Quality versus mere popularity: a conceptual map for understanding human behavior

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Quality versus mere popularity: a conceptual map for understanding human behavior

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Abstract We propose using a bi-axial map as a heuristic for categorizing different dynamics involved in the relationship between quality and popularity. The east–west axis represents the degree to which an agent's decision is influenced by those of other agents. This ranges from the extreme western edge, where an agent learns individually (no outside influence), to the extreme eastern edge, where an agent is influenced by a large number of other agents. The vertical axis represents how easy or difficult it is for an agent to discern the relative quality of available choices. When a case study is located on the map, it becomes easier to select the range of tools to use for understanding and predicting the relation between quality and popularity.

Keywords Cultural transmission · Evolution · Pattern formation · Popularity · Social learning

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1 Introduction

When faced with making decisions that involve multiple options, agents can do one of two things: They can learn individually, meaning they attempt to think everything through by themselves, or they can cut corners and learn socially by using other agents as sources of information. Social learning characterizes diffusion models (Bass 1969; Rogers 1962), informational cascades (Bikhchandani et al. 1992; O'Brien and Bentley 2011; Ormerod and Colbaugh 2006; Schiffer 2005; Watts 2002), information scrounging (Mesoudi 2008; Rogers 1988), and even maladaptive behaviors that spread by "hitchhiking" on the prestige of the people demonstrating them (Henrich and Gil-White 2001). Indeed, evolutionary anthropologists and psychologists (e.g., Dunbar and Shultz 2007; Herrmann et al. 2007) have argued persuasively that the anomalously large brain (neocortex) size in humans evolved primarily for social-learning purposes. In view of the different processes and scales involved in decision-making, especially decisions about the quality of a behavior or product, how do we determine which one predominates in a given situation?

2 A conceptual map

We propose using a bi-axial map as a heuristic way of categorizing the different possibilities (Fig. 1). The east–west axis represents the number of people influencing an agent's decision. This ranges from the extreme western edge, where an agent learns individually (no outside influence), to the extreme eastern edge of the map, where an agent is influenced by a large number of other agents (Bentley

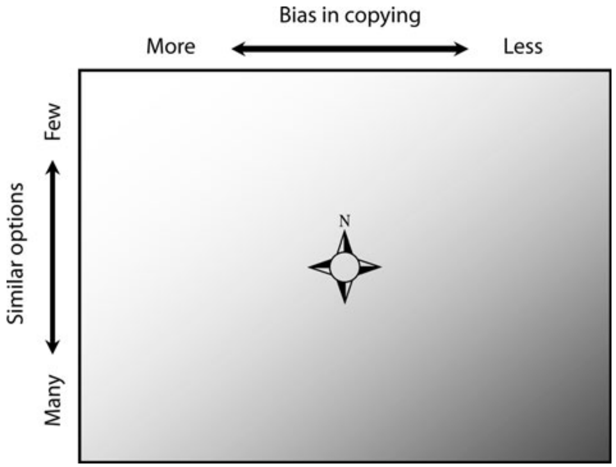

Fig. 1 A conceptual map for understanding human behavior that plots case studies on two axes. The horizontal axis represents how agents make decisions. At the western end, agents learn individually, whereas at the eastern end they base decisions solely on the choices of others—they copy. The vertical axis represents the number of choices available, ranging from very few in the north to many more in the south

and O'Brien 2011). The north–south axis represents how easily an agent can discriminate quality among the different options, or equivalently, how clearly the agent comprehends the different payoffs among the options, whether social or material (e.g., Perrot and Linnemer 2000).

This simple map is not only conceptually helpful but practical, too, because the directions are phenomena that we can quantify, or at least qualify in fairly precise terms, for different situations. Although the map represents a continuous space, we find it easier for discussion to divide it into quadrants. Our characterizations below are based on extreme positions within each quadrant.

