Social-Emotional Expertise (SEE): Interoception, Person Perception, and Granularity

By

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Thesis

Submitted to the Faculty of the

Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE

In

Psychology

May 8, 2020

Nashville, Tennessee

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

“Social-emotional expertise” (SEE) is a construct that describes individual differences in the ease and adaptability of navigating social situations. Variability in SEE has implications for both the ability to manage interactions and satisfaction with those interactions. The SEE construct concerns the translation of affect-related perceptions and behaviors into socially engaging behavior, such that individuals who are higher in SEE are more likely to have better quality interactions than those who are lower in SEE. Social-emotional expertise is in part conceptualized as consisting of relative strengths and deficits in a socioemotional “toolkit,” in which multiple, moderately correlated affect-related skills drive high-SEE individuals to excel at the social-emotional components of interactions (e.g., person perception, timing, and coordination). Although many of these components have been studied, corresponding empirical work with relation to SEE is in its infancy. This experiment tested the associations between variability in self-reported SEE and performance on skills that we hypothesize are in part driven by individual differences in SEE. I was specifically interested in testing the associations among SEE, interoceptive measures (i.e., accuracy and awareness) and affect-related skills (i.e., person perception and emotional granularity).

1.1 Interoception

As humans, we perceive feelings from our bodies that relate to our state of well-being, energy and stress levels, and mood and disposition (Barrett, 2017; Craig, 2002). Interoception, defined as subjective awareness of our inner feelings, is a representation of Damasio's so-called "material me," the sense of the physiological condition of the body (Craig, 2003; Cameron, 2001). Pain, temperature, heart rate, and arousal are all visceral sensations that can be detected via interoception. Several influential theorists have emphasized that emotional feeling states can arise from the perception of physiological changes from within the body (Critchley, Wiens, Rotshtein, Öhman & Dolan, 2004; James, 1894; Lange, 1922). Additionally a complex neural system comprised of various subregions of the brain have found to be associated with interoceptive awareness, including the thalamus, brainstem, anterior cingulate cortex, amygdala and anterior insula (Terasawa & Umeda, 2018; Cameron, 2001). This system of brain regions that are essential for interoception and body-budgeting has been referred to as "the interoceptive network" (Barrett, 2017). The anterior insula (AI) is particularly implicated in this process of homeostatic self-awareness, as the AI is engaged when individuals attend to a number of bodily states (Zaki, Davis & Oschner, 2012). The AI is also thought to be involved in the processing of affective valence and arousal, particularly in the expression of disgust (Grunkina, Holtz, Klepzig, Neubert, Horn, Domin, & Lotze, 2017). As the AI is implicated in the process of regulating temperature, pain, heart rate, and arousal, it is not surprising that the anterior insula is thought to have a primary role in interoception.

A relatively new theory in emotion science identified interoception as monitoring our internal processes and sending necessary updates to the brain, manifested through our interpretation of four rudimentary signals (pleasantness, unpleasantness, arousal, and calmness) (Barrett, 2017). In this theory of constructed emotion, allostasis (defined as achieving resource allocation through physiological and behavioral change) is identified as maintaining the central function of the nervous system, while the primary function of interoception involves maintenance of homeostatic function by interpreting and discriminating internal bodily signals. This principal role for interoception creates the foundation of a holistic model of emotion that considers the whole brain-body phenomena in the context of our external, physical and social environment.

When an unexpected event occurs in a particular context, a prediction error occurs. Prediction errors are described as the difference between the brain's anticipated outcome and incoming sensation (Barrett & Simmons, 2015). As the primary goal of this model is to minimize the number of prediction errors the brain receives, interoception provides the necessary somatic information to interpret that incoming sensation (Barrett & Simmons, 2015). Therefore, it follows that having greater interoceptive awareness and accuracy could lead to providing more clear and precise sensory information to the brain, leading to fewer prediction errors and a lower allostatic load. The Embodied Predictive Interoception Coding (EPIC) model (Barrett & Simmons, 2015) further teases out how prediction errors (informed by interoceptive information) flow through the architecture of the corticocortical connections that make up the interoceptive network. The interoceptive network consists of components of two overlapping networks, the salience network and the default mode network, both of which contain a large portion of limbic tissue in the cerebral cortex and are important for achieving bodily stability (Barrett, 2017

The EPIC model focuses primarily on tracing the communication pathway of interoceptive information through subregions of the cortex, with little to no mention of the role of the anterior insula in this process. Although Barrett and Simmons acknowledge the role of the insula, claiming it has a key part in comparing predictions and prediction errors in a conscious and purposeful way, they also argue that the EPIC model allows for multiple pathways within the cortical system to result in the same transference of interoceptive information. This perspective is supported by two rare patients who had severe damage to the anterior insula, but maintained intact affective experience and emotional self-awareness (Barrett & Simmons, 2015). Given that multiple neural pathways have been implicated in the brain's processing of interoception, further delineating the complex and large-scale brain system that informs the interoceptive process could lead to a greater understanding of how individuals interpret and categorize information they receive from both internal and external milieux (Barrett, 2017).

Heartbeat-detection tasks are moderately valid and commonly used procedures to measure interoception. These tasks include both "heartbeat tracking" (Schandry, 1981) and "heartbeat discrimination" procedures (Brener & Kluvitse, 1988; Katkin, Reed & Deroo, 1983; Whitehead, Drescher, Heiman & Blackwell, 1977). The Heartbeat Tracking Task, also referred to as the Heartbeat Detection Task, is used to measure cardiac interoceptive accuracy and awareness. In this task, participants are asked to count their heartbeats (relying only on their bodily sensations and not monitoring their pulse) during an established time interval. The reported number of heartbeats is then compared to the actual number of recorded beats (as measured by a heartbeat monitor). In the Heartbeat Discrimination Task, participants are presented with a temporal tone and are asked to identify whether it is faster, slower, or in sync with their heartbeat. We opted to use the Heartbeat Tracking Task to measure interoceptive accuracy, as participants must rely only on internal cues to monitor their physiological state, without any exteroceptive signals or prompts.

Despite the frequency with which heartbeat-detection tasks are utilized in the literature to measure interoception, there are mounting criticisms of these methods as well. Zamariola, Maurage, Luminet, and Corneille (2018) questioned the efficacy and validity of the heartbeat interoception tasks, arguing that these tasks lack fundamental construct validity and claiming that a valid measure of interoception should not be necessarily tied to monitoring the heart. Other recent critiques have highlighted the importance of developing new tasks to measure interoception, since studies that utilize only a heartbeat task to measure participants' awareness of their internal state are limiting their definition of interoception to the cardiac domain (Ring & Brener, 2018; Allen, 2018). In line with these concerns, Murphy, Catmur, and Bird (2018) recently re-affirmed the need for well validated and methodologically sound procedures that draw from awareness of other internal sources. One such measure, piloted by Murphy et al. (2018), focuses on interoception in the respiratory domain through the use of spirometry. Specifically, participants are presented with a peak-flow meter (a device that measures the maximum speed in which air can be pushed out of the lungs) and asked to perform one large exhalation at 100% effort. Participants are subsequently asked to produce follow-up exhalations that are 30%, 50%, 70%, and 90% of that first baseline exhalation. The use of spirometry to help individuals attend to their internal state is not unusual. Other biomedical research has used peak-flow meters as a tool to assist individuals in monitoring co-morbid asthma and PTSD, as well as providing a resource for those with COPD and other respiratory difficulties to gain insight into how their lungs are performing in various conditions (Rietveld & Brosschot, 1999; Feldman et al., 2016; Ayala et al., 2014).

Being self-aware is central to what it means to be human (Blanke & Metzinger, 2009). Excessive self-focus has, however, been linked to negative affect, anxiety, and depression (Mor & Winquist, 2002). Therefore, further understanding group differences in interoception has numerous clinical implications. Previous research on interoception has made clear that clinical, emotional, and health implications can occur when something goes awry with this internal, physiological process. Difficulties with disordered eating, alexithymia, aging, autism and affective disorders have all been shown to be associated with disruptions in the interoceptive process (Merwin, Zucker, Lacy, & Elliott, 2010; Ernst, Boker, Hattenschwiler, Schupbach, Northoff, Seifritz, & Grimm, 2013; Khalsa, Rudrauf & Tranel, 2009; Schauder, Mash, Bryant, & Cascio, 2015). These disruptions manifest differently across disorders: Excessive focus on internal states can lead individuals to experience anxiety and panic as well as support a distorted body image and contribute to disordered eating behavior. In contrast, ignoring internal perceptions is commonly associated with alexithymia, depression, and autism spectrum disorder. If an increase or decrease in interoceptive awareness assists individuals in their social, emotional, health, and interpersonal processes and functioning, attempting to develop interventions that target interoceptive processes could be an effective clinical tool.

Research has shown that alignment of interoceptive dimensions (e.g., accuracy and awareness) can predict emotional symptoms (Critchley & Garfinkel, 2017). Additional studies have examined the relationship between interoception and emotional awareness, finding that individuals with higher interoceptive awareness also reported lower levels of alexithymia and performed better on tasks measuring emotional processing (Muir, Madell, & Brown, 2017; Herbert, Herbert, & Pollatos, 2011). If the range and flexibility of an individual's social-emotional skill is also tied to being "in tune" with one's own physiological arousal and bodily state, then individuals who score highest on a self-report measure of SEE can be expected to have the highest levels of interoceptive ability. In this study, we test this general prediction by measuring interoceptive accuracy and awareness (in both cardiac and respiratory domains) in individuals who vary in SEE. In comparison to low-SEE participants, I hypothesized that high-

SEE participants would have higher levels of interoceptive awareness based on their performance on both the Heartbeat Tracking and Respiratory Discrimination tasks. I did not expect a significant group difference in interoceptive accuracy scores between high-SEE and low-SEE individuals.

1.2 Person Perception

Given that the SEE construct is about converting affect-related signals into socially engaging behavior, examining interpersonal ability as it relates to variability in SEE is a second potentially fruitful area of study. Person perception is a broad element of social psychology research that concerns how people form impressions and make judgements about other individuals (Fiske, 2018). People can learn about other's feelings and emotions, and make inferences based on the information that they gather. This information could include physical appearance, gesture, facial expression, and verbal and non-verbal communication. For the purpose of this study, person perception focused on the social and cognitive biases that influence our interpretation of others (Rubinstein, Ridgley, Callan, Karami, & Ehlinger, 2018).

