People, Place and Time:

The Daily Rhythms of Deception in Interpersonal Text Messaging

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Abstract

Text messaging has grown in popularity recently, particularly among young adults who regularly use texting to coordinate and communicate to maintain relationships. Little is known, however, about the relational context (i.e., to whom messages are sent) and temporal dynamics (i.e., when messages are sent) of texting. Moreover, the addition of location sharing capability to mobile communication tools has the potential to alter communication and relationship maintenance strategies, such as deception. This paper presents an examination of text messaging, focusing on interpersonal deception and location sharing. A custom text messaging application was developed to allow for location sharing and recording of messages, which was used by 63 participants for one week. Results show that participants sent more text messages to significant others and that more of those messages included their locations. Temporal patterns of deception over the course of the day were observed, with late night spikes in the rate of lying, rate of butler lying, and rate sent without locations. The rate of butler lying also peaked around meal and social activity times

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As mobile phones have become increasingly popular, so too has text messaging. Recent reports indicate that 75% of all teens (Lenhart, 2012) and 73% of adult cell phone owners (Smith, 2011) use text messaging. Text messaging is so important to many college students that when study participants were restricted from using it for several days they felt anxious, stressed, and that their relationships had worsened (Skierkowski & Wood, 2011). These outcomes suggest that text messaging has transformed from a simple means of communication to one that is critical for students to maintain both their own psychological well-being and is also an important tool for managing relationships (Pettigrew, 2009). From a uses and gratifications standpoint, Grellhesl and Punyanunt-Carter (2012) found that the convenience of mobile phones was reported as the number one reason for undergraduates' use of text messaging.

In the present study we focus instead on the relational and temporal factors that drive text messaging, with an emphasis on how deception is used in texting across relationships and over time. We focus on deception because it is commonly used in conversation, both face-to-face and through mediated channels (DePaulo, Kashy, Kirkendol, Wyer, & Epstein, 1996; Hancock, Thom-Santelli, & Ritchie, 2004). One specific type of deception, the butler lie, is used regularly in text messaging for managing social interactions in an always-connected world, especially for tactfully avoiding interactions in a way that does not damage relationships (Birnholtz, Guillory, Hancock, & Bazarova, 2010; Hancock et al., 2009). For example, if one person explains to a friend that they didn't respond to the last text message because their phone battery had died, when in fact it had not died, the person is explaining their unavailability in a way that protects the relationship. While butler lies and deception have been shown to be common strategies for

managing relationships, however, there is reason to believe that these strategies may be used differently in different types of relationships. This has not previously been explored, though a clear understanding of these strategies is critical if we are to understand and support communication in an always-connected world. We therefore ask how deception and butler lies are used among the different relationships that are managed, at least in part, through text messaging.

Moreover, the temporal dynamics of text messaging – that is, the times of day at which messages are sent and responded to – are poorly understood. This is also the case for deception. These temporal dynamics, however, are important given that text messaging plays such a crucial role in what Ling (2004) refers to as micro-coordination, in which people use text messaging to coordinate their daily activities, such as arranging where to meet and when. Given that daily activities for most populations are highly cyclical and regular (Golder & Macy, 2011), the timing of text messaging and deception should both reflect and reveal patterns of daily activity. For university students, for example, a daily schedule includes classes, mealtimes, and evening social activities. To the best of our knowledge, however, no study has examined how deception is used over the course of the day, and certainly not within text messaging. Given the role of text messaging in coordinating these activities, we ask how texting and deception fluctuate over the course of the day.

Finally, location sharing has become an important feature for many online activities, especially as more people begin to rely on location-based services on their smartphones (Zickuhr, 2012). Sharing one's location using popular services such as FourSquare or Facebook Messenger can provide the benefits of letting others know where one is for coordination or to see who is nearby, but at the same time limits the ambiguity that can be drawn on when constructing

deceptive messages. The common butler lie "I'm on my way!" often sent when one is running late but has not yet left home, for example, would not be plausible if the receiver knew the sender's location. A similar effect might be expected for the intersection of temporal dynamics and location sharing, with certain locations likely to carry a different meaning at different times of day (e.g., visiting a bar at 10:00 am versus the same bar at 10:00 pm). We therefore asked how location sharing affects text messaging and deception.

To investigate these questions we developed a custom text messaging application for this study. Participants installed our app, called Butler Messaging, on their cell phones and used it to send and receive text messages for one week. In addition to standard text messaging functionality, the app asked recipients as they sent each message whether it was deceptive or not, and also allowed for location sharing with sent text messages. In this paper we analyze participants' use of deception and location sharing in the text messages they sent with Butler Messaging. Our analyses focus on two key questions: 1) the pattern of messaging and location sharing across different types of relationships and 2) the temporal dynamics of deception and location sharing over the course of the day. In the sections that follow we relevant related literature, our methods and findings, including feedback from our participants.

Relationships and Text Messaging

Prior work has shown that people communicate in different ways and using different media with different people, depending on their relationship type and closeness (Agosto, Abbas, & Naughton, 2012; Baym, 2010). Text messaging has received substantial recent research attention, with results suggesting that it is a form of communication used primarily by young adults to communicate with core groups of close friends (Van Cleemput, 2010), within the bounds of romantic relationships (Coyne, Stockdale, Busby, Iverson, & Grant, 2011; Drouin &

Landgraff, 2011), and less commonly with acquaintances (Battestini, Setlur, & Sohn, 2010). Moreover, Pettigrew (2009) found that text messaging is viewed as an important relational tool, and that it is not used the same way in all close relationships. While these studies draw on a range of methods and offer useful insights into how text messaging is viewed and generally used in different types of relationships, there has been little detailed, systematic examination at the message level of exactly whom text messages are being sent to, and, of interest to the present work, how individuals use texting to deceive relational partners.

