# Staccato Social Support in Mobile Health Applications

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## ABSTRACT
Social support plays an important role in health systems. While significant work has explored the role of social support in CMC environments, less analysis has considered social support in mobile health systems. This paper describes socially supportive messages in VERA, a mobile application for sharing health decisions and behaviors. The short and bursty interactions in social awareness streams [36] afford a particular style of social support, for which we offer the label *staccato social support*. Results indicate that, in comparison to previous work, staccato social support is characterized by a greater prevalence of esteem support, which builds respect and confidence. We further note the presence of 'following up', a positive behavior that contributes to supportive interactions, likely via social pressure and accountability [7, 38]. These findings suggest design recommendations to developers of mobile social support systems and contribute to understanding technologically mediated social support for health.

### Author Keywords
Mobile health; social support; user experience.

### ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

## INTRODUCTION
Supporting health and wellbeing has long interested the CHI and CSCW communities [7, 41, 19], but the question as to how technology might best aid wellbeing remains relatively open. As a community, we monitor and assess diet and exercise [5]; deliver prompts, reminders, and interventions throughout the day [17]; build intelligent systems that quietly classify and record our activities [8]; and develop novel tools for measuring our momentary stress and affect [39]. When we allow users to leverage others' assistance, designed interactions commonly imitate intimate in-person dialog [9, 26, 15], are competitive[1], or are intended specifically to aid in health crises [45, 43].

[1]e.g. http://www.healthymagination.com/applications/fit-friendzy


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Social support, those processes "through which social relationships might promote health and wellbeing" [6], is increasingly leveraged via computer-mediated communication (CMC). Social interaction does not simply remain valuable in a mediated context [25], but mediated social support has its own set of advantages [50] and in specific cases may obviate the need for face-to-face counseling [33]. Much research has explored and described social support over CMC [4, 43, 38], but the overwhelming majority of these mediating channels are bulletin boards, online forums, rich email threads, and other net-based interfaces accessed via the desktop. As people increasingly engage with each other via mobile CMC in pervasive social awareness streams (SAS) [36], the nature of the social interaction changes, as do the ways in which social support is provided and received. Inspired by the notion of staccato attention, an effective multitasking behavior characterized by attend to off-task content in many short bursts [22], we are therefore interested in the health applications of *staccato social support* (SSS): the particular style of social support enacted in mobile environments designed for brief, rapid social sharing and interaction.

## RELATED WORK

### Social support and CMC
Social support is verbal and nonverbal communication that helps reduce an individual's uncertainty, lack of perceived personal control, or stress, and, "whether directly or indirectly, communicate[s] to an individual that she or he is valued and cared for by others" [1]. Furthering and broadening our understanding, Cohen describes social support as "any process through which social relationships might promote health and wellbeing" [6], and can be leveraged in two ways. First, as an exchange of resources, emotional or informational, in response to a perception of another in need. Second, as "benefits accrued from participation in distinct social groups that influence cognition, emotion, behavior, and biological responses beneficial to health and well-being through interactions not explicitly intended to help or support" [6].

Online venues (Usenet, bulletin boards, online fora) that afford socially supportive communication have existed since at least the mid-1980s (see [50] for examples). Illuminating the effectiveness of social support for health via CMC, much previous work reports participants valuing a reduction in geographic barriers, the availability of rapid response and 'just in time' support, and the online open discussion of health concerns [13, 18]. Often, online social support fora mirror the role of

face-to-face support groups, serving the needs of those living with particular struggles such as Huntington's disease [9], asthma [26], or post-partum depression [15]. Today, online social support experiences often occur through general-use SNS, such as Facebook (where there are 57 support oriented groups for breast cancer alone [3]), and via online health communities (OHCs) such as SparkPeople[2] and dLife[3]. The most commonly cited goal for interacting with others around health is receiving and providing emotional support, and users value their membership in OHCs particularly for the access to similar others who provide encouraging, positive, and rapid responses [38]. While there is a growing trend of doctor-patient engagement in online communities, it is important to recognize that the support offered by non-professional peers is different from that provided by clinicians, often more personal and experiential, and a valuable domain of health expertise in its own right [21].

To understand types of social support, Cutrona and Suhr [11] developed a five-category social support behavior code (SSBC), which provides a rich typology of socially supportive behaviors. Designed from a survey of existing social support literature, as well as a series of questionnaire studies, this behavior code is a non-exhaustive list of 23 mutually exclusive socially supportive behaviors organized into five major categories: information support, tangible assistance, esteem support, network support, and emotional support. Although originally used to describe face-to-face behaviors supportive of stress management, these categories have subsequently been used in assessing social support in other contexts online, including living with disabilities [4], managing long-term disease [9], diabetes [29], or HIV/AIDS [10], eating disorders [51], and communication in marriage [12]. Information and emotion are the most frequently reported social support types in these studies. Maitland and Chalmers report on multiple forms of peer involvement specific to socially supporting weightloss: obstructive ("don't do it"), inductive ("you should do it"), proactive ("do it with me"), supportive ("I'll do it too"), and co-operative ("let's do it together") [30]. These forms are valuable to consider, although are less inclusive than Cutrona and Suhr's as well as being less well established.