In this study, participants completed three person-perception tasks that test discrimination accuracy for basic facial expressions, interpersonal interactions, and perceptual processing of social cues. The first measure was the Interpersonal Perception Task (IPT; Costanzo & Archer, 1993). The IPT is a dynamic method for studying the process of social perception. Participants watch 15 brief video clips that last between 60 and 90 s; each clip features an interpersonal interaction. Participants are then asked a multiple choice question based on the video they just viewed, which requires them to make a judgement about interpersonal constructs. The second interpersonal measure was a task that required participants to make judgements based on facial information: distinguishing between Duchenne vs. non-Duchenne smiles. A Duchenne smile is considered a “genuine smile;” it involves the contraction of both the zygomatic major and the orbicularis oculi muscles (Gunnery & Ruben, 2016). A non-Duchenne smile involves only the zygomatic major muscle. While this task has been shown to be less tightly coupled with internal state than has been previously believed, distinguishing Duchenne from non-Duchenne smiles is still considered a nuanced social-processing task as it involves distinguishing purportedly genuine from posed smiles (Bernstein, Young, Brown, Sacco, & Claypool, 2008).

The third and final measure included to measure person perception was a Trustworthy/ Untrustworthy Categorization Task (Todorov, Pakrashi, & Oosterhof, 2009). Research results suggest that reported social trust may emerge after a brief viewing of someone’s face (Cogsdill, Todorov, Spelke, & Banaji, 2014; Holtz, 2015). This “trust” is based on the inclusion (or exclusion) of certain facial features (Todorov, Baron, & Oosterhof, 2008). In this task, participants determined whether an individual is trustworthy or untrustworthy based only on their face. These faces have been manipulated via a computer algorithm to possess specific features (see Figure 1): As examples, a trustworthy face may have high inner eye brows and prominent cheekbones, while an untrustworthy face may have low inner eye brows and shallow cheekbones. This task was selected because discrimination accuracy for basic facial expressions (as in the smile task described above) tends to be greater than for making social judgments, likely because social interactions require processing more cues in order to achieve accurate categorization (Sacco, Merold, Lui, Lustgraaf & Barry, 2016).

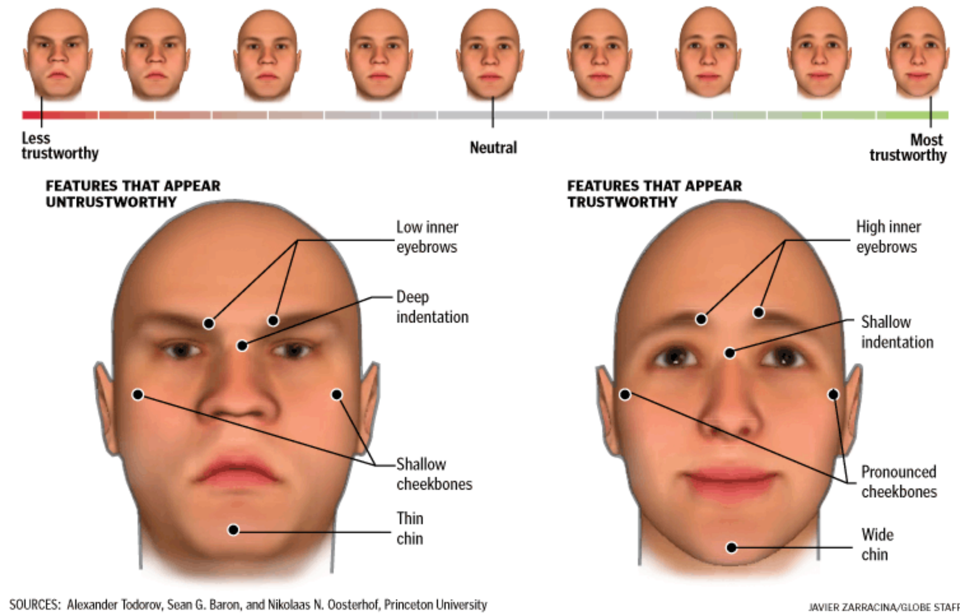


Figure 1. Examples of two computer-generated human faces that vary in trustworthiness. These images demonstrate several of the key features (i.e., eyebrows, cheekbones, chin) that are manipulated in incremental intensity to make a face appear more or less trustworthy to participants.

In comparison to low-SEE participants, I expected that high-SEE participants would perform better on the IPT-15, distinguishing Duchenne vs. non-Duchenne smiles, and the trustworthy/ untrustworthy categorization task, as high-SEE individuals are hypothesized to be more skillful at interpersonal perception.

1.3 Emotional Granularity

A third component that I hypothesize may be related to SEE is emotional granularity (EG). EG is defined as an individual's ability to both differentiate among emotions and to provide specificity regarding their emotional experiences (Lee, Lindquist, & Nam, 2017). While it may be considered a relatively simple task to differentiate between two competing emotions of different valence (e.g., feeling happy vs. feeling sad), research results have shown that distinguishing between affective feelings of a similar valence relies on carefully attending to an arousal dimension, particularly by comparisons to one's experience of internal activation in similar environmental situations (Pond, Kashdan, DeWall, Savostyanova, & Fincham, 2012). Individuals who are able to correctly make these nuanced differentiations are therefore typically characterized as having relatively high levels of emotional granularity (Pond et al., 2012). As previous work has also illustrated the positive influence emotional granularity has on effective communication and emotion processing in psychosocial situations (Barrett, Gross, Conner, & Benvenuto, 2001; Kring, Barrett, & Gard, 2003), it raises the possibility that an individual's ability to describe their emotions in a more fine-tuned, nuanced manner may be related to the array of affect-related behaviors that are used to enhance the quality of social interactions.

Emotional granularity is most typically measured using some form of ecological momentary assessment, or similar methods that capture multiple time-points using Likert-scale ratings of a variety of emotions. In this study, I utilized a modified version of the Day Reconstruction Method (DRM; Kahneman, Krueger, Schkade, Schwarz & Stone, 2004) to measure emotional granularity. When completing the DRM in our laboratory, participants were asked to recall three events from the morning, three events from the afternoon, and three events from the evening of the day before the experimental session. Participants wrote these responses in a “diary” that they could refer to when finishing the second portion of the task. Participants were then asked to indicate what level (from 0 to 6) they experienced each of 20 emotion categories while they were engaged in each event; ten emotion categories were positive and ten emotion categories were negative. As per the literature, granularity was calculated as the covariation between participants’ use of emotion terms across emotional experiences for the day they were reporting (Barrett, Gross, Christensen, & Benvenuto, 2001; Demiralp, Thompson, Mata, Jaeggi, Buschkuehl, Barrett et al., 2012; Lee et al., 2017). We expected those higher in SEE to report higher levels of differentiation when reporting their emotions on the DRM, because they are hypothesized to be higher in emotional granularity.

The primary goals of this research were to test the previously derived hypotheses, including: a) characterization of the associations among SEE, interoceptive awareness, and interoceptive accuracy; b) accuracy of person perception in three laboratory tasks; and c) a delineation of granularity between low- and high-SEE individuals. The results will be used towards an explication of the SEE construct.

A secondary goal of this research was to explore gender as a factor in the overall analysis. Gender differences on self-reported SEE have not been observed in previous samples (or in scale development/ validation), but there is a slight edge for gender in affect-related perception (Robinson, Johnson, and Fields, 1998; Harris, Hayes-Skelton, and Ciaramitaro, 2016). Additionally, previous studies (Grabauskaité, Baranauskas, & Griškova-Bulanova, 2017; Murphy & Bird, 2019) have shown evidence for gender differences on various measures of interoception (i.e., interoceptive accuracy, interoceptive awareness, self-report), though these findings have varied significantly by both task and sample. By examining gender as a factor, I aim to explore the relationship between gender and SEE in relation to laboratory measures of interoception, person perception, and emotional granularity.

CHAPTER II

METHOD

2.1 Participants

Sixty adults (30 males, 30 females), 18 years of age and older were recruited from the Nashville community via the not-for-profit website ResearchMatch.com. There were no exclusion criteria. The study lasted 2.5 hours and participants were compensated $25. No participants withdrew from the study. Mean age was 46.07 years (SD = 19.28), with a range from 18 to 80. Mean education level was 16.98 years (SD = 3.08), where 16 years = 4-year college degree. Most participants were Caucasian (83.3%), followed by Black and African Americans (15.0%), Asian Americans (6.7%), and Hispanic and Latino Americans (5.0%).

2.2 Measures

To test the associations among SEE and conceptually related constructs in a community sample, additional self-report measures were included in this study. These comprised three of the constructs identified as having considerable conceptual overlap with SEE during validation of the SEE Scale (McBrien et al., 2018), as well as alexithymia; a subclinical personality trait we expected to have a negative relationship with self-reported SEE.

The Social-Emotional Expertise Scale (SEE; McBrien et al., 2018) is a 25-item, self-report measure of social-emotional expertise. The scale items represent both specific cognitive abilities thought to be related to social interactions and behaviors that emphasize the timing and synchrony of interpersonal behaviors. Factor analyses revealed that the SEE Scale consists of two factors, a) Adaptability ("I'm a natural at knowing how to coordinate my emotional responses to others' emotions"); and b) Expressivity ("I'm animated when I speak"). Respondents rate how well each item best describes what is typical for them on a Likert scale from 1 (Never) to 5 (Always). Higher scores on the SEE Scale are therefore purportedly correlated with higher social-emotional expertise in actual social interactions. The SEE Scale is reliable, test-retest: $r(80) = .82, p < .001$, and internally consistent (Cronbach's $\alpha = .90$).

The Trait Emotional Intelligence Questionnaire—Short Form (TEIQue; Schutte et al., 1998) is a 30-item self-report questionnaire designed to measure trait emotional intelligence. Respondents rate the extent to which each item applies to them on a Likert scale anchored by ratings of 1 "strongly disagree" and 5 "strongly agree." The TEIQue—Short Form is a subset of the items used in the full form of the TEIQue; the short form has good internal consistency (Cronbach's $\alpha = .86$) and external validity.

