archaeologucal Perspectives. Blackwell, Oxford, pp 142–158

Borrero L (2008) Early Occupations in the Southern Cone. In: The Handbook of South American Archaeology. Springer, Berlin, pp 59–77

Borrero LA (2012) The Human Colonization of the High Andes and Southern South America During Cold Pulses of the Late Pleistocene. In: Hunter-Gatherer Behaviour: Human Response During the Younger Dryas, Left Coast Press, Walnut Creek, pp 57–78

Borrero LA, Barberena R (2006) Hunter-gatherer home ranges and marine resources. Curr Anthropol 47(5):855–868

Borrero LA, Franco NV (1997) Early Patagonian hunter-gatherers: subsistence and technology. J Anthropol Res 53(2):219–239

Borrero L, Charlin J, Barberena R, Martin F, Borrazzo K, L'Heureux L (2008) Circulación humana y modos de interacción al sur del río Santa Cruz. In: Borrero L, Franco N (eds) Arqueología del extremo sur del continente americano. Resultados de nuevos proyectos, CONICET e Instituto Multidisciplinario de Historia y Ciencias Humanas, pp 155–175

Borrero LA, Barberena R, Franco NV, Charlin J, Tykot RH (2009) Isotopes and rocks: geographical organisation of southern Patagonian hunter-gatherers. Int J Osteoarchaeol 19(2):309–327

Boschín M (2002) Indigenous History of Northwest Patagonia. Regional Identities During the Seventeenth and Eighteenth Centuries. In: Briones C, Lanata JL (eds) Archaeological and Anthropological Perspectives on the Native Peoples of Pampa, Patagonia, and Tierra del Fuego to the Nineteenth Century. Bergin and Garvey Publishers, Westport, pp 7–8

Boschín MT (2001) Original Peoples. Archaeology of Northern Patagonia. In: Boschín MT, Casamiquela R (eds) Patagonia, 13,000 years of History. Leleque Museum, Emecé Editores, Buenos Aires, pp 6–4

Boschín M, Andrade A (2011) Poblamiento de Patagonia septentrional Argentina durante el Holoceno tardio: paleoambientes e imperativos sociales. Zephirus LXVIII:41–61

Boschín M, Del Castillo F (2005) El Yamnago: del registro histórico al registro arqueológico. Rev Esp Antropol Am 35:99–116

Bossert W, D'Ambrosio C, La Ferrara E (2011) A generalized index of fractionalization. Economica 78:723–750

Bowles S, Gintis H (2004) Persistent parochialism: trust and exclusion in ethnic networks. J Econ Behav Organ 55(1):1–23

Boyd R, Richerson P (2006) Culture and the Evolution of the Human Social Instincts. In: Levinson S, Enfield N (eds) Roots of Human Sociality. Berg, Oxford

Brown GK, Langer A (2010) Conceptualizing and measuring ethnicity. Oxf Dev Stud 38(4): 411–436

Brown CH, Holman EW, Wichmann S, Velupillai V (2008) Automated classification of the world's languages: a description of the method and preliminary results. STUF Lang Typology Univers 61(4):285–308

Campbell L (1997) American Indian Languages. The Historical Linguistics of Native America. Oxford Studies in Anthropological Linguistics, Oxford University Press, New York

Cardillo M (2011) Exploring latitudinal patterns of lithic technology variation in continental coastal Patagonia, Argentina. J Archaeol Sci 38(10):2675–2682

Carley K (1991) A theory of group stability. Am Sociol Rev 56(3):331–354

Carlón F (2010) Leadership and indigenous socio-political organizations in Pampas and Northern Patagonia during the 18th century: a reconstruction from inter-ethnic relationships in the Buenos Aires frontier. Rev Colomb Antropol 46(2):435–464

Casamiquela RM (1965) Rectificaciones y ratificaciones hacia una interpretación definitiva del panorama etnológico de la Patagonia y área septentrional adyacente. Instituto de Humanidades, Universidad Nacional del Sur, Argentina

Casamiquela RM (1983) Nociones de gramática del gününa küne. Centre National de la Recherche Scientifique P.U.F., Paris

