What's the Folk Theory?

Reasoning About Cyber-Social Systems

ABSTRACT

The present paper explores people's folk theories of cyber-social systems by identifying the metaphors people hold and then analyzing them semantically for underlying attitudes and beliefs. In Study 1 ($N = 3375$) we use a novel method for eliciting metaphors for how people understand the Facebook News Feed and Twitter. In Study 2 ($N = 1547$) we used factor analysis to aggregate these metaphors into underlying folk theories for both Facebook and Twitter. In Study 3 ($N = 1597$) we replicate the factor analysis from Study 2 and examine the semantic dimensions for each of the folk theories across these two cyber-social systems, finding that there are four primary folk theories that people hold for the News Feed and Twitter: the *rational assistant*, the *unwanted observer*, the *transparent platform* and the *corporate black box*. The implications of identifying and understanding these folk theories for these cyber-social systems are discussed.

People constantly interact with complex systems that require them to understand, reason, and predict how that system will work, from how gravity operates to theories of how other people's minds work. To interact with these complex systems, people develop folk theories that guide their thoughts and actions. For example, understanding how gravity works is crucial for moving safely through the world, though few people have a grasp of the physics of gravitational forces. Similarly, understanding how other people might feel or think about a situation is important for predicting how someone might react to that situation, though few people are versed in neuroscience (AUTHORS, 2010; Malle, 2011).

People must now also interact with complex cyber-social systems, which refer to digital technologies that "facilitate, enhance, and scale human endeavors" (Stanford Cyber Initiative, 2014). These cyber-social systems take on a wide variety of roles and functions. They can act as a telephone operator facilitating human interaction, as in the case of social network sites like Facebook that support communication between people in a social network. They can act as a helpful friend by providing recommendations, as in the case of Amazon and Netflix suggestions for books and movies. They can act as a boss assigning work, as in the case of Uber or TaskRabbit. And these cyber-social systems are highly complex and sophisticated, often involving massive amounts of data and complex computational processes.

The adoption of cyber-social systems into daily life raises questions about how people conceptualize and differentiate the roles and operation of such systems. Research to date has begun to examine how systems that draw on data and algorithms function as a social and cultural force (Gillespie, 2014; Sandvig, 2015). While this effort has made

more salient the presence of algorithms and the complexity of cyber-social systems, it remains unclear how users model cyber-social systems governed by algorithms and other computational processes in their social lives.

There are several important motivations for understanding how people reason about cyber-social systems. First, how do people understand the way in which communication behavior and activity is organized on social network sites, such as Facebook or Twitter? A user's beliefs about social network sites can help explain why people behave in certain ways, advancing theories of communication that focus on how people interact with one another, such as computer-mediated communication, as well as with technology, such as human-computer interaction. Second, technology design is enhanced when a user's reasoning about the technology is understood and incorporated in the design process (Norman, 1988). Third, understanding a user's expectations regarding how a system allows that user to interact with other users, such as disclosing information on a social network site, can help a system avoid violating those expectations.

In the present study we use the notion of folk theory as a way to model how people reason about cyber-social systems and we develop a multi-step paradigm for discovering, identifying and specifying folk theories. The first phase elicits metaphors about a system by using a wikisurvey, a collaborative form of survey that allows respondents to submit their own metaphors about a system. The second step uses factor analysis to identify underlying folk theories for the metaphors obtained in phase 1. In the third phase we analyze the primary dimensions along which folk theories can be defined by examining semantic differentials for each folk theory relative to other folk theories. We apply this paradigm to examine the folk theories people hold about components of

two important cyber-social systems, the Facebook News Feed and Twitter Feed, and we compare and contrast the folk theories for these two systems.

Folk theories and Conceptual Metaphors

One's understanding of a technology or interface has been referred to by a range of terms in the literature, including schema, mental models, and folk theories. Mental models, a concept commonly employed in HCI research, refers to the mental representations of how a person believes a system operates developed through interaction and previous experiences with the system (Norman, 1988). This model is then used to reason, predict, and explain the system's behavior.

Folk theories, in contrast, refer to a person's intuitive, causal explanation about a system (e.g., another human's mind, gravity, etc) that guide their thoughts, beliefs, and actions with that system (Gelman & Legare, 2011). Although folk theories and mental models are conceptually similar, we argue here that folk theories are more appropriate for modeling how people reason about cyber-social systems. First, the intuitive nature of folk theories highlights that people's understanding is often imprecise and not consciously recognized, while the causal and explanatory nature of folk theories highlights that people's mental representation of technology is not a cognitive blueprint of the relationship between inputs and outputs, but rather an implicit collection of beliefs about the system.

Second, folk theories can account for beliefs beyond simply about how the system works, but also beliefs about the company behind the cyber-social system, their goals, and how their goals influence the system as a whole. These broader beliefs are influenced by how the company describes their system. For example, Google has described their

search algorithm as a robotic nose (Sandvig, 2015). Folk theories can therefore account for how popular discussions, such as news coverage, can influence a person's beliefs about a system. For example, discussions about twitter feeds becoming algorithmically-curated was a wide-spread topic that may have influenced people's folk theories about Twitter, separate from any specific interaction with the Twitter system (Isaac, 2016). In contrast, a mental model approach to understanding a system represents how people expect the system to behave when interacting with it. Folk theories, as collection of beliefs and attitudes formed through many sources, represent thoughts about the system as a whole.

It is important to note that the folk theory approach does not assume that users hold faulty theories that require training in order to correct. Instead, this framework emphasizes that users intuitively hold informal beliefs about a system that are developed, tested, and re-evaluated through their interactions with technology and exposure to the media. Rather than a deficit approach, in which users are assumed to not know what they are doing, this approach emphasizes that people regularly develop folk theories to make their way through the world.