The Tromsø Social Intelligence Scale (TSIS; Silvera et al., 2001) is a 21-item questionnaire designed to measure individuals' self-reported social intelligence. The TSIS has three subscales: Social Information Processing, Social Skills, and Social Awareness. Respondents rate the extent to which each item describes them on a 7-item Likert scale with the lowest rating of 1 indicating that the item "describes me extremely poorly" and the highest rating of 7 indicating that the item "describes me extremely well." Using Cronbach's alpha coefficient to evaluate the internal reliability for each of the three factors, SIP ($\alpha = .81$), SS ($\alpha = .86$), and SA $\alpha = .79$), the TSIS shows acceptable internal reliability. Higher scores on the TSIS are indicative of higher trait-levels of social intelligence.

The Toronto Empathy Questionnaire (TEQ; Sprenget al., 2009) is a 16-item self-report questionnaire which assesses empathy as primarily an emotional process. Respondents read a list of statements and rate how frequently they feel or act in the manner described on a Likert scale extending from 1 (Never) to 5 (Always). The TEQ demonstrates good internal consistency (Cronbach's α = .85) and high test-retest reliability.

The Toronto Alexithymia Scale (TAS; Bagbyet al., 1994) is a 20-item instrument that is one of the most commonly used measures of Alexithymia. Alexithymia is a trait that refers to individuals who have difficulties identifying and describing emotions (both their own and the emotions of others), and who minimize emotional experience. Respondents rate to which degree each item applies to them on a Likert scale from 1 "strongly disagree" to 5 "strongly agree." The TAS demonstrates good internal consistency (Cronbach's α = .81) and test-retest reliability (r = .77, $p < .001$).

The Day Reconstruction Method (DRM; Kahneman et al., 2004) is a survey with the initial purpose of assessing how people spend their time and how they experience the various activities and settings of their everyday lives. For the purposes of this study, the DRM was used to assess granularity and modified (Lee et al., 2017) to include a section where participants indicated to what level (from 0 to 6) they experienced each of 20 emotion categories while they were participating in each daily event. These ratings were then used to calculate the degree of emotional granularity in each participant's life.

2.3 Apparatus

Participants were fitted with a pre-moistened respiratory belt to record cardiac activity via a heartbeat monitor (Polar H10 Heart Rate Monitor, Bluetooth HRM Chest Strap). Respiratory Activity was measured using a manual Peak Flow Meter (PEAKAIR Peak Flow Meter by Omron).

2.4 Procedure

The experiment consisted of a single, two and a half hour testing session. Participants were tested individually in a large, comfortably furnished laboratory room. Participants were seated in a comfortable chair with arm rests, at a 68" table in our research laboratory. After being greeted by a research assistant, participants were provided with a brief description of the study and informed consent was obtained using REDCap electronic data capture tools hosted at Vanderbilt University (Harris, Taylor, Thielke, Payne, Gonzalez, and Conde, 2009). Participants were then asked to complete a brief demographics form, which included questions relating to age, gender, education, ethnicity, and socio-economic status. Participants then completed the collection of self-report questionnaires described above, administered via a small laptop using REDCap. To allow for greater privacy, the research assistant left the room while participants completed self-report measures as well as questionnaires that were a component of behavioral tasks (described below).

Participants then began the experimental tasks. Interoceptive accuracy and awareness was measured using two tasks: the Schandry Heartbeat Tracking Task and the Respiratory Discrimination Task (Kleckner et al., 2015; Murphy et al., 2018). In the Heartbeat Tracking Task, participants were asked to count their heartbeats (relying only on their bodily sensations and not monitoring their pulse) during an established time interval of 25 s. Thirty trials of the Heartbeat Tracking Task were conducted. After every 10 trials, participants were asked to rate their confidence in the scores they reported during the Heartbeat Tracking Task (i.e., "How confident are you in your reported ratings?") using REDCap. This procedure resulted in three confidence ratings for each participant.

In the Respiratory Discrimination Task, which measures interoceptive accuracy and awareness in the respiratory domain, participants were presented with a peak-flow meter, a device that measures the speed at which air is pushed out of the lungs. Peak airflow was assessed by having participants complete three large exhalations (to establish peak airflow) and calculating the average. Next, participants were asked to aim for a 30%, 50%, 70%, or 90% match of that initial, maximum baseline exhalation. In total, participants completed six blocks of four trial targets (30%, 50%, 70%, 90%). The order of the percentage targets was randomized within each block. Each block took approximately 1 min to complete. After every two blocks, participants completed the same confidence ratings (in REDCap) that were used for the Heartbeat Tracking Task. This procedure resulted in three confidence ratings for each participant.

To measure emotional granularity, participants completed a modified version (Lee et al., 2017) of the Day Reconstruction Method (DRM) (Kahneman et al., 2004). The DRM took approximately 25-30 min to complete. It was completed using both a written "diary" packet and questionnaires administered via REDCap. Participants first recalled three events from the morning, three events from the afternoon, and three events from the evening of the day before the experiment. For each event, they then wrote what they were doing, where they were, and whom (if anyone) they were interacting with. Finally, they indicated to what level (from 0 to 6) they experienced each of 20 emotion categories while they were engaged in each event. Ten emotion categories were positive and ten emotion categories were negative.

Last, participants completed three tasks designed to measure person perception: distinguishing Duchenne from non-Duchenne smiles (Bernstein et al., 2008) a trustworthy-untrustworthy categorization task (Krieglymeyeret al., 2010), and the Interpersonal Perception

Task (IPT-15) (Costanzo & Archer, 1993). In the IPT-15, participants watched 15 video interactions that last a total of approximately 20 min. The Duchenne/non-Duchenne task and the Trustworthy/ Untrustworthy task featured written directions at the beginning of the task and each took approximately 5-7 min to complete. These tasks were completed in REDCap.

CHAPTER III

RESULTS

3.1 Data Analysis

Statistical analyses were conducted using SPSS, Version 25 (SPSS, 2017) and RStudio (Team, 2015). All 60 participants recruited for this study were included in sample-wide analyses investigating the statistical associations between SEE and other self-report and behavioral measures. Individuals identified as being at the top, middle, and bottom third of the SEE Scale distribution were described as high-, average-, and low-SEE, respectively. Mean differences questionnaires and behavioral measures were tested using Analysis of Variance (ANOVA) with multiple planned, pairwise comparisons. Bonferroni corrections were used to account for multiple comparisons. Pearson correlation coefficients were used for continuous variables. Sample-wide differences were assessed using two samples *t*-tests.

3.2 SEE and Related Measures

Significant, positive correlations were found among the SEE Scale and self-report measures of emotional intelligence, social intelligence, and empathy (Table 1). As hypothesized, TAS (alexithymia) scores were found to correlate negatively with SEE scale scores. These positive and negative correlations further illustrate the convergent and discrimination validity data previously reported (McBrien et al., 2018).

Table 1. *Associations among the SEE Scale and related measures*

Measure	SEE Scale	EI	SI	Empathy	Alex.	*M*	*SD*
SEE Scale	1	.801**	.640**	.522**	-.426**	91.42	12.04
TEIQue			.715**	.596**	-.587**	119.93	14.34
TSIS				.572**	-.480**	104.60	12.68
TEQ					-.379**	50.42	6.59
TAS					1	52.32	10.02

Note. TEIQue = Emotional Intelligence Questionnaire; TSIS = Social Intelligence Scale; TEQ = Empathy Questionnaire; TAS = Alexithymia Scale. *N = 60, ** p<.01*

3.3 Interoceptive Accuracy

The number of heartbeats participants reported for each trial was compared to the actual number of recorded beats (as measured by the Heart Rate Monitor, see Apparatus above). Thus, Interoceptive accuracy (IAcc) on the heartbeat tracking task was calculated using the following formula:

(IAcc) = (1–(|actual heartbeats – reported heartbeats|) / actual heartbeats).

Thus, interoceptive accuracy scores can range from 0 to 1, with higher scores indicating less discrepancy between self-reported and monitored heartbeats. This formula is designed to make over-counting (counting heartbeats that do not occur) and under-counting (missing actual heartbeats) equivalent, in a score bounded by 0-1 (Schandry et al., 1981). This same formula was used to calculate IAcc on the respiratory discrimination task.

Interoceptive accuracy was computed at the trial level, as individual trials were used as the unit of analysis. Each participant completed 30 trials of the heartbeat tracking task and 24 trials of the respiratory discrimination task. Because no violations of normality or homogeneity of variance were observed for either the heartbeat tracking and respiratory discrimination interoceptive accuracy scores, group differences were assessed using a two-way ANOVA.

No significant differences were found in interoceptive accuracy among low-SEE (M= 0.57, SD = 0.20), average-SEE (M= 0.59, SD = 0.24) or high-SEE (M= 0.59, SD = 0.31) individuals on the heartbeat tracking task ($F(2, 3.619) = 0.087$, $p = .916$, $\eta^2 = .003$). Likewise, no significant differences were found in interoceptive accuracy between low-SEE (M= 0.71, SD = 0.13), average-SEE (M= 0.69, SD = 0.14) or high-SEE (M= 0.72, SD = 0.07) individuals on the respiratory discrimination task ($F(2, 54) = 0.409$, $p = .666$, $\eta^2 = .015$).

3.4 Interoceptive Awareness

Interoceptive awareness (IAwe) on both the heartbeat tracking and respiratory discrimination tasks was computed by calculating the Pearson correlation coefficient between interoceptive accuracy and self-reported confidence ratings after each set of 10 trials (Garfinkel et al., 2015). Therefore, interoceptive awareness scores can range from -1 to 1. Higher scores indicate greater correspondence between interoceptive accuracy and confidence ratings.

Because no violation of normality or homogeneity of variance was observed for either heartbeat tracking and respiratory discrimination interoceptive awareness scores, group differences were assessed using a two-way ANOVA. No significant differences were found in interoceptive awareness among low-SEE (M= -0.01, SD = 0.77), average-SEE (M= 0.11, SD = 0.84) or high-SEE (M= 0.07, SD = 0.71) groups on the Heartbeat tracking task ($F(2, 54) = 0.106$, $p = .900$, $\eta^2 = .004$). Similarly, no significant differences were found in interoceptive awareness between low-SEE (M= 0.31, SD = 0.69), average-SEE (M= 0.16, SD = 0.66) or high-SEE (M= 0.23, SD = 0.73) individuals on the Respiratory discrimination task ($F(2, 27.081) = 0.251$, $p = .779$, $\eta^2 = .009$).

