Social and Cognitive Effects of Smartphone Use in Face-to-Face Verbal Interactions
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ABSTRACT. Smartphone possession is on the rise in the United States, and their presence may have detrimental effects in face-to-face (f2f) interactions. Two potential theories were explored: expectation violation theory, which suggests that smartphone presence in a conversation could lead to negative social evaluations, and cognitive load theory, which suggests that smartphone use during f2f conversations could be a distraction. Participants engaged in a scripted dyadic conversation scenario with a confederate, where the confederate did or did not appear to use a smartphone during the conversation, and/or the participant did or did not use a smartphone for a simultaneous texting task. In each condition, participants were asked to socially evaluate their confederate partner’s conversation behavior and perform a conversation recognition task. As predicted, participants had more negative social evaluations for behaviors of confederate partners using their smartphones ($\eta_p^2 = .07$) and scored lower on the recognition task ($\eta_p^2 = .22$) when engaged in their own smartphone use. Results of this study suggest social and cognitive rationales for not using smartphones in f2f interactions and encourage continued research on the effects smartphones may have in different f2f interactions.

Keywords: smartphones, face-to-face, cognitive load, expectation violation

From 2011 to 2018, the percentage of U.S. adults possessing smartphones has rapidly doubled from 35 to 77%. This number is expected to grow, considering that 94% of individuals aged 18–29 have a smartphone (Pew Research Center, 2018). A 2014 survey of eight European countries suggested that 69% of children use a mobile phone, indicating 10 years old as the modal age for first phone ownership (GSMA, 2014). The impact that the growing rate of mobile phone possession has on relationships and human interactions continues to be explored, with the current focus on smartphone use. Although some consider smartphones as a tool for maintaining relationships (Borae & Peña, 2010; Lundquist, Lefebvre, & Garramone, 2014) by allowing connections with far-away friends or sustained constant communication with others, some suggest that smartphones, or even just mobile phones, might be a detriment to more intimate human interactions (Lundquist et al., 2014) or that they may change the dynamics of face-to-face (f2f) interactions completely (Humphreys, 2005).

Many studies on smartphones’ interactions with human relationships have focused on individuals’ beliefs about smartphone use in their relationships.
as a whole, or through field observations of behaviors when smartphones are present in f2f interactions. These studies have found that people generally think their conversations with others are less satisfying, and that they feel less connected and close when their conversation partners are using a smartphone. Thus, the mere sight of a conversation partner using a smartphone, whether or not it actually distracts the partner from the conversation, could violate a cultural expectancy of undivided attention in a conversation.

Developed by Burgoon (1978) to understand individuals’ reactions to personal space violations, expectation violation theory describes communication violations in many different situations (e.g., romantic relationships: Bevan, 2003; education: Frisby & Sidelinger, 2013; first dates: Morr & Mongeau, 2004). Burgoon (1993) defined expectancies as an enduring pattern of anticipated behavior specific to a particular individual or relationship (p. 31). An expectancy violation occurs when an individual’s expectancy for anticipated, typical behavior in a particular relationship (e.g., paying for someone’s food on a first date or personal space when talking with a stranger) is violated by the relationship partner’s behavior (e.g., no offer to pay for a meal on a first date, being uncomfortably close when speaking with a stranger). A violation of an individual’s typical expectations consequently leads to more awareness of the violating behavior and a sequence of evaluation where the individual interprets the unexpected behavior (Afifi & Metts, 1998; Bevan, 2003; Burgoon & Walther, 1990).

