

Physiological Linkage and Communication of Emotion via Touch

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Master of Science

In

Psychology

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August 21, 2020

Blacksburg, VA

Keywords: Physiological linkage, dynamic time series modeling, touch, dyadic interaction,
emotion communication

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Academic Abstract

Previous research has demonstrated that communication of emotion via touch is possible and occurs well-above chance levels, though the potential mechanism whereby this occurs has yet to be determined. The current study aimed to determine if physiological linkage, or the synchrony between various physiological signals between two interaction partners, played a role in successful communication of emotion via touch. Dynamic linear times series analysis was used to determine the strength and length of synchrony between the inter-beat intervals of fifty-two stranger female-female dyads ($n=104$, mean age=19.88) during two rounds of an emotion communication task in which they communicated a randomized list emotions to each other via forearm touch alone without being able to see their interaction partner. Results showed the highest magnitude linkage coefficients and the greatest number of consecutive lagged linked seconds during the “touch alone” communication—demonstrating that touch increases physiological linkage. Stronger and longer physiological linkage across tasks predicted emotion word, valence, intensity, and quadrant (from the circumplex model) detection accuracy. Participants serving as the initial communicator in the first round of emotion communication tended to have a greater influence on the physiology of initial receivers. Overall, greater physiological linkage as the result of touch predicted successful communication of emotion via touch and is therefore likely a portion of the mechanism underlying this phenomenon.

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General Audience Abstract

People often communicate with their friends, family, and acquaintances using touch—when meeting a loved one after a long time, we might give them a particularly tight hug; to congratulate someone, we give a high five; and even in business settings, handshakes are used as a form of greeting or parting. Touch can also be used to communicate distinct emotions, just like a frown or a stern tone can communicate visually and aurally that someone is angry. However, although past research has demonstrated this communicative ability of touch, it is not yet known how touch is able to communicate emotion. The current study hypothesized that physiological linkage might play a role. Physiological linkage occurs when physiological signals, such as heart rate, between interaction partners starts to sync up—for example, when one person’s heart rate speeds up, so does the heart rate of the person with whom they are interacting. Results showed that greater levels of physiological linkage occurred in response to touch and that these increased levels of physiological linkage predicted people’s ability to successfully determine which emotion was communicated to them via touch to their forearm. All the emotions were communicated via touch alone; participants could not see or hear their interaction partner. This demonstrates how powerful communication via touch can be. Future research should examine how touch and physiological linkage can be incorporated into medical and psychological therapies.

Acknowledgements

I wish to acknowledge and thank my advisor, Dr. Bruce Friedman, and the rest of my thesis committee (Dr. Rachel Diana and Dr. Angela Scarpa) for their time and support of this project. I would also like to specifically thank Dr. Angela Scarpa, who not only provided her time and support, but supplied the necessary lab space and equipment to complete the experiment and data analysis. Working with her on a project involving physiological linkage previously inspired my idea for this project and allowed me to meet with her collaborators—their help, especially the help received on the dynamic times series modeling used for linkage analysis from Dr. Yu Zhou, was invaluable in completing my thesis. I am very grateful to my research assistants, including Aditi Barga, Sierra Hennessy, Sidrat Hassane, Rachel Silver, Caroline Sullivan, and Liza White for all their help in every aspect of this project. I also want to express gratitude to the Virginia Tech Graduate Student Assembly's Graduate Research Development Program and Phi Kappa Phi's Love of Learning Grant program for funding this project. Lastly, I want to thank my family and friends who have always believed in me and provided invaluable continuous support throughout my graduate studies.

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List of Abbreviations

Abbreviation	Definition
PL	Physiological linkage
IBI	Inter-beat interval
ECG	Electrocardiogram
ICG	Impedance cardiography
PEP	Pre-ejection period
LVET	Left ventricular ejection time
hfHRV	High frequency heart rate variability
RMSSD	Root mean squared successive differences of R-R intervals
LSAS	Leibowitz Social Anxiety Scale
SHS	Sensory Hypersensitivity Scale
DASS	Depression Anxiety and Stress Scale
R-HHQ	Recent Health History Questionnaire

1. Introduction

Although researchers have discovered and labeled senses beyond the classic five of vision, audition, olfaction, gustation, and touch as originally described by Aristotle, physiological and neuroscientific research continues to discover new insights regarding the original five senses. However, although it is the largest, oldest, and first to develop of the senses, touch has been neglected in research compared to its counterparts (Field, 2010). Despite the relatively sparse literature on touch, this sense is recognized as playing an important role in early development (Field, Hernandez-Reif, & Diego, 2010), interpersonal relationships (Gueguen & Fischer-Lokou, 2003), and stress and pain responses (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Mancini et al, 2014). Furthermore, touch can impact compliance (Joule & Gueguen, 2003), attention (Field, Grizzle, et al., 1996), vagal activity (Field & Diego, 2008), and depression (Field, Ironson, et al., 1996).

Given the many physiological, psychological, and interpersonal processes in which touch plays a role, further research into this sense is warranted. The literature reviewed below outlines the above aspects of touch to provide support for why continued research, including studies like the one described in this thesis, are necessary. The current study adds to the literature on touch by exploring physiological linkage as a potential mechanism for how communication of emotion via touch occurs. Prior studies examining communication of emotion via touch focused on if this kind of communication was possible; the current study attempts to partially answer how this kind of communication occurs. Understanding the mechanisms of this kind of touch communication could lend empirical support for touch therapies and development of new strategies for couple and family therapies.

2. Literature Review

2.1. The Role of Touch in Early Development and Interpersonal Relationships

As stated, touch is the first of the senses to develop and manifests in the womb through thumb sucking and grasping the umbilical cord (Field, 2010). Grasping continues after birth as one of the primary ways in which infants explore their environment (Field et al., 2010). Beyond touching objects to explore the environment, infants also receive many kinds of touches from caregivers, with skin-to-skin contact providing comfort and protecting against cognitive and neurodevelopmental delays, deficits commonly seen as the result of touch deprivation (MacLean, 2003). Maternal touch has also been shown in humans and non-human animals to attenuate infant's physiological stress reactivity (Feldman, Singer, & Zagoory, 2010) and to assist in emotion regulation (Weller & Feldman, 2003). The comforting and protective factors of touch extend beyond the child-caregiver relationship; touch and physical affection are associated with overall relationship and partner satisfaction in romantic couples (Gueguen & Fischer-Lokou, 2003), as well as increased positive affect, intimacy, and psychological well-being in partners who touched more often (Debrot et al., 2013).

Even in non-romantic or familial relationships, touch can impact compliance. Studies have demonstrated that a request made simultaneously with a friendly touch is more likely to be fulfilled (Joule & Gueguen, 2003). For example, bus drivers who were touched when asked to give a free ride more readily agreed to this request (Gueguen & Fischer-Lokou, 2003). However, touch may not always signal a positive interpersonal interaction; nonreciprocal touch, as viewed by others, can reduce the perceived power of the person being touched regardless of the person's status or sex (Summerhayes & Suchner, 1978). Nonreciprocal touch in the context of a romantic relationship is perceived as an expression of warmth or love between partners (Pisano, Wall, &

Foster, 1986). Location of touch is also viewed differently based upon the relationship context; for example, in an examination of nine different types of touch, face touches were viewed as the most flirtatious and loving, but also the most inappropriate and sexual harassing among coworkers (Lee & Guerrero, 2010).

2.2. Touch and Responses in Stress and Pain

The comforting and protective effects of touch may be due to its attenuation of stress and pain responses. Women who received a neck and shoulder massage from their partner prior to a stressful task demonstrated lower heart rate responses and lower cortisol levels after the task than women who received verbal support or no partner contact before the task (Ditzen et al., 2007). During a four-week touch intervention study, couples of men and women who received the intervention showed reduced alpha amylase (a salivary biomarker of stress) throughout the intervention in comparison to the control couples (Holt-Lunstad, Birmingham, & Light, 2008). Furthermore, women who held the hand of their husband while receiving a painful shock to the ankle while in an fMRI scanner showed less response to the threat than those not holding hands (Coan, Schaefer, & Davidson, 2006). Beyond romantic couples, female patients receiving painful intravitreal injections endorsed having their hand held by a technician as a pain management technique (Gomez et al., 2016) and massage therapy has reduced pain in patients with cancer (Kutner et al., 2008) and many types of chronic pain in adults (Field, Diego, & Hernandez-Reif, 2006) and adolescents (Suresh, Wang, Porfyrus, Kamasinski-Sol, & Steinhorn, 2008). Tactile touch reduced anxiety in intensive care patients (Henricson et al., 2008) and physical contact produced decreases in heart rate, blood pressure, pain ratings in a laboratory cold pressor task (Fishman, Turkheimer, & DeGood, 1995). Gentle touch, provided as treatment for patients with a variety of mental health concerns in an open study, resulted in reductions in anxiety, stress, and

depression in addition to increased relaxation and coping, especially in patients with the most severe initial symptoms (Weze et al., 2006)

Several systematic reviews have also demonstrated effectiveness of healing touch and/or therapeutic touch treatments for decreasing pain and stress and increasing relaxation and a sense of well-being (Anderson & Taylor, 2011; Monroe, 2009) for a wide range of conditions including sickle-cell (Thomas et al., 2013), severe burns (Turner et al., 2008), cancer (Aghabati, Mohammadi, & Esmail, 2007), and fibromyalgia (Denison, 2004). However, there is a need for studies with larger and more diverse samples using these treatment techniques (Fazzino et al., 2010) and for higher quality studies for using these techniques to treat anxiety disorders (Robinson & Dolk, 2007). Healing touch has also been shown to reduce state/trait anxiety and physiological measures of stress (such as heart rate and blood pressure) in healthy adults (Maville, Bowen, & Benham, 2008). A study by Mancini et al (2014) applying touch simultaneously with laser pulses demonstrated that the significant analgesic properties of touch are due to reduced sensitivity in detecting the intensity of the laser pulses, resulting from decreased functionality of information processing in the ascending A δ pathway.

2.3. Touch's Impact on Attention and Vagal Activity

The mechanism whereby touch impacts the stress response involves the tenth cranial nerve, or vagus nerve (Field, 2010). Physical touch stimulates dermal and subdermal pressure receptors that transmit signals to the vagus nerve (Field, 2010). This nerve provides parasympathetic control of the heart, and vagal activation results in decreased heart rate, reduced blood pressure, and lowered cortisol levels (Porges, 2001). Vagal activity also mediates the effect of touch on increased attentiveness (Diego, Field, Sanders, & Hernandez-Reif, 2004). Increased attentiveness is typically associated with a decreased heart rate as provided by vagal

activation, and following chair massages and/or regular massage therapy, both typically developing adults and children with autism displayed lower heart rates and increased attentiveness (Field, Grizzle, et al., 1996; Field et al., 2006). Vagal tone is also higher in infants during touch synchrony with their mothers (Feldman, Singer, & Zagoory, 2010). For a review of the organization of touch receptors and their sensory neuron organization, see Abaira and Ginty (2013).

2.4. Touch and Depression

Beyond its general therapeutic effects for those experiencing stress or pain, touch also alleviates symptoms of depression and can protect against its development. For example, depressed mothers showed attenuation of their depression symptoms following regular massaging of their infants (Field et al., 1996) and adolescents experiencing chronic pain reported less depressed mood after massage therapy sessions (Suresh, Wang, Porfyris, Kamasinski-Sol, & Steinhorn, 2008). Furthermore, self-reported lower frequency of parental interpersonal touches during childhood was associated with developing depression later in life (Takeuchi et al., 2009). One explanation for touch's impacts on depression and pain involves its relationship to serotonin. Serotonin decreases the expression of substance P and other pain-causing chemicals, and lower levels of serotonin are associated with depression (Field, 2010). Touch increases serotonin levels, and this may account for some of the benefits of touch (Field et al., 2002).

2.5. Touch and Emotion

Due to touch's connections to the autonomic nervous system and related biochemistry, it is unsurprising that touch is related to emotion. Though touch is most frequently associated with feelings of "love" or pair-bonding because it can stimulate oxytocin release (Shermer, 2004), touch can communicate a variety of emotions similar to facial expressions and vocal tones

(Elfenbein & Ambady, 2002) and provides distinct emotional content from that provided by visual and aural stimulation (Schirmer & Adolphs, 2017). Going beyond the stereotype of oxytocin as prosocial bonding hormone (Bartz et al., 2010) to include a broader view of its behavioral effects including anxiety reduction, perceptual selectivity/social salience, and affiliative motivation (Bartz, Zaki, Bolger, & Ochsner, 2011), oxytocin provides another biological pathway for touch to “get under the skin” to communicate emotion. Specifically, because oxytocin may increase the salience of emotional cues, especially facial affect recognition (Shahrestani, Kemp, & Guastella, 2013) when introduced nasally to participants, oxytocin may also mediate detection of emotion via touch. Alternatively, oxytocin could lead to increased approach motivation and decreased withdrawal motivation instead of increased emotional salience (Kemp & Guastella (2011)). Regardless of whether oxytocin affects behavior through increased social salience or facilitated approach motivation, touch’s relationship to oxytocin links touch with behavioral expressions and physiological experiences of affect.

For example, in a study that measured communication of emotion via touch (but not oxytocin), participants touched only each other’s forearm in order to communicate a list of basic emotions (Hertenstein, Keltner, App, Bulleit, & Jaskolka, 2006). Those being touched chose which emotion was communicated from a forced choice list of those possible, and detected anger, fear, disgust, love, gratitude, and sympathy above chance levels. In a second study, participants were allowed to touch any appropriate part of their blindfolded co-participant’s body in order to convey emotion; those being touched were able to distinguish even more emotions in this design, including joy and sadness, than when just touched on the forearm (Hertenstein, Holmes, McCullough, & Keltner, 2009).

2.6. Physiological Linkage and the Communication of Emotion via Touch

Although there remains debate concerning autonomic specificity of emotions, studies using multivariate pattern classification demonstrate different emotions can be distinguished through distinct patterns of autonomic activity (see Friedman, 2010 for review). Such studies sometimes include indices derived from heart rate variability and impedance cardiography, which give information concerning parasympathetic and sympathetic nervous system control of the heart. Given touch's connection to vagal activity, it follows that the communication of emotion via touch could be captured through physiological variables. Specifically, touch may act in such a way as to arouse different patterns of physiological emotional response based upon how the touch is interpreted by the skin receptors.

Because touch involves a dyadic interaction, it may also lead to a greater degree of physiological linkage between the two persons touching. Physiological linkage, or the synchronization over time of physiological responses between interaction partners, has been shown to occur in strangers (Scarpa et al., 2018), but more commonly in social groups that involve touching, such as parent-child (Feldman et al., 2011), romantic partner (Levenson & Gottman, 1983), or team interactions (Järvelä, Kivikangas, Kätsyri, & Ravaja, 2013). Scarpa et al. (2018) found no difference in physiological linkage based on the content of the conversation (happy, sad, or neutral), suggesting facial and vocal tones may not be sufficient for concordance of emotion between interaction partners. However, only inter-beat intervals were examined for linkage in this study—inclusion of additional autonomic measures could demonstrate more specific individual emotional patterns as well as dynamic dyadic linkage in response to different emotional touches. Early studies in physiological linkage, such as Levenson and Gottman (1983), did examine multivariate physiological linkage using four different physiological measures (inter-beat intervals, pulse transmission time to the finger, skin conductance levels, and

general somatic activity), but used large time segments (10 second windows) for their time series analysis. This did not allow for second-by-second analysis of changes as in Scarpa et al. (2018). Regardless, because physiological linkage has been demonstrated to occur more strongly in groups of people participating in cooperative gaming or romantic/familial relationships that tend to involve touching using diverse autonomic indices such as electrodermal response (Guestello, Pincus, & Gunderson, 2006) and respiration and heart rate (Helm, Sbarra, & Ferrer, 2012), physiological linkage may be the pathway by which communication of emotion via touch occurs.

2.7. Autonomic Indices Needing Further Exploration with Physiological Linkage

Although diverse sets of autonomic indices were used in the above-cited studies of physiological linkage, none examined cardiac indicators of sympathetic nervous system activation. Because emotional expressions involve sympathetic activity (as previously indicated in physiological linkage studies including electrodermal response as a measure), sympathetic indicators that form a time series should be explored for physiological linkage analysis.

Specifically, since the IBIs serve as a time series documenting a blend of sympathetic and vagal control of the heart, looking to the same organ, the impedance cardiographic indices of pre-ejection period (PEP) and left ventricular ejection time (LVET), detailed below, can serve as time series documenting more clear sympathetic influences.

Impedance cardiography refers to a non-invasive technique in which a high frequency, low amplitude constant current of electricity is passed through the thoracic cavity (i.e., the chest; Sherwood et al., 1990). The current takes the path of least resistance through the blood, but as blood volume changes with the pumping of the heart, so too does the opposition to current flow (or impedance); as blood volume increases, impedance decreases. PEP can be derived from the signal collected from this technique and refers to the period of time from the onset of ventricular

depolarization (the Q-wave of the ECG) to the opening of the aortic valve (the start point of ejection of blood from the left ventricle and beginning of ventricular contraction; Newlin & Levenson, 1979). LVET measures the time between the end of PEP (the opening of the aortic valve) and the closing of the aortic valve; basically, the time for blood to be ejected from the left ventricle (Newlin & Levenson, 1979). Both PEP and LVET relate to sympathetic activation such that these time intervals decrease with increased sympathetic activity, primarily driven by beta adrenergic influences that increase contractility of the heart (Sherwood et al., 1990). With these measures included in a physiological linkage analysis, it would be clearer how sympathetic activation is linked in interacting partners, both in general and in response to emotional stimulation. To date, only one study has used PEP as the time series of choice for analyzing physiological linkage (Thorson & West, 2018).

3. Present Study

The goal of the present study was to examine physiological linkage as a potential mechanism for the successful communication of emotion via touch. Additionally, this study sought to replicate and extend Hertenstein et al. (2006) by including physiological measures, specifically those derived from the electrocardiogram (ECG; interbeat interval and heart rate variability) and impedance cardiography (ICG; systolic time intervals). To address this goal, female participants, unseen and unknown to each other, communicated a randomized list of twelve emotions to each other's forearm through an opaque black curtain using only touch and then recorded their responses on a laptop. While they were completing this communication task, which was performed as described in Hertenstein et al. (2006) except for the addition of neutral as an emotion, their physiology was recorded via seven electrodes.

The specific aims for the study were as follows:

1. The primary aim was to determine if physiological linkage is part of the mechanism for communication of emotion via touch. Though physiological linkage may not be the sole predictor of successful detection, it was hypothesized that higher levels of physiological linkage overall would be related to increased emotion detection accuracy.

2. To address the primary aim, it was necessary to explore the relationship between touch and linkage. Specifically, it was hypothesized that (1) increased levels of linkage should occur as the result of touch and (2) that this increase in linkage as the result of touching should predict emotion detection accuracy. Hence, the physiological linkage of dyads was assessed during the communication of the emotions and compared to the initial and second baselines as well as the recovery periods between each emotion presentation.

4. Method

4.1. Participants

Approval from the Virginia Tech partner Institutional Review Boards, Western Institutional Review Board and later BRANY, was obtained. Because physiological linkage has been shown to occur to a greater extent in women, at least with stranger dyads (Scarpa et al., 2018), only female participants over the age of 18 were recruited. This restriction also avoided the need to recruit the larger sample needed to examine gender interactions. Prior studies of communication of emotion via touch have had sample sizes of around 200 (e.g., Hertenstein et al. 2006), but this was to obtain adequate power for the ANOVA testing the influence of gender composition of the dyad on emotion detection accuracy. Because the main analysis for this study (PL) involved dynamic linear times series regression analysis, which relies on length of time rather than number of participants for adequate power, the “N” size had to be set to a sufficient length of time (each second as an “n”). Linkage has been demonstrated in interactions lasting 30 minutes (1800 seconds; Thorson & West, 2018); the current study’s paradigm exceeded this length, with sessions lasting a minimum of 3736 seconds to a maximum of 4907 seconds ($M=4298.57$, $SD=256.99$).

However, the sample size still needed to be sufficient for the final multiple regression analyses predicting emotion detection accuracy from PL, so the target sample size was 100 participants (50 dyads), based on a G*Power analysis demonstrating a need for 92 participants to obtain a medium effect (.15) at $\alpha=.05$ and power=.80 for a multiple regression analysis with five predictors (corresponding to PL overall, PL during first and second baseline, PL during emotion communication, and PL during recovery). Recruitment occurred via flyers posted in Williams

Hall and dorms, advertisements posted to the Graduate Life Center weekly email listserv, and through the Virginia Tech SONA participant management system.

Of the 711 people who completed at least some portion of the prescreen, 322 were invited to participate in the study. Overall, 124 signed up for the study, but only 104 had usable data, due to Mindware or Qualtrics crashing during the experimental session. The participants ranged in age from 18 to 29 ($M=19.88$, $SD=1.62$) and included 101 undergraduates and 3 graduate students (refer to Table 1 for participant characteristics). Exclusion criteria included endorsing the presence of any cardiovascular (e.g. atrial fibrillation) or neurological (e.g., stroke) conditions, or self-reported regular use of nicotine or drug abuse.

Prior to participation in the lab portion of the study, participants received instructions for study preparation. The emailed instructions included their assigned role (communicator or receiver), instructions of when to arrive and to which room (receiver and communicator arrived at different times and at different rooms to conceal their identities), and reminders to wear loose clothes and abstain from consumption of caffeine for six hours and from food for two hours prior to arriving for the session.

Participants were compensated for participation in a pro-rated fashion. Full credit (0.5 points of extra credit to be applied to any applicable Psychology class through SONA) was given for any level of completion of the online prescreen, but those who did not complete it fully or who met exclusion criteria were not invited to the lab session. Participants received 0.5 for arriving at the lab, another 0.5 for completing the first round of emotion communication, and the last 0.5 for finishing the second round of emotion communication (for a total of 1.5 extra credits points for the in-lab session and 2.0 points for the entire study).

4.2. Prescreen and Self-Report Measures

Students interested in participating completed an online prescreen to gather demographic information and determine eligibility before coming to the lab. In addition to demographic and information about general physical and mental health, specific questionnaires assessing variables that could impact the physiological variables, linkage, or touch manipulation were administered to control for those variables or for exclusion purposes as described.

4.2.1. Demographic Information. The Virginia Tech SONA system includes an online prescreen which gathers demographic information from study participants including age, race/ethnicity, biological sex, gender identity, sexual orientation, substance use, and prescription medication. This prescreen information was used in addition to the Mind-Body Laboratory Health History Questionnaire (Appendix A) to determine study eligibility, specifically biological sex and gender identity, as only female participants were invited to participate in the study.

4.2.2. Mind-Body Laboratory Health History Questionnaire. When participants enrolled in Part 1 (the online portion) of the study on SONA, after completing the prescreen they were asked to complete this questionnaire addressing history or current presence of significant medical or psychiatric conditions. Those endorsing the presence of any cardiovascular (e.g. atrial fibrillation) or neurological (e.g., stroke) conditions or the regular use of nicotine or drug abuse were excluded from the study. This limited the number of variables to control, especially those demonstrated to have an impact on cardiac health, as the physiological variables collected in this study focus on autonomic cardiac control. Prescription medications and other physical and mental health conditions were addressed statistically, rather than serving as exclusion criteria.

4.2.3. The Liebowitz Social Anxiety Scale (LSAS; Fresco et al., 2001; Appendix B). Though potential participants uncomfortable with touch likely self-selected out of the study, participants with social anxiety were still eligible to participate. The MBL-HHQ asks about

specific diagnoses including anxiety disorders and social phobias, but the LSAS is the most commonly used self-report questionnaire used to assess social anxiety disorder and provided information on a continuous, rather than categorical, anxiety scale. The LSAS has good internal consistency (coefficient alpha= .94) and validity in persons with and without social anxiety disorder (Fresco et al., 2001); the internal consistency in the current study's sample was also good, $\alpha=.96$. The measure consists of 24 scenarios, such as "telephoning in public," that respondents rate according to how much fear the scenario gives them (from none to severe on a 4-point scale) and how often they avoid such scenarios (from never to usually on a 4-point scale). Social anxiety was statistically controlled using this measure.

