First I "like" it, then I hide it: Folk Theories of Social Feeds

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ABSTRACT

Many online platforms use curation algorithms that are opaque to the user. Recent work suggests that discovering a filtering algorithm's existence in a curated feed influences user experience, but it remains unclear how users reason about the operation of these algorithms. In this qualitative laboratory study, researchers interviewed a diverse, non-probability sample of 40 Facebook users before, during, and after being presented alternative displays of Facebook's News Feed curation algorithm's output. Interviews revealed 10 "folk theories" of automated curation, some quite unexpected. Users who were given a probe into the algorithm's operation via an interface that incorporated "seams," visible hints disclosing aspects of automation operations, could quickly develop theories. Users made plans that depended on their theories. We conclude that foregrounding these automated processes may increase interface design complexity, but it may also add usability benefits.

Author Keywords

Algorithms; Folk Theories; Seamful Design; Social Media Feeds

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Online platforms such as YouTube, Google, and Facebook are examples of complex online platforms that use algorithms to curate, select and present information. While the operation of these algorithms is typically opaque to users, users often develop and sometimes share theories about how these curation algorithms work in order to plan their behavior. A Facebook user might think, for example, *I should always click "like" on my own status updates in order to tell the algorithm to start sharing them* [9]. Engineers who design computer systems may not find a user's folk theory to match their own understanding of a system, but a folk theory can affect behavior in positive ways [16] and even shape the evolution of the system as a whole [22].

For example, in 2012 there was speculation within YouTube's user community that YouTube's "Up Next" recommendation algorithm gave significant weight to uploaded videos that were flagged as a "reply" made to another video. A group that became known as "Reply Girls," acted on this theory and uploaded irrelevant videos with sexually suggestive thumbnails, then flagged them as replies to popular videos. Although the internal operation of YouTube's recommendation algorithm was never known by the users, the Reply Girls identified this flag as the reason they earned more clicks and upwards of tens of thousands of dollars in ad sharing revenue. Many YouTube users participated in campaigns against the "Reply Girls," and YouTube reportedly "tweaked" its algorithm to dissuade such behavior [25]. The "Reply Girls" could be seen as spam or abuse, but more mundane scenarios where folk theories guide user behavior in social media abound. Just as the Facebook News Feed algorithm is likely trained by the act of clicking "like," so is the Facebook user trained by the algorithm's dissemination of some posts and not others. In this way, content curation is co-produced by both users and machines [37].

Curation algorithms are often black boxes, preventing users from understanding the details of their functionality. While this opaqueness often exists to protect intellectual property, it also stems in part from the merits of "seamless" design, where designers hide details from users to make interactions effortless [6, 23]. However, some now argue that adding visibility into system operation by designing "seams" into technologically-mediated experiences helps people to become more adaptive, innovative and intelligent users [13, 6]. However, little is known about whether and how providing seams into a social media curation algorithm would affect the folk theories users create and use.

This paper explores the interplay between folk theories and seamful design in the domain of social media feed curation algorithms. We sought to discover the folk theories of News Feed curation held by 40 Facebook users before and during a probe that provided some seams into the News Feed curation process by displaying several views of the Facebook News Feed algorithm's outputs. A previous publication involving these data reported on the degree to which users were aware of the algorithm, what factors resulted in awareness, and its effects on user behavior [9]. In contrast, this paper reports findings about how users reason and talk about their ideas about the operation of the algorithm – their folk theories. We found that revealing the outputs of the algorithm in a new way and incorporating intentional seams into the feed in a structured manner helped participants who were unaware of the algorithm's existence develop theories similar to par-

ticipants who were aware of the algorithm's presence prior to the study. Several of these theories, like the one referenced by the quote in this paper's title, were unexpected. In considering theories' functionality, we learned that users called on theories they had control over to guide their behavior.

RELATED WORK

Folk Theories

While everyone has ideas about how the world works, "folk theories" are those non-authoritative conceptions of the world that develop among non-professionals and circulate informally. Technological systems exist in tension with folk theories because designers try to reduce the uncertainty of their users by enrolling them in a specific understanding of what the system is, and sometimes, how it works [18]. Although a system's documentation, advertising, aesthetics, and interface may strive to convey the producer's canonical view of a technological artifact [37], users also develop or acquire their own "folk" or non-professional perspectives via first-hand experience and social interactions [16].

The theories developed by users may differ substantially from the institutionalized, professionally legitimated conceptions held by experts and system designers. One definition of successful interface design has been that an effective interface produces alignment between the conceptual model held by a technology's producer and its user [21, 23]. In contrast, more recent work assumes that producers and users require fundamentally different conceptions of a system. In this view, technologies should strive to provide a theory of the system that is useful, although not necessarily aligned with "expert" views, and appropriate to the task at hand [22]. Interestingly, folk theories that explicitly disagree with expert descriptions have been found to be superior to authoritative knowledge in some circumstances [16, 36].

For example, in his studies of home heating thermostats, Kempton discovered two folk theories: (1) The Feedback Theory, where the thermostat behaves as a sensor and a switch and turns on/off to maintain a target temperature, and (2) The Valve Theory, where the thermostat controls a level of heat flow (like a water valve in a sink). While technical experts consider the feedback theory essentially correct, up to half of Kempton's participants found the valve theory to be functional and produced advantages. Folk theories have been studied in a wide spectrum of areas. We highlight sample cases below that investigate reasoning about the invisible, using analogy and what Lynch calls "sketching" [17]. While many philosophers provide processes for reflecting and seeking truth in the intangible physical and metaphysical (e.g., physics, religion) [7, 26, 33], we focus more specifically on explorations of black-boxed algorithmic systems.

Sketching: To uncover underlying perceptual features in urban space, Lynch, an urban planner, asked local participants to draw a map or sketch of a space for a foreigner. He discovered that these often fragmented mental maps revealed participants' personal histories and socio-economic conditions of the space. His findings are at the core of good urban design [17]. Our methodology, which asked participants to describe

what they believe is happening in their social media feed and why, mimics Lynch's approach [13].

