The Effects of Conversation Arousal Level on Attention Processes
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ABSTRACT. The current study investigated how arousal level during phone conversations affects specific attention processes (i.e., executive, orienting, phasic alertness, and vigilance). Participants engaged in 1 of 3 conversation conditions (i.e., no conversation, low emotional arousal, and high emotional arousal) while completing either a spatial cueing task (Exp. 1) or a Stroop Test (Exp. 2). Neither orienting nor phasic alertness were affected by conversation, but both overall reaction time (RT) and intraindividual variability (vigilance) increased when the conversation was introduced, $t(49) = 5.01$, $p = .001$, $r^2 = .34$, and $t(49) = 2.44$, $p = .009$, $r^2 = .11$, respectively. Stroop Test RT was significantly increased by conversation when attentional demands were low (congruent), $t(50) = 2.22$, $p = .031$, $r^2 = .09$, but not when attention demands were high (incongruent). Level of conversation arousal did not moderate these effects. Our findings suggest that competition for executive attention by the task and by the conversation are dynamic. This has implications for safe cell phone use while performing everyday activities (e.g., driving, work, studying).

Keywords: conversation arousal, attention processes, executive attention, orienting alerting, phasic alerting

O ver the last several decades, abundant evidence has emerged to suggest that cell phone use interferes with the performance of many everyday tasks. Studies have found that a growing number of driving, pedestrian, and workplace accidents can be attributed to the increasing number of people talking and texting on smartphones (see Caird, Willness, Steel, & Scialfa, 2008; Nasar & Troyer, 2013). However, questions do linger about the specific mechanisms that underlie the detrimental effect of phone conversation on attention processes. This article examines one potential risk factor that has been posited by several authors, that conversations on the phone interfere with attention, which in turn interferes with cognition and behavior in the real world (see Horrey & Wickens, 2006; Hyman, Boss, Wise, McKenzie, & Caggiano, 2010).

Dating back to James (1890), researchers have conceptualized attention as the ability to process information that is relevant to the task at hand and to ignore irrelevant information. Specific attention processes underlie people’s ability to perform different tasks. There are many attentional processes involved in everyday activities, such as driving on a crowded highway, crossing a busy intersection, or operating a dangerous factory machine (Nobre & Kastner, 2014; Pashler, 1998; Posner, 2012). Posner and Peterson’s (1990; Peterson & Posner, 2012) network model involves three of these processes: executive attention, orienting, and phasic alertness.

Executive attention may come closest to
James’s definition: purposefully selecting important information, and inhibiting responses to competing information. For example, when driving on a highway, these processes enable people to attend to the distance between their car and the car ahead while ignoring the herd of cows they are passing.

The orienting network allows people to disengage their attention from one thing (e.g., the car ahead) and shift their attention to something else (e.g., the herd of cows; Posner & Petersen, 1990). Sometimes, people shift their attention voluntarily (endogenous orienting), and sometimes, their attention is automatically shifted by some stimulus (exogenous orienting; Jonides & Yantis, 1988; Posner, 1980). Because automatic shifts can be problematic, executive attention is required to inhibit or at least swiftly correct for unwanted shifts. In the earlier example, when the drivers’ attention is exogenously reoriented by the herd of cows, they may endogenously reorient their attention back to the car ahead.

Finally, the alerting system allows the drivers to respond to stimuli quickly. These processes include phasic alertness (i.e., the automatic state of alertness triggered by the sudden appearance of a stimulus, usually lasting seconds at most) and tonic alertness, (i.e., a longer lasting state of arousal that must be maintained by the individual; Posner & Petersen, 1990). When driving, the sudden appearance of brake lights ahead is likely to evoke phasic alertness in drivers automatically. However, drivers will need to work to maintain a state of tonic alertness (sometimes referred to as vigilance) for the long, late-night drive home from work. There is evidence to suggest that these vigilance processes involve both the alerting system and executive control (Petersen & Posner, 2012).

Attention researchers have used a variety of experimental paradigms to isolate each of these processes in the laboratory, and more recently this research has begun to reveal the dynamic and interactive nature of these systems (Petersen & Posner, 2012). The study of how these specific attention networks impact behavior outside of the laboratory presents a greater challenge. It is one thing to examine how cell phone use impedes reaction times (RTs) to brake lights or distance maintenance while driving on an obstacle course or in a driving simulator. It is another to examine how cell phone use might impact executive attention, orienting, or phasic alertness, which in turn might affect RTs to brake lights or distance maintenance while driving. For example, Harbluk, Noy, Trbovich, and Eizenman (2007) used eye-tracking during a driving task and found some evidence that overt visual orienting (i.e., eye movements) was impacted by a cell phone conversation. However, their paradigm included no direct evidence that orienting attention itself was affected.

