Postures in Mobile Device Usage: Effects on Interpretation Bias, Mood, and Physical Tension

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POSTURES IN MOBILE DEVICE USAGE: EFFECTS ON INTERPRETATION BIAS, MOOD, AND PHYSICAL TENSION

by

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ABSTRACT

Past research has shown that there is a relationship between body posture and cognitive processes. However, postures used with technological devices has not been studied more extensively. The purpose of this study was to examine posture effects when using a mobile device on interpretation bias, mood, and physical tension. Each participant was randomly assigned one of three conditions: sitting slumped, sitting upright, or lying down. Participants were asked to complete the Scrambled Sentences Task (SST), a task of unscrambling emotional and neutral sentences, to measure their interpretation bias. Additional questions were asked to measure the participant's physical tension and mood. Results suggested no significant differences in interpretation bias depending on posture. There was no significant difference in the performance of unscrambling emotional sentences compared to neutral ones for sitting slumped and sitting upright. When lying down, participants unscrambled fewer neutral sentences compared to emotional ones. Physical tension was found to be a mediator for the relationship between posture (slumped and upright) and mood. The results of this study provide insight of possible confounding variables influencing the relationship between posture and mood. It additionally showed that emotional content is processed differently compared to neutral content when lying down. Further research is needed to understand how physical tension caused by posture being altered when using mobile device affects psychological well-being.

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INTRODUCTION

According to the American Psychological Association (2017), ninety-nine percent of the adult population in the United States possesses an electronic device, e.g. a computer, a smartphone, a tablet, or a television. People engage with these mobile devices whether they are sitting in a doctor's office, walking around a supermarket, or lying down in bed. The excessive use of mobile devices could lead to both physical and psychological problems. Research studies have reported that using mobile devices influences head posture (Albin & McLoone, 2014; Dennerlein, 2015; Gold et al., 2012; Guan et al., 2016, 2015; Lee, Kang, & Shin, 2014). When people flex their neck to use their smartphones, the weight of their head may increase up to 27 kg, which could lead to neck and back problems (Robles, 2019). In addition, there is a concern that slumped posture, the collapsed upper body posture when using mobile devices, could possibly lead to negative emotional states (Cuddy, 2015). Furthermore, studies found that using mobile devices in bed is associated with poor quality of sleep and insomnia symptoms (Buboltz, & Igou, 2010; Exelmans & Van den Bulck, 2016; Fossum et al., 2013).

Given that body posture changes based on the usability of electronic devices, particular postures used for engaging with mobile devices and computers might affect cognitive (mental) processing. For example, a study that focused on investigating the effect of stress response on posture found that the posture of sitting upright improved rate of speech compared to sitting slumped (Nair et al., 2015). The theory that the human body influences the mind is known as embodied cognition, which is when the physical human body plays a significant role in cognitive processing (Wilson, 2015). When an individual is feeling upset, his or her emotions are reflected on their slouching or slumping posture. In fact, it was reported that patients with major depressive disorder showed increased head flexion and increased curve of the spine (Canales et al., 2010). This posture of patients with major depressive disorder is similar to the body posture often used for engaging with mobile devices. Since mobile device users usually bend their necks forward to use their phones, this posture could affect their cognitive processes. Therefore, it is important to consider how sitting slumped might affect mood and cognition compared to other postures.

The James-Lange theory was one of the earliest theories on bodily feedback. This theory was developed independently by William James and Carl Lange (1922), which suggested that a physiological response occurs before experiencing an emotion. For example, suppose that a student sees a bear coming from the woods. As the bear approaches, the student’s heart begins to race. Based on the James-Lange theory, the physical reaction that the student experienced is what led to the emotional response of fear. This theory inspired further investigation on how the human body plays a role in emotion.

Previous research studies considered the role that whole-body posture plays in emotional responses. Researchers reported that sitting with the back straight is associated with higher self-esteem and improved mood relative to slumped posture (Nair et al., 2015). The results of this study expanded the search on emotion and gave insight into how postures affect responses to stress. In addition, a study suggested that when participants generated words associated with failure and disappointment, their posture height declined compared to the participants that generated words associated with success and pride (Oosterwijk, Rottevel, Fischer, & Hess, 2009). This study provided evidence that emotional stimuli has an effect on posture. To support the idea that mood is related to posture, other researchers reported that posture is important for recovering from negative mood, such as participants were less likely to recover from negative mood when they were in a slumped compared to upright posture (Veenstra, Schneider, & Koole, 2016). Furthermore, other studies found that slumped posture is associated with helpless behavior and decrease in energy level compared to upright posture (Peper & Lin, 2012; Riskind & Gotay, 1982). According to these findings, posture plays an important role in experiences related to both positive and negative emotions.

While some studies directly focused on how posture influences emotional response, other studies on embodied cognition suggested that body postures play a role in advanced cognitive processes vis-à-vis emotion. An experiment by Friedman and Foster (2000) indicated that flexing one's arms, in contrast to extending them, encourages creative insight during tasks that involve analytical problem-solving. This evidence expands the association of the effect of embodied cognition with emotional responses to higher cognitive processes, such as problem solving. Other researchers looked into how body posture affects consumer choice of products and found that operating a shopping cart with arms flexed is associated with purchasing more goods compared to extended arms (Streicher & Estes, 2016). These studies provided an insight of how certain postures plays a role in motivation and problem solving.

Moreover, other studies investigated how certain postures influences memory. It was found that body postures similar to those from when the memory initially took place improves the retrieval of emotional autobiographical memories (Dijkstra, Kaschak, & Zwaan, 2007). This finding suggest that bodily manipulation influences other cognitive processes that are linked to memory. A similar study that asked participants to practice specific facial expressions and postures, i.e., happiness, sadness, and anger, found that the participants recalled emotional events even when they were no longer performing the emotional expressions that they practiced (Schnall & Laird, 2003). In general, these studies gave insight into how manipulating posture influences attitude change and memory.

The present study was interested in determining whether specific postures manipulated by the use of electronic devices influences cognitive bias. Cognitive bias is when decisions and judgments are misguided in cognitive processes. An example would be memory bias, which is a bias that influences what an individual may or may not recall. That being said, a previous study that investigated the effects of embodiment on depressive memory bias found that depressed patients who were sitting slumped recalled more negative words compared to those who were sitting upright (Michalak, Mischnat, & Teismann, 2014). Given that there is a connection between memory bias and embodiment, this study examined how posture manipulation influences interpretation bias. Interpretation bias is the tendency to negatively or positively interpret or analyze ambiguous information (Huppert et al., 2003). Interpreting information in a negative fashion has been found to be associated with social anxiety and depression (Amir, Beard, Bower, 2005; Huppert et al., 2003; Joormann, Waugh, & Gotlib, 2015).

A way to measure interpretation is through the scrambled sentences task (SST) (Wenzlaff & Bates, 1998). The SST consist of 20 emotional sentences and 20 neutral sentences. For the emotional sentences, each sentence can be unscrambled in a positive way or negative way. The way that interpretation bias is calculated by the number of grammatically correct emotional sentences unscrambled with a negative word. Given that people are often interpreting text messages on their phones, it is worth to investigate whether posture influences their interpretation in a negative or positive fashion. In addition, the effects of postures on interpretation would not only provide insight into how these certain postures used for engaging with mobile devices affects cognitive processes, but it could be applied clinically to further develop embodied treatments.

