Technology and Community Behavior in Online Environments

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1. Introduction

The literature on virtual or online communities contains two largely disjoint bodies of scholarship. One, which we call the "communities" literature, is concerned primarily with the social and psychological processes observable within groups of people that interact regularly in online environments. The other, concerned primarily with the effects of technological environments on individual and group behavior, we call the "environments" literature.

Of necessity, the "environments" literature must also address social and psychological processes. However, much of the "communities" literature fails to discuss aspects of technology that might contribute to an explanation of the findings reported. We believe that greater attention to technological issues on the part of "communities" researchers would enhance knowledge integration and theory development. The purpose of this paper is to build a case for this integration through a review of prior research and an empirical illustration in four online environments that target the same general membership but differ dramatically in their technological support for social processes.

The plan for our paper is as follows. We first review some of the prior empirical evidence suggesting that virtual community behavior is sensitive to differences in technological environments. We note that there are many theoretical explanations for this relationship, just as there are for social and psychological processes considered on their own. We present a rudimentary analytic framework linking social processes with

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technological features and then illustrate the framework with evidence from four "Mommy" sites, online environments for information of interest to, and interaction among, new mothers.

1.1 Prior Research on the Role of Technology in Online Community Behavior

The field of social psychology pioneered the study of the effects of communication media on human communication (Kiesler, Siegel, & McGuire, 1984; Short, Williams, & Christie, 1976). More recently, the fields of computer science and information systems have contributed to "a growing body of empirical evidence that the medium can shape the message, or at least, how the message is packaged and processed" (Herring, 2004, p. 26).

A review of over twenty recent studies in technology-related and communication journals suggests several conclusions. First, human communication behavior in online environments exhibits predictable variations that can be attributed in part to human adaptation to the technical design characteristics of online environments. Technical characteristics such as the following appear to matter, statistically, for the behavior observed in online environments:

- How quickly messages are made available to communicators (Hancock & Dunham, 2001; Malhotra, Gosain, & Hars, 1997)
- Whether "reply" functions support message quoting (Eklundh & MacDonald, 1994; Markus, 1994b)
- Whether or not there is a persistent record of the communication (Condon & Cech, 2001; Gergle, Millen, Kraut, & Fussell, 2004; Herring, 1999)
- Whether there are explicit turn-taking cues (Hancock & Dunham, 2001)
- Whether participants can see the same things (Hancock & Dunham, 2001)
- In what order/groupings (threads) messages are made available to members (Hewitt, 2001, 2003; Schoberth, Preece, & Heinzl, 2003; Venolia & Neustaedter, 2003)
- Whether there are facilities for private, as well as public communication (Coghill, Fanderclai, Kilborn, & Williams, 2001; da Silva, de Souza, Practes, & Nicolaci-Da-Costa, 2003)
- Where and what kinds of additional material can be included in text messages (e.g., links, attachments) (Ducheneaut & Bellotti, 2003)

- Whether there is message search capability and how it works (da Silva et al., 2003)
- Whether there is automated moderation (filtering of messages) or indications that humans are filtering messages (Leimeister & Krcmar, 2005; Malhotra et al., 1997; Maloney-Krichmar & Preece, 2005)
- Whether and how participants can reveal information about themselves and learn about others' identities or their availability for communication (Greenfield & Subrahmanyam, 2003; Leimeister & Krcmar, 2005)
- How message content is presented (e.g., headers) (Hewitt, 2003; Schoberth et al., 2003)
- How complex and voluminous content is managed for, or can be managed by, participants (Jones, Ravid, & Rafaeli, 2004; Schoberth et al., 2003).

Technology is not the sole source of behavioral regularities in online environments; social learning is also important. Furthermore, not all individuals adapt the same way to the conditions of communication environments, and people can appropriate technological features in creative ways, e.g., for play (Herring, 1999). The nature and the quality of human communication strategies are clearly very influential (Hancock & Dunham, 2001; Hewitt, 2003). Nevertheless, technology matters.

Second, technologists understand online environments in terms of distinct "types" such as email clients, newsgroups, chat software, blogging, etc. (Preece & Maloney-Krichmar, 2003). Each type exhibits different characteristic behavioral regularities. For example, there are noticeable differences between synchronous environments such as chat and asynchronous environments such as newsgroups (Condon & Cech, 2001). Similarly, effective strategies for maintaining communication coherence are different in email than in newsgroups (cf. (Ducheneaut & Bellotti, 2003; Hewitt, 2001). However, there are also substantial technical design differences within each type, and these differences can be associated with different behavior patterns. For example, email designed with both sequential message presentation and a threaded tree structure is a very different tool in terms of the behavior of its users than is email with only sequential presentation (Venolia & Neustaedter, 2003). In a fully crossed experiment, (Griffith & Northcraft, 1994) found significant main effects for both individual technical features (such as anonymity) and for "media" types (e.g., group decision support systems), as well as significant interaction effects between features and types.

Third, the technological environments used by online or virtual communities (understood as groups of *people* interacting online for a purpose governed by policies; de Souza & Preece, 2004; Preece &

Maloney-Krichmar, 2003) may consist of several different technology types (informational sites[1], newsgroups, chat, blogs) either alone or in combination. Even apparently similar virtual communities may have access to very different technical capabilities and resources. Consider the two health sites described by (Leimeister & Krcmar, 2005; Maloney-Krichmar & Preece, 2005). The latter has a bulletin board, a library, and a photo album. The former has a bulletin board, a library, an "ask an expert" service, chat, email, contact search, and "awareness" functions. Assuming that some of the behavior of online community members can be attributed to characteristics of their technological environments, it is important to consider such differences across sites when generalizing about social behavior in online communities. Furthermore, Maloney-Krichmar & Preece (2005) reported that community members attributed their attachment to the site, not only to social interactions with other members, but also to the site's research library, a valued information resource. This line of reasoning suggests that, although many virtual community researchers only study computer-mediated and/or offline *communication,* more studies should examine the totality of community members' behavior in their multi-functional online environments[2].