Sease (2008) notes that metaphors can act as a bridge between these unstated and intuitive beliefs and our verbal capacity, helping frame complex, abstract objects and processes in familiar terms. Lakoff and Johnson (1980) argue that people's conceptual system is largely metaphorical in nature, and these metaphorical concepts imply something about how we think about the world. In western cultures, people say something is a "waste of time" because they value time as a commodity. Eliciting

metaphors about particular systems can unearth underlying folk theories that a person holds regarding the system.

Given the complexity and abstract nature of many cyber-social systems, metaphors play an important role in the interaction and design of technology as well. Interface metaphors are commonly used to make interface design intuitive (Barr, Biddle, & Noble, 2002). For example, the send button for e-mail has been modeled after a letter to evoke an "e-mail as postal mail" metaphor, where users implicitly know that the message is being delivered to their recipient as it would via a postal system (Sease, 2008). Similarly, computer menus have been modeled after restaurant menus, drawing from a familiar script of viewing options and making selections to facilitate user interaction (Norman & Chin, 1989).

Anderson (1992) argues that the metaphors elicited by technology should not only reflect the interface, as described above, but also the inner workings of a system. However, much of the prior research has focused on what metaphors can facilitate successful navigation of a system. This work fails to take into account how people reason about how systems work and the social nature of people's goals when using cyber-social systems.

The study of folk theories and conceptual metaphors obviously predate computational systems. Folk theories help people navigate the world and interact with others. People hold folk theories about what underlies the actions of others, something that is ultimately unknowable and likely a result of a complex set of variables. However, to accomplish this task, people first evaluate behavior as intentional or unintentional (Malle, 2011). If a person was to trip over another person's foot, this action can be

perceived as intentional (i.e. the person meant to trip the other) or as unintentional (i.e. it was just an accident). The chosen folk theory shapes subsequent interactions, perceiving the person as malicious or as simply clumsy. Perceiving this event as malicious will have important social consequences, as the viewer is less likely to trust or interact with the target person. This is simply one example of how one's folk theory of intentionality can guide future interactions. In the same way, people's folk theories of technology should guide their interactions with the system.

Folk Theories and Cyber-Social Systems

Researchers have begun to identify the ways that people reason about algorithms in a variety of domains. Research on work management algorithms, for example, found that drivers for Uber, a car-sharing application, rejected and accepted drive assignments based on if the algorithm's decision made sense to them, even accepting inconvenient assignments as long as they believed they understood the reasons behind the decision (Lee, Kusbit, Metsky, & Dabbish, 2015).

Work on people's understanding on the Facebook News Feed, a content curation algorithm, found that many users first noticed the algorithm when certain expectations were violated, such as posts that were not presented in chronological order or their friends mentioned a post they had never seen (Rader & Gray, 2015). When expectations were violated, users often speculated about the algorithm, constructing theories about what the News Feed was trying to show them (e.g., interesting posts), or how it was making its decisions (e.g., I see posts by people I comment on) (Eslami et al., 2015).

Building on this initial work, Eslami et al (2016) outlined a detailed a list of folk theories users have about how the Facebook News Feed organizes their content. In their

sample, less than half of participants were aware that the News Feed was filtered at all by an algorithm. Amongst the people that were aware, people held a variety of theories about the factors that were important for the algorithm. A large proportion of people held a personal engagement theory, where people proposed that one's own behavior was important to the algorithm, such as the posts people liked and commented on. Another common folk theory proposed that the type of post was important, where text, video, or images were prioritized. Some users proposed that other people's behaviors and interest were important, holding a global popularity theory where posts that got a large amount of engagement was prioritized. Finally, some people thought that the algorithm considered the similarity between users rather than behavior, which the authors referred to as a narcissus theory, in which people with similar interests were prioritized. Overall, this study highlights that users form beliefs about how a cyber-social system works, and those beliefs can be quite concrete even if often unstated.

The Folk Theory Paradigm for Cyber-Social Systems

We build off of this initial work by developing a folk theory paradigm to understand how users make sense of cyber-social systems, with a focus in the present study on two social feed systems, the Facebook News Feed and the Twitter Feed. Twitter and Facebook, as social network sites, support similar functions and have similar affordances. They both establish connections between people via friends or followers, provide a form of self-representation via a profile or bio, and afford the sharing of information between people via status updates or tweets, and aggregate that sharing into some sort of feed for users (boyd & Ellison, 2007). However, these platforms differ in important ways. Primarily, they differ in underlying infrastructure that aggregates

information into a given user's feed. Twitter's feed is organized primarily chronologically, with the most recent tweets of followed users presented first. Twitter will collapse tweets into a "Show Me More" and button to reduce content overload and "Tweets you may have missed" to surface older content. In contrast, Facebook's News Feed is determined by a proprietary algorithm that ranks content based on a number of factors, such as how frequently a post has been liked or shared, how popular the poster is, how frequently a user reacts to content from that poster, amongst others (Oremus, 2016). How do people reason about these two different cyber-social systems, both of which are designed to share and communicate social information?

The paradigm we have developed for discovering and identifying folk theories involves three phases. The first is the *Metaphor Discovery Phase* that involves eliciting metaphors that fit users' understanding of a cyber-social system. We accomplish this task with a novel type of survey that allows users to suggest their own metaphors. The second phase is *Folk Theory Identification* which involves factor analyzing the metaphors elicited in phase 1 to identify the underlying folk theories that capture the variance in the metaphors. The last phase is *Folk Theory Specification* in which we use semantic differentials to characterize the folk theories identified in phase 2 in order to understand the key properties of each folk theory. We conduct one study for each phase, with independent samples for each of the two cyber-social systems.