Most studies that looked into postural effects on mood or cognitive biases mainly looked sitting or standing positions (Michalak, Mischnat, & Teismann, 2014; Nair et al., 2015; Oosterwijk, Rottevel, Fischer, & Hess, 2009; Peper & Lin, 2012; Veenstra, Schneider, & Koole, 2016). However, postural effects when lying down has not been studied extensively. A 2011 Sleep Foundation study found that 9 out of 10 Americans used an electronic device within an hour before going to bed, which was linked with difficulty in falling asleep (Gradisar et al., 2013). Therefore, it is important to consider how using mobile devices while lying down affects mood and cognition.

A preliminary study was conducted to understand the head posture effects when sitting, standing, and lying down, which suggested that standing without back support had a greater amount of head flexion compared to positions that provided sufficient back support, such as sitting on an office chair or lying down on a massage table (Flores, Sims, & Whitmer, in press). Based on the results of this study, it was concluded that slumped postures can be manipulated by removing back support. In addition, upright postures can be manipulated by providing an adequate amount of back support.

The goal of this research study was to (1) examine how often people engage with a mobile device in a general or absent-minded fashion, (2) determine whether postures when using mobile devices have an effect on interpretation bias when completing the Scrambled Sentences Test, (3) observe whether postures influences performance when completing the Scrambled Sentences

Test, (4) determine if differences of reported mood and reported physical tension were dependent on postures. The specific postures that were manipulated in the study were sitting slumped, sitting upright, and lying down. The following four hypotheses were generated:

1. The participants sitting upright will use less negative target words compared to those sitting slumped and lying down when forming emotional sentences by the Scrambled Sentences Test. This was based on a previous study on memory bias that suggested that participants sitting slumped recalled more negative words compared to those who were sitting upright (Michalak, Mischnat, & Teismann, 2014).
2. The participants sitting upright will form more grammatically correct sentences compared to the participants sitting slumped or lying down when completing emotional and neutral sentences in the Scrambled Sentences Test. This was based on previous research that suggested that participants who were sitting upright generated more words when speaking compared to those who were sitting slumped (Nair et al., 2015).
3. Participants sitting slumped will report a more negative mood compared to those sitting upright and lying down.
4. There will be a difference in physical tension between those sitting upright, sitting slumped, and lying down.

METHOD

Design

A mixed methods experiment was conducted to determine the effects of posture when using mobile devices on interpretation bias. The independent variables were posture (3 groups: sitting slumped, sitting upright, and lying down) and sentence type (2 groups: emotional sentences and neutral sentences). The “posture” variable is a between-subjects variable. The variable for “sentence type” is a within-subjects variable. All conditions were randomized and equally counterbalanced. For the upright posture, participants sat on an office chair and were asked to maintain their back straight while completing the study. For the slumped posture, participants sat on a stool and were asked to hold the iPad mini on their lap throughout the entire study as a way to maintain the slumped posture. For the lying down posture, participants were asked to lie down with their face and torso facing up.

Participants

This research study collected 170 participants. The participants were recruited from SONA, the Psychology Research Participation System website and earned 1 credit towards their class course in exchange for participating in the study. Twenty participants were removed because they either missed manipulation checks or did not fully complete the study. The final sample size included 150 participants (78 females and 72 males). The participants age ranged from 18-31 (M = 18.71, SD = 1.93). For each posture there were 51 participants sitting slumped, 50 participants sitting upright, and 49 participants lying down. All of the participants agreed to the informed consent before participating in the study.

Apparatus

The mobile device that was used for all of the conditions in this study was a first-generation iPad mini. An office chair without armrests was used for the upright posture condition because it provided sufficient back support for participants to maintain an upright posture. A height adjustable stand was used to place the iPad mini at the eye-level of the participants in the upright posture condition, which was used to prevent participants from flexing their necks when engaging with the iPad mini. A stool without armrests and back support was used for the slumped posture condition. Since participants lacked back support when they were sitting on a stool, this forced them to flex their neck and lean towards the iPad mini. A massage table was used for the lying down condition.

Materials

This research study used Qualtrics Survey Software. The Scrambled Sentences Test (SST), developed by Wenzlaff & Bates (1998), was used to measure interpretation biases (See Appendix A). The SST consist of 40 scrambled sentences (20 emotional and 20 neutral sentences) which are each six words in length. The participants unscrambled each sentence to form a grammatically correct statement using only five of the six words presented. For the emotional sentences, there were negative and positive target words. For example, in the scrambled sentence “life interesting my boring generally is” *interesting* (positive) and *boring* (negative) are the target words. The neutral sentences did not contain emotional content. An example would be “to books read magazines I prefer" with *books* and *magazines* as the target words.

Participants were instructed to unscramble the sentences as quickly as possible as a way to measure their reaction times. Each scrambled sentence was first displayed for 8 seconds. After the sentence was displayed, the participants were asked to unscramble the sentence within 14 seconds. Participants unscrambled the sentences by ranking each word in order into a grammatically correct complete sentence. The extra word that participants did not choose was placed behind a line as shown in Figure 1.

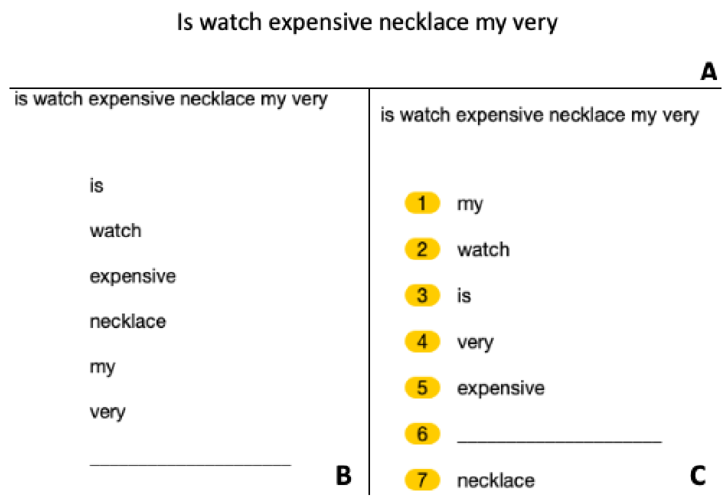

Figure 1. A screenshot of a scrambled sentence task that was completed on the Qualtrics Survey Software. A: The scrambled sentence displayed for 8 seconds. B: The unscrambling sentence task displayed for 14 seconds. C: Example of a way to unscramble the sentence by placing the extra word behind the line.

As a way to reduce priming effects, neutral scrambled sentences were presented after one or two emotional sentences were presented. The interpretation bias was calculated by the ratio of negatively selected target words over the amount of correctly unscrambled emotional sentences.

The scrambled sentences were divided into four blocks, each containing ten sentences. The second and fourth blocks included a cognitive load condition to reduce participant's conscious efforts to create socially desirable sentences. Similar to previous research that used the SST, the cognitive load task was presented at the beginning of the block. Participants were asked to memorize a six-digit number within 8 seconds and were asked to recall the memorized number (Everaert et al., 2017; Rude et al., 2002). At the end of the second and fourth blocks, a prompt asked them to enter the six-digit number.