Fourth, technology continually evolves. The technical characteristics of a single type of online environment at one point in time are different from those of the same type five years later (Ducheneaut & Bellotti, 2003). Therefore, changing behavior patterns over time may reflect technical characteristics that are co-evolving with socially learned use practices. (See Blood, (2004) for a description of this process of co-evolution with respect to blogging.) Thus, generalizing about the behavior of online communities requires sensitivity to the historic era in which each study is conducted (cf. Markus, 1994a).

Fifth, there are numerous plausible explanations for the effects of technology on behavior in online environments. Many of the studies cited above rely on common ground theory (Clark, 1996), but others draw on social presence or diminished cues theory (Kiesler et al., 1984; Short et al., 1976), cognitive limitations theory (Jones et al., 2004; Murphy, Hofacker, & Mizerski, 2006), etc. These theories coexist with many other relevant theories of online communities that do not necessarily address technological issues (Ling et al., 2005; Preece & Maloney-Krichmar, 2003). No single theory or framework that we are aware of accommodates

[1] Community behavior has been inferred from patterns of website linking, not solely from newsgroup style communication. See Mitra (1999)

[2] We agree with Porter (2004) that the off-line environment may also be important.

both the range of social and psychological processes observed in virtual communities *and* the range of technological aspects of online community environments. It is beyond the scope of this paper to develop such a framework, but two obvious candidates for inclusion are the concept of social processes and the concept of technology features. In the next section, we briefly discuss these concepts before we discuss their interplay in several empirical virtual communities.

2. Social Processes and Technology Features in Virtual Communities

A perennial theme in the virtual communities literature is whether virtual communities are indeed communities (Blanchard & Markus, 2004; Wellman & Gulia, 1997). There is little doubt that some online environments fail to develop or maintain sustainable levels of membership and contributions (Joyce & Kraut, 2006; Porra & Parks, 2006). By contrast, it seems likely that the more successful virtual communities exhibit developmental processes similar to those observed in groups (Chang, Bordia, & Duck, 2003; McKenna & Green, 2002). At one time, all groups were thought to pass through a set of developmental stages in sequence (Bion, 1961). Today, the evidence suggests that some groups exhibit non-linear developmental patterns. Nevertheless, there is consensus in the field that (at least the more successful) groups work through a number of key issues in the process of group "formation". Three such issues that appear highly relevant to successful virtual community development are *identity* (or inclusion), *influence*, and *intimacy* (Bion, 1961).

Early in the life of a group, members often experience anxiety about their inclusion in the group (Chang et al., 2003). Much of their participation takes the form of attempting to establish an identity and to experience feelings of belonging to the group. In our prior research, we observed two types of identity issues in virtual communities: attempts to present an identity to other members and efforts to learn something about the identities of other members (Blanchard & Markus, 2004). The identities established in online communities are sometimes "real" ones (O'Mahony & Ferraro, forthcoming). Sometimes, however, participants experiment with alternative presentations of self (Turkle, 1995). Many "community" researchers focus on how learning the identity of others (Postmes, Spears, & Lea, 2000) and how presenting one's identity (Ma, 2004; McKenna & Green, 2002) contribute to a range of behavioral and

affective outcomes, including participation in, and satisfaction with, the community. Additionally, identity is believed related to the influence processes of creating and following norms (Postmes et al., 2000; Sassenberg, 2002).

A second set of group development processes involve individuals' attempts to work out a role for themselves in the group (Chang et al., 2003). This involves efforts to gain status and to influence others' behavior. In the virtual communities literature, two influence processes have received considerable research attention: the development of norms of appropriate behavior and the sanctioning of counter-normative behavior (Birchmeier, Joinson, & Dietz-Uhler, 2005; Burnett & Buerkle, 2004; Postmes et al., 2000; Sassenberg, 2002; Wagner, Chung, Ip, & Lee, 2005).

In the groups literature, the development of trust and intimacy represents an important milestone in the life of a group. In physical communities, the exchange of support has been observed as an essential contributor to the perception and experience of a community as a community (McMillan & Chavis, 1986; Schuster, 1998). The exchange of support has also been observed as a key process in virtual communities (Baym, 1995; Bergquist & Ljungberg, 2001; Rothaermel & Sugiyama, 2001; Turner, Grube, & Meyers, 2001; Weis et al., 2003). In particular, the exchange of support is important in common ground theory (Clark, 1996), because it allows the group to develop a history of discussions on topics that are important both to the group and to specific individuals, which is believed to help establish shared meanings and lead to the development of trust.

The analogy between small group formation and virtual community processes should not be stretched too far. After all, most virtual communities are orders of magnitude larger than the collectives studied in the groups literature. Second, much of the groups literature examines experimentally established collectives in which all members join at the same time and remain in the group for a considerable duration. By contrast, although successful virtual communities do exhibit a core of faithful members, members are continually coming and going. Some members lurk invisibly, rarely or never entering into community life. And some people join virtual communities with the malicious intent of crashing and disrupting the party (Birchmeier et al., 2005; Burnett & Buerkle, 2004; Wagner et al., 2005). Despite these differences between small groups and virtual communities, there are enough indications to suggest the importance of identity, influence, and intimacy processes in virtual communities.