METAPHOR DISCOVERY

To discover the metaphors that people hold about social feeds we used a novel class of survey instrument, called a wiki-survey, that allows for contributions from participants. This survey approach follows three general principles that make it ideal for

discovering metaphors: 1) greediness, adaptivity and collaborativeness (Salganik & Levy, 2015).

Collaborativeness refers to permitting respondents to provide new information that may not be anticipated by the researcher. Importantly, unlike traditional surveys that provide an "other" box, any new information from respondents is then presented to future respondents for evaluation. Thus, the survey construction is partially created by its respondents, making ideally suited for exploring the kinds of folk models that people use when they think about visibility mechanisms.

Greediness refers to capturing as much or as little information as a respondent is willing to provide, rather than collecting the set amount of information from each participant with a standard survey. Following successful aggregation projects, like Wikipedia, wikisurvey permits a participant to respond as many times as they like. This approach collects much more information from heavy contributors, the "fat head," and from light contributors, the "long tail," that is often left uncollected in traditional surveys

Adaptivity refers to an instruments ability to continually optimize to elicit the most useful information given what is already known from responses. That is, while traditional surveys are static in their order, an adaptive survey instrument can maximize the amount of information that can be learned from each respondent.

While each of these principles increase the complexity of data analysis, the efficiency of adaptivity, the increased information derived from greediness and the open nature of collaborative surveys make wikisurveys an excellent choice for discovering metaphors associated with folk theories of cyber-social systems.

METHODS

Participants

Participants were recruited from Mturk and paid $0.50 for participating. For the Facebook sample, 1471 people voted 46,914 times. For the Twitter sample, $N = 1{,}904$ people voted a total of 39,487. The median number of times a participant voted on the Facebook wikisurvey was 9 and on Twitter was 6. Note that the All Our Ideas website did not allow for the collection of demographic data.

Procedure

We used Salganik & Levy (2015)'s All Our Ideas wiki-survey to ask participants "What is the best metaphor for how the Facebook News Feed [Twitter Feed] selects and orders your content?" Participants were presented with two metaphor options in a head-to-head comparison, or they could choose to submit their own response that then enters that metaphor for future voters. Note that for both the Facebook News Feed and Twitter samples we seeded the wiki-survey with 13 initial metaphors (decision tree, coin sorting, butler, night club bouncer, recipe, water filter, black box, input-output, rube Goldberg, magic, dominos, lock, and e-mail).

The format of the wiki-survey options included the metaphor and a one sentence elaboration. For example, a participant could choose option A (e.g., black box – you put some input in and some output comes out) or option B (e.g., coin sorting – types of content are sorted and responded to if they meet set criteria) or they could enter their own response (e.g., Stalker – watches everything you do). Subsequent participants would then see this new option in future pairwise comparisons.

After a choice was made, a new pair-wise comparison between two metaphors is automatically generated from the full response list, which included the seed metaphors

and the participant-generated metaphors. Participants were only asked to complete one pairwise comparison, but were free to continue if they wished.

RESULTS AND DISCUSSION

The All Our Ideas survey uses responses to construct an opinion matrix, and summarizes the matrix to calculate the probability that any response would be chosen over a randomly chosen option by a randomly chosen respondent (for review see Salganik & Levy, 2015). The top ten metaphors for each platform are presented in Table 1 with their probability of winning a random head-to-head comparison (with 0.50 being equally likely to win or lose).

The metaphor discovery procedure elicited 30 metaphors from participants in the Facebook wiki-survey. This procedure elicited 32 metaphors from participants in the Twitter wiki-survey. Of the top metaphors, seven out of ten (7/10) for Facebook and seven out of ten (7/10) for Twitter were submitted by users. The fact that the majority of the top metaphors were user-generated highlights the benefit of using collaborative surveys that combat researcher assumptions about how people think about technologies.

Amongst the top ten metaphors for the Facebook News Feed, several themes are apparent. First, the inclusion of personal shopper and personal assistant suggest beliefs that the News Feed is in some way personalized. The explanations included for these metaphors were “choosing and offering just the content I am most likely to interact with” and “presents things that are important to you,” respectively.

The inclusion of mass media platforms, such as Magazine and Network T.V., highlights that for some users the News Feed has features similar to broadcast media, where content is curated for general appeal, and then users have freedom to choose which

content they engage with. The explanation included for Network T.V., was " they pick what you see and you decide what to watch." Similar beliefs inspired the metaphor, "Menu," which included the explanation "provides the options and you can only select from those offerings."

In addition to metaphors that highlight the subjective nature of the News Feed, the top ten also included metaphors that highlight the rational, rule-based nature of algorithms, such as coin sorting and decision tree. In stark contrast to some of the more positive metaphors, such as personal shopper, and rational metaphors, several metaphors had deeply negative connotations that highlight beliefs about the invasions of privacy, asymmetric access to information, and use of information for other people's gain, such as spy, stalker, and paparazzi.

Though the top metaphors of the Twitter Feed are very different from those elicited for the Facebook news feed, there are several similar themes. Some of the Twitter metaphors also had negative connotations, such as bad assistant, chaos, train wreck and mess similar to the paparazzi, spy, and stalker of the Facebook News Feed. However, the negative metaphors for Twitter focused more on the poor quality of the feed, rather than the intrusiveness of the negative Facebook News Feed metaphors.

While several metaphors for Facebook focused on personalization (personal shopper, etc.), several metaphors for Twitter focused on a linear process, such as queue, chain reaction, and dominos. Other metaphors for Twitter described objects that branch off in several directions, such as spider web, highway, and tree that were not surfaced for the Facebook News Feed. This may suggest that Twitter is seen as a platform that

presents content in an ordered fashion, that trails off in different directions, while Facebook is seen as a more curated collection of content that is supposed to interest users.