Castellano C, Fortunato S, Loreto V (2009) Statistical physics of social dynamics. Rev Mod Phys 81(2):591

Cavalli-Sforza L, Menozzi P, Piazza A (1994) The History and Geography of the Human Genes. Princeton University Press, Princeton

Chakravarty SR, Maharaj B (2011) Measuring ethnic polarization. Soc Choice Welfare 37(3): 431–452

Chandra K, Wilkinson S (2008) Measuring the effect of "ethnicity". Comp Polit Stud 4/5:515–563

Charlin J, Borrero LA (2012) Rock Art, Inherited Landscapes, and Human Populations in Southern Patagonia. In: A Companion to Rock Art. Wiley, London, pp 381–397

Charlin J, González-José R (2012) Size and shape variation in Late Holocene projectile points of Southern Patagonia: a geometric morphometric study. Am Antiq 77(2):221–242

Childs H (1936) El Jimmy, Outlaw of Patagonia. JB Lippincott, Philadelphia

Claraz J (1988 [1865–1866]) Diario de viaje de exploración al Chubut. Ediciones Marymar, Buenos Aires, Marymar

Cobos V, Della Negra C, Bernal V (2012) Patrones de variación morfométrica craneofacial en poblaciones humanas del noroeste de patagonia durante el holoceno tardío. Rev Argent Antropol Biol 14(1):5–16

Cox GE (1999 [1862–1863]) Viaje en las regiones septentrionales de la Patagonia. Elefante Blanco, Buenos Aires

Currie TH, Mace R (2009) Political complexity predicts the spread of ethnolinguistic groups. Proc Natl Acad Sci USA 106:7339–7344

D'Andrade R (1987) The Development of Cognitive Anthropology. Cambridge University Press, New York

de Orbigny A (2002 [1833]) Viaje a la América Meridional. Instituto Francés de Estudios Andinos/Plural Publications, La Paz

Del Castillo F (2012) Modelando la heterogeneidad Étnica y la diversidad cultural en arqueología de cazadores recolectores patagónicos. aproximaciones desde la simulación computacional y los modelos basados en agentes. Ph.D. thesis, Autonomous University of Barcelona

Del Castillo F, Barceló J (in press) Simulando etnicidad y etnogénesis en grupos cazadores-recolectores. patagonia como caso de estudio. Libros de la Serie de Arqueología Americana, British Archaeological Report - BAR

Del Castillo F, Mameli L, Barceló J (2011) La arqueología patagónica y la reconstrucción de la historia indígena. Rev Esp Antropol Am 41(1):27–50

Del Castillo F, Barceló J, Mameli L, Miguel F, Vila X (in press) Modeling mechanisms of cultural diversity and ethnicity in hunter-gatherers. J Archeol Method Theory 13

Doornbos M (1991) Linking the Future to the Past – Ethnicity and Pluralism. In: Salih MMA, Markasis J (eds) Ethnicity and the State in Eastern Africa. Elanders Gotab, Stockholm

Dow MM, Burton ML, Reitz K, White DR (1984) Galton's problem as network autocorrelation. Am Ethnol 11(4):754–770

Duclos J, Esteban J, Ray D (2004) Polarization: concepts, measurement, estimation. Econometrica 72(6):1737–1772

Eff E (2004) Spatial and Cultural Autocorrelation in International Datasets. Technical Report 200401, Middle Tennessee State University, Department of Economics and Finance. http://ideas.repec.org/p/mts/wpaper/200401.html

Escalada F (1949) El complejo tehuelche. Estudios de etnografía patagónica. Instituto Superior de Estudios Patagónicos

Esteban J, Ray D (1994) On the measurement of polarization. Econometrica 62(4):819–851

Fabra M, DeMarchi D (2011) Geographic patterns of craniofacial variation in pre-hispanic populations from the Southern Cone of South America. Hum Biol 83(4):491–507

Fabre A (2005) Diccionario etnolingüístico y guía bibliográfica de los pueblos indígenas Sudamericanos. Self-published (online). http://www.ling.fi/Diccionario%20etnoling.htm