A series of questions regarding back and neck problems were used to confirm that participants did not suffer from any back or neck illness (see Appendix B). A self-report scale was used to measure the mood of the participants (see Appendix C). On a scale from 0 (very negative) to 10 (very positive), participants reported their mood. In addition, a self-report physical tension scale was used to determine how physically tensed or relaxed the participants were in the manipulated body posture (see Appendix D). On a scale from 0 to 10 (0- Very physically tense; 10- Very physically relaxed) participants reported their level of physical tension. Demographics questions were used to collect information regarding participant's age and biological sex (see Appendix E). In addition, a set of questions generated by Marty-Dugas, Ralph, Oakman, and Smilek (2018) were used to gather information about of the participant's possession and usage of mobile devices (see Appendix F). The mobile device use questions were on a scale from 1 (never) to 7 (all the time).

Procedure

This study was conducted in a laboratory. Participants were asked if they have any back or neck problems prior to participating in the study. Those who reported any type of back or neck problems were not eligible to participate. Participants began with an informed consent and were asked to press "yes" if they agreed with the conditions of the study. Each participant was randomly assigned one of three conditions: sitting upright, sitting slumped, and lying down (see Figure 2). Once participants were in their assigned postures, they were told that this study will investigate how people hold mobile devices when completing a task as a way to reduce the awareness of their posture. About one minute after their postures were manipulated, participants self-reported their mood and physical tension, which were equally counterbalanced. Once they reported their mood and physical tension, they were instructed to complete the Scrambled Sentences Test (SST). For the SST, the participants completed a training phase. The training for the SST was an explanation of the task and three trials of the SST with neutral content. The training phase was followed by a testing phase which included all 40 scrambled sentences. After the SST, participants were asked to complete the Mobile Device Use scale. Once participants completed the Mobile Device Use scale, they were asked to report their mood and physical tension again. The duration of time between the first- and second-time participants reported their mood and physical tension ranged from 24.73 to 31.95 minutes (M = 26.48, SD = 1.22). After the second time that participants reported their physical tension and mood, participants were asked to fill out demographic questions. Once the participants completed all of the tasks in the study, they were asked to stretch their arms to reduce the effects of the posture.

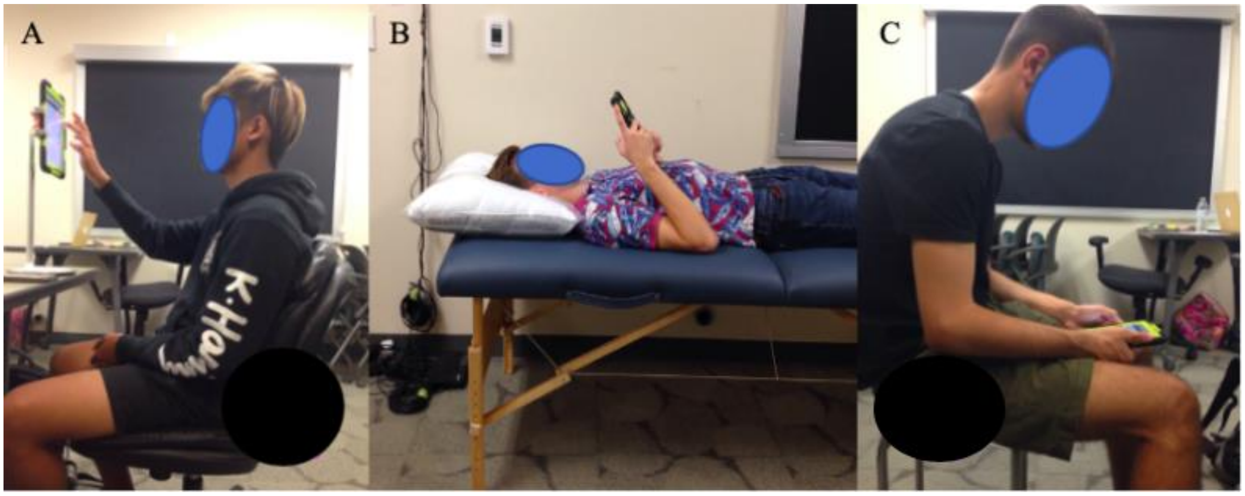

Figure 2. Postures that were manipulated. A: Sitting upright. B: Lying down. C: Sitting slumped

RESULTS

Data screening procedures were performed on the data that were collected for this research study. Responses with reaction times above three standard deviations from the average and sentences that were not grammatically correctly unscrambled were omitted from the analysis.

Analysis for Mobile Device Use

The purpose of this analysis was to estimate how often the participants engage with their own mobile device and whether they use it in a general or absent-minded way. The added scores for general or absent-minded mobile device use ranged from 0-70, with 35 representing the middle of the scale. A one sample *t*-test was carried out for general and absent-minded scores to determine whether participants' average scores of mobile device use was higher than the middle value. The results of the *t*-test suggested that participants significantly scored a value higher than 35 for the reported general use (M = 50.55, SD = 7.40, t (149) = 25.75, p <.001) and absent-minded (M = 48.56, SD = 10.59, t (149) =15.68, p <.001) use of mobile devices. A paired sample *t*-test was conducted to test differences in general and absent-minded mobile device use. The *t*-test suggested a significant difference between reported general and absent-minded use of mobile devices (t (149) = 2.85, p = .005) (see Figure 3). In addition, a positive correlation was found between general and absent-minded use of mobile devices (r (148) = .60, p<.001).

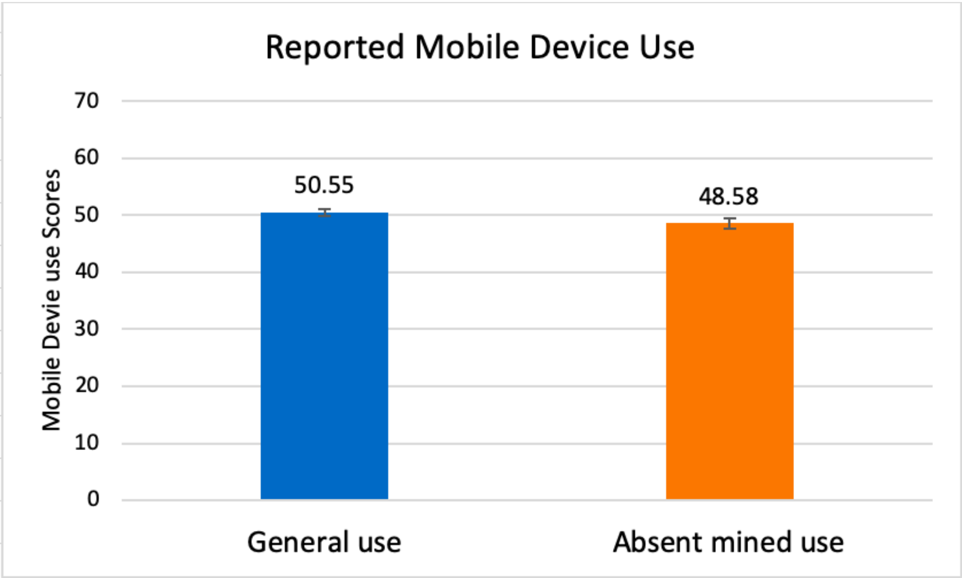

Figure 3. Reported general and absent-minded use of mobile devices. Error bars represent the standard error of the mean.