Although the overall ANOVA model was not significant, pair-wise comparisons revealed differences between groups based on an interaction effect between SEE X Gender. Results of comparisons between average-SEE men and women on interoceptive awareness collected via the heartbeat tracking task (see Figure 2) indicated that women with average, self-reported SEE had significantly higher interoceptive awareness than average-SEE men ($F(1, 54) = 5.975$, $p = .018$, $\eta^2 = .100$). There were no significant interactions between interoceptive awareness and gender in low- or high-SEE groups, though it was observed that female participants reported higher interoceptive awareness scores across all groups in the Heartbeat tracking task.

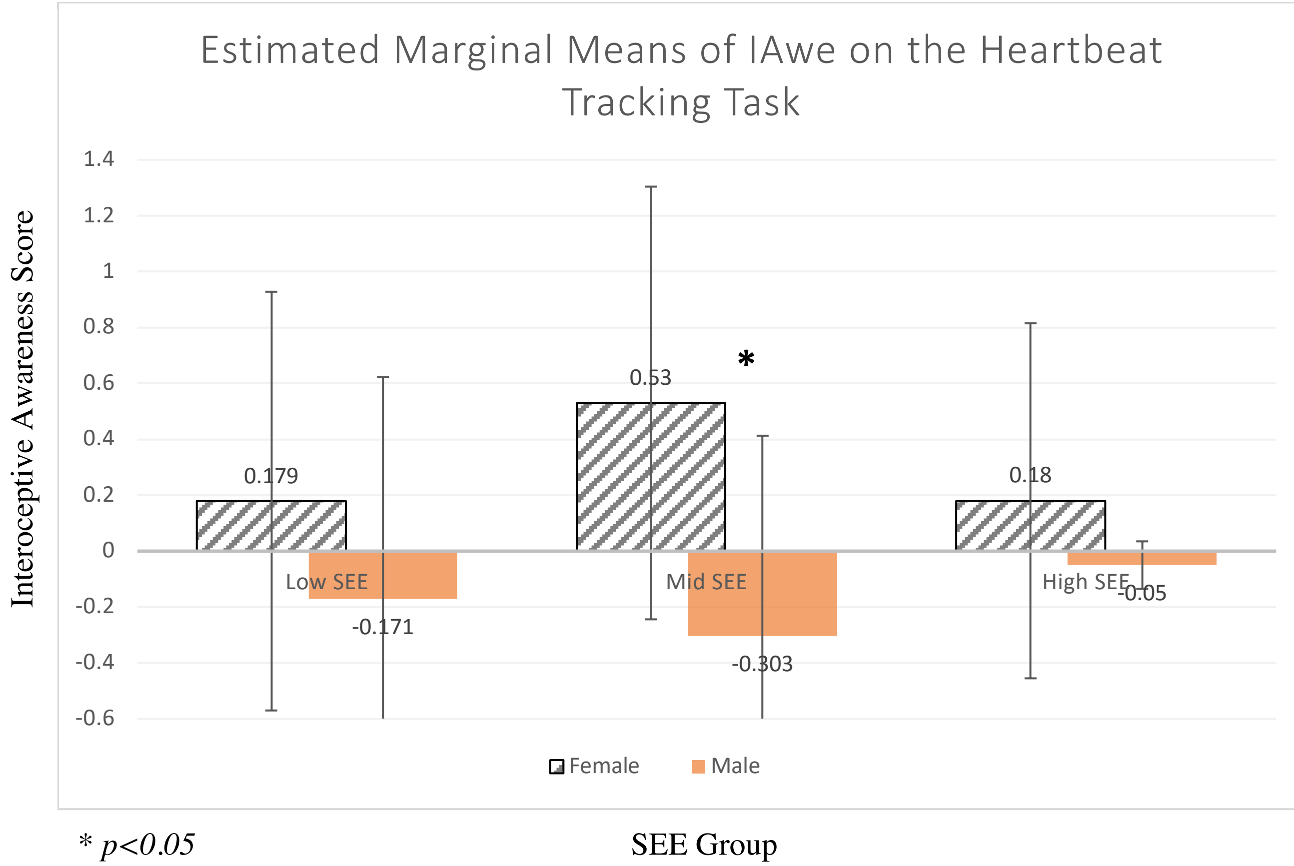
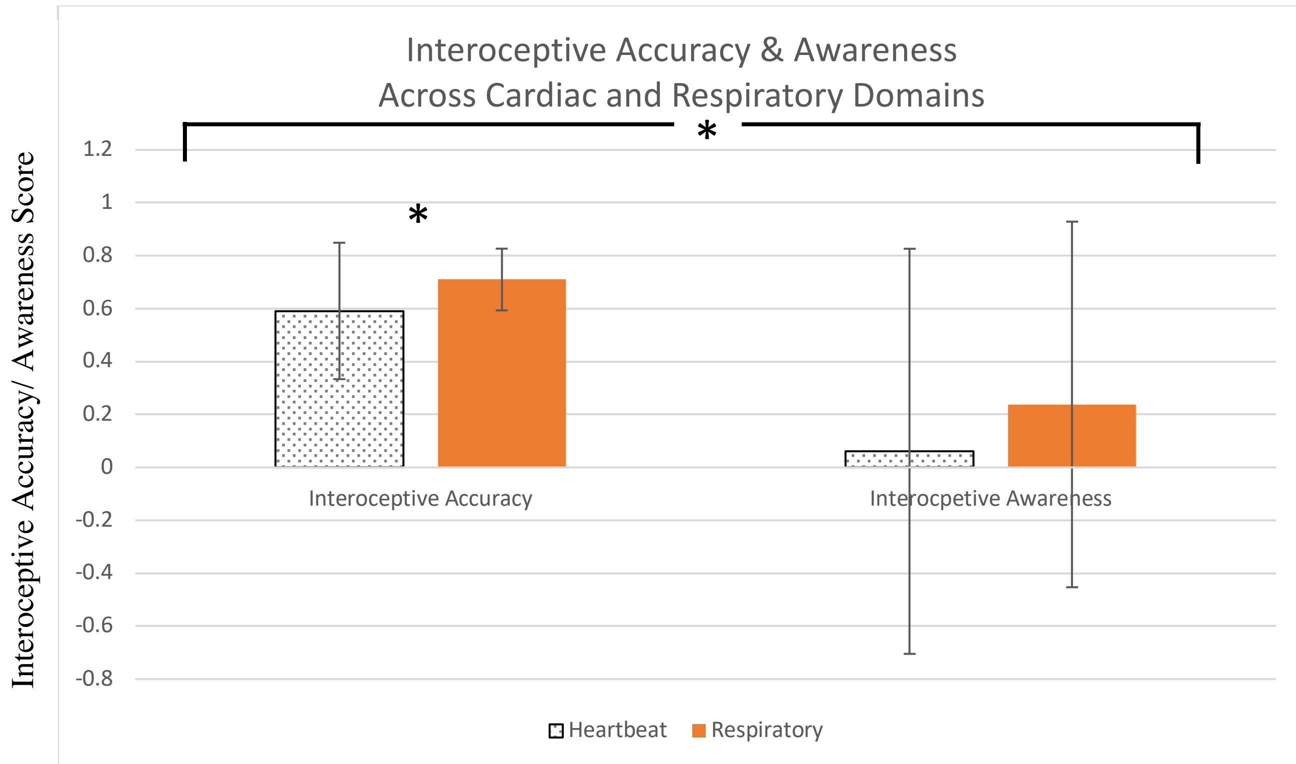


Figure 2. Comparisons of Interoceptive Awareness Scores (ranging from -1 to 1) of low-SEE, average-SEE vs. high-SEE participants on the Heartbeat tracking task, separated by gender.

3.5 Interoceptive Measures

Two laboratory measures of interoception, one associated with the cardiac domain and the second with the respiratory domain, were used in this study. This next series of analyses assessed whether the dimensions of interoception (accuracy and awareness) were consistent across the domains (cardiac and respiratory). Interoceptive accuracy between cardiac and respiratory domains was not significantly correlated ($r = 0.078$, $p = 0.553$). Moreover, interoceptive awareness across the two domains did not significantly correlate ($r = -0.045$, $p = 0.734$

Two sample *t*-tests (assuming unequal variance) were used to calculate sample-wide differences between interoceptive accuracy and awareness. Across both respiratory and cardiac domains, participants received significantly higher interoceptive accuracy than awareness scores (See Figure 3). A significant difference was observed between participants' reported interoceptive accuracy (heartbeat; ($M= 0.59$, $SD = 0.25$); respiratory; ($M= 0.71$, $SD = 0.11$)) and interoceptive awareness (heartbeat; ($M= 0.06$, $SD = 0.76$); respiratory; ($M= 0.23$, $SD = 0.69$)) scores in both the cardiac ($t(72) = 5.08$, $p < 0.001$) and respiratory ($t(62) = 5.21$, $p < 0.001$) domain. A significant difference was also found between the two estimates of interoceptive accuracy ($t(82) = -3.24$, $p < 0.001$).



** p<0.001*

Interoceptive Measure

1) and

Interoceptive Awareness Scores (ranging from -1 to 1) on the Heartbeat tracking task and Respiratory discrimination task. Error bars represent standard deviations.

3.6 Person Perception

Because violations of neither normality nor homogeneity of variance were observed, group differences in performance on the three person-perception tasks were assessed using a two-way ANOVA. No significant differences were observed in the performance of high-, average-, and low-SEE individuals on any of the three person perception tasks (see Figure 4). It is worth noting that none of the participants obtained a perfect score on any of these measures, indicating that ceiling effects were not the basis for supporting the null.

Although the overall ANOVA model was not significant, pair-wise comparisons revealed differences between groups based on an interaction effect between SEE and Gender. Results of comparisons between low-SEE men and women on the Interpersonal Perception Task (see Figure 5) indicated that women with low, self-reported SEE performed significantly better on the IPT-15 than low-SEE men ($F(1,54) = 4.674$, $p = .035$, $\eta^2 = .080$). There were no significant interactions between performance on the IPT-15 and gender in average-SEE or high-SEE groups.