#### Mobile social interaction and mHealth

Compared to more traditional modes of online communication such as online fora, blogs, bulletin boards, and list-servs, CMC interaction today is increasingly characterized by the rapid (semi-) public sharing of short messages and just-captured media whose consumption is often driven by articulated online contact networks. Naaman et al. describe this style of communication as social awareness streams [36]; such streams are often organized into a stream of updates and produced and consumed on mobile devices. The growing popularity of Facebook status updates and tweets, and the corresponding quick-response style interaction, are evidence of this trend - indeed, almost 1 in 10 online U.S. adults now use Twitter on a typical day, up fourfold since late 2010 [44]. Multiple explanations account for various aspects of this shift. In a study of IM use in the workplace, Nardi et al. suggest that this style of near-synchronous text-based communication effectively allows for the negotiation of availability ("interrupting without interrupting too much") and allows for sustained social connection [37]. Work on Twitter suggests motivations for use of such a system include daily chatter and seeking and sharing information [24], while Marwick and boyd indicate that such interactions do afford self-presentation and strategic commodification [31].

Another way to frame the rapid sharing and consumption of short messages is to draw on staccato attention [22]. Exploring the relationship of multitasking and (memory) performance, Hembrooke and Gay report that "sustained distraction, regardless of content relevance, appears to be the nemesis of the multitasker." Instead, many shorter bursts of attention given to non-primary task content more effectively facilitates multitask [22]. Staccato attention describes the interactions on the modern web particularly well, with users interleaving bursts of short mediated behaviors, such as skimming the Facebook newsfeed, sending a tweet, or checking in on Foursquare, into their work day and social events. Further, staccato attention is exactly the attention desired in ecological momentary assessment (EMA, [35, 46]) self-report measures, designed to capture data in frequent, quick, and unobtrusive bursts that neither interrupt nor disturb subjects' daily lives. In this paper, we draw on that previous work to suggest that *staccato social support* (SSS) may be a useful label in describing the ways social support is enacted in social awareness streams.

To date, little work has attended to the style of social support afforded in mobile technologies for health (mHealth). Most commonly, mobile social support services attempt to replicate the more traditional CMC social support experience for the mobile space. Indeed, such technologies do and should retain many of the advantages of CMC social support described by Walther and Boyd [50], such as drawing on weak ties, access to remote expertise, anonymity, and hyperpersonal aspects. For example, Houston, step counts (a proxy for physical activity) are shared with other Houston users; drawing on others may well encourage meeting health goals through social support or social pressure [7]. In another example, EatWell [19] enables users to access a community via their cell phones, both to share and to hear voice memories describing healthy eating attempts in their local neighborhood. EatWell facilitated a sense of being heard, and generated feelings of hope of community empowerment around healthier eating behaviors. Increasingly, though, mHealth apps leverage affordances unique to the mobile device, such as location information and the ability to intervene at the moment of decision [23]. Short messages, when they are used, most commonly take the form of interventions and reminders from 'the system' (as in e.g. [27, 28, 14, 16]) rather than from others. mHealth apps routinely leveraging external services to provide social support, for example linking to a user's Twitter, Facebook, or OHC account and posting updates about the user's health accomplishments (e.g. My Diet Diary[4]). More recently, Turner-McGrievy and Tate describe the social support typology of a Twitter-based be-

[2] http://sparkpeople.com
[3] http://dlife.com
[4] http://www.healthymagination.com/applications/my-diet-diary

havioral weight-loss intervention with 47 participants over a 6-month period; Twitter was used as platform for updates and social interaction among participants [49]. 75% of the tweets were informational in nature (65% of the total were coded 'teaching') while esteem support accounted for less than 7% [49].

## METHODS[5]

### System Design: VERA

Virtual Environments for Raised Awareness (VERA) is a mobile phone application that encourages users to record their health decisions and to share them with other users. When making a health-related decision, a user opens the VERA application and makes a status update. This begins by taking a photograph documenting the decision (Figure 1, left). The user then also records a subjective healthiness rating from -3 (most unhealthy) to +3 (most healthy); a binary variable indicating whether they performed the depicted action (e.g., the user might not have taken the stairs); an optional free-text caption; and how s/he feels about the health decision using PAM [39] (Figure 1, center; PAM not shown). PAM, a validated image-based measure of affective state, is intended for frequent in-situ delivery via mobile phones.