Poole et al. asked users to sketch the layout of their home computer network and an ideal network and confirmed that people, even some experts, lack the mental models or theories to easily manage their home networks [27]. The authors suggested the use of shared visualizations across stakeholders of a system, a tactic that highlights the potential utility of the present study. In a related study, Friedman et al. investigated conceptions of Web security, finding that the theories of the more expert participants were no more reliable than those of anyone else [10]. Friedman et al. also conclude that new visualizations are critical to make sense of network security.

Analogy: A wide range of prior studies demonstrated when moving from familiar to unfamiliar domains, analogies from the familiar often help people structure the unfamiliar [11]. Poole et al. elicited folk theories from people that were unfamiliar with Radio Frequency Identification (RFID) technology [28]. One folk theory suggested that RFID might work in a way analogous to Global Positioning Systems (GPS), such that satellites would continuously track RFID tags. These folk theories could be barriers to adoption; in this case, because participants feared being tracked by the government.

Moving specifically to studies and commentary about Facebook feeds, Gillespie argued in *Culture Digitally* that people develop expectations about News Feed by analogizing it to older media and information systems such as "the telephone network" vs. "the newspaper editor" [12]. In another study, people were found to conceptualize the overall goal of News Feed in very distinct ways, some seeing analogies to paparazzi, others to personal shoppers or even spies [14].

Feed assumptions and outcomes: Bernstein et al. explored Facebook users' imagined audience [3], discovering that people used information in the interface such as friend count, likes, and comments to develop folk theories to estimate the relationship between these indicators and the size of their audience. Users underestimated their audience by a multiple of four. Burke et al. discuss how feedback and distribution on feeds affected newcomers contributions; a newcomer who received a comment on a photo was more likely to contribute more photos [5]. Eslami et al. [9] investigated users' awareness of the News Feed algorithm and found that users who did not realize their feed was filtered, attributed the actions of the curation system to their own family and friends. Hogan further emphasizes the importance of understanding mediated relationships in feeds to better participate in them. [15]. Rader and Gray [29] studied Amazon Mechanical Turk survey respondents' Facebook curation awareness and their theories of causal feed relationships. This paper expands on these recent investigations of social feed curation processes, to uncover and codify folk theories or lay understandings of the algorithms that govern these feeds.

Seamful Design

At the same time that researchers in human-machine interaction have debated the function, content, and proper role of folk theories, a separate school of thought has advocated

for the reduction or even the total elimination of them. This tactic, termed "seamless" design or "seamlessness," imagines a successful interaction to be one where a user experiences "metaphoric direct manipulation" [6] of something without any awareness of mediation. In seamless design, "technology is hidden" [35] and there may be no way to develop a folk theory or mental model. Arguably this approach is popular in the computing industry.

However, commentators have also considered the logical opposite of an invisible machine: "seamful" designs that emphasize mechanism [34]. A seamful design makes system infrastructure elements visible when the user actively chooses to understand or modify that system. Such design emphasizes *experience* and *reflection*, inviting the user to explore and discover connections in the system through manipulation, comparison, and feedback [1, 6]. Consider the case of 802.11 wireless networks: A seamless interface states that the building "has wireless," gives all access points the same name, and hides all details of their implementation – even hiding the access points themselves above a drop ceiling. In contrast, a seamful interface would convey the patchwork of wireless signals and access points while highlighting signal strength and the boundaries of different networks.

The seamful approach helps users get the most out of the system and can help them understand why it does not work in some cases [6]. Seamful design can transform perceived flaws into a revelatory experience. Wikipedia, for example, can be criticized for its "bare-bones" aesthetic that varies little from most wire-frames, but it can also be praised for making its functionality visible and promoting user education about them, manifesting some of the principles of seamful design. But little research has established the benefits or effectiveness of such an approach in algorithmic systems. The probe interface used in our study introduced seams to highlight the differential treatment of specific people and content in users' News Feeds.

Research Questions
In this study, we examine the interplay of folk theories and seamful design on the Facebook News Feed curation algorithm. Facebook launched News Feed in September 2006 [30] to create a personalized list of stories for each user. Facebook has provided an abstracted model of the News Feed curation process in its public blog, describing the three most important features involved in the algorithm: engagement (*"see more stories that interest you from friends you interact with the most"*), popularity (*"the number of comments and likes a post receives"*) and story format (*"what kind of story it is; e.g. photo, video, status update"*) [20]. Previous work investigated users' awareness of curation algorithms, paths toward awareness and effects of awareness [9, 29], yet much remains unknown about which folk theories exist to make sense of these algorithms, the connection between design and the development of folk theory, and the utility of these theories. To address these lacunae, we investigate:

RQ1: After typical use of News Feed, what folk theories do users hold that explain the curation algorithm?

RQ2: Does providing seams into the Facebook News Feed algorithm help users develop new theories or change their existing theories about the algorithm? If so, how?

RQ3: Do users perceive their theories to be useful?

METHOD
To address these research questions, we devised a three-phase qualitative laboratory study using a within-subjects design. Data collection occurred from November 2013 to April 2014. (Other results from this study were previously published in [9][1].) In the first phase, we evaluated our participants' awareness of the algorithm's existence. We then interviewed those participants who were aware of the algorithm's presence in their News Feed to understand their preexisting folk theories about the algorithm's operation. In the second phase, termed the probe, we revealed algorithm outputs to the participants through a custom Facebook application (FeedVis) [8]. Through this probe we sought to understand how differing visualizations of their News Feed affected participants' folk theories of the curation algorithm. In the third phase, we asked how participants would use the theories they developed during the probe to alter the News Feed's behavior. Each participant spent from 1 to 3 hours in our laboratory during the study. Participants received $10/hour for the interview.

