Attending to Attention:

How Do People Attract, Manage and Negotiate Attention Using Mobile Devices?

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Abstract

In today's always-connected world people have an ever-increasing array of ways to stay in touch, often selecting among multiple media that allow for different degrees of attention (e.g., phone calls vs. texting) and may vary in convenience for their interaction partner. In this environment, people must manage their attention to each other. Recent work suggests attention management can be considered as a dyadic negotiation process in which people are continually acting to display their own focus of attention and gather information about others' focus of attention, and may seek to increase or decrease the current level of attention from their partner. To explore attention management and negotiation on mobile devices, we built a custom application to track people's SMS and phone call activity. Drawing on log and transcript data, we use qualitative and quantitative methods to explore the details of attention management behavior within specific relationships for a few participants, and then used hierarchical clustering to identify different patterns of attention management in relationships of varying tie strength. Results suggest that attention is managed both implicitly and explicitly, with explicit negotiation more likely when there are conflicts. There are also substantial differences in interaction patterns by tie strength, with phone calls and shorter text response times more common for weaker ties.

Key words: attention, texting, conversation, negotiation, channel switching.

Introduction

People today have more opportunities to interact with more contacts than ever before. The ubiquity of "smart" mobile devices and connectivity mean that people can make phone calls, send text messages and use myriad social applications to connect with friends, family and colleagues (Chen, 2011; Smith, 2011; Turkle, 2011). People no longer interact only with those nearby or only with those who are remote, but rather are involved in multiple simultaneous conversations, via multiple media and with varying degrees of synchrony. All of these interactions require attention at varying levels (Wohn & Birnholtz, 2015), and this can take a toll. Recent work finds that people are regularly interrupted (Czerwinski, Horvitz, & Wilhite, 2004; Mark, Gudith, & Klocke, 2008), that expectations for rapid response have increased (Hall & Baym, 2011; Pielot, Oliveira, Kwak, & Oliver, 2014) and that the many communication applications or channels available can sometimes make it harder to reach others.

Research suggests that managing attention to others can be usefully conceptualized as a negotiation process analogous to the conversational grounding process described by Clark (1996). The key question for Clark is whether interlocutors have reached a shared understanding of what is being discussed and what knowledge each participant brings to the interaction. With attention management, the key question is whether interlocutors share an understanding of the level of mutual attention between them. Drawing on studies of how people gauge and negotiate attention in face-to-face contexts by continually monitoring the situation for and adjusting behavior in response to evidence of attention or inattention (Goffman, 1963; Kendon, 1990), this approach suggests that people similarly monitor their mediated interactions for signs of attention or inattention, and adjust their behavior accordingly (Wohn & Birnholtz, 2015).

There is further evidence, moreover, that people manage attention in a relationally sensitive manner, by responding to messages or requests for attention when they believe they are

expected to do so, and offer explanations or accounts (Schonbach, 1990; Scott & Lyman, 1968) when they are likely to violate others' expectations for attention, such as when failing to respond (Birnholtz, Reynolds, Smith, & Hancock, 2013).

Beyond this initial work, however, there have been few detailed empirical studies of how people negotiate interpersonal attention using mobile devices. Such studies are necessary, however, to better understand attention management and negotiation in today's complex communication ecosystem and update our theoretical models for understanding interaction processes. In the paper that follows, we take an exploratory empirical approach to understanding how attention is managed across multiple conversations and media on mobile devices. We developed a custom app that, with participants' consent, tracked the applications they used, the content and details of their short message service (SMS) text messages, and phone call details.

Background

Building on results presented by Wohn and Birnholtz, we consider attention broadly to include elements of what some call "awareness" (Cornejo & Favela, 2012; Dourish & Belotti, 1992; Gutwin, Penner, & Schneider, 2004; Schmidt, 2002), as well as a more cognitive notion of attention as focus on a specific activity or phenomenon (Kastner & Ungerleider, 2000). We define "interpersonal attention" as direct or technology-mediated awareness of or engagement with another individual.

As noted above, we start from the premise that interpersonal attention is negotiated in a manner similar to the grounding process described by Clark (1996). Just as Clark describes a level of shared understanding that interaction partners bring to a conversation, we assume an existing level of mutual attention between any given individuals, that people seek and provide evidence of the current level of mutual attention (i.e., to assess or maintain it), and that people

sometimes seek to alter the current level (i.e., to escalate or de-escalate it) of attention between them to facilitate interaction.