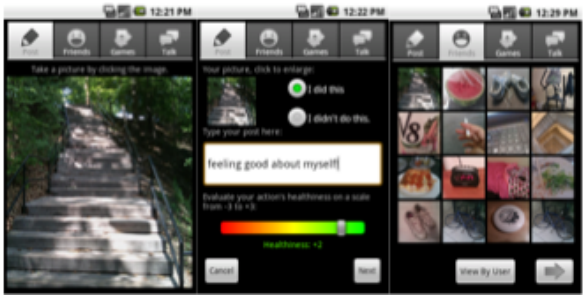


**Figure 1. Screenshots of VERA taking a photo (left), status update details (center), and viewing others' photos (right)**

Upon completing a status update submission, the user is shown a newsfeed view displaying photos recently shared by others in their deployment condition (Figure 1, right). Similar views allowed the browsing of posts by individual user; both showed posts in reverse-chronological order. Selecting one of these photos shows which user shared this photo, when, whether they performed the action or not, and their optional note. At this point, a viewing user can also send a message about the status update to the status' author, and review any discussion s/he has had with the author about this status. All messages in this version of VERA are visible only to the messages' author and recipient, and are essentially private messages associated with a single status update. Users can also communicate via a group chat feature that worked like a simple IRC channel. This version of the VERA platform runs on both Android and iOS devices.

[5]A previously published paper [2] also reports on data collected in two of the deployments described in this work, but drew exclusively on qualitative interview data. Here, we analyze social messages from within the system, employing anecdotes from the interviews to help contextualize and interpret our findings. We include descriptions of both the system and the deployments for clarity.

### Deployment

In this study, we discuss system use in two VERA deployments at a large northeastern university in the US. In both deployments, the features of the VERA system were demonstrated to the participants individually, each of whom were asked to make five status updates daily. While participants were shown how to engage socially within the VERA system, reviewing others' activities and posting comments were not a required part of the study protocol. Participants were not directed to focus the recording of their activity in any one area of health, as the VERA platform draws on the mobile health design principles of open-ended social awareness [2]. Participants who owned an Android or iOS device installed VERA on it; others were loaned an Android-based 3G MyTouch Slide for the study.

*Deployment 1 (2010)* Participants were recruited via university departmental and student listservs and physical fliers for participation in a mobile phone-based research study examining healthy decision-making processes. Recruitment resulted in two deployment conditions: 17 participants in a social condition in which all were strangers, and 17 participants in an individual condition for a total of 34. As we are concerned with *social* support, we restrict our discussion with respect to deployment 1 to the 17 participants in the social condition. Participants used VERA for two weeks, completed both pre- and post-test surveys, and were compensated with $20 for their participation.

*Deployment 2 (2011)* Participants were recruited from a wellness program for faculty and staff, via two mailing lists: a general mailing list for all members of the program (∼4600), and a list for those individuals focusing on weightloss (∼125). Recruitment resulted in 44 interested participants; for several reasons some participants dropped out, leaving 17 participants in the general group (deployment 2a) and 8 in the weightloss group (deployment 2b) for a total of 25. The groups were enrolled into VERA separately, such that those in a given group only see the status updates of others in their group. Two dyads were previously acquainted, but most were strangers. All participants used VERA for four weeks, completed both pre- and post-study surveys, and all but two general group members participated in an interview during the third or fourth week. Each participant was compensated with $20 and entered into a drawing for a $250 Amazon.com gift card.

### Analysis

The analysis of the messages participants sent to one another was informed both by iterative, inductive coding and by comparison to previous work on mediated social support. Analysis began with a grounded approach rather than simply using an existing taxonomy because we were exploring social support enacted in mobile health applications, a medium affording a different interaction style from those in previous work on mediated social support work. The codes emerging from this analysis were then mapped to previously reported social support categories, and the relative distributions compared. Finally, as described above, interviews were also conducted with the participants. During the analysis process, the interview data were referenced to help understand participants' explanations

and experiences of messaging in the system. These interview data are used below as occasional anecdotes, but the primary analysis and results pertain to the message content.

The analysis began with substantive coding, with one author reading iteratively through the messages in the context of the status to which they refer to identify themes in the messages, focusing in particular on social support. Organization of these themes resulted in a first codebook for SSS. Following standard qualitative coding practice, the codebook was then iteratively refined during the training of two research assistants as coders. After establishing satisfactory intercoder reliability on a reliability sample ($n$=100, Krippendorf's $\alpha$=.81), the assistants each independently coded half the remaining messages. Because many messages only made sense in the context of the original private message thread, coders were shown the original status image as well as each message in the thread; codes were then applied to the message as the unit of analysis. Providing context was essential in affording meaningful resolution to coder differences, in contrast to [36] where such context was unavailable and inter-rater agreement was therefore impossible to achieve. Due to the brevity of the messages the need for tie-breaking was relatively rare; when necessary, tie-breaking was a two-step process: first, subjectively considering relative emphasis, and then by position (selecting the first code). The resulting codebook, which is available upon request, contains 13 socially supportive codes, which are displayed with their counts in Table 2.

