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Modelling mechanisms of social network maintenance in hunter–gatherers

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ABSTRACT

Due to decreasing resource densities, higher latitude hunter–gatherers need to maintain their social networks over greater geographic distances than their equatorial counterparts. This suggests that as latitude increases, the frequency of face-to-face interaction decreases for 'weak tie' relationships in the outer mating pool (~500-strong) and tribal (~1500-strong) layers of a hunter-gatherer social network. A key question, then, is how a hunter-gatherer tribe sustains coherence as a single identifiable unit given that members are distributed across a large geographic area. The first step in answering this question is to establish whether the expectation that network maintenance raises a challenge for hunter–gatherers is correct, or whether sustaining inter-group contact is in fact trivial. Here I present a null model that represents mobile groups as randomly and independently moving gas particles. The aim of this model is to examine whether face-to-face contact can be maintained with every member of an individual's tribe at all latitudes even under the baseline assumption of random movement. Contrary to baseline expectations, the number of encounters between groups predicted by the gas model cannot support tribal cohesion and is significantly negatively associated with absolute latitude. In addition, above ~40° latitude random mobility no longer produces a sufficient number of encounters between groups to maintain contact across the 500-strong mating pool. These model predictions suggest that the outermost layers of hunter–gatherers' social networks may require additional mechanisms of support in the form of strategies that either enhance encounter rates, such as coordinated mobility patterns, or lessen the need for face-to-face interaction, such as the use of symbolic artefacts to represent social affiliations. Given the predicted decline in encounters away from the equator, such additional supports might be most strongly expressed at high latitudes.

1. Introduction

Modern human social networks comprise a series of concentric layers that decrease in intimacy as they expand out from each individual (Roberts, 2010; Roberts et al., 2009). These layers appear to map onto ethnographically observed groupings that recur in archaeological (e.g. Grove, 2010b, 2011) and anthropological studies (e.g. Hamilton et al., 2007; Zhou et al., 2005), suggesting that they may be universal features of human social organisation. There is compelling evidence that the size of an individual's social network and the quality of their supportive social relationships are positively related to their life-expectancy (Holt-Lunstad et al., 2010; Kroenke et al., 2006; Pinquart and Duberstein, 2010), their mental and physical health (e.g. Umberson and Montez, 2010), and the health and survival of their children (Adams et al., 2002; Iaupuni et al., 2005). Maintaining one's social network is therefore crucial for survival and reproduction.

Extensive social networks facilitate the spread of information, knowledge and resources. At the lowest level, independent family units nested within bands pool risk associated with foraging by sharing unpredictable resources such as meat (Hames, 1990; Kaplan et al., 1990; Winterhalder, 1996). If the environment is sufficiently heterogeneous for scarcity in one region to parallel abundance in another, exchange of information and resources may occur between residential bands. At the highest level, such exchange may occur across the entire mating pool (~500 individuals in an endogamous 'megaband' comprising a number of residential bands) and ethnolinguistic tribe (~1500 individuals comprising several mating pools) (Dunbar, 1998; Zhou et al., 2005). The mating pool and tribe are the outermost network layers beyond each individual's 'active network' of people that they feel they share a relationship with and with whom they make a conscious effort to

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keep in contact (Roberts, 2010). Keeping track of the indirect or 'weak' ties that emerge from the overlapping active networks within a tribe allows individuals access to a wider variety of resources and information covering a greater geographic area through 'friends of friends'.

Since resource seasonality generally increases and resource density generally decreases with latitude (Grove et al., 2012; Nettle, 1999), nearer the poles it might become particularly imperative for hunter–gatherers to be able to (i) ensure safe passage during the seasonal round by avoiding conflict with the members of different residential groups, (ii) share information about the whereabouts of resources and (iii) conserve cultural knowledge about storage processes and the manufacture of reliable and diverse technology through social learning. Given that these functions are principally facilitated through social relationships, large cohesive social networks might be especially important for high latitude hunter-gatherers (Pearce et al., 2014). However, although social bonds can help assuage ecological difficulties, the maintenance of social networks is likely to present cognitive challenges in terms of co-ordination of individuals or sub-groups and time management challenges in relation to ensuring sufficient time investment in face-to-face bonding, without which relationships tend to deteriorate (Roberts and Dunbar, 2011; Sutcliffe et al., 2011). These challenges are likely to be exacerbated at higher latitudes for at least two reasons. Firstly, since the geographic area occupied by each population (tribe) increases faster with absolute latitude than does the size of the population (tribe) itself, social networks become spread over greater home ranges at higher latitudes: see Fig. 1 (Grove et al., 2012; Kelly, 1995; Pearce et al., 2014). Maintaining relationships across long distances is costly in terms of time and the risk of exploitation (Fitzhugh et al., 2011). Secondly, as larger groupings fission into smaller, more numerous foraging units in order to maintain manageable day journey lengths at higher latitudes, individuals need to mentally keep track of, and coordinate, larger numbers of groups (Grove et al., 2012; Lehmann et al., 2007).