In face-to-face contexts, this can take the form of, for example, shifting one's physical position relative to others (Goffman, 1963; Kendon, 1990) or changing gaze direction (Argyle & Cook, 1976; Frischen, Bayliss, & Tipper, 2007). We know less about how this occurs in mediated contexts, but initial evidence shows that people are conscious of how and when their contacts attend and respond to messages (Walther, 1996; Walther & Tidwell, 1995), and that they strategically use specific media (Haythornthwaite, 2005; Isaacs, Szymanski, Yamauchi, Glasnapp, & Iwamoto, 2012) and cues (Clark & Brennan, 1991; Hancock, Thom-Santelli, & Ritchie, 2004; Reynolds, et al., 2011). Our focus in this exploratory paper is on strategies people employ for managing interpersonal attention and how these vary across relational contexts.

Mobile Attention Management: What Does It Look Like?

Norms and practices around attention management with mobile devices are taking shape and evolving. Some work has focused on allocating attention between face-to-face and mobile interactions (Ames, 2013; Humphreys, 2005; Weilenmann, 2003) or between multiple in-person and telephone conversations in busy work environments (Ticca, 2014). Moreover, there is evidence that people appreciate app notifications (Shirazi, et al., 2014), but that they respond at different rates and in ways that vary by context (Chang & Tang, 2015). Additional work suggests that people draw on location information in conversation to co-situate themselves relative to each other with the possible goal of meeting face-to-face (Licoppe, 2009).

Additional work has focused on the details of how people use mobile phones to interact and coordinate socially. Ling (2004) uses the term "micro-coordination" to describe the coordination of social plans at a finer level of granularity and with more flexibility (e.g., "Text

me Monday and we'll figure it out" vs. "Let's meet at our usual Starbucks at 10 on Monday"). There is also evidence from studies of "butler lies," deceptive messages that offer explanations for communication behavior violates others' expectations, that people feel the need to strategically manage relationships in the face of many demands on attention (Birnholtz, Guillory, Hancock, & Bazarova, 2010; Birnholtz, et al., 2013; Hancock, et al., 2009; Reynolds, et al., 2011; Reynolds, Smith, Birnholtz, & Hancock, 2013). In a qualitative, reflective exploration of attention management using mobile devices, Wohn and Birnholtz (2015) raise several issues that suggest two broad questions about mobile attention management.

The first concerns how attention is managed within a single ongoing conversation via one medium. The authors observed that ongoing text conversations often feature a conversation-specific "ambient" level of attention. That is, ongoing conversations with a person over several days or even weeks often do not require ritual greetings or farewells common in face-to-face conversations (e.g., Sacks, 1992), unless one party or the other wishes to change the level of attention (i.e., soliciting quicker responses or slowing down). Moreover, people often bring some understanding to their interactions of others' habits with regard to attention and media usage (O'Hara, Massimi, Harper, Rubens, & Morris, 2014). From this perspective, key questions concern the linguistic and para-linguistic strategies that maintain the current level of attention, or that seek to alter it. We therefore asked:

RQ1: Within a single text-based conversation, what evidence is there of strategies employed to maintain or alter interpersonal attention on mobile devices?

The second broad question concerns the strategic use of multiple media or channels to direct or re-direct attention within the scope of an individual relationship. Media multiplexity, for example, suggests that people use many channels to communicate with others, and tend to use

more channels with stronger ties (Haythornthwaite, 2005). Similarly, Isaacs et al. (2012) argue that multiple channels can be used to direct attention between multiple parallel streams in an ongoing group interaction. These channels can theoretically then be used strategically either to sensitively attract attention (e.g., by using a less salient medium such as texting to coordinate a good time before calling) or potentially to be even more invasive (e.g., by calling if texting fails to attract desired attention). Key questions from this perspective concern how switching between multiple media or channels of varying salience might itself be used as a para-linguistic cue for managing attention. We therefore asked:

RQ2: Within a relationship with interaction that spans multiple channels, what evidence is there of using channel switching or other media properties to manage attention?

Relational Differences

As noted above, there is evidence that people use media differently within different relational contexts, such as strong and weak ties (Haythornthwaite, 2005). It is further likely that people will vary their attention management strategies based on the type and closeness of contacts, stemming from theories on the pragmatics of language usage and politeness. Brown and Levinson (1987) argue that people will vary their politeness strategies based on relationship closeness, and Wolfson's (1986) "bulge" theory suggests that people will be most polite with contacts of moderate closeness, and feel less need for politeness with strangers and intimates.

In mobile and online interactions, recent work suggests that people vary certain politeness strategies (e.g., deception to save face) based on relationship type (Reynolds, et al., 2011). People also have some awareness of a contact's communication habits (e.g., knowing what applications send them notifications). Additionally, Wohn and Birnholtz (2015) saw evidence that people structure their communication environment to make it easier or harder for

certain others to reach them. These strategies, and others like them such as contact-specific ring tones or notifications, can make it easier to hear from a partner or child, for example, than to hear from a colleague or acquaintance (Chang & Tang, 2015).