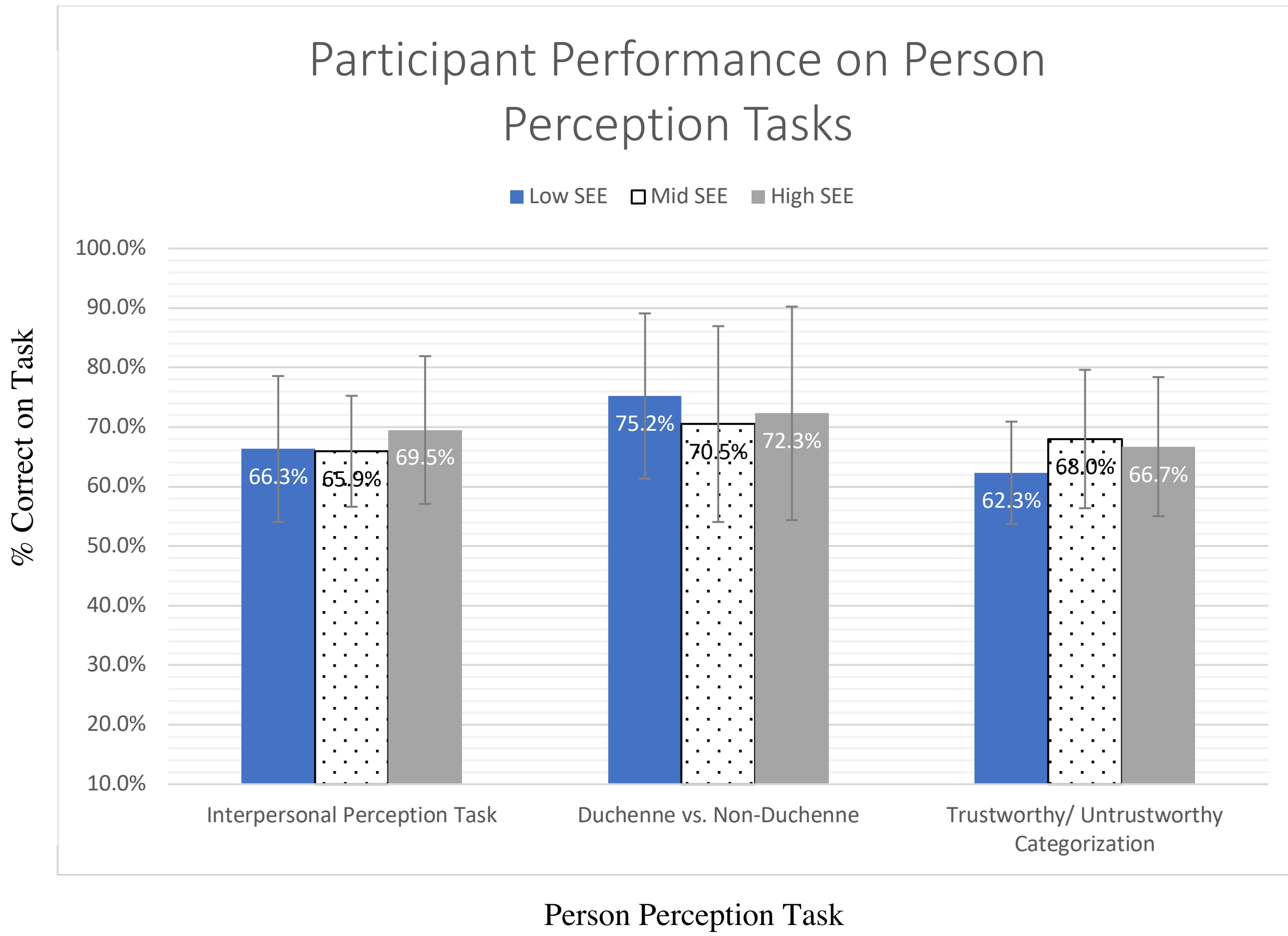


Figure 4. Comparisons of the performance (% correct) of low-SEE, average-SEE vs. high-SEE participants on three tasks used to measure person perception. Error bars represent standard deviations.

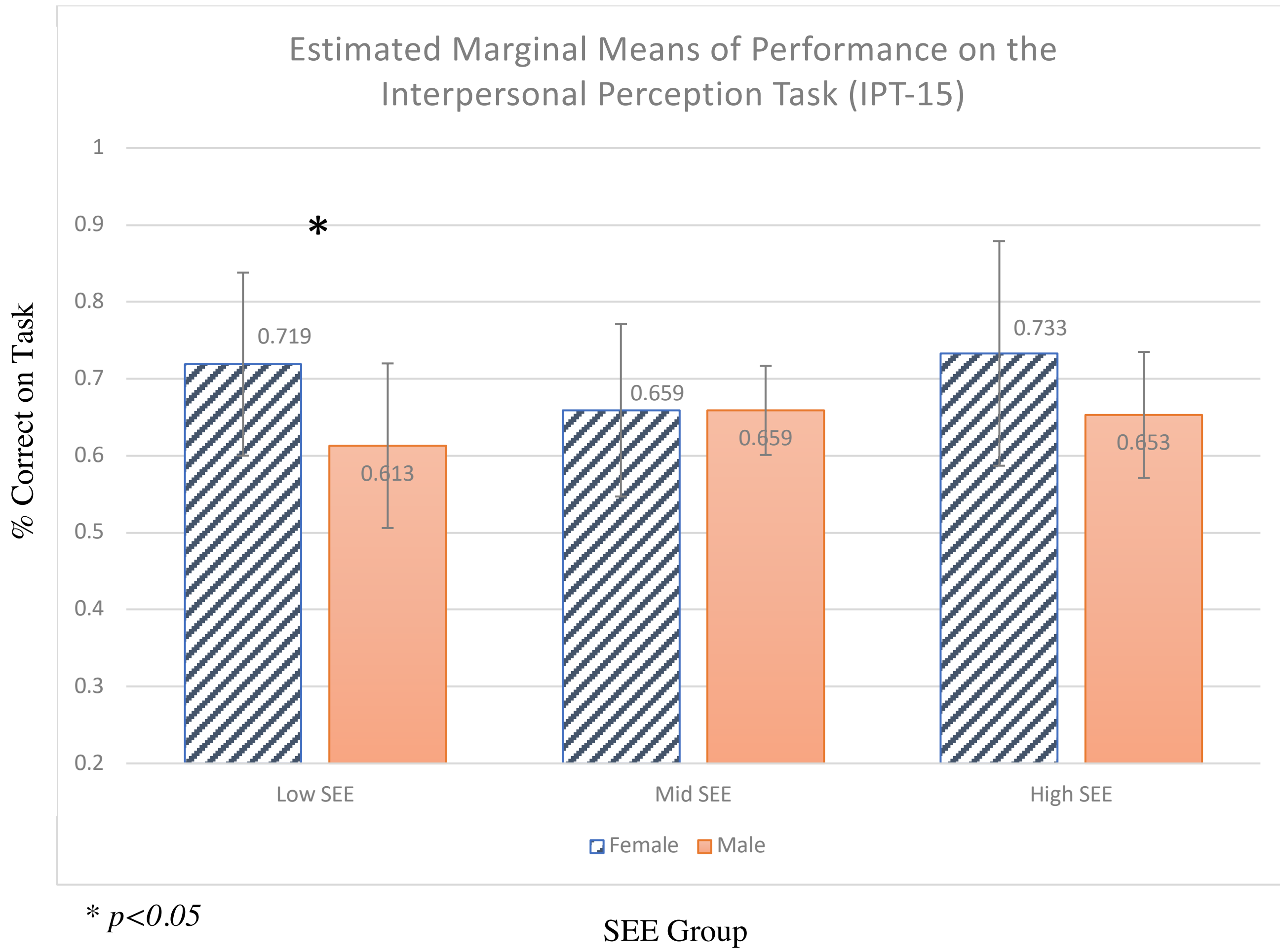


Figure 5. Comparisons of the performance (% correct) of low-SEE, average-SEE vs. high-SEE participants on the Interpersonal Perception Task (IPT-15), separated by gender. Error bars represent standard deviations.

3.7 Emotional Granularity

Emotional granularity was calculated as the covariation among participants' use of emotion terms across emotional experiences for the day they were reporting (Barrett et al., 2001; Demiralp et al., 2012). Intraclass correlations (ICCs) have been frequently used to calculate granularity in studies utilizing either ecological momentary assessment methods (Tugade, Frederickson, & Barrett, 2004; Kimhy, Vakhrusheva, Khan, Chang, Hansen, Ballon, & Gross, 2014) or the DRM (Lee et al., 2017). Average ICCs with absolute agreement between responses were calculated separately for both positive and negative emotion words, then averaged to derive a single emotional granularity value. A low ICC score indicates that the participant can describe their feeling state in response to daily events with an array of distinct emotion words, whereas a high ICC score indicates that the participant uses similar emotion words interchangeably. For simplicity of interpretation, all ICCs were subtracted from 1 to make higher scores correspond with greater levels of emotional granularity. The average granularity of the participants was 0.65 (SD = 0.23).

ICCs were calculated from participants' responses across events on the DRM, based on a sampling of 4 positive (amusement, excitement, pride, happiness) and 4 negative (tired, sadness, disgust, anger) words, selected from the total of 20 twenty that were assessed. These emotions were selected as they represent a wide range of prototypical positive and negative feeling states (Tugade, 2004).

Because no violations of either normality or homogeneity of variance were observed for emotional granularity scores, group differences were assessed using a two-way ANOVA. No significant differences were found in emotional granularity between low-SEE (M= 0.70, SD = 0.22), average-SEE (M= 0.65, SD = 0.21) or high-SEE (M= 0.60, SD = 0.28) individuals on the

DRM ($F(2, 54) = 0.876$, $p = .422$). There were no significant interactions between emotional granularity ratings on the DRM and gender in low, average, or high-SEE groups.

Two sample *t*-tests (assuming unequal variance) were used to calculate sample-wide differences between positive and negative emotional granularity scores. Across all groups, participants showed higher levels of negative emotional granularity in comparison to their positive emotional granularity scores ($t(106) = -5.84$, $p < 0.001$). Planned comparisons showed that this effect between positive and negative granularity occurred in low-SEE, average-SEE, and high-SEE individuals (outcomes are plotted in Figure 6). These results indicate that participants were able to be more granular, or distinct, when describing their negative emotional response to events that occurred in their everyday life.