4.2.4. Sensory Hypersensitivity Scale (SHS; Dixon et al., 2016; Appendix C). In addition to social anxiety that could have been triggered by dyadic interactions, the study involved electrodes, which could be mildly irritating to the skin, as well as physical touch, sensory sensitivity was assessed. This was done using the SHS, a 25-item self-report inventory addressing sensory sensitivity across 9 factors: allergies, heat, cold, light, pain, smell, hearing, taste, and touch (Dixon et al., 2016). The original development and validation study of the SHS with 1202 participants demonstrated adequate internal reliability, $\alpha=0.81$ (Dixon et al., 2016), though the internal consistency for the current study was poor, $\alpha=.31$. Respondents rated how much they agreed with statements such as "I suffer from allergies" using a 5-point Likert scale from strongly disagree to strongly agree. Overall score on this scale (average of all the items) was used to control general sensory sensitivity, with separate analyses focusing on the average of the three touch sensitivity items. The internal consistency for the touch items in the current study was good, $\alpha=.89$.

4.2.5. Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995b;

Appendix D). Furthermore, because chronic mood states like depression and extreme stress or anxiety impact the processing (e.g., “negativity bias,” Williams et al., 2009) and expression (e.g. blunted affect; Loas et al., 1994) of emotion, as well as confer other social risk factors (Kupferberg, Bicks, & Hassler, 2016) the DASS was included in the prescreen to control how these states and conditions might impact the results. The DASS includes 42 items that assess the three related negative emotional states of depression, anxiety, and tension/stress (Lovibond & Lovibond, 1995b). Each emotional state forms a subscale with 14 items. The items on the Depression scale assess anhedonia, devaluation of life, dysphoria, hopelessness, inertia, lack of interest or involvement in daily activities, and self-deprecation. Anxiety scale items index autonomic arousal, situational anxiety, skeletal muscle effects, and the subjective experience of anxious affect. The Stress scale assesses levels of chronic non-specific arousal including difficulty relaxing, irritability, impatience, and nervous arousal. Participants use 4-point scales from “did not apply to me at all” to “applied to me very much, or most of the time” to rate the extent to which they had experienced things like “I found myself getting upset over quite trivial things” over the past week. In a sample of 717 participants, confirmatory factor analyses demonstrated satisfactory internal consistency for each scale in addition to discriminant validity among the three constructs (Lovibond & Lovibond, 1995a). The internal consistency of each scale was good in the current study as well, $\alpha=.96$ for Depression, $\alpha=.93$ for Stress, and $\alpha=.90$ for Anxiety.

4.2.6. The Mind-Body Laboratory Recent Health History Questionnaire (R-HHQ;

Appendix E). This questionnaire assessed whether participants complied with the request to abstain from non-prescribed substances, caffeine, alcohol, food, and vigorous exercise before the

study for the time periods described below in section 4.3. If a participant reported using such substances within the allotted time, a note was made on the files with their participant code.

Because excluding them from the study would have led to the need to reschedule with the second participant and two research assistants, they were allowed to participate and all failures to follow the abstention requests were statistically analyzed to determine if they affected target variables of interest. This questionnaire additionally asked about other variables to control for, such as sleep the night before and last menstrual cycle.

4.3. Physiological Measures

Physiological signals were collected using MindWare Technologies Ltd. software and hardware (MindWare Technologies Ltd., Gahanna, OH). The signals from the MindWare Mobile PDAs were amplified and integrated as analog data by the mobiles before reaching a laptop computer in the control room next to the experimental room via Wi-Fi. The ECG signal and ICG dz/dt and Zo signals were amplified and digitally sampled at 1000 Hz using MindWare BioLab 3.3.0 software (MindWare Technologies Ltd., Gahanna, OH). This software was employed and the “x-axis” movement channel selected to detect and remove movement artifact. Both ECG and ICG were collected with MindWare conductive Ag/AgCl adhesive pre-gelled electrodes (refer to Appendix F for a diagram of the electrode placement). All physiological measures were collected in real time and then visually examined and exported from MindWare HRV Analysis 3.1 and IMP Analysis 3.1 software in five-minute intervals to prepare for statistical analyses.

4.3.1. Electrocardiogram (ECG). ECG was measured using a Lead II electrode configuration in which electrodes are placed on the thorax: one below the right collar bone and one on the bottom of the left ribcage (a ground is also placed on the bottom of the right ribcage). Distances between the peaks of the QRS complex in the ECG signal (R-spikes) were detected

using MindWare HRV Analysis 3.1 software in order to derive inter-beat interval (IBI) values, the distance between two consecutive R-spikes, from the ECG signal. The HRV Analysis 3.1 software also computed mean heart rate and heart rate variability (HRV) measures. Values for very low, low, and high frequency heart rate variability were obtained using spectral analysis of the ECG signal and yielded variability in various frequency bands (0.003-0.040 for very low frequency, 0.040-0.120 for low frequency, and 0.120-0.400 Hz for high frequency) using a Fast-Fourier Transform function to derive power (ms²). Baseline values of the power in each frequency band were then converted with a natural logarithm transformation to normalize them.

High frequency heart rate variability (hfHRV) and RMSSD, a time-based proxy for hfHRV (also natural log-transformed), were regarded as indexes of vagal activity. These were calculated and extracted in addition to the IBI series for the entire experiment (used in linkage analyses) in case baseline vagal activity also predicted emotion detection accuracy. Just as hfHRV and RMSSD were extracted for exploratory analyses examining the potential impact of baseline vagal activity, low (LF) and very low frequency (VLF) HRV were calculated and extracted to determine the potential impact of baroreflex activity and the renin-angiotensin system respectively. However, LF and VLF HRV power are not pure indexes of either baroreceptor or renin-angiotensin system activity (Shaffer & Ginsberg, 2017). LF HRV is produced by both sympathetic and parasympathetic influences in addition to blood pressure regulation via baroreceptors, while VLF HRV power stems from yet-to-be determined physiological mechanisms that include the renin-angiotensin system, but also thermoregulatory and endothelial effects, among others (Shaffer & Ginsberg, 2017).

4.3.2. Impedance cardiography (ICG). Noninvasive thoracic impedance measurements were taken using a standard tetrapolar electrode configuration with two electrodes placed on the

chest (at the top and bottom of the sternum) and two on the spine (1.5 inches above and below the electrodes on the sternum). The impedance waveform (ΔZ) and dz/dt waveforms were derived in real time by BioLab 3.3.0. The dZ/dt waveform, as analyzed by the IMP Analysis 3.1 software, provided average PEP, LVET, cardiac output, and stroke volume values. Average values were extracted in 5-minute intervals (corresponding to the time period of each baseline). The researcher attempted to export the values between each B point in the dZ/dt signal and the q value of the corresponding heart beat's QRS complex from the ECG signal to form a time series of PEP values, as well as the values between each X value and B point in the dZ/dt signal for continuous LVET values for linkage analysis; however, this option is not available in the IMP Analysis software. The IMP Analysis 3.1 software used the ECG signal in conjunction with the dZ/dt signal derived in real time to form an ensemble average of all the R-spikes (starting 200 ms before each R-spike and lasting a total 750 ms) and used this along with a portion of the dZ/dt signal to locate the B, Z (also known as C), and X landmarks. The B-point was located using the percent of dZ/dt Time+C option, while the X point was estimated using the Framingham LVET windowing option. The distance between the front electrodes was also entered into the analysis.

4.4. Laboratory Procedure

Participants were invited as described above. To ensure that participants did not see each other's facial expressions during the communication of emotions or learn each other's identities, the participant randomly selected as the receiver received instructions in their email asking them to come to the session 10 minutes early. This allowed the receiver to be ready behind the curtain in the experimental room when the communicator arrived in the control room. This masking of the facial expressions was necessary because studies have demonstrated that emotional facial expressions impact the perception of touch (Ravaja, Harjunen, Ahmed, Jacucci, & Spapé, 2017).

In the experimental room, the receiver received a verbal description of the informed consent and could ask any questions. Following the answering of their questions, they received a paper copy of the informed consent to sign. After granting consent, a research assistant administered the Mind-Body Laboratory Recent Health History Questionnaire (R-HHQ) via Qualtrics on a laptop.

Following the administration of this questionnaire, the research assistant attached seven electrodes to the receiver's torso. These included one on the collarbone and one on the bottom of each rib (three total for electrocardiogram) and one on the top and bottom of sternum and two on the spine (four total for impedance cardiography). Leads from each electrode were attached to a Mindware Mobile device, which the participant clipped to a belt loop or waist band or placed in their pocket. Before each electrode was attached, the area for attachment was wiped with a 70% isopropyl alcohol with pumice electrode prep pad. The research assistant checked the electrocardiogram and impedance signals on a laptop with Biolab 3.3.0 software in the control room to ensure proper attachment. Once proper attachment was ensured, the receiver was seated behind a curtain where they could not be seen from the door in view of the camera that was synched with the physiological recording through Biolab 3.3.0. The research assistant also provided the receiver with a sheet outlining the dictionary definition of the emotions to be communicated in the study, and verbally confirmed that the receiver knew what each of these emotions were and could distinguish in words between each emotion listed.

Meanwhile, in the control room, a second research assistant conducted the same consent procedure and electrode attachment with the communicator with a second Mindware mobile device. The communicator was also given a randomized list of twelve emotions on paper to communicate to the receiver before entering the experimental room, of which the research assistant had an electronic copy. This emotions list also contained their definitions and the

communicator's comprehension of each emotion definition was assessed, as with the receiver. The emotions listed included anger, fear, happiness, sadness, disgust, surprise, love, gratitude, sympathy, and none of these choices is correct/neutral (neutral appeared in the list three times), following Hertenstein et al. (2006). That study also included embarrassment, pride, and envy, but obtained null results, so those emotions are not included in the present study. Love, gratitude, and sympathy are prosocial emotions that Hertenstein and colleagues demonstrated to be more reliably communicated by touch than facial or vocal expressions, hence their inclusion. The option "neutral" was always listed as the first emotion to get a baseline effect of touch with no other emotional content. Neutral appeared on the list two additional times randomly, allowing for the added instructions "Some emotions will be presented more than once" to keep the process of selecting the emotion from becoming easier over the course of the experiment via process of elimination. The communicator was free to communicate the emotion however she believed would best convey the emotional expression without using any sensory modality besides forearm touch.

Once the communicator entered the room with the receiver and was seated, both were instructed to sanitize their hands and forearms before being read instructions about the experimental session. A 5-minute baseline of physiological activity was then simultaneously recorded for the communicator and receiver. The communicator was then signaled by the research assistant to begin communicating the emotions via touch, one at a time from the given list to the forearm of the receiver that the receiver had placed through a hole in the curtain and rested on the arm of the communicator's chair. Each expression lasted one minute; a research assistant stated when the minute time period ended. After each emotion communication, the research assistant presented a list of the possible emotions on a laptop screen from which the

receiver chose which emotion was communicated, including the option “none of these items are correct.” Following the question in which they selected a word label for the emotion, the receiver also rated the emotion communicated on two Likert scales about valence (very unpleasant to very pleasant) and intensity (not at all intense to very intense). Inclusion of these Likert scale questions allowed for comparison of the accuracy of emotion detection based on discrete label versus on the relevant axes of the circumplex model (pleasantness and activation/degree of arousal; Russell, 1980). A one-minute recovery period then commenced before the next emotion communication. The research assistant ensured the receiver’s responses were recorded until all twelve emotions (anger, fear, happiness, sadness, disgust, surprise, love, gratitude, sympathy, and neutral three times) were communicated.

After the communication of the twelfth emotion, the participants switched roles. The communicator placed her forearm through the curtain to the receiver’s side. The receiver-turned-communicator then received the same instructions as the communicator did at the beginning of the session. Another five-minute baseline was collected before the communication of the twelve emotions using a new randomized list (still including neutral as the first emotion, with two other instances of neutral mixed in). Once the second round of communication of emotions took place, the original communicator was led back to the control room to commence physiological equipment removal and debriefing. The research assistant who stayed in the experimental room to give instructions debriefed and removed equipment for the original receiver. Before leaving, the height and weight of each participant was recorded in the experimental room to derive body mass index (BMI). The original receiver’s measurements were taken first; they were then thanked and once they had left the hallway the communicator’s measurements were taken. The

communicator was then thanked for their participation and extra credit compensation was provided online to both participants after the communicator had departed.

4.5. Data Analyses

4.5.1. Emotion detection accuracy. Accuracy of emotion detected was calculated by summing the number of times the receiver accurately chose the emotion communicated over all emotions (specifically, number of correct emotions detected over 12 and multiplied by 100). Before proceeding with the physiological linkage analyses, the detection accuracy percentages were examined to determine if detection occurred above chance levels. Chance level was set at 25% for these binomial tests as suggested by Frank and Stennett (2001) and used by the prior studies of communication via touch. Setting the chance level at 25% rather than 1/10 for the options given made the test more conservative but accounted for the fact that some emotion words are so similar that participants were not truly choosing from the whole list at any time. Furthermore, as demonstrated by the circumplex model of emotion (Russell, 1980), most emotions can be placed within the four quadrants formed by the axes pleasant-unpleasant and aroused-unaroused. Because of this, emotion detection accuracy was also assessed based on the accurate placing of the emotions along each of these axes and into the quadrants created by them. For example, according to the circumplex model, happiness should fall in the upper right quadrant; it has some intensity (the term used in place of arousal in this study) and a positive valence. So, participants should have rated intensity as greater than not at all and valence as greater than neutral to receive correct detection scores for intensity (arousal) and valence if the emotion communicated was happiness,. To receive a correct score for quadrant, both valence and intensity had to be rated correctly. These accuracy scores were also converted into percentages,

with chance level set to 25%. Assessing the quadrant accuracy allowed for testing the circumplex model by comparing this accuracy to that obtained from selecting discrete emotion words.

4.5.2. Physiological linkage analyses. Because past studies of physiological linkage demonstrated no impact of a different emotional communication on linkage (Scarpa et al., 2018), even if emotions were not detected above chance levels, physiological linkage assessment was still planned to occur to determine if physiological linkage occurs in response to touch at all (aim 2.1). To assess physiological linkage, dynamic time series modeling as described by Scarpa et al. (2018) was used. The first step of this modeling procedure is to transform the “quasi time series” of IBI, PEP, and LVET into equi-spaced, second-by-second time series. For the IBI series, this was completed as such: if a heartbeat of length x milliseconds started at or before the beginning of second t and ended at or after the end of second t , then the $IBI(i,t)$ was equated to x . If, however, a heartbeat of length x ms ended during second t and a heartbeat of length y ms began (but did not end) during this second, then the $IBI(i,t)$ was equated to $\alpha x + (1-\alpha)y$, where α was the fraction of second t which was prior to the end of the heartbeat with length x . Because the time-series data were not normally distributed, they were natural log-transformed to normalize them. Once the IBI series was converted into an appropriate equi-spaced time series, separate equations, one for each participant in the dyad (with the initial communicator being participant C and the initial receiver being participant R) were computed to determine the degree to which each participant’s physiology affected their future as well as their partner’s future IBI values.

These equations are model regressions estimated using OLS procedures of the form $IBI_C(i,t) = \Phi_{CC}(B)IBI_C(i,t) + \Phi_{CR}(B)IBI_R(i,t) + \alpha_{C,I} + \beta_{C,it} + \sum \gamma_{Cj}D_{Cj(i,t)} + u(i, t)$ for predicting the average natural log IBI of participant C of a dyad based upon their own past IBI length (“own-effect” lag structure: $(\Phi_{CC}(B))$ and partner’s past IBI length $(\Phi_{CR}(B))$ where terms of the type

$\Phi_{CC}(B)$ represent a distributed lag structure going back p periods (number of seconds) as a p th degree polynomial in the lag operator (B). Nonzero values for the lag structure coefficients indicate the presence of physiological linkage. These equations also include participant-specific (fixed-effects-style) intercepts ($\alpha_{C,i}$) and linear time trends ($\beta_{C,it}$) and dummy variables ($D_{Cj(i,t)}$) for each “type” of event occurring in the experiment (first baseline, touching with no emotional content, emotion communications with participants in their initial roles, recovery periods during the first round of emotion communications, second baseline, emotion communications after the participant switch, recovery periods after the participant switch, and time between tasks, such as when the emotion detection survey was being completed) to control for variation in the population means of the dependent variables (the average natural log IBI for that participant) across the experimental situations. These dummy variables’ beta values were tested for statistical significance along with the interactions of these task-specific dummy variables with the lagged values of participant C and participant R’s IBIs for inclusion in the final model equations. Significance of these interaction terms indicated if that “task” affected linkage. In order to test the statistical significance of these equations across all fifty-four dyads with usable data, the coefficient estimates of the lagged IBI variables were averaged using pooled estimation techniques and 95% confidence intervals computed using nonparametric bootstrap Monte Carlo methods with 1000 simulated datasets. The lag structure was extended for a maximum of 10 seconds, as was done in Scarpa et al. (2018); this eliminates apparent serial correlation in the models’ fitting errors. However, lag structures extending up to 60 seconds were examined.

The significance of the lag structure coefficient estimates from the pooled estimation were used as a guide for which linkage coefficients to use from each dyad’s set of two equations to predict emotion detection accuracy. Specifically, only coefficients that were significant in the

pooled estimation from the first lagged second for both the communicator and receiver were pulled from the equation set for each dyad as potential predictors. For a description of which coefficients met this criteria, see the Regression Analyses Supplement in Appendix G. Of the coefficients collected, only their absolute values were used (as the linkage coefficients could be negative and only their magnitude was of interest). The average coefficient values for those coefficients with multiple lag values were computed. Due to the complete extent of the linkage being masked by only pulling these particular coefficients, the number of significant lagged seconds in each task by lagged natural log IBI of partner interaction up to lag 10 was summed for each dyad. The number of linked seconds across all time periods was also summed. The individual linkage coefficient magnitudes, their averaged values, and the total of linked seconds by task and across the entire experiment for each dyad were all used as potential predictors in multiple regression equations of emotion detection accuracy. These regression equations were calculated for the entire dataset, as well as for communicators and receivers independently.

4.5.3. Control variables. Several variables were collected or computed as potentially needing statistical control in the analyses. Specifically, the LSAS, SHS, and DASS were collected during the prescreen to control for social anxiety, touch and overall sensory hypersensitivity, depression, general anxiety, and stress. Scores on the LSAS were computed by summing the values of the rating for each question. These numeric scores were also translated into different categories of severity of social anxiety (no social anxiety, 0-29; mild, 30-49; moderate, 50-64; marked, 65-79; severe, 80-94; and very severe, greater than 95). For the SHS, the values of the rating for each question were averaged for a total score. The three questions regarding touch sensitivity were also averaged separately to form a touch hypersensitivity measure. These averages were translated into categories of “not sensitive” (less than 3),

“somewhat sensitive” (between 3 and 4), and “sensitive” (greater than 4). The DASS was scored per the instructions in its manual (Lovibond & Lovibond, 1995b), yielding three subscale values. The numeric scores for depression, anxiety, and stress were translated into severity categories from normal to extremely severe for each subscale. The quantitative versions of the scores on each of these were entered as predictors in regression equations predicting emotion detection accuracy and the linkage coefficient variables to determine if they impacted either the independent or dependent variables of interest in the experiment. The categorical versions of the scores were entered into ANOVAs with emotion detection accuracy variables as dependent variables to see if there were mean differences in these outcomes based on severity category.

In addition to the above, participants indicated in the prescreen if they had any medical or psychiatric conditions. Before the experiment on the MBL RHHQ, they reported whether they complied with the abstention requests (in regard to alcohol, non-prescription medications, food, caffeine, and exercise), the amount of sleep they got the night before, and what phase of the menstrual cycle they were currently experiencing. All of these have the potential to affect physiological variables. For many of these, t-tests were performed to determine if there were mean differences in emotion detection or linkage coefficients between those who complied with the abstention requests versus not or who had a medical or psychiatric condition or not. Phase of the menstrual cycle was entered into an ANOVA for the same purpose. Those variables that did not indicate any impact on emotion detection or linkage were not used as covariates in the final regression equations predicting emotion detection from linkage, and those that did were entered as covariates.

Lastly, because participants could possibly infer the race of their experimental partner from the skin tone of their partners' forearm, a variable was created categorizing dyads as

“mixed” or “same”-race dyads based on the self-reported race/ethnicity of each member of the dyad. For example, if both participants reported their race/ethnicity as White/Caucasian, this was categorized as a same-race dyad; however, if one participant listed their race/ethnicity as Asian American/Asian Origin/Pacific Islander or selected multiple race/ethnicity categories and the second participant listed their race ethnicity as White/Caucasian, this was categorized as a mixed race dyad. T-tests were performed to determine if there were mean differences in emotion detection or linkage coefficients between those in same versus mixed race dyads.

5. Results

For descriptive statistics of emotion detection accuracy variables; linkage coefficients and other physiological variables including very low, low, and high frequency heart rate variability and RMSSD; LSAS, SHS, and DASS scores and severity categories; and abstention rates, refer to Tables 2 through 5.

5.1. Emotion Detection Results

5.1.1. Discrete emotion word detection accuracy. Participants had a mean percentage accuracy score of 54.97% ($SD=23.06\%$); on average, participants selected the correct emotion word for 6.60 ($SD=2.77$) of the twelve emotions that were communicated to them. Binomial tests with the probability of “success” set to chance level (25%) indicated that the null hypothesis should be rejected for all twelve emotions—the proportion of “successful” detections was significantly higher than 25%, $p<.001$. The range of percentage accuracy was 0-100%. Overall, eight participants did not have an emotion detection accuracy percentage greater than 25%. Each of these participants were the randomly assigned initial receiver for their dyad.

5.1.2. Valence detection accuracy. All participants had a valence accuracy percentage greater than 25%. On average, participants had a valence percentage accuracy of 63.22% ($SD=15.73$) and detected the correct valence for 7.59 ($SD=1.89$) of the twelve emotions they received. Binomial tests with the proportion of “success” set to chance level (25%) indicated that the null hypothesis should be rejected for all twelve emotions’ valences—the proportion of “successful” valence detections was significantly higher than 25%, $p<.001$. The minimum valence percentage accuracy was 25%, with a maximum of 91.67% (corresponding to a range of 3-11 correct valences detected).

5.1.3. Intensity detection accuracy. Participants had the highest intensity detection accuracy out of all the detection accuracies assessed, with an average percentage detection accuracy of 81.25% (SD=10.69), corresponding to 9.75 correct intensities detected from the twelve emotions communicated. Percentage intensity detection accuracy ranged from 41.67% to 100%, or 5 to 12 correct intensities detected. Binomial tests indicated that the proportion of successful intensity detections was greater than chance level (25%), $p < .001$.

5.1.4. Quadrant detection accuracy. Participants had a mean quadrant percentage accuracy score of 52.48% (SD=16.00%); on average, participants selected the correct quadrant for 6.30 (SD=1.92) of the twelve emotions that they received. Binomial tests with “success” set to chance level (25%) indicated that the proportion of “successful” quadrant detections was significantly higher than 25%, $p < .001$. The range of quadrant percentage accuracy was 8.33-83.33%, corresponding to 1 to 10 quadrants correctly detected. Three participants did not have a quadrant detection accuracy percentage greater than 25%.