FOLK THEORY IDENTIFICATION

The next phase in the folk theory paradigm is to identify folk theories that underlie these metaphors. Recall that our use of metaphors was designed to uncover the intuitive but typically unarticulated folk theories of cyber-social systems. In this phase we use the metaphors discovered in the discovery phase to tap into implicit underlying folk theories about each system. To identify these underlying folk theories of each platform, we conducted an exploratory factor analysis on people's agreement that Facebook or Twitter is like a given metaphor, and we then applied factor analysis to identify metaphors that factor together and represent an underlying folk theory.

METHODS

Participants

We recruited respondents using Amazon's Mechanical Turk. MTurk workers were exclusively from the USA who were paid $0.50 for participating. Our Facebook sample was N = 758 (56% female, 1% other), with 70% white, 5% Black or African American, 5% Hispanic or Latino, 8% Asian and the remainder indicated bi- or multi-racial. The average age was 33.65 (*SD* = 10.42). Our Twitter sample was *N* = 799 (49% female), with 73% white, 8% black or African American, 7% of Asian descent and the remainder indicated bi- or multi-racial. The average age was 33.65 (*SD* = 10.42).

Procedure

Participants were directed to a Qualtrics survey, where they viewed a consent form explaining the study. If they decided to participate, they were asked to rate how

much they agreed with each of the metaphors from Phase 1 that had a probability of winning 0.50. Each metaphor was rated on a Likert scale of 1 (strongly disagree) to 7 (strongly agree). In total, there was 28 metaphors for Twitter and 23 metaphors for Facebook. The items were formatted as "The Facebook News Feed [Twitter Feed] is like a [Metaphor]." These ratings were used to identify the common latent constructs underlying the diverse range of metaphors discovered in Study 1 for the two systems.

RESULTS AND DISCUSSION

To identify the underlying folk theories for each platform we conducted an exploratory factor analysis on people's agreement that Facebook or Twitter is like each metaphor, where latent factors were conceptualized as latent folk theories. The first step was to determine how many factors should be extracted. A common method in determining the appropriate number of factors uses the number of eigenvalues greater than one. However, relying on eigenvalues is known to overestimate the number of latent factors. Previous work has established that parallel analysis provides the most accurate number of underlying factors (Henson & Roberts, 2006). Parallel analysis is a method that creates a random dataset with the same numbers of observations and variables as the original data. When the eigenvalues from the random data are larger than the eigenvalues from the factor analysis then the factors are mostly random noise. Parallel analysis indicated that there were four latent factors for both Facebook and Twitter.

The factor analysis was conducted with a varimax rotation, and the factor loadings were examined to determine which metaphors loaded together. Given the exploratory nature of this work, metaphors that loaded greater than 0.35 on a single factor and loaded less than 0.30 on the rest of the factors were kept.

For Facebook, three metaphors were dropped because they didn't load on any factors. Two metaphors were dropped because they loaded on multiple factors. Seven metaphors loaded on factor 1; four metaphors loaded on factor 2; three metaphors on factor 3; and three metaphors on factor 4. For Twitter, five metaphors were dropped because they didn't load on any factors. Five metaphors were dropped because they loaded on multiple factors. Ten metaphors loaded on factor 1; Five metaphors loaded on factor 2; Three factors loaded on factor 3; Two metaphors loaded on factor 4 (see Table 3).

To measure the extent that people held each folk theory, we averaged agreement ratings across the metaphors included in each factor separately. This resulted in each participant having a separate score for each of the four factors for either Facebook or Twitter. The most strongly held factor for Facebook included metaphors for traditional content providers, such as platform, network T.V., and magazine ($M = 4.50$, $SD = 1.03$). The second most strongly held factor consisted entirely of the negatively metaphors, such as spy and stalker ($M = 4.27$, $SD = 1.33$). The third mostly strongly held factor included metaphors for objects that needed work put into them such as untended garden and jigsaw puzzle ($M = 3.66$, $SD = 1.27$). Finally, the least strongly held folk factor for Facebook included personal help and process-based metaphors such as personal assistant, butler decision tree, and coin-sorting ($M = 2.83$, $SD = 1.05$).

The most strongly held factor for Twitter included metaphors for linear processes such as input-output, chain reaction, and dominos ($M = 4.50$, $SD = 1.22$). The second most strongly held factor consisted of all of the negatively-valence metaphors about Twitter, including bad assistant, chaos, and mess ($M = 4.18$, $SD = 1.32$). The third most

strongly held factor included two metaphors that revolved around organizing objects including coin sorting and egg sorting ($M = 3.57$, $SD = 1.41$). Finally, the least strongly held factor for Twitter included a diverse range of metaphors that included metaphors around choice, such as decision tree and flower picking, but also more whimsical metaphors such a time traveling and gift ($M = 3.29$, $SD = 1.016$).

FOLK THEORY SPECIFICATION

In the final phase of the paradigm, folk theory specification examines the attitudes and beliefs associated with each of the folk theories identified in phase two. There were four primary dimensions we were interested in assessing for each folk theory of the social feeds. *Overall evaluation* measured the valence of a folk theory with respect to the social feed, which was measured with seven semantic differentials that tapped perceived utility and personal meaning of the feed, such as useless-useful, unimportant-important, meaningless-meaningful, where higher values indicate more positive evaluations.

Extent of control measured the degree to which a folk theory was associated with perceived transparency of the feed, and perceptions surrounding the ability to influence the content of the feed. Extent of control consisted of three semantic differentials that measured how easy it is to influence the feed, clarity of how the feed works, and the extent of control that the feed allows, where higher values indicate higher levels of perceived control.