Testing the impact of cell phone conversations on specific attention processes involved in real-world contexts (e.g., driving, walking) may not yet be possible. For this reason, we have elected to focus on the effect of cell phone conversations on each attentional process in the laboratory. Our aim with this study was to examine the effect of cell phone use on executive attention, exogenous orienting, phasic alertness, and tonic alertness. We selected these four target-processes because they can be separated from one another using established, well-documented paradigms. We believe this is a necessary preliminary step in the overall process of understanding how cell phone use might influence attention-related components of real-world behaviors.

The Nature of Conversation and Attention

A cell phone can now have many functions besides conversation, such as texting, browsing the internet, and checking messages. Each of these involves specific motor and cognitive processes. To minimize the number of potential confounds, we focused on the conversation function of cell phone use in our experimental design.

The results from numerous studies have established that RT of various processes, such as choice RT time in a car-following situation, braking, and dual-task performance, have been found to be impaired during cell phone conversations (Alm & Nilsson, 1995; Strayer & Johnston, 2001; Strayer, Drews, & Johnston, 2003). This leads to an obvious question: What specific aspects of conversation actually affect people’s reactions to their surroundings? One possibility is that the cognitive demands involved in the conversation interfere with the attentional demands involved in walking, biking, and driving. Prior studies have found that increasing cognitive demands impair visual orienting (Harbluk et al., 2007). During discrimination tasks, both hands-free and handheld cell phone conversations affected RTs and attention-related brain activity (Garcia-Larrea, Perchel, Perrin, & Amenedo, 2001). Although conversations slowed responses in simple detection tasks, these costs were even greater for more demanding discrimination.
tasks (Kemker, Stierwalt, LaPointe, & Heald 2009). Their findings suggest that the costs of conversation are most pronounced when the task-related cognitive demands are relatively high (i.e., making quick discriminations).

Although conversations appear to influence cognitive and attention processes, it is not clear which specific aspects of conversation contribute to these costs, and which attention processes are affected by the conversation. For example, does increasing the cognitive difficulty in a conversation increase these cognitive and attentional costs? Difficult conversations have been found to have more adverse effects on driving performance than do simple conversations (Briem & Hedman, 1995). However, their “difficult conversation” condition involved a working memory task and not a naturalistic conversation. More recently, this issue has been examined using a more conversation-like condition, in which participants were interviewed during a driving task (Rakauskas, Gugerty & Ward, 2004). When the difficulty level of the interview questions was manipulated, behaviors such as higher variability in accelerator pedal position and higher variability in driving speed were observed.

It should be noted that evidence has been found to suggest that the costs of engaging in naturalistic conversation may be greater than the costs of performing cognitively demanding tasks (Horrey & Wickens, 2006). This suggests that conversation-related costs are not simply a function of cognitive demand. The level of emotional intensity during cell phone conversations may moderate the amount of interference on driving (Caird et al., 2008). This hypothesis was not supported by Irwin, Fitzgerald, and Berg’s (2000) earlier findings that manipulating conversation intensity had no effect on braking RT. It should be noted that Irwin et al.’s interview questions involved topics about which many people feel strongly (e.g., “What are your views about gun control?” and “What are your views about abortion rights?”). However, their questions were not tailored to the individual participants and might not have evoked arousal in all of their participants.

There is growing evidence that having to regulate emotion can interfere with memory recall, working memory, and executive attention (Bush, Luu, & Posner, 2000; Richards & Gross, 2000; Schmeichel, 2007). However, it is not clear if emotion regulation negatively impacts other attention-related processes (e.g., orienting and alerting). Unfortunately, much of the research above has focused on the impact of emotion-evoking visual stimuli (e.g., pictures, videos, faces), and not on the effect of emotional arousal evoked by a conversation on cognitive and attention processes. Thus, it is difficult to evaluate the association between the level of emotional intensity during cell phone conversations and specific attention-related processes.