We took elaborate precautions to minimize experimenter and demand effects throughout all phases. After confirming an algorithm existed in News Feed, participants, especially the Unaware participants asked many questions. To avoid leading participants towards particular theories, the interviewer followed a protocol wherein she did not respond to questions about the algorithm's functionality. In response to participants' questions about News Feed's algorithmic process, she consistently replied, *"I don't have any more information than you do about how Facebook works."* In addition, she was consistent in following a script for both close-ended and open-ended questions and did not validate or deny any theories. We provide further methodological details in the appendices. We emphasize that while the Aware participants' theories discovered in the first phase developed naturally from their regular Facebook usage, the theories proposed during the probe phase are affected by the FeedVis design and the seams we chose to reveal. We elaborate on this seam selection in the discussion.

Participants
As this is a study investigating folk theories, sampling is of critical importance. For example, a convenience sample of computer science undergraduates would be indefensible as a population of "folk" or laypeople. To address this concern, we went to great lengths to employ modified quota sampling for variation and balance in gender, age, race/ethnicity, and socioeconomic status. We recruited a diverse non-probability sample of 40 Facebook users from the Champaign, Illinois and surrounding area through social media announcements, flyers in public places and email to local communities. Our

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[1]While the previous article focused on paths to users' awareness of *the mere existence* of the Facebook News Feed curation algorithm, this paper mainly reports new findings about users' folk theories of the functionality of the algorithm.

sample also supported a variety of occupations including housekeepers, artists, bartenders and servers besides university students and staff [2]. The sample was 60% female, with the age range of 18 to 64. More than half of the participants (68%) reported themselves as Caucasian, 15% as Asian and the rest as African-American, Hispanic and Native American. The annual income of half of the participants was less $50,000 and the rest between $50,000 and $150,000. Our participants fall within prior work's reported age, gender, race and income [2, 31].

Phase 1: Pre-Probe

After inviting participants to our lab, we began by asking them questions to understand their awareness level of the filtering process in their News Feed. As previously reported and analyzed in [9], we presented participants with a scenario: we asked them to imagine that their friend, "Sarah," posted a story visible to all her friends in Facebook. We then asked them whether and why this specific story would or would not appear in their News Feed. We refer to those participants who believed that Sarah's story might not appear on their feed due to News Feed algorithmic curation as "Aware" participants and the rest as "Unaware" participants. We next asked the Aware participants to scroll down their News Feed and explain how they thought Facebook chose what to display in their News Feed. During this open-ended discussion, participants described their theories about how the algorithm functions in great detail.

Phase 2: Algorithm Probe

Our goal in the second phase was to provide an alternative view of News Feed to see how (or if) this new information changed participants' understanding of the algorithm. We walked participants through an algorithmic probe to show them two alternative views of the algorithm's outputs that highlight differences in content (with or without curation) and across people (whose stories are shown or hidden).

The first view, the Content View (Figure 1(a)), displayed stories that appeared in the user's feed ("Shown Stories") adjacent to stories posted by a user's network of friends ("All Stories"). We obtained "Shown Stories", in the right column, by querying user_id/home/user via Facebook's API 1.0. While this column consisted of stories the algorithm chose for user's News Feed, the user might miss some stories if they did not log into Facebook or if they scrolled through the feed too quickly. The left column, "All Stories", contained the union of friend_id/feed/ queries for every friend. This content view highlights the difference in length between the two columns and emphasizes the stories that were hidden from the user by color (shown stories in blue & hidden stories in white).

We first walked our participants through this view and asked them to scroll through the interface and compare the "Shown Stories" and "All Stories" columns, sharing their thoughts aloud about the columns' differences, noting anything they

found interesting or surprising. We then started a discussion with participants by asking them to explain the possible reasons that some certain stories had been filtered out and others had not. In continuing this discussion, we chose some hidden stories and asked participants *"What criteria do you think Facebook might have used to decide to exclude the item from the feed?"* Through this open-ended discussion, we sought to understand the possible theories participants developed about how the filtering algorithm might work.

We then used another FeedVis view, the Friend View (Figure 1(b)), to show the participants their Facebook friend network sorted into three groups based on the proportion of each individual's stories that were selected by the algorithmic sort for inclusion in News Feed. One group, "rarely shown," displayed friends for whom 10% or less of their stories appeared in the participant's Feed; "sometimes shown," for whom approximately half of their stories were shown; and "mostly shown," whose stories almost always appeared. Absolute numbers of shown and hidden stories from a friend appeared in each group (i.e., to distinguish proportions such as two shown stories out of four stories versus 60 shown stories out of 120 stories). We asked participants to compare the three groups and discuss their thoughts on why some friends' stories appear less than others in the feed. We chose some friends from each group and asked participants *"What criteria do you think Facebook might have used in deciding how much material to release into your feed?"* for each friend. We started by grouping nine friends into these categories, and gradually enlarged the list, checking with participants at each point to see if and how their theories evolved.
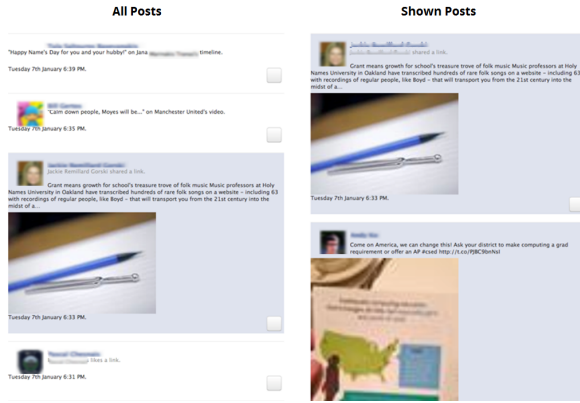
Phase 3: Post-Probe

After understanding participants' folk theories of how the algorithm might work before and during the probe, we wanted to know whether participants believed their theories were useful. To explore this, we directed participants to two new FeedVis views where they could tweak algorithm outputs. In the Friend Rearrangement View, users explicitly articulated which friends should belong in each of the three categories ("rarely shown," "sometimes shown," or "mostly shown"). In the Content Rearrangement View, participants selected which content News Feed should show and which it should hide. After participants modified the content they wished to see and the friend groupings, we chose a few modified friends/stories and asked the participants, *"Do you think there might be anything you could do to try and accomplish that change, simply through how you use Facebook?"* For example, if John was in the "rarely shown" category and they moved him to the "mostly shown" category in FeedVis, what would they do in Facebook to see most of John's stories? This interview question allowed us to code which folk theories of Facebook's operation had the potential to affect planned behaviors by the user.