To better understand SSS, we drew on previous work on mediated social support, particularly Braithwaite et al., who describe the typology of social support in an online forum for people with disabilities [4], and Coursaris and Liu who similarly describe the support typology in online HIV/AIDS self-help groups [10]. These studies both use Cutrona and Suhr's [11] five-category social support behavior code (SSBC), mentioned above, as an organizing framework. The five categories are (1) information support, providing information about stress itself or how to deal with it; (2) tangible assistance, providing or offering to provide goods or services needed in the stressful situation; (3) esteem support, communicating respect and confidence in abilities; (4) network support, communicating belonging to a group of people with similar interests and concerns; and (5) emotional support, communicating love or caring. The mapping of our 13 social support codes to these five categories can be seen in Table 1; we further describe these categories and the codes mapped to them next.

| Support category | Support codes |
|---|---|
| Information support | more information<br>advice<br>variation suggestion |
| Tangible assistance | perform direct task |
| Esteem support | 'like button'<br>I'm inspired<br>'yummy' |
| Network support | |
| Emotional support | sympathy<br>cheerleading<br>'me too' |
| n/a | following up<br>expressing thanks<br>request for support |

**Table 1. The mapping of our generated social support codes (right) to Cutrona and Suhr's five-category SSBC [11] (left).**

### *Information support*

Cutrona and Suhr's information support category includes messages that convey instructions, including advice, referrals to experts, situation appraisal, and teaching. Three of our generated codes obviously map into information support (see Table 1): 'more information', 'variation suggestion', and 'advice'. As VERA participants are interested in daily wellbeing and weightloss, many of the messages in this category offer guidance around exercise and nutrition. 'More information' messages were most commonly responses to requests for more information provoked by a status update - for example, the response to *What's purple sticky rice? It sounds good.*.

A common theme from interviews regarding status creation was keeping the practice of healthful behaviors engaging and fun - healthy habits can start to feel repetitive. Interviews suggest this motivation drove the majority of 'variation suggestion' messages which perhaps most closely parallel Cutrona and Suhr's teachable moment subcategory. Common exemplars include alternative ways to stay active (*Nice... You ever take the sporting field ornithology class offered by the olab? Lots of birdwatching walk opportunities!* or *I sometimes park in a farther away parking lot for the same reason*), and recipe tweaks (*have u tried adding in sliced banana? yum + potassium* or *looks just like my breakfast but I add some nuts and flax seed*).

Advice-giving messages can be straightforward in the vein of 'eat this not that' as in a thread on coffee, *not evil! its [sic] good for you. much better than getting you cafeine [sic] from a soda!*. Not uncommonly, these messages can offer a cognitive reframing (*when i see candy on someone's desk, i say to myself 'that's for the fat people'*). Advice giving sometimes includes an element of humor, especially when the advice comes in the form of a friendly telling-off, as in *Looks good but not a good food pick huh?* or *So, what was your penance?*.

### *Tangible assistance*

Tangible assistance involves a reference to or commitment toward taking physical action in support of the recipient. Our generated code 'perform a direct task' maps well here. The two messages labeled with this code are in response to a dog owner posting a picture of a walk with her golden retriever: a commenter expresses delight and promises to share as a status a picture of her own dog, and the original poster says they will keep an eye out for the upcoming status.

Interestingly, among the few messages posted to the real-time chat were multiple suggestions and seconding requests to meet up in person to continue conversations begun in VERA.

### *Esteem support*

Esteem support messages "validate the recipient's self-concept, importance, competence, and rights as a person and include compliments, validation, and relief from blame" [4].

Our codes 'like button' and its food-specific subcode 'yummy!' are applied to messages that compliment and validate participants' behaviors and decisions as with *good way to stay clean!* and *OH! now that looks yummy!*. They may also apply specifically to the poster her/himself, as with *Nice smile!*. Short messages such as *Neato!* and positive emoticons also fit here.

Also mapping well to esteem support is the code 'I'm inspired', which labels messages expressing something close to envy or an explicit intent to imitate, as in *humm, now thinking i should dice an apple and toss that in MY morning oatmeal??*, and *you've got more willpower than i do!*, and *how do you stay so SKINNY???*.

#### *Network support*

While previous work describes network support interactions as those that create structural connections (for example, by introducing people to each other); in this VERA deployment we do not see examples of network support. In fact, in later social support studies [11] Cutrona and Suhr themselves dropped network support from the coding scheme due to low inter-rater reliability and "questionable relevance to dyadic interactions".

#### *Emotional support*

Emotional support communicates love and caring. Coursaris and Liu list 7 subcategories: relationship, physical affection, confidentiality, sympathy, understanding, encouragement, and prayer. We map the generated codes 'sympathy', 'me too!', and 'cheerleading' to this category.

'Sympathy' messages recognize and call out familiar and difficult situations as with *Tough when both other people in the car are eating it saying 'want some? Want some?'* or *Oh no... That sux! people can be so rude! Sorry to hear that*. They also express solidarity in pain *bummer! I know how much I hate it when I am injured!* and, mapping also to relationship, simply indicate a sense of 'being there' alongside a struggling poster *awwwwwwww! you are not alone*.

