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Follow Your Gut? Emotional Intelligence Moderates the Association Between Physiologically Measured Somatic Markers and Risk-Taking

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Emotional Intelligence (EI) is a set of adaptive skills that involve emotions and emotional information. Prior research suggests that lower EI individuals behave maladaptively in social situations compared to higher EI individuals. However, there is a paucity of research on whether EI promotes adaptive decision-making. Leveraging the somatic marker hypothesis, we explore whether EI moderates the relationship between skin conductance responses (SCRs) and risky decision-making. In two separate sessions in the behavioral lab, participants ($N = 52$) completed tests of emotional intelligence and made a total of 5,145 decisions involving risk. At Time 1, participants completed an ability test of EI and cognitive intelligence. At Time 2, participants completed 100 decision trials of the Iowa Gambling Task (IGT). Consistent with prior research using the IGT, participants played a computerized card game with real monetary rewards in which two "safe" decks led to higher average monetary rewards and two "risky" decks led to higher average losses. We found that EI moderates the relationship between physiological arousal, as measured by SCRs, and risk-taking. Specifically, lower EI individuals exhibited a maladaptive, positive association between SCRs and risk-taking, whereas higher EI individuals did not exhibit a relationship between SCRs and risk-taking. Our findings suggest one important way in which low EI may lead to maladaptive decision-making is through appraising physiological arousal incorrectly.

Keywords: decision-making, emotional intelligence, Iowa Gambling Task, physiology, skin conductance

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Emotional Intelligence (EI) is a mental ability to solve problems about emotions and is considered a separate construct from cognitive ability and personality (Mayer, Roberts, & Barsade, 2008; Mayer & Salovey, 1997). At a broad level, EI includes the abilities to (a) perceive emotions accurately, (b) use emotions to facilitate thought, (c) understand the causes of emotions, and (d) regulate emotions (Mayer, Caruso, & Salovey, 2016; Mayer & Salovey, 1997; Salovey & Mayer, 1990).

There is some evidence that individuals with lower EI experience worse life outcomes compared with individuals with higher EI (Côté, 2014; Fernández-Berrocal & Extremera, 2016; Lopes, 2016; Mayer et al., 2008; Mayer, Salovey, & Caruso, 2004; Roberts et al., 2006; Rossen & Kranzler, 2009). For example, relative to individuals with higher EI, individuals with lower EI are more likely to develop weak social relationships (Brackett, Rivers, Shiffman, Lerner, & Salovey, 2006; Lopes, Salovey, Coté, Beers, & Petty, 2005), achieve worse job performance (Côté & Miners, 2006; Libbrecht, Lievens, Carette, & Côté, 2014), and perform worse in negotiations (Elfenbein, Der Foo, White, Tan, & Aik, 2007; Sharma, Bottom, & Elfenbein, 2013).

So why do individuals with lower EI experience relatively worse overall life outcomes? This question, although intuitively sensible, remains a puzzle because there is a paucity of research on the microprocesses through which EI might relate to adaptive and maladaptive life outcomes. In the current research, we advance our understanding of the manifestations of EI by investigating whether EI moderates the effect of physiological arousal on risk-taking.

We draw theoretically and methodologically from research on the somatic marker hypothesis (SMH). The SMH suggests that somatic markers, which are automatic emotion-related signals that

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are manifested by physiological arousal such as skin conductance responses (SCRs), "warn" individuals in advance of risky decision options and "guide" individuals to safe decision options (Bechara & Damasio, 2005; Bechara, Damasio, Tranel, & Damasio, 1997, 2005; Bechara, Tranel, Damasio, & Damasio, 1996; Damasio, 1994). Prior research suggests that somatic markers promote approach or avoidance behavior, but it is unclear whether some individuals are more effective at translating their physiological arousal into information that guides approach or avoidance behavior than others. In this work, we examine whether emotional intelligence may moderate the relationship between SCRs and risk-taking. That is, we explore whether individuals with higher EI utilize physiological arousal to adaptively avoid risky decision options, whereas individuals with lower EI do not utilize physiological arousal to guide behavior or even utilize physiological arousal to maladaptively approach risky decision options.