For attention management, this suggests that people bring to each interaction some understanding of their communication partner's behavior, relationship-specific norms and the existing level of attention or interaction between them. In examining this at a more detailed level, we would expect to see evidence in several aspects of interaction such as the total volume of interaction, types or channels of interaction, response time to messages, and ignored potential interactions (e.g., missed calls). While there have been studies of responsiveness to messages and notifications (e.g., Pielot, et al., 2014) that address attention management at some level, these did not distinguish between types of contacts. Thus, we have some sense of the times of day at which people are most likely to respond to notifications and the types of notifications they are likely to respond to, but we know less about how people do this within particular relationships. We therefore asked:

RQ3: How do people's attention management strategies and interactions vary by relationship?

Methods

Building on Orman and Thorhauge's (2015) call for qualitative analysis of mobile log data and Boase and Ling's (2013) observations of inaccuracies in mobile self-report data, we used a mixed-methods approach. Data were collected primarily via a custom-developed Android mobile application run by participants on their own phones for 7 days. Most participants also completed database-driven web pre-and post-study questionnaires with tailored questions based on study activity. Questionnaires asked participants about communication habits and application

preferences. We gathered data from October, 2014 - January, 2015, with participants joining the study on a rolling basis.

Participants

There were 102 participants who completed the study (of 179 who began enrollment). Participants were recruited via flyers posted on our university's campus in the midwestern US and advertisements on Craigslist in the 9 most populous US cities. Recruitment materials specified that the study focused on mobile communication and required participants to own an Android OS phone, be 18-29 years old and use English as their primary language. Participants received a $20 Amazon gift card for their participation. Mean participant age was 25.8 (SD= 5.05; N=98, 4 did not report). Gender was provided by 98 participants (34 male). Forty-one participants were full- or part-time students, 36 were employed, 21 were unemployed and 4 did not respond. To verify that we had a diverse sample, we collected self-reported race (with the option to select more than one): 19 were Asian, 20 were Black, 60 were White, and 21 were Hispanic/Latino.

Materials: Tracker App

We selected Android OS for our tracker app because it has a larger and more diverse user base than iOS, and because it uses SMS as its default text messaging protocol, instead of proprietary systems (e.g., iMessage) in which messages are difficult or impossible to capture. Our application sent participant data to our secure database server once per day during the study. To protect privacy, participant and contact phone numbers were encrypted via one-way hashing prior to storage on the server. Contacts' names were stored with only first name and last initial, so that they could be identified to participants in the post-study questionnaire.

Activities logged included powering the phone on or off; the foreground application running any time the phone's screen was active; phone call length, incoming/outgoing status and contact; and SMS text message time/date, content, sent/received status and contact. Push notifications and MMS content (e.g., photos, emoji or group messages) in the texting app were not captured. While we gathered all application usage, we focused on SMS because it is known to be commonly used and was by far the messaging application most commonly used by our participants (see below).

Procedure

Participants enrolled and participated in the study entirely online. After emailing our research team, they received a link to a web enrollment page. They first read and agreed to an online consent form indicating they would run an application on their phones that logged their activity and shared their text messages and phone call statistics with our research team. Participants were then prompted to complete the pre-study questionnaire, download and run our tracking app for one week while using their phone as they usually do, and complete a post-study survey. Upon completing the post-study questionnaire, participants were given instructions for un-installing the app and were compensated. While some participants ran the app for longer than 7 days, we include only the first 7 days per participant in our analyses.

The pre-study questionnaire collected demographics, phone information (model/OS version), mobile plan details (e.g., limits on texting or data) and attitudinal data regarding social interaction and phone use. The post-study questionnaire asked participants to reflect on and estimate their phone use and asked about their relationships (e.g., type and closeness) and communication with 6 specific contacts. We do not report on the questionnaire data in this paper, but include this description for a complete account of the procedure.

Data Processing, Validation and Analysis

Our analyses rely on two types of data aggregation. First, to examine the temporal dynamics of phone and app usage, we divided each participant's phone use into discrete sessions. Based on iterative manual examination of transcripts, we defined a session as being a period of phone activity bounded by 2 periods where the phone's screen is dark for 30 or more seconds. On average, sessions lasted 3.5 minutes, with substantial variance.