Messages more explicitly demonstrating solidarity and similarity were labeled 'me too!'. Many were variants of this label, while others expressed shared passions for activity (*pilates? i love pilates!*) or food (*wow i thought i was the only one who liked that combo - what flavor?*). Sometimes the status reminded the messager to return to a 'me too' behavior, as in *i use[sic] to keep gum in my desk for just that reason! I should probably get some more!*

The code 'cheerleading' was difficult to cleanly map into Cutrona and Suhr's five categories. Our codebook applies it to messages that are encouraging and complimentary, which suggests that 'cheerleading' may sit across emotional support (through encouragement) and esteem support (when complimentary). Messages such as *excellent! keep it up and soon you will notice how flexibleb[sic] you are... go girl!* and the not uncommon *go you!* clearly contain elements of both encouragement and compliments. A conversation with a coder indicates that the conversational thread within which 'cheerleading' messages occur are more about providing confidence and hope - elements Coursaris and Liu associate with encouragement and emotional support - even when some messages in isolation can feel more complimentary. We therefore map 'cheerleading' to emotional support.

#### *Other supportive messages*

A number of identified themes did not directly align with the SSBC. As in previous literature, including Cutrona and Suhr's [11] original presentation of the SSBC, we noted requests for social support, here around temptation from late-night snacking behaviors: *trying to stay away from it tonite[sic]...wish me luck!*. In studies such as these, there are rarely more than a few exemplars (we noted just the one) so they are commonly not given their own category.

Messages coded 'expressing thanks' acknowledge and appreciate others' support. At some times this is as simple as a quick *thnx*; at others the thank you is more directed, for example *Thanks for the reminder!* in response to a message encouraging the recipient to remain mindful about evening snack choices. Thanking and acknowledging was sometimes associated with further opening up, as when the original poster of a status about putting down a long-lived pet cat responded to a series of sympathetic messages: *Thanks. It was a good long life. She lived in 5 houses, 3 states and with 5 different dogs at different times*. Expressing thanks is a positive style of interaction also found in previous social support literature (e.g. [10]).

'Following up' describes messages that check back in with others after a little time (later that day, during the next couple days) either within a conversation or in a subsequent status update by the original update sharer. These messages convey sense that someone is paying attention and taking an interest. For example, in following up with a participant who struggled with late-night snack food temptations one user left the message *How did you do? I only caved in to a single sugar cookie craving last night (usually more like 6!)*. Or, after a post about walking in the snow, another observed *Hope you wore your boots today!*. 'Following up' can also complete variation suggestion conversations, for example messaging *Oh good, you tried it! I hope it did not disappoint...* upon observing a fellow group member trying Greek yogurt as recommended. This type of message is not accounted for in the traditional support literature; we discuss similar messages in other mHealth systems below.

## RESULTS

In this section, we first describe the messaging patterns in each of the three social groups over the two deployments, to provide a greater sense of messaging in VERA. We then report the distribution of social support observed in VERA, and contrast SSS to the distribution of support types reported in both Braithwaite et al. [4] and Coursaris and Liu [10].

### System use

Over the three deployments, every user posted status updates ($n$=1885, mean 44.9, median 38.5) and the overwhelming majority sent (all but three users, mean 15.0, median 8.0) and received (all but one user, mean 13.9, median 9.0) a total of $n$=586 messages. Of these messages, 575 contained supportive content. The group chat feature was rarely used (at total of 34 messages in all), commonly for introductions and questions

| Support code | Dep. 1 | Dep. 2a | Dep. 2b |
|---|---|---|---|
| more information | 31 (.28) | 118 (.34) | 40 (.35) |
| variation suggestion | 4 (.04) | 8 (.02) | 3 (.03) |
| advice | 4 (.04) | 18 (.05) | 1 (.01) |
| perform direct task | 0 (.00) | 0 (.00) | 2 (.02) |
| 'like button' | 20 (.18) | 57 (.16) | 20 (.18) |
| I'm inspired | 7 (.06) | 21 (.06) | 3 (.03) |
| 'yummy' | 19 (.17) | 21 (.06) | 11 (.10) |
| sympathy | 3 (.03) | 17 (.05) | 6 (.05) |
| cheerleading | 5 (.05) | 42 (.12) | 11 (.10) |
| 'me too' | 10 (.09) | 21 (.06) | 9 (.08) |
| following up | 4 (.04) | 14 (.04) | 3 (.03) |
| expressing thanks | 3 (.03) | 13 (.04) | 5 (.04) |
| request for support | 0 (.00) | 1 (.00) | 0 (.00) |
| | 110 (1.0) | 351 (1.0) | 114 (1.0) |