Analysis for Postures and Interpretation Bias

The main focus of this analysis was to determine whether posture influences interpretation bias. Interpretation bias is calculated by the number of negative words selected in the grammatically correct emotional sentences that were unscrambled. Therefore, a between-factors one-way ANOVA for posture as the independent variables was performed on the number of negative or positive words that were chosen when unscrambling emotional sentences. The results of the ANOVA indicated that there was no significant difference for the amount of negative words (F (2, 147) =1.12, p = .33, η_p^2 = .02) or positive words (F (2, 147) = 0.52, p = .59, η_p^2 = .01) chosen in emotional sentences (see Figure 4).

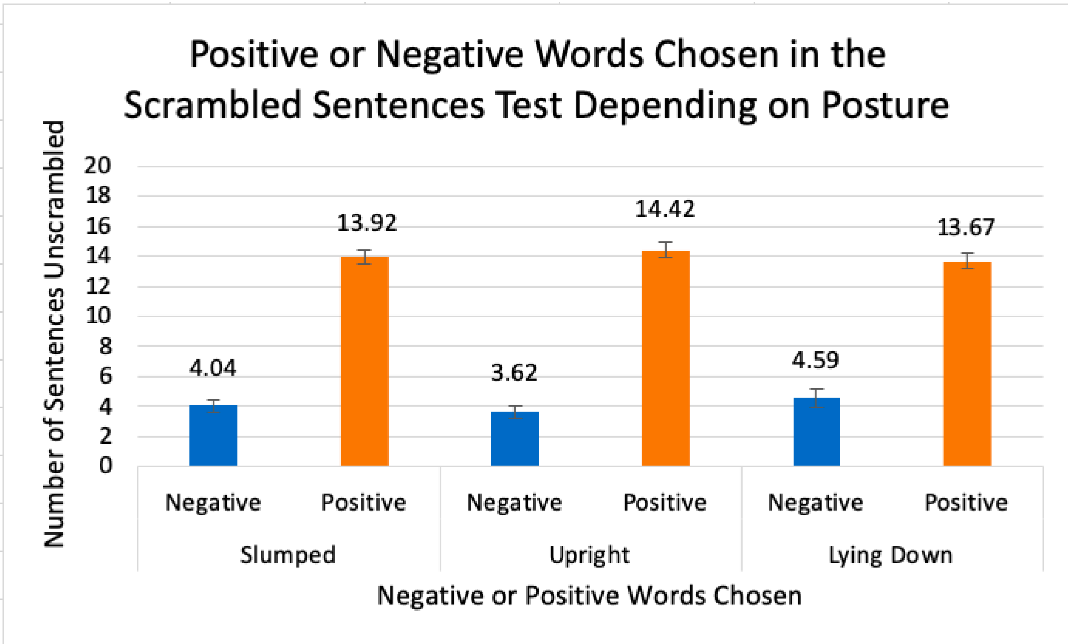

Figure 4. Positive or negative words chosen in the Scrambled Sentences Test depending on posture. Error bars represent the standard error of the mean.

Analysis for Postures and Performance of Unscrambling Sentences

The purpose of this analysis was to examine the effect of postures on the ability to unscramble sentences. For posture as the independent variable, a between-factors one-way ANOVA was conducted on the total number of sentences unscrambled (emotional and neutral) and the average reaction times for unscrambling the sentences. The results suggested no significant differences for the overall number of sentences unscrambled (F (2, 147) = 0.36, p = .70, η_p^2 = .01) and average RTs for the total number of sentences unscrambled (F (2, 147) = 1.26, p = .29, η_p^2 = .02).

A 3 (posture) x 2 (sentence type) repeated measures ANOVA was conducted to determine differences on the number of neutral or emotional sentences that were processed. The "posture" variable (3 groups: sitting slumped, sitting upright, and lying down) was a between-subjects variable. The "sentence type" variable (2 groups: neutral and emotional) was a within-subjects variable. The results of the ANOVA suggested that there is no main effect for sentence type (F (1, 144) =.79, p = .38, η_p^2 = .01). However, a significant interaction was found between sentence type and position (F (2, 144) = 3.33, p = .04, η_p^2 = .04). As illustrated in Figure 4, post-hoc paired t-tests indicated no significant differences for sitting slumped (t (50) = .08, p = .93) and sitting upright (t (49) = -.81, p =.42). However, the participants who were lying down unscrambled fewer neutral sentences (17.57, SD = 2.00) compared to emotional ones (M = 18.27, SD = 1.54, t (48) = 2.51, p = .016).

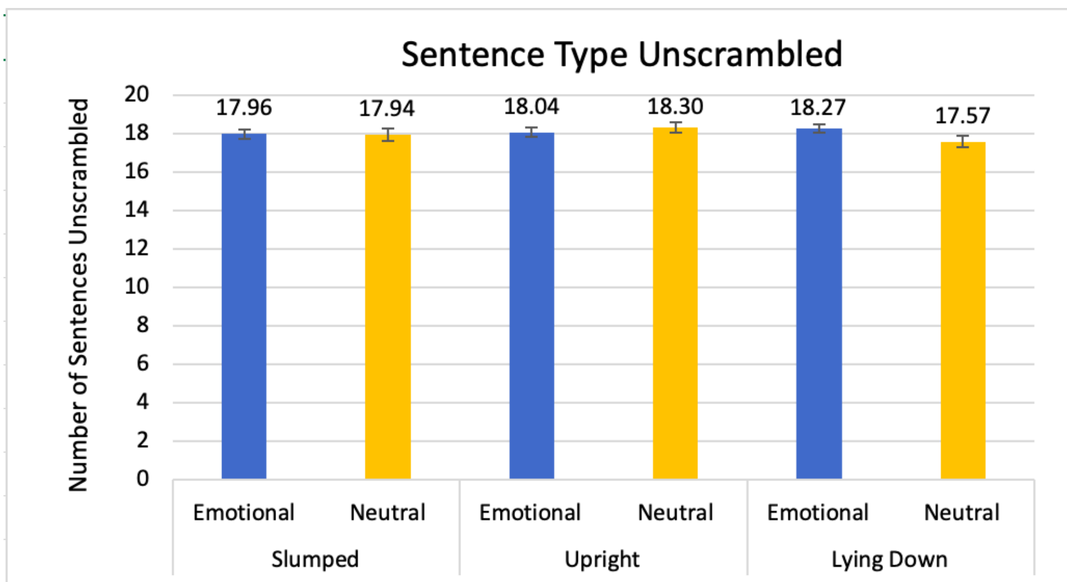

Figure 5. Differences in unscrambling neutral or emotional sentences based on postural manipulations. Error bars represent the standard error of the mean.