2.1 Northwest: agents, singly or interacting with a few other agents, choose from among options of discernibly different quality

At the extreme western edge of this quadrant, each agent decides whether or not to adopt a certain variant based strictly on personal assessment of the quality of the options. The classical rational-actor model of the last century, where each individual carefully considers the inherent costs and benefits of all options, is located in the Northwest quadrant. The model often begins with agents who select for quality (or "fitness") in all decisions. Under this assumption, careful selection by all agents collectively finds the best quality and brings it to the top of communal popularity. In anthropology and economics, optimization and rational selection for quality, in terms of costs and benefits, is prominent, although work on social learning and lack of discernible quality, or random payoffs among binary choices, is growing (e.g., Brock and Durlauf 2007; Perrot and Linnemer 2000). Optimization models are useful when payoffs are predictable—hunting and gathering in a consistent environment, for example, or participating in particular modern situations where there are clear differences among choices (Winterhalder and Smith 2000). When the inherent qualities of the choices are difficult to discern, however, the outcome can no longer be predicted by finding a single equilibrium and/or optimal choice (e.g., Akerlof 1970; Milgrom and Roberts 1990; Perrot and Linnemer 2000; Salganik et al. 2006).

Moving slightly to the east on the map implies that agents make decisions with the influence of at least a few agents, although still among options of discernibly different quality. Here is where considerable work has been done in cultural evolution (Richerson et al. 2010), social psychology of the 1950s and 1960s (e.g., Asch 1955; Milgram 1963), and behavioral economics (e.g., Bikhchandani et al. 1992; Brock and Durlauf 2010; Milgrom and Roberts 1990; Perrot and Linnemer 2000). Cultural evolution has focused on the costs and benefits of social learning, including the roles played by prestigious individuals (Henrich and Gil-White 2001), how much is invested in punishing nonconformists for the greater public good (Boyd et al. 2010), and why conformist instincts evolved in humans. Pure conformity—defined as deliberately copying the majority (e.g., Boyd and Richerson 1985; Boyd et al. 2010; Henrich 2001)—is in the Northwest quadrant if it involves an omniscient, rational calculation of deterministic outcome.

2.2 Northeast: agents, interacting with many other agents, choose from among options of discernibly different quality

Large numbers of interacting agents who face a limited number of differentiable options occupy the Northeast quadrant. Agents copy each other, and if copying is directed toward the action/thing itself, which Boyd and Richerson (1985) refer to as "direct bias" and Laland (2004) calls "copy if better," then considering populations means that we can exploit traditional social-diffusion theory: Higher quality inevitably becomes widespread but requires time to diffuse through the relevant population, as agents must introduce it to each other. Classic diffusion models work best when the new option is a noticeable improvement in quality, as often happens with technology, such as the bow and arrow of prehistoric North America (Lyman et al. 2009) or hybrid corn in the American Midwest (Griliches 1957). S-shaped curves are typical of new technologies (e.g., Rogers 1962).

In the case of hybrid corn, consider the cumulative percentage of farmers in two Iowa communities who adopted hybrid seed corn over a period of 15 years (Griliches 1957): It took 9 years for the frequency of hybrid planters to reach 20% but only 6 more years for it to reach fixation at 99%. Here we have a classic S-curve, with slow adoption followed by a significant upward shift in 1933–1934 and a peak in 1936–1937. Early on, a few farmers experimented with hybrid corn, but this yielded almost no shifts in behavior until enough farmers began experimenting with it that it finally reached a point where social learning took over.

It is tempting to see a "tipping point" in the spread of hybrid corn—a definable moment where conformity took hold (Boyd and Richerson 1985; Henrich 2001). Here, however, the S-curve does not *necessarily* require conformity as long as the use of the corn grew in visibility with its adoption by fellow farmers. A fuller version of the classic behavioral-diffusion model mentioned above accounts for copying by introducing a variable, q, to represent the degree of imitation of the new and better behavior—better in the sense that agents do not switch back to the older behavior—such that the probability of adoption $p(t) = (\mu + qF(t))(1 - F(t))$, where the parameters μ and q represent the probability of innovation and imitation, respectively, and $F(t)$ represents the cumulative fraction of adopters at time t (Bass 1969). Different parameter values predict identifiably different patterns in the adoption and subsequent abandonment of ideas within a population, whether this takes place over years or decades of adoption (Bass 1969) or mere days through online "buzz" (Bentley and Ormerod 2010). As Brock and Durlauf (2010:248) conclude, "even in the presence of observable and unobservable heterogeneity, it is possible to uncover properties of adoption curves that observationally differentiate environments in which social interactions matter from those that do not."