Dependence on behavior measured the extent to which a folk theory holds that behavior, either by the user or by others in their network, influence the social feed. This dimension consisted of two semantic differentials that measured beliefs about whether

the feed is influenced by behavior, where higher values indicate the feed is dependent on behavior.

Bias towards the company measured the degree to which a folk theory holds that social feeds favor the user's interests or whether the social feed is biased towards the company that hosts them. Bias towards the company consisted of six semantic differentials consisting of beliefs about whether the feed prioritizes users or company's interest, beliefs about use of personal data, extent that the feed understands them, extent that the feed represents personalized or general interests and finally, extent that the feed is considered biased opposed to unbiased, and emotional opposed to rational, where higher values indicate perceived biased processing favoring the company; and

Level of curation measured the extent that folk theories assume that the feed use algorithms to filter people or content types. In this measure, there were four semantic differentials that measured the variety of content types shown, variety of people shown, proportion of content shown, and valence of content shown, where higher values indicate beliefs that the content is unfiltered.

METHODS

Participants

We recruited respondents using Amazon's Mechanical Turk. MTurk workers were exclusively from the USA who were paid $0.50 for participating. Our Facebook sample included 758 (57% female, 1% other) people, with 81% white, 5% Black or African American, 5% Hispanic or Latino, 8% Asian and the remainder indicated bi- or multi-racial. The average age was 32 (SD = 9.65). Our Twitter sample included 839 (53%

female) people, with 70% white, 7% black or African American, 7% of Asian descent and the remainder indicated bi- or multi-racial. The average age was 34.95 (*SD* = 11.82).

Procedure

Just as in the identification phase, participants rated how much they agreed with each of the metaphors that loaded sufficiently in the identification phase. Each metaphor was rated on a Likert scale of 1 (strongly disagree) to 7 (strongly agree). The items were formatted as "The Facebook News Feed [Twitter Feed] is like a [Metaphor]."

In addition to indicating the strength of their agreement with each of the metaphors, participants also rated either Facebook News Feed or Twitter Feed on the five dimensions described above that included overall evaluation of the feed, extent of control over the feed, extent that the feed is influenced by behavior, extent that feed works in the company's interest, and finally, extent that content shown on the feed is curated. The reliability of the items for each index was acceptable and are described in Table 4.

Using the same process to measure folk theories as in the identification phase, we examined how the strength of each of the folk theories is associated with beliefs and attitudes about either the Facebook News Feed or Twitter using these five dimensions.

RESULTS AND DISCUSSION

The first step for third study was a replication of the factor analysis in Study 2. For Twitter, only one of the 14 metaphors (decision tree) did not load according to our previous criteria. In study three, decision tree cross-loaded on several factors when it previously loaded strongly (0.59) on factor 1. For Facebook, two out sixteen metaphors (highway and untended garden) no longer loaded on any factor, and two out of fourteen metaphors cross-loaded on multiple factors (bouncer and coin sorter). This replication

suggests that the underlying four factors of the metaphors for both systems were relatively stable. We therefore used the original factor compositions from Study 2 to analyze the semantic differential data in Study 3.

To assess the attributes associated with each folk theory, we explored the extent that each folk theory predicted each dimension from the semantic differentials separately, controlling for the other folk theories. Average strength of agreement for each of the four factors identified in Study 2 were entered into linear regression predicting each of our semantic differential indexes. Overall, five regressions were run for each platform (ten in total). To correct for multiple tests, bonferroni corrections were applied to significant levels for p-values. Tables 6 outlines which dimensions were significantly associated with each folk theory for both Twitter and Facebook.

For both Facebook and Twitter, folk theory 1 was associated with positive evaluations of the platform and beliefs that the platform works in their personal interest, rather than the company's interest. For Facebook, folk theory 1 was also associated with beliefs that content is independent of their and other's behavior. For both Facebook and Twitter, folk theory 2 was associated with positive evaluations, beliefs that platform is easy to understand and influence, and beliefs that the feed is not curated, showing wide variety of content and wide variety of people they follow.

In stark contrast to folk theory 1, for both Facebook and Twitter, folk theory 3 was associated with negative evaluations of the platform, beliefs that the feed works in the company's, rather than their personal, interest, and beliefs that the platform is curated in some way, showing a limited variety of content and limited range of people they follow. For Twitter, folk theory was also associated with beliefs that the process

underlying the feed is opaque and difficult to influence. Finally, folk theory 4, for both Facebook and Twitter, was associated with beliefs that the feed works in the company's interest. For Facebook, folk theory 4 was also associated with negative evaluations and beliefs that the feed is opaque and difficult to influence.

Despite the striking differences in the metaphor samples that were used to derive the folk theories for Facebook and Twitter, they have very similar semantic profiles. This suggests that there are four underlying folk theories of social feeds that capture overall evaluations about the platform, beliefs about control of the feed, and beliefs about whose interests are prioritized in the curation process. Based on the semantic qualities of the four folk theories and the metaphors that load on each of them, we have named these four folk theories *Rational Assistan*t, *Transparent Platform*, *Unwanted Observer*, and the *Corporate Black Box*.

The *Rational Assistant* is characterized by positive feelings towards the feed, beliefs that the feed understands and prioritizes their interests. The *Transparent Platform* is characterized by positive evaluations and beliefs that the feed is unfiltered. *Unwanted Observer* is characterized by negative evaluations, and beliefs that the feed is overreaching in their use of personal data to serve the company's interests. Finally, the *Corporate Black Box* is the least coherent of the four folk theories. However, this folk theory is associated with beliefs that the feed serves the company's interest. Our results also suggest that the *Corporate Black Box* is associated with beliefs that the process underlying the feed is opaque and difficult to control.