To validate the data, we ensured that participants used their phones to interact with others during the study. Participants spent, on average, 4.35 (SD=3.61) hours using their phones each day. They used 998 distinct apps, but 142 of these accounted for over 90% of observed activity. We developed a coding scheme to characterize these 142 apps as "primarily communicative" (allow production and consumption of content for and from contacts, e.g., Snapchat, Whatsapp, Facebook, etc.), "potentially communicative" (share information in standardized form, such as Fitbit), or "non-communicative" (do not allow sharing content with contacts, e.g., transit or reading apps). Participants spent an average of 45.3% of their time on their phone each day using communicative apps. Within this set, the most common was the Android SMS app, which was observed as the foreground app 256,278 times versus 52,790 for Snapchat, 26,287 for Go SMS Pro, 22,124 for Facebook Messenger and 17,619 for WhatsApp. This strongly suggests that SMS was frequently used by our participants. Their remaining time was spent using potentially communicative apps (14.6%), non-communicative apps (31.3%) and apps we did not code (8.9%).

We focused on participants' SMS and phone call behavior. Participants used these media to interact with an average of 13.56 (SD = 8.77) contacts during the study, with whom they exchanged an average of 20.00 (SD = 20.44) SMS messages and 5.50 (SD = 6.35) phone calls per day. Overall, excluding 5 participants who did not send SMS messages or make phone calls, participants exchanged an average of 140.06 (SD = 143.12) SMS messages and 38.91 (SD= 44.47) calls and spent a total of 107.49 (SD = 182.22) minutes on the phone during the 7-day study period. Thus, we see that participants used their phones regularly, used them to communicate with multiple contacts and, presumably, to negotiate attention in these interactions.

Second, to examine the dynamics of phone usage and message exchange, we calculated participants' response time for each received text message. To account for possible skew from times when the participant was asleep, we calculated response time only for messages received and responded to on the same day. As sleep patterns do not usually reflect the formal start of a 'day' at midnight, we defined a 'day' as beginning at 5:00 AM and ending at 4:59 AM the following night. We selected this time because the lowest volume of activity was between 4:00 – 5:00 AM. We also realized that temporal dynamics could be affected by messages that did not warrant a response. Unfortunately, we could devise no automated way to discern these, but we would not expect them to vary systematically between contacts for any individual. We discuss these data further in the results section.

Results

Our first two research questions concern the strategies people use to manage attention on mobile devices and if they are managing attention at all. As our approach is relatively novel, our first step was to understand whether people seemed to be negotiating attention and how they did it. Using prior results cited above as a guide, we compiled chronological activity transcripts of

the full 7-day study period for five randomly selected participants that included timestamped records of all SMS text messages (including message content) and phone calls, with information about the contact and whether the message or call was incoming or outgoing. These transcripts each had a mean of 210.2 (SD=180.76) entries.

We iteratively developed a coding scheme to identify attention management behaviors, based on our understanding of how attention management works in other contexts, careful examination of several transcripts and discussion among the authors/coders. Our coding scheme sought to characterize likely intent with regard to the current level of mutual attention (RQ1), and also identify ways that multiple channels were used to do this (RQ2).

In this process, we recognized that we could not always accurately infer our participants' intent. To include as wide a range of behaviors as possible, we chose to err on the side of inclusivity, with deliberately broad definitions. We use these broad definitions and detailed examples below to illustrate these behaviors. We operationalized our key concepts as follows, applying a binary code (i.e., present or not) for each category to each entry in the transcript (i.e., to each phone call, each text message, etc.). As this coding was exploratory, categories were not mutually exclusive, and we did not include a second coder at this stage.

Potential impact on mutual attention was divided into three categories: escalation, de-escalation, and maintenance. Behavior was coded as "escalation" when it sought to increase the level of mutual attention between communicators, such as by re-starting a dormant conversation, seeking faster response or moving toward more synchronous communication (e.g., using a text message suggest a phone call). Behaviors were coded as "de-escalation" when the aim was to end the conversation or otherwise reduce the current level of attention (e.g., texting "gotta go").

Behaviors were coded as "maintenance" when they did not appear intended to change the level of attention, but rather to continue to interact at that level. Many non-behaviors (i.e., doing nothing) fall into this category, but these could obviously not be coded.

Rather than simply counting episodes and reporting summary statistics, we used the coding scheme as a guide for qualitatively understanding the transcripts. We report here on observed behavior related to attention management.

Management of Attention

In addressing RQ1, which focuses on attention management within a single text-based channel, we first considered the initiation of conversations and escalation of attention. We noticed three general patterns in participants' interactions via text message, each of which had its own escalation style. One pattern was brief, highly interactive exchanges focused on coordination or answering questions in the moment. These exchanges were characterized by an apparent attempt to escalate mutual attention, simultaneously display interest in interaction and gather information about the contact's availability, exchange the necessary information, and sometimes de-escalate attention after the information was exchanged. This raises the question of how attention is escalated, given the limited range of strategies text provides. We found this was often accomplished via salutations, which serve to mark the interaction as a discrete episode. For example, one participant, 5 days after their last message with one contact, escalated their state of mutual attention by saying "Hey man! When were you planning on getting in? Hope your [sic] enjoying NorCal." This served to display the sender's attention to the recipient and interest in a response.