Arousal and Decision-Making

Emotions influence decision-making by providing critical signals to avoid danger and capitalize on profitable social and economic opportunities (Johnson & Tversky, 1983; Loewenstein, Weber, Hsee, & Welch, 2001; Schwarz & Clore, 2007; Seo & Barrett, 2007; Sinaceur, Heath, & Cole, 2005; Slovic, Finucane, Peters, & MacGregor, 2002; Yip & Schweitzer, 2016). Previous research conceptualizes emotion as being characterized by physiological arousal, valence, and cognitive appraisals (Barrett, 2012; Ekman, 1999; Russell, 2003; Russell & Barrett, 2014; Yip & Schweitzer, 2019). When individuals experience physiological arousal (which often manifests in SCRs) in reaction to decision options, they are experiencing an emotion, but they are unable to determine the specific emotion without assessing valence and cognitive appraisals. For example, when individuals encounter risky decision options, individuals may experience anxiety, which is characterized by negative valence and appraisal of uncertainty, or excitement, which is characterized by positive valence and appraisal of uncertainty (Akinola, 2010; Bechara et al., 1997; Figner & Murphy, 2011; Lerner, Li, Valdesolo, & Kassam, 2015).

Recent research suggests that anxiety and excitement are similar because both emotions are characterized by the anticipation of an outcome and by uncertainty, but they differ by valence and the behavioral consequences are distinct (Brooks, 2014). Individuals appraising their arousal as anxiety become more likely to choose safer decision options because they seek to protect themselves and their resources (Akinola & Mendes, 2012; Gino, Brooks, & Schweitzer, 2012; Larrick, 1993; Wood Brooks & Schweitzer, 2011). However, individuals who appraise their arousal as excitement become more likely to choose riskier decision options because they believe that they can achieve more positive outcomes (Ashby, Isen, & Turken, 1999; Brooks, 2014).

It is important to note that arousal can be consciously experienced, but can also be unconsciously experienced, and influence judgment and behavior (Bechara et al., 1997; Damasio, 1994). For example, when participants observe liars who appeal to the press for the return of a missing person even though they actually murdered the missing person, they often experience physiological arousal, which provide a signal of threat as measured with pulse plethysmography, relative to when participants observe truth-telling individuals (ten Brinke, Lee, & Carney, in press).

Prior research suggests that people can make mistakes in attributing physiological arousal (Schachter & Singer, 1962). For example, consistent with the feeling-as-information model, Dutton and Aron (1974) found that males were more likely to contact a female experimenter when they had crossed an arousal-inducing suspension bridge instead of a stable bridge, because they misattributed the physiological arousal from the suspension bridge to the sexual attraction associated with the female experimenter (Savitsky, Medvec, Charlton, & Gilovich, 1998; Schwarz & Clore, 2007; White, Fishbein, & Rutsein, 1981). Relatedly, according to the affect infusion model, affect infuses decision-making when a decision is complex, requires constructive processing, and is unfamiliar (Forgas, 1992, 1995). Taken together, physiological arousal is a main component of emotion, and physiological arousal influences judgment.

Somatic Marker Hypothesis

The somatic marker hypothesis (SMH) proposes that the uncertainty of decision options generates somatic markers in a complex decision context. Empirical support for the SMH is based on studies employing the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994; Bechara et al., 1996, 1997). In the IGT, participants select cards from decks that differ in the uncertainty of the payoffs. Two of the decks are disadvantageous because they contain cards with high rewards but even higher relative losses, resulting in an overall loss in the long-run. Two other decks are advantageous because they contain cards with small rewards but relatively smaller losses, resulting in an overall gain in the long-run.