**Table 2. Counts (and percentages) of social support codes in each of the three groups across the two VERA deployments.**

| Support type | (a) | (b) | (c) | (d) |
|---|---|---|---|---|
| Information support | 43.0 | 31.3 | 58.2 | 81.3 |
| Tangible assistance | 1.0 | 2.7 | 1.1 | 0.3 |
| Esteem support | 34.0 | 18.6 | 8.9 | 7.0 |
| Network support | 0.0 | 7.1 | 9.4 | 0.5 |
| Emotional support | 23.0 | 40.0 | 22.3 | 10.9 |

**Table 3. Comparisons of adjusted percent of support types across the three studies: (a) the aggregate of the VERA deployments, (b) Braithwaite [3], (c) Coursaris and Liu [10], and (d) Turner-McGrievy and Tate [49].**

about the study in the first few days and later requests to meet up in person; we do not include these data in the results presented here. Messages coded as containing no supportive content (11 total) were logistics-related (e.g. regarding the VERA system) or uninterpretable (e.g. *cd,*).

The 17 users in deployment one generated 582 statuses (mean 34.2, median 26.0) and 111 messages were sent (mean 7.4, median 6) and received (mean 6.5, median 5.0); two users did not send messages and all but one message contained supportive content. Deployment 2a's 17 users created 1000 statuses (mean 58.8, median 23.5) and 358 messages were sent (mean 12.06, median 8) and received (mean 19.89, median 15.0); all users sent and received messages and seven messages contained no supportive content. The 8 users in deployment 2b created 303 statuses (mean 37.9, median 23.5) and 117 messages were sent (mean 16.4, median 7.0) and received (16.4, median 15); one user neither sent nor received a message and all but 3 messages contained supportive content.

Anticipated by the means and medians above, several communicative users in each deployment sent large numbers of messages to the others in their groups. Accordingly, most other users received a few more messages than they sent. A network analysis (users as nodes and directed edges as messages sent) shows reasonably uniform receipt of messages, but that one pair and one triad in deployment 2a sent and received messages particularly to each other (two in the triad were those previously acquainted).

There was a long-tail distribution of messages over statuses, with 1559 updates not provoking any response and 61 instances of a status being associated with at least three messages. There are several reasons this may have occurred. First, several participants used VERA much more as a personal diary than as a social interaction tool, therefore leaving less messages and not intentionally crafting statuses with an eye to presentation and performance. Second, while participants could page through the newsfeed (going back in time), many status updates appeared around common meal and workout times, meaning that some were very quickly relegated beyond the first newsfeed page. Third, as many health behaviors require habitual performance to be effective, not a few posts are thematic 'duplicates' of previously shared health decisions. Those statuses that received more messages contained more unusual content, were perceived to be particularly impressive, or tapped into a positive 'me too' experience. For example, a status picturing a horse and captioned *Equine-derived mental health moment* prompted 7 varied responses from *So envious! Did you get to ride?* to *he's a cutie!*.

The length of conversational threads tended short. Of the 368 unique conversational threads, 221 contained only one message and 95 two messages. No thread was longer than four messages and only 8 conversations reached this length.

As we had hoped, interviews with participants shed further light on system use. For example, we learned that participants tried to keep their posts creative and fun, both for reasons of self presentation and to maintain or even elevate the interest for, and value to, others in their group. A common sentiment was that the newsfeed view 'should be kept interesting'. We saw this in both the variety and range of health decisions and activities shared, and in the ways common activities would be photographically represented - for example, different angles of views of feet and running shoes in an effort to keep the sharing of a repetitive activity engaging. Multiple participants reported crafting such creative statuses not simply for others' interest, but expressly to provoke supportive feedback. Of course, a few users ended up using the same or very similar images over and over to record repeated activities; this was noted by other participants, and sometimes interpreted as demonstrating a lack of effort in participation.

To keep posts interesting, participants also commonly employed humor, particularly laced with sarcasm. Participants at times gently called attention to less healthy decisions - for example, in response to a picture of a giant ice cream sandwich, one participant joked *plus three, right?*, referencing VERA's subjective healthiness scale of -3...+3. Similarly, commenters might underscore the original poster's recognition and admission of such less healthy updates: *pizza isn't good for you?!?! say it isn't so! :)*.

Status creation was also a way to more subtly provide social support, an aspect not captured by this analysis. One example is the trend of reporting healthy walks with one's dog that originated with one dog-loving participant; subsequent imitative posts both validate and express commonality with the first poster's behaviors.

### Support typology distribution

Consistently in the literature on mediated social support, information and emotional support are the categories most frequently observed. Selecting Braithwaite et al. [4] and Coursaris and Liu [10] as representative of the above described literature and including Turner-McGrievy and Tate's recent Twitter-based work, Table 3 compares the adjusted percent distribution over Cutrona and Suhr's five support categories. SSS affords a greater frequency of esteem support than support mediated by traditional online forums (even when mapping 'cheerleading' to the emotional support category), and in [49] information-giving dwarfs all other categories. In both short-message studies there is a noticeable absence of network support.

## DISCUSSION

The above results demonstrate differences in the relative frequencies of the types of social support observed in this paper and those in previous work (Table 3). More important, though, is considering why these differences may occur.