The second pattern we saw was ongoing conversations characterized by temporally sporadic utterances relevant to each other, but that were not focused on a particular topic or

characterized by an attempt to alter the level of mutual attention. Rather, attention between the individuals was assumed to already exist, so gathering and display were not being used strategically or paralinguistically. There were, however, frequently times where there was an attempt to gather information about a partner's attentional focus by sending a question to display continued attention and perhaps assess whether one's interaction partner was available for a more synchronous conversation and escalated attention. A common question for these participants was "what are you doing?". These were sometimes followed by more synchronous conversation, depending on how quickly the receiver then displayed attention to the sender and whether the receiver indicated availability or not. Often these ongoing conversations, particularly those with romantic partners, were characterized by regular temporal rhythms of interaction, such as texting when waking up or calling before bed.

The third pattern included messages that provided information, but did not do so synchronously or aim to get immediate attention, but also did not appear to be part of an ongoing interaction where mutual attention was continually assumed. Rather, the implicit assumption in these messages appeared to be that the receiver would understand why attention was necessary and attend to the message when they were able to. Thus, there was no reason to escalate attention in the moment or via a salutation, but there seemed to be an assumption that it would be escalated later. One example of these was when the goal was to receive information about availability at a later time, for coordination purposes. For example, one participant sent the message "Let me know when you all are wrapping up dinner," as they coordinated later evening activities.

Continuing to address RQ1, we then focused on how attention was de-escalated or reduced. In the transcripts, there was very little evidence of explicit verbal de-escalation of

attention. More common was what appeared to be simply delaying response to messages as a possible paralinguistic indicator of fading attention or interest. This strategy reflects the semi-synchronous nature of texting. By delaying responses, one can easily shift from focused attention on a single interaction (as in a focused conversation to answer a question) to focusing one's attention more broadly on a series of interactions or tasks. And indeed, the full data set suggests that SMS response time varied widely, with a mean of 52 (SD=27) minutes. It is possible in some cases, of course, that slow response reflects attention to other activities and is not deliberate.

Where conversations were explicitly brought to a close via verbal de-escalation, this most commonly involved conventional conversation closers such as "see you tomorrow," "good night" and "thanks!". We saw some cases, however, where additional de-escalation was needed to accomplish one partner's apparent goal of de-escalating mutual attention between the pair. For example, one participant said: "about to call it a night" as a likely hint at de-escalation, followed by "ok well Nite Nite" to be a bit clearer, and finally "ok...Goodnight!???" These examples highlight an important distinction between de-escalation via text and de-escalation in other media. Face-to-face conversations are often accompanied by body language and physical cues of attention that can make clear when a conversation has ended or when one party is no longer paying attention (Schegloff & Sacks, 1973). Telephone conversations do not allow for body language, but the timing and content as utterances can serve as cues about the desire for further engagement. Telephone conversations also have clear start and end points (i.e., answer and hang-up). In text messaging, on the other hand, there are fewer cues about mutual attention and the medium provides no clear start or end points for an interaction with a contact. This lack of discrete boundaries combined with ambiguity about conversational engagement (i.e., whether a

partner desires further conversation) can make it difficult to reach a shared understanding of each other's mutual attention and engagement. Thus, it makes sense that some participants were explicit about de-escalating attention, especially when their interaction partner was more engaged and may have been trying to escalate, or where the delay was not a viable paralinguistic strategy.

A case of different levels of engagement occurs in this conversation, where the participant ('A' in this conversation) seems more engaged and sought to escalate attention but their partner appears less engaged and acts to de-escalate attention:

9:35 pm *B: Goodnite*
9:39 pm *A: Why u going to bed?*
9:41 pm *B: Not feeling to good*
9:42 pm *A: U faking... Call me right now*
9:43 pm *B: U aint thinkin bout me*
9:43 pm *B: Call u tommorow*

The participant was persistent in trying to escalate attention, calling the contact twice immediately after this (once for 12 minutes, and again for 53 minutes just after the first call ended) suggesting significant engagement.

De-escalations also varied somewhat with conversation type, though this difference was less clear than with escalations. For people in sustained, ongoing conversations, verbal de-escalations appeared to be used to indicate when one party or the other was going to bed or would be otherwise unavailable, both examples above suggest. Verbal de-escalations were also sometimes used to end a short, focused exchange.