Data Analysis

We recorded and transcribed the interviews to conduct qualitative data analysis on the transcripts[3] using Nvivo [24]. We

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[2]Five participants were computer science students, and we expected their theories to be substantially different from our other interlocutors. However they did not differ noticeably other than in the use of more technical vocabulary.

[3]The resulting transcripts contained more than 160,000 words.

(a) FeedVis Content View. It is composed of two columns: all stories written by the users friends (*left*) and those shown in News Feed (*right*).
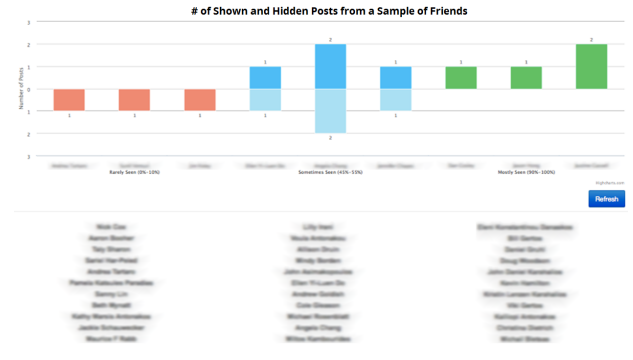
(b) FeedVis Friend View. Shows three categories of friends: rarely, sometimes and mostly shown, based on the percentage of shown stories.

Figure 1: FeedVis Content and Friend Views

first employed line-by-line open coding to identify the participants' theories in each phase. We then revised and categorized the theories of each phase through a collaborative and inductive process. Finally, we used axial coding to extract the relationships between the theories from the different phases.

RESULTS

Pre-Probe Folk Theories (RQ1)

Fewer than half of our participants (n=15) were aware of the algorithm's existence in their News Feed [9]. We found that these participants employed abductive reasoning to develop theories; reasoning from an observation to a simple and likely hypothesis although other hypotheses might be possible [19, 32]. That is, they used the observation of their own feed to make sense of the behavior of the algorithm. A few participants (n=3) reported learning about the algorithm from external sources such as news articles and friends. We expect this to be part of developing folk theories, as we take the prefix "folk" to be similar to its use in "folklore" in that a folk practice does not necessarily denote an individual view, but rather ideas that are developed, shared, and circulated by everyday people who are not expert.

Participants held multiple theories even when they could logically be considered mutually exclusive. We also note that despite developing these theories, participants were often uncertain and described the filtering process as "*a very strange game [...] because [we] don't really know what the rules are*" (P28). Nevertheless, many participants converged on similar theories. Here, we present the four primary theories proposed by the Aware participants of how the algorithm might work (Table 1, column 1) ordered by their relative prevalence (how many participants mentioned them).

The Personal Engagement Theory: The most common theory of feed curation among the Aware participants was based on the amount of interactions they had with a friend on Facebook. Most of the Aware participants believed that "*the more interactions that you have with somebody, the more their stuff*

will show up on your News Feed" (P15). From their point of view, engagement mainly included commenting on or liking a friend's stories: "*If there are things on the News Feed that I comment on or like, sometimes things [from that person] will start showing up more*" (P13).

Believing that "*[Facebook] can figure out who's going on whose wall*" (P26), some participants argued that "*when you go to [your friends'] sites more, if you go check out their stories, like you read some of their stuff [...], you get them more [in] your News Feed*" (P21). Messaging, poking, tagging a friend, sharing their stories, visiting a friend's wall or posting on a friend's wall were all forms of engagement that many believed could influence the algorithm. They also argued the opposite: "*if you are not interacting with a person too much then Facebook hides it [from News Feed]*" (P20).

We found that some participants used The Personal Engagement Theory in practice: "*Sometimes when I see someone on my News Feed who I don't often see, I might go and click in [their timeline] and so I can see their stuff more often*" (P21). Interestingly, there were participants who used this theory in reverse, trying to counteract their own previous interaction to avoid the effects they theorized: "*When I 'like' something, I usually hide it from my News Feed because I like it but I don't necessarily want to know all about it all the time*" (P20). While they wanted to send a signal to their friend via the "like" feature, they did not want their News Feed to change. In their view, they added some weight to that friend and then removed some weight to maintain a balance.

While most Aware users thought their engagement level was one of the main factors affecting the filtering process, some expressed uncertainty after describing their theories: "*Sometimes I'm not seeing anything on my News Feed from a particular person, and then I'll go to their friend page and I'll check them out a little bit and then almost the next day more things from them start showing up. So, I don't know if Facebook is tracking who I'm interacting with and putting that on*

my News Feed or if it just happens to be a coincidence or what ..." (P13).

The Global Popularity Theory: Some participants believed the likelihood that content would appear was primarily measured by the number of "likes" and comments made by others: "*The more people that click that they like [a story], the more people that comment, the more people get to see it*" (P28). Sometimes popularity was envisioned as a threshold: "*there's got to be a certain amount of popularity weight*" (P33) for a story to appear in others' News Feeds. A few participants said that they used The Global Popularity Theory to affect their News Feed. For example, because News Feed can not contain everything and it prioritizes popular content, they sometimes unfollowed friends who produced popular content to be sure there was enough "open space" for stories from others.