Social-learning biases add an extra layer of complexity to social-diffusion models: An agent might direct attention toward agents who meet one or more of the following criteria: They are prestigious, related to the agent, attractive, similar in behavior to the agent, popular, older, younger, and so on (e.g., Henrich and Gil-White 2001; Laland 2004). Among these copying biases, perhaps the most adaptive for the copier are those that are directed toward an agent or group of agents with which the copier seeks to identify. This can be a type of conformist bias, which can lead to social diffusion within the limits of the group that is conforming. A popular name might diffuse through a generation (Berger and Le Mens 2009), a certain dialect through an ethnic community, or a certain set of interlinked customs through a community. In these cases, the copying is directed according to the rule of "copy the majority" (Laland 2004).

True conformity, in the sense of determining the majority decision and copying it, can introduce punctuated effects or a degree of unpredictability that is uncharacteristic of standard diffusion curves. If copying is directed, then larger populations mean that agents often can observe popularity only locally (leaving aside modern online search engines and popularity lists). In other words, agents often try to conform locally rather than globally. When conformity is directed locally, it might mean agents adopt something only after enough of their friends or colleagues have adopted it. Watts (2002) showed how even a deterministic rule of conformity at the local scale can lead to unpredictable cascades of behavioral change at the population scale. Watts modeled a network of interconnected agents, with each agent assigned a threshold value of how much "peer pressure" it would take for the agent to adopt the new behavior. A threshold of 0.85, for example, meant that an agent adopted an idea once 85% of its neighbors adopted it. Thus, each time an agent adopted, it might cause a neighbor to switch, and so on, leading to a cascade of adoption across the network.

As expected, adoption cascades occurred more readily with globally low thresholds (cf., Bikhchandani et al. 1992). More unexpectedly, Watts (2002) found that introducing variation among agent thresholds—representing "innovators" at low thresholds, "early adopters" at mid-level thresholds and "late majority" at higher thresholds—made system-sweeping cascades more likely (Ormerod and Evans 2011). Early adopters (low threshold) started an avalanche, and early and late majority agents kept it going. Cascades were weak in very sparsely connected networks but also weak in overly connected networks because of the local stability of the individual nodes (Watts 2002). The point is that all this rich complexity in the spread of innovations was modeled with no reference to inherent quality. Agents made decisions based only on their individual threshold for local conformity.

2.3 Southwest: agents, singly or interacting with a few other agents, choose from among many similar options

Agents confronted with problems that have no clear solutions—there are many possible options—populate the Southwest quadrant. For example, an agent might be faced with different mobile phones, which may objectively be different but in such numerous, minor and often incomprehensible ways that they exemplify what Sela and Berger (2011) call "decision quicksand." Consider what Beinhocker (2007: 8–9) said about the plethora of consumer choices for the average New Yorker: "The Wal-Mart near JFK Airport has over 100,000 different items in stock, there are over 200 television channels offered on cable TV, Barnes and Noble lists over 8 million titles, the local supermarket has 275 varieties of breakfast cereal, the typical department store offers 150 types of lipstick, and there are over 50,000 restaurants in New York City alone."