When an individual evaluates a partner’s atypical behavior, Afifi and Metts (1998) suggested that the sequence of evaluation is summarized by three distinct aspects. The first is violation valence, which refers to the desirability (or undesirability) of a violating behavior. Valence refers to whether a behavior is positive or negative (e.g., do I find a stranger’s violation of my personal space as a good thing or a bad thing?). Second, violation expectedness refers to how far a violating behavior differs from what is otherwise normally expected (e.g., how much was I expecting that stranger to enter my personal space?). Last, violation importance refers to the impact a behavior has on the relationship of the people in the interaction (e.g., will I want to interact with that stranger again in the future? What do I think of them as a person?). By applying the principles of expectancy described by Burgoon (1993) to a conversation scenario, there is a common expectancy of undivided attention when speaking in f2f interactions. Recently, Miller-Ott and Kelly (2015) extended expectation violation theory to describe a violation in expectation caused by mobile phone use during times when undivided attention is expected in romantic relationships, such as when two people are getting acquainted on a first date or going out on a formal date. These particular situations represent moments when undivided attention during verbal communication is desired but violated by the use of a smartphone. A smartphone’s visibility during conversation has been shown to decrease partner ratings of closeness, connection, relationship quality, conversation quality, and satisfaction in f2f conversation settings (Misra et al., 2014; Przybylski & Weinstein, 2013), suggesting that this expectancy violation might have a clear effect on f2f interaction evaluations. An individual appearing to use a phone in an f2f interaction will be evaluated as violating the undivided attention behaviors expected of conversation (violation expectancy) and their deviant behavior is evaluated in a negative light (violation valence).

Cognitive Impact of Smartphones

Perhaps there is an additional, but separate, cognitive explanation for the social belief that smartphones negatively affect relationships. The use of a phone may overload an individual’s ability to attend and remember details of a conversation, thus making them a negative conversation feature. This would not be surprising, considering that mobile phone use can be a cognitive distraction in a variety of settings (e.g., education: Gingerich & Lineweaver, 2013; driving performance: Horberry, Anderson, Regan, Triggs, & Brown, 2005; walking: Hyman, Boss, Wise, Mckenzie, & Caggiano, 2010). Although research on the distracting effects of smartphone use on verbal communication
specifically has yet to be conducted, to the authors’ knowledge, its capability to distract individuals from a task at hand could implicate similar distractions in verbal communication.

Cognitive load theory, which states that working memory is limited in the number of stimuli or schemas it can contain simultaneously (Sweller, 1988), might explain possible distracting effects of smartphones. Heavy cognitive load can cause errors or interference with a current cognitive task (Cooper & Sweller, 1987; Sweller, 1988). It is plausible that stimuli present from smartphone use (e.g., texting, skimming articles, mobile games) could place a load on working memory. People who are engaged in the primary task of conversing with another person would have their working memory burdened by tasks or distractions of a simultaneous secondary task of smartphone use (Drago, 2015). Consequently, the increased load on working memory would cause difficulty with cognitive tasks demanded in f2f communication, such as attentive listening (Kirschner, 2002).

**Current Study**

In the present study, we explored the negative (rather than positive) beliefs about smartphones. There are two pieces to explore in an ecologically valid laboratory experiment: the effects of the smartphone’s use by a conversation partner and the effects of the smartphone’s use on the person using it. Thus, the investigation was social cognitive in nature. To assess how a person views a conversation partner’s phone use, we investigated whether this violates social expectations (Burgoon, 1978), and in order to assess the impact of the phone use on the person internally, we sought to determine if the phone use is an attentional and memory distraction (e.g., Sweller, 1988).

Both social evaluation and working memory overload were investigated as causes of potential smartphone related negative effects in f2f interactions. Specifically, expectancy violation and cognitive load theories were assessed by measures of partner behavior evaluation and conversation recall, respectively, in a conversation scenario with a confederate where smartphones were present or absent.

The hypotheses for the present study are as follows:

1. Behavior expectancy: Participants will view their partners’ behavior as violating typical conversation behavior more if the partners used their phones during the conversation than if not.

2. Behavior desirability: Participants will rate their partners’ conversation behaviors as more desirable if the partner was not using a smartphone.

3. Interaction of expectancy and phone use: If both the confederate and participant were using their phones, it was predicted the participants would rate their partner’s behaviors as violating typical conversation behavior less than if only the confederate used the phone.

4. Interaction of desirability and phone use: Partner behavior will be rated more desirable by the participant if both individuals were using their phone than if only the confederate used it.

5. Cognitive load: Retrieval performance of information from the conversation would be lower when the participants used a smartphone for a texting task than when they did not use it.