Naturally, how these processes play themselves out in virtual communities is likely to bear some relation to differences in kinds of technical opportunities available to people in online environments (Resnick, 2002). In face-to-face groups, for example, it is much more difficult than in virtual communities to construct a false identity around such easily observable characteristics as gender. Similarly, people have shown themselves to be more susceptible to influence attempts in some mediated environments (specifically telephone (Short et al., 1976): the word "phony" originated in response to the success of telephone con artists). Opportunities to express support and intimacy are likewise more constrained in online than in face-to-face environments.

In identifying which technical features to examine in relation to our group development processes, we cannot turn to previous literature since the purpose of this paper is to develop and present these relationships. Instead, we grounded our choice of technical features in our initial observations of virtual community interactions. From these initial investigations, three bundles of features in the online environments appeared to align roughly with these three groups of processes[3]. We call them 1) *identity cues*, 2) *status and control tools*, and 3) *attention, availability, and response indicators*. Identity cues are the technological means by which a virtual community member, for example, signals her own identity or interprets the identity of others. One example is self-completed "profiles" that allow members to communicate information about themselves such as number of children and particular interests (Greenfield & Subrahmanyam, 2003; Leimeister & Krcmar, 2005). Profiles may allow a member to control others' access some or all of her personal information. (We note that some of our technological features could conceivably fall into more than one of our groupings. For example, profiles may also be used by online environment software to control the presentation of information to the member herself—for example, limiting access only to particular threads or blocking communications from certain members. Thus profiles are also related to the attention, availability, and response indicators discussed below. However, we consider each technical feature in the grouping where it appears most relevant.) Another feature is the ability to automatically append a "signature file" to all messages a member sends to other members (Blanchard & Markus, 2004).

Status and control cues are the technological indicators of members' role or status in the group and the means by which counter-normative behaviors can be controlled, whether automatically, by human administrators, or by members. For example, some online environments

[3] See Resnick (2002) for a different way of grouping features.

automatically keep track of the number of messages a member has posted in the past. Just as members of face-to-face groups often indicate or achieve social dominance by talking a lot, members of virtual communities who are known to participate frequently tend to be influential. However, given people's episodic participation in online environments, others' frequent participation is likely to be missed without technological features that signal communication frequency. Empirically, we have observed that frequent contributors to online environments where frequency of communication is automatically flagged are often treated by others as high status members. Also included in this category of technology cues are member registration procedures, automated message filtering, and signals or posted information (de Souza & Preece, 2004) about acceptable behavior, human moderation of content (Malhotra et al., 1997), and penalties for unacceptable behaviors such as the ability to block members from further participation or to suppress their contributions. Even control cues that incorrectly signal that content is monitored or filtered appear to reduce the incidence of unacceptable behavior like flaming, trolling, etc. (Malhotra et al., 1997).

A third important category of technical features are attention, availability, and response indicators. These are the means by which 1) members can learn that something is happening in the group that could be of interest to them; 2) members can (or software automatically does) signal to others that they are available for participation; and 3) members can learn, in particular, whether someone is "talking" directly to them. Examples of features in this category are the structures of communication forums and/or of topics within forums, indicators of new postings, signals that someone is online, and techniques for indicating that a message posted by a member has received a reply—such as an email, a flag on the site itself, or technical aids for quoting the original message content within a reply (Eklundh & MacDonald, 1994). There is strong evidence that such features have significant effects on members' participation behavior. For example, Joyce and Kraut (2006) found that newsgroups members are much more likely to stay in newsgroups if they get any sort of response to messages they point. However, Hewitt (2003) as well as Murphy and colleagues (2006) reported that people are much more likely to respond to messages that are marked as "unread" and to messages that appear at the top of their screens. Therefore, how online environments present information can affect the likelihood that members will receive replies to their communications and therefore their likelihood of continued participation, and by extension the likelihood that the virtual community will remain active and self-sustaining.

We do not mean to imply that these are the only important features of online environments. Nor do we contend that there is a one-to-one correspondence between specific technical features or bundles of technical features and social or behavioral outcomes. In the first place, just because an online environment has features by which certain things can be done does not mean that people will actually use them at all or in the ways we suggest. Second, some features can be used in more than one social process. However, we do suggest that virtual communities interacting in different online environments are likely to exhibit different behaviors and outcomes and that some of this variation will be consistent with the differences in technical features. We believe this hypothesis is plausible, and therefore, that it deserves both theoretical engagement and empirical examination. As a first step in that direction, we explored the behavior in four virtual communities that are similar in audience and interests but that differ considerably in technical features. We believe our preliminary evidence warrants the need for future theorizing and research on the links between the technology of online environments and the behavior and outcomes of virtual communities.

3. Method

The hypothesis that technical differences are related to behavioral outcomes is, we believed, best examined in virtual communities that are otherwise as similar as possible. That is, they target the same potential members with the same area of common interest. The first author conducted an exploratory investigation of approximately 175 hours over 12 months of four "Mommy" sites, online environments that primary target and are populated by new mothers[4]. This choice of domain is essentially arbitrary, but it does have the advantage that there are different theories of parenting and that parental beliefs about some of the issues are extremely strong. One example of a controversial parenting style is attachment parenting, which encourages extended breastfeeding and co-sleeping. Thus, Mommy sites invite, not just people in search of information and personal support, but also conflict and controversy. Consequently, "inappropriate behavior" can and does occur on these sites.

The four sites we examined are **Babycenter.com**, **CharlotteMommies.com**, **Phantom Scribbler**, and **DrSears.com**. Three

[4] Although men also participate in these sites, they are overwhelmingly inhabited by women.

of the sites are comprehensive web forums that contain, to a varying degree, links to parenting information, discussion boards, and online stores. CharlotteMommies.com is not for profit while Babycenter.com and DrSears.com are commercial. All three cites have paid advertising, the proceeds of which provide the bulk of their funding. **Phantom Scribbler**, a personal blog site, does not offer these options.