Without further information, available options would appear to be almost indistinguishable. If the agent acquires useful information, then the decision moves northward on the map. For a modern example, let's suppose a potential mutual-fund investor turns to a page of the financial newspaper, with hundreds of choices on it, and, without looking, sticks a pin in the page and buys whatever fund it happens to go through. As an individual decision, made randomly among many undifferentiated choices, it would land on the southwestern edge. In this case of a completely random allocation, we expect a uniform probability distribution, where each potential choice has the same probability. Simply put, if there are N possible choices of something, each perceived with equivalent quality, then each has a probability of $1/N$ of being chosen (Ehrenberg 1959; Frank 2009). In economics, assumptions of ignorance in decision-making dates back to Knight's (1921) distinction between risk and uncertainty; it was a persistent theme in the work of Keynes (1921, 1936); and it was later featured strongly in Hayek's 1974 Nobel Lecture (Hayek 1992). Ehrenberg (1959) considered consumer markets in which consumers effectively guessed from among the appropriate choices, and other work has explored radical uncertainty and game theory, although focusing on binary decisions (e.g., Brock and Durlauf 2007; Milgrom and Roberts 1990; Perrot and Linnemer 2000).

2.4 Southeast: agents, interacting with many other agents, choose from among many similar options

We assign to the Southeast quadrant agents who interact with many other agents and confront many options whose quality is difficult to discern because the choices are similar. If agents are not choosing independently, as in the Southwest quadrant, then they can copy another agent's choice. A simple, useful null hypothesis is that the majority of agents in a population copy one another in an effectively undirected manner, whereas a minority innovates its own original behaviors. Using this null model is not to assume it applies universally, but it does help to identify, through empirical testing, situations where it is falsified—where there is some generally agreed-upon quality that most people are selecting, as opposed to such little consensus about quality that the dynamics behave *as if* people were copying others in a random manner (see below). This useful base model is also known as the *neutral model* of cultural evolution, which is based on the differential replication of variants through time by random sampling. When adapted for cultural evolution, the neutral model applies best to behaviors that are not essential to survival, where what is chosen has no *inherently* better or worse quality relative to other options.

In terms of understanding the behavior of this model, there are examples from biological sciences (Hahn 2008), and economics (Ijiri and Simon 1964). A model of undirected copying was used, for example, to identify social-network arrangements favorable to selection versus random drift in the sorting of variation (Lieberman et al. 2005), and it was also used to show how highly clustered social networks favor the evolution of cooperation (Ohtsuki et al. 2006). Practical applications, with favorable comparison to real-world data, include baby names (Hahn and Bentley 2003), English words (Bentley 2008; Reali and Griffiths 2009), and prehistoric pottery designs (Neiman 1995).

The undirected copying model works basically like this: Take a number of agents, most of whom from one time interval to the next choose their new ideas by copying another agent. A small fraction, μ, of the pool of individuals, however, invents something new. Do this over and over, in a series of time steps, and count up the frequencies of the variants over a specified duration of time steps. More formally, we consider a homogeneous population of size N, which remains constant but where agents are replaced in each generation by N new agents. With probability $1 - \mu$, an incoming agent either copies the variant held by an agent within the previous m time steps or else, with probability μ, innovates by choosing a unique new variant at random. This simple model of undirected copying yields surprisingly rich results, including a wide variety of heavy-tailed distributions through varying μ and m, which can be fit to popularity distributions from phenomena that undergo continual turnover, or drift (Bentley et al. 2011).

3 Data patterns expected within the map

The usefulness of the conceptual map lies in the different empirical data patterns expected from the different quadrants. Assuming there are data available on the popularity of options through time, we consider three diagnostic types patterns: synchronic distributions of popularity, turnover among the most popular choices, and individual timelines.

3.1 Synchronic distributions of popularity

Generally speaking, the Northwest quadrant should be characterized by normal distributions of popularity, as is typical of cost–benefit optima. We might expect the Northeast quadrant to be represented by a bimodal distribution, at least for binary-decision models. In a model that we would place squarely in the Southwest, Ehrenberg (1959) made the assumption that choice "incidence tends to be… so irregular that it can be regarded *as if random*" (Goodhardt et al. 1984:626, emphasis in original), and from this he predicted what is known as a negative binomial distribution of variant popularity. This distribution contrasts with more right-skewed, "long-tail" distributions, which generally characterize the Southeast quadrant (Bentley et al. 2011).

