Trends in Cognitive Sciences

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Spotlight

A Modeling Approach that Integrates Individual Behavior, Social Networks, and Cross-Cultural Variation

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How do psychological traits shape social networks? How does this relationship influence the spread of behavior? In a recent paper, Muthukrishna and Schaller (*Pers. Soc. Psychol. Rev.*, 2019) use a modeling approach to explore these questions. In doing so, they illustrate the value of using a multilevel approach to study human behavior.

To understand the human mind and the behaviors it produces, we must appreciate that those minds – and the bodies to which they are attached – evolved, developed, and act in the context of their ecological and social environments. Thus, a complete cognitive science is necessarily integrated with the evolutionary, developmental, and social sciences. Formal models provide us with a way to handle this otherwise overwhelming complexity. They advance our ability to theorize: about distributed processing with connectionism, about social tradeoffs with game theory, and about the structure of interactions with network theory. These modeling frameworks allow us to better compartmentalize the components of complex systems, providing scaffolds for the development of richer theories.

All too often, psychological theories are described only at the level of individual processing. Muthukrishna and Schaller [1] (M&S) buck that trend. They present a model of how the distribution of individual cognitive features in a population can influence the structure of social networks and how that network structure may interact with other cognitive features to affect how opinions, behaviors, or norms may or may not spread (Figure 1). Individuals in their model have two psychological traits: 'extraversion', which controls the propensity to form social ties, and 'influenceability', which controls the propensity to change one's beliefs or behaviors in response to others. For both traits, M&S consider how individuals vary within a population, as well as how overall distributions of trait values can vary between populations.

Extraversion leads to the formation of social ties. Greater extraversion in a population is associated with denser networks, higher clustering, and shorter average path lengths. Individuals in the model are initialized to hold one of two possible behaviors (which can also be conceptualized as opinions or norms). They then have opportunities to update their behaviors based on the behaviors exhibited by their network ties ('acquaintances'). M&S consider a simple proportional social influence as well as a conformist bias in which majority opinions are weighted more highly. The probability of actually updating one's behavior is weighted by an individual's influenceability.

Unsurprisingly, a popular behavior will saturate more rapidly in populations with more influenceable individuals. A conformist bias accelerates this process. When this conformist bias exists and initial behaviors are randomly assigned, behaviors also spread more rapidly in societies with lower levels of extraversion (although this effect was not found for all starting assumptions). In sparser networks, where individuals are more likely to see stronger majorities due to smaller group sizes, beliefs may take hold particularly quickly.

M&S also considered the spread of initially rare behaviors, in which all individuals exhibited behavior A except for a lone 'ideologue' who exhibited behavior B and

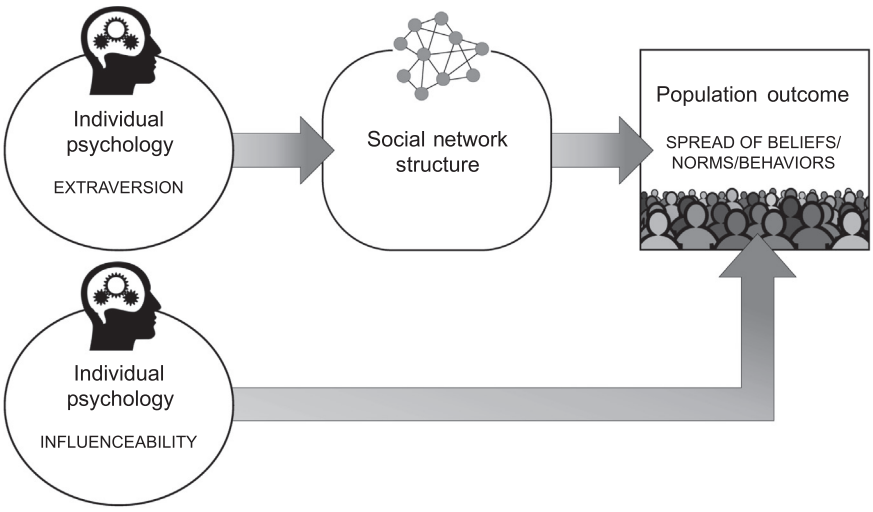

Figure 1. A Causal Diagram of the Model Dynamics in [1]. The distribution of individuals' extraversion influences the formation of social ties and thereby shapes the structure of the emergent social network. That social network structure, in turn, interacts with the distribution of individuals' susceptibility to social influence to shape how beliefs, norms, and behaviors spread (or fail to spread) in a population. The model helps to relate between-population variation in relatively stable psychological traits to variation in the dynamics of social behavior by illustrating how the former shapes the mechanisms that give rise to the latter.

could not be influenced to switch. They found, again, that rare behaviors were most likely to spread in populations highest in influenceability, presumably because there were more opportunities for the rare behavior to spread. Rare behaviors were also more likely to spread in populations with low extraversion, which is not immediately intuitive.

Cynically, readers familiar with the literature on network dynamics may find the results unsurprising once the emergent network structures are understood. Influenceability is simply the probability that a transmission event occurs, so of course more influenceable populations see faster and more effective spread of behavior – this is a core principle of contagion dynamics [2]. The version of the model without a conformist bias is equivalent to one of neutral evolution. This helps to explain why behaviors spread more effectively in populations with lower extraversion: in a network models of neutral evolution, sparser networks are known to reach fixation more quickly due to the smaller effective populations [3].

However, everything is obvious once you know the answer [4], and there is much to celebrate in this approach. The paper represents an attempt to describe how social network structure emerges from individual psychology and goes on to consider how cultural differences might stem, ultimately, from differences in psychological features. It is not just about how network structure influences behavior, but also about how behavior influences network structure. Consider, for example, a population in which initially rare beliefs spread rapidly. To explain this cultural signature, perhaps we should look for signs that individuals within that culture exhibit high susceptibility to social influence but low propensity for social ties. More generally, the attempt to integrate individual psychology, social structure, and cross-cultural variation should be applauded and encouraged.

While the multilevel approach adopted by M&S is certainly not the norm, there are several noteworthy examples of which broad-minded cognitive scientists should be aware. One recent study [5] used evolutionary game theory to consider differences in the spread of norms in loose versus tight cultures, where the latter are characterized by stricter emphasis on social conformity. The paper showed how 'tipping points' in which rare norms suddenly gain rapid adoption should, perhaps counterintuitively, be more common in tight cultures. In another study [6], agent-based modeling was used to show how larger populations could facilitate a greater variety of easily-learned behaviors but a smaller assortment of hard-to-learn traits, in line with empirical research indicating that languages associated with larger populations show larger vocabularies but simpler grammars. Researchers have also considered how models can bridge the gap between individual-level behavior and population structure to explore cultural differences, showing how more complex societies might exhibit more apparent diversity in personality traits [7] and how denser societies should have weaker norms of fairness [8].

These models are in line with a cultural evolutionary approach that represents, in my view, the most coherent attempt to provide a unified theory of human behavior [9,10]. A science of human behavior must not only integrate individual cognition with social structure but also consider how societal structures emerge, change, and shape information flow. An interdisciplinary approach, informed by theory and empirical data and scaffolded by formal models at multiple levels of analysis, is our best bet.

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