**Method**

**Participants**

The participants for this study were from the student population of a small liberal arts college (ages ranged from 18–22 years old). Because the design for this study combined both cognitive and social evaluation measurements into one methodology, the number of participants required for this study was based on effect sizes of previous studies involving expectancy violation. These studies had smaller effect sizes than studies involving cognitive load theory. For a moderate multivariate effect size ($f^2$) of .06, as indicated by Burgoon and Le Poire (1993), with power = .80, a total sample size of 116 participants was needed across all experimental groups. Due to the difficulties of recruitment from such a small population, only 108 participants were originally recruited. Ultimately, 87 participants (44 women and 43 men) completed the study due to the criterion that excluded participants who had prior familiarity with the confederates. Each participant was compensated $5 USD. Before conducting this study, Institutional Review Board approval by Eureka College was granted (#2018-01).

**Design and Materials**

A 2 (confederate phone use) x 2 (participant phone use) between-subjects design was used in order to determine if the two independent variables of confederate phone use and participant phone use demonstrated a change in the dependent variables of behavior expectancy and behavior desirability (measuring social evaluation) and conversation desirability.

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1 For the full set of materials, please see our open materials and data: https://osf.io/l66ue/
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retention (measuring the effects of cognitive load). Participants engaged in a partially scripted conversation with a same-gender confederate in one of four dyadic conditions: (a) the participant conversed with a confederate with both phones absent; (b) the participant conversed with a confederate who appeared to be using a phone, while the participant’s phone was absent; (c) the participant used a phone to text the researcher and conversed with a confederate who was not using a phone; (d) the participant used a phone to text the researcher and conversed with a confederate who also appeared to use a phone.

The use of a confederate as the conversation partner was deliberate. This allowed us to isolate a single perspective in a conversation dyad to reduce noise and confounds. One major issue in previous partner f2f interaction studies (Misra et al., 2014; Przybylski & Weinstein, 2013) is that the participants selected their partners and likely knew each other before the study. Not only might this have caused a bias in partner ratings, but also it would have led to more variation due to the different partners. Additionally, participants were only selected to participate if they did not have a prior relationship with the confederate (to reduce bias). Another difference of this study compared to previous methodologies (Misra et al., 2014; Przybylski & Weinstein, 2013) is that we introduced deception to the actual purpose of the study prior to their interaction with their conversation partner. This approach rules out the possibility that the hypothesized negative effects would bias participants.

Social evaluation. Participants completed two 5-question, 7-point Likert-type scale questionnaires. These scales were adapted from Burgoon and Le Poire’s (1993) measures of violation expectancy and violation valence. The first measured the extent to which expectations of normal conversation were violated by partner behavior (Expectancy). For example, participants were asked whether they agreed or disagree with a statement such as “My conversation partner behaved appropriately during our conversation.” The second questionnaire asked for the participant’s evaluation of the desirability of the confederate’s conversation behavior (Desirability). For example, participants were asked to agree or disagree with statements such as “My conversation partner interacted in a way that most people would find enjoyable.”

Cognitive load. To test cognitive load effects, a basic adaptation to existing task-switching methodologies (e.g., Chandler & Sweller, 1996; Sweller 1998) was adopted. The task-switching method measures the cognitive load induced by a secondary task by measuring performance on a memory test related to a primary task. Participants were assigned the primary task of conversing with the confederate in an icebreaker question exercise. Both the participant and confederate were asked to “try to listen to and retain” their partner’s answers to the questions. In the two participant phone use conditions, participants were asked to keep their phone out and at strategic intervals, the researcher texted the participants additional personal questions to answer, representing the secondary task. The effect that this secondary task had on cognitive load, and consequently listening attention, was measured by recognition accuracy scores on a post-conversation multiple choice test. Participants answered several questions about the confederate that were mentioned in the icebreaker activity (e.g., confederate’s hometown, leisure activities). Their raw score out of the total questions was used in all analyses.