One aspect of everyday communication that can yield insights into people's communication behavior is deception (DePaulo et al., 1996), which is defined as an intentional attempt to mislead another person without forewarning (Vrij, 2008). Deception is commonly used in conversation to avoid possible threats to the relationship that might stem from hurt feelings (DePaulo, Wetzel, Weylin Sternglanz, & Wilson, 2003) or threats to one person or the other's standing within the relationship (Reynolds, Smith, Birnholtz, & Hancock, 2013). For example, one might say "you look nice today," to cheer up a colleague who seems upset but does not, in fact, look particularly nice. In text messaging, a similar effect might be achieved by, for example, providing encouragement (e.g., "I know you'll do great in your interview!" when one does not actually believe this). Prior work on text messaging has shown that approximately 10% of messages are deceptive (Birnholtz et al., 2010; Reynolds et al., 2013), suggesting that deception is a common feature of conversation, even if it occurs infrequently relative to the overall stream of messages.

There has been limited research, however, examining the rate and patterns of text-message deception within and across specific types of relationships. Research examining face-to-face deception and relationships has been mixed. Some research (DePaulo & Kashy, 1998) found

that people tend to lie more to strangers and acquaintances than to romantic partners, presumably because they have the desire to be honest with people they are closest to, or because friends and spouses know more about us and our activities, making it more difficult to lie to them (Anderson, Ansfield, & DePaulo, 1999). Other research, however, has shown that people lie frequently to their romantic partners, with one study revealing that 92% of individuals report lying to their significant other (Cole, 2001). We may lie more to our significant others for many reasons, including other-oriented reasons such as protecting their feelings (e.g., "No you don't look fat in these pants?"), self-oriented reasons (e.g., "It's your turn, I did the dishes last time."), or for reasons privacy reasons (e.g., "I'll be home late tonight, I have to work late."). In fact, some of the most serious lies people tell are related to infidelities and are told to save the relationship (Anderson et al., 1999).

How might deception relate to relationships in text messaging? One important factor is the role of text messaging for coordinating social activities (Ling, 2004). One consequence of this is that people may need to lie more to those that they coordinate with most, which may help explain several of the findings related to butler lies. First, as noted, butler lies are a common type of text messaging deception, frequently making up one fifth of all lies told (Birnholtz et al., 2010; Reynolds et al., 2013). Second, there is some evidence that butler lies are told to closer contacts. Reynolds et al. (2011) observed that their participants told more butler lies to their closest contacts. Given this preliminary evidence, and the fact that text messaging is used within multiple relationship types, text messaging and deception should vary across relationship types. In the present study we use the Butler Messaging app, which captures text message conversations with a range of different relationship contacts, to examine how texting and

deception take place in several close relationship types, including friends, significant others, and family.

Another important feature related to text messaging is the dramatic increase of mobile communication applications (i.e., "apps") that rely on location information (Smith, 2012). Many popular applications, such as FourSquare, Facebook Messenger, Path and Twist, share users' locations with their contacts. Some of these apps share location generally, such as Facebook Messenger which appends a description of one's location onto the end of all sent messages; and Foursquare which allows one to "check in" to public places so others can see who is there to coordinate social events on the fly. Other apps allow for more context-specific sharing, such as Twist which allows for location sharing with a designated group of contacts within a specific timeframe, so that one's progress toward arrival at an even can be tracked. Overall, these and other location sharing apps are growing in popularity (Zickuhr, 2012). With these apps, people often share details about their location, which were not previously shared and can threaten the ambiguity formerly afforded by mobile communication.

While this location information can be useful in coordination, it also threatens the ambiguity previously inherent to mobile communication. Typical text messaging includes no indication of where the sender is, thus location and other contextual factors, such as when a message was seen and by whom, are ambiguous. This ambiguity is commonly drawn on strategically to deceive others when telling butler lies. For example, Alex might send Bill the butler lie "on my way" when he actually hasn't left home yet. Because Alex's true location is ambiguous, the lie is plausible to Bill. This and other butler lies serves a relationship-preserving purpose by tactfully explaining behavior that might otherwise be considered rude (Birnholtz et al., 2010). Given that butler lies often serve a relational function, and that location sharing can

threaten one's ability to tell butler lies, we were interested in the ways in which location sharing would be used with different types of relationship partners. To explore this possibility, we used the Butler Messaging app to allow participants to include or exclude location information with text messages they sent.

Based on the above discussions of messaging in different types of relationships, deception, and location sharing, we first explored the general research question:

RQ1: How does relationship type affect how people text, lie, butler lie and share locations with one another?

The Timing of Lies in Texting

As noted above, the temporal nature of text messaging is relatively unexplored in the social sciences. In one of the few studies concerned with the temporal dynamics of text messages, Battestini et al. (2010) examined text messages sent over a four-month period and identified times at which there were spikes in message sending. They found, for example, that text messages were sent and received most in the evening and at night, as well as some in the early hours of the morning. The authors noted that this pattern seemed to reflect the typical pattern of students' lives, but there was little analysis of the content of these messages within the context of the time that they were sent. It stands to reason, however, that there are lessons to be learned from such an examination.

As Goffman (1966) points out, the temporal context of a communication episode can affect both appropriate content and the way in which it is perceived. A message from one's boss may be perceived and treated differently, for example, on a Monday morning than it would be late on a Saturday night; and the same is true for a message from a friend or acquaintance.

