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A Letter on:

Memes on memes
- a critique of memetic models

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In these pages and elsewhere a lot has been made of the "new science of memetics". I argue that this phrase misleads. First, work on evolutionary models and indeed replicator based models of cultural phenomena is not terribly new, though too much current work in the field ignores this history. Second, the scientific progress made in the area, if by science one means formalized models, is often quite immature. An exemplar of these weaknesses is the recent contribution to this journal by Aaron Lynch (1998).

Evolutionary theories of cultural change pre-date Darwin himself. By the turn of the century evolutionary theories had established themselves as dominant models of epistemology (e.g. Spencer 1864; see Campbell 1974) and language change (e.g. Lyell 1863; Darmesteter 1886; see Nerlich 1990). In other words, evolutionary theories of "ideas" dominated late nineteenth century thought and are certainly no newer then evolutionary theories for organic biology.

Examining the history of organic evolution one sees that theories of the mechanisms for change (namely natural selection (Darwin 1859)) predate modern theories for transmission (namely population genetics (Haldane 1932; Fisher 1930)). The same seems to be true for cultural evolution with theories for change established well before transmission models. Nonetheless, in the last twenty years a collection of formal replicator based transmission models for cultural phenomenon have been proposed (Cavalli-Sforza & Feldman 1973; Lumsden & Wilson 1981; Cavalli-Sforza & Feldman 1981; Boyd & Richerson 1985; Barkow 1989; Durham 1991; reviewed in Durham 1990).

Dawkins (1976), in a nice turn of phrase, proposed the word "meme" to describe replicating cultural units. However, other terms have also been put forth for this purpose including "culturgen", "symbol", "culture-type", and "theme". Lynch (1998) claims to introduce a new neologism, the "mnemon", though in point of fact this term was first proposed by Campbell (1974). Debate continues on what is meant exactly by these various terms.

In his recent contribution, Lynch (1998) proposes a formal transmission model for population memetics. Thus, he is working within the mode of, in particular, Cavalli-Sforza, Feldman, Boyd, and Richerson; though he does so without reference to any of their work. He devotes some time to the description of differential equations which aim to model the dynamics of two distinct memes which vie for hosts within a population.

A formal model should aim to describe empirical data (present or sought after) and should shed explanatory light on some phenomena. Lynch's do neither. This is due to a number of problems -- the wrong tool, focused at the wrong areas of the problem, creating a model which is too complex to make progress with, which encapsulate a set of assumptions that are neither stated nor justified.

$$\begin{aligned}\frac{dN_1(a,t)}{dt} = &\int_a^\infty R_1(p-a)K_{11}(p,a)N_1(p,t)dp \\ &+ \int_a^\infty R_2(p-a)K_{21}(p,a)N_2(p,t)dp \\ &+ \int_0^\infty \gamma_{12}(p,a)N_1(p,t)N_2(a,t)dp \\ &+ \int_0^\infty \frac{\beta_{12}(p,a)N_1(p,t)N_2(a,t)}{N(t)}dp \\ &- \alpha_1 N_1(a,t) + \alpha_2 N_2(a,t) \\ &+ \frac{\partial}{\partial a}N_1(a,t) - M_1(a)N_1(a,t)\end{aligned}$$

Equation (1)

Consider just the first term to Equation 1, taken from Section 16 of Lynch's paper. Here Lynch describes the change with time, *t*, of the acquisition of a particular meme in a population of a given age due to transmission from parents. This is expressed in terms of the number of parents at time *t* of some particular age *p*, $N_1(p,t)$, the number of offspring they have of the appropriate age, $R_1(p-a)$, and the ratio of parents who posses the meme that transmit it to their offspring given these ages, $K_{11}(p,a)$. Note that this is given as a *ratio* and not a *probability* resulting in a deterministic model. Lynch chooses to model everything as continuous functions with time or age and to integrate over all age groups whenever he wants a fixed number. The mis-application of the continuous domain is evident by the fact that even within his formalisms Lynch is compelled to discretise time. Here, $K_{11}(p,a)$ is the ratio *per year* of a transmission event and not a continuos ratio over time. I am not sure what it means to integrate over continuous ages a value measured in discrete time steps and to, subsequently, differentiate that over continuous time.