An additional 3 (posture) x 2 (reaction times of sentence type) repeated measures ANOVA was conducted to examine the effects of posture on the reaction times for unscrambling neutral sentences compared to emotional ones. The results of the ANOVA showed no significant main effect for RTs of sentence type (F (1, 144) =1.08, p = .301, η_p^2 = .01). No significant interaction was found between RTs of sentence type and posture (F (1, 144) = 2.51, p = .085, η_p^2 = .03).

<u>Analysis for Postures and Self-Reported Mood and Physical Tension</u>

A between-factors one-way ANCOVA for posture as the independent variable was performed on changes in self-reported measurements of mood. The change scores for mood was calculated by subtracting the second reported mood from the initial reported mood. The first reported mood was used as a covariate. The results of the ANCOVA suggested no significant differences for change in reported mood based on postures (F (2, 144) = 0.69, p = .51, η_p^2 = .01). A significant main effect was found on first reported mood (F (1, 144) = 5.70, p = .02, η_p^2 = .04). However, no significant interaction was found between first reported mood and postures (F (2, 144) = 0.33, p = 0.72, η_p^2 = .01). The changes in reported mood is depicted in Figure 5.

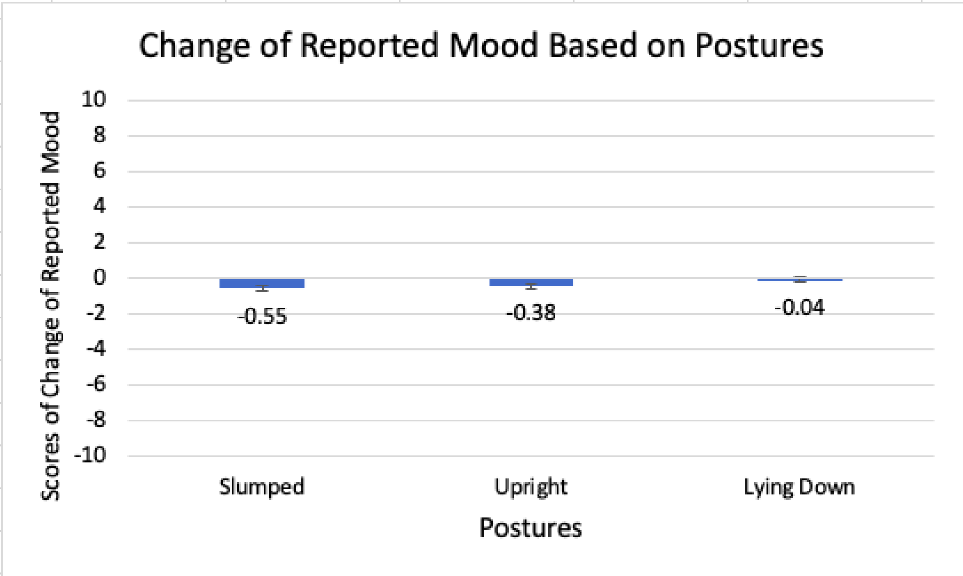

Figure 6. Change of reported mood based on postures. More negative scores indicate more negative mood. Error bars represent the standard error of the mean.

A between factors one-way ANOVA for posture as the independent variable was carried out on changes in reported physical tension. The change scores for physical tension was calculated by subtracting the second reported physical tension from the initial reported physical tension. The results of the ANOVA suggested that posture influenced the amount of physical tension that participants reported (F (2,147) = 6.04, p = .003, η_p^2 = .08). LSD post-hoc (see Figure 6) showed that those who were slumped reported to be more physically tensed compared to those who were sitting upright (p = .006) and lying down (p = .002). No significant difference of reported physical tension was found between those sitting upright and lying down (p = .67).

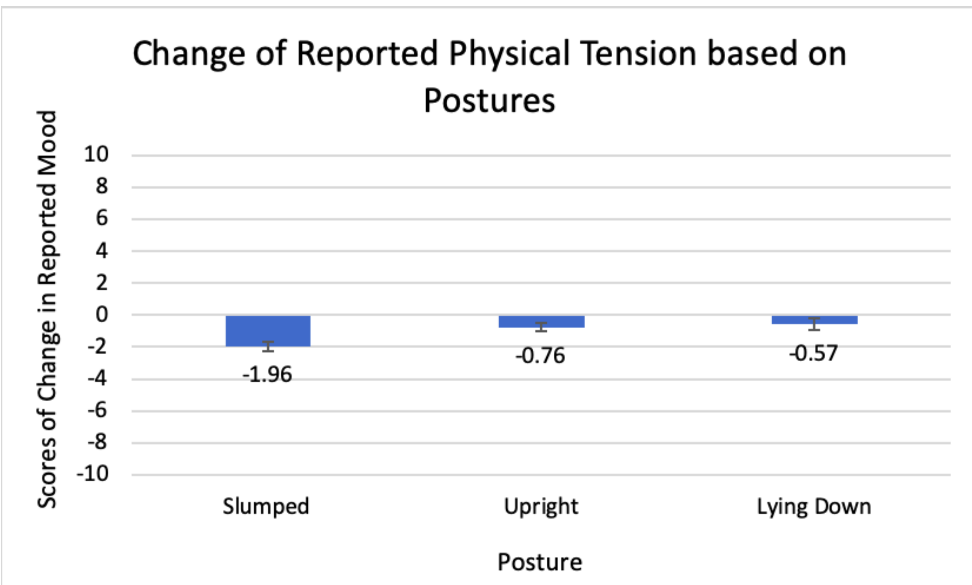

Figure 7. Change of reported physical tension based on postures. Physical tension is based on how physically relaxed participants felt. More negative scores indicate feeling more physically tensed. Error bars represent the standard error of the mean.

A bivariate correlation was carried out to examine the relationship between the variables for posture, reported physical tension, and reported mood. The results suggested that there is a correlation between posture and reported physical tension (r (148) = .25, $p < .001$), posture and reported mood (r (148) = .17, $p < .05$), and reported mood and reported physical tension (r (148) = .38, $p < .001$).

A mediation analysis was conducted to assess the possibility of confounding variables, which is based on the results that posture influenced reported change in physical tension but not in mood. In addition, reported physical tension was found to be associated with reported mood. A mediated model where change scores in physical tension mediates the relationship between posture and change scores in mood was tested. The score of first reported mood was used as a covariate. As a way to ease interpretation of the physical tension mediating effects between posture and mood, this analysis used binary variables for postures, which means that the lying down condition was omitted from this analysis. The results of the mediation model suggested that unstandardized regression coefficient between postures and change scores in physical tension was statistically significant, as well as the unstandardized regression coefficient between change scores in physical tension and mood (see Table 1). The direct effect B = 0.13 of postures on reported mood was not found to be statistically significant $p = .61$. However, at the 95% confidence level, the indirect effect B = 0.28 of mood contains a true mean between 0.05 and 0.42. Given that the confidence interval does not contain a value of zero, the effect was determined to be significant at $p<.05$. An illustration of the mediated model is provided in Figure 7. In addition, the F-test of overall significance are displayed in Table 2.

Table 1. Unstandardized coefficients for change scores in physical tension mediation effects on change scores in mood. *p<.05, **p<.001.