Procedure

Participants arrived at the study location and were told that they would be participating in a research study on the effectiveness of icebreaker questions with a stranger. The cover story included a situation where the participants discussed five icebreaker questions with a partner. This partner was believed to be a second participant, but it was a confederate working on behalf of the researcher. Before the icebreaker activity, participants were told to either place their smartphones in a box outside the room or to use their smartphones in a text messaging task (these were the two conditions of the participant phone use variable). During the icebreaker session, the participant and confederate took turns answering the questions. The researcher was in a separate room during this time. The confederate answered the questions according to a pre-established script. The icebreaker session lasted approximately 5–10 minutes. Confederates were also instructed before each study (separately from the participant) whether to appear to use their phone or to keep it away when the participant was answering questions (these were the two conditions of the confederate phone use variable).

Participants instructed to use their phones received unrelated background questions from the researcher. An example of this kind of questioning was “How many people would you consider to be in your closest friendship circle, how many in your acquaintance circle, and how many in your enemy
circle?” They were instructed that these messages should be read and replied to while their partner was answering questions. There were five separate text message questions in total, and they were sent and received strategically when the participant was answering an icebreaker question. This was done so participants would attend to the text and their partner simultaneously. Thus, this created two competing question-and-answer tasks at specific times during the icebreaker scenario. In the confederate phone use condition, the confederate appeared to be doing a similar texting task (in actuality, they texted the researcher random information).

After the icebreaker conversation ended, the researcher directed the participant to a different room. Participants completed the social evaluation scales and then completed the multiple choice test. Participants were debriefed, compensated, and excused. After data collection was completed on campus, all participants received an email fully debriefing them on the purposes of the study and rationale for the use of deception.

Results
Eighty-seven participants initially completed the study. Eight participants were removed because they did not use their phone as instructed. After removal, 79 participants remained in the analysis. Thirty-six of the remaining participants were instructed to use their phones during the study and 43 were not. Forty-one participants interacted with a confederate who appeared to be using a phone, and 38 participants interacted with a confederate who did not appear to use it. Three separate 2 x 2 Analyses of Variance were conducted to determine if the phone usage of the participant and confederate produced differences on measures of social evaluation and cognitive load.

Social Evaluation Analyses
To measure the effects of phone use on cognitive load, participant scores on a 21-question conversation-recall questionnaire were analyzed. Although the questionnaire originally contained 27 questions, six questions were removed from the analysis due to confederate script errors. Participants received one point for each correct answer on the questionnaire and received an overall score from 0 (none correct) to 21 (all correct). Overall, participants answered approximately 76% of the questionnaire correctly across conditions. Means and standard deviations are available in Table 1.

Hypothesis 5 was supported. Scores on the recall questionnaire were significantly lower when the participants were using their phones ($M = 14.14$, $SD = 2.76$) than when they were not ($M = 16.93$, $SD = 2.75$), $F(1, 75) = 19.86$, $p < .001$, $\eta^2_p = .21$ (see Figure 3 for overall effect).

Discussion
The findings of the present study indicate that smartphones indeed may have negative effects on both social evaluation and attention in dyadic f2f interactions. The behavior of an individual who...
appears to use a smartphone when conversing is rated as less desirable and more in violation of normal conversation behavior expectations than the behavior of someone not using a phone during a conversation. Additionally, individuals who use a smartphone to text in an f2f conversation remember less from a conversation than those who do not use a phone.

Practically, these findings build on previous research to suggest a strong argument for putting down smartphones when interacting with other individuals in an f2f context. The social findings using the expectation violation theory complement previous studies (Misra et al., 2014; Przybylski & Weinstein, 2013), which focused mostly on partner evaluations rather than partner behavior evaluations. This study demonstrated that the behavior of phone use itself is commonly viewed as undesirable and a violation of expected conversation behaviors. This socially unexpected and undesirable behavior may be the root of lower ratings of partner closeness, connection, relationship quality, conversation quality, and satisfaction found in previous smartphone-influenced f2f interaction studies (Misra et al., 2014; Przybylski & Weinstein, 2013).

Additionally, this study successfully extended previous findings of mobile phones’ distracting power in many contexts (Gingerich & Lineweaver, 2013; Horberry et al., 2005; Hyman et al., 2010) to the particular situation of f2f conversations. Phones in a conversation are distracting and compete for the limited attentional and memory resources needed to be a good conversation partner. This represents a step forward in the ecological validity of previous findings to the particular context of conversation and human relationships.