As individuals ponder decisions in the IGT, somatic marker signals are generated which activates autonomic nervous system activity in the skin's sweat glands. Because autonomic nervous system activity can be unconscious and difficult to report, electrodermal activity, which is assessed by skin conductance responses (SCRs), is simultaneously recorded with decisions and used to index the magnitude of somatic markers (Damasio, 1994; Dunn, Dalgleish, & Lawrence, 2006). The SMH posits that these somatic markers—although involuntary—serve as affective signals that guide adaptive decision making.

In the canonical demonstration of the SMH (Bechara et al., 1997; Bechara & Damasio, 2002; Reimann & Bechara, 2010), participants who had ventromedial prefrontal cortex lesions and participants who were normal made a series of decisions in the IGT. Though individuals with lesions to the ventromedial prefrontal cortex have normal intelligence and problem-solving skills, they encounter problems experiencing affect and generating somatic markers. Results demonstrated that normal participants generated more pronounced somatic markers (i.e., anticipatory SCRs) prior to the disadvantageous decks and eventually choose more cards from the advantageous decks. In contrast, individuals with damage to the ventromedial prefrontal cortex did not generate SCRs in response to disadvantageous decks, and as a result, did not modify their decision-making. This finding offers an empirical demonstration that anticipatory SCRs can serve as affective signals that nudge participants away from making risky choices.

Emerging work has begun to explore the role of individual differences in the SMH involving normal, fully functioning participants (e.g., Fernández-Serrano, Pérez-García, & Verdejo-

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García, 2011). For example, cognitive intelligence predicts performance on the IGT (Dunn et al., 2006; Guillaume et al., 2009; Maia & McClelland, 2004; Toplak, Sorge, Benoit, West, & Stanovich, 2010).

Recent work suggests that cognitive intelligence, rather than emotional intelligence, is more strongly associated with performance on the IGT (Demaree, Burns, & DeDonno, 2010; Li et al., 2017; Webb, DelDonno, & Killgore, 2014). These studies found no association between EI and performance on the IGT (Demaree et al., 2010) or that EI failed to contribute above and beyond cognitive ability in the prediction of IGT performance (Li et al., 2017; Webb et al., 2014). However, none of these studies measured somatic markers (i.e., SCRs) simultaneously with each decision trial. In fact, no research has directly investigated whether EI influences the utilization of somatic markers to avoid or approach risky decisions. In our investigation, we explore whether EI moderates the association between SCRs and risk-taking.

Emotional Intelligence as a Moderator of the Association Between Somatic Markers and Risk-Taking

The ability model of emotional intelligence (EI) conceptualizes EI as four distinct abilities: (1) perceiving emotions, (2) using emotions to facilitate performance, (3) understanding emotions, and (4) managing emotions (Mayer & Salovey, 1997; Mayer, Salovey, Caruso, & Sitarenios, 2003; Salovey & Mayer, 1990; Yip & Martin, 2006). However, the ability model of emotional intelligence is evolving. For example, in more recent models, EI encompasses six distinct skills (Elfenbein & MacCann, 2017; Elfenbein, Jang, Sharma, & Sanchez-Burks, 2017).

We propose that EI moderates the relationship between somatic markers and risk-taking. Specifically, we expect that individuals with high EI exhibit a negative association between SCRs and risk-taking, whereas individuals with low EI exhibit no association or a positive association with risk-taking.

There is some indirect evidence suggesting that individuals with low EI may struggle to use emotions as a source of information appropriately to make adaptive decisions. First, existing research revealed that incidental anxiety reduces risk-taking among individuals with lower rather higher levels of emotion-understanding ability (Yip & Côté, 2013). Incidental anxiety refers to anxiety that is triggered by an unrelated situation and irrelevant to the decision at hand (Loewenstein & Lerner, 2003). Relative to individuals with high EI, individuals with low EI exhibit a negative effect of incidental anxiety on risk-taking because they incorrectly attribute their anxiety and mistakenly believe that their anxiety is relevant to their decision-making (Yip & Côté, 2013). We build on this line of research by focusing our investigation on integral arousal, which is physiological arousal that is related and relevant to the judgment at hand (Lerner & Keltner, 2001; Schwarz & Clore, 2007). That is, anticipatory SCRs generated on the IGT reflect integral arousal because the physiological arousal is associated with the riskiness of the decision options. We explore whether low EI individuals may experience difficulty in interpreting their integral arousal correctly when making decisions.