The Current Studies

We conducted two experiments to examine the effect of phone conversation on attention processes. In Experiment 1, we used Posner’s (1980) exogenous spatial cueing task to examine the effect of hands-free phone conversation on orienting and phasic alertness when stimuli suddenly appear in the periphery. We also used intraindividual variability (SD) in RTs as a measure of sustained attention during the spatial cueing task (Esterman, Noonan, Rosenberg, & DeGutis, 2013; Stuss, Murphy, Binns, & Alexander, 2003). The presumption is that RTs vary as a function of an individual’s attention fluctuating across the task. Intraindividual variability has been recognized as a marker for vigilance problems in clinical research (MacDonald, Li, & Bäckman, 2009). In Experiment 2, we examined the effect of phone conversations on executive attention during the performance of the color Stroop Test (Stroop, 1935).

We tested two competing hypotheses: First, we reasoned that conversation itself would influence orienting, phasic alertness, and vigilance (Experiment 1), as well as executive attention (Experiment 2), regardless of the amount of arousal. Specifically, we anticipated that any conversation, regardless of arousal level, would (a) interfere with orienting and phasic alertness, reflected in increases in both of these effects in the spatial cueing task; (b) interfere with vigilance, reflected in increased intraindividual variability in both experiments; and (c) interfere with executive attention, reflected in a more pronounced Stroop effect in Experiment 2. Our second hypothesis, based on Caird et al.’s (2008) speculation, predicted that the effect of the phone conversation would increase as the amount of conversational arousal increased. Specifically, we expected that, as the conversational arousal increased, these three effects would all increase linearly.

In both experiments, we randomly assigned undergraduate participants to engage in one of three cell phone conversation conditions: (a) no conversation, (b) a low arousal interview, and (c) a high arousal interview. During the conversation, the participants simultaneously performed one of
the two attention tasks. The first two conversation conditions were similar to the conditions used by both Irwin et al. (2000) and Dula, Martin, Fox, and Leonard (2011). However, our high arousal condition critically differed from the earlier studies. We based the conversation on a list of topics each participant had previously identified as being very upsetting, allowing us to manipulate the conversational arousal intensity with an issue that was personally relevant for each participant. This approach has long been used to evoke emotionally charged conversations in marital and family systems research (Levenson & Gottman, 1983).

**Experiment 1**

In Experiment 1, we examined the impact of cell phone conversation on performance during a variant of Posner’s (1980) exogenous spatial cueing task. For a review of the large body of literature involving this task, readers are referred to several excellent reviews (see Chica, Martín-Arévalo, Botta, & Lupiáñez, 2014; Wright & Ward, 1998). This task involves several attention processes, and any of these could be impacted by the conversation. Posner’s paradigm allowed us to assess the participant’s ability to detect and respond to stimuli suddenly appearing in the periphery (i.e., orienting). It also allowed us to examine the degree to which the participant becomes alert for impending events after a visual cue is presented (i.e., phasic alertness; Fernandez-Duque & Posner, 1997). Finally, we used intraindividual standard deviation in RT as a measure of fluctuations in each participant’s tonic alertness (vigilance; Stuss et al., 2003). This paradigm allowed us to test Caird et al.’s (2008) hypothesis about the effect for varying the level of conversational arousal with each of these attention processes (i.e., increasing the level of conversational arousal would increase the degree of impairment). We also tested the competing notion that any conversation, regardless of the arousal level, might affect orienting, phasic alertness, or vigilance.

**Method**

**Participants.** We recruited 54 undergraduate participants ($M_{age} = 19.4, SD = 0.8$) from introductory psychology classes. After we randomly assigned them equally to one of the three conversation conditions, one participant in the control condition withdrew from the study. The data from a second control participant was omitted due to excessively long RTs throughout the task. This left a final sample of 52 participants (36 women and 16 men). All participants received extra credit in their class in exchange for participating in the study and were treated in accordance to the ethical standards of the American Psychological Association (APA). Our protocol was approved by the SUNY Cortland Institutional Review Board (IRB).

**Instruments.**

**Prescreening.** Before arriving for the experimental session, the participants had completed a battery of prescreening surveys, most of which were not used for this study. However, we included two open-ended questions: (a) “Please name three people, places, or things that usually bring you pleasure or make you happy when you think about them” and (b) “Please name three people, places, or things that usually make you upset or angry when you think about them.” The first question served as a filler item, and their responses were discarded. The participants’ responses to the second question provided personal information about topics that might evoke emotional arousal in the high arousal interview condition.

**Vision screening.** A Snellen visual acuity chart was used to conduct a brief visual acuity screening (Snellen, 1862). All participants had normal or corrected normal visual acuity.