5.2. Physiological Linkage Results

5.2.1. Pooled estimation. Two pooled regression equations using OLS procedures were estimated using the data from all fifty-one dyads with usable data. These two equations are as follows (specific values of the coefficients and their significance can be found in Table 6):

Equation 1 (predicting the average natural log IBI of the initial communicator, “IBI” refers to the natural log transformed IBI in all terms): $IBI_C(i,t) = \Phi_{CC}(B)IBI_C(i,t) + \Phi_{CR}(B)IBI_R(i,t) + \alpha_{C,I} + \beta_{C,it} + \sum \gamma_{Cj}D_{Cj(i,t)} + \sum \gamma_{Cj}D_{Cj(i,t)} \Phi_{CR}(B)IBI_R(i,t) + \sum \gamma_{Cj}D_{Cj(i,t)} \Phi_{CC}(B)IBI_C(i,t) + u(i, t)$

Equation 2 (predicting the average natural log IBI of the initial receiver): $IBI_R(i,t) = \Phi_{RR}(B)IBI_C(i,t) + \Phi_{RC}(B)IBI_C(i,t) + \alpha_{R,I} + \beta_{R,it} + \sum \gamma_{Rj}D_{Rj(i,t)} + \sum \gamma_{Rj}D_{Rj(i,t)} \Phi_{RC}(B)IBI_C(i,t) + \sum \gamma_{Cj}D_{Cj(i,t)} \Phi_{RR}(B)IBI_R(i,t) + u(i, t)$

These equations contain the following terms as described previously: participants' own past IBI length ("own-effect" lag structure: $(\Phi_{CC}(B))$ and partner's past IBI length ($(\Phi_{CR}(B))$) where terms of the type $\Phi_{CC}(B)$ represent a distributed lag structure going back p periods (number of seconds) as a p th degree polynomial in the lag operator (B); participant-specific (fixed-effects-style) intercepts ($\alpha_{C,i}$), linear time trends ($\beta_{C,it}$), and dummy variables ($D_{C_j(i,t)}$) for each "type" of event occurring in the experiment; and the interactions of the task-specific dummy variables with the lagged values of participant C and participant R's IBIs.

5.2.2. Linkage equations for predicting communicator IBIs. Separate OLS regression equations of the same form as used for the pooled estimation predicting the natural log IBIs for each dyad's communicator were also calculated. From these equations, based on the results of the pooled regression, the absolute values of the following coefficients were collected for use in the regression equations predicting emotion detection accuracy: lags 1 and 2 of the receiver's IBIs predicting the communicator's, lags 1-4 of the interaction of the second baseline dummy variable with the receiver's IBIs, and lag 1 of the interactions between the receiver's IBIs and the neutral touch-only communication dummy variable, first round of emotion communication dummy variable, and first and second rounds of recovery periods dummy variables. These coefficients were not significant in all dyads. Values of all the coefficients and their significance values in the regression equations for the communicators is available upon request as a supplemental material. As described in section 4.5.2., the number of linked seconds across all the interactions between the receiver's IBIs and experimental tasks predicting the communicator's IBIs was summed. The average number of linked seconds (the average number of seconds the receiver's IBIs predicted the communicator's IBIs across all tasks) was 11.27 (SD=5.28). For a summary of the maximum, minimum, and average number of linked seconds per each task, see

Table 3. This table also contains the descriptive statistics for the linkage coefficients' absolute values.

5.2.3. Linkage equations for predicting receiver IBIs. Just as with the communicators, separate OLS regression equations predicting the natural log IBIs for the receivers were also calculated and the same set of coefficients was pulled for later use based on the pooled regression results. Values of all the coefficients and their significance values in the regression equations for the receivers is available upon request as a supplemental material. The number of linked seconds across all the interactions between the communicator's IBIs and experimental tasks predicting the receiver's IBIs was also summed with an average number of linked seconds equal to 12.04 (SD=5.93). For a summary of the maximum, minimum, and average number of linked seconds per each task and the descriptive statistics for the linkage coefficients' absolute values, see Table 3.

5.3. Control Variable Results

5.3.1. Prescreen control variables. Multiple linear regression equations with LSAS; DASS Depression, Anxiety, and Stress subscales; and SHS total and touch scores entered as predictors indicated no significant effect of these variables on emotion word, valence, or intensity detection accuracy values; $F(6, 97)$, all $p > .05$. However, SHS touch score was a significant predictor of quadrant detection accuracy, $\beta = .27$, $p = .03$ and the entire multiple regression equation was significant; $F(6, 97)$, $p = .045$, $R^2 = .12$. Hence, SHS touch score was controlled for in final regression models predicting quadrant detection accuracy.

The same quantitative total scores of the prescreen surveys were entered as predictors in multiple regression equations predicting the absolute values of the selected linkage coefficients (lags 1 and 2 of the receiver's IBIs predicting the communicator's and vice versa, lags 1-4 of the

interaction of the second baseline dummy variable with the other participant's IBIs, and lag 1 of the interactions between the other participant's IBIs and the neutral touch-only communication dummy variable, first round of emotion communication dummy variable, and first and second rounds of recovery periods dummy variables) and the sum of lagged seconds per task. No other regression models were significant except that predicting the number of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during the "neutral" emotion communication (touch alone), $F(6, 95)$, $p=.046$, $R^2=.12$. The only significant predictor was DASS Depression score, $\beta= -.32$, $p=.046$.

However, even though the model was not significant for predicting any other linkage dependent variable, some prescreen measures did predict various linkage indicators; specifically, LSAS predicted the absolute value of the lag 2 linkage coefficient for the communicator predicting the receiver's IBIs ($\beta= -.26$, $p=.045$); DASS Anxiety predicted the absolute value of the lag 1 linkage coefficient for the communicator predicting the receiver's IBIs during the "neutral" emotion communication (touch alone, $\beta= -.37$, $p=.043$); DASS Stress predicted the number of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline ($\beta= -.41$, $p=.045$) and the number of significant linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first round of emotion communication ($\beta=.47$, $p=.022$); SHS total score predicted the absolute value of the lag 3 and lag 4 linkage coefficients for the receiver predicting the communicator's IBIs ($\beta=.29$, $p=.023$ and $\beta=.27$, $p=.036$) and the number of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first baseline ($\beta=.26$, $p=.044$); and SHS touch predicted the sum of significant linked seconds of the receiver's IBIs predicting the communicator's IBIs across all tasks ($\beta= -.26$, $p=.044$). Hence, because all the prescreen survey measures were

associated with some aspect of linkage, these were all retained as covariates in final regression models predicting emotion detection accuracy (of all types).

ANOVAs using the severity categories for LSAS; DASS Depression, Anxiety, and Stress subscales; and SHS total and touch scores indicated no significant mean differences in emotion word, valence, intensity, or quadrant detection accuracy values based on severity. T-tests examining mean differences in the emotion detection and linkage variables based on whether participants indicated a psychological or other medical disorder on the prescreen only found a mean difference in the number of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first round of emotion communication, $t(100) = -2.80$, $p = .006$. The mean number of linked seconds was significantly higher in those who indicated a psychological or medical disorder ($n = 17$, $M = 2.33$, $SD = 2.13$) versus those who did not ($n = 87$, $M = 1.12$, $SD = 1.44$).

5.3.2. Abstention request and R-HHQ results. T-tests examining potential mean differences in the emotion detection and linkage variables based on whether participants complied with each abstention request indicated mean differences in several linkage variables, but no mean differences in emotion detection variables. All participants abstained from alcohol, so the grouping variables were based on abstention of caffeine, food, and exercise. For caffeine (abstained=85, did not abstain=17), the mean absolute value of the lag 1 linkage coefficient for the receiver predicting the communicator's IBIs during the first round of recovery periods ($M = .04$, $SD = .04$ for abstained, $M = .03$, $SD = .03$ for did not abstain) and the mean number of linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first round of emotion communication ($M = 1.43$, $SD = 1.68$ for abstained, $M = .59$, $SD = .94$ for did not abstain) were significantly higher in those who abstained, $t(100) = 2.02$, $p = .046$ and $t(100) = 2.90$, $p = .006$.

For food (abstained=52, did not abstain=50), the mean absolute value of the lag 1 linkage coefficient for the communicator predicting the receiver's IBIs during the first round of emotion communication was higher in those who did not abstain ($M=.08$, $SD=.07$) versus those who abstained ($M=.05$, $SD=.05$), $t(100) = -2.06$, $p=.042$. For exercise (abstained=98, did not abstain=4), the mean number of linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first round of emotion communication was higher in those who abstained ($M=1.08$, $SD=1.39$) versus those who did not abstain ($M=.00$, $SD=.00$), $t(100) = 7.71$, $p<.001$. For each of these t tests, in order to account for the differences in the number of abstainers and non-abstainers, Levene's test for equality of variances was computed. If the variances were not equivalent, the t test was recomputed to account for this difference.

ANOVAs with phase of the menstrual cycle as independent variable indicated no significant mean differences in emotion word, valence, intensity, or quadrant detection accuracy values. However, the mean absolute value of the linkage coefficient for lag 1 of the communicator's IBIs predicting the receiver's IBIs during the second baseline was higher in those on birth control with no period versus those in the middle of their menstrual cycle and higher in those at the end of their menstrual cycle versus in the beginning or middle, $F=5.27$, $p=.002$.

5.3.3. Same versus mixed race dyad results. Thirty dyads were mixed race, while twenty-one dyads were same race. T-tests indicated that intensity accuracy percentage was higher in same versus mixed race dyads ($M=83.33$, $SD=10.29$ in same, $M=78.40$, $SD=10.68$ in mixed), $t(102)=2.37$, $p=.02$. In terms of the linkage variables, t-tests indicated that the mean number of linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first round of emotion communication ($M=.97$, $SD=1.21$ in same, $M=1.76$, $SD=1.97$ in mixed),

the mean number of linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first round of emotion communication ($M=.80$, $SD=1.29$ in same, $M=1.38$, $SD=1.45$ in mixed), and the mean sum of linked seconds of the communicator's IBIs predicting the receiver's IBIs across all tasks ($M=10.93$, $SD=5.45$ in same, $M=13.62$, $SD=6.30$ in mixed) were higher in mixed versus same race dyads; $t(102)=-2.01$, $p=.047$; $t(102)=-2.33$, $p=.02$; $t(102)=-2.13$, $p=.03$; and $t(102)=-2.30$, $p=.02$, respectively. However, the mean absolute value of the linkage coefficient for lag 1 of the receiver's IBIs predicting the communicator's IBIs during the second round of recovery periods ($M=.06$, $SD=.05$ in same, $M=.04$, $SD=.04$ in mixed) was higher in same race dyads, $t(102)=3.79$, $p<.001$. For a summary of the significant t-test results, see Table 7.

5.4. Regression Results

An initial multiple regression equation predicting emotion word accuracy percentage from all linkage variables (all absolute values of the lagged seconds for each participant predicting the other and the interactions of these with the dummy variables, as well as the sum of significant lagged linked seconds per each task and overall) indicated the following linkage variables as significant predictors: the absolute values of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs overall and the linkage coefficients for lag 3 and 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline and the sum of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch only and the second round of emotion communication. Valence accuracy percentage was predicted by the absolute values of the linkage coefficients for lags 1, 3, and 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline. Intensity accuracy percentage was predicted by the absolute value of the linkage coefficient for lag 1 of

the communicator's IBIs predicting the receiver's IBIs overall. Quadrant accuracy percentage was predicted by the absolute values of the linkage coefficient for lag 1 of the communicator's IBIs predicting the receiver's IBIs overall and the linkage coefficients for lag 3 and 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline. Hence, for the final regression models predicting each form of emotion detection accuracy, only these were entered along with the prescreen survey measures quantitative scores (LSAS, SHS total and touch scores, and DASS subscale scores), the presence or absence of a psychological or medical disorder, whether or not abstention requests were followed, and the racial composition of dyad as covariates as they demonstrated a relationship with one or more linkage variables.

The final regression models entered predictors in blocks, with the prescreen survey scores entered first, followed by abstention requests, followed by racial composition of the dyad, and lastly the relevant linkage variables. The final equations were as follows:

$$\text{Emotion word detection accuracy} = B_0 + B_1(\text{DASS Stress}) + B_2(\text{DASS Anxiety}) + B_3(\text{Depression}) + B_4(\text{SHS touch score}) + B_5(\text{SHS total score}) + B_6(\text{LSAS}) + B_7(\text{Psychological or medical condition}) + B_8(\text{Caffeine abstention}) + B_9(\text{Food abstention}) + B_{10}(\text{Exercise abstention}) + B_{11}(\text{Racial composition}) + B_{12}(\text{sum of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch only}) + B_{13}(\text{sum of significant linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second round of emotion communication})$$

The absolute value of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs overall and the absolute values of the linkage coefficients for lag 3 and lag 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline were tested for inclusion, but were not significant and therefore removed. The overall model was not significant,

$F(13, 88)=1.52, p=.13$, with an $R^2=.18$. None of the control variables were significant predictors, though both linkage predictors were, $\beta_{12}=.26, p=.02$ and $\beta_{13}=.22, p=.03$.

Valence detection accuracy: No final regression equation was found for valence detection accuracy. The overall model and individual predictors were not significant.

Intensity detection accuracy= $B_0 + B_1(\text{DASS Stress}) + B_2(\text{DASS Anxiety}) + B_3(\text{Depression}) + B_4(\text{SHS touch score}) + B_5(\text{SHS total score}) + B_6(\text{LSAS}) + B_7(\text{Psychological or medical condition}) + B_8(\text{Caffeine abstention}) + B_9(\text{Food abstention}) + B_{10}(\text{Exercise abstention}) + B_{11}(\text{Racial composition}) + B_{12}(\text{absolute value of the linkage coefficient for lag 1 of the communicator's IBIs predicting the receiver's IBIs overall})$

The overall model was approaching significance, $F(12, 89)=1.81, p=.058$, with an $R^2=.20$. None of the control variables were significant predictors except for racial composition, $\beta_{11} = -2.64, p=.01$; the absolute value of the linkage coefficient for lag 1 of the communicator's IBIs predicting the receiver's IBIs overall was also significant, $\beta_{12}=.21, p=.04$.

Quadrant detection accuracy: No final regression equation was found for quadrant detection accuracy. The overall model and individual predictors were not significant; however, the initial model with only the prescreen surveys entered was significant, $F(6, 95)=2.38, p=.035$, with SHS touch score as only significant predictor, $\beta=.271, p=.03$.

All B, beta, standard error, significance, and R^2 change values can be found in Table 8.

5.4.1. Regression results (communicators only). Multiple regression equations predicting the emotion word, valence, intensity, and quadrant accuracy percentage were calculated individually for communicators and receivers. For communicators, the following predictors were significant for emotion word accuracy percentage: the absolute values of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs overall,

the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs during the second baseline, and linkage coefficients for lag 1 and 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline, along with the number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch alone. Valence accuracy percentage was predicted by the absolute value of the linkage coefficient for lag 3 of the receiver's IBIs predicting the communicator's IBIs during the second baseline, the number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first and second baselines, touch alone, the first round of recovery periods, and the second round of emotion communication, and the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first and second round of recovery periods and across all tasks. No significant predictors emerged for intensity accuracy percentage. Quadrant accuracy percentage was predicted by the absolute values of the linkage coefficient for lag 1 of the communicator's IBIs predicting the receiver's IBIs overall and the linkage coefficients for lag 3 and 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline, along with the number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second round of emotion communication and the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs across all tasks.

Along with the same covariates and the predictors entered in blocks as mentioned in the equations for all participants, the final regression models for communicators only are:

$$\textit{Emotion word detection accuracy} = B_0 + B_1(\text{DASS Stress}) + B_2(\text{DASS Anxiety}) + B_3(\text{Depression}) + B_4(\text{SHS touch score}) + B_5(\text{SHS total score}) + B_6(\text{LSAS}) + B_7(\text{Psychological or medical condition}) + B_8(\text{Caffeine abstention}) + B_9(\text{Food abstention}) + B_{10}(\text{Exercise abstention}) +$$

B_{11} (Racial composition)+ B_{12} (absolute value of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs during the second baseline).

The absolute value of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs overall and the absolute values of the linkage coefficients for lag 1 and lag 4 of the receiver's IBIs predicting the communicator's IBIs during the second baseline along with the number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch alone were tested for inclusion, but were not significant and therefore removed. The overall model was significant, $F(16, 34)=2.05, p=.046$, with an $R^2=.39$. Presence of a psychological or medical disorder was a significant predictor, $\beta_7=.37, p=.02$, as was the absolute value of the linkage coefficient for lag 2 of the communicator's IBIs predicting the receiver's IBIs during the second baseline, $\beta_{12}=-.30, p=.049$.

Valence detection accuracy= B_0 + B_1 (DASS Stress)+ B_2 (DASS Anxiety)+ B_3 (Depression)+ B_4 (SHS touch score)+ B_5 (SHS total score)+ B_6 (LSAS)+ B_7 (Psychological or medical condition)+ B_8 (Caffeine abstention)+ B_9 (Food abstention)+ B_{10} (Exercise abstention)+ B_{11} (Racial composition)+ B_{12} (absolute value of the linkage coefficient for lag 3 of the receiver's IBIs predicting the communicator's IBIs during the second baseline)+ B_{13} (number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the first baseline)+ B_{14} (number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline)+ B_{15} (number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch alone)+ B_{16} (number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second round of emotion communication)+ B_{17} (number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs overall)+

B_{18} (number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first round of recovery periods)+ B_{19} (number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during the second round of recovery periods)+ B_{20} (number of significant lagged linked seconds overall) The overall model was not significant, $F(20, 30)=1.02$, $p=.47$, with an $R^2=.40$. Only the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs overall and the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during the first round of recovery periods were significant, $\beta_{17}=.47$, $p=.03$ and $\beta_{18}=.42$, $p=.04$, but the other linkage variables were retained as when they were removed from the model, these two were no longer significant.

Intensity detection accuracy: No final regression equation was calculated for intensity detection accuracy as no significant predictors were found in the preliminary equations without control variables.

Quadrant detection accuracy: No final regression equation was found for quadrant detection accuracy. The overall model and individual predictors were not significant; however, the initial model with only the prescreen surveys entered was significant, $F(6, 44)=2.76$, $p=.02$, with DASS Stress and DASS Depression subscale scores as the only significant predictors, $\beta = -1.07$, $p=.002$ and $\beta=.68$, $p=.007$.

All B, beta, standard error, significance, and R^2 values can be found in Table 9.

5.4.2. Regression results (receivers only). For receivers only, the absolute values of the linkage coefficient for lag 2 of the receiver's IBIs predicting the communicator's IBIs overall and the linkage coefficient for lag 3 of the receiver's IBIs predicting the communicator's IBIs during the second baseline predicted emotion word accuracy percentage. Valence accuracy

percentage was predicted by the number of lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second round of recovery periods and the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during touch alone. Intensity was predicted by the number of lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline. Lastly, quadrant accuracy was predicted by the number of lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline and second round of recovery periods and the number of significant lagged linked seconds of the receiver's IBIs predicting the communicator's IBIs during touch alone.

Along with control variable covariates and all predictors entered in blocks as before, the final regression models for receivers only are:

Emotion word detection accuracy: No final regression equation was found for emotion word detection accuracy. The overall model and individual predictors were not significant.

Valence detection accuracy: No final regression equation was found for valence detection accuracy. The overall model and individual predictors were not significant; however, SHS touch score was a significant positive predictor in all models.

Intensity detection accuracy = $B_0 + B_1(\text{DASS Stress}) + B_2(\text{DASS Anxiety}) + B_3(\text{Depression}) + B_4(\text{SHS touch score}) + B_5(\text{SHS total score}) + B_6(\text{LSAS}) + B_7(\text{Psychological or medical condition}) + B_8(\text{Caffeine abstention}) + B_9(\text{Food abstention}) + B_{10}(\text{Exercise abstention}) + B_{11}(\text{Racial composition}) + B_{12}(\text{number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline})$

The overall model was not significant, $F(12, 38)=1.21, p=.31$, with an $R^2=.28$. The number of significant lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during the second baseline was the only significant predictor, $\beta_{12} = -.40, p=.02$.

Quadrant detection accuracy: No final regression equation was found for quadrant detection accuracy. The overall model and individual predictors were not significant; however, the initial model with only the prescreen surveys entered was significant, $F(6, 44)=2.40, p=.04$, with DASS Anxiety subscale score ($\beta = -.55, p=.03$), SHS touch score ($\beta=.36, p=.04$), and LSAS score ($\beta=.40, p=.045$) as significant predictors.

All B, beta, standard error, significance, and R^2 change values can be found in Table 10.

5.5. Other Physiological Variable Results

All other physiological variables collected (mean heart rate; RSA; respiration rate; RMSSD; very low, low, and high frequency heart rate variability power and peak power frequencies; and the LF/HF ratio) during the first and second baseline were entered into multiple regression equations predicting emotion word, valence, intensity, and quadrant detection accuracy as exploratory analyses. BMI, presence of a psychological or medical disorder, and the abstention criteria served as covariates. None of these models were significant; only the models for emotion word and intensity detection accuracy had any significant predictors. For emotion word detection accuracy $F(29, 74)=1.18, p=.28$, these were presence of a psychological or medical disorder ($\beta=.26, p=.03$) and baseline 1 low frequency heart rate variability peak power frequency ($\beta=.28, p=.02$). For intensity detection accuracy $F(29, 74)=1.28, p=.20$, these were BMI ($\beta=.27, p=.02$) and baseline 2 RSA ($\beta=.77, p=.04$).

Because the impedance cardiography data could not be analyzed as a time series for linkage analyses, the baseline 1 and 2 average PEP and LVET values as well as the change in

these from baseline 1 to baseline 2 were entered as predictors in a multiple regression equation along with BMI, presence of a psychological or medical disorder, and the abstention criteria as covariates. None of these models were significant.

6. Discussion

The primary goal of the present study was to examine physiological linkage as a mechanism for the communication of emotion via touch. To address this aim, it was first necessary to determine if communication via touch occurred, thereby replicating Hertenstein et al. (2006). Results confirmed that communication of emotions via touch did occur. Detection was successful more than half of the time, whether that was detecting the word, valence, intensity, or quadrant of the circumplex model in which the emotion would fall. Hence, emotion detection occurred well above chance levels, consistent with Hertenstein et al. (2006). Participants were better on average at detecting the discrete emotion words than the emotion quadrant. However, they were much better at placing the emotions along the respective axes (valence and intensity) of the circumplex model. All of the eight participants who had emotion word percentage accuracy scores less than 25% were the initial receivers in the experiment, indicating that communicators may have struggled with how to communicate emotions in the first round, but that the experimental emotion communication task became easier once participants switched roles (because initial receivers could mimic their partner's communications once they switched roles, increasing initial communicators' chances of choosing the correct emotion). This consequence is also supported by the observation that all participants with a 100% emotion word detection accuracy score were initial communicators.

Once it was shown that emotion communication via touch occurred above chance levels, it was then necessary to examine if physiological linkage occurred in response to touch and if this increase in linkage led to increased emotion detection accuracy. Based on the pooled estimation results, physiological linkage occurred consistently for two lags across the experiment and did increase as the result of touch. The longest consistent lagged linkage occurred during

touch alone (up to four consecutive linked seconds of one participant's IBIs predicting the other participant's IBIs versus two for any other experimental task). The greatest number of significant linked seconds and the highest linkage coefficients also occurred during touch alone.

However, although longer and stronger linkage occurred during touch alone, there was little difference in the magnitude of the linkage coefficients or the number of significant linked lagged seconds between emotion communication and recovery periods. This lack of difference may be due to differences in motion during the emotion communication; the communicator would be relatively active, while the receiver sat passively, unlike during touch alone. As such, increases in the communicator's heart rate may have impacted the degree of linkage possible. The linkage persisting into recovery, though, may indicate that touch facilitates linkage beyond that which occurs acutely in response to touch, whether during emotion communication or alone. This impression is also supported by linkage increasing between the first and second baseline. There were no signs of linkage at baseline in receivers, but in the second baseline, there were two significant linked seconds of the communicators' IBIs predicting the receivers' IBIs. Similarly, while there were two linked seconds in the first baseline (but not from the first lagged second) for communicators, this increased to five linked seconds (and from lag 1) in the second baseline for receivers' IBIs predicting the communicators' IBIs.

On average, there were more significant lagged seconds of the communicator's IBIs predicting the receiver's IBIs than vice versa. This disparity indicates that the initial communicator had a greater impact on physiological linkage, which may be because they were the initial "transmitters" of information. The lowest magnitude linkage coefficients and lowest number of linked seconds occurred during the second round of emotion communication. These low linkage values may indicate that communicators were using a different mechanism (other

than physiological linkage) to complete the task: namely, as mentioned before, receivers may have communicated emotions back to communicators in the same manner as they received them. Hence, the communicator focused on their memories of how they communicated each emotion, rather than on the touch itself and the communication it was transmitting.