Walther and Tidwell (1995), moreover, note that the timing of messages and replies can have important effects on expectations and perceptions of the relationship.

As with messaging more generally, temporal dynamics should also be important for deception, and particularly, butler lies. Butler lies may be especially sensitive to temporal dynamics. For example, text messages are often used for micro-coordination (Ling, 2004) and butler lies are often related to explaining one's behavior over time (e.g., "sorry, I just saw your message!" when the message had actually been seen much earlier). Further, these messages have been shown to vary when the parameters of a medium are varied. For example, some messaging platforms, such as BlackBerry Messenger (BBM) and Apple's iMessage, include a "read" notification to indicate whether the message recipient has viewed a message. In a comparison of BBM and regular text messaging, (Reynolds et al., 2011) found participants to intentionally delay opening messages more often with BBM. Given the importance of time to butler lies, we might expect that many butler lies would occur in the morning, for example, to explain late responses to messages received from friends the previous night. More generally, since butler lies focus on coordinating social interaction (or the avoidance of interaction), butler lies should be observed around times that people gather to meet, including meal times and evenings (at least for the students in our sample). In sum, butler lies should be affected by temporal dynamics more than other types of deception are.

The temporal context is also important when considering location sharing. A college student might be willing to share her location with her mother, for example, at 3:00pm on Tuesday when she is studying in the library, but not at 11:00pm Friday when she is out at a party. While many studies of text messaging have focused on the number of messages sent per day (Smith, 2011) and research on deception has focused on the number of lies told per day

(DePaulo et al., 1996), the data presented here allow us to examine the specific times of day when these messages were sent, and whether people are willing to share their location differentially across the day. Thus, to understand the temporal dynamics of text messaging, deception, and location sharing our second major research question asked:

RQ2: How does time affect how we text, lie, butler lie, and share our locations with one another?

Our final objective in this study was to create a novel data collection system for investigating these and other research questions. To do this we developed *Butler Messaging*, a text messaging application for mobile phones, and deployed it to collect the data presented in this paper. We also provide a discussion of feedback from our participants.

Method

Participants

A total of 63 participants completed this study, nine of whom were excluded from data analysis because they sent fewer than 10 text messages using the Butler Messaging App. Of the 54 remaining participants, 34 were female and 20 were male. Participants were primarily (94.4%) undergraduate students and ranged in age from 18 to 29. They reported an average of six years of text messaging experience (range 1-10, SD=2.0) and estimated sending an average of 30 text messages per day (range 2-200, mode = 20, SD=38.9). Participants were recruited via an on-campus web-based recruitment system and compensated with either course extra credit or a $20 Amazon.com gift certificate.

Butler Messaging App

Butler Messaging is a text messaging app for Android smartphones that was developed specifically for this study. The app is designed to be as similar as possible to the text messaging

app that comes standard on an Android phone, with three additional features that allowed us to gather data for this study. First, all text messages sent and received using the app were logged in our password-protected SQL database. To preserve participant privacy, our application used a hash function to replace phone numbers with unique identifiers before storing them in the database. These hashed identifiers cannot be traced back to the actual phone numbers without the hash key. In addition, proper names were automatically removed from the text messages before logging, by comparing the words in each text message to a list of the 5000 most common proper names and replacing matches with "[name]". Second, users were asked via a pop-up window after sending each message whether or not that message was deceptive, as shown in Figure 1-C. Their response was stored in the database, but not shared with the message recipient or saved on participant phones.

The third unique feature was that the app was configured to include a text description of the user's current location in each sent message. The Butler Messaging app uses the phone's built-in location services to determine the coordinates of the participants' physical location when they compose a new message. Using the Google Maps API, a text description of this physical location is retrieved, generally in the form of the nearest street address. This text description of the location was automatically appended to the end of the text message being sent by default. For example, if Alice sends the message "Hi! How are you?" to Bob and includes her location, "123 Main St. Springfield, USA," Bob will receive a text message that reads "Hi! How are you? (Sent From: 123 Main St. Springfield, USA)." Participants had the option of removing their location before sending a message by deselecting a checkbox, as shown in Figure 1-B. Whether the location was sent or not, it was stored in our database. Another version of the app that did not

include this location sharing feature was also developed and deployed, but data from that version are not discussed here.

Procedure

After enrolling in the study, participants were sent an initial email with a link to an online consent form. After giving consent they filled out a short background survey that asked for their birth year, gender, ethnicity, occupation, as well as a few questions about their experience with text messaging and their level of privacy concern. Next, participants were asked to read a tutorial that described the definition of deception used in this study and provided examples of deceptive and non-deceptive messages to distinguish between jocular messages that are not factually true but are not intended to deceive (e.g., "I'm so hungry I could eat a horse") and deceptive messages (e.g., "I'm not at the bar" when in fact the person was at the bar).

Participants were then provided with instructions on how to download, install, configure and use the Butler Messaging app on their phones. Next, they were shown an overview description of the study and asked to email one of the researchers with any questions or problems using the app. Participants were asked to use the Butler Messaging app in place of their regular text messaging app for one week. To encourage the use of Butler Messaging instead of the default Android texting app, participants were provided with instructions explaining how to set the Butler Messaging app as the default messaging app on their phones and to disable notifications from any other text messaging apps. They were also emailed mid-way through the week with a reminder to continue using the app; and emailed again at the end of the week with link to the post-study questionnaire to complete their participation.