**Spatial cueing task.** This experimental paradigm has been widely used for several decades by attention and neuroscience researchers to examine visual orienting (Posner, 1980). During each trial of this task, three types of stimuli, fixation, cue, and target were presented (see Figure 1). The fixation stimuli consisted of a “+” presented in the center of the display. The cue stimulus consisted of a yellow
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box, presented to either the left or right of the fixation or two boxes presented to the left and right of the fixation (bilateral cues). The target stimulus consisted of the letter “X” presented to either the left or right of the fixation. This test measures RTs in various cueing conditions, and we observed strong split-half reliability for overall RTs ($r_s = .95$).
The spatial cueing task was performed on a Dell Optiplex GX240, (1.8-GHz Pentium 4 processor), with a Dell™ 20.1” Active Matrix TFT LCD display (1600 x 1200). The participants were fitted with a wireless Jabra BT135 Bluetooth earpiece that was connected to an LG EnV2 VX9100M cellular phone. The interviewer used a desk phone in the adjacent room during the cell phone conversation with the participant. The spatial cueing task was performed with E-Prime v1.1 (copyright 2002, Psychology Software Tools, Inc.). A chin rest was used to minimize lateral head movements.

**Procedure.** During each trial of the spatial cueing task, a fixation point was presented in the center of the screen. After 900 ms, a cue was presented on the left or right side of the screen, or both the left and right side of the screen simultaneously (neutral cue). When the target appeared, the participants responded by hitting the space bar as quickly as possible. The lag between the cue and target presentations, referred to as the stimulus onset asynchronicity (SOA), was also varied (150 ms, 700 ms, or 1250 ms), with an equal number of trials for each SOA. During no-cue trials, only the fixation stimulus remained visible during the variable cue/target lag. This experimental task included four cueing conditions: (a) valid cues, in which the target cue appeared on the same side of the display (30% of trials); (b) invalid cues, in which the target cue appeared on the opposite side of the display (30% of trials); (c) neutral cues (30% of trials); and (d) no cue (10% of trials). Targets were presented in each hemifield (left and right) in 50% of the trials for each condition. The order of SOA, cue validity, and target location were randomized within and across participants. The individual’s ability to shift attention rapidly from the invalidly cued location to the target location (orienting effect) was reflected in the RT difference between validly and invalidly cued targets ($RT_{valid} - RT_{invalid}$). The degree to which individuals become alert when a cue suddenly appears regardless of its location (phasic alertness) was reflected in the difference between targets following neutral cues and no-cue targets ($RT_{no\ cue} - RT_{neutral}$). The intraindividual standard deviation in RT was used to measure the individual’s ability to maintain attention consistently across the task (Stuss et al., 2003). RT reflects how quickly the individual is able to respond to targets while performing the task. The experimental task consisted of two blocks of 126 trials and took a mean of 8.5 minutes to complete.

Before beginning the actual trials, each participant performed a minimum of 25 practice trials. Then, the interviewer moved to the adjacent room to initiate the cell phone call. After making the connection, the interviewer instructed the participant to begin the actual task. Participants were assigned to one of three conversation conditions: (a) no conversation (control); (b) low arousal conversation; and (c) high arousal conversation. In the low arousal condition, the interviewer asked participants a series of general “getting-to-know-you” type questions (see Appendix A for a copy of survey questions). The high arousal participants were interviewed about a previously identified personally upsetting topic (see Appendix B). Because the goal was to make the conversation as arousing as possible, the interviewers were trained to probe the participants on the topic, with the goal of evoking an emotional response during the conversation. In keeping with our IRB-approved protocol, topics that had been identified by the participant but were considered to be highly sensitive in nature (e.g., sexual assault, child abuse, criminal convictions) were not discussed during the interview. Our interviewers were also trained to shift the subject of discussion if they believed that the participant was becoming overly upset, although this did not occur. In both the low and high arousal conditions, the interview began immediately after the instruction to begin the task was given.