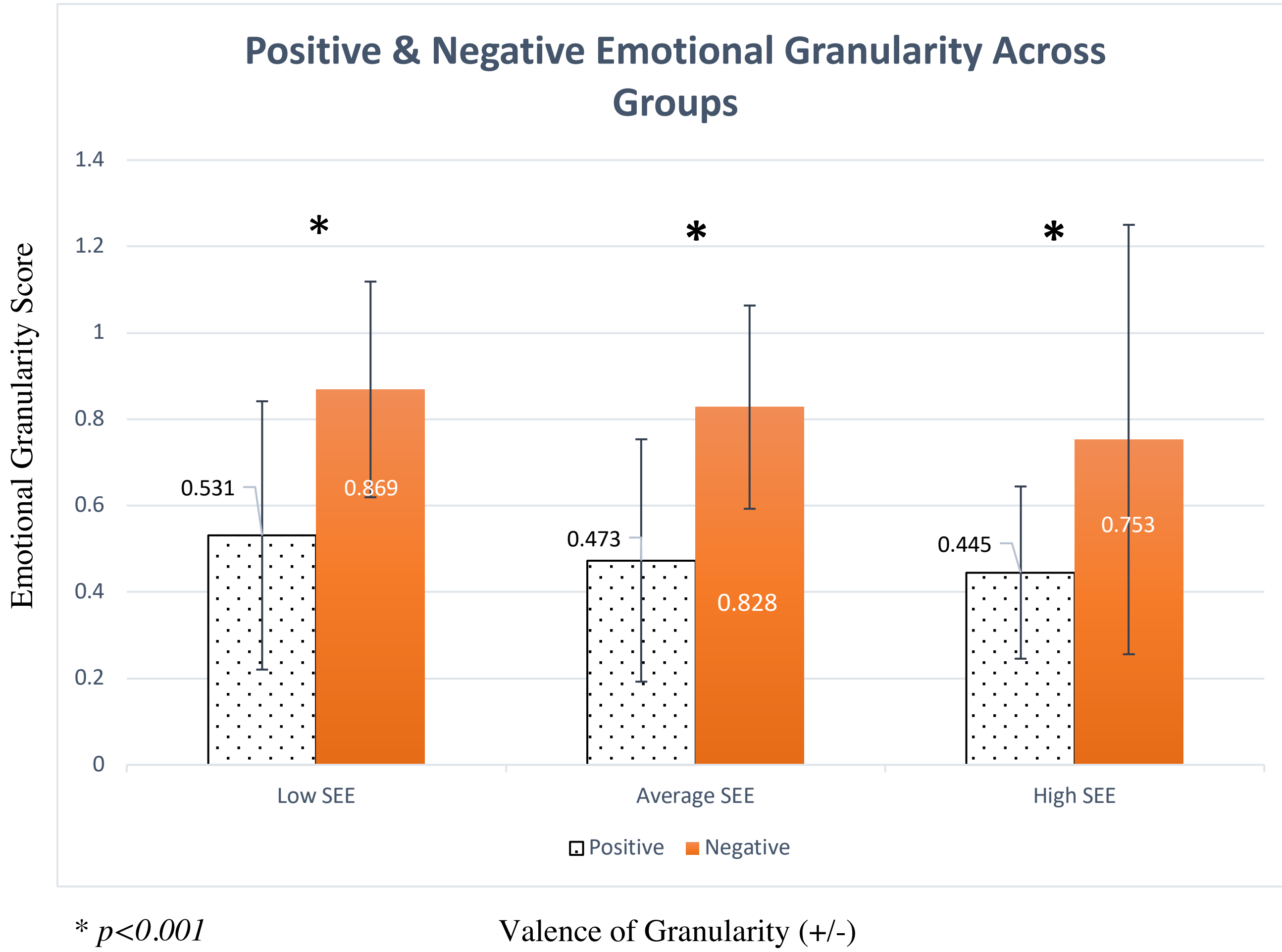
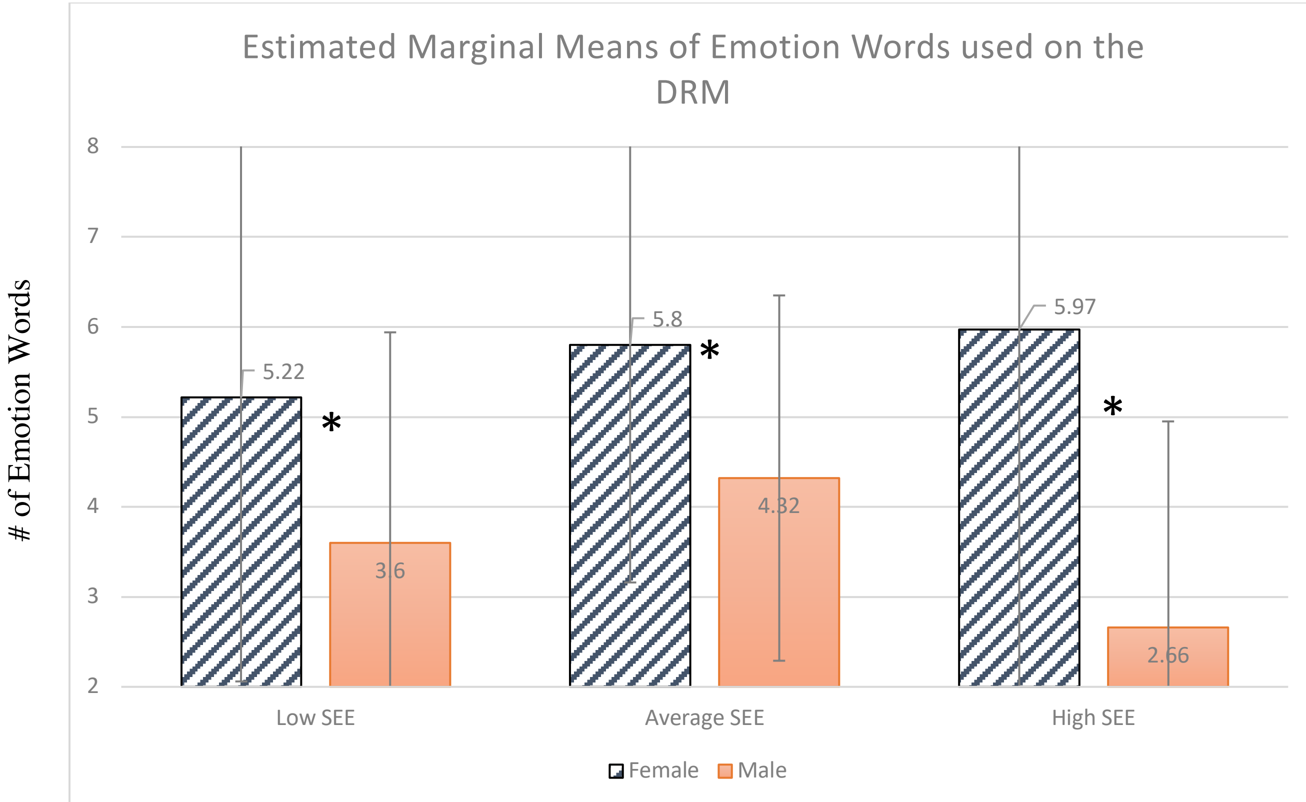


Figure 6. Comparisons of positive and negative emotional granularity scores (ranging from 0 to 1) on the DRM across low, average, and high-SEE groups. Error bars represent standard deviations.

Two analyses were completed on the free-response portion of the DRM. The number of emotion words participants used across all nine events was totaled to provide one value for each participant. Reliability of identifying emotion words was determined based on the overall number of emotion words across all events. The correlation was high, indicating the ratings were consistent across raters and participants' free-response writing samples ($r = .94, p < .001$). The average number of emotions used across all events by participants was 4.46 ($SD = 2.98$).

Because no violations of normality or homogeneity of variance were observed, group differences were assessed using a two-way ANOVA. There were no significant differences between the number of emotion words used in low vs. high-SEE participants. There was, however, a main effect of gender across all groups (see Figure 7). These results indicate that women with low, average, and high-SEE used significantly more emotion words when writing about their day than their male counterparts ($F(1, 53) = 8.171, p < .006,\ \eta^2 = .080$).

Lastly, an overall word count for each participant was calculated from across all events they described in their DRM diary. A one-way ANOVA was used to compare the word count in each group. No significant differences were found in word count between low-SEE ($M = 51.19$, $SD = 26.15$), average-SEE ($M = 56.70$, $SD = 27.16$) or high-SEE ($M = 61.28$, $SD = 43.77$) individuals, though scores ranged significantly within-group. It is worth noting that high-SEE individuals used, on average, 10 more words in their diary than low-SEE individuals.



* *p<0.006* SEE Group

Figure 7. Comparisons of the number of emotion words used on the DRM across low, average, and high-SEE groups. Error bars represent standard deviations.

CHAPTER IV

DISCUSSION

The primary goals of this research were to test three hypotheses related to the individual difference variable of SEE. Specifically, these hypotheses included: a) characterization of the associations among SEE, interoceptive awareness, and interoceptive accuracy; b) accuracy of person perception in three laboratory tasks; and c) a delineation of granularity between low- and high-SEE individuals.

Using the heartbeat tracking task (Schandry, 1981) and a respiratory discrimination task, we found evidence that these two measures of interoceptive processes do not significantly correlate. While Murphy, Catmur, and Bird (2018) piloted three new interoception measures (including a respiratory task similar to the one used in this study), to our knowledge, this is the first study to include measures of interoceptive processes in both the cardiac and respiratory domain. These results provide support for the dissociable impact two distinct measures of interoception provide, across both accuracy and awareness.

Additionally, the findings of this study provide further support to the criticisms presented by Zamriola and colleagues (2018). They argue that the nearly exclusive use of heartbeat tasks in interoception research lacks fundamental construct validity and mount the claim that our conceptualization of interoception should not be tied exclusively to monitoring the heart. Our findings also showed that people are generally much better at interoceptive accuracy than interoceptive awareness. That is, it’s easier for individuals (across groups) to more accurately identify the internal state of their body than to combine that identification with a judgement regarding their own confidence in this perception. This aligns with other recent findings by Murphy, Geary, Millgate, Catmur, & Bird, 2018 and Forkman, Scherer, Meessen, Michael, Shachinger, Vogele, & Schulz which have emphasized the division between these two measures, positing that accuracy and awareness scores provide valuable, but distinct, information on an individuals' interoceptive ability. The results of the study reported here support Allen (2018)'s argument for expanding and diversifying our measurement of interoception. Our findings indicate the value in accessing various physiological measures that draw from different internal states (i.e., cardiac, respiratory), as well as including methods that account for individuals' accuracy and awareness.