Babycenter.com, henceforth **Babycenter**, is a comprehensive web site containing articles, advertisements, stores, a video library, and "communities" all relating to conception, pregnancy, and parenthood. **Babycenter** has over 875 bulletin boards and "birth clubs". Birth clubs are forums for people who are due to give birth or gave birth in a particular month (e.g., July 2004). These groups can be tremendously active. Other bulletin boards include Q&A about specific issues (e.g., exercise during pregnancy) or for parents with similar interests to discuss pregnancy and parenting issues (e.g., infertility, holistic families, Mormons, parents in North Carolina). Other groups called Great Debates are for parents who do not share the same interests to get together expressing to discuss controversial parenting topics like attachment parenting and whether or not to let children cry themselves to sleep.

Charlottemommies.com, henceforth **CM**, is a local parenting forum for Charlotte, NC area mothers only. (There are similar sites in many other cities around the country.) Members have to apply and demonstrate that they live in the area and either that they have children or are trying to have children. **CM** members can participate in over 25 common forums on various topics. But members can join any number of other private groups based on their interests or their geographic neighborhood in Charlotte.

Phantom Scribbler, henceforth **Scribbler,** is a very popular and interactive blog in a genre known as "Mommy blogs". The author of **Scribbler** discusses her two children as well as various political and social issues. **Scribbler** has a very long blog roll (lists of other blogs tracked), and the author's posts often has many (10-30) comments from regular readers. **Scribbler** has a posted comments policy describing the author's expectations and rules for people who want to comment. The most current comments are listed in a sidebar on the main blog page.

AskDrSears.com, henceforth **DrSears**, is a web site for fans of Dr. Bill Sears and his family and for non-fans seeking parenting advice and information. Dr. Sears has several very popular pregnancy, baby, and parenting books and is an advocate of attachment parenting. **DrSears** has five community forums all related to Dr. Sears' parenting philosophy

(Attachment Parenting, All Night Sucker[5], Father Nursing, Moving Baby from Bed to Crib, and Family Nutrition).

We conducted a detailed examination of each site in which we documented the technological features in each of the three categories discussed above—identity cues, status and control tools, and attention, availability, and response indicators. We described how the features worked, and we made observations about how and how frequently members made use of those features. A summary of this analysis can be found in Tables 1, 2, and 3 in the Appendix. Then we considered how these features were likely related to the three social processes of identity, influence, and intimacy. Our exploratory analysis of these issues is presented below.

3.1 Technology and Behavior in Mommy Sites

In this section we discuss how differences in technology features across the four Mommy sites appear to be related to differences in the behavior of the members. The discussion is organized around the three major social processes of identity, influence, and intimacy.

Identity

The most basic clue to the identity of a virtual community member is username. A familiar situation is for members to choose usernames when they join an online environment. These usernames may reflect something about the user, such as part of one's real name (Louise813) or another identity cue (JaylensMommy). However, in some systems, the choice of usernames is constrained by software design or system administration rules: e.g., the username must not previously been chosen, it must be linked to a valid email address, there may be only one username per valid email address, etc. The net result of such rules can be to disallow truly anonymous postings and to permit the traceability of postings to individuals.

Anonymity and traceability are very important in virtual communities where self-disclosure of personal information is to be expected. First, anonymity may free people from the fear of censure, encouraging them to disclose more (Pinsonneault & Heppel, 1997/1998). On the other hand, anonymity may also disinhibit people, promoting critical or even

[5] This is a pun related to babies who will not sleep through the night and want to breast or bottle feed instead.

objectionable comments that discourage others from contributing (Pinsonneault & Heppel, 1997/1998). However, traceability allows system administrators and members to censure offenders through removal, blocking or shunning. Finally, traceability is likely related to people's willingness to trust the people who make comments and the information they provide (Markus, 2001). Beyond usernames, many systems provide additional ways for members to disclose information about themselves, such as profiles, avatars (icons or photographs), and signature files, which can lend credibility to members' postings or can invite personal interaction from similar others.

As shown in Table 1, we found surprising variations in the ways the four sites handled all aspects of members' identity, even such basic issues as username. At one extreme, **DrSears** provides no technological support related to member identity. The system does not assign unique usernames nor track them to participants; indeed, participants must type in a username every time they post, and there is nothing to prevent people from adopting multiple identities or even from hijacking a username previously used by someone else. There is no profile support, no avatar feature, no support for signature files, unless a poster were to type one in manually with every post. Nonetheless, participants on the site tend to keep the same or a very similar username across posts and threads. Without this consistency in behavior, participants would have great difficulty referring to each others' posts and thus difficulty keeping conversations going. However, **DrSears** participants sometimes also use the freedom of ad hoc usernames to present themselves in light of a current state or problem related to the board ("OneTiredMommy").

At the other extreme, site administrators at **CM** not only link unique usernames to valid email ids, they also check that users have a valid street address in the Charlotte area. Potential members must also indicate they have or are trying to have children. This precaution helps ensure members that others are who they claim to be: local area mothers seeking information on parenting versus, say, distant business owners flogging products or malicious hecklers. Beyond this initial level of member identification, **CM** provides members with an easy-to-use profile system that allows members to input a personal icon or photograph, a signature file with information about their pregnancies or children, and, if they choose, an email address for one-to-one contact off the site.

Because they can enter this information all in one place, nearly all **CM** members use both an avatar and a sig file and keep their profiles up-to-date. By contrast, whereas **Babycenter** allows members to add more personal information and information unrelated to parenting than **CM**

does, **Babycenter** requires users to update personal information in three different locations on the site. Not surprisingly, therefore, we found that, while the use of avatars and sig files is common, most **Babycenter** members do not have both avatars and sig files. We also observed that personal information unrelated to parenting did not serve to promote personal connections among members to the same extent as personal information relevant to parenting. Despite the fact that **Scribbler** herself is an anonymous blogger, her site may actually provide greater opportunities for her commenters to learn about each other than in either **CM** or **Babycenter**, because comments contain links to commenters' websites, and these sites are usually frequently updated blogs, not static profile information.