**Design and analysis.** The between groups experimental design involved the conversation (none, low arousal, and high arousal) as the independent variable. We used a series of planned contrasts to test two hypothetical patterns of interference on four dependent variables: (a) overall reaction time (RT), (b) mean orienting effect ($RT_{invalid\ cues} - RT_{valid\ cues}$), (c) mean phasic arousal ($RT_{no\ cue} - RT_{neutral\ cue}$), and (d) intraindividual standard deviation (a measure of vigilance across the task). We adopted this approach because contrast analysis provides a more efficient and powerful
approach to evaluating hypotheses about specific patterns of change than would omnibus $F$ tests with post hoc pairwise comparisons (Furr & Rosenthal; 2003; Rosenthal, Rosnow, & Rubin, 2000; Wiens & Nilsson, 2017). The first contrast predicted a linear amount of interference as the arousal was increased. The second contrast tested a nonlinear trend, in which any conversation, regardless of the amount of arousal, interfered with the performance. These predicted patterns are depicted in Figure 2, with the contrast weights assigned accordingly. Whereas the first contrast speculated that the interference would increase across the three conditions, the second contrast predicted that the two conversations would differ from the no-conversation, but not from one another. A one-sample $t$ test was then used to determine if each contrast was significantly different from zero, as would be predicted by the null hypothesis. In cases in which neither contrast was significant, traditional overall $F$ tests and post hoc tests were used to determine if the conversation had any effect on the respective dependent variables that were not predicted by the two hypotheses.

**Results**

Preliminary analyses were conducted using related-groups $t$ tests (1-tailed) to test for the expected orienting ($RT_{invalid\ 150ms} - RT_{valid\ 150ms}$) and phasic alerting ($RT_{no\ cue} - RT_{neutral}$) effects. As expected, both the orienting and alerting effects were significant, $t(51) = 1.83, p = .034, r^2 = .06$ and $t(51) = 4.31, p = .001, r^2 = .27$, respectively (see Table 1). The planned contrast predicting a linear increase in overall RT was not significant, but the contrast predicting a nonlinear increase in RT was both significant and strong, $t(49) = 5.01, p = .001, r^2 = .34$ (see Figure 3). This suggests that any conversation slowed responses to targets. When we tested the same contrasts with the orienting or phasic alerting effects, neither model predicted significant cell phone conversation interference (all $p's > .05$). Furthermore, post hoc one-way Analyses of Variance (ANOVAs) revealed no significant or large conversation effects on either of these dependent variables, $F(2, 49) = 1.86, p = .166, \eta^2 = .04$ and $F(2, 49) = 1.66, p = .201, \eta^2 = .03$, respectively. Finally, the planned contrast predicting a linear effect on intraindividual variability ($SD$) was not significant, but the contrast predicting a nonlinear effect was found to be both significant and moderately strong, $t(49) = 2.44, p = .009, r^2 = .11$ (see Figure 4).
Discussion
In line with earlier findings (Alm & Nilsson, 1995; Strayer & Johnston, 2001; Strayer et al., 2003), our results revealed that conversation negatively influenced RT. However, the emotional arousal level evoked by the conversation did not affect RT, as reflected in the significant nonlinear contrast. This finding does not support Caird et al.’s, (2008) speculation that the level of emotional intensity during conversations moderates the attention process.

The results that neither exogenous orienting nor phasic alerting were impacted by conversation suggests that these two automatic attention processes are not the main factors that slowed responses. The fact that conversation did affect intraindividual variability suggests that the participants’ ability to remain vigilant throughout the task was negatively impacted. This raises an interesting question. Unlike phasic alertness, sustaining attention does involve purposeful control, and may involve executive processes (Petersen & Posner, 2012). The degree of conversation interference on executive control was further investigated in Experiment 2.

Experiment 2
In Experiment 2, participants performed a version of the color Stroop Test (Stroop, 1935). This task often is used to examine executive attention processes related to responding to one type of stimulus information (color) while ignoring another type of stimulus information (word; Posner, 2012). In this task, participants are shown a series of color names (i.e., “RED,” “BLUE,” and “GREEN”). In some cases, the words are displayed in the related color (e.g., the word “RED” is written in red). In other cases, the words are displayed in a different color (e.g., the word “RED” is written in green). Participants are instructed to name the color and not to read the word. Conflicts between the word and color often result in an increased number of errors, and RTs tend to be longer when the word and color are incongruent. Poor performance on this task has been associated with impairments in executive processing, including selective attention (MacLeod, 1991; Petersen & Posner, 2012; Strauss, Sherman, & Spreen, 2006).

Participants were assigned to the same three conversation conditions used in Experiment 1 (i.e., no conversation, low arousal, and high arousal). We used planned contrasts to test the two competing hypotheses tested in Experiment 1: (a) that participants in the two conversation conditions would perform more poorly on the Stroop Test than would the participants in the control condition, regardless of the arousal condition, and (b) conversation-related costs would be greater in the high arousal condition than in the low arousal condition.

