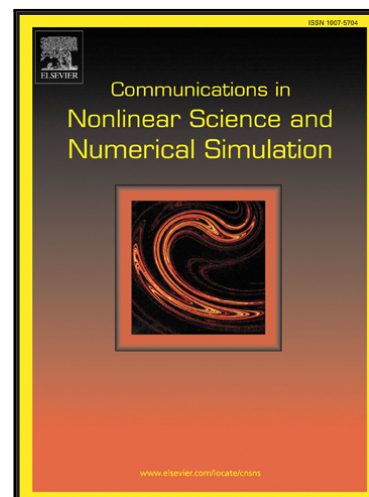


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Cultural ecologies of adaptive vs. maladaptive traits: A simple nonlinear model

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Abstract

In this paper, we generalize a model by Enquist and Ghirlanda (2007) to analyze the “macro” dynamics of cumulative culture in a context where there is a coexistence of adaptive and maladaptive cultural traits. In particular, we introduce a different, nonlinear specification of the main processes at work in the cumulative culture dynamics: imperfect transmission of traits, generation of new traits, and switches from adaptive to maladaptive and vice-versa. We find that the system exhibits a variety of dynamic behaviors where the crucial force is the switching between the adaptive and maladaptive nature of a certain trait, with the other processes playing a modulating role. We identify in particular a number of dynamic regimes with distinctive characteristics.

Keywords: Cumulative culture; cultural traits; adaptive traits; maladaptive traits.

1. Introduction

The cumulative nature of human culture is at the root of the evolutionary success of our species (Flinn, 1997), and through its embodiment in goods, services, and social environments it allows individuals to access and productively use crystallized information they wouldn't be able to generate and deploy autonomously (Hidalgo, 2015). Understanding in detail the social mechanics of cultural accumulation vis-a-vis the gene-culture coevolution process is no easy task (Laland, 1992; Chudek and Henrich, 2011), but recent research shows that the role of cumulative culture does not limit itself to the acquisition and transmission of useful cultural traits, but extends to the building of the cognitive structures that make such acquisition and transmission possible and effective (Heyes, 2012). In its essence, cumulative culture is the product of the tension between the Malthusian dynamic of population growth and the sophisticated evolutionary strategies that are harnessed to overcome the environmental constraints that limit or impede it through smart adaptations (Nekola et al., 2013), which are maintained, reinforced and transmitted through social interaction (Kurzban and Barrett, 2012; Muthukrishna et al., 2014)). Although cultural adaptations are not uncommon in the natural realm, the strong cumulative character of human culture is substantially unique at the current state of knowledge, and derives from a human-specific socio-cognitive regime that enables the production and diffusion of an ample range of complex traits rather than of a few simple traits (Kempe et al., 2014), and reflects into specific differences in a variety of distinctive cognitive domains (Vaesen, 2012). This differential type of socio-cognitive ability has been successfully replicated in experimental settings (Caldwell and Millen, 2008; Dean et al., 2012), although the empirical research on these topics is still in its early phase (Dean et al., 2013).

There is clearly a complex relationship between the size of a population and its capacity to carry a certain level of cumulative culture (Strimling et al., 2009), as in a large population individuals have the opportunity to learn from multiple cultural models and creatively combine them (Kempe and Mesoudi, 2014), and therefore the dynamic interaction between population growth and its cultural assets is especially subtle and crucial. However, the introduction of a large number of cultural variants may increase short-term cultural diversity, but it might even reduce it in the long term, thus suggesting the existence of complex nonlinear effects (Kandler and Laland, 2009). It is therefore not only a matter of population size, as the fine-grained nature of the social interaction that enables individuals to transmit and acquire certain cultural traits is of major importance for the aggregate outcome. In particular, population size interacts with the rate of cultural innovation, on how innovations are received by the population, and on how they are transmitted (Aoki et al., 2011), as well as with environmental characteristics (Whitehead, 2007), selection pressure (Vegvari and Foley, 2014), cultural transmission costs (Mesoudi, 2011a), and size of information flows (Yeaman et al., 2012), among others. Moreover, learning can occur at the individual or at the social level, and both individual and social learning itself can deploy various levels of sophistication (Ehn and Laland, 2012; Nakahashi, 2013). The combinations of such factors reflect into the structure of the limit distributions of cultural traits (Lehmann et al., 2011), and this makes their specification particularly important. The highly structured organization of human societies has a clear role in the adaptive calibration of learning processes (Lehmann et al., 2010). For instance, Nakahashi (2014) develops a model of cultural transmission where individuals learn cultural traits from multiple parents and test them before

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