

The Multilevel Model of Meme Diffusion: A Synopsis

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As genes are to the transfer of biological information from one organism to another, memes are to the transfer of cultural information from one organism to another. A meme is an act or set of acts that has information capable of replication. That is, memes are messages that are capable of imitation (i.e., copying) and reproduction (e.g., re-tweeting). Memes are hypothesized as the basic mechanisms of cultural transfer over time and space. Any digital message transferrable across media is, by definition, a form of meme. Memes, therefore, comprise a version of signs, texts, ideographs, and tropes (Hoeken, Swanepoel, Saal, & Jansen, 2009; Johnson, 2007; Kilpinen, 2008; Shifman, 2014; Tyrkkö, 2007) and memetypes (Shifman, 2013; Wiggins & Bowers, 2014). The process of memetic diffusion is characterized by repetition, variation (Segev et al., 2015) and fitness selection (Blackmore, 1999; Henrich, Boyd, & Richerson, 2008; Spitzberg, 2014).

Mememes and Memetypes

Mememes are distinguished from everyday face-to-face communication by the extraordinary difficulty of serial replication of such ephemeral nonverbal and oral verbal messages. Information fidelity is degraded through replication, due at least to noise in the system as well as source modification (Brodie, 1996; Elfering et al., 2012; Nahari, Sheinfeld, Glicksohn, & Nachson, 2015; Warren & Woodall, 1999). Even direct quotations reveal substantial rates of mutation in social media propagation (Simmons, Adamic, & Adar, 2011), and some memetic features of messages and groups may be more generative and adaptive in sustaining propagation than others (Spitzberg, 2014; Wiggins & Bowers, 2014). Although some oral traditions can sustain high degrees of fidelity (Showren, 2014), in general, cultural transmission tends to be a dynamic process in which nonrandom representations and reframing of issues help promote and maintain cultural diversity and stability (Acerbi & Mesoudi, 2015, p. 483). Whereas genes reproduce with endogenous sources of errors in the process of self-replication, they also experience exogenous (i.e., environmentally induced) alterations across their development (Ségurel, Minyoung, Wyman, & Przeworski, 2014). Mememes are far from an exclusive propagator of culture, but in a digital age have the potential to represent a major driver of cultural maintenance and evolution (Heylighen & Chielens, 2009; Wang & Wang, 2015; Wiggins & Bowers, 2014).

The multilevel model of meme diffusion (M³D) outlines the meme diffusion process as a function of six levels of facilitating or impeding factors (Spitzberg, 2014): *meme level* (i.e., message factors, such as distinctiveness, redundancy, simplicity, media convergence, richness), *source level* (i.e., motivation, knowledge, skill, credibility, centrality/proximity, adaptation to media), *structural network level* (i.e., past memes, number of connected nodes, network interdependence, centrality, structural homophily), *subjective network level* (i.e., counter-memes, frame or narrative fidelity, subjective homophily, relative informational advantage, cascade thresholds), *societal level* (i.e., rival social networks, counter-memes and –frames, diffusion stage, mitigating publicity or issue emergence, media accessibility), and *geotechnical level* (i.e., system limitations, geospatial scope or span, proximity, etc.). To illustrate these levels in a particular medium, the diffusion of information in Twitter is affected by each of these levels: the meme level (e.g., tweets with fear-eliciting words may diffuse more than more neutrally-worded tweets), the source level (e.g., tweets from a government authority or celebrity may diffuse more than tweets from an average citizen), the social network level (e.g., tweets shared in dense

social networks diffuse more rapidly within that network than in dispersed networks), the societal level (e.g., tweets that have strongly competing news events, such as Zika tweets during a political campaign, may diffuse less extensively unless they can be tied into the competing topic frames), and the geotechnical level (e.g., tweets diffuse more readily in developed communities with high technology adoption). Factors at each of these levels facilitate or impede meme diffusion, and the influence of a given meme can be indexed according to outcome criteria such as its diffusion span (i.e., popularity), diffusion velocity, longevity, fecundity (i.e., spawning new mutated or altered versions of the original meme; Adamic, Lento, Adar, & Ng, 2014; Segev et al., 2015), and the outcome or effect(s) on the outcome(s) of interest (e.g., policy change, election outcome, product purchase, social movements, etc.).