In addition to influencing their own News Feed, a few used The Global Popularity Theory to affect others' News Feeds: they purposefully "liked" or commented on their own stories, which they hoped would make their stories more likely to appear in others' feeds. In particular, business page owners, who saw page followers as potential customers, consciously tried to increase their follower count. While one way to increase this number is by purchasing "likes," one participant argued that this practice might decrease their profit: "*[Suppose that] I'm going to buy more 'likes' and all of a sudden I had 2000 more [...] But what happens is they have a whole bunch of fake people [...] So then if they're sending [a story] out to 10% of the people and if you have 2500 'likes', 250 of them are getting it. But if 90% of those are fake, then fewer real people are seeing it. So it doesn't help you at all*" (P28).

The Format Theory: A few participants thought some types of stories would be more likely to appear in News Feed than the others. For example, P28 argued that stories composed of text had a higher priority than videos or photos: "*This is what I found: If you just do a written post, just words, it reaches more people. As soon as you put a video or photo attached, they cut down how many people are going to see it*".

The Narcissus Theory: In classical mythology, Narcissus loved his twin and his own reflection. A few participants stated that their similarity to a friend would affect the number of stories they would see from those friends: "*I feel like people that I have sort of the least in common with are the ones I tend not to see very much*" (P34). Examples of features that characterized this theory included "liking" the same stories, listing similar interests in the profile and belonging to the same Facebook group. P13 stated, "*Maybe if we're from the same group, like the rugby people, I see more from [them].*"

Probe Folk Theories (RQ2)

After discussing the Aware participants' theories in the pre-probe interviews, we walked both Aware and Unaware participants through FeedVis. Participants again employed abductive reasoning to develop their theories, this time by observing the FeedVis views of the News Feed's outputs. We present these theories below (Table 1, column 2).

The Personal Engagement Theory, Revisited: This theory was previously mentioned in the pre-probe by the Aware participants, but during the probe it was proposed by most participants. They suggested that Facebook "*has some kind of history of how [they] interact with things on News Feed*" (P39) and considered their interaction with others as an "*interest gatherer*" (P21) for Facebook. In addition to the types of interaction already mentioned, some thought that clicking on a friend's story in their own News Feed would affect the algorithm: "*I'm sure it adds something to the algorithm that shows that you have an interest in a person*" (P7). Some extended this view, suggesting that Facebook tracked users' reading behaviors by "*monitoring scrolling [patterns]*" (P21) to understand whose stories they spent more time reading.

Based on this theory, participants suggested that "*Facebook is doing some fancy [process] [...] by virtue of who is tied with whom*" (P3) to choose what to show to users. Given this theory, some were surprised that friends they frequently interacted with did not appear in the "mostly shown" category: "*I'm kind of surprised about them because she just had a baby, and I'm constantly liking pictures of her son. So, I would think she would be in the green [mostly shown group] because I'm always on there and she's always liking my things too so this is weird; She should be in the green!*" (P32). As highlighted by this example, the probe interface supported the development of new theories but also challenged participants' existing theories.

Participants worried about the possibility of negative feedback loops. For example, if they were to interact with a friend too infrequently, they believed the algorithm might start hiding that friend's stories – making it harder to interact with her content in the future. One participant noted a friend was rarely shown in her News Feed "*because we don't interact that much, but I don't interact because I don't see his posts!*" (P20). If they saw their friend's stories, they might want to interact more: "*I feel like it's somebody who never interacts with me on Facebook and I never interact with her but it's interesting that I might interact with her if I would see some stuff like this [that wasn't made visible to her]*" (P19).

The Format Theory, Revisited: During the probe, users described an expansion of The Format Theory: They often believed Facebook contained two kinds of stories: primary and secondary. From the participants' perspective, primary stories were in a format that conveyed important information: e.g. the textual status update. In contrast, secondary stories were automated notifications, such as those that declared that "*people [were] interacting with each other*" (P30), had "liked" or commented on a story, became friends with someone, or sent birthday greetings. However, there was no general agreement among participants about the value of some formats. While some believed photos were clearly primary, others disagreed. Overall, participants stated that filtering secondary stories made sense because their lower value: "*This kind of stuff I don't care to see, so I'm fine with that being left off*" (P15).

The Control Panel Theory: After the probe, many participants posited that using some control settings might affect their News Feed. Some stated that a friend's stories were hidden from their News Feed because of their input to the

Theories \ Participants	Pre-Probe Aware (n=15)	Probe Aware (n=15)	Probe Unaware (n=25)	Post-Probe Aware (n=15)	Post-Probe Unaware (n=25)
Personal Engagement Theory	12 (80%)	15 (100%)	22 (88%)	6 (40%)	12 (48%)
Format Theory	2 (13%)	14 (93%)	23 (92%)	–	–
Control Panel Theory	–	9 (60%)	12 (48%)	7 (46%)	10 (40%)
Theory of Loud and Quiet Friends	–	7 (46%)	12 (48%)	–	–
Eye of Providence Theory	–	6 (40%)	11 (44%)	–	–
Narcissus Theory	2 (13%)	6 (40%)	9 (36%)	–	–
OC Theory	–	2 (13%)	10 (40%)	–	–
Global Popularity Theory	5 (33%)	2 (13%)	3 (12%)	–	–
Fresh Blood Theory	–	3 (20%)	2 (8%)	–	–
Randomness Theory	–	2 (13%)	3 (12%)	–	–

Table 1: Theories of feed curation proposed by participants in the pre-probe and probe phases and their described utility in the post-probe phase; a participant might propose/utilize anywhere from zero to many theories in each phase.

system: they had unfollowed or blocked that friend. However, in other cases where the friend was not unfollowed or blocked, participants speculated that a prior use of Facebook's "I don't want to see this" option on a status update might result in more widespread filtering because their intent could have been interpreted more broadly by the platform. Facebook might think they were no longer interested in that person. Some participants thought this could apply similarly to story formats. That is, hiding a specific story format once might cause widespread filtering of that format: "*I've hidden things like this before, like the daily horoscope and things like that, so maybe that's why these types of things don't show up on my feed*" (P35).