Second, previous research suggests that individuals who can correctly interpret their physiological signals exhibit better decision-making. For instance, individuals with lower levels of interoceptive awareness—the ability to detect changes in bodily systems that is measured with a heartbeat detection task—exhibited a positive association between bodily signals (a composite of heart rate and electrodermal activity) and risky decisions (Dunn et al., 2010; Farb et al., 2015). In contrast, individuals with higher levels of interoceptive awareness exhibited a negative association between bodily signals and risky decisions (Dunn et al., 2010). Furthermore, Wölk, Sütterlin, Koch, Vögele, & Schulz (2014) found that interoception reduces risk-taking on the Iowa Gambling Task.

In our work, we extend our understanding about the SMH by directly linking EI, physiological arousal, and risk-taking. Specifically, we expect that EI moderates the association between SCRs and risky decisions. In particular, among individuals with higher EI, we expect a negative association between SCRs and risk-taking. Among individuals with lower EI, we expect no association or a positive association between SCRs and risk-taking.

Overview of the Current Research

To test whether individual variation in EI predicts the link between SCRs and risk-taking, we first administered a standardized test of EI and cognitive ability, and then exposed participants to 100 decision trials involving a trade-off between risk and rewards in the IGT (Bechara, Damasio, Tranel, & Damasio, 2005). The IGT is a card game with real monetary rewards in which two (low risk) decks of cards lead to high average monetary rewards and the other two (high risk) decks lead to high average losses. We measured SCRs and recorded whether participants chose from a risky deck in each trial. We measured trait-level arousal through baseline skin-conductance level. We include both baseline skin-conductance level and momentary SCRs because state-level arousal may be related to trait-level arousal (Fleeson, 2001).

Method

We report how we determined our sample size, all data exclusions, and all measures in this study (Simmons, Nelson, & Simonsohn, 2011). We set sample size before any data were collected. We determined our sample size based on available resources; with these resources, we were able to double the sample size used in past SMH research (e.g., Bechara et al., 1997). No data were analyzed until after data collection ended.

Participants

We aimed to recruit 60 participants from a North American university on the East Coast and ended up recruiting a sample of 62. As is often the case in highly software-dependent physiological research, some participants' data failed to be saved or were overwritten by the computer. Skin-conductance responses were not recorded for six participants, IGT data were not saved for one participant, and the event markers for synchronizing the skin-conductance responses with the IGT were not properly recorded for three participants. No data were excluded. The data were not merged or analyzed until after data collection ended. The final sample size was 52 participants (M_{age} = 24 years, SD_{age} = 4 years; 63% female). For some secondary analyses, the sample size was smaller (see footnotes for explanation). Overall, each of the participants completed 100 trials of the Iowa Gambling Task and

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physiology was measured prior to each decision trial. In total, we collected data for 5,145 observations.[1]

Procedure

We collected data in two sessions that occurred within 10 days of each other to separate the measurement of EI from the measurement of the physiological index of somatic markers and risky decision-making in the Iowa Gambling Task. In an initial 60-min testing session, participants completed measures of EI and cognitive ability and were paid $10 for their time. Approximately 10 days later, participants arrived at the laboratory for a 30-min individual experimental session and completed the Iowa Gambling Task (IGT) while SCRs were continuously measured (Bechara et al., 1997). Baseline physiology was measured during this session as is typical (e.g., Miu, Heilman, & Houser, 2008) so that tonic skin conductance at rest could serve as a control variable for the reactivity SCRs to the stimuli. Participants were compensated with 1/200 of any winnings accrued from the Iowa Gambling Task (range: $2.50 to $28.22, M = $14.05; SD = $5.92).