However, based on the final regression models predicting emotion detection accuracy from the linkage variables, continued linkage through the second round of emotion communication played a role in successful emotion word detection accuracy in addition to strong initial linkage during touch alone. The significant number of lagged linked seconds of the communicator's IBIs predicting the receiver's IBIs during touch alone and the second round of emotion communication were the only significant predictors of emotion word detection accuracy. Linkage overall was also important, as successful intensity detection accuracy was predicted by the magnitude of the lag 1 linkage coefficient for the communicator's IBIs predicting the receiver's IBIs across all tasks.

Splitting the data into results for initial communicators and receivers separately revealed that different linkage variables determined successful emotion detection for each. For communicators only, emotion word detection accuracy was predicted by the absolute value of the lag 2 linkage coefficient of their own IBI's predicting the receiver's IBIs during the second baseline. The communicators' emotion detection accuracy being predicted by their own IBIs' influence on the receiver's IBIs further indicates communicators were driving the linkage between the two participants and that persistence of strong linkage values into the second baseline helped the communicator detect emotions once participants switched roles. However, communicators' valence detection accuracy was predicted by the number of significant linked lag seconds of the receivers' IBIs predicting their IBIs overall and during the first round of

recovery periods, meaning some feedback from the receiver was necessary, even while they were the participant communicating the emotions. For just receivers, only intensity accuracy was predicted by a linkage variable, specifically the number of significant lagged link seconds of the communicators' IBIs predicting their IBIs during the second baseline. Overall, linkage seems to increase as the result of touching. However, the increase in linkage resulting from touch is not a good predictor of emotion detection accuracy. Stronger and sustained physiological linkage across tasks is a better predictor of successful emotion communication. Although it could be assumed that the strong and sustained linkage resulted from touching (because the participants had no other form of interaction or communication with each other and touch alone had the longest and strongest linkage), this speculation requires further study. Time spent together and/or spent touching seems to be particularly important in regard to increasing linkage. This increased linkage, in turn, impacts emotion detection accuracy. Final regression equations indicated stronger impacts of linkage in communicators versus receivers. Communicators began the emotion detection task after at least 36 minutes spent together and 12 minutes of touching, demonstrating the importance of time spent/together or spent touching.

Several control variables were also noteworthy in their impact on linkage variables and emotion detection accuracy. SHS touch score positively predicted quadrant detection accuracy; being hypersensitive to touch stimuli increased detection of the correct emotion. However, SHS touch score also negatively predicted the number of significant linked seconds of the receiver's IBIs predicting the communicator's IBIs across all tasks, suggesting the benefit in quadrant detection accuracy from hypersensitivity to touch did not use physiological linkage as a mechanism. Sensory hypersensitivity in general did predict increased linkage coefficient magnitudes in addition to increased linked seconds during baseline, suggesting that

hypersensitive individuals may be better able to pick up on physiological signals of interaction partners. As expected, anxiety, social anxiety, and depressive symptoms (as measured by the LSAS and DASS Anxiety and Depression subscales) affected the results. Higher levels of anxiety, social anxiety, and depression resulted in lower levels of physiological linkage. Stress, however, had a mixed relationship with linkage; it was associated with decreased linkage during baseline, but increased linkage during the first round of emotion communication.

Also as expected, abstention from caffeine, food, and exercise for the required time before the study resulted in higher levels of physiological linkage because the abstaining participant's physiology was more susceptible to the influence of the other participant's physiology without the presence of these variables that impact individual heart rate and therefore potential noise in the linkage relationship. Caffeine decreases (Pincomb et al., 1985, Pincomb et al., 1987), while food (Horio, 2000) and exercise increases heart rate, and therefore affect IBI length—potentially washing out the subtle effects from a partner's physiology. Linkage was also higher in participants on birth control and/or at the end, rather than the beginning or middle, of the menstrual cycle. Estradiol enhances vagally mediated baroreceptor control of heart rate (Tanaka et al., 2003) and is higher in women on birth control and in the preovulation through the luteal phases of the menstrual cycle (which would have been the phases of the menstrual cycle the participants selecting “end” would have been in). Hence, this increased linkage may have been influenced by increases in baroreceptor sensitivity. Those participants indicating the presence of a psychological or medical disorder demonstrated higher mean linked lagged seconds of the communicator's IBIs predicting the receiver's IBIs during the first round of emotion communication. Though it is completely speculative, perhaps participants with these conditions are more vulnerable to influence by their interaction partner.

Lastly, because participants could potentially infer the race of their fellow participant based upon the other's skin tone (or at least difference in skin tone from their own), the racial composition of dyads was examined for potential effects on linkage or emotion detection accuracy. The racial composition of the dyad significantly predicted intensity detection accuracy, with intensity detection accuracy being higher in same versus mixed race dyads. Research documents differences in touch types (hand versus non-hand, cross-sex or same sex) and frequency across different cultures (Dibiase & Gunnoe, 2010; Remland, Jones, & Brinkman, 2010), so it may be that same race dyads have more similar touch expressions for specific emotion communications. However, four different indices of linkage were stronger in dyads with mixed racial composition. These differences in linkage could be the result of increased physiological arousal in both interaction partners; interracial contact can be stressful for both parties (Trawalter, Richeson, & Shelton, 2009).

7. Conclusions

Two previous studies indicated that touch can communicate distinct emotions (Hertenstein et al., 2006; Hertenstein et al., 2009). The current study corroborates these findings, but also examined how touch communicates emotions. As hypothesized, physiological linkage plays a role. Larger magnitude linkage coefficients across a longer amount of time predicted emotion detection accuracy. Because the only interaction the two participants had was via touch, these higher levels of linkage that facilitated successful emotion communication must have resulted from touch. Hence, physiological linkage likely is part of the mechanism responsible for touch's ability to communicate distinct emotions. However, other factors also play a role, such as memory (how the interaction partner previously communicated that specific emotion), social convention (how a specific emotion is communicated in naturalistic settings, such as a high five to convey excitement at a job well done), individual differences in emotion and social communication and processing (as could be affected by depression and social anxiety), and the addition of facial and vocal expressions in the emotional display (since emotions are normally conveyed in these modalities in addition to touch).

The study did have several limitations that should be acknowledged. First, the effect of memory on successful emotion detection accuracy once participants switched roles was not controlled. Depressive/anxious symptoms on the day of the experimental session was not assessed. Touch sensitivity was evaluated by self-report alone, rather than using more precise measures such as monofilament force detection (Bell-Krotoski et al., 1993). Generalizability was limited by the exclusion of male participants and the limited age range of the sample. Also, the degree to which the results generalize to participants known to each other is unknown. Although the participants were limited to healthy young adult women in order to maximize the likelihood

of successful emotion detection and stronger linkage between strangers, this precluded examination of emotion communication via touch and physiological linkage in men, same versus opposite sex dyads, in different age groups, and in different relationships (stranger, friend, romantic partner, etc.). Understanding the complete mechanism for how communication of emotion via touch occurs requires understanding how physiological linkage and emotion detection accuracy change over time, specifically along with changes in variables such as sensitivity of touch receptors in the skin or length of relationship with interaction partner.

7.1. Future Directions

Many future directions exist for research and incorporation of touch into therapy. First, in terms of research, data from the current study should be further examined. Specifically, in the spirit of replication, the videos of the participants communicating the emotions via touch should be coded and shown to new participants to see if they can correctly detect the emotion being communicated in the scenes as was done in Hertenstein et al. (2006). The videos would be coded based on the type of touch used to communicate each emotion (hitting, squeezing, stroking, shaking, trembling, etc.), alone and in combination. These codes would then be compared to that found by Hertenstein et al., 2006 to see if participants used the same techniques to communicate the emotions. These videos could then be edited to focus in on the forearms of participants and shown to a new set of participants who would try to correctly detect the emotion being communicated by touch in the video.

Beyond using the data for further validation of Hertenstein et al. (2006), the physiological linkage data should also be re-analyzed. There are many models of physiological linkage besides dynamic linear time series modeling as was used in the current study and by Scarpa et al. (2018). For example, a common model is the stability and influence model, which can be used

with raw and reactivity scores (Thorson, West, & Mendes, 2018). A new package for R, entitled “rties,” can be used to estimate linkage using this model or using the coupled linear oscillator model (Butler & Barnard, 2019). Both provide parameters for latent profile analysis to characterize the linkage (e.g., phase versus anti-phase and amplifying versus damping). These profiles can impact individual health and global relationship quality (Butler, 2015). The IBI data from the current study could be reanalyzed using rties to determine if specific latent profiles relate to emotion detection accuracy. Other modeling techniques for physiological linkage have also been described, including tips for modeling trend, concurrent, and lagged synchrony that could also be used in reanalyzing the data (Helm et al., 2018).

Furthermore, beyond completing additional analyses with the data already collected, this study could also be replicated with male participants, participants of different age groups, participants in different kinds of relationships, objective measures of touch sensitivity, time series versions of PEP and LVET, and full body touch. Inclusion of men could change results; women initiate more touching and are involved in more touching than men (Jones, 2009), and have greater linkage in stranger dyads (Scarpa et al, 2018). Hence, women may perform better at the emotion communication task because of greater familiarity with touch expressions and increased ability to synchronize physiological signals. Furthermore, both men and women tend to engage in more opposite-sex than same-sex touch (Jones, 2009), so a mixed-sex dyad may lead to even better performance as the touch display may be more natural. Hertenstein and Keltner (2010) found differences in emotion communication via touch based on the reanalysis of data from Hertenstein et al. (2006): happiness was only successfully communicated in all-female dyads, while anger was only detected if one dyad member was male, and sympathy was only detected if one dyad member was female. Hertenstein et al. (2009) also showed the importance

of full body touch for successful emotion communication, especially for successful detection of prosocial emotions. Full body touch allows for more naturalistic touch displays of emotions (such as hugging), but also could lead to greater degrees of physiological linkage (given the greater number of touch receptors being stimulated and feeding back to the vagus).

Communication of emotion via touch in romantic couple versus stranger dyads has been explored, with romantic couples successfully communicating more emotions (Thompson & Hampton, 2010), perhaps because of increased linkage; this remains to be examined. As mentioned above, PEP, and especially LVET, have been neglected as measures used for physiological linkage analysis. Extending the current study to include these variables as time series, as opposed to averages, could yield interesting insights into sympathetic nervous system synchrony. Thorson and West (2018) demonstrated using PEP that people with greater physiological linkage to their partners in sympathetic nervous system responses are less stable in their individual responses, making their physiology “vulnerable” to social influences.

In this case, it is clear why different linkage profiles influence individual health and relationship outcomes: stress (related to autonomic activity and corresponding heart rate and contractility changes) can bleed between partners, especially if one or both are more prone to linkage in PEP. Similarly, increased linkage could lead to positive influence on an interaction partners physiology and ease communication. This harkens back to early studies of physiological linkage, which examined similarity in heart rate between patients and therapists and its influence on rapport and antagonism (Coleman, Greenblatt, & Soloman, 1956; DiMascio, Boyd, & Greenblatt, 1957). Therapists then can use physiological linkage to the advantage of their clients, especially if, as was demonstrated in the current study, those with psychological or other medical conditions are particularly vulnerable to physiological influences from their interaction

partner. However, this could take a negative turn, as the studies on marital satisfaction by Levenson and Gottman (1983, 1985) demonstrated that higher levels of linkage, particularly during periods of conflict, resulted in greater marital dissatisfaction on the day of the interaction, but not three years later. A review by Timmons, Margolin, and Saxbe (2015) found partial support for Levenson and Gottman's findings, but also summarized research indicating that linkage can be tied to positive relationship outcomes, such as connectedness. Future research on physiological linkage in relationships should focus on the type or profile of linkage as described previously in order to clarify what profiles lead to positive versus negative outcomes. These patterns between therapist and client or between clients could then be monitored in the clinic.

If further research supports the link between touch and physiological linkage, then touch should be further incorporated into treatment programs, especially with the already demonstrated positive outcomes of massage therapy for those with autism (Field et al., 2006) or depression (Field et al., 1996; Suresh et al., 2008). Given that linkage is a two-way street, this may give the treatment team even further insights into the client's symptoms and what they are feeling to serve them even better.

Touch may have been understudied as compared to the other four of the traditional five senses, but studies like these demonstrate the need for further exploration of this sense, especially as it seems inextricably "linked" to the current zeitgeist of physiological linkage. Though further research is necessary to definitively conclude touch increases linkage, it is nonetheless necessary to consider the regularity and type of touching occurring in the dyads in which linkage is studied. While people may not cognitively understand or be able to verbally express what another person is feeling, through touch, in some sense, the body seems to know.

Table 1. *Participant characteristics*

Demographic Measures	Mean±SD or N(%)
<i>Age (in years)</i>	19.88±1.62
<i>Major</i>	
Accounting & Information Systems	1 (1.00%)
Animal & Poultry Sciences	1 (1.00%)
Biochemistry	3 (2.88%)
Biology	12 (11.54%)
Engineering (all subfields)	2 (1.92%)
Business (all subfields)	3 (2.88%)
Communications	1 (1.00%)
Criminology	1 (1.00%)
Public Health	1 (1.00%)
Education	1 (1.00%)
Environmental Sciences	1 (1.00%)
Finance	1 (1.00%)
Food Science & Technology	1 (1.00%)
Forestry	1 (1.00%)
HNFE	11 (10.58%)
Human Development	12 (11.54%)
Interior Design	2 (1.92%)
Marine Fisheries & Conservation	1 (1.00%)
Marketing	1 (1.00%)
Neuroscience (all subfields)	8 (7.69%)
Psychology	17 (16.35%)
University Studies	1 (1.00%)
Double major	18 (17.31%)
Undecided	3 (2.88%)
<i>Education Level</i>	
Undergraduate	101 (97.12%)
Graduate	3 (2.88%)
<i>Gender Identity</i>	
Bigender (female and nonbinary)	1 (1.00%)
Cis female (cisgender)	5 (4.81%)
Female	93 (89.42%)
Straight	2 (1.92%)
Woman	3 (2.88%)
<i>Sexual Orientation</i>	
Lesbian	1 (1.00%)
Bisexual	3 (2.88%)
Heterosexual	100 (96.15%)
<i>Social Class (of place where grew up)</i>	
Blue collar, working class	7 (6.73%)
Lower middle class	5 (4.81%)

Middle class	43 (41.35%)
Poor, unemployed	1 (1.00%)
Poor, working class	1 (1.00%)
Upper middle class/professionals	46 (44.23%)
Wealthy	1 (1.00%)
<i>Family Annual Income</i>	
\$10,000-\$25,000	3 (2.88%)
\$25,000-\$50,000	13 (12.50%)
\$50,000-\$75,000	16 (15.38%)
\$75,000-\$100,000	22 (21.15%)
Over \$100,000	50 (48.08%)
<i>Race/Ethnicity</i>	
African American/Black/African Origin	4 (3.85%)
Asian American/Asian Origin/Pacific Islander	12 (11.54%)
Caucasian/White	75 (72.12%)
Hispanic/Latino(a)	4 (3.85%)
Middle Eastern	3 (2.88%)
Other	1 (1.00%)
Multiple races/ethnicities	5 (4.81%)
<i>Dyad Racial Composition</i>	
Same	60 (57.69%)
Mixed	44 (42.31%)
<i>Dominant Hand</i>	
Ambidextrous	1 (1.00%)
Left	8 (7.69%)
Right	95 (91.35%)
<i>Height (cm)</i>	165.15±7.40
<i>Weight (lb)</i>	147.65±33.05
<i>BMI (kg/m²)</i>	24.49±4.95

Table 2. *Emotion detection accuracy*

Type of Detection Accuracy	Mean	SD	Minimum	Maximum
Emotion Word, Sum	6.60	2.77	0	12
Emotion Word, Percentage	54.97	23.06	0	100
Valence, Sum	7.59	1.88	3	11
Valence, Percentage	63.22	15.73	25	91.67
Intensity, Sum	9.75	1.28	5	12
Intensity, Percentage	81.25	10.69	41.67	100
Quadrant, Sum	6.30	1.92	1	10
Quadrant, Percentage	52.48	16.00	8.33	83.33

Table 3. *Descriptive statistics for linkage coefficients and baseline physiological variables*

Physiological Variable	Mean	SD	Minimum	Maximum
<i>Absolute value linkage coefficients (Communicator predicting Receiver)</i>				
Overall (lag 1)	0.07	0.06	0.001	0.25
Overall (lag 2)	0.11	0.11	0.002	0.42
Second baseline (lag 1)	0.06	0.05	0.000	0.27
Second baseline (lag 2)	0.09	0.08	0.001	0.32
Second baseline (lag 3)	0.09	0.07	0.000	0.31
Second baseline (lag 4)	0.08	0.07	0.006	0.28
Touch only (lag 1)	0.13	0.10	0.003	0.37
Emotion communication (round 1, lag 1)	0.06	0.06	0.001	0.24
Recovery (round 1, lag 1)	0.05	0.04	0.001	0.19
Recovery (round 2, lag 1)	0.11	0.09	0.004	0.44
<i>Absolute value linkage coefficients (Receiver predicting Communicator)</i>				
Overall (lag 1)	0.06	0.06	0.001	0.24
Overall (lag 2)	0.08	0.07	0.002	0.36
Baseline 2 (lag 1)	0.05	0.05	0.000	0.24
Baseline 2 (lag 2)	0.10	0.08	0.003	0.41
Baseline 2 (lag 3)	0.08	0.07	0.001	0.29
Baseline 2 (lag 4)	0.08	0.08	0.001	0.36
Touch only (lag 1)	0.12	0.10	0.000	0.42
Emotion communication (round 1, lag 1)	0.05	0.04	0.003	0.18
Recovery (round 1, lag 1)	0.04	0.03	0.000	0.14
Recovery (round 2, lag 1)	0.10	0.07	0.000	0.29
<i>Number of significant linked seconds (Communicator predicting Receiver)</i>				
Overall	1.00	1.09	0.000	4.00
Baseline 1	2.00	1.60	0.000	7.00
Baseline 2	1.45	1.55	0.000	7.00
Touch only	1.35	1.54	0.000	6.00
Emotion communication (round 1)	1.29	1.61	0.000	8.00
Emotion communication (round 2)	0.80	0.98	0.000	4.00
Recovery (round 1)	1.18	1.55	0.000	8.00
Recovery (round 2)	0.84	0.98	0.000	4.00
Time between tasks	2.12	1.55	0.000	6.00
Across all tasks	12.04	5.93	2.000	33.00
<i>Number of significant linked seconds (Receiver predicting Communicator)</i>				
Overall	1.24	1.46	0.000	4.00
Baseline 1	1.77	1.65	0.000	6.00
Baseline 2	1.02	1.28	0.000	5.00

Touch only	1.29	1.29	0.000	5.00
Emotion communication (round 1)	1.04	1.38	0.000	5.00
Emotion communication (round 2)	0.77	1.22	0.000	4.00
Recovery (round 1)	1.12	1.39	0.000	5.00
Recovery (round 2)	1.04	1.24	0.000	4.00
Time between tasks	2.00	1.72	0.000	7.00
Across all tasks	11.27	5.28	1.000	23.00
<i>ECG Measures (Baseline 1)</i>				
Heart rate	81.80	11.33	54.714	114.67
RSA	6.11	1.09	2.707	8.49
IBI length	747.87	106.49	523.257	1096.61
Respiration rate	23.47	70.96	8.418	739.53
RMSSD	37.23	22.19	5.795	116.02
VLF power	847.79	799.54	51.695	4604.03
VLF peak power frequency	1.53	15.47	0.003	157.74
LF power	822.38	623.28	0.030	3768.81
LF peak power frequency	0.08	0.03	0.040	0.12
HF/RSA power	772.03	889.33	14.988	4846.33
HF/RSA peak power frequency	0.18	0.07	0.120	0.37
LF/HF ratio	1.91	1.81	0.153	11.53
<i>ECG Measures (Baseline 2)</i>				
Heart rate	79.20	12.89	2.742	107.76
RSA	6.34	0.95	4.132	8.72
IBI length	764.79	105.65	556.801	1163.82
Respiration rate	16.08	3.20	9.886	24.09
RMSSD	40.44	22.68	12.538	147.32
VLF power	1503.01	2388.24	93.902	22829.10
VLF peak power frequency	0.02	0.01	0.003	0.04
LF power	1238.41	1167.10	170.997	8532.10
LF peak power frequency	0.08	0.02	0.040	0.12
HF/RSA power	895.80	1019.61	62.288	6135.46
HF/RSA peak power frequency	0.18	0.07	0.120	0.37
LF/HF ratio	2.21	1.94	0.135	11.53
<i>ICG Measures (Baseline 1)</i>				
PEP	81.83	31.18	26	180
LVET	288.18	52.16	178	416
<i>ICG Measures (Baseline 2)</i>				
PEP	85.04	31.56	26	174
LVET	290.68	47.55	164	373

Table 4. *LSAS, SHS, and DASS*

Prescreen Survey	Mean	SD	Minimum	Maximum
LSAS	35.69	21.38	3	104
LSAS severity	N		Percentage (%)	
No social anxiety	47		45.2	
Mild	35		33.7	
Moderate	9		8.7	
Marked	9		8.7	
Severe	2		1.9	
Very severe	2		1.9	
SHS total	2.77	.51	1.48	4.04
SHS severity	N		Percentage (%)	
Not sensitive	75		72.1	
Some sensitivity	26		25	
Hypersensitive	3		2.9	
SHS touch	2.64	1.12	1	5
SHS touch severity	N		Percentage (%)	
Not sensitive	68		65.4	
Some sensitivity	13		12.5	
Hypersensitive	23		22.1	
DASS Depression	6.70	8.58	0	41
DASS Depression severity	N		Percentage (%)	
Normal	77		74	
Mild	9		8.7	
Moderate	7		6.7	
Severe	8		7.7	
Extremely severe	3		2.9	
DASS Anxiety	6.54	6.89	0	31
DASS Anxiety severity	N		Percentage (%)	
Normal	70		67.3	
Mild	6		5.8	
Moderate	15		14.4	
Severe	3		2.9	
Extremely severe	10		9.6	
DASS Stress	10.83	8.62	0	37
DASS Stress severity	N		Percentage (%)	
Normal	74		71.2	
Mild	9		8.7	
Moderate	13		12.5	
Severe	6		5.8	
Extremely severe	2		1.9	

Table 5. *Other control variables and abstention rates*

Control variable	N	Percentage (%)
<i>Presence of psychological or medical disorder</i>		
Yes	15	14.7
No	87	85.3
<i>Caffeine</i>		
Abstained	85	83.3
Did not abstain	17	16.7
<i>Food</i>		
Abstained	52	51.0
Did not abstain	50	49.0
<i>Exercise</i>		
Abstained	98	96.1
Did not abstain	4	3.9
<i>Phase of menstrual cycle</i>		
Birth control/no period	38	36.5
Beginning	20	19.2
Middle	23	22.1
End	23	22.1

Table 6. *Pooled estimation results*

Predictor	B	SE	t	p	95% CI LB	95% CI UB
<i>For predicting Communicator's IBIs</i>						
second1	0.002671	0.000682	3.91	0	0.001333	0.004008
second2	-0.00081	0.000812	-0.99	0.32	-0.0024	0.000784
second3	0.003451	0.001204	2.87	0.004	0.001092	0.005809
second4	0.001895	0.001168	1.62	0.105	-0.00039	0.004185
second5	-0.00154	0.000631	-2.45	0.014	-0.00278	-0.00031
second6	0.001242	0.00064	1.94	0.052	-1.2E-05	0.002496
second7	-0.00124	0.000509	-2.44	0.015	-0.00224	-0.00025
second8	0.002161	0.001027	2.1	0.035	0.000148	0.004173
second10	0.001488	0.000493	3.02	0.003	0.000522	0.002453
second11	-0.0009	0.000514	-1.75	0.08	-0.0019	0.000109
second12	-0.0008	0.000476	-1.68	0.094	-0.00173	0.000136
second13	0.00223	0.000571	3.91	0	0.001111	0.003348
second14	0.003893	0.000627	6.21	0	0.002664	0.005121
second15	0.00357	0.000665	5.37	0	0.002266	0.004874
second16	-0.00176	0.000585	-3.01	0.003	-0.00291	-0.00062
second17	-0.00111	0.000777	-1.42	0.155	-0.00263	0.000417
second18	-0.00029	0.000481	-0.6	0.55	-0.00123	0.000655
second19	0.000577	0.00052	1.11	0.267	-0.00044	0.001596
second20	0.002507	0.000728	3.44	0.001	0.001079	0.003935
second21	-0.00262	0.000518	-5.06	0	-0.00363	-0.0016
second22	-0.0041	0.001243	-3.3	0.001	-0.00654	-0.00167
second23	0.001115	0.000864	1.29	0.197	-0.00058	0.002809
second24	0.001055	0.000692	1.53	0.127	-0.0003	0.002412
second25	0.000559	0.000469	1.19	0.234	-0.00036	0.001479
second26	-0.00027	0.001079	-0.25	0.806	-0.00238	0.001849
second28	0.001059	0.00055	1.93	0.054	-1.9E-05	0.002138
second29	-0.00079	0.000588	-1.35	0.178	-0.00194	0.000362
second30	0.001098	0.000923	1.19	0.234	-0.00071	0.002907
second31	0.002915	0.000391	7.46	0	0.002149	0.003681
second32	-0.00106	0.000528	-2.02	0.044	-0.0021	-2.9E-05
second33	-0.00123	0.000809	-1.51	0.13	-0.00281	0.000361
second34	0.000123	0.00044	0.28	0.78	-0.00074	0.000986
second35	0.000339	0.000385	0.88	0.379	-0.00042	0.001092
second37	-0.0003	0.000722	-0.41	0.678	-0.00172	0.001116
second38	-0.00309	0.000721	-4.29	0	-0.00451	-0.00168