Favier Dubois C (2004) Fluctuaciones climáticas referibles al Período Cálido Medieval en Fuego-Patagonia. indicadores indirectos y el aporte de modelos climáticos. In: Actas de las V Jornadas de Arqueología de la Patagonia, Instituto Nacional de Antropología y Pensamiento Latinoamericano (INAPL), pp 545–556

Fearon JD (2003) Ethnic structure and cultural diversity by country. J Econ Growth 8:195–222

Fernandez Garay A (1998) El tehuelche. Una lengua en vías de extinción, Anejos de Estudios Filológicos, vol 15. Universidad Austral de Chile, Valdivia

Fernandez Garay A (2004) Diccionario tehuelche-español/ Ìndice español-tehuelche, CNWS Publications, vol 138/Indigenous Languages of Latin America (ILLA). Research School of Asian, African and Amerindian Studies, Universiteit Leiden, Leiden

Fernández Garay A, Hernandez GB (2004) La terminologia de parentesco entre los tehuelches ó aonek'enk de la Patagonia Argentina. Anclajes 155:121–151

Fiore D (2006) Poblamiento de imágenes: arte rupestre y colonización de la Patagonia. variabilidad y ritmo de cambio en tiempo y espacio. In: Fiori D, Podestá MM (eds) Tramas en la Piedra. Producción y usos del arte rupestre, WAC-SAA-INAPL, Buenos Aires, pp 4–2

Fiske P (1991) Structures of Social Life: The Four Elementary Forms of Human Relations. Free Press (Macmillan), New York

Fitz-Roy R (1932 [1833–1839]) Narración de los viajes de levantamiento de los buques de su Majestad Adventure y Beagle, años 1826 a 1836 (Tomos I y II). Biblioteca oficial de Marina

Flensborg G (2011) Lesiones traumáticas en cráneos del sitio Paso Alsina 1. explorando indicadores de violencia interpersonal en la transición Pampeano-Patagónica Oriental (Argentina). Intersecciones Antropol 12:45–59

Frank A (2012) Los fogones en la meseta central de Santa Cruz durante el Pleistoceno final. Magallania 40(1):145–162

García F, Moraga M, Vera S, Henríquez H, Llop E, Aspillaga E, Rothhammer F (2006) mtDNA microevolution in Southern Chile's archipelagos. Am J Phys Anthropol 129:473–481

García-Bour JA, Pérez-Pérez S, Álvarez E, Fernández A, López-Parra E, Arroyo-Pardo, Turbón D (2003) Early population differentiation in extinct aborigines from Tierra del Fuego-Patagonia: ancient mtDNA sequences and Y-chromosome STR characterization. Am J Phys Anthropol 123:361–370

Garro L (2000) Remembering what one knows and the construction of the past: a comparison of cultural consensus theory and cultural schema theory. Ethos 28(3):275–319

Giuliano P, Spilimbergo A, Tonon G (2006) Genetic, Cultural and Geographical Distances. Technical Report IZA Discussion Papers 2229, Institute for the Study of Labor (IZA). http://ideas.repec.org/p/cpr/ceprdp/5807.html

Gómez Otero J (2007) Dieta, uso del espacio y evolución en poblaciones cazadoras-recolectoras de la costa centro-septentrional de Patagonia durante el Holoceno medio y Tardío. Ph.D. thesis, Facultad de Filosofía y Letras, Universidad de Buenos Aires

Gómez Otero J, Banegas A, Goye S, Franco N (2009) Variabilidad morfológica de puntas de proyectil en la costa centro-septentrional de Patagonia Argentina: primeros estudios y primeras preguntas. In: VIII Congreso de Historia Social y Politica de la Patagónia argentino-chilena. Las fuentes en la construcción de una historia patagónica, Trevelin, pp 110–118

Goñi R, Barrientos G (2004) Poblamiento tardío y movilidad en la cuenca del lago Salitroso. In: Civalero M, Fernández P, Guraieb A (eds) Contra Viento y Marea. Arqueología de Patagonia, INAPL - Sociedad Argentina de Antropología, Buenos Aires, pp 313–324