Measures

Emotional intelligence (EI). We assessed EI using the most widely used and validated measure of EI, the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT; Mayer & Salovey, 1997). The MSCEIT is a 141-item ability measure of EI that consists of four branches: emotion-recognition, emotion-facilitation, emotion-understanding, and emotion-management. The MSCEIT produces scores for four branches and a score for total EI (Mayer et al., 2004). The total EI score is an average of a participant's performance across all four branches (M = 96.30, SD = 17.64).

Emotion-recognition ability. The emotion-recognition ability subscale of the MSCEIT consists of 48 problems about identifying the emotion being expressed in a photograph of a face or identifying the emotion being evoked by a photograph of a landscape (M = 98.70, SD = 14.88; α = .89).

Emotion-facilitation ability. The emotion-facilitation ability subscale of the MSCEIT is composed of 30 problems about identifying the usefulness of a specific emotion to perform an activity or identifying the sensations affiliated with an emotion (M = 97.20, SD = 14.39; α = .41).

Emotion-understanding ability. The emotion-understanding ability subscale of the MSCEIT includes 32 problems about identifying the cause of emotional reactions and labeling complex emotions that result from blending basic emotions (M = 103.01, SD = 18.00; α = .81).

We also administered a newer measure of emotion-understanding ability called the Situational Test of Emotion Understanding (STEU; MacCann & Roberts, 2008). The STEU presents a series of 42 scenarios and asks respondents to choose the emotion that is most likely to be generated by the situation depicted in each scenario, among five options that are presented (M = 27.22, SD = 5.94; α = .78). As expected, the STEU was positively correlated with the analogous emotion-understanding ability branch of the MSCEIT, $r(44) = .61$, $p < .001$.[2]

Emotion-management ability. The emotion-management ability subscale of the MSCEIT includes 29 problems about identifying the most effective course of action to influence emotions in another person and manage personal relationships (M = 89.77, SD = 14.99; α = .72).

Cognitive ability. Past research has demonstrated that cognitive ability is positively correlated with EI (Joseph & Newman, 2010), and cognitive ability is positively associated with decision-making in the IGT (Toplak et al., 2010). To verify that EI was not confounded by cognitive ability, we administered the Wonderlic Personnel Test, a commonly used test that includes 50 verbal, mathematical, and analytical problems (M = 116.76, SD = 10.89; α = .90; (Wonderlic, 1992).[3]

Baseline skin conductance level. We controlled for individual differences in tonic electrodermal activity to capture whether some individuals are more sensitive in their physiological reactions compared to others (Wilder, 1962). We calculated baseline skin conductance levels for each participant over the last three minutes of a 5-min resting period, after the participant had become habituated to the equipment (Cacioppo, Tassinary, & Berntson, 2007; SCL was M = 5.81; SD = 4.08). We report all analyses both with and without controlling for individual differences in baseline tonic skin conductance level. The results are identical (see online supplemental material).

Skin-conductance responses (SCRs). Data were acquired using the GSR100C amplifier connected to the BIOPAC MP150 system at a rate of 10 samples per second in a noise-free environment. SCRs were recorded by placing a pair of silver-silver chloride electrodes with 0.05 M sodium chloride gel on the distal phalanges of the first and second digits of the nondominant hand. SCR data were analyzed using the SCR analysis module of Acq-Knowledge. As in past research (e.g., Miu, Heilman, & Houser, 2008; Oya et al., 2005), we measured the amplitude of the SCRs during the 5-s window that preceded each decision. The average SCR amplitude was 1.95 (SD = 4.53).