The post-study questionnaire displayed participants' recorded text messages, separated by recipient, and asked questions about the recipients and some of the messages. For each recipient

the participants were asked if they recognized the recipient based on their conversation log with them. To protect privacy, phone numbers and names were not stored and could not be displayed at this phase, which meant that some recipients were not readily recognized by participants. If recognized, the participant also asked to specify the type of relationship they have with this person (Acquaintance, Friend, Family, Significant Other) and how close they are to that person (on a scale of 1 = not close to 5 = very close). For each message they had indicated via the pop-up window to be deceptive they were asked to explain what about the message was deceptive and to rate its deceptiveness (on a scale of 1 = slightly deceptive to 5 = extremely deceptive). If participants removed or edited their location information they were asked to explain why they did so.

Participants then answered questions about their experience with the study, specifically about their use of other text messaging apps during the study period, the burden of the pop-up deception question, and their experience with the location-sharing features. Lastly, they were told how to uninstall Butler Messaging from their phone, debriefed, and thanked for their participation.

Data Analysis

To answer our research questions we analyzed the text message logs along with questionnaire responses, associating each participant's text message records with their explanations and their relationships with the message recipients. Additionally, text messages were coded for whether or not they contained butler content, and as deceptive or non-deceptive, to ensure that jocular or other messages that clearly did not meet our definition of deception were not considered deceptive. Research assistants trained using existing text messaging data sets to practice with the coding schemes. After attaining acceptable reliability rates with the training

data, the two coders independently coded each text message sent during this study. Messages were reviewed in the context of their full conversation logs to make this determination and discrepancies were resolved by one of the researchers.

Butler: All sent messages logged during the study were coded for whether or not they contained butler content. We defined *butler messages* as those that pertained to the coordination of social interactions. Butler messages can be truthful or deceptive, and we refer to deceptive butler messages as butler lies. For example, the message "i am so happy right now." is not a butler message while the message "alright, will do :) see u at 7:15" is, because the latter message was scheduling a social event. Of the 3,963 total sent messages, 24.2% of them were found to be butler messages. The two coders agreed on 83.1% of the messages (kappa=.535).

Deception: The 274 messages that participants indicated to be deceptive along with the participants' explanations were also coded to ensure that they met our definition of deception. Thirty-six messages (13.1%) were not actually deceptive because the participant had marked them as deceptive accidentally, seven (2.6%) were coded as jocular rather than deceptive, and the remaining 230 (84.3%) were confirmed as deceptive. The two coders agreed on 94.2% of the messages (kappa=.787).

Results

Messaging, Deception and Location Sharing with Different Relationship Types

Our first research question (RQ1) asked about the ways in which our participants used text messaging with different types of message recipients. To answer this question we focused on the types of relationships participants had with the recipients they messaged during the study. Participants sent text messages to an average of 12.5 recipients using the app (range 2-32, SD=7.04). Of the 676 total recipients, participants recognized and provided relationship type and

closeness ratings for 581 (85.9%). The most common types of relationships were friend (55.6% of recognized recipients), acquaintance (28.2%), family (8.7%), and significant other (3.8%). Using a linear mixed model with participants and recipients as random effects and controlling for gender, we found that the type of relationship the participant had with the recipient had a significant effect on the number of messages sent to the recipient $F(4, 560.7)=31.48, p<.001$[1]. Post-hoc t-tests (all p's < .001) revealed that significantly more messages were sent to significant others than family, acquaintances, friends, or other contacts. The mean number of messages sent per recipient for each of these different types of recipients is shown in Table 1.

To further understand this trend we reviewed the text message logs between our participants and their various recipients and observed that the conversations with different recipients took on different forms. For example, one participant [p1047] sent text messages to seven different recipients during the study period. He identified five of those recipients as friends, one as family, and one as his girlfriend. Over the course of the week he sent between two and seven text messages to each of the friends and family members. During the same time he sent 139 messages to his girlfriend. The messages sent to friends were primarily butler messages, most of which were sent while coordinating plans to eat together. With his girlfriend, on the other hand, fewer than one third of the messages he sent her were butler messages. So while he used text messaging mainly to coordinate specific activities with most of his recipients, he used it to maintain an ongoing conversation with his girlfriend throughout the week.

Next we investigated how people used deception in text messaging across these different types of relationships. We examined the rates of lying and butler lying among messages sent to each category of recipient. The average rate of lying (number of messages sent to a recipient that

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[1] Note that the denominator degrees of freedom in a linear mixed model can yield non-integer degrees of freedom, see http://www. spss.ch/upload/1107355943_LinearMixedEffectsModelling.pdf.

were deceptive) and rate of butler lying (number of butler messages sent to a recipient that were deceptive) for each relationship type are shown in Table 1. These rates were tested with linear mixed models structured the same as above, but no significant differences in the rates of lying or butler lying were found between relationship types. These data suggest that deception rates were relatively constant across the relationship types.

Next, we examined our participants' use of the location sharing features in the Butler Messaging app in conversations with different types of recipients. We excluded four participants from this analysis who included their location with fewer than 5% of their sent messages. These participants were excluded because they did not seem to be making case-by-case decisions about sharing their location, but rather excluding it as a default. The average rates of location sharing for each recipient (percent of messages sent to the recipient that included the participants' location) for each of the relationship types are shown in Table 1. Using a linear mixed model structured the same as above, we found that the type of relationship had a significant effect location sharing, $F(4, 492.4) = 3.22$, $p <. 05$. Post-hoc t-tests revealed that significantly more messages were sent with locations to significant others than acquaintances, friends, or other contacts (all p's < .05).