3.2 Turnover among the most popular choices

If we rank choices in order of popularity at any given time, we have different expectations from the quadrants for how much turnover there will be within this ranked list over time. In the Northwest and Northeast quadrants, the best option should be the most popular, until something better is invented, and so turnover will generally be proportional to population size (Henrich 2010): The larger the population, the more ideas that can be accumulated (Kline and Boyd 2010; Laland et al. 2010; Powell et al. 2009). In the Southwest and Southeast quadrants, turnover should be continual, but even greater in the Southwest, where choices are more irregular than in the Southeast. In the latter, constituents of the long-tailed distribution are in continual flux, in the same way that pop-culture elements in the real world are. The turnover results from a balance of invention, which introduces new ideas, and by random drift, through which variation is lost as a result of sampling (bad luck). Unlike in the Northeast quadrant, in the Southeast turnover is expected to increase in proportion to the fraction of inventors in the population, not simply the number of agents (Bentley 2008; Byers et al. 2010; Eriksson et al. 2010).

3.3 Individual timelines

In the Northwest quadrant, we expect cost-beneficial options to become popular very shortly after they become available and known to agents, and to remain popular once they get there. If we assume for simplicity that regardless of its relative frequency, each choice is known to all members of a population, then a classical diffusion model, even simpler than the Bass (1969) model mentioned above, posits that the probability of adopting a new behavior is $p(t) = \mu(1 - F(t))$, where μ represents the probability for individual selection and $F(t)$ is the overall frequency (popularity) of the behavior at time t. This gives rise to so-called *r-curves* of adoption, meaning the adoption rate is fastest at the beginning and then declines exponentially as the behavior comes to be adopted by the entirety of the interested population. On a plot of cumulative adoption (as opposed to rate), the curve takes an "*r*" shape.

In the Northeast quadrant, we expect better options to follow smooth diffusion curves, but also, once options have reached an appropriate level of popularity, to remain at that level (Bentley 2008; Kandler and Laland 2009). In the Southwest, where agents are simply guessing, we expect popularity to jump unpredictably from one time period to the next. This contrasts with the Southeast, where change through time should be stochastic rather than random. By stochastic we mean that the best predictor of popularity in the next time period is the popularity in the current time period. More specifically, the neutral model predicts that the only source of change in variant frequencies over time is random sampling, such that $V = v(1 - v)/N$, where V is the variance in frequencies over time and $v \leq 1$ is the relative frequency of a variant as a fraction of N, the maximum possible number of variant copies per generation. Salganik et al. (2006), for example, demonstrated in a controlled experiment that music-downloading behavior is herdlike and unpredictable when users are allowed to see what others are downloading. With many choices and many interacting choosers, work of quality had barely more chance than any other of being selected.

4 Conclusion

Here we have presented a conceptual map of human behavior as a way of providing a heuristic characterization of available real-world data. Once the map is established and well explored, we can then move into unknown territory by adding, incrementally, new and existing models with additional parameters. The potentially large number of possibilities requires us to think through carefully what these new parameters might be. If we take the undirected-copying model, for example (Southeast), introducing a parameter to represent the salience of discernible quality of different ideas should bring the resulting patterns closer to the S-curves of the Northeast quadrant. In other words, starting with neutral variants and slowly increasing the discernible differences in the quality of choices should decrease turnover, increase predictability, and make population size more important. Another variation to add could be network structure, or specific spatial structure, as is the case for many alternative models.

All of this is excellent material for discussion, especially concerning the future of “quality” as opposed to mere popularity. Given our species’ evolution in small groups, many of the communication technologies developed over the centuries—urban settlements, postal services, telephones, the Internet—have served to keep our personal worlds clustered and familiar—on the left side of the space—with fewer acquaintances to connect us to the rest of the world. In terms of the map, these communications may have helped us parse a world trending toward the Southeast into an interconnected montage of personal worlds in the Northwest. The interesting question lies in the balance of local influences amid far-reaching networks. Ideally, the population selects something for its demonstrable superior quality—the “wisdom of crowds” effect. In reality, of course, the result reflects the extraordinary social nature of our species and our ability to learn from each other.

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