Channel Switching and Attention

RQ2 concerned the management of attention across multiple media or channels, texting and phone calls in our case, within a single ongoing conversation between a participant and one of their contacts. There is some evidence in Wohn & Birnholtz's (2015) work that people

frequently use a lower-attention medium like texting to negotiate the start of a telephone call. In the transcripts we examined, however, we saw little evidence of this. We did see the reverse, however. People would attempt to call a contact, fail to reach them, and then send a text saying something like "call me." Or in a more extreme case, one participant made 3 unanswered calls within a minute to a contact, and then sent a text saying "grill [sic] answer your phone." This is interesting from the standpoint of attention management because it is essentially a display of attention and a request for escalation of mutual attention in the near future that follows directly from a failure to escalate attention and become the partner's current focus. That is, the implicit message is "you're paying attention to something else, but please pay attention to me when you can." We also saw a case where a participant made a brief (5 seconds) call, and then sent a text message when the call appeared to be disconnected that read: "I think the call dropped but thank you!! 6:21 is probably ideal." Here the implicit message seems to be that the participant had gotten what was needed from the conversation, and was texting to confirm this and close the interaction. It is interesting that a text message (which typically has few discrete start/end points) is used to provide an end to a telephone conversation, which may have otherwise been perceived as incomplete or rude.

With regard to attention across conversations, we wondered about the extent to which participants seemed to be attending to multiple ongoing conversations. In general, they seemed to be attending to multiple conversations in any given unit of time. It was rare that participants would pay active attention to only one interaction partner in cases where multiple people seemed to be requesting their attention.

While it is possible to pay attention to multiple text conversations at once, the same is not true (or at least is much more difficult) for phone conversations. We saw some evidence of

instances when an incoming phone call interrupted an ongoing text exchange and, particularly within conversations that had already started, there was often an explanation in the text conversation for the delay in response. For example, this conversation is initiated by A, then interrupted by a phone call, to B's puzzlement and concern:

7:32 pm	*A: Hi whatre you doing rn?*
7:49 pm	*B: lol nothingg home hbyyy haha*
7:50 pm	*B: wat up*
8:07 pm	*B: [A's NAME]?*
9:22 pm	*A: Sorry my friend called me and and we just hung up*
9:23 pm	*A: I miss yaa and wanted to know if you wanted to chill for a bit and talk but i dk if its too late cos you have class lol*
9:25 pm	*B: its alll good bebe i thot u needed help i got worried hahhaa*

The conversation here suggests many assumptions between interlocutors that are highly dependent on relational context. Both the participant and their contact have expectations around attention and the meaning of acts such as A's very slow response and B's concern that A might need help. These seem to be close friends, but these patterns of attention might look different for others where there are different relationship-specific expectations.

How Attention Varies By Relationship Type

Our third research question concerned how attention management plays out in different relational contexts. While prior work suggests that people interact differently with different types of contacts and our qualitative analysis supports this, there have been few studies of attention management within relationships at this level of granularity.

To classify contacts for each participant into different relationship types, we used cluster analyses based on participants' SMS and phone call data for each contact. First, we calculated 8 interaction variables for each contact (starred parameters were log transformed to account for skewed distributions): mean SMS response time*, mean phone call duration*, number of phone

calls, number of text messages, proportions of calls and texts that are incoming (vs. outgoing), and the proportion of all communication that occurs on the weekends (Friday, Saturday and Sunday[1]). We then performed a separate cluster analysis for each participant, to cluster that participant's contacts based on those contact-specific variables.

To calibrate the clustering algorithm parameters such that the clusters appeared to reflect meaningful relationship differences, we used a validation set of 10 participants who reported relationship types for their 30 contacts in the post-study survey[2]. These 30 relationships served as ground truth to validate the clustering outputs.

We iteratively manipulated the number of clusters (k=2,3,4) and clustering methods (single, complete, and average linkage method), and compared the output with the ground truth data. Better settings resulted in clusters of contacts with similar relationships (tie strength) into one group. Through iterative analysis and discussion, we found that 3 clusters resulted in the best performance. These three clusters tended to include: weaker ties (acquaintances and extended family), closer ties (romantic partners and friends), and closest ties (immediate family and close friends). Note that romantic partners were not always long-term, so tended toward the 'closer ties' cluster instead of always being 'closest.'

For the other parameters, the best performing algorithm used Euclidean distance to measure the similarity (distance) between two contacts, the complete linkage method to combine two groups, and the optimized number of clusters as three. Though the algorithm could not always separate the 'closest' and 'closer' tie groups because some categories can cross these

[1] Friday is included as part of the weekend because communication on Friday night much more closely resembles weekend communication than the rest of the week.
[2] Due to encryption intended to protect participant privacy and a database implementation error, relationship information could be reliably matched with specific contacts for 10 participants. These participants constituted our 'validation set' used here.

groups for a participant and their interaction patterns are often similar, we saw that it could clearly separate the weak ties group (100% correct) from other two close-tie groups (85% clustered correctly into one of these groups).