Method
Participants. We recruited 54 undergraduate students (M_age = 19.05, SD = 0.85) to participate in Experiment 2. One participant who had been randomly assigned to the low arousal conversation group was unable to perform the Stroop Test, leaving a final sample of 53 participants (39 women and 14 men). All participants received extra credit in their class in exchange for participating in the study and were treated in accordance with the ethical standards of the APA and our university’s IRB. All participants were determined to have normal or corrected-normal vision.

Instruments. We used the same prescreening survey, Snellen test, computer system, and cell phone with Bluetooth earpiece described in Experiment 1. The Stroop color/word test (Stroop, 1935) has been widely used to study selective attention in attention and neuroscience research, as well as clinical practice. During each trial, a stimulus word (i.e., “RED,” “BLUE,” or “GREEN”) was presented in the center of the display. In 33% of the trials, the color names and the actual stimulus color were congruent, and in 67% of the trials, the color names and the actual colors were incongruent. We observed strong split-half reliability for both RT (rSB = .96) and accuracy (percentage of correct responses; rSB = .81). Our version of the Stroop Test was created and presented using E-Prime v1.1 (copyright 2002, Psychology Software Tools, Inc.). Because the Stroop Test did not involve stimulus presentations to the two visual fields, head orientation was not considered to be a concern. Consequently, we did not stabilize the head with a chin rest. Given the level of difficulty presented by the Stroop Test, especially when the task was performed concurrently with an interview, we decided to minimize the time-on-task. Consequently, the actual task involved only 63 trials (not including practice trials).

Procedure. Participants were instructed to identify the color of the stimulus word by pressing
a red key for a word displayed in red, a blue key for blue words, and a green key for green words. The word was displayed until the participant pressed a key, or until 5 seconds had lapsed, in which case the trial was not counted. Participants completed a minimum of 25 practice trials before beginning the actual experiment. Participants repeated the practice trials until they were able to achieve an 80% accuracy level. During the actual experiment, the order of words and colors were randomized across participants.

After the practice trials, the participant was informed that the interviewer would move to the next room to call the participant’s cell phone. The participant was told that the interviewer might or might not begin a conversation with the participant. Regardless of whether or not a conversation took place, the participant’s primary task would be to perform the computer test. Once the participant understood these instructions and was able to perform the practice trials, the interviewer left the lab and made the phone call from the adjacent room. As soon as a connection was established, the interviewer instructed the participant to begin the actual Stroop Test. In the low and high arousal conditions, the interviewer waited 10 seconds after instructing the participant to begin the task (see Experiment 1 for a description of interview conditions).

**Design and analysis.** Our overall experimental design consisted of a 3 (conversation type) x 2 (color congruence) mixed factorial design. It has long been understood that RT and accuracy of response represent distinct, sometimes competing aspects of performance (MacLeod, 1991; Pachella & Pew, 1968). Therefore, our dependent variables of interest consisted of the Stroop effect on RT (RT\_incongruent − RT\_congruent), the Stroop effect on accuracy (percentage correct\_incongruent − percentage correct\_congruent), as well as the overall RT and overall accuracy. Our dependent variables of interest consisted of the Stroop effect on RT (RT\_incongruent − RT\_congruent), the overall RT, the Stroop effect on accuracy (percentage correct\_congruent − percentage correct\_incongruent), and overall accuracy. As in Experiment 1, we employed planned contrasts predicting linear and nonlinear decreases in the Stroop effect and overall RT, and linear and nonlinear declines in accuracy across the conversation conditions. When neither planned contrasts were found to be significant, overall F tests with post hoc comparisons were used to test for unpredicted effects.