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second39	-0.00086	0.0005	-1.72	0.085	-0.00184	0.000119
second40	3.61E-05	0.000759	0.05	0.962	-0.00145	0.001524
second41	0.001462	0.000504	2.9	0.004	0.000474	0.002449
second42	-0.00296	0.0007	-4.23	0	-0.00433	-0.00159
second43	-0.00175	0.000485	-3.6	0	-0.0027	-0.0008
second44	-0.00165	0.000458	-3.6	0	-0.00255	-0.00075
second45	0.002553	0.000765	3.34	0.001	0.001054	0.004052
second46	-0.00103	0.000605	-1.7	0.089	-0.00221	0.000157
second47	-0.00069	0.001362	-0.51	0.612	-0.00336	0.001978
second48	-0.00142	0.000434	-3.27	0.001	-0.00227	-0.00057
second49	-0.00244	0.000698	-3.5	0	-0.00381	-0.00107
second50	0.003549	0.000399	8.89	0	0.002767	0.004331
second51	0.00046	0.000594	0.77	0.439	-0.0007	0.001624
second52	0.002158	0.000624	3.46	0.001	0.000936	0.003381
second53	0.001093	0.001394	0.78	0.433	-0.00164	0.003824
second54	0.003651	0.000556	6.56	0	0.002561	0.004742
pair1	-6.85403	1.595546	-4.3	0	-9.98126	-3.72681
pair2	1.943818	1.357275	1.43	0.152	-0.71641	4.604041
pair3	14.3531	2.658749	5.4	0	9.142023	19.56418
pair4	20.9268	2.832884	7.39	0	15.37442	26.47918
pair5	8.414565	1.836351	4.58	0	4.815364	12.01377
pair6	-7.77813	1.245426	-6.25	0	-10.2191	-5.33713
pair7	4.280502	1.295401	3.3	0.001	1.741549	6.819455
pair8	-8.34042	2.253931	-3.7	0	-12.7581	-3.92277
pair10	13.49985	1.348429	10.01	0	10.85696	16.14274
pair11	1.911149	1.232869	1.55	0.121	-0.50524	4.32754
pair12	4.701736	1.181339	3.98	0	2.386342	7.017129
pair13	6.710511	1.306211	5.14	0	4.150371	9.270651
pair14	7.276129	1.470523	4.95	0	4.393941	10.15832
pair15	-6.46477	1.679394	-3.85	0	-9.75634	-3.1732
pair16	11.23415	1.272526	8.83	0	8.740029	13.72826
pair17	31.06021	1.934054	16.06	0	27.26952	34.85091
pair18	5.210117	1.149049	4.53	0	2.958011	7.462223
pair19	18.3075	1.269662	14.42	0	15.81899	20.796
pair20	11.57308	1.568904	7.38	0	8.498066	14.64809
pair21	8.984	1.397419	6.43	0	6.245095	11.7229
pair22	19.62509	4.058041	4.84	0	11.67143	27.57875
pair23	22.08887	1.855142	11.91	0	18.45284	25.7249
pair24	3.76865	1.764818	2.14	0.033	0.309652	7.227648
pair25	-2.35988	1.454245	-1.62	0.105	-5.21017	0.4904
pair26	3.870048	2.890063	1.34	0.181	-1.7944	9.534496

pair28	-7.57026	1.414465	-5.35	0	-10.3426	-4.79795
pair29	17.89515	1.499774	11.93	0	14.95563	20.83467
pair30	0.110938	1.893581	0.06	0.953	-3.60043	3.822308
pair31	-12.4559	1.047172	-11.89	0	-14.5084	-10.4035
pair32	19.52509	1.445472	13.51	0	16.692	22.35818
pair33	16.77522	1.757479	9.55	0	13.33061	20.21984
pair34	12.0067	1.108554	10.83	0	9.833967	14.17944
pair35	2.462675	0.983479	2.5	0.012	0.535082	4.390267
pair37	6.514275	1.874485	3.48	0.001	2.840332	10.18822
pair38	16.13861	1.937129	8.33	0	12.34189	19.93534
pair39	2.713001	1.310414	2.07	0.038	0.144623	5.281378
pair40	11.55621	1.746176	6.62	0	8.133747	14.97867
pair41	-5.25577	1.19946	-4.38	0	-7.60668	-2.90485
pair42	17.37652	1.723861	10.08	0	13.9978	20.75524
pair43	-2.25306	1.46107	-1.54	0.123	-5.11672	0.610597
pair44	19.19481	1.235961	15.53	0	16.77236	21.61726
pair45	5.784027	1.760459	3.29	0.001	2.333573	9.234481
pair46	-5.12758	1.320118	-3.88	0	-7.71498	-2.54018
pair47	-6.39524	2.084367	-3.07	0.002	-10.4805	-2.30993
pair48	-2.01265	1.328849	-1.51	0.13	-4.61716	0.591865
pair49	10.88224	1.724212	6.31	0	7.502833	14.26166
pair50	-3.20568	1.275209	-2.51	0.012	-5.70505	-0.7063
pair51	-1.50633	1.224	-1.23	0.218	-3.90533	0.892683
pair52	19.87537	1.628527	12.2	0	16.6835	23.06724
pair53	2.063108	2.42845	0.85	0.396	-2.69659	6.822806
pair54	-4.05384	1.426354	-2.84	0.004	-6.84945	-1.25822
First baseline C	35.38966	6.663048	5.31	0	22.33025	48.44906
Second_baseline C	11.15157	4.313816	2.59	0.01	2.696603	19.60654
Touch only C	11.23577	4.279898	2.63	0.009	2.847285	19.62426
Emotion communication (round 1) C	1.153689	2.306653	0.5	0.617	-3.36729	5.674668
Emotion communication (round 2) C	36.50912	8.784492	4.16	0	19.29174	53.72649
Recovery (round 1) C	4.149616	2.521559	1.65	0.1	-0.79257	9.091805
Recovery (round 2) C	226.4631	60.63141	3.74	0	107.6271	345.2991
Time between tasks C	18.4448	8.300804	2.22	0.026	2.175441	34.71417

Cut five seconds from start of each task C	2.550296	0.823031	3.1	0.002	0.937176	4.163417
Other C	-216.837	74.79008	-2.9	0.004	-363.423	-70.2501
<i>LIBI_C</i>						
L1.	1.165664	0.006817	171.01	0	1.152303	1.179024
L2.	-0.66794	0.009405	-71.02	0	-0.68637	-0.6495
L3.	0.494518	0.009329	53.01	0	0.476233	0.512803
L4.	-0.20278	0.00963	-21.06	0	-0.22165	-0.1839
L5.	-0.00361	0.009388	-0.38	0.701	-0.02201	0.014791
L6.	0.067007	0.00912	7.35	0	0.049132	0.084883
L7.	0.021379	0.008943	2.39	0.017	0.003852	0.038906
L8.	0.049814	0.00883	5.64	0	0.032508	0.06712
L9.	-0.01585	0.008305	-1.91	0.056	-0.03213	0.000427
L10.	0.043127	0.005542	7.78	0	0.032264	0.053989
<i>LIBI_R</i>						
L1.	0.025934	0.006072	4.27	0	0.014033	0.037835
L2.	0.02528	0.008138	3.11	0.002	0.00933	0.041229
L3.	-0.00555	0.008226	-0.67	0.5	-0.02167	0.010573
L4.	0.003158	0.008501	0.37	0.71	-0.0135	0.019819
L5.	-0.0065	0.008422	-0.77	0.44	-0.02301	0.01001
L6.	0.00828	0.008161	1.01	0.31	-0.00771	0.024275
L7.	-0.01255	0.008125	-1.55	0.122	-0.02848	0.00337
L8.	0.010388	0.007846	1.32	0.186	-0.00499	0.025767
L9.	-0.00682	0.007635	-0.89	0.372	-0.02178	0.008146
L10.	0.005515	0.005343	1.03	0.302	-0.00496	0.015986
<i>First baseline*LIBI_C</i>						
L1.	-0.00052	0.001463	-0.35	0.723	-0.00339	0.002349
L2.	-0.00051	0.002068	-0.25	0.803	-0.00457	0.003537
L3.	-0.00154	0.001815	-0.85	0.395	-0.0051	0.002013
L4.	0.001973	0.001787	1.1	0.269	-0.00153	0.005476
L5.	-0.00222	0.001837	-1.21	0.227	-0.00582	0.001382
L6.	-0.00491	0.001523	-3.23	0.001	-0.0079	-0.00193
L7.	-0.0002	0.001298	-0.15	0.878	-0.00274	0.002344
L8.	0.001115	0.001258	0.89	0.375	-0.00135	0.00358
L9.	0.002958	0.001457	2.03	0.042	0.000103	0.005813
L10.	0.000348	0.001163	0.3	0.765	-0.00193	0.002627
<i>Second baseline*LIBI_C</i>						
L1.	0.037394	0.008144	4.59	0	0.021433	0.053356
L2.	-0.0562	0.011807	-4.76	0	-0.07934	-0.03306

L3.	0.005667	0.011261	0.5	0.615	-0.0164	0.027737
L4.	0.028831	0.010662	2.7	0.007	0.007934	0.049728
L5.	-0.01572	0.010129	-1.55	0.121	-0.03557	0.004132
L6.	-0.02558	0.010003	-2.56	0.011	-0.04519	-0.00597
L7.	0.024197	0.010225	2.37	0.018	0.004156	0.044237
L8.	-0.00716	0.010058	-0.71	0.477	-0.02687	0.012554
L9.	0.01559	0.00927	1.68	0.093	-0.00258	0.033759
L10.	-0.00852	0.006085	-1.4	0.162	-0.02044	0.003408
<i>Touch only*LIBI_C</i>						
L1.	-0.05557	0.01325	-4.19	0	-0.08154	-0.0296
L2.	0.03759	0.016954	2.22	0.027	0.004361	0.070819
L3.	0.054615	0.017763	3.07	0.002	0.0198	0.089431
L4.	-0.06586	0.017399	-3.79	0	-0.09996	-0.03176
L5.	0.017347	0.016266	1.07	0.286	-0.01453	0.049229
L6.	0.003529	0.015966	0.22	0.825	-0.02776	0.034822
L7.	0.014549	0.017014	0.86	0.392	-0.0188	0.047895
L8.	-0.03344	0.016937	-1.97	0.048	-0.06663	-0.00024
L9.	0.055546	0.01726	3.22	0.001	0.021717	0.089375
L10.	-0.03457	0.012884	-2.68	0.007	-0.05982	-0.00931
<i>Emotion communication (round 1)*LIBI_C</i>						
L1.	-0.01347	0.005314	-2.53	0.011	-0.02389	-0.00305
L2.	0.004912	0.007683	0.64	0.523	-0.01015	0.019971
L3.	0.012494	0.00738	1.69	0.09	-0.00197	0.026957
L4.	-0.01489	0.007517	-1.98	0.048	-0.02962	-0.00016
L5.	0.00682	0.007495	0.91	0.363	-0.00787	0.02151
L6.	0.003302	0.007359	0.45	0.654	-0.01112	0.017726
L7.	-0.00403	0.007136	-0.56	0.572	-0.01801	0.009957
L8.	-0.01064	0.007188	-1.48	0.139	-0.02472	0.003451
L9.	0.021762	0.007093	3.07	0.002	0.007861	0.035664
L10.	-0.00748	0.004867	-1.54	0.125	-0.01702	0.002063
<i>Emotion communication (round 2)*LIBI_C</i>						
L1.	0.013825	0.010148	1.36	0.173	-0.00606	0.033715
L2.	0.009777	0.015323	0.64	0.523	-0.02026	0.039809
L3.	-0.00485	0.016358	-0.3	0.767	-0.03691	0.027214
L4.	-0.00995	0.016866	-0.59	0.555	-0.04301	0.023108
L5.	0.001131	0.018622	0.06	0.952	-0.03537	0.037629
L6.	0.009658	0.01728	0.56	0.576	-0.02421	0.043527

L7.	-0.02199	0.016686	-1.32	0.188	-0.05469	0.010713
L8.	0.036942	0.015806	2.34	0.019	0.005962	0.067921
L9.	-0.03592	0.017677	-2.03	0.042	-0.07057	-0.00127
L10.	0.002086	0.014559	0.14	0.886	-0.02645	0.030622
<i>Recovery (round 1)*LIBI_C</i>						
L1.	0.022135	0.005065	4.37	0	0.012207	0.032062
L2.	-0.02484	0.007416	-3.35	0.001	-0.03937	-0.0103
L3.	-0.00033	0.00723	-0.05	0.964	-0.0145	0.013842
L4.	0.002968	0.007414	0.4	0.689	-0.01156	0.017499
L5.	-0.00114	0.00744	-0.15	0.878	-0.01572	0.013439
L6.	-0.00816	0.007166	-1.14	0.255	-0.0222	0.005887
L7.	0.01705	0.006915	2.47	0.014	0.003497	0.030603
L8.	-0.00908	0.007047	-1.29	0.198	-0.02289	0.004733
L9.	-0.00383	0.006967	-0.55	0.582	-0.01749	0.009821
L10.	0.003382	0.004762	0.71	0.478	-0.00595	0.012716
<i>Recovery (round 2)*LIBI_C</i>						
L1.	-0.05763	0.011917	-4.84	0	-0.08098	-0.03427
L2.	0.043229	0.015676	2.76	0.006	0.012504	0.073955
L3.	-0.01899	0.016641	-1.14	0.254	-0.0516	0.013629
L4.	0.018726	0.017131	1.09	0.274	-0.01485	0.052302
L5.	-0.00936	0.018672	-0.5	0.616	-0.04596	0.027238
L6.	0.000958	0.017484	0.05	0.956	-0.03331	0.035226
L7.	-0.00051	0.016957	-0.03	0.976	-0.03375	0.032724
L8.	-0.0183	0.016273	-1.12	0.261	-0.0502	0.013593
L9.	0.023658	0.017786	1.33	0.183	-0.0112	0.058517
L10.	-0.00137	0.014241	-0.1	0.923	-0.02928	0.026543
<i>Time between tasks*LIBI_C</i>						
L1.	-0.00257	0.001252	-2.05	0.04	-0.00502	-0.00011
L2.	-0.00077	0.000818	-0.94	0.345	-0.00238	0.000831
L3.	0.000369	0.0008	0.46	0.645	-0.0012	0.001937
L4.	-0.00208	0.000735	-2.83	0.005	-0.00352	-0.00064
L5.	-0.00015	0.000704	-0.22	0.828	-0.00153	0.001226
L6.	-0.0008	0.000722	-1.1	0.27	-0.00221	0.000618
L7.	-0.00099	0.000825	-1.2	0.229	-0.00261	0.000624
L8.	9.13E-05	0.000821	0.11	0.911	-0.00152	0.0017
L9.	-3.2E-05	0.000791	-0.04	0.968	-0.00158	0.001518
L10.	-4.36E-06	0.000679	-0.01	0.995	-0.00134	0.001327
<i>First baseline*LIBI_R</i>						

L1.	-0.00233	0.001447	-1.61	0.107	-0.00517	0.000503
L2.	-0.00227	0.001999	-1.14	0.255	-0.00619	0.001644
L3.	0.002059	0.001726	1.19	0.233	-0.00132	0.005442
L4.	0.001464	0.001835	0.8	0.425	-0.00213	0.00506
L5.	-0.00123	0.001974	-0.63	0.532	-0.0051	0.002635
L6.	0.005299	0.001484	3.57	0	0.002391	0.008206
L7.	0.000299	0.001283	0.23	0.816	-0.00222	0.002814
L8.	-0.00079	0.001224	-0.65	0.519	-0.00319	0.001609
L9.	-0.003	0.001445	-2.08	0.038	-0.00583	-0.00017
L10.	-0.00126	0.001185	-1.06	0.287	-0.00358	0.001061
<i>Second baseline*LIBI_R</i>						
L1.	-0.03867	0.008038	-4.81	0	-0.05443	-0.02292
L2.	0.057077	0.011714	4.87	0	0.034118	0.080037
L3.	-0.00646	0.011141	-0.58	0.562	-0.0283	0.015376
L4.	-0.02825	0.0106	-2.66	0.008	-0.04902	-0.00747
L5.	0.015328	0.01005	1.53	0.127	-0.00437	0.035025
L6.	0.024992	0.009886	2.53	0.011	0.005615	0.044368
L7.	-0.02414	0.010098	-2.39	0.017	-0.04393	-0.00435
L8.	0.008226	0.009913	0.83	0.407	-0.0112	0.027655
L9.	-0.01624	0.009171	-1.77	0.077	-0.03421	0.001739
L10.	0.007463	0.006039	1.24	0.217	-0.00437	0.0193
<i>Touch only*LIBI_R</i>						
L1.	0.052338	0.012966	4.04	0	0.026924	0.077752
L2.	-0.03554	0.016596	-2.14	0.032	-0.06807	-0.00301
L3.	-0.05316	0.017339	-3.07	0.002	-0.08714	-0.01918
L4.	0.064451	0.016989	3.79	0	0.031152	0.097749
L5.	-0.01566	0.016006	-0.98	0.328	-0.04703	0.015717
L6.	-0.00536	0.015652	-0.34	0.732	-0.03603	0.025321
L7.	-0.01453	0.016656	-0.87	0.383	-0.04717	0.018119
L8.	0.033332	0.016592	2.01	0.045	0.000812	0.065852
L9.	-0.05459	0.017142	-3.18	0.001	-0.08819	-0.02099
L10.	0.033261	0.012885	2.58	0.01	0.008007	0.058514
<i>Emotion communication (round 1)*LIBI_R</i>						
L1.	0.013746	0.005194	2.65	0.008	0.003566	0.023927
L2.	-0.00475	0.007514	-0.63	0.527	-0.01948	0.009974
L3.	-0.01206	0.007216	-1.67	0.095	-0.0262	0.002085
L4.	0.01369	0.007364	1.86	0.063	-0.00074	0.028123
L5.	-0.00661	0.007339	-0.9	0.368	-0.02099	0.007776

L6.	-0.00273	0.007188	-0.38	0.704	-0.01682	0.011358
L7.	0.003408	0.006976	0.49	0.625	-0.01026	0.01708
L8.	0.010486	0.007025	1.49	0.136	-0.00328	0.024256
L9.	-0.02147	0.006939	-3.09	0.002	-0.03507	-0.00787
L10.	0.006877	0.004777	1.44	0.15	-0.00249	0.01624
<i>Emotion communication (round 2)*LIBI_R</i>						
L1.	-0.018	0.009861	-1.83	0.068	-0.03733	0.001326
L2.	-0.00942	0.015149	-0.62	0.534	-0.03911	0.020274
L3.	0.00442	0.016137	0.27	0.784	-0.02721	0.036048
L4.	0.009315	0.016621	0.56	0.575	-0.02326	0.041892
L5.	-0.00053	0.018472	-0.03	0.977	-0.03674	0.035673
L6.	-0.00951	0.017085	-0.56	0.578	-0.043	0.023976
L7.	0.021823	0.016471	1.32	0.185	-0.01046	0.054105
L8.	-0.03703	0.015596	-2.37	0.018	-0.0676	-0.00647
L9.	0.036225	0.017527	2.07	0.039	0.001872	0.070577
L10.	-0.00246	0.014456	-0.17	0.865	-0.03079	0.025871
<i>Recovery (round 1)*LIBI_R</i>						
L1.	-0.02186	0.004998	-4.37	0	-0.03166	-0.01207
L2.	0.025042	0.007321	3.42	0.001	0.010694	0.03939
L3.	-0.00031	0.007137	-0.04	0.965	-0.0143	0.013678
L4.	-0.00311	0.007291	-0.43	0.669	-0.0174	0.011179
L5.	0.001428	0.007285	0.2	0.845	-0.01285	0.015706
L6.	0.007945	0.007025	1.13	0.258	-0.00582	0.021714
L7.	-0.01643	0.006813	-2.41	0.016	-0.02978	-0.00307
L8.	0.008543	0.006934	1.23	0.218	-0.00505	0.022134
L9.	0.003717	0.00687	0.54	0.588	-0.00975	0.017181
L10.	-0.00428	0.004703	-0.91	0.363	-0.0135	0.004939
<i>Recovery (round 2)*LIBI_R</i>						
L1.	0.022638	0.010702	2.12	0.034	0.001663	0.043613
L2.	-0.04201	0.015462	-2.72	0.007	-0.07231	-0.0117
L3.	0.017685	0.016451	1.07	0.282	-0.01456	0.049928
L4.	-0.01786	0.017009	-1.05	0.294	-0.0512	0.015474
L5.	0.00901	0.018482	0.49	0.626	-0.02721	0.045234
L6.	0.000143	0.017321	0.01	0.993	-0.0338	0.034092
L7.	-0.00129	0.016847	-0.08	0.939	-0.03431	0.031728
L8.	0.018131	0.01606	1.13	0.259	-0.01335	0.049608
L9.	-0.02212	0.017593	-1.26	0.209	-0.0566	0.012364
L10.	0.000754	0.014109	0.05	0.957	-0.0269	0.028407

<i>Time between tasks*LIBI_R</i>						
L1.	-0.00023	0.000883	-0.26	0.794	-0.00196	0.001501
L2.	0.000335	0.00081	0.41	0.68	-0.00125	0.001922
L3.	0.000156	0.000816	0.19	0.849	-0.00144	0.001756
L4.	0.001191	0.000737	1.62	0.106	-0.00025	0.002635
L5.	0.000859	0.000686	1.25	0.21	-0.00049	0.002204
L6.	0.000355	0.000683	0.52	0.603	-0.00098	0.001693
L7.	0.000902	0.00084	1.07	0.283	-0.00075	0.002548
L8.	-0.00083	0.000792	-1.04	0.296	-0.00238	0.000724
L9.	0.000941	0.000768	1.23	0.22	-0.00056	0.002446
L10.	0.000429	0.000653	0.66	0.511	-0.00085	0.00171
<i>For predicting Receiver's IBIs</i>						
second1	-0.00296	0.000768	-3.85	0	-0.00447	-0.00145
second2	0.001651	0.000806	2.05	0.04	7.27E-05	0.00323
second3	-0.00074	0.000685	-1.08	0.28	-0.00208	0.000603
second4	-0.00076	0.000541	-1.4	0.162	-0.00182	0.000304
second5	0.000644	0.000359	1.79	0.073	-6E-05	0.001348
second6	-0.00208	0.000852	-2.45	0.014	-0.00375	-0.00041
second7	0.000704	0.000625	1.13	0.26	-0.00052	0.00193
second8	-0.00082	0.000967	-0.85	0.397	-0.00271	0.001077
second10	-0.00204	0.000795	-2.56	0.01	-0.00359	-0.00048
second11	0.001708	0.000639	2.67	0.008	0.000455	0.002961
second12	0.000589	0.000504	1.17	0.243	-0.0004	0.001577
second13	-0.00171	0.000743	-2.3	0.022	-0.00316	-0.00025
second14	-0.00207	0.000481	-4.3	0	-0.00301	-0.00113
second15	-0.00088	0.001003	-0.88	0.378	-0.00285	0.001081
second16	0.000702	0.000496	1.42	0.157	-0.00027	0.001673
second17	-0.00132	0.000601	-2.19	0.028	-0.00249	-0.00014
second18	-0.00061	0.000858	-0.71	0.479	-0.00229	0.001075
second19	-0.00137	0.000562	-2.44	0.015	-0.00247	-0.00027
second20	-0.00614	0.00076	-8.09	0	-0.00763	-0.00466
second21	0.001642	0.000583	2.82	0.005	0.0005	0.002784
second22	0.000106	0.000464	0.23	0.819	-0.0008	0.001016
second23	-0.00032	0.000377	-0.86	0.391	-0.00106	0.000415
second24	0.000859	0.000503	1.71	0.088	-0.00013	0.001844
second25	0.000783	0.000525	1.49	0.136	-0.00025	0.001813
second26	0.001247	0.000469	2.66	0.008	0.000328	0.002167
second28	-0.00189	0.000445	-4.24	0	-0.00276	-0.00101
second29	0.001731	0.000532	3.25	0.001	0.000688	0.002773
second30	-0.00117	0.000688	-1.7	0.089	-0.00252	0.00018