Diagram	Variables	B	*t* (df)	95% *CI*
Model 1	Constant	0.24	*t (*98) = 0.34	[-1.16, 1.65]
	Postures and Mood	0.15	*t* (98) = 0.60	[-0.35, 0.65]
	Covariate and Mood	-0.13	*t* (98) = -1.64	[-0.28, 0.03]
Model 2	Constant	0.72	*t* (97) = 1.07	[-0.61, 2.04]
	Postures and Physical Tension	1.18	*t* (97) = 2.92*	[0.34, 1.98]
	Physical Tension and Mood	0.24	*t* (97) = 4.02 **	[0.12, 0.35]
	Postures and Mood	0.13	*t* (97) = -0.52	[-0.61, 0.35]
	Covariate and Mood	-0.09	*t* (97) = -0.09	[-0.24, 0.05]

Table 2. *F*-test of overall significance for change scores in physical tension mediation effects on change scores in mood.

Diagram	Variables	R^2, *F*-test
Model 1	Postures and Mood	R^2 = .03, (*F* (2, 98) = 1.57, *p* = .21
Model 2	Postures and Physical Tension	R^2 = .31, (*F* (2, 98) = 1.57, *p* = .01
	Postures, Physical Tension, Mood, and Covariate	R^2 = .17 (*F* (3, 97) = 6.61, *p* < .001

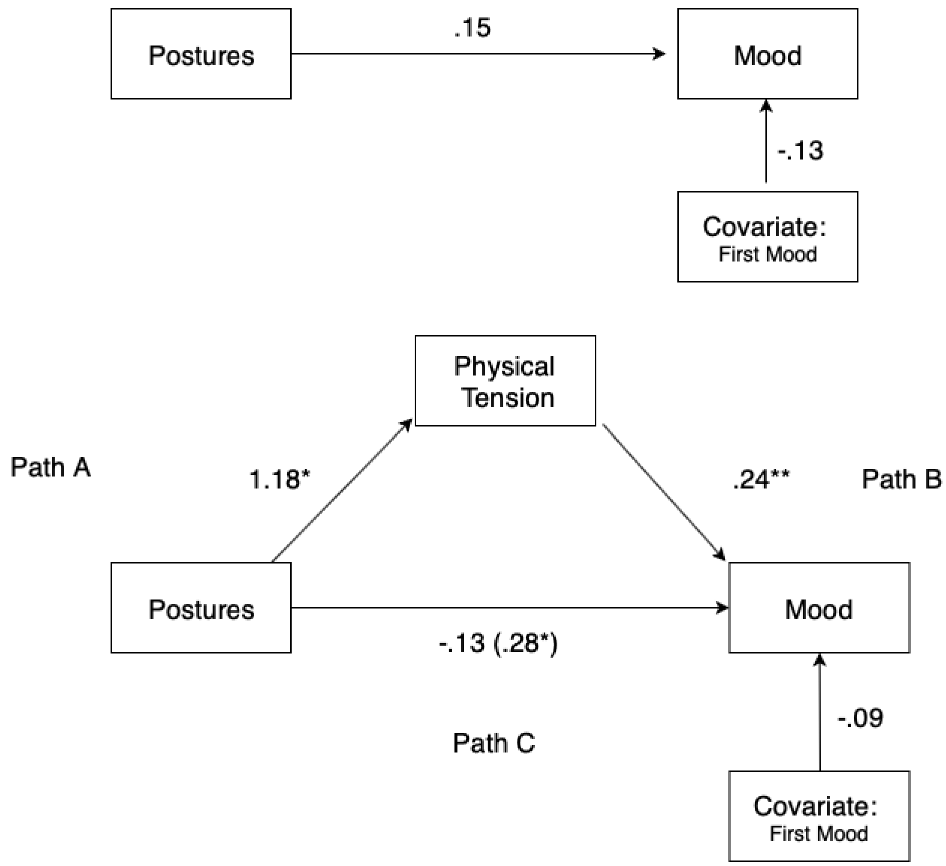

Figure 8. The following model illustrates the unstandardized regression coefficients for postures estimating change in reported mood, mediated by reported change in physical tension, and controlling for first reported mood. Physical tension is based on how physically relaxed participants felt. The top model displays the total effect of postures on mood. The bottom model displays the mediation model, which includes both direct and indirect (parenthesis) effects. The indirect effect size was determined through 5,000 bootstrapped samples. *p<.05, **p<.001.

DISCUSSION

Mobile Device Usage

The first research goal was to examine how often participants engage with a mobile device. The finding that participants on average reported high mobile device use in a general or absent-minded way is concerning given that the excessive use of devices has been found to be associated with musculoskeletal pain (Shan et al., 2013). In addition, engaging with a mobile device leads to an increase of head flexion (Dennerlein, 2015; Guan et al., 2016, 2015; Lee, Kang, & Shin, 2014), which means that it is possible that participants frequently flex their neck when they use with their mobile device.

Postures and Interpretation Bias

The second goal of this research study was to determine whether postures when using mobile devices have an effect on interpretation bias when completing the Scrambled Sentences Test. The hypothesis that those who are sitting upright will choose less negative target words compared to those slumped and lying down was not supported. The finding that there was no significant difference in interpretation bias depending on whether participants were sitting slumped, sitting upright, or lying down was surprising given that previous research found memory bias to be influenced by slumped or upright posture (Michalak, Mischnat, & Teismann, 2014). A possible reason why this occurred is that the research study that looked at posture effects on memory bias specifically examined depressed patients. This means that a depressed sample is more likely to show negative biases compared to a non-depressed sample. In addition, a study that reviewed cognitive biases in youth depression found sufficient evidence that claims interpretation bias to be a predictor of youth depression; however, mixed evidence was found for memory bias (Platt et al., 2017). Given that there is mixed evidence on the predictors of depression on memory bias, researchers should carefully consider the role of memory bias in embodiment effects.

Postures and Performance of Unscrambling Sentences

The third goal of the study was to observe whether posture influences performance when completing the Scrambled Sentences Test. The hypothesis that those who are sitting upright will form more grammatically correct sentences compared to those sitting slumped or lying down when completing the Scrambled Sentences Test was not supported. A possible reason why this occurred is that the experience of participants using their smartphones or tablet with or without back support may have interfered with the results of the study. Future research studies should look into how often people engage with their mobile devices when lying down.

In addition, the findings of this study indicated that the content of the sentence whether it is neutral or emotional matters. Although no significant difference was found for the upright and slumped postures, those who were lying down unscrambled fewer neutral sentences compared to emotional ones. A possible reason why this occurred is that participants who were lying down were aroused differently compared to those who were sitting. The Yerkes-Dodson Law suggests that performance decreases when a stimulus is too intense or dull (Yerkes & Dodson, 1908). Emotional content possibly aroused participants regardless of whether they were sitting slumped, sitting upright, or lying down. However, lying down possibly lead to lower arousal compared to sitting when exposed to stimuli with neutral content. A possible explanation for this is that people are aroused differently when exposed to a stimulus without emotional content when lying down compared to sitting positions (sitting slumped or sitting upright). Further research is needed to understand how certain positions, such as lying down, leads to lower arousal when exposed to a stimulus without emotional content. That being said, future research should use psychophysiological measures instead of self-reported measures to determine differences in arousal of stimuli with or without emotional content when lying down.