This model, naturally, focuses our attention on its parameterised spaces. Namely, it asks us to consider how transmission dynamics change with respect to the age of parent versus offspring. I question the value of this particular focus of attention. While age specific models might indeed be worthy of exploration we are offered no arguments as to why this particular age parameterisation is relevant. In particular, why would the age of the parent be given such attention? While Lynch correctly states that a model must hide certain elements while exposing others I question those he has chosen to expose. Other factors to consider include the relationships between model and learner (parental and non-parental

models), the numerical relationships between model and learner, the complexity of societies, spatial distributions, modes of communication, and so forth. Further, the model makes a number of assumptions which go unstated and unsupported. For example uniparental transmission; there is no consideration of two parents. Such a simplification demands defense and should not be included within the model without comment.

Consider again, $K_{11}(p,a)$, the ratio per year of a transmission event between a parent of age p and an offspring of age a. For this model to be of explanatory value we need to understand what this ratio K_{11} might look like in two-dimensional space. What would it mean for it to be concave, convex, increasing in a, increasing in p, and so forth. These are the sort of questions whose answers might provide value to these models. But Lynch provides no such explanation. He simply states the existence of this ratio, K_{11}. But it is this very ratio which goes to the phenomena Lynch presumes to be describing — namely, what are the dynamics of transmission between parent and offspring. From the vantage of population memetics, the action is in the likelihood of and factors around successful transmission. Lynch's formulation couches that phenomena in a quite complex set of continuous functions — who's born when and how does that vary with transmission. But it does not make any explanatory progress towards understanding these transmission dynamics. Moreover, it presents a deterministic ratio for the transmission event without offering any hope for actually arriving at this fixed (given a set of ages) rate of transmission. This side-steps what should be the central question of study — what is the probability distribution of these transmission events given a sound paramaterisation.

The overall complexity of Lynch's differential equation also is a drawback. It would be useful to understand, even within his parameterised spaces, what factors would lead to fixation of one meme versus another, what factors would lead to a frequency dependent mix, and so forth. However the sheer complexity of the model makes analytic (and indeed numerical) progress unlikely.

In Section 5 Lynch also presents a more simplified method to symbolize memetic transmission events. While the simplicity I applaud I find the overall mechanisms implausible. Lynch proposes to model the transmission of a "negatively defined mnemon". This is, apparently, some sort of "forgetting" event where a meme is removed from an agents memory. Lynch supports this mechanism through an argument by definition — he claims that this is consistent with his usage of "memory abstraction". While no doubt one could build a consistent model of the transmission of forgetting that does not make it a mechanism important (indeed even present) within human cultural evolution. Lynch goes on to claim that this is why birth control is a successful meme; it is easier to learn then to forget such concepts. Here we see how an implausible formal model leads to an unjustified conclusion. It seems far more likely that the concept of birth control maintains itself due to its epistactic co-adptive relationships to other meme complexes which render it stable in the presence of small numbers of competing memes. But, again, this is the very sort of question that Lynch's models should aim to investigate; our arm-chair theorizing amounts to nothing against well supported models and, of course, empirical data.

My critique of this model is towards a broader purpose. I hold building a science of memetics as an admirable project. Slow progress towards such a science has been made as evidenced by much of the cited literature. But the mis-application of science, that is formal models, does damage to the program. Mathematics, even if it is correct in some formal sense (and even this I question in the case of Lynch), is not of use unless it helps to explain the phenomena in question.

There exist a few practical methods to insure progress with formal modeling. Perhaps the most critical is an open and lively dialogue on these very matters; I hope this essay can help to stimulate such a discussion. Second, it is best to test formal models on real empirical data. In this way predictions can be verified, fit can be measured, hypotheses can be tested. Sadly, empirical data is not always available.

Alternatively, computational simulation and analysis can act as a surrogate for empirical data. In this case, hypothesis are stated, and analysis (numerical or symbolic) can serve to test these hypotheses. For instance, if Lynch is keen to employ an age-specific model, he might study what relationships between ages and transmission probabilities would result in points of fixation. Lynch, it must be said, makes some of these exact points himself; he argues for the value of falsifiable models. But, sadly, he does not take his own advise and try to support (or falsify) his own arguments.

Finally, the scientific method relies heavily on an appreciation of past art. Lynch would do well to study the transmission models (which include continuous-time models) within the literature (if he has studied them he would do well to cite and make use of their results). Indeed, cultural transmission is not the only important related work. I find myself, for instance, looking to research on social learning in animals, behavioral ecology, artificial life, and so forth.

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| Back to Issue 1 Volume 2 | Commentary on Lynch |