One area where the hypothesis for this study was not supported was the interaction between participant phone use and confederate phone use on social evaluation of confederate behaviors. It was expected that participants would rate their partners’ behavior more negatively when only the partner used a phone, rather than when both individuals used phones. This prediction was based on expectation violation theory and assumed that the confederate’s use of the phone would not violate expectations if both individuals had been instructed to use their phone by the researcher. The lack of an interaction actually builds upon the argument against using smartphones in f2f interactions. Essentially, the findings suggest that smartphone use in f2f conversations is unexpected and undesirable, possibly even if both individuals are using their phone. These results point toward a further examination of the social beliefs surrounding smartphone use in f2f interactions.

One interesting, unanticipated finding (albeit anecdotal) was that participants and confederates were both observably reluctant to use their phones

### TABLE 1

<table>
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<tr>
<th>Phone Condition</th>
<th>Behavior Expectancy M(SD)</th>
<th>Behavior Desirability M(SD)</th>
<th>Recognition Test Score M(SD)</th>
</tr>
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<tbody>
<tr>
<td>No phones used</td>
<td>6.54(0.50)</td>
<td>6.54(0.61)</td>
<td>16.24(2.76)</td>
</tr>
<tr>
<td>Confederate phone use; no participant phone use</td>
<td>5.93(1.23)</td>
<td>5.77(1.29)</td>
<td>17.59(2.24)</td>
</tr>
<tr>
<td>No confederate phone use; participant phone use</td>
<td>6.68(0.48)</td>
<td>6.48(0.35)</td>
<td>14.12(3.08)</td>
</tr>
<tr>
<td>Both use phones</td>
<td>6.34(1.16)</td>
<td>6.21(0.97)</td>
<td>14.16(2.99)</td>
</tr>
<tr>
<td>Total sample</td>
<td>6.35(0.95)</td>
<td>6.24(0.96)</td>
<td>15.66(3.08)</td>
</tr>
</tbody>
</table>

Figure 1. The average ratings that participants gave regarding the expectancy of their confederate partner’s behavior depending on confederate/participant phone use. There is a main effect of confederate phone use. Error bars represent standard errors.

Figure 2. The average evaluation ratings participants gave regarding their confederate partners depending on confederate/participant phone use. There is a main effect for confederate phone use. Error bars represent standard errors.
during the icebreaker scenario. Both confederates expressed to the researcher that the particular condition where they had to use their phones, but not the participant, was their “least favorite.” One confederate consistently groaned whenever he was told a data collection session would be for that condition. Post-hoc contrast analyses were conducted to investigate this anecdotal interpretation. On the expectancy measures, behavior violation and behavior desirability, the cell mean for the confederate phone use only was compared to the mean of the other three cells in a simple contrast test. For behavior violation, participants rated confederates significantly lower in the confederate phone use condition than the average of the other three conditions, (5.95 vs. 6.51) t(21) = -2.27, p = .04, d = .48. Additionally, for behavior desirability, participants rated confederates significantly lower in that condition than the average of the other three conditions, (5.77 vs. 6.41) t(21) = -2.32, p = .03, d = .50. These contrasts suggest that phone use was the most salient when the participant was not allowed to use their phone at the directive of the researcher but the confederate had no similar sanctions.

Similarly, several participants were excluded from analyses because they neglected to use their phone in the conversation when instructed. Although they listened to the researcher and expressed an understanding of the directions, many participants did not use their phones for the texting task unless prompted by the confederate to be at ease with remarks like: “Did he tell you to respond to questions or something? I honestly don’t mind if you do—I know you’re listening.” Some, even after prompting by both the researcher and confederate, refused to use their phones. In debriefing sessions, participants were probed informally; some gave answers such as “I don’t like it when people use their phone when talking to me, so I didn’t” or “It just seemed too rude.” Some participants also verbally expressed their difficulty in the recognition task because “it was hard to focus on the texts and listen at the same time.” These anecdotal observations built on the data to suggest that participants and confederates both were aware of social expectations and possible cognitive ramifications regarding smartphones in f2f interactions.

Limitations
These findings should not be over-generalized.