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second31	-0.00187	0.000605	-3.09	0.002	-0.00305	-0.00068
second32	0.000456	0.000534	0.85	0.394	-0.00059	0.001502
second33	0.003382	0.000567	5.97	0	0.002272	0.004493
second34	5.63E-05	0.000419	0.13	0.893	-0.00076	0.000877
second35	-0.00135	0.000552	-2.44	0.015	-0.00243	-0.00027
second37	0.000436	0.000627	0.7	0.487	-0.00079	0.001664
second38	0.001873	0.000631	2.97	0.003	0.000636	0.003111
second39	0.000485	0.000436	1.11	0.265	-0.00037	0.001339
second40	-0.00035	0.000669	-0.53	0.599	-0.00166	0.000959
second41	-0.00127	0.000851	-1.49	0.135	-0.00294	0.000397
second42	0.001048	0.00069	1.52	0.129	-0.0003	0.002401
second43	0.000367	0.000627	0.58	0.559	-0.00086	0.001596
second44	0.000575	0.000634	0.91	0.364	-0.00067	0.001816
second45	-0.00258	0.000505	-5.12	0	-0.00357	-0.00159
second46	0.000864	0.000746	1.16	0.247	-0.0006	0.002326
second47	-0.00236	0.000616	-3.84	0	-0.00357	-0.00116
second48	0.002639	0.000689	3.83	0	0.001289	0.003989
second49	0.001398	0.001233	1.13	0.257	-0.00102	0.003814
second50	-0.00291	0.000465	-6.25	0	-0.00382	-0.00199
second51	-0.00108	0.000479	-2.26	0.024	-0.00202	-0.00014
second52	-0.00073	0.000705	-1.04	0.298	-0.00211	0.000648
second53	-0.00133	0.000564	-2.36	0.018	-0.00244	-0.00022
second54	-0.00329	0.000913	-3.6	0	-0.00508	-0.0015
pair1	8.350616	1.731065	4.82	0	4.957773	11.74346
pair2	1.77943	1.724708	1.03	0.302	-1.60095	5.159813
pair3	-3.40892	1.600865	-2.13	0.033	-6.54657	-0.27127
pair4	-18.9574	1.225157	-15.47	0	-21.3587	-16.5561
pair5	-11.4573	1.040595	-11.01	0	-13.4969	-9.41779
pair6	11.05645	1.918274	5.76	0	7.296685	14.81622
pair7	-0.94295	1.314167	-0.72	0.473	-3.51869	1.632782
pair8	17.22464	2.424805	7.1	0	12.47208	21.97719
pair10	-3.67069	1.741677	-2.11	0.035	-7.08433	-0.25705
pair11	4.560263	1.427962	3.19	0.001	1.761495	7.359032
pair12	1.376735	1.326275	1.04	0.299	-1.22273	3.9762
pair13	-2.14319	1.528889	-1.4	0.161	-5.13978	0.853389
pair14	1.541713	1.214601	1.27	0.204	-0.83887	3.922298
pair15	24.3608	2.92256	8.34	0	18.63266	30.08894
pair16	-5.04109	1.178912	-4.28	0	-7.35173	-2.73046
pair17	-29.5754	1.490514	-19.84	0	-32.4968	-26.654
pair18	-3.31966	2.103265	-1.58	0.114	-7.442	0.802689
pair19	-13.7536	1.410035	-9.75	0	-16.5173	-10.99

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pair20	-8.14728	1.408262	-5.79	0	-10.9074	-5.38712
pair21	-3.73781	1.38598	-2.7	0.007	-6.4543	-1.02133
pair22	-3.17827	1.179987	-2.69	0.007	-5.49101	-0.86552
pair23	-17.0801	1.009385	-16.92	0	-19.0585	-15.1017
pair24	10.41034	1.686025	6.17	0	7.105776	13.71491
pair25	13.75174	1.462071	9.41	0	10.88612	16.61736
pair26	2.548336	1.307103	1.95	0.051	-0.01355	5.110224
pair28	8.78796	1.08878	8.07	0	6.653979	10.92194
pair29	-12.8041	1.349504	-9.49	0	-15.4491	-10.1591
pair30	7.319992	1.470121	4.98	0	4.438594	10.20139
pair31	10.29643	1.594139	6.46	0	7.171964	13.4209
pair32	-16.7018	1.544281	-10.82	0	-19.7285	-13.675
pair33	-4.95651	1.291311	-3.84	0	-7.48745	-2.42558
pair34	-7.83014	1.121827	-6.98	0	-10.0289	-5.63139
pair35	-0.68262	1.458175	-0.47	0.64	-3.54061	2.175364
pair37	-2.77977	1.632433	-1.7	0.089	-5.97929	0.419759
pair38	-8.83959	1.644684	-5.37	0	-12.0631	-5.61605
pair39	-3.60933	1.162206	-3.11	0.002	-5.88723	-1.33144
pair40	-7.51994	1.575089	-4.77	0	-10.6071	-4.43281
pair41	13.65996	1.807943	7.56	0	10.11644	17.20348
pair42	-9.07016	1.37417	-6.6	0	-11.7635	-6.37683
pair43	-2.47321	1.476078	-1.68	0.094	-5.36628	0.419866
pair44	-18.7659	1.775546	-10.57	0	-22.2459	-15.2859
pair45	-3.66285	1.16347	-3.15	0.002	-5.94322	-1.38248
pair46	11.64258	1.97359	5.9	0	7.77439	15.51076
pair47	11.31938	1.580247	7.16	0	8.222139	14.41663
pair48	7.315776	1.923226	3.8	0	3.546302	11.08525
pair49	-4.63131	2.98795	-1.55	0.121	-10.4876	1.224993
pair50	12.08213	1.385996	8.72	0	9.365618	14.79865
pair51	5.719397	1.090955	5.24	0	3.581154	7.857641
pair52	-10.3893	1.656882	-6.27	0	-13.6367	-7.14183
pair53	7.296818	1.374007	5.31	0	4.603799	9.989837
pair54	9.678146	2.345856	4.13	0	5.080328	14.27596
First baseline R	17.48967	25.16732	0.69	0.487	-31.8376	66.81697
Second baseline R	21.63513	5.292006	4.09	0	11.26293	32.00732
Touch only R	10.17609	14.78774	0.69	0.491	-18.8075	39.15968
Emotion communication (round 1) R	14.45993	2.646158	5.46	0	9.273528	19.64633
Emotion communication (round 2) R	54.13217	6.994967	7.74	0	40.42222	67.84213

Recovery (round 1) R	11.80203	2.469342	4.78	0	6.962185	16.64188
Recovery (round 2) R	151.5339	31.24961	4.85	0	90.28552	212.7824
Time between tasks R	13.96216	3.522074	3.96	0	7.058985	20.86533
Cut five seconds from start of each task R	7.887002	0.870798	9.06	0	6.18026	9.593744
Other R	-1455.81	353.2215	-4.12	0	-2148.11	-763.501
<i>LIBI_C</i>						
L1.	0.05106	0.006562	7.78	0	0.038199	0.06392
L2.	-0.00483	0.009604	-0.5	0.615	-0.02366	0.01399
L3.	0.010118	0.009528	1.06	0.288	-0.00856	0.028793
L4.	-0.00738	0.0095	-0.78	0.437	-0.026	0.011242
L5.	-0.00347	0.009182	-0.38	0.705	-0.02147	0.014524
L6.	0.002153	0.00895	0.24	0.81	-0.01539	0.019694
L7.	-0.00188	0.008917	-0.21	0.833	-0.01936	0.015593
L8.	-0.00666	0.008531	-0.78	0.435	-0.02338	0.010066
L9.	0.010541	0.007915	1.33	0.183	-0.00497	0.026054
L10.	0.003812	0.005176	0.74	0.462	-0.00633	0.013957
<i>LIBI_R</i>						
L1.	1.092669	0.007145	152.92	0	1.078665	1.106674
L2.	-0.52747	0.010561	-49.94	0	-0.54817	-0.50677
L3.	0.375526	0.010103	37.17	0	0.355725	0.395328
L4.	-0.11707	0.00995	-11.77	0	-0.13657	-0.09757
L5.	-0.03026	0.00958	-3.16	0.002	-0.04904	-0.01148
L6.	0.061774	0.009355	6.6	0	0.043438	0.080109
L7.	0.015718	0.009071	1.73	0.083	-0.00206	0.033496
L8.	0.047318	0.00889	5.32	0	0.029894	0.064742
L9.	0.001475	0.00836	0.18	0.86	-0.01491	0.01786
L10.	0.027202	0.005473	4.97	0	0.016476	0.037927
<i>First baseline*LIBI_C</i>						
L1.	-0.00183	0.001983	-0.92	0.356	-0.00572	0.002056
L2.	0.002164	0.001989	1.09	0.277	-0.00173	0.006062
L3.	0.000549	0.002092	0.26	0.793	-0.00355	0.004649
L4.	0.000601	0.002866	0.21	0.834	-0.00502	0.006218
L5.	-0.00217	0.002298	-0.94	0.346	-0.00667	0.002338
L6.	-0.00089	0.001638	-0.54	0.586	-0.0041	0.002318
L7.	0.000395	0.001397	0.28	0.778	-0.00234	0.003133
L8.	-0.00033	0.001379	-0.24	0.81	-0.00304	0.002371

L9.	0.00099	0.001468	0.67	0.5	-0.00189	0.003866
L10.	-0.001	0.00124	-0.81	0.418	-0.00343	0.001425
<i>Second baseline*LIBI_C</i>						
L1.	-6.5E-05	0.010266	-0.01	0.995	-0.02019	0.020055
L2.	-0.00428	0.015613	-0.27	0.784	-0.03488	0.026319
L3.	0.047843	0.014541	3.29	0.001	0.019343	0.076343
L4.	-0.04576	0.0131	-3.49	0	-0.07143	-0.02008
L5.	0.021672	0.012512	1.73	0.083	-0.00285	0.046194
L6.	-0.0101	0.013966	-0.72	0.469	-0.03748	0.017269
L7.	-0.01008	0.015541	-0.65	0.517	-0.04054	0.020383
L8.	0.010463	0.014582	0.72	0.473	-0.01812	0.039042
L9.	0.000843	0.012285	0.07	0.945	-0.02323	0.024921
L10.	-0.01229	0.007249	-1.7	0.09	-0.0265	0.001916
<i>Touch only*LIBI_C</i>						
L1.	0.056298	0.014401	3.91	0	0.028073	0.084523
L2.	-0.01966	0.02026	-0.97	0.332	-0.05937	0.020045
L3.	-0.0502	0.019551	-2.57	0.01	-0.08852	-0.01188
L4.	0.041679	0.020189	2.06	0.039	0.00211	0.081249
L5.	-0.0615	0.024621	-2.5	0.012	-0.10976	-0.01324
L6.	0.06664	0.024277	2.74	0.006	0.019058	0.114223
L7.	-0.05305	0.022121	-2.4	0.016	-0.09641	-0.0097
L8.	0.008875	0.019716	0.45	0.653	-0.02977	0.047517
L9.	-0.0204	0.018088	-1.13	0.259	-0.05585	0.015053
L10.	0.027556	0.013049	2.11	0.035	0.001981	0.053132
<i>Emotion communication (round 1)*LIBI_C</i>						
L1.	0.036155	0.006133	5.89	0	0.024134	0.048176
L2.	-0.03599	0.009042	-3.98	0	-0.05371	-0.01827
L3.	-0.00926	0.008549	-1.08	0.279	-0.02601	0.0075
L4.	0.011142	0.008612	1.29	0.196	-0.00574	0.028022
L5.	-0.01059	0.008202	-1.29	0.196	-0.02667	0.005482
L6.	0.008357	0.007985	1.05	0.295	-0.00729	0.024008
L7.	-6.5E-05	0.007915	-0.01	0.993	-0.01558	0.015449
L8.	-0.00702	0.007713	-0.91	0.363	-0.02214	0.008095
L9.	-0.00423	0.007189	-0.59	0.556	-0.01832	0.009863
L10.	0.008224	0.004822	1.71	0.088	-0.00123	0.017674
<i>Emotion communication (round 2)*LIBI_C</i>						

L1.	-0.00172	0.012506	-0.14	0.891	-0.02623	0.022789
L2.	-0.00307	0.018234	-0.17	0.866	-0.0388	0.032673
L3.	-0.02325	0.016574	-1.4	0.161	-0.05573	0.009237
L4.	0.023155	0.015183	1.53	0.127	-0.0066	0.052913
L5.	-0.00246	0.014981	-0.16	0.87	-0.03182	0.026903
L6.	0.004817	0.014249	0.34	0.735	-0.02311	0.032745
L7.	-0.01594	0.013694	-1.16	0.245	-0.04277	0.010904
L8.	0.041003	0.013601	3.01	0.003	0.014345	0.06766
L9.	-0.04084	0.013954	-2.93	0.003	-0.06818	-0.01349
L10.	0.017391	0.010243	1.7	0.09	-0.00269	0.037467
<i>Recovery (round 1)*LIBI_C</i>						
L1.	-0.01371	0.00587	-2.33	0.02	-0.02521	-0.0022
L2.	0.010744	0.008728	1.23	0.218	-0.00636	0.027851
L3.	0.030019	0.008507	3.53	0	0.013346	0.046692
L4.	-0.04077	0.008839	-4.61	0	-0.0581	-0.02345
L5.	0.02865	0.008264	3.47	0.001	0.012454	0.044847
L6.	-0.00758	0.00781	-0.97	0.332	-0.02289	0.007731
L7.	-0.00132	0.007716	-0.17	0.864	-0.01645	0.013802
L8.	-0.00033	0.007423	-0.04	0.965	-0.01487	0.014222
L9.	0.003144	0.006871	0.46	0.647	-0.01032	0.016612
L10.	-0.00601	0.004611	-1.3	0.192	-0.01505	0.003026
<i>Recovery (round 2)*LIBI_C</i>						
L1.	-0.03469	0.01289	-2.69	0.007	-0.05995	-0.00942
L2.	0.006004	0.018551	0.32	0.746	-0.03036	0.042364
L3.	0.010732	0.01712	0.63	0.531	-0.02282	0.044288
L4.	-0.00311	0.015917	-0.2	0.845	-0.0343	0.028091
L5.	0.007978	0.015766	0.51	0.613	-0.02292	0.038879
L6.	-0.00999	0.014995	-0.67	0.505	-0.03938	0.019398
L7.	0.02316	0.014546	1.59	0.111	-0.00535	0.051669
L8.	-0.0305	0.014508	-2.1	0.036	-0.05894	-0.00207
L9.	0.032196	0.014777	2.18	0.029	0.003234	0.061158
L10.	-0.01471	0.010536	-1.4	0.163	-0.03536	0.005937
<i>Time between tasks*LIBI_C</i>						
L1.	-0.00027	0.000896	-0.3	0.763	-0.00203	0.001487
L2.	-0.00098	0.000933	-1.05	0.296	-0.0028	0.000853
L3.	0.000251	0.000861	0.29	0.771	-0.00144	0.001939
L4.	-0.00033	0.000786	-0.42	0.671	-0.00187	0.001207
L5.	-0.00027	0.000718	-0.38	0.708	-0.00168	0.001138
L6.	0.001947	0.000687	2.83	0.005	0.0006	0.003294

L7.	-0.00012	0.000655	-0.19	0.853	-0.00141	0.001163
L8.	-0.00098	0.000658	-1.49	0.136	-0.00227	0.000309
L9.	-0.00043	0.000716	-0.59	0.552	-0.00183	0.000978
L10.	0.001083	0.000789	1.37	0.17	-0.00046	0.002629
<i>First baseline*LIBI_R</i>						
L1.	0.002863	0.003107	0.92	0.357	-0.00323	0.008953
L2.	-0.00183	0.001944	-0.94	0.347	-0.00564	0.001982
L3.	-0.00396	0.002218	-1.79	0.074	-0.00831	0.000385
L4.	0.002012	0.002837	0.71	0.478	-0.00355	0.007572
L5.	0.00098	0.002349	0.42	0.677	-0.00362	0.005584
L6.	0.000412	0.001622	0.25	0.8	-0.00277	0.003592
L7.	-0.00105	0.001366	-0.77	0.441	-0.00373	0.001625
L8.	-0.00056	0.00135	-0.41	0.679	-0.00321	0.002088
L9.	-0.00015	0.001447	-0.1	0.918	-0.00298	0.002686
L10.	0.000416	0.001236	0.34	0.737	-0.00201	0.002838
<i>Second baseline*LIBI_R</i>						
L1.	-0.00216	0.010335	-0.21	0.834	-0.02242	0.018094
L2.	0.005081	0.015603	0.33	0.745	-0.0255	0.035662
L3.	-0.04721	0.014504	-3.26	0.001	-0.07564	-0.01879
L4.	0.045054	0.013049	3.45	0.001	0.019478	0.070629
L5.	-0.02261	0.012409	-1.82	0.068	-0.04693	0.00171
L6.	0.009863	0.013937	0.71	0.479	-0.01745	0.03718
L7.	0.009873	0.01555	0.63	0.525	-0.02061	0.040351
L8.	-0.0094	0.014532	-0.65	0.518	-0.03788	0.019084
L9.	-0.00018	0.012209	-0.01	0.988	-0.02411	0.023752
L10.	0.010295	0.007223	1.43	0.154	-0.00386	0.024451
<i>Touch only*LIBI_R</i>						
L1.	-0.05512	0.014679	-3.76	0	-0.08389	-0.02635
L2.	0.020871	0.019778	1.06	0.291	-0.01789	0.059635
L3.	0.048041	0.019284	2.49	0.013	0.010244	0.085837
L4.	-0.04035	0.020028	-2.01	0.044	-0.0796	-0.00109
L5.	0.061385	0.024272	2.53	0.011	0.013813	0.108957
L6.	-0.06994	0.023895	-2.93	0.003	-0.11677	-0.02311
L7.	0.052559	0.021826	2.41	0.016	0.009781	0.095338
L8.	-0.00727	0.019482	-0.37	0.709	-0.04546	0.030911
L9.	0.019845	0.017879	1.11	0.267	-0.0152	0.054887
L10.	-0.02711	0.012888	-2.1	0.035	-0.05237	-0.00185

<i>Emotion communication (round 1)*LIBI_R</i>						
L1.	-0.03634	0.006065	-5.99	0	-0.04823	-0.02445
L2.	0.034761	0.008922	3.9	0	0.017275	0.052247
L3.	0.009817	0.008429	1.16	0.244	-0.0067	0.026338
L4.	-0.01128	0.008504	-1.33	0.185	-0.02794	0.005391
L5.	0.010022	0.008125	1.23	0.217	-0.0059	0.025947
L6.	-0.00799	0.007897	-1.01	0.312	-0.02347	0.007486
L7.	8.23E-05	0.007806	0.01	0.992	-0.01522	0.015381
L8.	0.007138	0.0076	0.94	0.348	-0.00776	0.022034
L9.	0.004199	0.00711	0.59	0.555	-0.00974	0.018135
L10.	-0.00899	0.004777	-1.88	0.06	-0.01835	0.000371
<i>Emotion communication (round 2)*LIBI_R</i>						
L1.	-0.00323	0.012459	-0.26	0.795	-0.02765	0.021189
L2.	0.002258	0.018086	0.12	0.901	-0.03319	0.037705
L3.	0.021372	0.016427	1.3	0.193	-0.01082	0.053568
L4.	-0.02112	0.015054	-1.4	0.161	-0.05063	0.008382
L5.	0.001178	0.014896	0.08	0.937	-0.02802	0.030375
L6.	-0.00585	0.014158	-0.41	0.679	-0.0336	0.021896
L7.	0.015689	0.013594	1.15	0.248	-0.01095	0.042332
L8.	-0.04172	0.013544	-3.08	0.002	-0.06826	-0.01517
L9.	0.040419	0.013875	2.91	0.004	0.013224	0.067615
L10.	-0.01633	0.010212	-1.6	0.11	-0.03634	0.003687
<i>Recovery (round 1)*LIBI_R</i>						
L1.	0.012109	0.005829	2.08	0.038	0.000685	0.023533
L2.	-0.01044	0.008659	-1.21	0.228	-0.02741	0.006533
L3.	-0.02907	0.008418	-3.45	0.001	-0.04557	-0.01257
L4.	0.03986	0.008725	4.57	0	0.022759	0.05696
L5.	-0.02811	0.008204	-3.43	0.001	-0.04419	-0.01203
L6.	0.007623	0.007787	0.98	0.328	-0.00764	0.022886
L7.	0.001658	0.007664	0.22	0.829	-0.01336	0.01668
L8.	0.000247	0.007382	0.03	0.973	-0.01422	0.014716
L9.	-0.00353	0.006846	-0.52	0.606	-0.01695	0.009885
L10.	0.005168	0.004592	1.13	0.26	-0.00383	0.014168
<i>Recovery (round 2)*LIBI_R</i>						
L1.	0.011272	0.012825	0.88	0.379	-0.01386	0.036409
L2.	-0.00456	0.01844	-0.25	0.805	-0.0407	0.031583

L3.	-0.00984	0.017009	-0.58	0.563	-0.04318	0.023493
L4.	0.001539	0.015843	0.1	0.923	-0.02951	0.032591
L5.	-0.00768	0.015711	-0.49	0.625	-0.03848	0.023109
L6.	0.009021	0.014933	0.6	0.546	-0.02025	0.038289
L7.	-0.0226	0.014448	-1.56	0.118	-0.05092	0.005716
L8.	0.029929	0.014439	2.07	0.038	0.001629	0.058229
L9.	-0.0295	0.014645	-2.01	0.044	-0.05821	-0.0008
L10.	0.012324	0.010398	1.19	0.236	-0.00806	0.032705
<i>Time between tasks*LIBI_R</i>						
L1.	-0.0032	0.000865	-3.7	0	-0.00489	-0.0015
L2.	0.00089	0.000823	1.08	0.279	-0.00072	0.002502
L3.	-0.00022	0.000772	-0.28	0.78	-0.00173	0.001296
L4.	0.000457	0.000778	0.59	0.557	-0.00107	0.001981
L5.	0.000528	0.000717	0.74	0.461	-0.00088	0.001934
L6.	-0.00173	0.000682	-2.54	0.011	-0.00307	-0.00039
L7.	0.000652	0.000645	1.01	0.312	-0.00061	0.001916
L8.	0.001483	0.000666	2.23	0.026	0.000177	0.002789
L9.	-0.00012	0.000692	-0.17	0.862	-0.00148	0.001236
L10.	-0.00047	0.000745	-0.63	0.527	-0.00193	0.000989