Influence

As noted above, the potential for disinhibited behavior—such as critical or hostile comments and worse—is believed greater when participants are anonymous—as at **DrSears**. And since the **DrSears** site is devoted to a controversial style of parenting, one has even more reason to expect the potential for inappropriate behavior there. It should not be surprising therefore that **DrSears** takes the most heavy-handed approach to the control of posters' behavior of the four sites we studied. (See Table 2.) Although there are no posted rules or visible human moderators on **DrSears**, people cannot make postings without automated warnings that their postings will be delayed up to 24 hours for review and will not be posted if found unacceptable. Posters are given an email address to question or comment on this policy and are presented with this prepared statement:

> **AskDrSears.com** is serious about family values. To uphold the integrity of **AskDrSears.com** all messages are subject to review. **AskDrSears.com** reserves the right to not post messages.

Given the speed with which messages are posted, we infer that automated filtering software is used to search for search and block messages containing objectionable keywords. Although we cannot observe how often blocking actually occurs, other research (Malhotra et al., 1997) suggests that the visible threat alone will reduce misbehavior.

The other three sites rely on a combination of posted rules, human moderators, and social control by members, but they vary in the uniformity and negotiability of rules. On both **CM** and **Babycenter**, discussion boards devoted to less controversial topics (e.g., trying to conceive) do not have posted rules and may not have a moderator, whereas boards devoted to

more controversial topics (e.g., attachment parenting and breastfeeding) are more likely to have extensive and highly visible rule statements as well as named human moderators. For example, on the **CM** attachment parenting board, a "sticky" (a permanent announcement at the top of the board) repeatedly reminds members that topics on this board should not be discussed outside it, particularly if the commentary is critical. On the **Babycenter** "great debate" boards, members are told:

> Please follow our community guidelines in all your posts. This is a debate board. On debate boards, viewpoints and opinions are questioned, challenged, and held up to scrutiny. If having your opinions challenged and being expected to defend your position will make you uncomfortable, please don't participate here. Instead, visit one of our more than 875 other bulletin boards, where you can find support on all sorts of topics.

Whereas **Babycenter** appears not to invite negotiation over the rules, **CM** occasionally signals to members an invitation to participate in the crafting of its governance. When some new **CM** boards are created, the "sticky" announcements that contain board rules are set to accept replies from members' approving or disagreeing with the rules. (At some point, however, human moderators usually disable this reply feature, disallowing further negotiation of the rules.) **Scribbler** also has policy of allowing comments on the rules, but as the sole administrator and moderator of the site, she may exhibit greater flexibility in enforcing site policies.

Human moderators have various technological tools at their disposal for enforcing site rules. **CM** administrators can "move" messages and threads to other forums, marking them with an icon labeled "Moved." For example, discussions on extended breastfeeding are often moved out of the general Mommy forum and into the Attachment Parenting forum. Moderators appear to use this device to protect members from potentially offensive remarks (e.g., "Breastfeeding that long is weird."), to maintain the topical coherence of a particular board, and to send a subtle message to posters about what is appropriate behavior. In a sense, these icons signify that "the poster made a mistake by talking about this topic elsewhere; it really should go here." In addition, the Moved icon helped readers of the receiving boards interpret apparently out-of-place remarks.

Moderators can also exert control by removing offensive messages or even members from a board, but this activity is difficult to observe, especially in larger boards. In **CM**, when an active user was deleted for cause, other members noticed the removal and talked about it. However, in the much more active and populous **Babycenter**, removal of a member might never be noticed. And of course, at **DrSears** no one would know if a troublemaker never got past the automated filtering at the front door.

Naturally, members, not just official moderators, can contribute to social control by how they respond (or don't respond) to offending comments. They can also report problematic posts to moderators and site administrators. **Babycenter** makes it extremely easy for members to engage in social control: at the beginning of each posted message is an icon that readers can click to report it to administrators as a violation of site policies.

Babycenter signals the role and authority of site moderators by putting "bcHOST" at the beginning of their usernames. In **CM**, moderators and administrators have their roles automatically identified below their regular usernames. **CM** has an additional feature that conveys members' unofficial role as a high-status contributor to the community: automated reporting of members' tenure, numbers of posts, and an associated status name. It seems reasonable that designating some members as "Queens" (versus "New Mommies" or "Moms-in-training") for frequent contributions will affect how much influence they can have on other members.

Intimacy

The success of online environments depends on continuity of participation (Porra & Parks, 2006), and research suggests that one important factor is a member's receiving replies to the messages she sends (Joyce & Kraut, 2006). This finding in turn directs attention to how online environments are organized in general, how the availability of communicators and messages is presented, and how people reply and receive replies. As outlined in Table 3, we found major differences across the four boards, even about such mundane matters as whether new content is presented at the top of a page, at the bottom, or buried in the middle.