Adding people to Facebook lists was another action that some participants believed might trigger the algorithm to show more or fewer stories from those people in News Feed: "*And also whenever I post a status, I post [it] to a custom group, and that group excludes people like family members. So, that might weigh into the tie strength. So, my guess is that again algorithmically, they are like 'ok well obviously you don't care about those [people]'*" (P3). Adding friends to the "close friends" list was another explanation for why more stories appeared from those specific friends. A few participants stated that they used a Facebook control option that allowed them to specify what format of stories (e.g. photos, "likes," comments, status updates) they wanted to see from a friend.

The Theory of Loud and Quiet Friends: Some participants discussed how the amount of content produced by a friend contributed to the presence of their stories in News Feed. While some believed "*if someone posts a lot on Facebook, then [you] will be more likely to see their posts*" (P22), others thought the opposite; they argued that the stories of users who posted more frequently were more likely to be filtered out in the interest of fairness. Some suggested that Facebook was "*trying to filter the amount of information one person's trying to put out*" (P30) to avoid filling people's News Feeds with one person's stories. If a user posts too much in a short period, they thought Facebook filters them more aggressively: "*Time definitely has something to do with it. If they're going

to post every single post onto someone's News Feed, someone could use that to their advantage and literally post the same letter over and over and over again to bury someone else's message. Or they could possibly spam a message of [...] like 'free the penguins' and just copy and paste, enter, copy and paste, enter, copy and paste, enter, and that's going to absolutely fill up whoever is on that list*" (P30).

The Eye of Providence Theory: The Eye of Providence is the notion common to many religions that God's all-seeing eye is watching over you. In the U.S., its iconography is often accompanied by the Latin "*Annuit cptis*", literally meaning "it approves." The participants who articulated this theory thought that Facebook was powerful, perceptive, and ultimately unknowable. Adherents to this theory said that Facebook saw into every story in some detail. They thought that Facebook was removing low quality content such as low resolution photos or very long stories. Some said that Facebook matched newly contributed content against all other contributed content on the platform. If a similar or identical photo, link, or status update was posted multiple times, "*maybe somehow Facebook recognized that it was the same thing and only announced it once*" (P4).

Others took the idea that Facebook processes content even further. Several thought Facebook uses face detection to prioritize photos of people over photos of objects or landscapes. Others proposed that "*there could be keywords that Facebook is taught to look for, identify, and if it sees it, maybe puts it lower on the priority list*" (P21). They believed that words about religion and politics would be most likely to cause a story to be suppressed. For instance, some explained how political stories were shown less in their News Feed compared to stories with other topics: "*Now to the average eye, you could probably think that the one that two girls sitting on a couch enjoying their day was not filtered because it's a lovely little picture and the other one [...] got filtered because it's highly saturated in government and politics*" (P30). Overall, these participants believed that Facebook avoided distributing political and religious content because it does "*not want to even have the opportunity to become polarized*" (P24).

Some participants said that Facebook tried to adjust News Feed based on interests they specified in their Facebook profile. "*I don't know if this is possible or not, but this guy [a friend's name] and the other guy [another friend's name] always post these very liberal posts and you know, I tend to be liberal in politics and I'm wondering [if that's the reason]*" (P27). However, perceptions of Facebook's all-seeing eye were negative: "*It's kind of weird. It's like 'don't make those decisions for me' or 'don't pigeonhole me'; just because I said I'm liberal doesn't mean I wanna see everybody's liberal stuff*" (P27).

Some adherents to the theory thought that interest-based filtering extended beyond Facebook, suggesting that Facebook "*tracks the outward links we're following*" (P21). A few suggested that Facebook has wide access to any user behavior, on the platform or beyond it. "*Because I do news searches on world news, but that's been through like CNN and Fox, not Facebook. But if Facebook is linked to Google, then Facebook is getting that search saying, 'Hey, [P10] is looking for political news'*" (P10).

The Narcissus Theory, Revisited: In addition to the instances of The Narcissus Theory mentioned in the pre-probe interviews, during the probe participants also considered family relationships, "*how many friends you share*" (P3), and shared geography as potential sources of similarity. Participants speculated that Facebook could determine that users were family either via stated relationships or by matching "*the same last name*" (P15). This theory was sometimes extended from the number of mutual friends to the user's relationship with those friends. For example, "*It might be because my wife is tied in with his wife and him pretty closely. So if my wife is looking at [a friend's name's] page all the time, I'm tied in with my wife's page so Facebook automatically ties me in all the time. So it's like the association*" (P10).

The OC Theory: On many Internet platforms, original content is referred to as "OC." Some participants thought that original "*self-composed content*" (P39) was shown more than shared content. Therefore, they assumed that "*when you upload your own photo versus just sharing another photo from another Facebook page*" (P19), it would more likely be displayed in News Feed. Overall, "*people who tend to create their own content*" (P39) would have more stories appear on others' News Feeds.

The Global Popularity Theory, Revisited: This theory appeared in the pre-probe discussion, but participants during the probe extended this idea of a popularity weight to friendships. For example, a participant suggested that having many friends itself implied a higher level of personal popularity which might trigger the algorithm to show more of that person's stories: "*I think it's possible that the people here [in 'mostly shown'], they have more friends. So maybe they think they are more social [...] for example, the number of [their] friends might be very large*" (P1).

The Fresh Blood Theory: A few participants thought they saw most of a friend's stories because they had recently become friends on Facebook: "*He recently friended me so*

maybe that's why [he's in the 'mostly shown' column]" (P32). Some thought that Facebook might not have enough information about new friends to filter well, so they suggested it might default to sharing all stories from new friends.