Goñi RA, Cassiodoro G, Rindel D, Bourlot T, Garcia Guraieb S, Re A, Tessone A, Aragone A, Nuevo Delaunay A, Flores J (2007) Distribución del registro arqueológico en cuencas lacustres del noroeste de la provincia de Santa Cruz. In: Proceeding of XVI Congreso Nacional de Arqueología Argentina III, Universidad Nacional de Jujuy, Argentina

Gonzalez PN, Perez SI, Bernal V (2011) Ontogenetic allometry and cranial shape diversification among human populations from South America. Anat Rec 294(11):1864–1874

Gonzalez-Jose R (2003) El poblamiento de la Patagonia. Análisis de la variación craneofacial en el contexto del poblamiento americano. Ph.D. thesis, Universitat de Barcelona

Gonzalez-Jose RG, Dahinten S, Hernández M (2001) The settlement of Patagonia: a matrix correlation study. Hum Biol 72(2):233–248

Gonzalez-José R, Bortolini M, Santos F, Bonatto S (2008) The peopling of America: craniofacial shape variation on a continental scale and its interpretation from an interdisciplinary view. Am J Phys Anthrop 137:175–187

Gordón F (2009) Atribución causal a traumas craneofaciales en muestras del Norte de Patagonia (República Argentina): una perspectiva experimental. Magallania 37(2):57–76

Guichón R (2002) Biological Anthropology in Fuego-Patagonia. In: Briones C, Lanata J (eds) Archaeological and Anthropological Perspectives on the Native Peoples of Pampa, Patagonia, and Tierra del Fuego to the Nineteenth Century. Bergin & Garvey Publishers, Westport, pp 13–30

Harrington T (1946) Contribución al estudio del indio Gününa Küne. Rev Mus Plata 2:237–275

Holman EW, Schulze C, Stauffer D, Wichmann S (2007) On the relation between structural diversity and geographical distance among languages: observations and computer simulations. Linguist Typology 11(2):393–422

Kalick S, Hamilton T (1986) The matching hypothesis reexamined. J Personal Soc Psychol 51: 73–82

Kim JW (2010) Evolution of cultural groups and persistent parochialism structure and dynamics. J Anthropol Relat Sci 4(2). http://escholarship.org/uc/item/2cr2681m

Kolo P (2012) Measuring a New Aspect of Ethnicity - The Appropriate Diversity Index. Ibero America Institute for Econ. Research (IAI) Discussion Papers 221, Ibero-America Institute for Economic Research

Lalueza C, Pérez-Pérez A, Prats E, Cornudella L, Turbón D (1997) Lack of founding Amerindian mitochondrial DNA lineages in extinct aborigines from Tierra del Fuego-Patagonia. Hum Mol Genet 1(6):41–46

Lazzari A, Lenton D (2000) Etnología y nación: facetas del concepto de Araucanización. Avá Rev Antropol 1:125–140

Lewis CM, Lizárraga B, Tito RY, López P, Iannacone G, Medina A, Martínez R, Polo S, De La Cruz A, Cáceres AM, Stone AC (2007) Mitochondrial DNA and peopling of South America. Hum Biol 79(2):159–178

L'Hereux GL (2006) El estudio arqueológico del proceso coevolutivo entre las poblaciones humanas y las poblaciones de guanaco en patagonia meridional y norte de tierra del fuego. Ph.D. thesis, Facultad de Ciencias Naturales y Museo

L'Heureux L, Franco N (2002) Ocupaciones humanas en el Área de Cabo Vírgenes (Pcia de Santa Cruz, Argentina): El sitio Cabo Vírgenes 6. Anales Del Instituto De La Patagonia (Serie Ciencias Humanas), vol 30. Univ Austral de Chile, pp 183–202

Llop E, Harb Z, Moreno R, Rothhammer R (2002) Genetic marker variation in coastal populations of Chile. Homo 53(2):170–177

Long J, Kittles R (2003) Human genetic diversity and the nonexistence of biological races. Hum Biol 75:449–471

López L, Silveira M, Stern C (2010) Uso de obsidianas entre los cazadores-recolectores en el bosque del lago Traful, Noroeste de la Patagonia, Argentina. Magallania 38(1):237–245