Consider a few items that we discuss as "attention indicators" in Table 3. At one extreme, all the reader finds at **Scribbler** is discussion: **Scribbler's** posts, most recent first, with others' comments following each post in the order it was received. By contrast, **Babycenter** members have to navigate through five webpages of material to get to the discussion boards. **Babycenter** and **DrSears** both show the fifteen most recently started conversation threads on the first page of each board, whereas **CM** shows 50 (!) threads. But when someone replies to a thread in **Babycenter** or **CM**, that reply "bumps" its thread to the top of the list (Culnan, forthcoming), easily showing the reader where the most recent activity occurred, whereas no bumping occurs at **DrSears**—there, the most recent message activity might not even show up on the first page of the board. **Babycenter** and **CM** readers can view up to 15 sequential replies in their entirety on a single page and **Scribbler** readers can see all the replies on a

single page. On **DrSears**, one can only read one message at a time, having to return to the main thread page to read the next reply in a thread. **Babycenter** members can elect to view only new messages in a thread instead of all messages, and they can also keep track of threads they are interested in via a heart icon (automatically attached to a thread when the member posts there).

An interesting difference in member behavior can be traced to these differences in features (in conjunction with differences in the community size and message volume). With its huge message activity and only fifteen threads on the first page of a board, threads can quickly roll off a main board page in **Babycenter**; once off the main page, they are much less likely to be read and replied to by others (Murphy et al., 2006). Consequently, communicators who are anxious to keep the conversational ball rolling or to get an answer to their posts will "bump" their thread back to the top of the first page by entering a one word message: "bump". By contrast, with the ability to keep as many as 50 threads on the first page and a much lower message volume, threads do not as easily rotate of the main pages of **CM** boards, and as a result, people rarely "bump".

Of course, having such a long list of items on a page is hardly an unmixed blessing. This is clearly visible in **DrSears.** Although only the most recent 15 threads are shown on the first page, the header of every single response to those threads is also visible at the same time (shown indented under the thread), and the result can be visually overwhelming. These threads change shape as new messages are added, making it challenging for readers to locate a favorite thread by remembering what it looks like.

The sites employ a number of other (different) features to entice users' participation. **Babycenter** lists "hot topics"—the five most active threads (based on total number of posts)—on the sidebar of its navigation page. Members can ask to be notified by email—once a day, once every three days, or once a week—that the site has received responses to the messages they posted on **Babycenter**, but they must go to the site to read them. By contrast, on **CM**, members are notified immediately by email when there is a new message; they still must go to the site to read it. On the **CM** board, members are able to see, not only the number of replies each message received, but also the *number of times each message was read*. (Similarly, a wiggling icon marks hot threads determined by both message volume and number of reads.) We believe the latter feature is very significant given the lower message volume in **CM** (relative to **Babycenter**). Because lower message volume reduces the likelihood that a poster will receive responses that reinforce her participation in the board

(Joyce & Kraut, 2006), **CM**'s automatic indication that people are "listening" may be reinforcing even when those listeners do not actually "speak".

In face-to-face communication people often address their remarks to individuals by eye gaze, by name, or by rephrasing their remarks. In online environments, various technological features make it easier or more challenging to accomplish analagous communication tasks. In **DrSears**, a reader cannot see the message to which they are replying and thus may forget to address some part of it. Further, because of a flaw in the software, if a reader posts a reply under another reply, the reader's own username is not attached to the reply, but rather the username of the person who replied first. These usability challenges may account for the frequency with which participants in **DrSears** put into their subject headings the username of the person to whom they wish to reply. This is an extremely uncommon occurrence in the other environments we observed. At the opposite extreme, not only does the thread structure at **CM** indicate clearly for whom a reply is intended, **CM** also provides a "quote" button for every message, allowing a communicator to target her remarks easily and precisely to particular posters.

4. Discussion

To summarize, we found great variation across the four Mommy sites in all three categories of technological features we examined (identity cues, status and control tools, and attention, availability, and response indications). We also found some interesting behavior patterns that appear to be related to the differences in features. For example, participants in one community (**Babycenter**), but not the others, routinely used "bumping" as a way to keep the floor and get responses to their posts. We found that in one community (**CM**), but not in others, automatic indicators of the number of times a message was read appeared to provide a viable alternative to the actual replies that have been shown in other contexts to keep participants coming back (Joyce & Kraut, 2006). Participants in another forum (**DrSears**), but not the others, routinely entered usernames manually into the subject line as a way of maintaining communication "coherence" (Clark, 1996) in the absence of other features that would allow a reader to identify a posting as a response to a particular message. In fact, the technological features of that site for community engagement were so limited that is perhaps amazing that participants were able to use the site at all for exchanging support.

In all four of the sites, participants found ways to engage in the processes of identity, influence, and intimacy. They did so differently, and some of those differences appear to relate to technological features. If the macro processes are the same, why do the micro processes matter? All four sites we looked at can be thought of as successful online communities of reasonable duration. We did not look at Mommy sites that failed. Our findings suggest it is at least plausible that some such sites never got going because of features that made it too challenging for members to work through the processes of identity, influence, and intimacy. We also did not look at Mommy sites during the process of community formation. Our findings suggest it is at least plausible that the different technological features of online environments create different behavioral demands on community leaders, e.g., to establish appropriate norms, to sanction unacceptable behavior, etc., if those communities are to succeed. And we only looked at four Mommy sites. We may have missed successful sites that are permanently locked into dysfunctional social behavior, such as routine flame wars or social scapegoating, in which particular members are singled out for hostile treatment. We don't *know* that dysfunctional online communities exist, but we do know that there are dysfunctional face-to-face groups and physical communities, so we suspect there might be an online equivalent. Our findings suggest it is at least plausible that the technological features of some online environments are the virtual equivalent of the poorly lighted alleys and broken windows that have been shown to promote crime and violence in urban neighborhoods.

In short, we conclude that the technological features of online environments are plausibly related to how participants can identify themselves and others, display status and engage in social control, and exchange support thus developing intimacy. In other words, technological features may promote or hinder to the successful formation and sustainability of online communities and may shape the nature of the "group dynamics" observed in them.