If high latitude individuals are to reap the benefits of extensive social networks, they require the means to sustain social bonds with partners in different groups dispersed over wide areas. Travelling to visit more distant groups or to take part in periodic aggregations is likely to be time-costly. However, one way of absorbing these potential time costs is to embed social activities within more subsistence-based ones (Whallon and Lovis, 2011). Mobility primarily linked to tracking resources might allow hunter-gatherers to remain connected through coincidental encounters with neighbouring groups. Higher latitude groups tend to exhibit higher mobility that their lower latitude counterparts (Fig. 2) and this may allow sufficient inter-group encounters to counteract the distribution of social networks across larger home range areas at high latitudes. An important question, then, is whether the normal movement of groups around the landscape for resource gathering could inadvertently allow neighbouring groups to stay connected without having to resort to special social visiting trips or other mechanisms of contact and cohesion that allow social ties to remain active in the absence of frequent face-to-face contact, such as the exchange of symbolic artefacts.

Hunter–gatherer mobility patterns vary both between different populations and seasonally over a year (Bettinger, 1999; Binford, 1980; Watanabe, 1968). However, in general, foraging subgroups from the same residential band tend to move radially out from, and back to, a home base, which is moved periodically within a home range when local resources are depleted and according to seasonal changes in resource distributions (Kelly, 1995). Foraging groups may return to their home base nightly, or may conduct more extended logistic trips to procure particular resources (Binford, 1980). The size of the residential band occupying a particular home base may vary according to season and bands may periodically fuse with other bands to form larger aggregations at particular locations where resources are relatively plentiful (Binford, 2001). Whether nightly coordination between band members and seasonal coordination between bands are consciously determined or merely a side-effect of resource distributions dictating aggregation

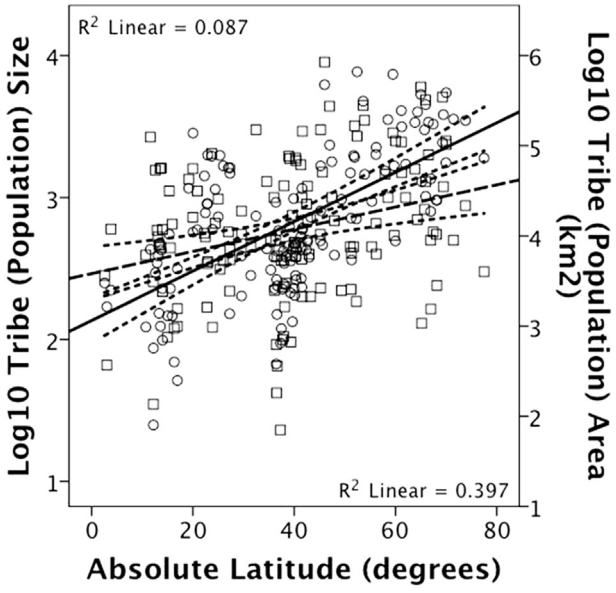

Fig. 1. Log_{10} total ethnic population/tribe (squares, long-dashed line) and log_{10} total home range area associated with the total ethnic population/tribe (circles, solid line) of each society plotted against absolute latitude for 136 hunter–gatherer societies (Binford, 2001). The short-dashed lines indicate 95% confidence limits for the regression lines. Note that the home range area associated with each tribe/population increases at a greater rate with absolute latitude (the slope is steeper) than does tribe/population size.

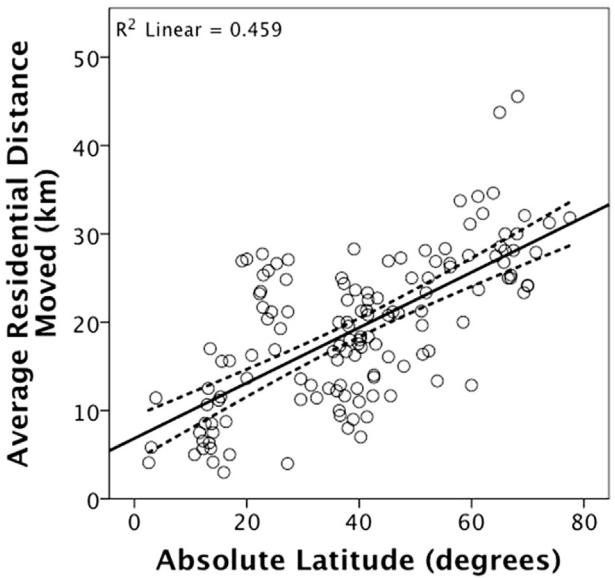

Fig. 2. The average distance covered per residential move (the total distance moved in a year divided by the number of residential moves in a year) plotted against absolute latitude for 136 hunter–gatherer societies (Binford, 2001). The dashed lines indicate 95% confidence limits for the regression line.