Luna L (2008) Estructura demográfica, estilo de vida y relaciones biológicas de cazadores recolectores en un ambiente de desierto. Sitio Chenque I (Parque Nacional Lihué Calel, provincia de la Pampa, Argentina). No. 1886 in BAR International Series, ArcheoPress, Oxford

Mancini MV, Franco NV, Brook GA (2013) Palaeoenvironment and early human occupation of southernmost South America (South Patagonia, Argentina). Quat Int 299:13–22

Mandrini RJ (1991) Procesos de especialización regional en la economía indígena pampeana (s. xviii-xix), el caso del suroeste bonaerense. Bol Am 41:113–136

Mandrini R (1992) Indios y fronteras en el área pampeana (siglos xvi-xix) balance y perspectivas. Anu IEhS 7:59–72

Martínez G, Flensborh G, Bayala P (2013) Chronology and human settlement in northeastern Patagonia (Argentina): patterns of site destruction, intensity of archaeological signal, and population dynamics. Quat Int 301:123–134

Martinic M (1995) Los Aónikenk, Historia y Cultura. Ediciones de la Universidad de Magallanes, Punta Arenas, Chile

Mascardi N (1963 [1670]) Carta y relación. In: Furlong G (ed) Nicolás Mascardi y Su Carta-Relación, Teoría

Mazia N, Chaneton EJ, Dellacanonica C, Dipaolo L, Kitzberger T (2012) Seasonal patterns of herbivory, leaf traits and productivity consumption in dry and wet Patagonian forests. Ecol Entomol 37(3):193–203

Mazzanti D (2006) La constitución de territorios sociales durante el Holoceno tardío. el caso de las sierras de tandilia, Argentina. Relac Soc Argent Antropol XXXI:277–300

Mena F (1997) Middle to Late Holocene Adaptations in Patagonia. In: McEwan C, Borrero L, Prieto A (eds) Natural History, Prehistory and Ethnography at the Uttermost End of the Earth. British Museum Press, London

Méndez CA, Stern CR, Reyes OR, Mena LF (2012) Transporte de larga distancia de obsidianas en Patagonia centro-sur durante el Holoceno temprano. Chungará (Arica) 44(3):363–375

Miotti L, Salemme M (2003) When Patagonia was colonized: people mobility at high latitudes during Pleistocene/Holocene transition. Quat Int 109:95–111

Montalvo J, Reynal-Querol M (2002) Why Ethnic Fractionalization? Polarization, Ethnic Conflict and Growth. Economics Working Papers 660, Department of Economics and Business, Universitat Pompeu Fabra. http://ideas.repec.org/p/upf/upfgen/660.html

Montalvo JG, Reynal-Querol M (2005) Ethnic diversity and economic development. J Dev Econ 76(2):293–323

Morello F, Borrero L, Massone M, Stern C, García-Herbst A, McCulloch R, Arroyo-Kalin M, Calas E, Torres J, Prieto A, Martinez I, Bahamonde G, Cardenas P (2012) Hunter-gatherers, biogeographic barriers and the development of human settlement in Tierra del Fuego. Antiquity 86:71–87

Moreno E, Izeta A (1999) Estacionalidad y subsistencia indígenas en Patagonia Central según los viajeros de los siglos xvi-xvii. In: Soplando en el viento, Universidad Nacional del Comahue, Neuquén, pp 477–490

Moreno E, Zangrando A, Tessone A, Castro A, Panarello H (2011) Isótopos estables, fauna y tecnología en el estudio de los cazadores - recolectores de la costa norte de Santa Cruz. Magallania 39(1):265–276

Müller A, Velupillai V, Wichmann S, Brown CH, Brown P, Holman EW, Bakker D, Belyaev O, Egorov D, Mailhammer R, Grant A, Yakpo K (2009) ASJP World Language Tree of Lexical Similarity: Version 2. http://email.eva.mpg.de/~wichmann/language_tree.htm

Musters G (1964 [1872–1873]) Vida entre los patagones. Un año de excursiones por tierras no frecuentadas desde el Estrecho de Magallanes hasta el Río Negro. Edciones Solar/Librería Hachette, Buenos Aires

Nacuzzi L (1998) Identidades impuestas. Tehuelches, Auca y Pampas en el Norte de la Patagonia. SAA, Buenos Aires