5. Conclusion

The purpose of this paper was to demonstrate the plausibility of our hypothesis that virtual communities interacting in online environments with different features will exhibit differences in behaviors and outcomes that are consistent with the differences in features. We believe that our exploratory research provides evidence sufficient to justify further empirical work and additional theoretical development.

The next step in this process will be to create an overarching theoretical framework to incorporate our findings as well as the previous "community" and "environment" literatures. We suggest that environmental or ecological psychology (Barker, 1968; Clitheroe, Stokols, & Zmuidzinas, 1998; Gibson, 1977; Scott, 2005; Stokols, 1995; Wicker, 1979, 1987) offers an area ripe for theoretical development in virtual communities. Environmental studies in psychology and other fields have a long tradition of examining embodied social and psychological behavior embedded in physical (as well as social and psychological) environments. Consequently, we believe that environmental studies can provide the elements of a theoretical framework within which various social and psychological theories of online behavior can coexist with theories relating to the effects of the technological environment.

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7. Appendix

Table 1: Identity Cues

	Babycenter	**CharlotteMommies**	**Scribbler**	**AskDrSears**
Unique Usernames	Usernames unique and linked to email.	Usernames unique and linked to email and street address.	Multiple users can have same username. One user can have multiple usernames.	Usernames are not unique and must be typed in by user at every message.
Anonymous Posting			Yes, but Scribbler receives some info on like location or IP address through blog software.	
Avatar	System icon or personal picture can be added in a profile.	Personal icon or picture can be added in the profile.	Personal icon or picture can be added in at commenter login.	
Signature ("Sig") File	Added in a profile. Contains tickers to countdown important events (e.g., birth of child), personal web pages, family information.	Added in the profile. Contains tickers to countdown important events (e.g., birth of child), personal web pages, family info. System has length limits.		Must be typed in by user in every message.
Other Profile Info	Users can add information unrelated to site (e.g., favorite movie). Users must update profile information in three different places.			
Link to Personal Email or Web Page	In a different profile than the avatar or sig file profiles, users can add an email id or a link to a web page. Others can find these references by looking in users' profiles.	In the same profile where avatar and sig files are entered, users can put a link to personal web page. They can also opt not to have others contact them via personal email. In every message, there is an option to use CM's private mail (PM) to contact user. This option is also available in profile.	Comments contain username and a link to the user's own webpage (usually their own blog). Email address is not available.	Must be typed in by user in every message.
Observations	Avatars and sig files are common. However, most people do not have both an avatar and a sig file. It appears that only the more active or more established members have updated all three of their profiles. Some people use profiles to advertise a home business.	Nearly all members have both an avatar and a sig file. Members will encourage others to "PM me" if they have a personal question or continue a conversation offline. PM is more common than contacting through personal email.	Despite the potential for non-unique names, members appear to use distinct usernames "the other Anita". Avatars are not very common. Scribbler also has blog roll (links to blogs she reads and often the commenters) and creates links to commenters' comments and blogs when they win "Wednesday Whining".	Usernames may change as they repeatedly type it in, often getting shorter. Usernames may reflect a particular state ("One Tired Mommy") or a particular belief ("AP Mommy"). Members rarely leave personal email ids or sig file information.

Table 2: Status and Control Tools.

	Babycenter	**CharlotteMommies**	**Scribbler**	**AskDrSears**
Posted Board Rules and Penalties	Rules differ by board. Contained in general introduction to board. Graduated penalties from messages deleted, user suspended, user removed.	General rules icon at top of main board's page. Specific group rules posted in a permanent thread (announcements) at the top of board. Other permanent threads (stickies) include info like board specific acronyms. Graduated penalties from messages deleted, user suspended, user removed.	Commenting policy ("House Rules") prominent on blog and include introducing oneself, being polite and not spamming Scribbler can delete messages, but cannot block users.	
Automatic Moderation				After posting message, users told of delay until message appears.
Thread Reorganization		Admin can moves messages between boards.		
Automated report violations	Icon at the beginning of each message to report it as violation.			
Posted Moderator Name	Name of "host(s)" listed in description of board.	Name of "moderator(s)" listed at top of board.	Scribbler herself.	
Automated Member status reporting	Moderators have the world "bcHOST" in their username.	Every message contains member's length of membership, the number of posts and their CM status name (New Mommy to Queen).		
Observations	The Great Debates boards encourage users who do not like alternative discussions to go elsewhere. Not clear how many memberships have been revoked. Hosts serve as regular participants and also as moderators. Some hosts are experts (e.g., medical doctors) who answer questions.	Announcements can be locked (in which members can't respond) or open so uses can respond. Once the board rules become fixed, users cannot reply to the board rules. Moderators and other admin frequently move threads to more appropriate boards, sometimes to protect members involved in controversial discussions like AP parenting. Revoked memberships have been noticed by other members. Members celebrate when they reach certain post numbers or status names.	Scribbler does not often have to delete comments. Other commenters will respond to inappropriate comments, too.	Although users are told of delay, the message usually appears immediately perhaps indicating it passed a message flagging program for particular words.