To further explore this pattern we examined the messages that participants sent with and without locations and the explanations they provided us when they chose not to include their locations. For example, one participant [p1012] always used his location when texting with his sister and his girlfriend, but not with other friends. He was texting with his sister during his trip back to campus after a break, and including his location in his texts helped her to know when he made it back to school. He also used location sharing when texting with his girlfriend, who lived in the same town. On the other hand, he avoided sharing his location with another friend on

campus. It seems he may have been more comfortable with his girlfriend knowing where he was on campus all day than his other friend. Similarly, another participant [p1137] generally shared her location when texting with her best friends and family members, whom she rated as being closer to, but not with acquaintances, colleagues or her church teacher, who she rated as being more distant.

Temporal Rhythms in Messaging, Deception and Location Sharing

Our second research question (RQ2) focused on the temporal dynamics of everyday text messaging. We analyzed the message timestamps included in the text message logs to determine the time at which each message was sent. We examined the number of messages sent for each hour of the day, and observed peaks in the number of messages sent from 11:00am to 1:00pm, 4:00pm to 6:00pm, and 9:00pm to 11:00pm, times that roughly correspond to social activities, such as eating meals. Not surprisingly, we also saw that the number of messages sent was lowest during the late night and early morning hours, between 12:00am and 10:00am, when many students were likely sleeping.

Next we looked at the temporal aspects of lying in text messaging, by examining the number and rate of sent messages that were deceptive by time. Figure 2 shows the number of lies sent and the rate of lying for each hour of the day. The rate of lying was fairly constant throughout the day, but increased in the evening hours, with a spike in the rate very late at night. While there are fewer messages sent late at night and early in the morning, a higher percentage of those messages are lies than during the rest of the day. For example, one participant [p1057] sent the deceptive message "home! night!" at 3:40am, although she had been home for while but had not told the recipient earlier.

Next we examined at butler lying by selecting only messages that contained butler content (see Figure 3). The rate of butler was more variable throughout the day with peaks at 11:00am, 1:00pm, and 5:00pm, and a large spike in butler lying very late at night. Similar to the overall spikes in text messaging described above, the peaks in butler lying roughly correspond to meal times. Many of the butler lies sent at these times were related to coordinating shared meals, and the late night butler lies were often related to coordinating other social activities. For example, the message "hey so i literally just missed the last bus back to [place1] from [place2] so i gotta stay overnight and i wont make brunch..i'm sorry! hope your med school trips went well!" which was sent at 2:01am when the participant [p1145] "was not stuck at [place2] but did not want to go to brunch that morning so [she] lied." The late night spike in deceptive texts is due almost entirely to butler lies, suggesting that deception very late at night often involve avoiding social interaction.

Finally, we looked at the use of location sharing by hour of the day (see Figure 4). The percent of messages sent without locations lowest in the morning and evening, with spikes in the rate during the afternoon and late night hours. For example, one participant [p1008] sent the message "i'm tired.... and don't want to go to class" at 7:57am and included her location, showing that she was at home. Another participant [p1047] did not include his location in text messages he sent at 9:05pm because he "Didn't want recipient to know how close I was" while he was still deciding what to do that evening. Note that the rate of text messages sent without locations also spiked late at night, consistent with the deception and butler lie rates, suggesting that deceptive messages sent very late at night rely on location ambiguity.

Experiences with the Butler Messaging App

The novel data collection method presented here is another contribution of this study. Using the Butler Messaging app allowed us to directly log users text messages as they sent them, an improvement over previous text messaging studies. However, as with any new method, there were challenges as well. In this section we present feedback from our participants about their use of the app and discuss potential threats to the validity of our data.

During the post-study questionnaire participants were asked to provide feedback about their usage of the app and their experiences taking part in the study. We asked specific questions about the deception pop-up message and location sharing functions of our app, as these were different from standard text messaging apps and we wanted to understand how they impacted our participants' use of text messaging and the app. They generally found the pop-up to slightly burdensome (on scale from 1=strongly agree to 5=strongly disagree, M=2.82, SD=1.45), but disagreed that it impacted their texting behavior (M=3.09, SD=1.66). Many explained that the pop-ups had no impact on them, such as [p1098], who wrote, "They didn't bother me, texting is second nature so it was easy to not think about them." While a small number of participants did describe some impact on their behavior, for example, [p1012] wrote, "I didn't want to be deceptive. It made me feel guilty." and [p1035] explained, "It made me write less often, because they were annoying." Thus the pop-ups may have prompted some participants to send fewer text messages and be more aware of their deceptions, which may explain why the overall rate of lying observed in the present study was lower than of prior work (Birnholtz et al., 2010; Reynolds et al., 2013).

When asked about the location sharing features, participants reported that the locations were generally accurate (M=2.25, SD=1.65) and that sharing them did not impact their texting

behavior (M= M=3.04, SD=1.574), although recipients did respond to seeing them (M=2.07, SD=1.744). Many participants described little or no impact of location sharing, as [p1134] explained, "It didn't really [have an impact], I was in the places I said I was in." While others described some changes in their behavior, as [p1012] wrote, "I wouldn't lie about my location or talk really about where I was if I meant to deceive." These responses indicate that location sharing constrained some participants' ability to lie, as we predicted. Additionally, a number of participants described their message recipients' reactions to seeing their locations, as [p1076] wrote, "They were curious, people who i knew better would comment on how sketchy it was." Such reactions from recipients are not surprising, since location sharing is not typically a feature of text messaging.

Although participants were instructed to use our app exclusively for text messaging for one week, we anticipated that they might sometimes use other apps instead. Approximately half of our participants admitted to using another text messaging platform during the study period. Most participants who reported using other apps did so in order to send or receive picture or group messages, which the Butler Messaging app did not support. Other participants switched after encountering a bug in the app and a few participants mentioned switching to avoid having specific messages recorded or to avoid the deceptive pop-up. Overall, we feel that the messages logged using the Butler Messaging app are representative of our participants' general text messaging behavior.