Risk-taking in the Iowa Gambling Task (IGT). Using an exact version of the IGT (Bechara et al., 2005), we recorded whether participants chose from one of the four decks of cards which varied in risk (and long-term loss) versus reward (and long-term gain). To begin the IGT, participants were endowed with a $2,000 loan and told they would be able to keep 1/200 of whatever they made in the game as a bonus in addition to their payment for participation in the two-part study. The goal of the IGT was to earn as much money as possible by choosing among four computerized card decks for 100 trials. Participants were not provided with explicit probabilities of the payoffs associated with the decks. Two decks were considered "risky" because these decks were associated with high rewards (+$100), but also severe losses (−$1,250), resulting in an overall negative expected value of −$250 over 10 trials (Bechara et al., 2005). Two decks were considered "safe" and were associated with low rewards (+$50), but periodically less severe losses (−$250), resulting in an overall positive expected value of +$250 over 10 trials (Bechara et al.,

[1] The total number of observations is 5,145 because some participants did not complete all 100 decision trials because of technical issues with equipment or time constraints.

[2] Six participants did not complete the STEU because they ran out of time in the 60-minute session.

[3] Two participants did not complete the cognitive ability test because they ran out of time in the 60-minute session.

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2005). Taking a card from the risky deck was coded as "1" and taking a card from a safe deck was coded as "0." Overall, our participants selected cards from the safe deck 36% of the time (*SD* = .48), which is consistent with past research on the IGT (Bechara et al., 1997).

Results

To analyze the data with 100 trials nested within each participant, we conducted linear mixed effects binary logistic analyses, with responses nested within participants (Tabachnick & Fidell, 2007). Specifically, we analyzed associations with risk-taking with generalized linear mixed-effects model, using the lme4 package in the statistical program R (Bates, Maechler, Bolker, & Walker, 2015). Participants were specified as a random factor and we added a random slope to allow SCR (a within-participant predictor) to vary within individuals which is a random intercept and random slope model (Aguinis, Gottfredson, & Culpepper, 2013; Brauer & Curtin, 2018; Pinheiro & Bates, 2000). To disentangle within- and between-individual effects, we centered all intra-individual (level-1) predictors around the mean for each individual, and all between-individual (level-2) predictors around the mean across individuals (Aguinis et al., 2013; Aiken, West, & Reno, 1991).

In each analysis, risk-taking in each trial (binary) was regressed on the measure of EI (continuous), SCR corresponding to each trial (continuous), and their interaction term (continuous), controlling for baseline skin conductance (continuous). This analysis tested whether EI moderate the relationship between SCR and risk-taking. Follow-up analyses using simple slopes (Aiken, West, & Reno, 1991) clarified the significance value of each slope in the interaction. Specifically, the association between SCR and risk-taking were tested for low (−1 *SD* below the mean) and high (+1 *SD* above the mean) levels of EI.

Does Emotional Intelligence Moderate the Association Between Skin Conductance Responses and Risk-Taking?

Consistent with our prediction, we found a significant two-way interaction between SCR and total EI, $b = -0.0023$, $SE(b) = 0.0008$, Wald test = −2.590, $p = .009$, $OR = 0.998$, 95% CI [0.996, 0.999]. We present the results in Table 1.

Follow-up analyses using simple slopes further investigated the interaction to determine whether one slope or both were responsible for the statistically significant interaction. Among individuals lower on EI, SCRs were positively associated with risk-taking, $b = 0.0302$, $SE(b) = 0.0141$, Wald test = 2.140, $p = .032$, $OR = 1.031$, 95% CI [1.003, 1.060]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 3.1% larger, holding all other variables constant. This finding supports our prediction that among individuals with lower EI, SCRs were positively associated with risk-taking. In contrast, among individuals with higher EI, we found a negative—albeit not statistically significant—association between SCRs and risk-taking, $b = -0.0265$, $SE(b) = 0.0180$, Wald test = −1.473, $p = .140$, $OR = 0.974$, 95% CI [0.940, 1.009]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 2.6% smaller, holding all other variables constant. This finding does not support our prediction that SCRs were associated with less risky decisions among individuals higher on EI.