Folk Theory Agreement across Facebook and Twitter

While our analysis so far suggests that there are four primary folk theories that account for the metaphors that people use to understand social feeds, an important question is whether there are any differences in how strongly those folk theories are held for the two systems. To examine how strongly the four folk theories were held across the two social feeds we examined how much participants agreed with each of the metaphors associated with each folk theory and compared those average agreement scores across Facebook and Twitter. For each folk theory we calculated the average agreement with all of the metaphors that comprise that folk theory. We then entered these average agreement scores into a mixed model, with folk theories and social feed (Facebook vs. Twitter) entered as fixed factors and participant nested in platform as a random effect to control for the non-independence of repeated measures.

The results are displayed in Figure 1. The effect of platform did not reach significance, ($F(1,7) = 3.40$, $p = 0.07$), but the analysis revealed a significant effect of folk theory ($F(3,7) = 450.87$, $p < 0.001$) and a significant interaction between platform and folk theories ($F(3,7) = 21.81$, $p < 0.001$).

Post-hoc comparisons revealed significant differences between Twitter and Facebook for each of the four folk theories (p's < 0.001). The most strongly held folk theory for Facebook was the *Transparent Platform* ($M = 4.40$, $SD = 1.18$), followed by *Unwanted Observer* ($M = 4.40$, $SD = 1.41$), *Corporate Black Box* ($M = 3.61$, $SD = 1.35$), then and finally *Rational Assistant* ($M = 2.90$, $SD = 1.09$). The most strongly held folk theory for Twitter was also the *Transparent Platform* ($M = 4.40$, $SD = 1.21$), followed by *Unwanted Observer* ($M = 4.16$, $SD = 1.42$), *Corporate Black Box* ($M = 3.37$, $SD = 1.46$), then and finally *Rational Assistant* ($M = 3.24$, $SD = 1.13$).

People held the *Unwanted Observer* folk theory for Facebook more strongly compared to Twitter, and held the *Rational Assistant* folk theory for Twitter more strongly compared to Facebook. Overall, this suggests that people felt more positively Twitter and believed it was working in their interest more so than Facebook. Furthermore, people held the Transparent Platform folk theory more strongly for Twitter than Facebook, suggesting the Twitter is believed to be less curated than Facebook.

GENERAL DISCUSSION

The Facebook News Feed and Twitter Feed have similar goals, they both employ computational processes to achieve this goal, and they are both purposefully opaque in their discussion of how these processes operate. The present paper used a novel paradigm to identify people's folk theories about these similar, but opaque, systems, specify the characteristics associated with each folk theory, and examine how the folk theories differ between the two social systems.

From different samples, we found four primary folk theories for Facebook and Twitter. After specifying the characteristics associated with the two sets of four folk theories identified in phase 2, we see similar semantic profiles across the platforms. First, a common folk theory, the *Rational Assistant*, was associated with positive evaluations, beliefs that the underlying process was transparent, and beliefs that the feed could be easily influenced. Second, a folk theory for both Facebook and Twitter was associated with positive feelings towards the social feed, beliefs that the feed understood them, and beliefs that the feed was working in their favor. Third, a shared folk theory was associated with negative feelings toward the platform and beliefs that the social feed is biased towards the company. Finally, the last folk theory shared the common trait of

believing the feed worked in the company's favor and was generally uncertain how the process worked. Despite the consistency of the characteristics of the folk theories across platforms, people held the folk theories at different strengths, suggesting that people evaluated the systems on the same dimensions, but the different two platforms fell at different ends of the dimensions (i.e., Twitter was evaluated more positively than Facebook).

The present paper makes two primary contributions: 1) illustrates underlying folk theories that cross algorithmically-driven systems with similar motivations and 2) develops an approach for identifying folk theories using people's implicit beliefs about a system. To date, much of the work on folk theories of cyber-social systems has focused on singular platforms, surfacing folk theories specific to the features of those platforms (e.g., Eslami et al., 2016). By focusing on implicit beliefs about systems that can be tapped using metaphorical thinking, we were able to identify people's global folk theories about social feeds that transcend specific platforms and allow cross-platform comparisons.

Understanding folk theories of cyber-social systems is an important component of understanding how people engage and interact online. It is not the case that folk theories are only about beliefs. Instead, folk theories inform how people engage and interact with various technological systems. One study found that dog owners were more likely to cooperate with a dog-like agent than non-dog owners in a Prisoner's Dilemma game (Kiesler, 2005). The authors conclude that the dog owners held different beliefs about the personality of dogs than non-dog owners that led them to be more trusting that a dog-like agent would cooperate as well. This finding suggests that one's beliefs about dogs, not

only transferred to a computer, but guided how one chose to interact with the system (i.e. be more cooperative).

In the same way, folk theories of cyber-social systems should shape how people interact with the system. People who strongly hold the *Unwanted Observer* folk theory are more skeptical of the platform and their intentions. As a result, these people may be less open to system changes, believing the company uses too much of their data and only serves itself. Comparatively, people who strongly hold the *Rational Assistant* folk theory may be more likely to welcome changes believing the platform is working to make their experience better.

Folk theories should also shape how people interact with not just the system, but how people interact with others via the system. People who strongly hold the *Transparent Platform* folk theory believe that Facebook News Feed or Twitter Feed is unfiltered. Beliefs about curation and underlying processes should shape how people make attributions about others on the platform. If one believes that the feed presents them all of the available content, any uncertainty that arises from missed posts or lack of responses will be targeted towards one's relationships. On the other hand, people who hold the *Corporate Black Box* folk theory may be more likely to attribute this uncertainty to the opaqueness of the system and the inherent corporate interest, rather than the people in the network.

Folk theories are not permanent. People learn through experience, and their folk theories change as new information is gained (Gelman & Legare, 2011). Future work aims to explore what experiences prompt folk theory re-evaluation and adjustment, as well as explore how folk theories differ between cyber-social systems with different

algorithmic systems and different social goals, such as online dating sites. Online dating systems do not just order content, but match and rank motivated by very specific relational goals. It is an open question how folk theories generalize to other online spaces.