These levels and memetypes obviously interact with one another, and there will be complex interdependencies (e.g., variable suppression, nonsummative interaction effects) among variables across levels. For example, Sundaram, Xie, Choudhury, Lin and Natsev (2012) developed an objective measure of text “interestingness,” which indexed the degree of conversational activity, cohesiveness, and thematic similarity generated around that text. A by-product of that measure is that it also provides a metric for assessing a given node’s or source’s interestingness. Shubeck and Huette (2015) found that linguistic features at the meme level (i.e., meme length, template vs. copy-and-paste or game, & swear words) appear to interact with network structure to influence meme propagation. Other research has found that innovation adoption of Twitter itself depends on both social (friendship) networks and spatiotemporal location (Toole, Cha & González, 2012), and that both message (meme) features and social network structures (i.e., number of followers) influence the propagation of tweets during crises (Sutton et al., 2015).

Several typologies of memes have been proposed (e.g., McFedries, 2011; Segev et al., 2015; Shifman, 2013, 2014; Shubeck & Huette, 2015). M³D conceptualizes three types of intersections between social media and realspace events. *Evememic* (i.e., event origins) episodes represent situations in which events in realspace elicit a strong signal in cyberspace, such as when a measles outbreak generates a high amount of Twitter traffic. *Etymemic* (i.e., word origins) episodes represent situations in which social media evoke noticeable individual or collective action in realspace, such as when social media spread sufficient fear of vaccinations to result in significant personal exemption behavior. *Polymemic* episodes represent situations in which these two forms of interaction synergize activity, such as when memes promote nonvaccination rates that facilitate disease outbreaks that in turn generate both expanded social media and political activity regarding vaccination policy.

Meme Dynamics

Fitness/Adaptiveness

At the micro-level, the M³D proposes that there are processes that influence the repetition, variation and selection of memes. Collectively, these represent the diffusion of memes throughout society. At the macro-level, again following the evolutionary metaphor, the diffusion of memes is likely to be influenced by principles of fitness, adaptability and survival (Adamic, et al., 2014). Simplifying the “unit of selection” debate, evolution may be primarily driven at the gene or cell (i.e., meme) level, individual (source or sender) level, the behavioral or group level, or the macro-evolutionary or taxonomic (cultural or structural) level (Lloyd, 1994). In parallel manner, the M³D proposes that memes, as forms of information, occupy a broader information environment in which fitness is influenced by adaptation to the availability of attention as a scarce resource (Simmons et al., 2014). For example, “most events and public speeches or debates have a half-life of impact measured in days” (Neuman, Guggenheim, Jang, & Bae, 2014, p. 203). A study of the carrying capacity of Twitter in responding to significant societal events found that Twitter is less constrained than traditional media (i.e., Twitter

traffic is elastic in volume and duration to realspace events). However, Twitter message production sometimes increases, and sometimes decreases, in response to events, suggesting constraints not only in production, but in user attention capacity (Jang & Pasek, 2015). Other research finds that globally individual memes compete with each other in an organized manner within a given time frame (Leskovec, Backstrom, & Kleinberg, 2009). This organized competition results in patterns of change while reflecting a tendency of new sources to mimic each other's choices to focus on specific topics, simultaneously favoring the new and penalizing old content (Leskovec et al., 2009). Think of the expression regarding a presidential candidate's activities "sucking the oxygen out of the room," suggesting a limited capacity for the informational oxygen in a given timespan and environment. Furthermore, certain information processing institutions may represent greater constraints than others. For example, "in 10 years, Congress went from receiving 30.5 million pieces of communication to 491.6 million" (Shogan, 2010, p. 231). Such deluged information domains face extreme competition for attention.

Thus, memes occupy information niches based on their fitness to the adaptive demands of attention-gaining dynamics. Novel, competently constructed, credible, useful memes are likely to be more adaptive to gaining and maintaining attention in the information environment. But different social network, societal, and geo-technical features of information environments present adaptive facilitations or challenges to any given meme's survival, and influence the evolution of the meme over time (Wiggins & Bowers, 2014). Furthermore, family resemblances among memes (McFedries, 2011; Segev et al., 2015) and the nature of bursts in certain topics (Eom, Puliga Smailović, Mozetić, & Caldarelli, 2015; Sasahara, Hirata, Toyoda, Kitsuregawa & Aihara, 2013) reveal parameters of collective attention that represent information ecology pressures on meme fitness.