Table 1
Analyses for Total Emotional Intelligence

Measure	Dependent variable: Risk (1)	(2)
Baseline SCL	.001 (.027)	.015 (.027)
SCR	.002 (.012)	.003 (.012)
EI	−.013 (.009)	−.001 (.012)
IQ		−.025** (.013)
SCR × EI	−.002*** (.001)	−.002** (.001)
Constant	−.683*** (.110)	−.692*** (.109)
Observations	5,145	4,945
Log likelihood	−3,146.115	−3,010.495
Akaike inf. crit.	6,308.230	6,038.990
Bayesian inf. crit.	6,360.596	6,097.546

Note. $N = 52$ for Model 1 and $N = 50$ for Model 2. For all analyses, there is a random intercept of participant and random slope of SCR. SCL = skin-conductance level. SCR = skin-conductance responses. EI = total emotional intelligence. IQ = cognitive ability. Values are unstandardized regression coefficients.
* $p < .10$. ** $p < .05$. *** $p < .01$.

Historically, EI and cognitive ability have been difficult to disassociate (Carroll, 1993; Jensen, 1998; Mackintosh, 2011). To disentangle EI from cognitive ability, researchers often test whether EI improves predictions of outcomes above and beyond cognitive ability (e.g., Côté, Lopes, Salovey, & Miners, 2010; Libbrecht et al., 2014). Therefore, we conducted additional analyses controlling for cognitive ability.

As presented in Table 1, when controlling for cognitive ability, the two-way interaction between SCR and EI was significant, $b = -0.0022$, $SE(b) = 0.0009$, Wald test = −2.281, $p = .022$, $OR = 0.998$, 95% CI [0.996, 1.000]. However, when controlling for the interaction between cognitive ability and SCR, the two-way interaction between SCR and EI was not significant, $b = -0.0019$, $SE(b) = 0.0012$, Wald test = −1.560, $p = .118$, $OR = 0.998$, 95% CI [0.996, 1.000]. To further explore this result, we tested whether cognitive ability and SCR interacted to predict risky decision-making. Controlling for the two-way interaction between SCR and EI cognitive ability did not interact with SCR to predict risky decision-making, $b = -0.0007$, $SE(b) = 0.0014$, Wald test = −0.536, $p = .592$, $OR = 0.999$, 95% CI [0.996, 1.00]. This suggests that cognitive ability did not act as a confound in the interaction between EI and SCR predicting risky decision-making. Taken together, these results provide some evidence that EI, rather than cognitive ability, moderates the relationship between SCRs and risk-taking.

We conducted additional analyses with each of the four separate branches of EI. The pattern observed for the overall EI composite variable was also observed for three of the four branches of EI when examined individually. We present the results for each of the EI branches in Figure 1 and Table 2.

EI Branch #1: Emotion-Recognition Ability

As expected, we found a significant two-way interaction between SCR and emotion-recognition ability, $b = -0.0023$,

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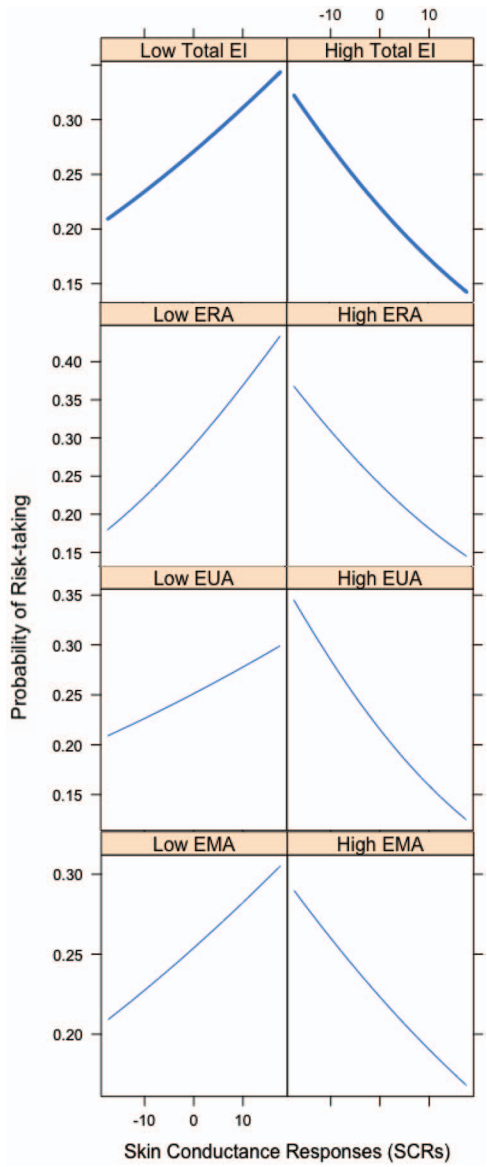