Conclusion

The present research is conducted in the domain of the two cyber-social systems, Facebook and Twitter, but seeks to be a first step in establishing systematic methods for identifying folk theories of cyber-social systems in a range of domains. Between these two platforms, we find four common underlying folk theories that significantly predict people's beliefs and attitudes the social feeds embedded in these platforms. The goal of this work is to explore how people think about system that have self-, other-, and computational components to help direct research focused on understanding how people interact with others in the diversity of social spaces available online.

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Table 1. Top 10 Metaphors from the Metaphor Discovery Phase

Facebook News Feed	Pr(win)	Twitter Feed	Pr(win)
Magazine* – collection of various stories/topics that might interest you	0.60	Surprise* - never know what will show up there	0.75
Personal shopper* – choosing and offering just the content I am most likely to want and interact with	0.59	Tree* - there are thousands of leaves, and you can look at the ones your find interesting	0.68
Paparazzi* – scrambling to show you what's hot and popular	0.59	Spider web* - conversations going off in all directions	0.67
Network T.V.* – they pick what you see and you decide what to watch	0.58	Newspaper* - a "what's new in the world today" sort of feed	0.65
Decision tree – you make a series of choices, which together determine some result	0.57	Large Salad* - mixes all the ingredients from different sources gives them back to you	0.63
Spy* – consolidating your viewing, browsing, and messaging history into a readable format	0.57	Coin Sorting – types of content are sorted and responded to if they satisfy set criteria	0.61
Jigsaw puzzle* – I see little pieces of everything	0.56	Grocery Store* - each topic is separated into departments, and your viewing is based on what you've shown to buy the most	0.60
Personal Assistant* – makes use of things that are important to you and presents it	0.56	Bad assistant* – personalized content that they think you want, but don't really	0.60
Coin sorting – types of content are sorted and responded to if they satisfy set of criteria.	0.56	Decision Tree – you make a series of choices, which together determine some result	0.60

Note: Pr(win) refers to the probability of winning in a randomly chosen comparison. Asterisks indicate metaphors that were submitted by participants.

Table 2. Factor Loadings for Twitter Metaphors from the Folk Theory Identification phase

	Factor 1	Factor 2	Factor 3	Factor 4
Proportion of Variance Explained	0.13	0.09	0.07	0.06
Recipe	0.48			0.326
Salad	0.49			
Flower Picking	0.55		0.21	0.23
Tree	0.46		0.32	0.27
Decision Tree	0.59			
Queue	0.47		0.32	0.26
Time Traveling	0.46		0.23	
Gift	0.62			
Cat	0.57			
Sketchbook	0.60	0.22		
Bad Assistant		0.52		
Mess		0.81		
Chaos		0.61		
Train Wreck		0.79		
Nosy Mother	0.27	0.45		
Dominos	0.31		0.45	
Chain Reaction			0.70	
Coin Sorting	0.2			0.67
Egg Sorting	0.2			0.68

Note. Loadings less than 0.2 are suppressed. The following metaphors did not load or loaded on multiple: surprise, spider web, sandbox, balancing act, swiss cheese, bingo, tree, queue, highway, river

Table 3. Factor Loadings for Facebook Metaphors from the Folk Theory Specification phase

	Factor 1	Factor 2	Factor 3	Factor 4
Proportion of Variance Explained	0.16	0.09	0.06	0.04
Personal Shopper	0.53		0.24	
Butler	0.62			
Bouncer	0.56			0.22
Coin Sorter	0.62			0.22
Decision Tree	0.61		0.24	
Recipe	0.61			
Scientific Method	0.68			
Private Investigator	0.28	0.60		
Stalker		0.78		
Spy		0.69	0.21	
Paparazzi		0.64	0.23	
Platform			0.37	
Network T.V.	0.30		0.37	
Highway			0.49	
Untended Garden	0.37			
Jigsaw Puzzle	0.40			0.50

Note. Factor loadings < 0.20 were suppressed. The following metaphors did not load or loaded on multiple: bubble, personal assistant, long list, banana, record logger, menu.

Table 4. Reliability of Items in the Semantic Differential Indices

Index	Semantic Differentials	Reliability
Overall Evaluation	Ineffective – effective Useless – useful Uninformative – informative Uninteresting – interesting Unimportant – important Meaningless – meaningful Powerless - powerful	0.90
Extent of Control	Unclear – clear how it works Difficult – easy to influence Allows no – complete control	0.62
Dependence on Behavior	Independent - Dependent on my behavior Independent - Dependent on other's behavior	0.36
Bias towards the company	Prioritizes my interest – {Platform)'s interest Uses too little – too much of my data Rational – Emotional Unbiased – Biased Represents Personal Interests – General Interests Completely – Does Not Understand Me At All	0.64
Level of Curation	Shows me a narrow – wide variety of content Shows me a narrow – wide pool of friends Shows me nothing – everything my friends post Shows mostly negative – positive content	0.61