2 We thank an anonymous reviewer for this analysis suggestion.

to phones in all relationships and interactions, because it merely represents three carefully selected cognitive and social effects that phones have in the specific instance of a dyadic, same-gender, f2f, casual verbal interaction between two strangers. The methodology also limits generalization to different uses of smartphones in conversation because it only examined the specific texting activity of individuals responding to the researcher’s questions. It is possible that there could be differences in behavior and evaluation if the participants were having a voluntary text conversation with another individual, or using their phone in some other manner.

Furthermore, participants for this study were all undergraduate college students from a small liberal arts college. We caution that the findings from such a specific population should not be generalized to all individuals of all ages. One difference between the college population sampled and the population at large that is significant for this particular study is age. Because the age group sampled (roughly 18–22 years) have likely grown up using smartphone technology, it is possible that we might observe different social and cognitive effects in f2f interactions between older individuals. Another difficulty with sampling on the small campus was a lack of an ability for random or stratified sampling. Instead, participants were selected via convenience sampling in different classrooms and common areas on campus. It is possible that a more outgoing, engaged sample of the student population selected in this way would likely differ from a random sample.

There were a few inconsistencies with the methodology of the study that might have added minor variation to the results. These include:

FIGURE 3

Figure 3. The overall scores of participants on the conversation recall task depending on confederate/participant phone use. There is a main effect for participant phone use. Error bars represent standard errors.
researcher script/procedure errors (e.g., asking to place phone away at different times or confederate arriving after participant), confederate behavior variance (e.g., accidentally forgetting something on the script, transitioning between questions differently, different clothing/appearance, or differences between style of speech between the two confederates), and participant phone use variance (e.g., some participants only used their phones halfway through, or used them to do other things than instructed). Although these methodological inconsistencies slightly reduced the internal validity of the study, the significant results found despite them are worth exploring. Real-life conversations are not predictable and include many minor variations between individuals.

It is also important to take into account a possible ceiling effect in the two social evaluation variables. Across conditions, participants rated their confederate partners’ behavior as conforming to conversation expectations and desirable. Although there was a significant difference in these variables when the confederates had a phone than when they did not, in both cases their behavior was rated highly. It can be argued that this ceiling effect is due to smartphones having an unexaggerated effect, but it is more likely due to the familiarity effect. Moreland and Zajonc (1980) found that a more familiar face is rated as more desirable and similar to an individual than an unfamiliar one. Being on a campus of fewer than 600 individuals, most participants would have interacted with the confederate at some point outside of the study, and crossed paths somewhat often. It is very likely that the familiarity effect would have an important role to play in how typical and desirable the participants rated their partners’ behavior.

Future Research
This data on smartphones’ effects on an individual’s cognitive load and social evaluation should establish a basis for more research on how phone use might measurably affect cognitive conversational abilities, social expectations, and behavior evaluations in different instances. It would be helpful to build on this basis by incorporating a measure of the effects of smartphone use on the social evaluation of the partners themselves, rather than simply their behaviors. This could demonstrate that the negative evaluation of smartphone use behaviors has implications for personal social desirability.

Future studies could assess similar effects in mixed-gender pairs, parent-child interactions, small groups, among close friends, and in romantic interactions. It is possible that different relationships and contexts beyond stranger-stranger interactions and icebreaker interactions might lead to different findings.

Conclusion
Although the limitations for the study should qualify these conclusions somewhat, they certainly form a basis and set a direction for future research on the effects of smartphones in F2F interactions. This study successfully demonstrated three significant, ecologically valid, negative effects that smartphone use in same-gender, dyadic, F2F interactions may cause on a college campus population. First, an individual using a smartphone in an interaction may be viewed as violating expectations for typical conversation behavior more than an individual who does not. Second, the smartphone-using individual’s behavior may be viewed as less desirable than someone not using a phone. Third, individuals who use their smartphones while listening will be often less capable of attending and remembering details from a conversation than others who do not use it. These results provide some rationale to rethink smartphone use in common F2F interactions.

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<td>Sept 28</td>
</tr>
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<td>Winter</td>
<td>Nov 15</td>
<td>Dec 14</td>
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