Discussion

This study examined the relational and temporal dynamics of deception and location sharing in text messaging. We found that our participants used texting and location sharing differently with the different types of relationships. Our first significant finding was that more

text messages were sent to participants' significant others that other types of recipients. This confirms prior research that has shown text messaging to be used most commonly with close contacts (Van Cleemput, 2010), and particularly romantic partners, who young adults have reported spending over an hour text messaging with each day (Jin & Peña, 2010).

We failed to find a difference in deception across the relationship types. While we knew from prior research that deception is common in text messaging (Birnholtz et al., 2010; Reynolds et al., 2013), few studies have examined deceptive text messaging with different types of message recipients. Reynolds et al. (2011) compared deception in BBM and text messaging by collecting messages sent via each medium from the same participants. They found that a higher percentage of deceptive messages were sent via BBM, which was generally used with closer message recipients, than via text messaging. The present study did not lead to the same observation when looking at the full range of relationships communicated with over the course of the week. These different findings are reflective of the more general research on deception, which has been split about whether we lie more to those we are less close to, such as acquaintances (DePaulo & Kashy, 1998), or to people that we are closest to, such as significant others (Metts, 1989; Miller, Mongeau, & Sleight, 1986). Our findings fail to resolve this debate, but suggest that more research is needed to understand deception in relationships. For instance, it seems clear that future research needs to look beyond simple rates of deception and begin to examine types and content used differentially across relationships.

Our first major finding was that our participants sent a significantly higher proportion of messages to their significant others with their locations included than in messages sent to other recipients. There are many privacy concerns related to location sharing, and one interpretation of this finding is that participants were least concerned with privacy when communicating with

their significant others. Locations were also included in messages sent to family members slightly more often than in those sent to friends, acquaintances, or other types of recipients. One potential explanation for this is that undergraduate students tend to move away from home to attend college and the family members they were text messaging with may not have been familiar with the area. In this case, a family member at home might not know whether a specific address is a fraternity house or a library, while a classmate who is familiar with the area would be more likely to identify the address. So although the participants frequently included their locations in messages sent to family members, they may have maintained higher levels of ambiguity through the obscurity of unfamiliar street addresses. Although message recipients were identified by relationship type in this study, their proximity to the participant's location is unknown, a topic we recommend consideration of in future investigations.

The second contribution of this study is our temporal analysis. We found that the number of text messages sent was lowest during the late night and early morning hours, with spikes throughout the day. These times confirm trends observed by Battestini, Setlur & Sohn (2010) who observed that many of the messages sent over a four-month period were sent in the evening. While prior research on deception has shown that lying occurs every day, this study is the first we are aware of to examine the specific times during the day that lies were told. Our findings suggest that while fewer messages are sent late at night and early in the morning, a greater percentage of these messages are deceptive. Indeed, during those same times fewer messages were sent with locations included. This suggests that, as we posited above, location sharing, which reduces the ambiguity available in text messaging, is likely at odds with deception, which often draws on that ambiguity. Investigation of the relationship between messages sent with locations and incidence of deception is another interesting further direction for this work.

The third contribution of this study is our novel data collection method. While researchers have used custom software to collect data from participants cell phones and computers in the past (Battestini et al., 2010; Hancock et al., 2009), the Butler Messaging app used here is the first used to log text messages and ask participants to rate each message at send time. Previous research on deception in text messaging relied on participants entering a relatively small number of sent messages into web surveys and reporting which messages were deceptive after the fact (Birnholtz et al., 2010; Reynolds et al., 2011; 2013). By using the Butler Messaging app for data collection we were able to more easily log a greater number of messages that were sent to a wider variety of recipients, which allowed us to investigate the relational aspects of text messaging. By logging messages as they were sent we were also able to collect time stamps and examine the temporal dynamics of text messaging. In addition, we were able to modify the app to study location-sharing behaviors, and future studies can further customize it to investigate other research questions.

Limitations and Future Work

One potential limitation of this work is that we examined everyday text messaging with a modified text messaging app, as opposed to the text messaging platforms that our participants typically use. The unique features of Butler Messaging, including deception pop-ups and location sharing, allowed us to collect data of interest to this study. However, these features are not typical in text messaging apps and may have impacted how participants used the app and used text messaging, as discussed in the participant feedback section above. Although participants admitted to occasionally using other apps during the study period, the self-selection of messages shared in the present study is unlikely to be different than that of other methods that are used to study text messaging.

Furthermore, our method relied on self-reports of deception, an issue most studies of deception face. However, asking participants about the deceptiveness of their messages as they were sent is an improvement over earlier methods that relied on participants' recalling their deceptions. In addition, participants were primarily students at a United States university, who may differ in their texting behavior from other populations. In future work, we aim to deploy the Butler Messaging app to collect text messaging data from a broader population of users in varying contexts, including international and business settings. The app can also be modified to study other relevant research questions, such as asking participants to rate incoming messages in order to measure perceptions of deception.

