THE ADAPTIVE ADVANTAGES OF KNOWLEDGE TRANSMISSION

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Language is normally seen as a mechanism of communication. However, Dessalles (2000) has argued that language must have evolved as a form of costly signalling, because giving up knowledge is not an adaptive trait. Knowledge transmission disadvantages the transmitting agent, because the transmitter gives up knowledge to its neighbours / competitors. However, it has long been known that altruistic behaviour *can* evolve in conditions where a population is viscous — that is, when children tend to stay near their parents (Hamilton, 1964; Queller, 1994; Griffin et al., 2004). The genes that are being benefited are to some extent the same as those being disadvantaged; and so long as this benefit times the relatedness does not exceed the cost, altruism can be adaptive (Hamilton, 1964).

However, it has also been shown mathematically that in such cases, one's kin become one's competitors (e.g. Marshall and Rowe, 2003). In this case, the costs and benefits of altruism should equalise and altruism is selected neither before or against. This argument has been sustained in a bacteria-based live simulation, where the altruistic act is digesting food external to the cell for the benefit of all surrounding cells (Griffin et al., 2004). Griffin et al. show that in the case of low relatedness (for food competition) and local competition (for reproduction) altruism dies out, in cases of high relatedness and global competition altruism is selected for, and in the other two cases (including the viscous one — high relatedness / local competition) altruism is a neutral trait.

Čače and Bryson (2005) demonstrate in an agent-based ALife simulation that altruism can be selected for when the altruistic act is communicating about accessing food. We simulate two 'species', Talkers (altruists) and Silents (free riders). At each iteration of the simulation, a Talker tells any agent nearby one piece of its knowledge about how to eat complicated / special foods. In all other respects the two species are identical. Both profit by hearing knowledge equally, both have lifespans determined by either a fixed upper bound or starvation, both reproduce asexually at a rate dependent on their success in foraging, and always give birth to another individual of the same species. New knowledge enters the system during an infant's first cycle, when five percent of agents discover new ways to eat.

There is a clear cost to transmitting this information, yet Talkers always outcompete Silents into extinction, provided only that there is anything to learn and that they have a large enough initial population to survive random fluctuations. In a classic Simpson's paradox, any Talker who knows about k types of food will have a lower average energy level (and thus a lower probability of reproduction) than a Silent who also knows about k types, however the average Talker has more energy than the average Silent. This is because Talkers tend to know more things, because in a viscous population they tend to live near more other Talkers.

Why does competition from 'kin' (both memetic and one-bit genetic) not neutralise the advantage of communication? I believe this is another instance of ABM finding a gaff in abstract mathematical modelling. The more information present in the environment, the higher its realized carrying capacity. This effect is not large in our simulation, but it is enough to tip the equilibrium.

The salience of this work to the evolution of language should be evident. We have shown that any transmission of knowledge (about food at least) is adaptive. Further, our simulations show that the higher the rate of transmission, the faster the Talkers outcompete the Silents. Thus assuming hominids communicate knowledge about food (Steele, 2004), we now know incremental increases in communicative efficacy *could* be sustained by selective pressure.

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