Table 7. *Racial composition of dyads t-test results*

Dependent Variable	t	df	Sig. (2-tailed)	Mean difference	Higher in:
Intensity accuracy percentage	2.37	102	.02	4.92	Same race dyad
Absolute value, LIBI R predicting LIBI C, recovery (round 2), lag 1	3.79	99.71	>.001	.05	Same race dyad
Number of sig. linked seconds, LIBI C predicting LIBI R, emotion communication (round 1)	-2.33	62.32	.02	.80	Mixed race dyad
Number of sig. linked seconds, LIBI R predicting LIBI C, emotion communication (round 1)	-2.13	100	.04	.58	Mixed race dyad
Number of sig. linked seconds, LIBI C predicting LIBI R, overall	-2.30	100	.02	2.69	Mixed race dyad

Table 8. *Physiological linkage and control variables predicting emotion detection accuracy*

Predictor	B	SE	β	p	F	df	p	Adj. R ²
For Emotion Word Detection								
<i>Overall Model (Block 1)</i>					.72	(6,95)	.64	-.02
DASS_Stress	-0.224	0.556	-0.084	0.688				
DASS_Anxiety	-0.269	0.612	-0.081	0.661				
DASS_Depression	-0.128	0.444	-0.048	0.774				
SHS_touchscore	4.045	2.614	0.198	0.125				
SHS_totalscore	-2.588	5.804	-0.058	0.657				
LSAS_totalscore	0.096	0.141	0.09	0.496				
<i>Overall Model (Block 2)</i>					.81	(10,91)	.62	-.02
DASS_Stress	-0.328	0.568	-0.123	0.565				
DASS_Anxiety	-0.22	0.622	-0.066	0.724				
DASS_Depression	-0.13	0.449	-0.049	0.774				
SHS_touchscore	2.802	2.72	0.137	0.306				
SHS_totalscore	-1.042	5.922	-0.023	0.861				
LSAS_totalscore	0.123	0.147	0.115	0.403				
Psych_or_heart_condition	10.166	6.846	0.157	0.141				
Met_caffeine_criteria	6.201	6.712	0.101	0.358				
Met_food_criteria	-1.37	4.726	-0.03	0.773				
Met_exercise_criteria	-10.29	12.319	-0.087	0.406				
<i>Overall Model (Block 3)</i>					.86	(11,90)	.58	-.02
DASS_Stress	-0.296	0.567	-0.111	0.603				
DASS_Anxiety	-0.199	0.621	-0.06	0.75				
DASS_Depression	-0.187	0.451	-0.07	0.679				
SHS_touchscore	2.696	2.716	0.132	0.324				
SHS_totalscore	-0.579	5.924	-0.013	0.922				
LSAS_totalscore	0.131	0.147	0.123	0.374				
Psych_or_heart_condition	11.055	6.875	0.171	0.111				
Met_caffeine_criteria	6.467	6.703	0.105	0.337				
Met_food_criteria	-2.322	4.787	-0.051	0.629				
Met_exercise_criteria	-12.74	12.475	-0.108	0.31				
Same or mixed race dyad	-5.664	4.874	-0.122	0.248				
<i>Overall Model (Block 4)</i>					1.52	(13,88)	.13	.06
DASS_Stress	-0.468	0.548	-0.175	0.395				
DASS_Anxiety	0.031	0.602	0.009	0.959				
DASS_Depression	-0.022	0.442	-0.008	0.96				
SHS_touchscore	2.05	2.624	0.101	0.437				
SHS_totalscore	-1.091	5.8	-0.025	0.851				
LSAS_totalscore	0.118	0.141	0.11	0.405				
Psych_or_heart_condition	10.142	6.63	0.157	0.13				
Met_caffeine_criteria	3.727	6.529	0.061	0.57				

Met_food_criteria	-0.812	4.634	-0.018	0.861				
Met_exercise_criteria	-11.26	12.048	-0.096	0.353				
Same or mixed race dyad	-4.925	4.692	-0.106	0.297				
sig_LIBI_C_Neutral_first	3.809	1.576	0.255	0.018				
sig_LIBI_C_emotion_sec	5.101	2.363	0.217	0.034				
For Intensity								
Overall Model (Block 1)					1.33	(6,95)	.25	.02
DASS_Stress	-0.245	0.256	-0.195	0.342				
DASS_Anxiety	-0.041	0.282	-0.026	0.884				
DASS_Depression	-0.054	0.205	-0.043	0.795				
SHS_touchscore	2.165	1.206	0.226	0.076				
SHS_totalscore	0.85	2.677	0.041	0.751				
LSAS_totalscore	0.033	0.065	0.066	0.614				
Overall Model (Block 2)					1.14	(10,91)	.34	.01
DASS_Stress	-0.16	0.262	-0.128	0.543				
DASS_Anxiety	-0.058	0.287	-0.037	0.839				
DASS_Depression	-0.062	0.208	-0.049	0.767				
SHS_touchscore	2.033	1.257	0.212	0.109				
SHS_totalscore	1.183	2.736	0.057	0.667				
LSAS_totalscore	0.027	0.068	0.054	0.688				
Psych_or_heart_condition	0.17	3.163	0.006	0.957				
Met_caffeine_criteria	2.854	3.102	0.099	0.36				
Met_food_criteria	0.986	2.184	0.046	0.653				
Met_exercise_criteria	9.379	5.693	0.17	0.103				
Overall Model (Block 3)					1.54	(11,90)	.13	.06
DASS_Stress	-0.133	0.257	-0.106	0.606				
DASS_Anxiety	-0.04	0.281	-0.026	0.888				
DASS_Depression	-0.112	0.205	-0.09	0.585				
SHS_touchscore	1.941	1.231	0.203	0.118				
SHS_totalscore	1.586	2.684	0.076	0.556				
LSAS_totalscore	0.034	0.067	0.068	0.608				
Psych_or_heart_condition	0.945	3.115	0.031	0.762				
Met_caffeine_criteria	3.086	3.038	0.107	0.312				
Met_food_criteria	0.156	2.169	0.007	0.943				
Met_exercise_criteria	7.247	5.653	0.131	0.203				
Same or mixed race dyad	-4.94	2.209	-0.226	0.028				
Overall Model (Block 4)					1.81	(12,89)	.06	.09
DASS_Stress	-0.109	0.253	-0.087	0.668				
DASS_Anxiety	-0.135	0.28	-0.086	0.632				
DASS_Depression	-0.155	0.202	-0.124	0.444				
SHS_touchscore	1.795	1.211	0.187	0.142				
SHS_totalscore	1.907	2.642	0.091	0.472				
LSAS_totalscore	0.055	0.066	0.109	0.408				
Psych_or_heart_condition	0.845	3.061	0.028	0.783				
Met_caffeine_criteria	2.885	2.986	0.1	0.336				

Met_food_criteria	-0.633	2.165	-0.029	0.771				
Met_exercise_criteria	5.462	5.621	0.099	0.334				
Same or mixed race dyad	-5.854	2.215	-0.268	0.01				
abv_LIBI_C_lag1	37.849	18.383	0.211	0.042				
For Quadrant								
<i>Overall Model (Block 1)</i>					2.38	(6,95)	.04	.08
DASS_Stress	-0.536	0.37	-0.288	0.15				
DASS_Anxiety	-0.557	0.407	-0.24	0.174				
DASS_Depression	0.51	0.296	0.275	0.087				
SHS_touchscore	3.85	1.739	0.271	0.029				
SHS_totalscore	-0.329	3.862	-0.011	0.932				
LSAS_totalscore	0.162	0.094	0.218	0.086				

Table 9. Multiple regression predicting emotion detection accuracy (communicators only)

Predictor	B	SE	β	p	F	df	p	Adj. R ²
For Emotion Word Detection								
Overall Model (Block 1)					1.59	(6,44)	.17	.07
DASS_Stress	-1.17	0.75	-0.54	0.13				
DASS_Anxiety	-0.03	0.69	-0.01	0.96				
DASS_Depression	-0.06	0.53	-0.03	0.91				
SHS_touchscore	3.75	3.14	0.22	0.24				
SHS_totalscore	2.50	6.30	0.07	0.69				
LSAS_totalscore	0.19	0.16	0.22	0.24				
Overall model (Block 2)					1.60	(10,40)	.14	.11
DASS_Stress	-1.26	0.74	-0.58	0.10				
DASS_Anxiety	0.23	0.68	0.09	0.74				
DASS_Depression	-0.20	0.55	-0.10	0.72				
SHS_touchscore	2.25	3.38	0.13	0.51				
SHS_totalscore	3.45	6.31	0.09	0.59				
LSAS_totalscore	0.21	0.16	0.24	0.19				
Psych_or_heart_condition	13.45	7.92	0.25	0.10				
Met_caffeine_criteria	5.61	7.93	0.11	0.48				
Met_food_criteria	-2.56	5.50	-0.06	0.64				
Met_exercise_criteria	-30.63	19.77	-0.21	0.13				
Overall model (Block 3)					1.72	(11,39)	.10	.14
DASS_Stress	-1.17	0.73	-0.55	0.11				
DASS_Anxiety	0.23	0.67	0.09	0.73				
DASS_Depression	-0.21	0.54	-0.1	0.7				
SHS_touchscore	1.10	3.40	0.06	0.75				
SHS_totalscore	3.26	6.21	0.09	0.60				
LSAS_totalscore	0.2	0.16	0.23	0.20				
Psych_or_heart_condition	14.79	7.84	0.27	0.07				
Met_caffeine_criteria	4.83	7.81	0.10	0.54				
Met_food_criteria	-5.59	5.75	-0.14	0.34				
Met_exercise_criteria	-36.09	19.76	-0.25	0.08				
Same or mixed race dyad	-9.26	6.00	-0.23	0.13				
Overall model (Block 4)					2.05	(12,38)	.05	.20
DASS_Stress	-0.84	0.72	-0.39	0.25				
DASS_Anxiety	-0.15	0.67	-0.06	0.82				
DASS_Depression	-0.29	0.52	-0.14	0.58				
SHS_touchscore	-0.08	3.33	-0.01	0.98				
SHS_totalscore	6.52	6.18	0.18	0.30				
LSAS_totalscore	0.19	0.15	0.22	0.21				
Psych_or_heart_condition	20.22	8.00	0.37	0.02				
Met_caffeine_criteria	6.45	7.56	0.13	0.40				
Met_food_criteria	-6.94	5.57	-0.18	0.22				

Met_exercise_criteria	-28.52	19.37	-0.20	0.15				
Same or mixed race dyad	-9.66	5.77	-0.24	0.10				
abv_LIBI_C_next_baseline_lag2	-72.97	35.90	-0.30	0.05				
For Valence								
Overall model (Block 1)								
DASS_Stress	-1.15	0.59	-0.70	0.06	1.04	(6,44)	.41	.01
DASS_Anxiety	-0.03	0.54	-0.02	0.95				
DASS_Depression	0.82	0.42	0.51	0.06				
SHS_touchscore	0.97	2.48	0.07	0.70				
SHS_totalscore	0.17	4.97	0.01	0.97				
LSAS_totalscore	0.08	0.12	0.12	0.51				
Overall model (Block 2)					.77	(10,40)	.66	-.05
DASS_Stress	-1.13	0.61	-0.68	0.07				
DASS_Anxiety	-0.16	0.56	-0.08	0.79				
DASS_Depression	0.99	0.45	0.62	0.03				
SHS_touchscore	0.69	2.80	0.05	0.81				
SHS_totalscore	-0.68	5.23	-0.02	0.90				
LSAS_totalscore	0.10	0.13	0.14	0.47				
Psych_or_heart_condition	-6.81	6.56	-0.16	0.31				
Met_caffeine_criteria	4.12	6.57	0.11	0.53				
Met_food_criteria	-0.51	4.56	-0.02	0.91				
Met_exercise_criteria	6.25	16.38	0.06	0.71				
Overall model (Block 3)					.77	(11,40)	.66	-.05
DASS_Stress	-1.08	0.61	-0.66	0.08				
DASS_Anxiety	-0.15	0.57	-0.08	0.79				
DASS_Depression	0.99	0.45	0.62	0.04				
SHS_touchscore	0.11	2.87	0.01	0.97				
SHS_totalscore	-0.77	5.24	-0.03	0.88				
LSAS_totalscore	0.09	0.13	0.13	0.50				
Psych_or_heart_condition	-6.14	6.61	-0.15	0.36				
Met_caffeine_criteria	3.73	6.59	0.10	0.58				
Met_food_criteria	-2.04	4.86	-0.07	0.68				
Met_exercise_criteria	3.50	16.68	0.03	0.84				
Same or mixed race dyad	-4.66	5.06	-0.15	0.36				
Overall model (Block 4)					1.02	(20,30)	.47	.01
DASS_Stress	-1.13	0.66	-0.69	0.09				
DASS_Anxiety	0.00	0.59	0.00	1.00				
DASS_Depression	0.59	0.48	0.37	0.23				
SHS_touchscore	1.89	3.03	0.14	0.54				
SHS_totalscore	-2.10	5.60	-0.07	0.71				
LSAS_totalscore	0.04	0.14	0.07	0.75				
Psych_or_heart_condition	-3.13	6.97	-0.08	0.66				
Met_caffeine_criteria	2.37	7.81	0.06	0.76				
Met_food_criteria	-2.40	5.78	-0.08	0.68				
Met_exercise_criteria	-1.05	17.64	-0.01	0.95				

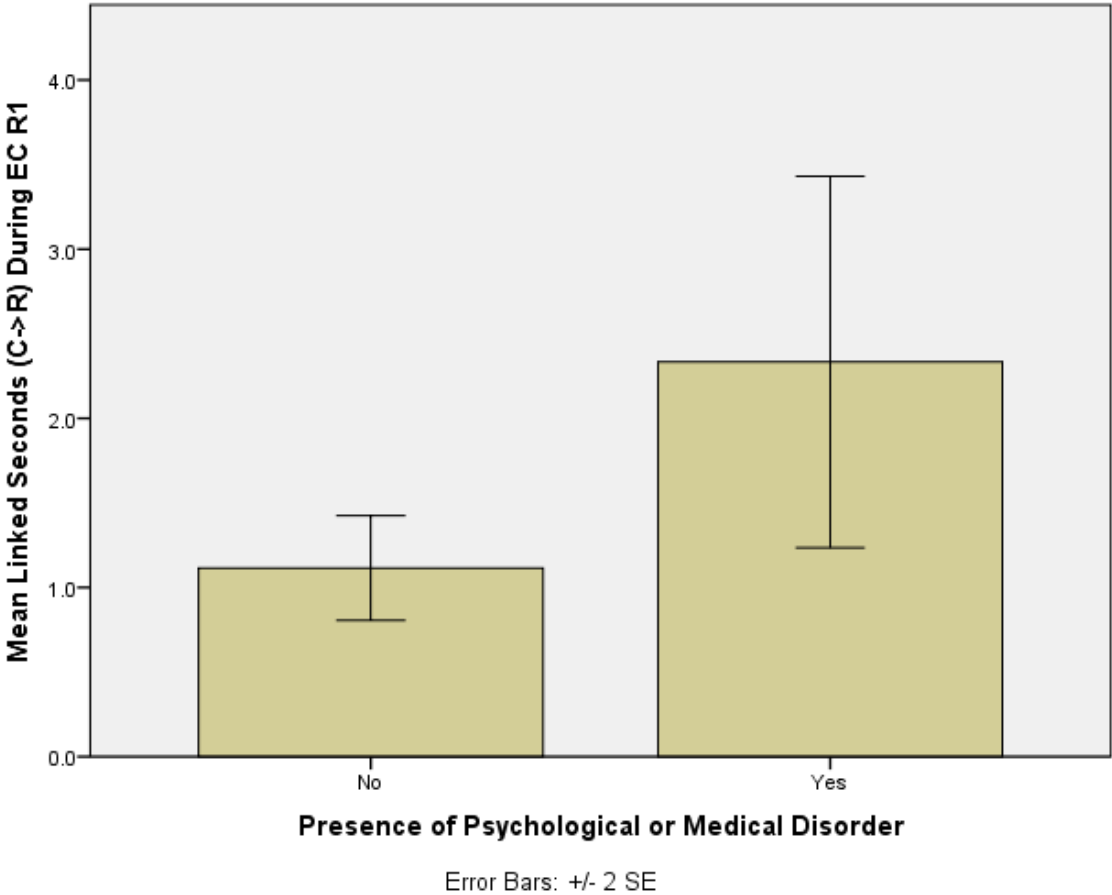
Same or mixed race dyad	-1.68	5.31	-0.05	0.75				
abv_LIBI_R_next_baseline_lag3	36.69	39.88	0.17	0.37				
sig_LIBI_C_first_baseline	2.66	1.83	0.28	0.16				
sig_LIBI_C_next_baseline	1.88	1.99	0.19	0.35				
sig_LIBI_C_Neutral_first	-0.37	2.11	-0.04	0.86				
sig_LIBI_C_emotion_sec	4.18	3.04	0.27	0.18				
sig_LIBI_R	4.90	2.19	0.47	0.03				
sig_LIBI_R_recovery_first	4.65	2.14	0.42	0.04				
sig_LIBI_R_recovery_sec	0.92	2.39	0.08	0.70				
sum_sig_overall	-0.91	0.51	-0.52	0.09				
For Quadrant								
Overall model (Block 1)					2.76	(6,44)	.02	.17
DASS_Stress	-1.88	0.57	-1.07	0.00				
DASS_Anxiety	0.13	0.52	0.06	0.80				
DASS_Depression	1.14	0.41	0.68	0.01				
SHS_touchscore	3.54	2.39	0.25	0.15				
SHS_totalscore	0.71	4.80	0.02	0.88				
LSAS_totalscore	0.15	0.12	0.22	0.21				

Table 10. *Multiple regression predicting emotion detection accuracy (receivers only)*

Predictor	B	SE	β	p	F	df	p	Adj. R ²
For Intensity								
Overall model (Block 1)					.29	(6,44)	.94	-.09
DASS_Stress	-0.12	0.28	-0.11	0.68				
DASS_Anxiety	-0.38	0.40	-0.26	0.35				
DASS_Depression	0.17	0.26	0.15	0.53				
SHS_touchscore	0.34	1.55	0.04	0.83				
SHS_totalscore	-0.51	3.76	-0.03	0.89				
LSAS_totalscore	0.09	0.10	0.20	0.36				
Overall model (Block 2)					.73	(10,40)	.69	-.06
DASS_Stress	-0.08	0.30	-0.07	0.78				
DASS_Anxiety	-0.24	0.41	-0.17	0.56				
DASS_Depression	0.15	0.27	0.13	0.59				
SHS_touchscore	0.78	1.58	0.10	0.62				
SHS_totalscore	-1.14	3.94	-0.07	0.77				
LSAS_totalscore	0.06	0.10	0.15	0.53				
Psych_or_heart_condition	-2.41	3.96	-0.10	0.55				
Met_caffeine_criteria	-3.31	4.14	-0.13	0.43				
Met_food_criteria	-1.72	2.76	-0.10	0.54				
Met_exercise_criteria	9.60	5.75	0.26	0.10				
Overall model (Block 3)					.65	(11,39)	.77	-.08
DASS_Stress	-0.10	0.31	-0.09	0.75				
DASS_Anxiety	-0.24	0.42	-0.17	0.58				
DASS_Depression	0.16	0.27	0.14	0.56				
SHS_touchscore	0.71	1.62	0.09	0.66				
SHS_totalscore	-1.41	4.09	-0.08	0.73				
LSAS_totalscore	0.07	0.10	0.15	0.53				
Psych_or_heart_condition	-2.53	4.03	-0.10	0.53				
Met_caffeine_criteria	-3.82	4.54	-0.15	0.41				
Met_food_criteria	-1.68	2.80	-0.10	0.55				
Met_exercise_criteria	9.75	5.84	0.27	0.10				
Same or mixed race dyad	0.90	3.10	0.05	0.77				
Overall model (Block 4)					1.21	(12,38)	.31	.05
DASS_Stress	-0.32	0.30	-0.29	0.29				
DASS_Anxiety	-0.15	0.39	-0.11	0.70				
DASS_Depression	0.24	0.26	0.20	0.36				
SHS_touchscore	1.27	1.54	0.16	0.42				
SHS_totalscore	-0.74	3.84	-0.04	0.85				
LSAS_totalscore	0.07	0.10	0.15	0.50				
Psych_or_heart_condition	-3.04	3.78	-0.12	0.43				
Met_caffeine_criteria	-4.27	4.26	-0.17	0.32				
Met_food_criteria	-0.94	2.64	-0.05	0.73				

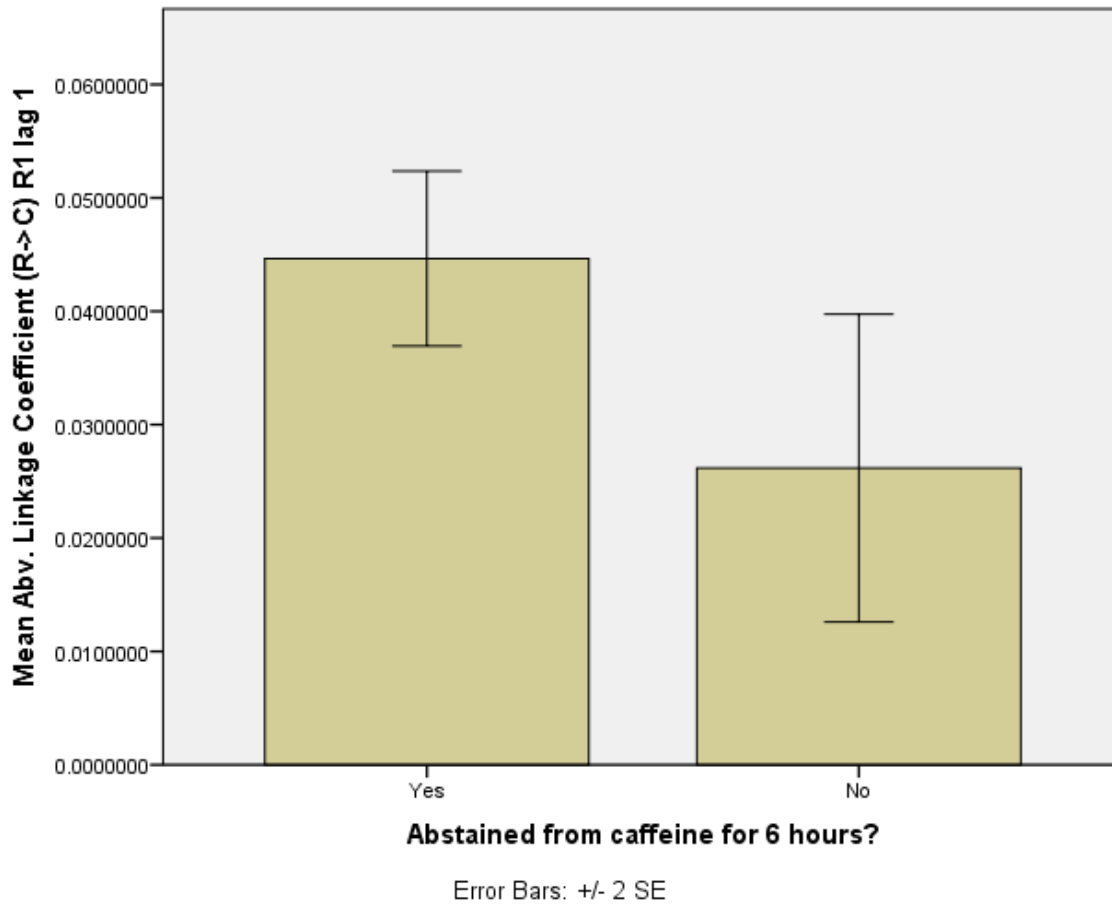
Met_exercise_criteria	6.19	5.66	0.17	0.28				
Same or mixed race dyad	1.24	2.91	0.07	0.67				
sig_LIBI_C_next_baseline	-2.22	0.88	-0.40	0.02				
For Quadrant								
Overall model (Block 1)					2.40	(6,44)	.04	.14
DASS_Stress	0.37	0.45	0.19	0.41				
DASS_Anxiety	-1.40	0.63	-0.55	0.03				
DASS_Depression	0.19	0.42	0.09	0.65				
SHS_touchscore	5.11	2.46	0.36	0.04				
SHS_totalscore	-2.69	5.96	-0.09	0.65				
LSAS_totalscore	0.31	0.15	0.40	0.05				

Figure 1. Mean number of significant linked lagged seconds of the communicator’s IBIs predicting the receiver’s IBIs during the first round of emotion communication by presence of psychological or medical disorder.