A secondary goal of this research was to explore gender as a factor in the overall analysis. Gender differences on self-reported SEE have not been observed in previous samples (or in scale development/ validation), but there is a slight edge for gender in affect-related perception (Robinson et al., 1998; Harris et al., 2016). There have been mixed results relating to the relationship between interoception and gender (Grabauskaité et al., 2017; Murphy & Bird, 2019) in previous work, further highlighting the importance of exploring this relationship more closely.

Interoceptive awareness is a sensory process involving receiving, accessing, and translating internal bodily signals (Craig, 2009). It notably draws on both an individuals' precision at identifying interoceptive cues, as well as their awareness of how accurate their determinations are. It was hypothesized that high-SEE individuals would exhibit higher levels of interoceptive awareness. No significant differences were observed between low-, average-, or high-SEE groups on laboratory tasks measuring interoceptive accuracy or awareness, in both the cardiac and respiratory domain. However, interestingly, we found average-SEE women had the highest levels of interoceptive awareness compared to all other groups. This measure of interoceptive awareness was derived from the correlation between participants' interoceptive accuracy rating and their self-reported confidence in their reporting. This finding indicates that women with average social-emotional expertise are more aware of how effective they are at interpreting the internal state of their body.

Previous research in this field has shown women often exhibit significantly higher interoceptive awareness than men (Grabauskaité et al., 2017). Given that global health trends indicate that women generally report more intense, frequent, and numerous bodily symptoms than men (Barsky, Peekna, and Borus, 2001) and are also more likely to seek medical treatment/ manage chronic health conditions (Wang, Hunt, Nazareth, Freemantle, and Petersen, 2013), it follows that women generally spend more time both thinking about their bodily processes, as well as receiving feedback. It is possible that average-SEE women, specifically, are more "in touch" with the internal sense of their bodies and attend more to this information, as they do not have the deficit of low-SEE individuals, nor the ability to draw from the numerous "toolkit" skills of high-SEE individuals. But despite this finding, we did not find clear evidence for a relationship between social-emotional expertise and interoception.

As expected, SEE was positively correlated with self-report measures of social intelligence, emotional intelligence, and empathy. A negative correlation between SEE and alexithymia was also observed. This finding was expected, given that it would be difficult to excel at coordinating and translating affect-related gestures/ vocalizations into pro-social interactions while lacking emotional awareness and struggling to identify and describe feelings (as is the case for individuals with alexithymia). It is important to note that the correlations between SEE, SI, and EI were very high, significantly higher than we have seen in other samples we have collected. SEE represents a blend of specific cognitive abilities (such as SI and EI), but also emphasizes the timing and synchrony of behaviors that help support meaningful and high-quality social interactions. As we recruited from a community sample and the average age of our participants (46.07 years; SD = 19.28) was significantly older than a college-aged sample, it is possible that age played a role in these higher than usual correlations. Older adults generally have less time and opportunity for the frequent socialization afforded to young college students, which could lead an older sample to conceptualize their self-reported SEE more in terms of the cognitive abilities underlying their social interactions. This would then map similarly onto both the SI and EI constructs.

It was hypothesized that high-SEE individuals would perform significantly better on three laboratory tasks designed to measure person perception. However, no significant differences were observed between low-, average-, or high-SEE groups in relation to their person perception abilities. However, interestingly, we observed low-SEE female participants out-performing all other groups at making accurate social perception judgements in the Interpersonal Perception Task (IPT). This task is the most ecologically valid of all the person perception tasks included in this study, as it involves making perceptual judgement on dynamic social interactions occurring in a real-world context. Previous research has shown that women often display slightly better and more accurate person perception skills, in comparison to men (Smith, Archer, and Costanzo, 1991). As SEE aims to bridge the gap between prosocial cognition and behavior, it is possible that low-SEE women might have an advantage in making nuanced social perception judgements, but struggle in translating that knowledge into smooth social encounters. Including a laboratory task that involves making interpersonal perceptions, then also integrating those observations into a socially meaning interaction would help further delineate this process.

This study tested how high- versus low-SEE individuals express the granularity of their emotional state using a modified version of the Day Reconstruction Method (DRM; Kahneman et al., 2004). While we did not find differences in emotional granularity between SEE groups, our results did indicate some interesting trends. First, women across all SEE groups used more emotion words then men when writing about their emotional experience and mood throughout the day. This was discovered by further analyzing the free-response “diary” of the DRM, which has not been included in previous research examining emotional granularity. Of note, two previous studies (Tugade et al., 2004; Lee et al., 2017) reported no gender differences in granularity scores when only reporting the ICCs among gender groups. This research shows the benefit of including an analysis of participants’ written responses in addition to calculating the covariation between participants’ use of emotion terms across emotional experiences for the day they were reporting. As Likert-type ratings do not capture all of an individual’s daily emotional experience, granularity can be best measured with a multi-method framework.

There were several limitations to the studies presented here. First, the manual nature of timing and collecting numerous interoception trials introduces a level of human-error that may have resulted in less precise measurements of interoception constructs. Second, the cultural variation of the participants in these studies was limited to American-English-speaking adults in the United States, significantly limiting the generalizability of these findings. Future work replicating these results in more diverse samples is necessary. Finally, the measures of person perception included in this study were all limited to short videos and images viewed on a computer screen. Further work would benefit from having more ecologically valid and realistic methods to measure the perceptual processing of social cues.

There are several specific exploratory analyses that might help us further tease out what the data from this study indicate. Testing the relative ability of SEE and related constructs (i.e., EI, SI, empathy) to predict performance on the dependent variables included in this study would be interesting, particularly in relation to what predicts high performance on measures of interoception and person perception. Additionally, it could be worthwhile to more closely look at individual and group performance throughout the numerous trials of interoceptive testing in the cardiac and respiratory domain: Does accuracy get better or worse as participants complete more trials? At what point (if any) do responses become consistent and even out? Does this change based on SEE group? Lastly, I would like to further explore the relationship between alexithymia and dependent variables. This study marks the first time we've investigated the relationship between alexithymia and SEE. Given the strong negative correlation observed between these two measures, it would be interesting to see how those who are high in alexithymia performed on interoception measures, in addition to exploring both the cognitive and affective self-report components that comprise this subclinical trait.

REFERENCES

Allen, M. (2018, July). *For whom the bell tolls? A potential death-knell for the heartbeat counting task*. Retrieved from https://micahallen.org/2018/06/29/for-whom-the-bell-tolls a-potential-death-knell-for-the-heartbeat-counting-task/amp/?__twitter_impression=true

Ambady, N., & Rosenthal, R. (1992). Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological bulletin*, *111*(2), 256.

Ayala, G. X., Gillette, C., Williams, D., Davis, S., Yeatts, K. B., Carpenter, D. M., & Sleath, B. (2014). A prospective examination of asthma symptom monitoring: provider, caregiver and pediatric patient influences on peak flow meter use. *Journal of Asthma*, *51*(1), 84-90.

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale—I. Item selection and cross-validation of the factor structure. *Journal of psychosomatic research*, *38*(1), 23-32.

Barsky, A. J., Peekna, H. M., & Borus, J. F. (2001). Somatic symptom reporting in women and men. *Journal of general internal medicine*, *16*(4), 266-275.

Barrett, L. F. (2017). The theory of constructed emotion: an active inference account of interoception and categorization. *Social cognitive and affective neuroscience*, *12*(1), 1-23.

Barrett, L. F. (2017). *How emotions are made: The secret life of the brain*. Houghton Mifflin Harcourt.

Barrett, L. F. & Simmons, W. K. (2015). Interoceptive predictions in the brain. *Nature Reviews Neuroscience*, *16*(7), 419.

Barrett, L. F., Gross, J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition & Emotion*, *15*(6), 713-724.

Bernstein, M. J., Young, S. G., Brown, C. M., Sacco, D. F., & Claypool, H. M. (2008). Social rejection initiates an adaptive response when discriminating among real and fake smiles. *Psychological Science*, *19*, 981-983.

Blanke, O., & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in cognitive sciences*, *13*(1), 7-13.

Brener, J., & Kluvitse, C. (1988). Heartbeat detection – Judgments of the simultaneity of external stimuli and heartbeats. *Psychophysiology*, 25(5), 554–561.

Cameron, O. G. (2001). *Visceral sensory neuroscience: Interoception*. Oxford University Press.

Cogsdill, E. J., Todorov, A. T., Spelke, E. S., & Banaji, M. R. (2014). Inferring character from faces: A developmental study. *Psychological science*, *25*(5), 1132-1139

Costanzo, M., & Archer, D. (1993). *Interpersonal Perception Task-15*. Center for Media and Independent Learning, University of California Extension.

Craig, A. D. (2002). How do you feel? Interoception: the sense of the physiological condition of the body. *Nature Reviews Neuroscience*, *3*(8), 655.

Craig, A. D. (2003). Interoception: the sense of the physiological condition of the body. *Current opinion in neurobiology*, *13*(4), 500-505.

Critchley, H. D., Wiens, S., Rotshtein, P., Öhman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature neuroscience*, *7*(2), 189.

Critchley, H. D., & Garfinkel, S. N. (2017). Interoception and emotion. *Current opinion in psychology*, *17*, 7-14.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin*, *52*(4), 281.

Demiralp, E., Thompson, R. R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Barrett, L. F., et al. (2012). Feeling blue or turquoise? Emotional differentiation in major depressive disorder. *Psychological Science,* 23, 1410–1416.

Ernst, J., Böker, H., Hättenschwiler, J., Schüpbach, D., Northoff, G., Seifritz, E., & Grimm, S. (2013). The association of interoceptive awareness and alexithymia with neurotransmitter concentrations in insula and anterior cingulate. *Social cognitive and affective neuroscience*, *9*(6), 857-863.

Feldman, J. M., Matte, L., Interian, A., Lehrer, P. M., Lu, S. E., Scheckner, B., ... & Shim, C. (2016). Psychological treatment of comorbid asthma and panic disorder in Latino adults: Results from a randomized controlled trial. *Behaviour research and therapy*, *87*, 142 154.