Using this algorithm, we clustered the contacts into these three groups for all participants (see Table 1). We used a reduced data set (N=78) for clustering because we had to eliminate 5 people with insufficient overall activity and 16 who interacted with 3 or fewer contacts for the clustering algorithm to function reliably.

	Weak Ties		Close Ties		Very Close Ties	
	Mean	SD	Mean	SD	Mean	SD
Mean Call Duration (seconds)*	25.90	148.73	88.02	131.47	172.37	285.61
Average SMS response time (minutes)*	31.69	34.73	45.60	80.39	59.58	71.43
Calls per contact	0.21	0.51	2.61	4.301	8.95	11.88
SMS per contact	10.69	13.07	18.95	27.70	34.50	46.00
Incoming Call Proportion	0.27	0.39	0.41	0.39	0.367	0.29
Outgoing Call Proportion	0.35	0.42	0.53	0.38	0.52	0.29
Missed Call Proportion	0.22	0.36	0.05	0.10	0.11	0.16
IncomingTXTProportion	0.51	0.18	0.49	0.19	0.52	0.16
WeekendProportion	0.44	0.35	0.40	0.32	0.49	0.27

*Notes: * indicates log transformation was used in computing clusters, but actual values shown here for legibility.*

Table 1. Descriptive interaction data by relationship-type cluster (N=78).

All of this clustering was to explore how attention management behaviors occur with contacts of varying closeness. While it is perhaps obvious that clusters created based on particular variables would differ according to those variables, we did not have *a priori* assumptions about the magnitude or direction of these differences. In our analyses we do not

mean to imply that the mere existence of differences is of consequence, but rather focus on the nature and details of these differences.

We first looked at text message response time. From an attention standpoint, text message response indicates that one is paying attention to the message sender, with shorter response times possibly indicating a higher level of mutual attention and a desire to maintain that level. One possible explanation would be that response times for closer ties should, on average, be shorter than response times for weaker ties. As Table 1 shows, however, this was not the case. A pairwise comparison using multiple t-tests shows that weaker ties had the shortest response time, with both closer-tie groups having longer response times by a statistically significant margin using an ANOVA and Tukey multiple comparisons, $F(2, 231) = 19.74$, $p < .01$. Thus, people tended to respond more quickly to those with whom they are not as close. This is puzzling but could reflect that messages from acquaintances may be more immediate in nature, and could also reflect that they occur less often and, consistent with our qualitative analyses above, may be more targeted in the need for response, so merit response when they do arrive.

To explore this we then looked at the number of text messages sent to contacts in each group. Indeed, as Table 1 shows, people exchanged far fewer messages with their weakest ties than their closer or closest ties. This suggests that a message from a weaker tie can command attention when it arrives and merit a quicker response, as it is intended to briefly escalate mutual attention. In closer relationships, on the other hand, the level of mutual attention may be more static, so messages may not merit an immediate response or any response. To further explore this, we examined the bivariate correlations between SMS response time and call frequency, but – likely due to significant variance in the data – these correlations were not statistically significant.

It is also possible, that people in closer relationships use the phone when they seek attention quickly, whereas people in less close relationships do not use the phone as much so their texts, on average, are responded to more quickly. As Table 1 further shows, the data seem to point in this direction. The average number of phone calls per contact was just .21 (SD=.50) for the weakest ties compared with 8.95 (SD=11.88) for the closest ties. To further explore this, we examined the proportion of calls that were incoming, outgoing and "missed" (i.e., incoming but not answered). In this examination, we see that, on average, 22% of calls from weaker ties were "missed" as compared with 5% for closer ties and 11% for the closest. Thus, people used the phone rarely with their weaker ties and were much more likely to not answer the phone when those contacts called, whereas they used it more often and were more likely to answer when a closer contact was calling.

Discussion

We began with questions about how attention is managed on mobile devices and what this looks like for different types of ties. These results lay the foundation for further study of how people manage attention to multiple streams of interaction over time. Importantly, this is distinct from related work on multi-tasking, which focuses on short-time-horizon settings, such as moving between tasks or conversations in a single sitting (Salvucci, Taatgen, & Borst, 2009; Ticca, 2014). Rather, our goal is to understand how interlocutors interpret and manage the level of attention between them over time and using multiple channels. Our results have several implications.