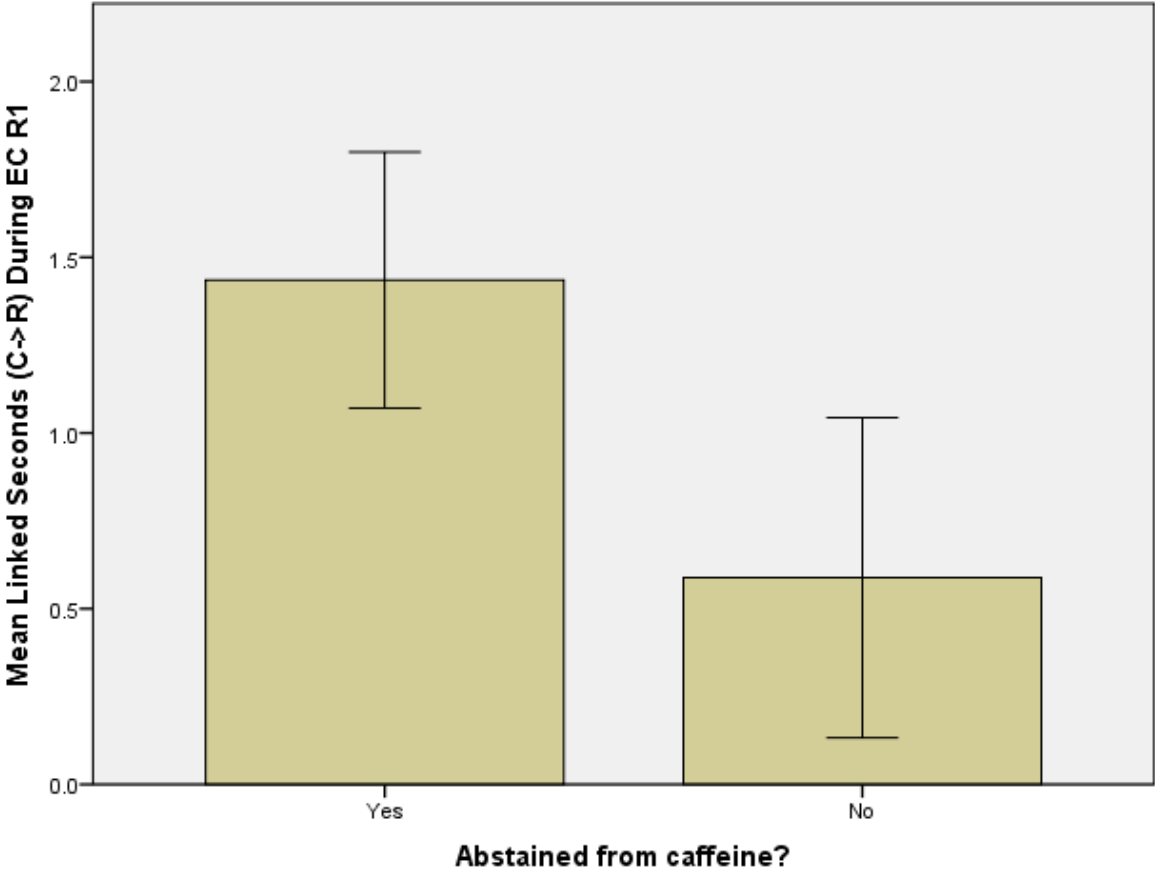
Note. $t(100)=-2.80, p=.006$

Figure 2. Mean absolute value of the linkage coefficient (lag 1) of the receiver's IBIs predicting the communicator's IBIs during the first round of recovery periods by caffeine abstention



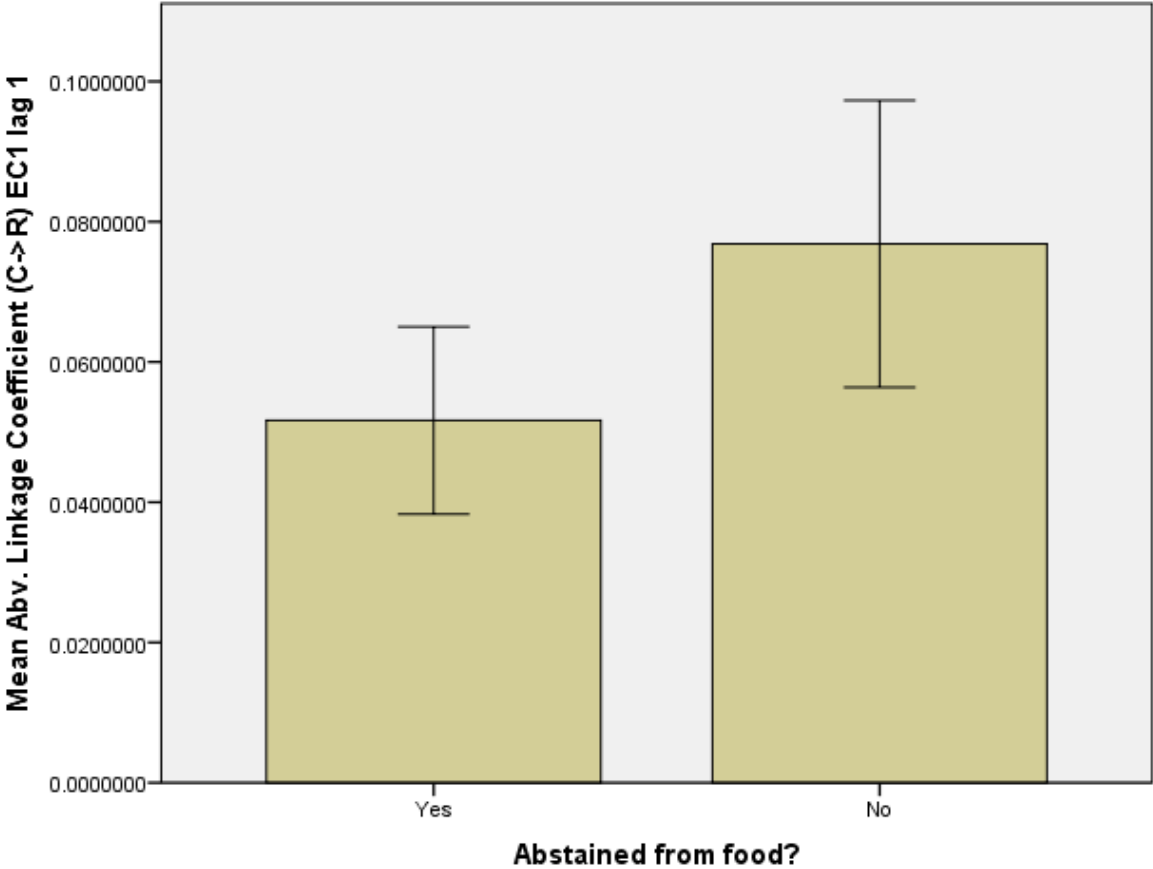
Note. $t(100)=2.02, p=.046$

Figure 3. Mean number of significant linked lagged seconds of the communicator’s IBIs predicting the receiver’s IBIs during the first round of emotion communication by caffeine abstention



Note. $t(39.89)=2.90, p=.006$

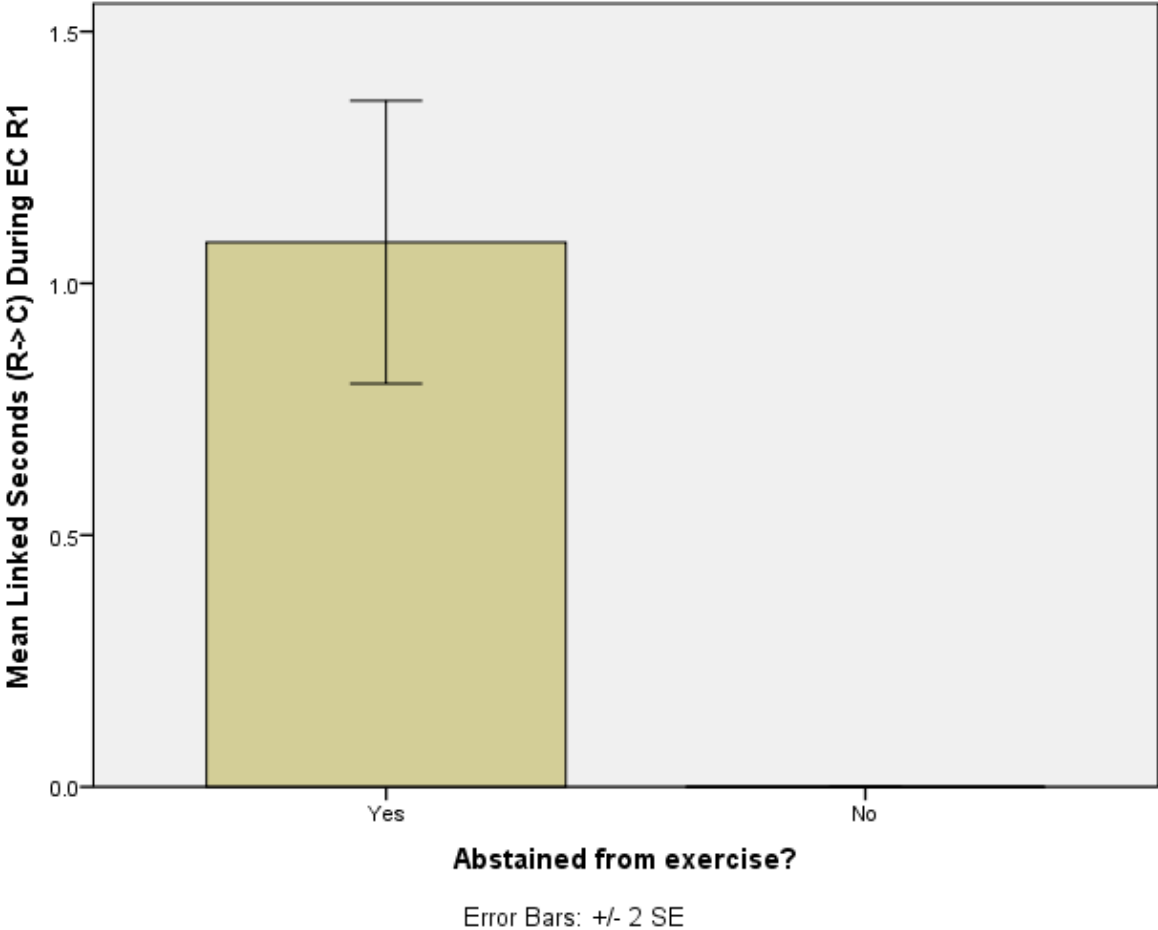
Figure 4. Mean absolute value of the linkage coefficient (lag 1) of the communicator's IBIs predicting the receiver's IBIs during the first round of emotion communication by food abstention



Error Bars: +/- 2 SE

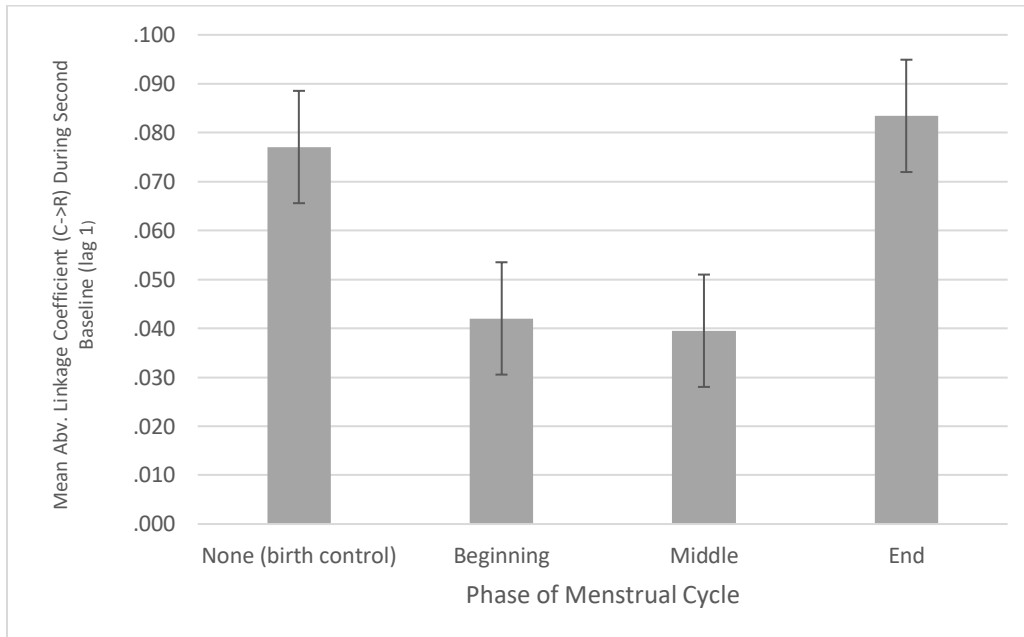
Note. $t(84.91)=-2.06, p=.042$

Figure 5. Mean number of significant linked lagged seconds of the receiver’s IBIs predicting the communicator’s IBIs during the first round of emotion communication by exercise abstention



Note. $t(97)=7.71, p<.001$

Figure 6. Mean absolute value of the linkage coefficient (lag 1) of the communicator's IBIs predicting the receiver's IBIs during the second baseline by menstrual phase



Note. $F(3,1)=5.27, p=.002$

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APPENDIX A

Mind-Body Laboratory Health History Questionnaire

A very brief medical history must be obtained as part of the experimental protocol. It is very important that you be completely honest. This information will be kept strictly confidential.

1. What is your age, height, weight, and gender?

Age: _____ years

Sex: ___M ___F

Height: _____ feet, _____ inches; weight: _____ pounds

Handedness: ___R ___L

2. Have you ever experienced a concussion or lost consciousness due to a blow to the head?

___ Yes ___ No

If Yes, briefly explain:

3. Have you ever had problems that required you to see a counselor, psychologist, or psychiatrist?

___ Yes ___ No

If Yes, briefly explain:

4. Do you use tobacco products of any kind?

___ Yes ___ No

If Yes, describe what kind how often/much:

5. Have you ever been diagnosed with a psychological disorder?

___ Yes ___ No

If Yes, briefly explain:

6. Do you currently have or have you ever had any of the following?

___ Yes ___ No Strong reaction to cold weather

Yes No Circulatory problems

Yes No Tissue disease

Yes No Skin disorders (other than facial acne)

Yes No Arthritis

Yes No Asthma

Yes No Lung problems

Yes No Cardiovascular disorder/disease

Yes No Diabetes

Yes No Hypoglycemia

Yes No Hypertension (high blood pressure)

Yes No Hypotension (low blood pressure)

Yes No Hepatitis

Yes No Neurological problems

Yes No Epilepsy or seizures

Yes No Brain disorder

Yes No Stroke

If you responded Yes to any of the above conditions, briefly explain:

7. Have you ever been diagnosed as having:

Yes No Learning deficiency or disorder

Yes No Reading deficiency or disorder

Yes No Attention deficit disorder

Yes No Attention deficit hyperactivity disorder

8. Do you have:

Yes No Claustrophobia (extreme fear of small closed spaces)

Yes No Blood phobia (extreme fear of needles or blood)

Yes No Phobia of any type (if Yes, briefly explain:)

Yes No Generalized anxiety disorder

Yes No Anxiety disorder of any type (if Yes, briefly explain:)

If you responded Yes, briefly explain here:

9. List any over the counter or prescription medications you are currently taking:

10. List the symptoms that these drugs are treating

11. List any other significant medical conditions that you have or have had in the past:

12. What is your average daily caffeine consumption (approximate number of cups/glasses of coffee, tea, or caffeinated soda)?

13. What is your average weekly alcohol consumption (approximate number of alcoholic beverages)?

14. How many hours of sleep do you average per night?

APPENDIX C

Sensory Hypersensitivity Scale

Rate how much you agree with each statement using the following response options: 1 = “Strongly Disagree.” 2 = “Disagree.” 3 = “Neutral/Not Sure.” 4 = “Agree.” to 5 = “Strongly Agree.”

I suffer from allergies

I am allergy-free

I have a number of allergies

I often feel too hot in an environment where others don't seem to be bothered

I am easily disturbed by high temperatures

I often feel too cold in an environment where others don't seem to be bothered

I am easily disturbed by low temperatures

My eyes are sensitive to sunlight

I am sensitive to bright light

I am not really bothered by bright lights

I am quite sensitive to pain

I can tolerate a large amount of pain

Things that would ordinarily hurt others are not painful to me

I often react to odors that other do not initially notice

I seem to notice smells that other people do not

I rarely notice smells

When I read, it must be totally quiet

I cannot study or read if there is any conversation or noise around

I can work even in noisy circumstances

I tend to be a picky eater

There are many foods that taste bad to me

I can eat almost anything

I am generally unable to wear clothes made of rough material

I am sensitive to rough textures

I can wear almost any kind of fabric without it bothering me

APPENDIX D

Depression Anxiety Stress Scale

The rating scale is as follows:

- 0 Did not apply to me at all
 1 Applied to me to some degree, or some of the time
 2 Applied to me to a considerable degree, or a good part of time
 3 Applied to me very much, or most of the time

1	I found myself getting upset by quite trivial things	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I just couldn't seem to get going	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I had a feeling of shakiness (eg, legs going to give way)	0	1	2	3
8	I found it difficult to relax	0	1	2	3
9	I found myself in situations that made me so anxious I was most relieved when they ended	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting upset rather easily	0	1	2	3
12	I felt that I was using a lot of nervous energy	0	1	2	3
13	I felt sad and depressed	0	1	2	3
14	I found myself getting impatient when I was delayed in any way (eg, elevators, traffic lights, being kept waiting)	0	1	2	3
15	I had a feeling of faintness	0	1	2	3
16	I felt that I had lost interest in just about everything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I perspired noticeably (eg, hands sweaty) in the absence of high temperatures or physical exertion	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life wasn't worthwhile	0	1	2	3

Reminder of rating scale:

- 0 Did not apply to me at all
 1 Applied to me to some degree, or some of the time
 2 Applied to me to a considerable degree, or a good part of time
 3 Applied to me very much, or most of the time

22	I found it hard to wind down	0	1	2	3
23	I had difficulty in swallowing	0	1	2	3
24	I couldn't seem to get any enjoyment out of the things I did	0	1	2	3
25	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
26	I felt down-hearted and blue	0	1	2	3
27	I found that I was very irritable	0	1	2	3
28	I felt I was close to panic	0	1	2	3
29	I found it hard to calm down after something upset me	0	1	2	3
30	I feared that I would be "thrown" by some trivial but unfamiliar task	0	1	2	3
31	I was unable to become enthusiastic about anything	0	1	2	3
32	I found it difficult to tolerate interruptions to what I was doing	0	1	2	3
33	I was in a state of nervous tension	0	1	2	3
34	I felt I was pretty worthless	0	1	2	3
35	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
36	I felt terrified	0	1	2	3
37	I could see nothing in the future to be hopeful about	0	1	2	3
38	I felt that life was meaningless	0	1	2	3
39	I found myself getting agitated	0	1	2	3
40	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
41	I experienced trembling (eg, in the hands)	0	1	2	3
42	I found it difficult to work up the initiative to do things	0	1	2	3

APPENDIX E

Mind-Body Laboratory Recent Health History Questionnaire (R-HHQ)

A very brief medical history must be obtained as part of the experimental protocol. It is very important that you be completely honest. This information will be kept strictly confidential.

1. When was the last time that you have had any alcohol before the study began?
2. When was the last time you have had a caffeinated beverage before the study began?
3. When was the last time that you ate before the study began?
4. What phase of the menstrual cycle are you currently in (beginning, middle, end, or N/A)?
5. How many hours of sleep did you get last night?
6. Did you engage in vigorous exercise within the last 2 hours?

APPENDIX F

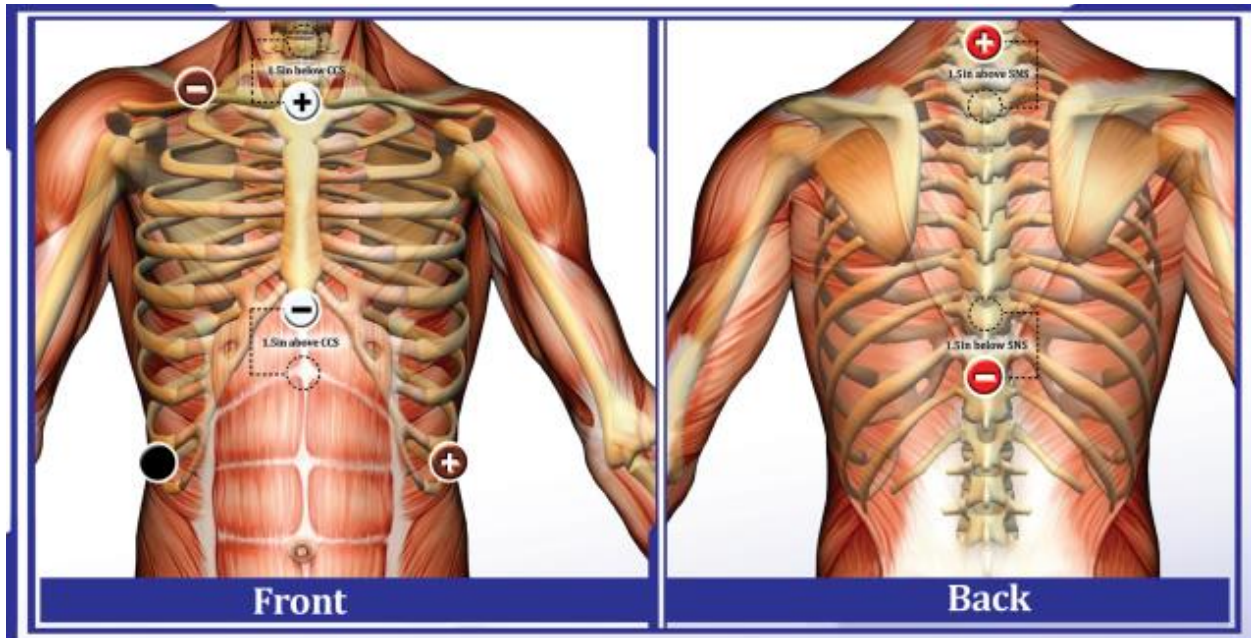


Photo from poster entitled “Electrode Attachment” provided by MindWare Technologies, LTD to users of their physiological recording equipment.

APPENDIX G

Regression Analyses Supplement

As described in Section 4.5.2., only coefficients that were significant in the pooled estimation from the first lagged second for both the communicator and receiver were pulled from the equation set for each dyad as potential predictors. For the communicators, the significant coefficients included those for lag 1 and lag 2 of the receiver's IBI values, lags 1-4 of the second baseline, lags 1-4 of the "neutral" touch-only communication, lag 1 of the first round of emotion communication, and lag 1 and lag 2 of the first and second round recovery periods (there were indications of linkage in the first baseline and second round of emotion communication, but not from the first lagged second). For the receivers, the significant coefficients included those for lag 1 of the communicator's IBI values, lag 1 of the "neutral" touch-only communication, lags 1 and 2 of the first round of emotion communication, and lag 1 of the first and second round recovery periods (there were no indications of linkage in the first baseline, though there were in the second baseline, the second round of emotion communication, and time between tasks, but not from the first lagged second).

From these, the absolute values (as the linkage coefficients could be negative and only their magnitude was of interest) of the following coefficients were collected: lags 1 and 2 of the communicator's IBIs predicting the receiver and vice versa, lags 1-4 of the second baseline, and lag 1 of the neutral touch-only communication, first round of emotion communication, and first and second rounds of recovery periods. The average coefficient values for those coefficients with multiple lag values were computed.

Due to the complete extent of the linkage being masked by only pulling these particular coefficients, the number of significant lagged seconds in each task by lagged natural log IBI of

partner interaction up to lag 10 was summed for each dyad. For example, if the dyad's equation predicting the natural log IBI of the communicator demonstrated that the interaction between the neutral touch-only communication and the receiver's lagged IBI values was significant at lags 1-4 and 8-10, the number of "linked" seconds would be 7. The number of linked seconds across all time periods was also summed.