Attention Competition

Among the macro-level principles that may be imported into the theoretical model is Wilson and Wilson's (2007, p. 345) axiom that "selfishness beats altruism within groups. Altruistic groups beat selfish groups. Everything else is commentary." Within groups or social networks, memes (and their authors) compete for prominence and status, but when a given homogenous group or network is competing against another group for prominence or status, groups with cooperative memetic dynamics (i.e., coherence, consistency of message content and sentiment) are expected to compete better than groups experiencing intragroup entropy, chaos or competition. Within any domain or issue-based electronic agora, any host of [online] co-occurring cultures or cultural subgroups are competing with each other for users' attention (Mocanu, Rossi, Zhang, Karsai, & Quatrociocchi, 2015). Within a group, a meme achieves dominance when it confers greater fitness to its group members or intended message(s) compared to other memes (Friedman & Singh, 2004). As such, certain groups reinforce the status of some memes more than others because they offer the group a competitive advantage relative to competing groups and their memes. In any broad and heterogeneous information ecology or agora with limited attention and information-processing capacity, memes seek to establish a foothold in the attention space available, and in the process, either hybridize with, or displace, existing memes (Domínguez, 2015; Leskovic, Backstrom & Kleinberg, 2009; Shifman, 2014; Weng, Flammini, Vespignani, & Menczer, 2012). As memes struggle with one another to garner the greatest amount of attention (Gleeson, Ward, O'Sullivan, & Lee, 2014), the more constrained the attention span and capacity, the more likely that new memes achieve such footholds through a process of displacement of existing memes (Weng, et al., 2012). Information regarding health is certainly becoming a very densely populated information ecology. Estimates currently place the rate of the world's present information as doubling every 11 hours, taking the competition for attention among health-related content to unprecedented levels (Macario, et al., 2011).

An excellent example of the constant need to compete for the limited attention of audiences comes from agent-based modeling of news cycles. These models suggest that news waves are primarily driven by journalists' adaptive reporting behavior, moderated by support activities of sponsors, who are agents with a direct interest in the issue, who continuously compete for audiences' attention (Waldherr, 2014, p. 854). There is a dynamic and reciprocal influence in achieving competitive attention between media coverage and social media reference (Guggenheim, Jang, Bae, & Neuman, 2015). Both issue fatigue and issue competition can contribute to meme displacement, extinction, or de-speciation (Djerf-Pierre, 2012). In addition, exogenous events and societal responses to an issue can create punctuated equilibrium effects on issue attention over time (Holt & Barkemeyer, 2012), similar to models of macro-evolutionary development (Workman, Jones, & Jochim, 2009). An examination of 2.3 million Facebook users (Italy) found that patterns of attention are fairly consistent across qualitatively different types of information, suggesting that unsupported claims and misinformation can persist as long as more evidence-based information (Mocanu et al., 2015). Such features suggest certain laws governing an informational life span that reveals a decrease in attention over time (Wu & Huberman, 2007, p. 17599; see also Leskovec, et al., 2009; Zubiaga, Spina, Martínez, & Fresno, 2015). These findings also suggest that the vast majority of memes are likely to last a relatively brief time, but may emerge cyclically, or may sustain a meme-family (i.e., cluster of thematically similar or related memes; see: Segev et al., 2015).

Agenda-Setting & Structuration

To the extent that memes are culturally structural (Wiggins & Bowers, 2014), their role in reflecting, agenda setting, and influencing public policy becomes a potentially fecund arena for social media surveillance. Provider-based interactions, institutional/policy mandates, personal/parental beliefs, social/environmental factors (e.g., media coverage) and perceived norms all are factors likely to affect parental decision-making in regard to vaccines (Sturm, Mays, & Zimet, 2005, p. 442). Although over 85% of scientists believe that childhood vaccines such as MMR should be required, only 68% of the general American public agrees (Pew Research Center, 2015 July), and up to a quarter of vaccination-related websites are anti-vax in sentiment (Kata, 2010). Among those who explicitly believe that vaccines are unsafe for children, the objections and bases for such beliefs appear heterogeneous (Pew Research Center, 2015, Feb.), and therefore not susceptible to a univocal public health campaign message strategy. Given the diverse nature of beliefs and opinions about vaccination policy, the importance of the health consequences of herd immunity and public compliance with vaccination objectives, and the degree to which such opinions may be accessible through social media, vaccination policy appears to be an ideal arena in which to explore the interface between social media and social policy. A case study that seeks insight into the intersection between the vax populi expressed in social media, and the passage of the California SB 277 vaccination requirements in 2015 should offer various analytic windows into the nature of vaccination opinion expression and diffusion in social media, and the correspondence of such opinion, or lack thereof, with subsequent public policy.

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