Table 5. Regression output for all 5 indexes for Facebook and Twitter

Facebook		Factor 1		Factor 2		Factor 3		Factor 4	
	B0	β	SE	β	SE	β	SE	β	SE
Evaluation	3.24	0.30***	0.05	0.23***	0.04	-0.09**	0.03	-0.10**	0.04
Influence	3.83	0.03	0.05	0.16***	0.04	0.02	0.04	-0.11**	0.04
Behavior	4.89	-0.14**	0.05	0.09*	0.04	0.07*	0.03	-0.08*	0.03
Interests	4.44	-0.23***	0.03	-0.04	0.03	0.11***	0.02	0.09***	0.03
Content	4.02	-0.01	0.04	0.14***	0.03	-0.07**	0.03	-0.01	0.03
Twitter									
	B0	β	SE	β	SE	β	SE	β	SE
Evaluation	4.35	0.25***	0.04	0.16***	0.03	-0.28**	0.03	-0.03	0.03
Influence	4.07	0.06	0.04	0.22***	0.03	-0.15***	0.03	-0.04	0.03
Behavior	4.68	-0.05	0.04	0.09**	0.04	-0.01	0.03	-0.07*	0.03
Interests	3.76	-0.13 ***	0.03	-0.02	0.02	0.17***	0.02	0.04***	0.02
Content	4.35	-0.05	0.03	0.14***	0.03	-0.08**	0.02	0.01	0.02

Note. Regression output from study 3 with mean score on the factors identified in study 2 predicting mean scores each of the 5 dimensions of social feeds separately. Each row represents one regression with the outcome variable presented in row and the predictor variable presented in the columns.

Table 6. List of each metaphor and associated characteristics for each folk theory by cyber-social system

	Facebook Metaphors	Predicted Facebook Characteristics	Twitter Metaphors	Predicted Twitter Characteristics	Folk Theory
Factor 1	Personal Shopper, Butler, Bouncer, Coin Sorter, Decision Tree, Recipe, Scientific Method	Positive Evaluations, Independent of Behavior, Rational Process Favoring User	Salad, Decision Tree, Flower Picking, Time-traveling, Gift, Cat, Sketchbook	Positive Evaluations, Rational Process Favoring User	Rational Assistant
Factor 2	Platform, Network T.V. Magazine	Positive Evaluations, High Perceived Control, Unfiltered Feed	Dominos, Chain Reaction, Input-Output	Positive Evaluation, High Perceived Control, Unfiltered Feed	Transparent Platform
Factor 3	Spy, Stalker, Private Investigator, Paparazzi	Negative Evaluations, Biased Process favoring company, Filtered Feed	Bad assistant, Mess, Chaos, Train Wreck, Nosy Mother	Negative Evaluation, Biased Process Favoring Company, Low Perceived Control	Unwanted Observer
Factor 3	Jigsaw Puzzle, Untended Garden, Highway	Negative Evaluation, Low Perceived Control, Biased Process Favoring Company	Coin Sorting, Egg Sorting	Biased Process Favoring Company	Corporate Black Box

Note. Listed metaphors loaded sufficiently in study 2 and listed characteristics were significantly related the four folk theories in study 3 ($p < 0.005$, corrected for multiple tests).

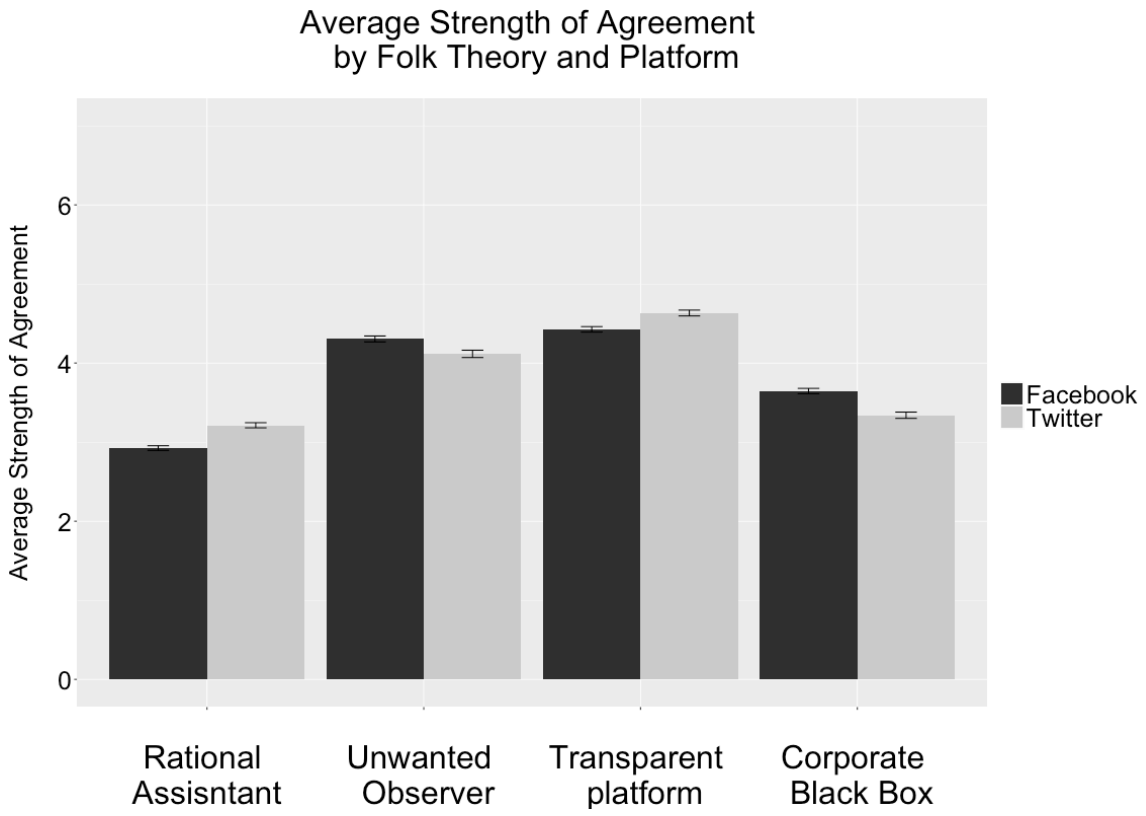

Figure 1. Average agreement with each folk theory by cyber-social system