The Randomness Theory: Finally, a few participants felt that the algorithm acted randomly: "*It looks to me that it's very random on what it weeds out because I do sometimes see posts where [a friend] is now friends with [a friend] but it looks like it's not posting all of those*" (P16). "*I'm guessing it only sends out 20% of [a friend's] posts, and maybe it just randomly selects which ones*" (P28).

Theory Development with Seamful Design
Comparing the theories of Aware participants before and after the FeedVis probe, we found that they extended their pre-probe theories and proposed new theories. This suggests the potential of such visibility tools, even in cases where it is difficult or impossible to reveal the authoritative description of a hidden algorithm. Although users were shown only outputs with and without algorithmic curation, they were able to develop their mental model of how News Feed worked, extending or exploring new ideas in response. Aware participants, while having preexisting theories, found that the probe allowed for more exploration opportunities than the current News Feed interface: "*This is fantastic by the way. It's lovely how you've made the trends and you can have hypotheses based on what you're seeing there*" (P21). This exploration helped them confirm their existing theories: "*The study confirmed a lot of things I assumed, or knew, about Facebook already and how I was using Facebook actually did make a difference to the things I saw on my News Feed*" (P20).

Since Unaware participants began with no initial theory of the algorithm's functionality, we compared their probe theories with the Aware participants' probe theories. In doing so, we examined whether providing visibility into the hidden algorithm's outputs could help participants with no prior understanding of the algorithm's functionality reach a similar level of understanding as the previously aware participants. Because we could not provide any "ground-truth" understanding of the algorithm's functionality, we considered Aware participants' understanding or theories as a baseline of the level of understanding that could be developed through Facebook usage and its interface. Through this comparison, we found out that each theory was similarly prevalent in both the Aware and Unaware groups (Table 1, column 2). That is, by the end of the probe, both groups had a considerable stock of common understandings about how the algorithm might work. This rapid similarity suggests that providing extra visibility could help the users rapidly develop new and predictable conceptual understandings of a system.

Applying Theories to Achieve Desired Outputs (RQ3)
With the post-probe phase, we hoped to better understand whether the theories developed during the probe would help users achieve their goals and more generally, how much control and influence participants felt they had over their News Feed with and without particular theories. We found that although the participants proposed many theories to explain how the algorithm might work, they primarily resorted to two

of them when trying to think of ways to accomplish their own tasks or goals within the system.

Reasoning with The Personal Engagement Theory: This was the most common theory users employed. They believed that changing the number of their interactions with a friend might accomplish their rearrangement goals. The primary forms of interaction they mentioned were "liking" or commenting: "*I would assume the next time I see him post something, if I click 'like', or I comment on it, I am more likely to see the next [story]*" (P28). Other interpretations of engagement were also proposed: "*I feel that if I [...] look at her page more, that would maybe trigger something*" (P14). Or, "*I would think that if looked for him, if I typed his name into the search, then I would think that I started seeing his posts but I don't know, that's just my hunch*" (P27). A few brought up tagging, noting that "*maybe tagging that person yourself; maybe Facebook starts recognizing patterns that maybe you are interested in what that person is doing.*" (P4). These participants thought of changes in their engagement as a message or "*an instigator*" (P21) "*that would cause Facebook to recognize that [they] wanted to see [a friend's] posts too much or not [at all]*" (P36).

Facebook users thought their own behaviors in these circumstances were manipulative as they did not represent a genuine or authentic interaction. In other words, they were forced to deceive the algorithm by changing their behavior. For example, one suggested that "*you could just prod the algorithm along*" (P38) to move someone from the "rarely shown" to the "mostly shown" category in FeedVis.

Reasoning with The Control Panel Theory: The second most common theory participants relied upon was The Control Panel Theory. The settings they were interested in were primarily those discussed earlier: following or unfollowing friends, hiding stories and using lists. "*I could probably just hide his posts to see less from him*" (P20). "*If [my] theories are correct, I can make sure he's on one of my kind of self-created groups of people*" (P39). A few suggested "*to go to the friends button [...] and click on 'show on News Feed' [option]*" (P9). There were also a few participants who believed that "*there has to be a filter on Facebook*" (P10) that can be controlled to achieve their rearrangements, though they were not aware of where it might be or how it would work.

Despite proposing a variety of actions, participants following both The Control Panel Theory and The Personal Engagement Theory were uncertain of their efficacy: "*I don't know if my writing on a person's wall has anything to do with it or not*" (P39). Of all the participants, eight could not suggest *any* method to reach their rearrangement goals. For example, in an attempt to find a way to change a story written by her cousin from the hidden to the shown category, one participant eventually stated that she did not "*know if there's a way you can decide what you see from a person*" (P15). Although these participants developed theories for how the algorithmic filtering operates, they asserted that "*there's a lot [they] don't know and understand about Facebook*" (P31) that prevented them from proposing any theory on how to accomplish a modification task such as this one: "*If I under-stood how Facebook chose to do what they did, then I would know what I needed to do but since I don't know what that is, I don't know. If they told me what to do, I would do it!*" (P35).

Beyond these two theories, why did the other folk theories go unused? In the Personal Engagement Theory and The Control Panel Theory, the participants considered themselves an active party with the power to change the inputs to the algorithm; for the remainder of their theories, they did not. In other theories, the main sources of agency were either other Facebook users, Facebook itself, or both. For example, if a user believed The Format Theory, there was no way to act on this theory for content to produced by others: they had no ability to make a friend upload more photos and less text. Some of the remaining folk theories do have potential behavioral implications in other contexts. The Eye of Providence Theory might lead a user who was concerned about privacy to carefully monitor the identifying information that appears in their own Web searches, as they believe everything they do is being collected and sent to Facebook. Alternately, the theory might lead them to abandon attempts to protect their privacy – the all-seeing eye is so powerful, it might make such attempts seem futile.