Nacuzzi L (2007) Los grupos nómades de la Patagonia y el Chaco en el siglo xviii: identidades, espacios, movimientos y recursos económicos ante la situación de contacto. una reflexión comparativa. Chungara Rev Antropol Chil 39(2):221–234

Nacuzzi LR (2008) Repensando y revisando el concepto de cacicazgo en las fronteras del sur de América (Pampa y Patagonia). Rev Esp Antropol Am 38(2):75–95

Neme G, Gil A, Garvey R, Llano C, Zangrando A, Franchetti F, De Francesco C, Michieli C (2011) El registro arqueológico de la Gruta del Manzano y sus implicancias para la arqueología de Nordpatagonia. Magallania 39(2):243–265

Nettle D (1999) Linguistic Diversity. Oxford University Press, Oxford

Nichols J (1997) Modeling ancient population structures and movement in linguistics. Annu Rev Anthropol 26:359–384

Nichols J (2008) Language spread rates and prehistoric American migration rates. Curr Anthropol 49(6):1109–1117

Orden M (2010) La frase verbal en gününa iajëch. un enfoque preliminar. In: Censabella M, González R (eds) Libro de Actas II de Lenguas Indígenas Americanas y II Simposio Internacional de Lingüística Amerindia, ALFAL, CONICET, Buenos Aires, cD-ROM

Orquera LA (1987) Advances in the archaeology of the Pampa and Patagonia. J World Prehistory 1(4):333–413

Orquera L, Gómez Otero J (2007) Los cazadores-recolectores de las costas de Pampa, Patagonia y Tierra del Fuego. Relac Soc Argent Antropol 32:75–99

Palermo M (2000) A través de la frontera. economía y sociedad indígenas desde el tiempo colonial hasta el siglo xix. In: Tarragó M (ed) Nueva Historia Argentina, vol 1. Editorial Sudamericana, Buenos Aires, pp 343–382

Papp C (2002) Die Tehuelche. Ein Ethnohistoricher Beitrag zu einer Jahrhundertelangen Nicht-Begegnung. Ph.D. thesis, Universität Wien

Paruelo JM, Jobbágy EG, Sala OE (1998) Biozones of Patagonia (Argentina). Ecol Austral 8(2):145–153

Perez SI (2011) Poblamiento humano, diferenciación ecológica y diversificación fenotípica en América. Runa 32(1):83–104

Pérez S, Bernal V, González P (2007) Morphological differentiation of aboriginal human population from Tierra del Fuego (Patagonia): implications for South American peopling. Am J Phys Anthropol 133(4):1067–1079

Perez S, Della Negra C, Novellino P, Gonzalez P, Bernal V, Cuneo E, Hajduk A (2009) Deformaciones artificiales del cráneo en cazadores-recolectores del Holoceno medio-tardío del Noroeste de Patagonia. Magallania 37(2):77–90

Politis GG, Prates L, Merino ML, Tognelli MF (2011) Distribution parameters of guanaco (lama guanicoe), pampas deer (Ozotoceros bezoarticus) and marsh deer (Blastocerus dichotomus) in Central Argentina: archaeological and paleoenvironmental implications. J Archaeol Sci 38(7):1405–1416

Posner DN (2004) Measuring ethnic fractionalization in Africa. Am J Polit Sci 48(4):849–863

Prates L (2008) Los antiguos habitantes del río Negro desde una visión arqueológica. Ediciones de la Sociedad Argentina de Antropología, Buenos Aires

Prates L (2009) El uso de recursos por los cazadores-recolectores posthispánicos de Patagonia continental y su importancia arqueológica. Relac Soc Argent Antropol XXXIV:201–229

Ramasco J (2007) Social inertia and diversity in collaboration networks. Eur Phys J Spec Top 143(1):47–50

Rivals F, Rindel D, Belardi JB (2013) Dietary ecology of extant guanaco (Lama guanicoe) from Southern Patagonia: seasonal leaf browsing and its archaeological implications. J Archaeol Sci 40(7):2971–2980

Romney AK (1999) Cultural consensus as a statistical model. Curr Anthropol 40:103–115