Acknowledgements

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	Acquaintance		Friend		Significant Other		Family		Other	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
Number Messages Sent per Recipient	6.46[b]	1.10	4.42[b]	0.87	32.86[a]	2.48	6.69[b]	1.70	8.84[b]	4.14
Percent Deceptive Messages per Recipient	6.2%[a]	1.8%	6.4%[a]	1.5%	10.9%[a]	3.7%	2.8%[a]	2.6%	2.2%[a]	2.6%
Percent Butler Lies per Recipient	2.2%[a]	1.3%	3.6%[a]	1.0%	2.7%[a]	2.6%	-0.5%[a]	1.8%	-0.8%[a]	4.3%
Percent Locations Sent per Recipient	54.4%[b]	5.7%	56.7%[b]	5.5%	75.7%[a]	8.0%	59.4%[a,b]	6.6%	40.3%[b]	11.6%

Table 1: Means and standard errors for the number of messages sent per recipient, the percent of those messages that were deceptive, the percent of butler message that were butler lies, and the percent of sent messages that included location for each recipient type. Superscripts indicate significant differences within each row.
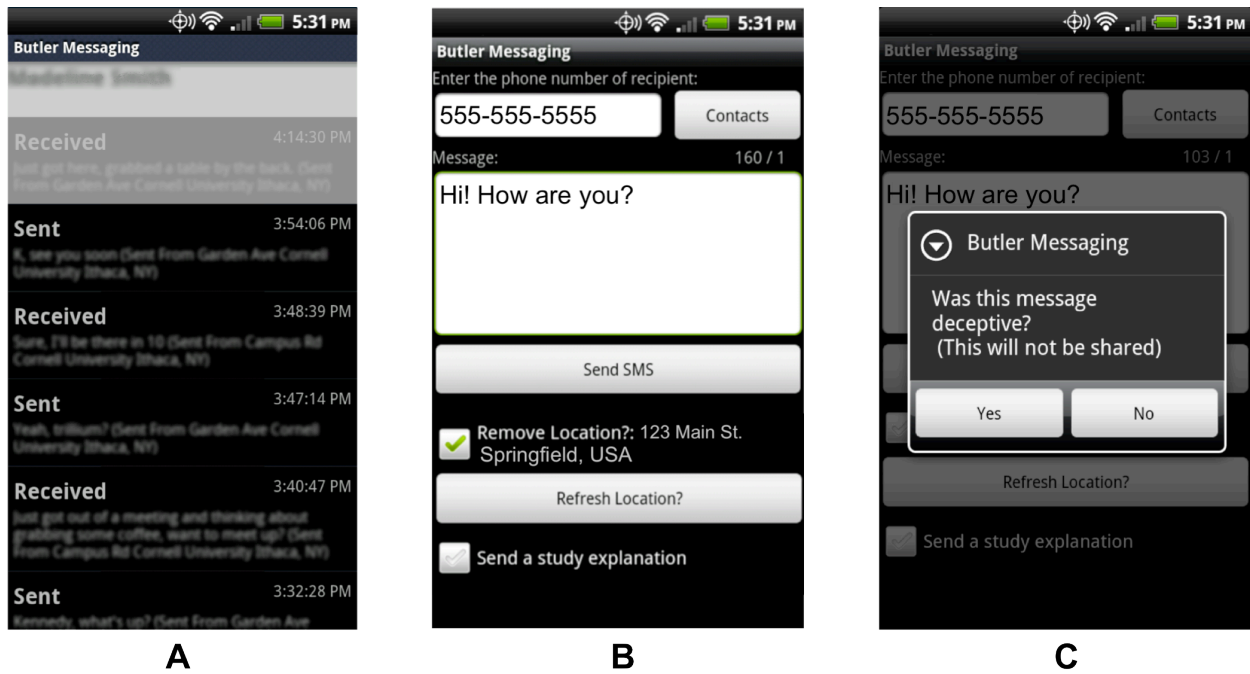