**Results**

Preliminary analyses revealed that the Stroop effect was significant for both RT and accuracy, t(52) = 4.36, p = .001, r2 = .27 and t(52) = 2.90, p = .005, r2 = .14, respectively. The planned contrast predicting a linear increase in overall RTs across conversation conditions was not significant, but the contrast predicting a nonlinear increase was significant and moderately large, t(50) = 2.22, p = .031, r = .09. Interestingly, the contrast predicting a linear conversation impact on the Stroop effect was significant t(50) = 2.46, p = .017, r2 = .11 (see Figure 5). The contrast predicting a nonlinear effect was not significant. The Stroop effect declined as the degree of arousal increased. It should be noted that increases in the Stroop effect (RT\_incongruent − RT\_congruent) could be a function of either faster responses to congruent stimuli, longer responses to incongruent stimuli, or both. To test for this, we ran the same contrasts (i.e., linear and nonlinear) as post hoc tests (with Bonferroni corrections for Type I error) with the congruent and incongruent word/color pairings. Although the contrast predicting a linear increase in RTs during the congruent condition was not significant, the nonlinear contrast was both significant and moderately large, t(50) = 2.85, p\_Bonferroni = .025, r2 = .14 (see Figure 6). Neither contrast predicting changes in RT in the incongruent condition were significant.
Finally, we examined potential conversation effects on accuracy. To this end, we tested contrasts predicting linear and nonlinear declines in the Stroop effect on accuracy. Neither contrast was found to be significant. Furthermore, when we conducted post hoc ANOVAs to test for differences in the Stroop effect on accuracy and on overall accuracy, no significant conversation effects were found (all \( p \)'s > .115).

Discussion
In Experiment 2, we examined the conversation-related costs on executive attention. Correctly responding during the incongruent condition has been associated with increased executive processing as compared to responses during the congruent condition (Strauss et al., 2006). At the same time, the demands of regulating emotion have been found previously to limit cognitive resources (Bush et al., 2000; Richards & Gross, 2000; Schmeichel, 2007). In light of this, Caird et al.’s (2008) hypothesis would predict that increasing the demands of regulating emotion during the high arousal condition would add additional interference with the executive demands in the incongruent condition. However, our results suggest that any conversation affects the RT, regardless of the amount of arousal. This is inconsistent with Caird et al.’s (2008) hypothesis that increasing conversational arousal would increase the interference of cell phone conversations (as reflected in the linear contrast).

General Discussion
In Experiment 1, the task performed by the participants required orienting to spatial cues, phasic alertness, and vigilance, but few executive attention demands. We found that neither orienting nor phasic alerting attention were affected by conversation or conversational arousal level. However, both the overall RT and intraindividual variability (associated with vigilance) increased when the conversation was introduced. We suspect that the vigilance impairments associated with the conversation contributed to the increased RTs.

Experiment 2 focused on conversational effects on executive attention. We observed a conversational effect on executive attention, but this effect appeared to be limited to the congruent condition. One explanation for this phenomenon has to do with nonequivalent demands placed on the executive attention network by the two Stroop conditions. In the congruent condition, there is no color/word conflict. The incongruent condition, however, involves a conflict between color and word. It is believed that resolving this conflict depends in part on inhibition of the semantic processing of the word (Cohen, Dunbar, & McClelland, 1990; MacLeod, 1991; Posner & Snyder, 1975). The inhibition of the incongruent semantic properties of the word also may result in the inhibition of conversation interference. The fact that the conversation effects were limited to the low-demand condition of this task are in line with the observed conversation effects in Experiment 1, which also involved low attentional demands. Admittedly, this explanation is highly speculative, and we would encourage future researchers to explore this further. If true, however, this would suggest that executive attention processes are relatively dynamic, self-adjusting to the competing attentional demands of the task and distractors in the environment (in this case conversation). This explanation is in line with arguments made by Lavie (1995).

We can imagine how this phenomenon might be similar to the real-life scenario of studying in a crowded café. When the study material is relatively simple, a student may tend to be easily distracted by the noise in the environment. However, when the material becomes more cognitively challenging, the student may tend to tune out the noise and muster more attention to focus on the study. The same may be true when one is studying and listening to music at the same time. As processing the study material becomes more demanding, the person is forced to focus on the material more and may become oblivious to the music. The development of approaches to studying attention processes (e.g., executive attention control, orienting, phasic alertness) outside of the laboratory would enable researchers to test this speculation about the dynamic nature of attention in daily life in the real world.

Our hypothesis regarding the effect of conversational arousal was not supported. However, other aspects of the conversation may influence attention. For example, we could imagine that the complexity of the conversation might present additional attentional demands. A conversation that involved cognitively challenging topics (e.g., science, work, philosophy) might be more distracting than a conversation that was relatively light in nature. Alternatively, a conversation that was relatively free-flowing, jumping from topic to topic might require more cognitive demands than a more focused conversation that involved fewer shifts in topics. Future research should examine the effect of these conversational issues on attention.