Romney AK, Weller S (1984) Predicting informant accuracy from patterns of recall among individuals. Soc Netw 4:59–77

Romney A, Kimball S, Weller J, Batchelder W (1986) Culture as consensus: a theory of culture and informant accuracy. Am Anthropol 88:313–338

Rothhammer F, Llop E (2004) Poblaciones Chilenas: Cuatro décadas de Investigaciones. Editorial Universitaria, Santiago de Chile

Schulze ED, Mooney HA, Sala OE, Jobbagy E, Buchmann N, Bauer G, Canadell J, Jackson R, Loreti J, Oesterheld M, Ehleringer J (1996) Rooting depth, water availability, and vegetation cover along an aridity gradient in Patagonia. Oecologia 108(3):503–511

Sieck WR (2010) Cultural Network Analysis: Method and Application. In: Schmorrow D, Nicholson D (eds) Advances in Cross-Cultural Decision Making. CRC Press/Taylor & Francis, Boca Raton, pp 260–269

Silveira M, López L, Pastorino G (2010) Movilidad, redes de intercambio y circulación de bienes en el sudoeste del Neuquén (Norpatagonia, Argentina): Los moluscos marinos del lago Traful. Intersecciones Antropol 11(2):227–236

Soriano A, Volkheimer W, Walter H, Box EO, Marcolın AA, Vaierini JA, Movia C, Vasina WG (1983) Deserts and Semi-Deserts of Patagonia. In: Ecosystems of the World. Temperate Deserts and Semi-Deserts. Elsevier, Amsterdam

Spegazzini C (1884) Costumbres de los patagones. An Soc Cient Argent 17:221–240

Stein J (1997) How institutions learn: a socio-cognitive perspective. J Econ Issues 31(3):729–740

Suárez J (1970) Clasificación interna de la familia lingüística chon. AILM 10:29–59

Taylor C, Hudson M (1972) The World Handbook of Political and Social Indicators, 2nd edn. Yale University Press, New Haven

Vezub J (2006) Lenguas, territorialidad y etnicidad en la correspondencia de Valentín Saygüeque hacia 1880. Intersecciones Antropol 7:28–24

Vezub JE (2009) Valentín Saygüeque y la gobernación indígena de Las Manzanas. Poder y etnicidad en la Patagonia septentrional (1860–1881). Prometeo Libros, Buenos Aires

Vezub JE (2011) Llanquitruz y la "máquina de guerra" ma puche-tehuelche. continuidades y rupturas en la geopolítica indígena patagónica (1850–1880). Antíteses 4(8):613–642

Viedma A (1836 [1784]) Diario y descripción de la Costa Meridional del Sur llamada vulgarmente Patagonia. Biblioteca Virtual Miguel de Cervantes, Buenos Aires. http://bib.cervantesvirtual.com/servlet/SirveObras/49250514294669165350046/

Viega Barros J (2005) Voces en el viento. Raíces lingüísticas de la Patagonia. Mondragón, Buenos Aires

Vigdor JL (2002) Interpreting ethnic fragmentation effects. Econ Lett 75:271–276

Villar D, Jiménez J (2003) La tempestad de la guerra: conflictos indígenas y circuitos de intercambio: elementos para una periodización (Araucanía y las Pampas, 1780–840). In: Mandrini R, Paz CD (eds) Las fronteras hispanocriollas del mundo indígena latinoamericano en los siglos XVIII-XIX:un estudio comparativo, Universidad Nacional del Comahue, Neuquén, pp 123–171

Weller SC (2007) Cultural consensus theory: applications and frequently asked questions. Field Methods 19(4):339–368

Whitmeyer J (1997) Endogamy as a basis for ethnic behavior. Sociol Theory 15(2):162–178

Wichmann S, Holman E, Stauffer D, Brown C (2008) Similarities Among Languages of the Americas: An Exploration of the WALS Evidence. http://email.eva.mpg.de/~wichmann/SantaBarbWichmannRevSubmit.pdf

Wilensky U (1999) NetLogo. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston. http://ccl.northwestern.edu/netlogo

Zúñiga F (2006) Mapundungun. El habla de los mapuches. Centro de Estudios Públicos, Santiago de Chile