Figure 1: The Butler Messaging app: (A) conversation view of sent and received messages to a recipient, (B) compose message screen, and (C) deceptive pop-up after sending the message.
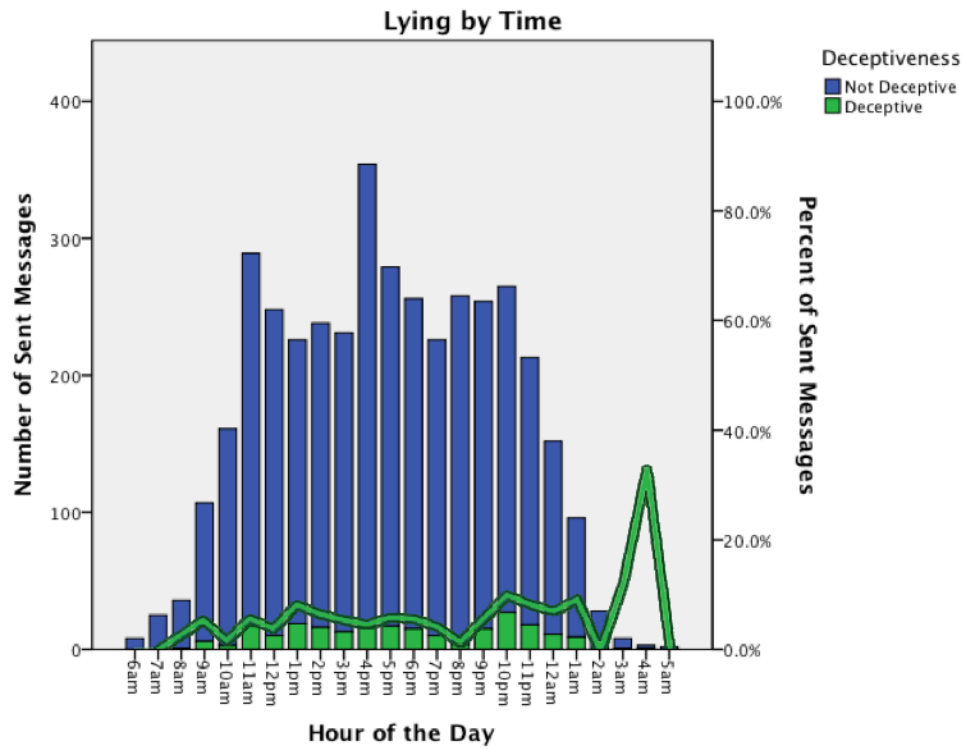
Figure 2: Bars represent the number of sent messages that were deceptive and not deceptive and the green line represents the rate of deceptive messages as a function of total sent messages by hour of the day.
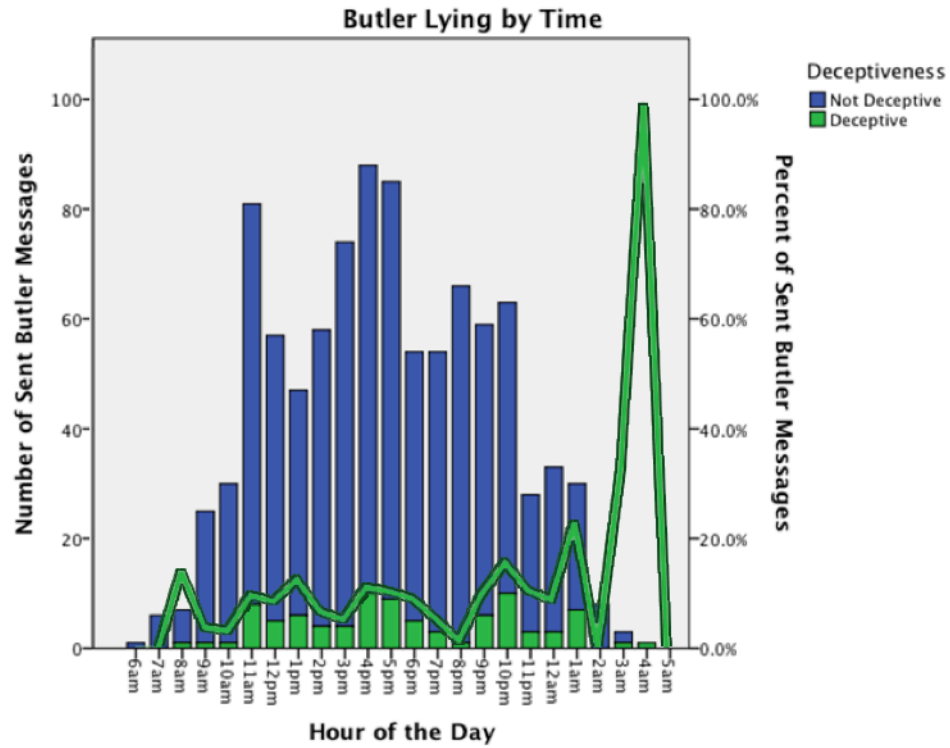
Figure 3: Bars represent the number of sent butler messages that were deceptive and not deceptive and the green line represents the percent of butler lies as a function of sent butler messages by hour of the day.
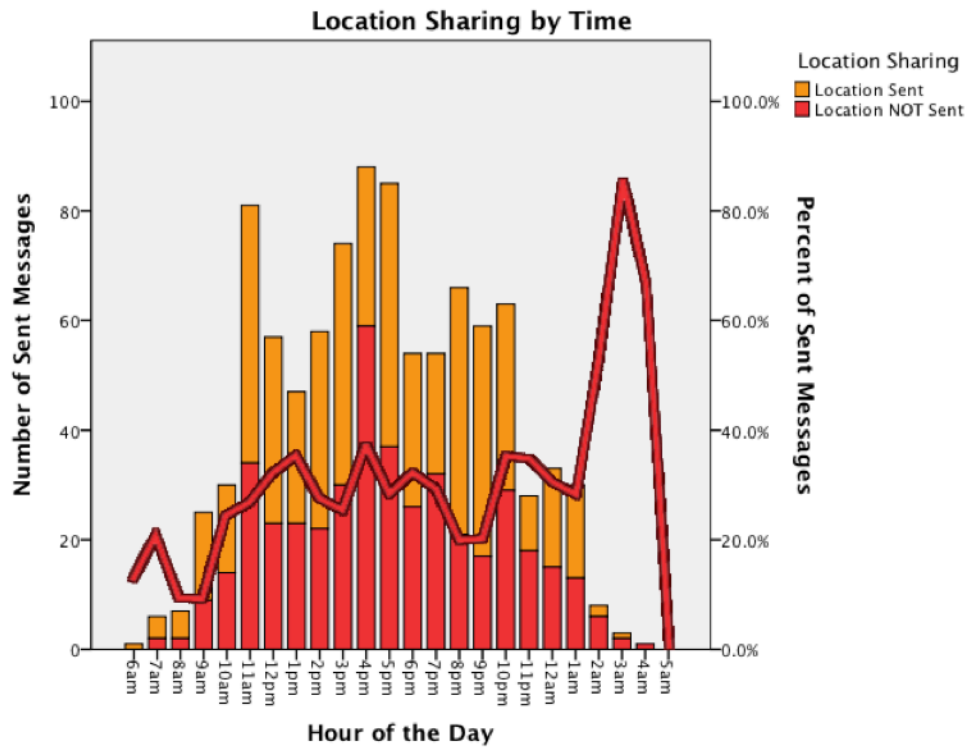
Figure 4: Bars represent the number of sent messages that were and were not sent with locations and the red line represents the percent of messages sent without locations as a function of total sent messages by hour of the day.