Postures and Self-Reported Mood and Physical Tension

The fourth goal of this study was to determine if differences of reported physical tension and reported mood were dependent on postures. The hypothesis that there will be a difference in physical tension between those sitting upright, sitting, slumped, and lying down was supported. Sitting slumped caused more physical tension compared to sitting upright or lying down, which means that increased neck flexion when engaging with smartphones or tablets leads to experiencing a greater amount of muscular tension. The increased of physical tension when sitting slumped goes in hand with research suggesting that increased head flexion is associated with musculoskeletal pain (Andersen et al., 2003).

The hypothesis that those who are sitting slumped will report a more negative mood compared to those sitting upright was not supported. The finding that there was no significant difference in reported mood was shocking given that embodied research studies found slumped posture when walking to be associated with negative energy level or mood (Nair et al., 2015; Oosterwijk, Rotteveel, Fischer, & Hess, 2009; Pepper & Lin, 2012;Veenstra, Schneider, & Koole, 2016). A possible explanation of why this occurred is that there is not a consistent way to measure mood in embodied studies. This research study measured mood in a simplistic manner; however, other research studies measured mood by using generating sad words, Profile of Mood States, or Affect Valuation Index (Nair et al., 2015; Oosterwijk, Rotteveel, Fischer, & Hess, 2009; Veenstra, Schneider, & Koole, 2016). It is possible that the way that mood is measured may interfere with the results of the study. That being said, researchers should carefully consider which measurements of mood to use when conducting embodied research.

Another possible reason why postures did not show to influence mood is that there could be confounding variables mediating embodiment effects on mood. This research study found physical tension to be a mediator between posture (sitting slumped and sitting upright) and mood. According to the American Chiropractic Association (n.d.), poor posture leads to stress, weak postural muscles, excessive muscle strain, and increases chances of being injured. Furthermore, the American Psychological Association (n.d.) found that stress increases muscle tension, which leads to pain in areas of shoulders, neck, and head. It is possible that the poor posture of sitting slumped when using a mobile device leads to an increased amount of muscular tension or stress, which essentially impacted participant’s mood. Additional research is needed to understand how variables such as stress and muscle tension plays a role in embodiment effects on mood.

Furthermore, the present study had an average time of 26 minutes between the pre-mood to post-mood self-report. A previous study found difference in energy level when comparing slumped and upright posture after 2-3 minutes (Peper, & Lin, 2012). Other studies found a link between using devices for more than 2-3 hours a day and musculoskeletal pain (Hakala, Rimpelä, Saarni, & Salminen, 2006). It is possible that poor posture when using mobile devices could influence mood, muscular discomfort, and pain after using the device for a long period of time. However, it is not clear how long it takes to detect differences in mood and muscular tension depending on posture. Future studies should use a longitudinal research design to observe embodiment effects on mood and muscular tension.

Response to the Literature

Most studies in embodied cognition investigated effects of posture in positions such as sitting and standing. This research study expanded embodied cognition literature by exploring the lying down position, which is a position that has not been studied extensively. Moreover, this study found that self-reported change scores in physical tension as a mediator between the relationship between posture and change scores in mood. Studies on embodied cognition should consider possible confounding such as physical tension or stress to further understand how posture influences mood. Additionally, with the increase of technology use, it is essential to observe the effects of posture when engaging with a mobile device. Research in the realm of embodied cognition should further investigate the physiological aspect of the human body. Studies that focuses on observing the effects of different postures on mental processes should consider using different physiological measures to deepen the understanding of what aspect of posture influences cognition and emotion.

Limitations

One limitation of this research study is that the measurement of physical tension was a self-reported question. This question does not provide insight of the changes involved during muscle contractions or areas of the body where participants experienced tension. A second limitation of this research study was that measurements of mood and physical tension were not recorded prior to participants being exposed to postural conditions. This means that this research study provided insight of how mood and physical tension changes from the duration of initially being exposed to the posture manipulation and after being in the manipulated posture for a certain period of time. However, this research did not directly compare mood and physical tension before and after being exposed to the posture conditions in the study.

Conclusion

The present study investigated how postures in mobile device usage influenced interpretation bias, physical tension, and mood. This study showed the prevalence of using a mobile device in both a general and absent-minded fashion. Although no embodiment effects were found on interpretation bias, the lying down position was found to be worse at unscrambling neutral sentence compared to emotional ones. In addition, physical tension was found to mediate the relationship between posture (slumped and upright) and mood. It is important to consider confounding variables such as stress or muscle tension when investigating embodiment effects on mood and cognitive biases. Future research should use physiological measurements, such as an electromyography (EMG) electrodes, to examine muscle contractions generated by electrical impulses to better understand the role of physical tension in the relationship between posture and mood. Furthermore, given that it is common for people to use their smartphones in bed, it is worth to further investigate cognitive effects of lying down when engaging with mobile devices. The present study is one of the first studies that examined cognitive effects of lying down when engaging with mobile devices.

APPENDIX A: SCRAMBLED SENTENCES TEST

Emotional content

1. "looks bright future the dismal very"
2. "is interesting life my boring quite"
3. "to dislike people me like tend"
4. "others equal am inferior I to"
5. "life truly worth is not living"
6. "a worthwhile I worthless am person"
7. "a am failure quite success I"
8. "loved I do deserve don't being"
9. "about do people me don't care"
10. "have I lost my helped friend"
11. "is impossible to happiness possible attain"
12. "appearance unchanged physical my worsening is"
13. "me well people of poorly think"
14. "is not college worth well it"
15. "seem misunderstand to people understand me"
16. "am I ruining life improving my"
17. "person am inadequate I adequate an"
18. "others' cannot I can meet expectations"
19. "I little offer have much to"
20. "my wasted I utilized have opportunities"

Neutral content

1. "playing computer fun is boring games"
2. "is hearing worse getting vision my"
3. "environment riding busses helps bicycles the"
4. "to books read magazines I prefer"
5. "much fun hiking going dancing is"
6. "very child my is pet cute "
7. "breakfast cereal eat eggs I for"
8. "is watch expensive necklace my very"
9. "Chinese difficult a simple is language"
10. "I up early getting late love"
11. "politicians conservative too much liberal promise"
12. "long shower take I bath a"
13. "foreign exciting countries expensive is visiting"
14. "animals snakes very bunnies entertaining are"
15. "an appetizing snack donuts unhealthy are"
16. "want Asia visit I Europe to"
17. "to letters I emails write prefer"
18. "of introverts know extroverts I lots"
19. "too coffee my tea is bitter"
20. "my beautiful needs ugly repairs car”

APPENDIX B: BACK AND NECK PROBLEMS QUESTIONNAIRE

Do you have back problem(s)?	I suffer from this condition	I do NOT suffer from this condition
Degenerative Disc Disease		
Spinal Stenosis		
Currently have Back Pain		
Cauda Equina Syndrome		
Fracture of the Thoracic and Lumbar Spine		
Herniated Disk		
Kyphosis (Roundback) of the Spine		
Currently have Lower Back Pain		
Lumbar Spinal Stenosis		

Do you have back problem(s)?	I suffer from this condition	I do NOT suffer from this condition
Sciatic		
Scoliosis		
Spondylosis and spondylolisthesis		
Osteoporosis		

Do you have neck problem(s)?	I suffer from this condition	I do NOT suffer from this condition
Cervical Fracture		
Cervical Radiculopathy		
Cervical Spondylosis		
Congenital Torticollist (Twisted Neck)		
Herniated Disk		
Currently have Neck Pain		
Currently have Neck Sprain		

APPENDIX C: REPORTED MOOD SCALE

My mood is

|——————————————————|

0 (Very negative) 10 (Very positive)

APPENDIX D: REPORTED PHYSICAL TENSION SCALE

Rate how physically relaxed you are at this moment.

|————————————————————|

0 (Very physically tense)   10 (Very physically relaxed)

APPENDIX E: DEMOGRAPHIC QUESTIONNAIRE

What is your age? _____

What is your biological sex?