In this study, we focused on one theoretical
perspective (Posner & Petersen, 1990) to select four specific attention processes to examine (i.e., orienting, phasic alerting, vigilance, and executive attention). It is possible that other attention processes may be differentially impacted by conversation arousal. Future researchers may utilize competing theoretical perspectives to examine the impact of conversation on attention (e.g., Lavie & Tsal’s perceptual load theory, 1994; Salvucci and Taatgen’s threaded cognition theory, 2008; Wegner’s ironic process theory, 1994). It is also important to note that we selected widely used, somewhat brief measures of these attention processes. Other assessments (e.g., flanker tasks, stop-go tasks, endogenous orienting tasks) might reveal additional attention processes that are vulnerable to conversational interference. We would encourage replications with these measures.

We employed a widely used approach to eliciting conversation arousal from clinical research (i.e., using self-identified troublesome topics). However, we did not include a manipulation check. Nor did we include physiological measures of their effects on the participants. Follow-up studies with electroencephalogram measures of emotion-centers in the brain and electrodermal response measures of stress and arousal during the task might provide additional insights into the interplay between attention and conversational arousal. Participants in the current study were young adults in college. These conversational demands may increase later in life when the ability to multitask becomes more difficult (see Zanto & Gazzaley, 2017). The student population at the time of data collection was relatively homogenous (roughly 87% white, non-hispanic)². Although we did not collect these data from our participants, we suspect our sample was similarly homogenous. Our sample did include both males and females, but power constraints precluded our testing for gender differences. Therefore, we encourage future researchers to examine the generalizability of our findings. Finally, we used experimental tasks in a controlled laboratory setting. Ultimately, the ecological validity of these findings should be replicated under real-world conditions.

Conclusions
We found that conversation did not seem to affect the ability to orient attention or to respond quickly to suddenly appearing stimuli (phasic alertness), but it does seem to influence the ability to maintain attention (vigilance). Interestingly, as demands on executive attention are increased, interference by the conversation is minimized. Finally, the level of conversation arousal had little or no effect on executive attention or vigilance. Our findings suggest that competition for attentional resources by the demands of the task and by the conversation are relatively complicated and dynamic. In light of this, we would recommend that more effective workplace rules and driving laws governing cell phone use would need to be more nuanced, taking into account the demands of the task or road conditions.

References

² Based on Common Data Set (CDS) for our college for the period in which data collection occurred, reported by the SUNY Cortland Institutional Research and Analysis Office.

Fu, White, and Collings | Conversation Arousal Level and Attention
Conversation Arousal Level and Attention


Appendix A

Low Arousal Questions

Instructions: I’m going to ask you several questions to get to know you a little better.

1. How would you describe yourself?
2. How do you think others would describe you?
3. When is your birthday?
4. What year are you as of this semester?
5. How satisfied are you with your college experience so far?
6. Have you chosen a major?
7. What is your major? OR What major are you thinking of choosing?
8. What do you like best about college so far?
9. What are your plans after college?
10. Are you involved in any sports? If so, what ones?
11. Are you involved in any clubs or extracurricular activities? If so, what ones?
12. Are you in a sorority/fraternity?
13. What is your current living situation? How satisfied are you with your current living situation?
14. Did you bring a car to campus?
15. Do you have any siblings? If so, what are their ages? How close are you to them?
16. Did you live with your biological parents as a child and teenager?
17. Do you have any pets at home? If so, what kind?
18. How important is it to you to live near your parents after finishing college?
19. What was your family’s religion when you were growing up, if any? Have you stuck with that religion?
20. Where were you born?
21. Where did you grow up?
22. How would you describe the community where you grew up?

Appendix B

High Arousal Questions

Instructions: When you completed the prescreening surveys, you mentioned that the topic of (insert topic selected from prescreening for discussion) makes you upset, and I would like to talk to you about that. (Note: Interview uses the following questions to generate discussion. Participants are allowed and encouraged to elaborate as much as they want.)

1. Can you tell me why you get upset when you think about (this topic)?
2. Do you tend to avoid discussing (this topic) with others?
3. How upset would you say you get when other people start discussing (this topic)?
4. Do most of your friends or family members tend to have the same negative feelings toward (this topic)?
5. Have you considered the opposing side of your argument about (this topic)?
6. Do you find yourself getting defensive when (this topic) is brought up?
7. Would you consider yourself very set in your beliefs or perhaps even stubborn about (this topic)?
8. What sort of negative feelings do you experience when you think about (this topic)? Frustration? Anger? Sadness? Grief?
9. Do you ever feel that your negative reactions to (this topic) are extreme or irrational?
10. Can you describe a situation in which you became particularly annoyed or upset when you thought about or discussed (this topic)?
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