LIMITATIONS

We found these results provocative, but our small, non-representative sample leaves us unable to assess folk theories across all Facebook users, much less all people. This study did not use a randomized experimental design, therefore it cannot state that particular probes cause particular kinds of reasoning. It is also important to note that the elicitation procedure used in this study is intentionally a demand response. That is, we almost certainly produced some folk theories in the minds of the participants when they may have held no theory at all before participating in this study. Our within-subjects design is intended to expose users to several views of Facebook as puzzles in order to maximize the chance to observe and collect reasoning and variance in folk theories. Although we achieved a diverse sample, the prevalence of these theories "in the wild" cannot be measured by this research design, and is left for future work.

DISCUSSION

The Power of Seams

In this study, FeedVis introduced seams to flag that Facebook News Feed curation algorithms were doing behind-the-scenes work, provoking the users to speculate about how that algorithmic work might function. System-builders wish to hide this mediation for both pragmatic and self-serving reasons. On Facebook, a discontinued service previously known as "sponsored stories" allowed advertisers to pay to use status update text and images of users as advertisements. According to journalists, most users were unaware their contributed materials could be used in this way, making sponsored stories "one of Facebook's most unpopular" and controversial features for those users who were aware of it [4]. Yet most users probably never knew their writing could be sponsored, as the feed interface blended advertising and so-called "organic" posts in a way difficult to visually disentangle. It is

unlikely that commercial platforms will highlight mediations such as invasive personal data collection or resale.

Seamful interfaces may then be legitimately seen as a tool for the user to be empowered against a system when their interests might differ. Seams could be deployed to build trust and dispel suspicion. Our study of seamful design, however, demonstrates additional roles for the practice. Using FeedVis combined the experience of learning about a platform that was important in our participant's lives with the experience of introspection about their own relationships. We speculate that seams themselves can be pleasurable, as they satisfy curiosity as readily as they might produce oversight.

We found that participants' ability to derive theories was a function of the information revealed via the seams in our interfaces. This information is present on the Facebook web interface; it is simply displayed differently, in some cases with different seams. The participants in our study noticed features such as story format and engagement with friends, probably stemming from our Content View and Friend View, respectively. This certainly suggests that choosing which seams to reveal affects the theories that people create. While no design can or even should reveal all the possible seams into an algorithmic system, this finding shows that selecting specific seams would affect users' understanding of algorithmic systems. The exploration of seams in algorithmic processes is in its infancy. This work presents a first step.

Our intervention revealed seams through a third-party interface. We stated earlier that seams make elements visible *when the user actively chooses to understand or modify that system*. This approach enables selective exploration, but it is not the only approach. Accidental or unintentional reveals in the main interface as well as variance due to A/B testing catalyze community discussion and exploration. We ponder how institutionalizing an intermittent "glitch" day or hour, whereby a system would temporarily reveal potential debugging or additional information (e.g., audience size) would affect the community and their algorithm awareness.

Uncertainty: Challenges & Opportunities
Though using the probe helped many participants propose new theories or extend their existing theories, participants were still uncertain about some of their proposed theories. For example, some participants proposed a theory and then noticed in the probe that the theory did not work everywhere: "*I have absolutely no clue, because I don't even talk to that person on a regular basis – which I thought is what they show me: 'people whom I talk to'* " (P15). Such inconsistencies made it difficult for some to "*see any type of pattern* " (P4) to develop a theory. A few participants even argued that the algorithm might function randomly in some cases.

While the uncertainty resulting from inconsistent outputs confused some participants, it prompted others to further reflect on the algorithmic process. In these cases, participants found the inconsistency more intriguing than confusing: *"It's interesting that it shows me that somebody liked a webpage but it won't show me when a friend changes a picture"* (P5). It prompted them to examine many News Feed features si-

multaneously and come to the realization that some received more weight than others. We posit that uncertainty stemming from seamful design can lead users to deeper thinking and even more creative and innovative use of the system.

Agency
We found that participants relied on two of their theories, and they could not imagine applying their other theories. In fact, in most of their proposed theories, they did not see themselves as possessing any agency; either the content creators or the algorithm determined what they saw. And yet, in the post-probe phase, users clearly did have goals and tasks they wished to accomplish – changing which people they saw most frequently or what types of stories they saw. However, many users see even these simple tasks as being outside of their abilities. This suggests an important area for potential growth in interface design: changing the design to give users a greater feeling of agency over their News Feed and promoting learning about it using seamful design.

Folk Theories and Platforms
Reflecting on the folk theories we discovered, we conclude that they may be formed in a process of interactions between a user's prior assumption about a platform's status or motive and their experience of seams. For instance, the Control Panel Theory and the Eye of Providence Theory both envision a position of powerlessness, but the former posits filtering is unmanageable due to the user's personal limitations, while the latter suggests it is due to a vast power differential with the platform. Other filtering theories may be epiphenomenal of assumptions about fairness — for instance, some imply a commitment to representing all voices (the theory of Loud and Quiet Friends, Randomness). This suggests a critical role for future research that disambiguates the role of seams, trust in the platform, perceived personal efficacy, and other factors.

CONCLUSION
While earlier work has stressed the use of folk theories for sense-making, this work compared folk theories derived from a popular public-facing algorithmic interface, Facebook's News Feed, to an alternative interface that incorporated seams into basic algorithmic feed function, FeedVis. We found that our participants could morph folk theories effectively and rapidly using seamful interfaces that reveal glimpses into algorithmic process. We also found that theories generated by less aware users were remarkably consistent with those developed by long-term users of the Facebook interface. We argue that as more algorithmic processes provide curated information, structured seamful design approaches will benefit not only algorithm awareness but overall human-algorithm interaction and human agency in complex systems.

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