Table 3: Attention, Availability and Response Indicators

	Babycenter	**CharlotteMommies**	**Scribbler**	**AskDrSears**
Attention				
Board Organization	Main page lists general topics (e.g., pregnancy, birth clubs, great debates). Users navigate through main topics to subtopics until reach list of boards within specific topic (birth clubs for 2004).	Main page contains all boards user has subscribed to in the profile. There are 25 public boards that all members can read and then private boards that members join based on interest (e.g., attachment parenting) or physical neighborhood. Links to CM's private email and board rules on this page, also.	Main page is like a typical blog. Most recent blog posts at top with comments at bottom of post. Long blog roll along the side.	Main page contains links to the five boards.
Thread Organization	Subject, id of thread starter, time thread started, and id and time of last replier on subject line. Most recent 15 threads on first page. A new message moves the thread to the top of the board.	Subject, id of thread starter, time thread started, and id and time of last replier on subject line. Most recent 50 threads on first page. A new message moves the thread to the top of the board.	Comments attached to blog post. Most recent blog post on top of web page.	Subject, id of thread starter, time thread started. Each reply contains a new subject heading and replier id and time. Most recently started 15 threads on first page. Replies do not move thread to top of page.
Message Organization	Most recent message at end. After 15 messages, new messages are put on another page. Users can skip to particular pages. Users can see all messages on the page. Users can read only new messages or all messages.	Most recent message at end. After 15 messages, new messages are put on another page. Users can skip to particular pages. Users can see all messages on the page.	Most recent message at end. All messages are on one page. Users can see all messages on the page.	Replies are organized so that replies are indented under replies. Most recent message is embedded under the message to which it was a reply. Users can only read one message at a time. Users must return to main thread page to select next reply in a thread.
Tracking Threads	A heart icon indicates a thread that a member has posted to or has opted to follow.			
Availability				
# of messages	Thread: Total number of messages and time and id of last reply.	Board: Total number of messages and time and id of last reply for entire board. Thread: Total number of messages and time and id of last reply.	Number of comments listed at end of post.	All messages listed on first board page.

Indication of New Messages	For each thread, lists “X new out of Y” messages	Icon changes color to indicate new messages	Last 10 comments are posted on web sidebar	
Message Activity	Number of replies. Five most active threads listed in sidebar of navigational web page. Based on number of posts.	Number of replies. Number of times read. Within a board, icon wiggles for very active threads. Based on number of posts and number of times read.		Threads change shape as replies are added.
Other users on board		At main CM community board, all current users are listed at bottom of page. Within each board, current users are listed at the top of the page.	Blog roll indicates other blogs. Scribbler reads and likely who read her blog.	
Response				
Replying	Member can only see the message she is replying to. Members can embed pictures, web links and use many text formatting options and icons. Users can edit or delete their own messages after they have posted it.	If using the quick reply option, member can see all messages, above reply. If using the reply button, member can scroll through all messages below reply. Members can embed pictures, web links and use many text formatting options and icons. Users can edit or delete their own messages after they have posted it.	User sees all messages when replying.	User does not see any previous message when replying. There is also a flaw in the software so if members post a reply under a reply, their username isn’t attached to the reply, but the previous message’s username is.
Quoting		Quote button available on every message.		
Email notification of responses	Members must choose to be notified of responses. Can opt to be notified every day, every 3 days or once a week.	Using the reply or quote button automatically notifies user of replies. No new notifications until member returns to thread. Button to stop watching a thread at bottom of each thread		
Observations				
Attention	Although reading only new messages helps cut down on the number of msgs to parse, it makes it more difficult to follow conversations. In active groups, threads will quickly pass off the first page of the board. Users have to search for the threads they are following. Users will move a message to the top of the board	Boards rarely have more than 50 active threads at one time, so all active threads are easily scanned on the first board page. Bumping messages using a (((bump))) is rare.	Most commenting activity only occurs on the most recent blog post.	Members will use a subject heading in their reply as a quick summary of their post to entice readers. Reading messages in order is difficult because of the need to return to the main menu to read the next message.

	by posting a reply often with the single word (((bump))) so the message will get the attention of other users. The heart icon helps members scan for their favorite threads.			
Availability	Users have to enter the board to see if there are new messages. Presences of new messages may make people think board is populated and popular. The notification for the "hot topics" is on the main navigational web pages in Babycenter. Can involve hundreds of posts. These tend to be very interactive posts (e.g., "Who just found out they're pregnant!?") or controversial ("I let my child cry to sleep last night").	Identifying number of messages and whether they are new at the board level allows users to quickly decide whether to stay or go. Being able to see the number of times message is read provides even more cues that board is populated and popular. The hot topics in CM are indicated within the board and therefore clearly related to the user's interests. Also, because topics can be "hot" due to number of times read. Listing users reading the same board at the top of the board may provide more social presence cues than listing everybody on CM at the bottom of the main board.	Readers must return and go into comments to check for new messages. Listing 10 most recent replies allows for commenter publicity as well as indicting that the blog is popular. Seeing the number of comments at the blog level quickly lets users decide whether to leave, read comments, or post the first comment to the blog.	Users have to enter the board to see if there are new messages. Members must search for new replies since they are not necessarily at the end of the thread nor at the beginning. When members return to check for replies, they may need to scan across pages to find the thread. Because shape of thread changes, they must remember initial subject heading.
Response	When replying, members sometimes use pp to stand for previous poster if they do not remember poster's id. Users must cut and paste to quote which is not common. One exception is a frequent thread type is when the initial poster will ask a question (when are you due?) and then modifies this first message to include everyone's subsequent reply.	Users will reply to others by name. Users will also use the pp abbreviation for a general "I agree with what all the other pps have said." Quoting allows for conversations to extend over more messages. Immediate email notification of responses alerts user to activity on threads of interest.	Users tend to only reply to the first couple of comments or the last couple of comments. Commenters often refer to each other by name. Scribbler has a weekly "Wednesday Whining" post in which commenters whine about their troubles in the comments section. On Thursday, Scribbler names winners whose comments and blogs are highlighted in her main post. This is a very popular post with over 100 comments as compared to 10-30 on regular days.	Users occasionally refer to each other in replies. They will also use others' ids in their subject line. The flaw in the technology makes it look like users are talking to themselves. It also makes it more confusing to read active threads and a malicious user could sabotage someone's identity. Mistakes in replying are relatively common and thread topics on just using the software are not rare. Quoting must occur through cut and paste and is rare.