One potential explanation comes from Cutrona and Suhr's optimal matching model in which the type of support given is that perceived to be the most beneficial [11]. Specifically, supportive behaviors promoting action are beneficial around circumstances under the recipient's control, while those promoting comfort and healing fit better when a scenario is outside the control of the recipient. This well explains why advice and suggestions were salient in studies of stress management in marriage [11], while emotional support was most salient in online support groups for those dealing with disabilities and health problems [4]. For the data reported here, the model correctly predicts the presence of informational support as the health decisions shared by our participants are largely nutritional and exercise based, activities almost completely under their control. The salience of esteem support in VERA through this lens also makes sense, as participants compliment and validate each others' healthful decisions.

A second consideration is that social support is likely sensitive to network composition. Taylor [47] reports cultural differences in the impact of social support on psychological and biological responses, while Toscos [48] finds network composition very important for certain age-groups. McLean [32] reports that in weightloss, adolescents fair best when treated alone, children improve best with parental support, and adults lose most effectively with spousal support. With homophily, jargon also plays a role; for example, status notes in the VERA weight-loss group contained slang such as 'reefy,' meaning 'refeeding,' the practice of calorie overloading on non-diet days to keep the body's metabolism high.

Relatedly, social support in mHealth systems is increasingly provided by connecting to popular social networks, meaning that at least some support can be provided by intimates, and that social support can be visible to (potentially very large) groups. VERA does not do this, for two reasons. First, privacy: Newman et al. [38], for example, found that participants did not want to share everything with their friends, and deploying an app separate from Facebook and Twitter avoids such issues. Second, this decision allows for consistency and fairer comparison with previous work. Members of many online support fora (e.g., [9]), as well as those of in-person support structures, begin as strangers. This is by necessity but also by design: research shows that anonymity is a recognized benefit of mediated [50] social support. While contrasts in support type frequencies across this work, Cutrona and Suhr's dyad-based studies [11], and Turner-McGrivey and Tate's broadcast model [49] do not lead us to believe that group makeup and sharing models alone explain the differences we report, this opens up interesting avenues for future work in exploring SSS along both connectedness and group size dimensions.

In addition to group makeup, the media through which support is communicated may directly impact support type. As users grow accustomed to the increasing prevalence of social awareness streams (SAS), they are trained to 'like' others' statuses and offer short and peppy responses that often validate and compliment their friends. Interacting via mobile devices as in VERA and other mHealth systems means communication often happens in in brief moments (e.g. while standing in line) and using small keyboards, further constraining message preparation and length. It may be that esteem support is the most natural and effective mapping to the (mobile) SAS medium - but this does not explain the differences in relative support type frequencies from [49]. It is clear from both the current analysis and from Turner-McGrievy and Tate's work on Twitter that support enacted within SAS has a different typology than that in more traditional CMC spaces such as online fora. Further, both [49] and the current deployments involved participants not previously well acquainted who were all targeting daily wellbeing goals like weightloss. Why then does the current analysis demonstrate such a prevalence of esteem support while [49] does not? First, the Twitter participants were not in a closed network as in an OHC and in VERA, thereby impacting users' privacy and sharing as discussed above, as well as their self-presentation concerns [38]. Second, it is likely that [49]'s focus on education and information-giving, which yielded large numbers of 'listening' responses (correctly categorized by Turner-McGrievy and Tate as emotion support), limited the presence of other message types. Future work should explore the impact of system framing, or study instructions, on support types.

While 'following up' messages do not map well into categories from the CMC social support literature discussed above, there is definitely social influence at work throughout these messages. Addressing this type of message in Houston, Consolvo et al. report that sharing health activities afforded a sense of social pressure, in addition to socially supportive behaviors, among their participants [7]. Similarly, Newman et al. draw on social accountability, particularly for those messages sharing sticking to a plan visible to others [38]. It appears that in SAS affording frequent and quick 'checking back in,' lightweight social pressure and accountability manifest as staccato support. Future work should determine if 'following up' is more broadly applicable in CMC social support, or if it pertains specifically to mHealth contexts.

### Limitations

While potentially beneficial, there are styles of interaction that SSS may preclude. For instance, [21] indicates that detailed and personal 'war-stories' are an important component of peer support in health support communities, but none of the current studies nor [49]'s Twitter-based study show evidence of more intimate, longer narrative. Other previous work further observes longer emotional responses to shared struggles with disease, disability, or a cessation behavior (e.g. [4, 18]). It could therefore be that SSS does not afford this type of sharing (Newman found a similar dichotomy in content type over media [38]); it may also be that within the confines of short studies participants did not have the opportunity to reach necessary levels of mutual comfort and familiarity. While VERA does not support explicit user profiles to hasten self-presentation and connectedness, Twitter does and [49] also reports low levels of emotional support. Lastly, the domains of general wellbeing and more casual weightloss may not yield personal and intimate war-stories in the same way as those such as terminal disease.