Fiske, S. T. (2018). Warmth and competence are parallels to communion and agency: Stereotype content model. In *Agency and Communion in Social Psychology* (pp. 39-51). Routledge.

Forkmann, T., Scherer, A., Meessen, J., Michal, M., Schächinger, H., Vögele, C., & Schulz, A. (2016). Making sense of what you sense: Disentangling interoceptive awareness, sensibility and accuracy. *International Journal of Psychophysiology*, *109*, 71-80.

Grabauskaitė, A., Baranauskas, M., & Griškova-Bulanova, I. (2017). Interoception and gender: What aspects should we pay attention to?. *Consciousness and cognition*, *48*, 129-137.

Grunkina, V., Holtz, K., Klepzig, K., Neubert, J., Horn, U., Domin, M., & Lotze, M. (2017). The Role of Left Hemispheric Structures for Emotional Processing as a Monitor of

Bodily Reaction and Felt Chill–a Case-Control Functional Imaging Study. *Frontiers in human neuroscience*, *10*, 670.

Gunnery, S. D., & Ruben, M. A. (2016). Perceptions of Duchenne and non-Duchenne smiles: A meta-analysis. *Cognition and Emotion*, *30*(3), 501-515.

Harris, D. A., Hayes-Skelton, S. A., & Ciaramitaro, V. M. (2016). What's in a face? How face gender and current affect influence perceived emotion. *Frontiers in psychology*, *7*, 1468.

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of biomedical informatics*, *42*(2), 377-381.

Herbert, B. M., Herbert, C., & Pollatos, O. (2011). On the relationship between interoceptive awareness and alexithymia: is interoceptive awareness related to emotional awareness?. *Journal of Personality*, *79*(5), 1149-1175.

Holtz, B. C. (2015). From first impression to fairness perception: Investigating the impact of initial trustworthiness beliefs. *Personnel Psychology*, *68*(3), 499-546

James, W. (1894). Discussion: The physical basis of emotion. *Psychological Review*, *1*(5), 516.

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004). A survey method for characterizing daily life experience: The day reconstruction method. *Science*, *306*(5702), 1776-1780.

Katkin, E. S., Reed, S. D., & Deroo, C. (1983). A methodological analysis of 3 techniques for the assessment of individual-differences in heartbeat detection. *Psychophysiology*, 20(4), 452-452.

Khalsa, S. S., Rudrauf, D., & Tranel, D. (2009). Interoceptive awareness declines with age.

Psychophysiology, *46*(6), 1130-1136.

Kimhy, D., Vakhrusheva, J., Khan, S., Chang, R. W., Hansen, M. C., Ballon, J. S., ... & Gross, J. J. (2014). Emotional granularity and social functioning in individuals with schizophrenia: an experience sampling study. *Journal of psychiatric research*, *53*, 141-148.

Kleckner, I. R., Wormwood, J. B., Simmons, W. K., Barrett, L. F., & Quigley, K. S. (2015). Methodological recommendations for a heartbeat detection-based measure of interoceptive sensitivity. *Psychophysiology*, *52*(11), 1432-1440.

Krieglmeyer, R., Deutsch, R., De Houwer, J., & De Raedt, R. (2010). Being moved: Valence activates approach-avoidance behavior independently of evaluation and approach avoidance intentions. *Psychological Science*, *21*(4), 607-613.

Kring, A. M., Barrett, L. F., & Gard, D. E. (2003). On the broad applicability of the affective circumplex: representations of affective know

Lange, C. G., & James, W. (1922). *The Emotions* (Vol. 1). Williams & Wilkins.

Lee, J. Y., Lindquist, K. A., & Nam, C. S. (2017). Emotional granularity effects on event-related brain potentials during affective picture processing. *Frontiers in Human Neuroscience*, *11*, 133.

McBrien, A., Wild, M., & Bachorowski, J. A. (2018). Social–Emotional Expertise (SEE) Scale: Development and Initial Validation. *Assessment*, *00*(0), 1-13.

Mehrabian, A. (2017). *Nonverbal communication*. Routledge.

Merwin, R. M., Zucker, N. L., Lacy, J. L., & Elliott, C. A. (2010). Interoceptive awareness in eating disorders: Distinguishing lack of clarity from non-acceptance of internal experience. *Cognition and Emotion*, *24*(5), 892-902.

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: a meta-analysis. *Psychological bulletin*, *128*(4), 638.

Muir, K., Madill, A., & Brown, C. (2017). Individual differences in emotional processing and autobiographical memory: interoceptive awareness and alexithymia in the fading affect bias. *Cognition and Emotion*, *31*(7), 1392-1404.

Murphy, J., Viding, E., & Bird, G. (2019). Does atypical interoception following physical change contribute to sex differences in mental illness?. *Psychological review*.

Murphy, J., Catmur, C., & Bird, G. (2018). Alexithymia is associated with a multidomain, multidimensional failure of interoception: Evidence from novel tests. *Journal of Experimental Psychology, 147*(3), 398.

Murphy, J., Geary, H., Millgate, E., Catmur, C., & Bird, G. (2018). Direct and indirect effects of age on interoceptive accuracy and awareness across the adult lifespan. *Psychonomic bulletin & review*, *25*(3), 1193-1202.

Murry, M. W., & Isaacowitz, D. M. (2018). Age Similarities in Interpersonal Perception and Conversation Ability. *Journal of Nonverbal Behavior*, *42*(1), 101-111.

Pond Jr, R. S., Kashdan, T. B., DeWall, C. N., Savostyanova, A., Lambert, N. M., & Fincham, F. D. (2012). Emotion differentiation moderates aggressive tendencies in angry people: A daily diary analysis. *Emotion*, *12*(2), 326.

Rietveld, S., & Brosschot, J. F. (1999). Current perspectives on symptom perception in asthma: a biomedical and psychological review. *International Journal of Behavioral Medicine*, *6*(2), 120-134.

Ring, C. & Brener, J. (2018). Heartbeat counting is unrelated to heartbeat detection: A comparison of methods to quantify interoception. *Psychophysiology*, *55*(9), e13084.

Robinson, M. D., Johnson, J. T., & Shields, S. A. (1998). The gender heuristic and the database: Factors affecting the perception of gender-related differences in the experience and display of emotions. *Basic and Applied Social Psychology*, *20*(3), 206-219.

Rubenstein, L. D., Ridgley, L. M., Callan, G. L., Karami, S., & Ehlinger, J. (2018). How teachers perceive factors that influence creativity development: Applying a Social Cognitive Theory perspective. *Teaching and Teacher Education*, *70*, 100-110.

Sacco, D. F., Merold, S. J., Lui, J. H., Lustgraaf, C. J., & Barry, C. T. (2016). Social and emotional intelligence moderate the relationship between psychopathy traits and social perception. *Personality and Individual Differences*, *95*, 95-104.

Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends in cognitive sciences*, *17*(11), 565-573.

Schandry, R. (1981). Heart beat perception and emotional experience. *Psychophysiology*, 18(4), 483–488.

Schauder, K. B., Mash, L. E., Bryant, L. K., & Cascio, C. J. (2015). Interoceptive ability and body awareness in autism spectrum disorder. *Journal of experimental child psychology*, *131*, 193-200.

Schutte, N. S., Malouff, J. M., Hall, L. E., Haggerty, D. J., Cooper, J. T., Golden, C. J., & Dornheim, L. (1998). Development and validation of a measure of emotional intelligence. *Personality and individual differences*, *25*(2), 167-177.

Silvera, D., Martinussen, M., & Dahl, T. I. (2001). The Tromsø Social Intelligence Scale, a self-report measure of social intelligence. *Scandinavian journal of psychology*, *42*(4), 313 319.

Slepian, M. L., Young, S. G., Rule, N. O., Weisbuch, M., & Ambady, N. (2012). Embodied impression formation: Social judgments and motor cues to approach and avoidance. *Social Cognition*, *30*(2), 232-240.

Smith, H. J., Archer, D., & Costanzo, M. (1991). “Just a hunch”: Accuracy and awareness in person perception. *Journal of Nonverbal Behavior*, *15*(1), 3-18.

Spreng, R. N., McKinnon, M. C., Mar, R. A., & Levine, B. (2009). The Toronto Empathy Questionnaire: Scale development and initial validation of a factor-analytic solution to multiple empathy measures. *Journal of personality assessment*, *91*(1), 62-71.

Smidt, K. E., & Suvak, M. K. (2015). A brief, but nuanced, review of emotional granularity and emotion differentiation research. *Current Opinion in Psychology*, *3*, 48-51.

Terasawa, Y., & Umeda, S. (2018). Neurocognitive mechanisms of social anxiety and interoception. In *Island of Reil (Insula) in the Human Brain* (pp. 113-120). Springer, Cham.

Todorov, A., Baron, S. G., & Oosterhof, N. N. (2008). Evaluating face trustworthiness: a model based approach. *Social cognitive and affective neuroscience*, *3*(2), 119-127

Todorov, A., Pakrashi, M., & Oosterhof, N. N. (2009). Evaluating faces on trustworthiness after minimal time exposure. *Social Cognition*, *27*(6), 813-833.

Tugade, M. M., Fredrickson, B. L., & Barrett, L. F. (2004). Psychological resilience and positive emotional granularity: Examining the benefits of positive emotions on coping and health. *Journal of personality*, *72*(6), 1161-1190.

Wang, Y., Hunt, K., Nazareth, I., Freemantle, N., & Petersen, I. (2013). Do men consult less than women? An analysis of routinely collected UK general practice data. *BMJ open*, *3*(8), e003320.

Whitehead, W. E., Drescher, V. M., Heiman, P., & Blackwell, B. (1977). Relation of heart rate control to heartbeat perception. *Biofeedback and Self-regulation*, *2*(4), 371-392.

Zaki, J., Davis, J. I., & Ochsner, K. N. (2012). Overlapping activity in anterior insula during interoception and emotional experience. *Neuroimage*, *62*(1), 493-499.

Zamariola, G., Maurage, P., Luminet, O., & Corneille, O. (2018). Interoceptive accuracy scores from the heartbeat counting task are problematic: Evidence from simple bivariate correlations. *Biological Psychology*, *137*, 12-17.