Attention is negotiated implicitly and explicitly

One clear implication is that interpersonal attention is no longer an 'all or nothing' proposition as it was with phone calls and as it is often treated in studies that focus on a single interaction. Instead, people are involved in multiple simultaneous interactions and use a range of strategies to manage attention between them. One notion from Clark's (1996) framework that is particularly useful here is that language serves two purposes in an interaction, which Clark calls "tracks". Track 1 refers to the "official business" of the interaction, where Track 2 refers to a more instrumental function in communicating evidence of success or failure in grounding. In managing attention, we can say that Track 2 is comprised of attempts to maintain, escalate or de-escalate attention using cues and techniques available through different media. This could include response time and chronemics, as others have studied within short conversations (Kalman, Scissors, Gill, & Gergle, 2013), as well as other strategies we observed such as shifting from text to a call, or verbal negotiation of attention. Understanding attention management, and online interaction more generally, as a continuous stream of interaction at varying levels of negotiated attention – rather than as a series of discrete interaction episodes – will help us better theoretically understand the online interaction and how people manage their conversations and relationships in an always-on world.

A second implication is that the negotiation of attention is often implicitly handled through Track 2, but becomes explicit (and most obvious) where there are apparent disagreements and further negotiation is required. That is, a move to escalate attention, such as a phone call, can result either in an escalated level of attention via a completed call, or may require more explicit negotiation (e.g., texting "Pick up your phone") if the other party does not respond. The same is true for attempts to de-escalate attention, such as saying "Good night" to end a

conversation. Further negotiation is only required if the other party does not wish to end the conversation, as we saw above. This is notably distinct from media like the telephone where conversational openings and closings generally co-occur with the technical opening and closing of the communication channel between the participants (Schegloff & Sacks, 1973). Importantly, this does not mean attention is negotiated only when such negotiation is explicit. Rather, it adds further weight to the need to focus on the various ways in which attention is negotiated via sequences of gathering and displaying behaviors between individuals who are interacting.

Attention management varies with tie type

A third implication of our results is that the nature of attention management varies with the strength of social ties. Participants appeared to use phone calls far less often with their weaker ties and were much more likely to ignore calls from these people. From an attention management standpoint, weaker ties in these cases may have been seen as requesting to escalate attention too much or too quickly. Given that they also interact less frequently with these ties, participants were also less likely to gather information via text or other means about whether the participant was available for a phone call. Instead, texting seemed to be a more successful strategy for escalating attention between weaker ties, in that response time to these messages tended to be shorter than for stronger ties.

When it comes to managing attention with stronger ties, participants tended to be more receptive to and more likely to themselves escalate attention rapidly with a phone call. Our qualitative analyses also suggest that people sometimes used multiple channels to escalate attention or attempt to do so in cases of conflict. Where text messages were used with stronger ties, response times were – on average – longer even after correcting for hours when they were likely asleep. From an attention management standpoint, this means that text messaging was

likely used mostly to maintain the level of attention and that texts were part of an ongoing conversation between these individuals. The smaller number of salutations and farewells in these conversations we saw in our qualitative analyses further supports this point. It is also possible, however, that closer ties were simply more likely to send messages that did not warrant a response. Our qualitative results suggest that both explanations are supported by the data, with further research needed to discern which explanation is most frequent.

Limitations

As with any study, our work has multiple limitations that urge interpretation of results with caution. First, our data was limited to phone calls and SMS, thus offering an incomplete record of communication. While we saw substantial communication and SMS was the most commonly observed foreground app by far (see above), it is possible that participants used other applications to communicate with some of their contacts and that they did so differently. Another related element of mobile attention management that we did not capture is push notifications. We do not expect these to vary systematically within our data set, but future work should take these and other communication applications into account, to the extent possible given limitations in the capacity to record activity in different apps.

Second, our qualitative analysis of transcripts was limited to a relatively small subset of our participant sample. This allowed for a detailed reading and analysis of these transcripts and reporting useful examples, but does mean that our observations may not generalize beyond these participants. Preliminary support is provided by our quantitative analyses, but additional work is needed through larger manual content coding studies in addition to using techniques such as natural language processing and machine learning to identify patterns in attention management

behavior. These are beyond the scope of the present exploratory study, but would be fruitful areas of future work.

Third, as with any statistical clustering, our algorithm likely made some classification errors due to limited availability of ground truth data for validation. Our validation, however, showed no evidence of systematic bias in these errors, so this should not significantly impact our findings.

Finally, we also do not know if or how often participants talked to contacts face-to-face. This is a common limitation in studies of this nature and is not debilitating, but does suggest a potentially important topic for future work on the full set of interactions.

Conclusion

We have presented data from a mobile phone log study to explore how people negotiate attention when interacting on their mobile devices. Through the analysis of interaction logs and communication patterns with contacts in various relationship categories, we have argued that people seem to strategically manage and negotiate attention using a variety of communication techniques on their devices. Moreover, attention management involves both implicit and explicit strategies, with explicit strategies being more important when there is disagreement about the appropriate level of mutual attention or when more subtle tactics seem to fail.

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