Another contrast in distributions observed is the complete absence of network support in the VERA deployments. Network support is about creating structural connections and making introductions. While Cutrona and Suhr themselves later dropped network support due to low inter-rater reliability and "questionable relevance to dyadic interactions" [11], online self-help and support groups appear to provide valuable opportunities for introducing those struggling with disabilities or disease with each other (e.g. via triadic closure) and with medical professionals. It is possible that such connection-making did not occur in VERA deployments because there was less perceived need for introductions to medical professionals or because the longest deployment was only four weeks. It seems unlikely that introductions cannot be made in SAS, but this possible should be considered.

This initial work on SSS does not explore the potential for negative impact through either negative short messages or non-participation. While in VERA we see no evidence of such negative feedback cycles, future work should be aware that negative staccato interactions could be detrimental to participant wellbeing.

Further, we do not offer insights regarding staccato social support as experienced by lurkers. Preece finds there are many reasons people lurk in CMC [40], and within social support, Mickelson reports that online lurkers "can obtain comparison information or vicarious support without having to disclose anything about themselves... (and) obtain validation for their feelings of stigma without having to communicate those feelings to others" [34] (p172). Future work should investigate if staccato social support affords a similar 'vicarious support', and further, how increased trust may motivate lurkers to begin contributing support themselves, as suggested in [42]. A recent update to VERA allows for such investigation via rich activity logs.

### Design implications

As reported, in SSS we see a propensity of esteem and information support; the shorter, bursty messages seem particularly amendable to these subtypes. Here we consider how SSS systems may be designed to further facilitate SSS.

SSS need not be text-only, but could be represented by a button similar to the Facebook 'like' or thumbs-up, Instagram's heart or the Google+ '+1'. An explicit 'like' button not only affords positive ambiguity, but also allows for support without demanding a response. A like button allows for easier, even more rapid response than a short text-based note. Secondly, more than 10% of VERA messages contained an emoticon, most commonly smiley or winkey faces. On a touchscreen device, the on-screen keyboard can be modified to present buttons that will insert one of several emoticons in a single keystroke. We suggest that affording these even more lightweight modes of support will boost the valuable engagement of participants with more resources in their daily lives who typically engage less in OHCs than those with more need for support [20], while still providing meaningful, attention support for 'like' recipients, as with the audible 'cheer' in Path's Nike+ integration.[6]

Enabling users to label responses as particularly supportive or helpful both affords real-time feedback to other users in the system regarding their communication, as well as a growing source of tagged messages that could be used to train automated assistance to some users in some situations.

As mentioned, many informational queries and responses had physical location components (e.g. *ooooh[sic] where can I try one of those?* or *try running around Beebe [Lake] at sunrise*). Using geocoding and reverse geocoding, messages can be visually annotated with location information or displayed directly on a map. One concern with affording non-text based communication and providing responses to location-based information queries would be short-circuiting the back-and-forth interaction SSS affords: by designing maps into the system, we obviate the need for interpersonal dialog and attention-giving used in VERA to pass along location information. Future work should attend to this tension.

An element common to all types of social support including 'following up' is the awareness and appreciation of others' attention. Mobile applications commonly invite attention-giving by providing notifications. In VERA, we can imagine alerts such as, 'Dave just left you a message on your status'. Indeed, several participants requested either notifications or daily summaries of others' activities, particularly for received messages. However, it is not yet clear if such interruptive notifications would be effective paired with SSS. Staccato attention in [22] is valuable when individuals attend in short, bursty ways to new content not via interrupts, but freely, by choice. This unobtrusiveness matches [8]'s call for behavior change technologies that integrate into daily life, as well as the design requirements of EMA [46].

## CONCLUSION

While social support plays a significant role in facilitating health behaviors, the nature of that support may differ depending on the system that mediates it. This paper suggests *staccato social support* (SSS) as a means of describing the

[6] https://path.com/nike

kinds of support seen in mobile health applications characterized by short, rapid bursts of communication. This paper's examination of SSS in VERA [2], a mobile phone application that allows users to share photos documenting daily health decisions, finds high levels of information support, in the form of advice-giving, and esteem support, i.e., complements and short validations. This analysis enables two core contributions. First, by using a common typology [11] to compare these results with analyses of social support in other CMC, we find esteem support far more prevalent in VERA. This difference advances our understanding of how social support for health plays out in different media. Second, to existing typologies of social support we contribute 'following up.' This positive behavior, which was not previously reported in work on mediated social support, leverages social pressure [7] and social accountability [38] to support health behaviors. In sum, this paper furthers our understanding of the role that technologically mediated social support plays in wellbeing.

While our results pertain directly to mobile health communication, they also carry broader implications. As described in our paper, staccato-style interaction is increasingly common in many areas of HCI, raising important questions about the differences in the social interactions facilitated by such media. These findings, and our comparisons with previous work, help address such questions, thus contributing to our general understanding of how different communication media afford different styles of social interaction.

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