Male

Female

Prefer not to respond

APPENDIX F: USAGE OF MOBILE DEVICE QUESTIONNAIRE

Do you own a mobile device? (e.g., smartphone or tablet)

Yes

No

How often do you have your mobile device on your person?

|——————————————————|

1 (never)   7 (all the time)

How frequently do you send and receive text messages or e-mails?

|——————————————————|

1 (never)   7 (all the time)

To what extent do you have push notifications enabled on your mobile device?

|——————————————————|

1 (never)   7 (all the time)

How often do you find yourself checking your mobile device for new events such as text messages or emails?

|——————————————————|

1 (never)   7 (all the time)

How often do you use your mobile device for reading the news or browsing the web?

|——————————————————|

1 (never)   7 (all the time)

How often do you use sound notifications on your mobile device?

|——————————————————|

1 (never)   7 (all the time)

When you get a notification on your mobile device, how often do you check it immediately?

|————————————————|

1 (never) 7 (all the time)

How often do you use the calendar (or similar productivity apps?)

|————————————————|

1 (never) 7 (all the time)

How often do you check social media apps such as Snapchat, Facebook, or Twitter?

|————————————————|

1 (never) 7 (all the time)

How often do you use your mobile device for entertainment purposes (i.e. apps and games)?

|————————————————|

1 (never) 7 (all the time)

How often do you open your mobile device to do one thing and wind up doing something else without realizing it?

|————————————————|

1 (never) 7 (all the time)

How often do you check your mobile device while interacting with other people (i.e. during conversation)?

|————————————————|

1 (never) 7 (all the time)

How often do you find yourself checking your mobile device “for no good reason”?

|——————————————|

1 (never) 7 (all the time)

How often do you automatically check your mobile device without a purpose?

|——————————————|

1 (never) 7 (all the time)

How often do you check your mobile device out of habit?

|——————————————|

1 (never) 7 (all the time)

How often do you find yourself checking your mobile device without realizing why you did

|——————————————|

1 (never) 7 (all the time)

How often have you realized you checked your mobile device only after you have already been using it?

|——————————————|

1 (never) 7 (all the time)

How often do you find yourself using your mobile device absent-mindedly?

|——————————————|

1 (never) 7 (all the time)

How often do you wind up using your mobile device for longer than you intended to?

|——————————————|

1 (never) 7 (all the time)

How often do you lose track of time while using your mobile device?

|——————————————|

1 (never) 7 (all the time)

APPENDIX G: INFORMED CONSENT

University of Central Florida

Postures in Mobile Device Usage

Informed Consent

Principal Investigator(s): Gabriela Flores

Sub-Investigator(s): ***Valerie Sims, PhD***

Investigational Site(s): Applied Cognitive and Technology Lab

Psychology Building in rooms 207C & 207D in the suite labeled PSY 207.

University of Central Florida, Psychology Department

Why am I being invited to take part in a research study?

We invite you to take part in a research study because you are an undergraduate student at UCF.

You must be 18 years of age or older to participate in this study.

What should I know about a research study?

- Someone will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Who can I talk to?

If you have questions, concerns, or complaints, or think the research has hurt you, talk to Gabriela Flores, the researcher, by emailing her at gabrielaflorescru@knights.ucf.edu or the faculty mentor, Dr. Valerie Sims, at valerie.sims@ucf.edu

This research has been reviewed and approved by an Institutional Review Board ("IRB"). You may talk to them at 407-823-2901or irb@ucf.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get information or provide input about this research.

Why is this research being done?

The purpose of this study is to examine how mobile device usage affects cognition.

How long will the research last?

We expect that you will be in this research study for 45 minutes.

How many people will be studied?

We expect about 185 people here will be in this research study out of 255 people in the entire study nationally

What happens if I say yes, I want to be in this research?

The research study will be completed in the Applied Cognitive and Technology lab.

- You will start reading this entire consent form. After obtaining your voluntary agreement on the participation, you will be considered enrolled.
- First, you will complete a list of surveys (mood scale and the physical tension scale).
- After the initial surveys, you will complete either the Leahy Emotional Scale (LESS) or the Scrambled Sentences Test (SST).
- The training phase will be followed by a testing phase which includes all 40 scrambled sentences. After you complete both the LESS and the SST, you will be asked to report mood and physical tension again.
- During the course of the tasks, you may be asked to lie with the face and torso facing up or to sit down.
- Photos of your posture will be taken.
- Finally, you will answer demographic questions and the Usage of Mobile Device scale.

What happens if I do not want to be in this research?

Participation in research is completely voluntary. You can decide to participate or not to participate.

Your participation in this study is voluntary. You are free to withdraw your consent and discontinue participation in this study at any time without prejudice or penalty. Your decision to participate or not participate in this study will in no way affect your continued enrollment, grades, employment or your relationship with the individuals who may have an interest in this study.

What happens if I say yes, but I change my mind later?

You can leave the research at any time it will not be held against you.

Is there any way being in this study could be bad for me?

There are no risk associated to this type of research.

What happens to the information collected for the research?

Efforts will be made to limit the use and disclosure of your personal information, including research study and medical records, to people who have a need to review this information. We cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization.

What else do I need to know?

You will receive 1 SONA credits for your participation in this study.

UCF University of Central Florida IRB
IRB NUMBER: SBE-18-14249
IRB APPROVAL DATE: 10/22/2018
IRB EXPIRATION DATE: 08/28/2019

APPENDIX H: INSTITUTIONAL REVIEW BOARD APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Gabriela Flores-Cruz**

Date: **August 29, 2018**

Dear Researcher:

On 08/29/2018 the IRB approved the following modifications / human participant research until 08/28/2019 inclusive:

Type of Review:	Submission Correction for UCF Initial Review Submission Form; Expedited Review Category #6 and #7; Phase I n=70 and Phase II n=155 *This approval includes a Waiver of Written Documentation of Consent allowing electronic consent*
Project Title:	Postures in Mobile Device Usage: Effect on cognitive bias
Investigator:	Gabriela Flores-Cruz
IRB Number:	SBE-18-14249
Funding Agency:	CBA Summer Research Grant
Grant Title:	Summer Undergraduate Research Fellowship
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 08/28/2019, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent language is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of **six years** past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

This letter is signed by:

Signature applied by Jennifer Neal-Jimenez on 08/29/2018 11:34:38 AM EDT

Designated Reviewer

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