Figure 1. Two-way interaction of skin-conductance response (SCR) and emotional intelligence (EI) on risk-taking (EI measure graphed at ±1 *SD*). EI = total emotional intelligence. ERA = emotion-recognition ability. EUA = emotion-understanding ability. EMA = emotion-management ability. See the online article for the color version of this figure.

SE(*b*) = 0.0008, Wald test = −2.785, *p* = .005, *OR* = 0.998, 95% CI [0.996, 0.999]. This interaction supports our hypothesis that EI moderates the link between SCR and risk-taking. We probed the interaction using a test of simple slopes. For individuals lower on emotion-recognition ability, SCR was positively associated with risk-taking, *b* = 0.0343, *SE*(*b*) = 0.0147, Wald test = 2.321, *p* = .020, *OR* = 1.035, 95% CI [1.005, 1.065]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 3.5% larger, holding all other variables constant. As expected, among individuals with lower emotion-recognition ability, SCRs were positively associated with risk-taking. In contrast, among individuals with higher emotion-recognition ability, there was a negative, marginally significant association between SCR and risk-taking, *b* = −0.0350, *SE*(*b*) = 0.0199, Wald test = −1.760, *p* = .078, *OR* = 0.966, 95% CI [0.929, 1.004]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 3.4% smaller, holding all other variables constant.

EI Branch #2: Emotion-Facilitation Ability

We did not find a significant two-way interaction between SCR and emotion-recognition ability, *b* = −0.0010, *SE*(*b*) = 0.0008, Wald test = −1.229, *p* = .219, *OR* = 0.999, 95% CI [0.997, 1.001]. Therefore, the data did not support our prediction.

EI Branch #3: Emotion-Understanding Ability

Our focal measure of emotion-understanding ability was the third branch of the MSCEIT. As predicted, we found a significant two-way interaction between SCR and emotion-understanding ability, *b* = −0.0016, *SE*(*b*) = 0.0006, Wald test = −2.531, *p* = .011, *OR* = 0.998, 95% CI [0.997, 1.000]. Follow-up analyses using simple slopes probed the interaction. As expected, for individuals lower on emotion-understanding ability, SCR was positively associated with risk-taking, *b* = 0.0324, *SE*(*b*) = 0.0146, Wald test = 2.219, *p* = .026, *OR* = 1.033, 95% CI [1.004, 1.063]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 3.3% larger, holding all other variables constant. In contrast, among individuals higher on emotion-understanding ability, we found no association between SCR and risk-taking, *b* = −0.0252, *SE*(*b*) = 0.0175, Wald test = −1.442, *p* = .149, *OR* = 0.975, 95% CI [0.942, 1.009]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 2.5% smaller, holding all other variables constant.

We also measured emotion-understanding ability using the Situational Test of Emotion Understanding (STEU). We did not find significant two-way interaction between SCR and emotion-understanding ability, *b* = −0.0024, *SE*(*b*) = 0.0024, Wald test = −0.990, *p* = .322, *OR* = 0.998, 95% CI [0.993, 1.002].

EI Branch #4: Emotion-Management Ability

Consistent with the other branches of EI, we found a significant two-way interaction between SCR and emotion-management ability, *b* = −0.0015, *SE*(*b*) = 0.0007, Wald test = −2.179, *p* = .029, *OR* = 0.998, 95% CI [0.997, 1.000]. We conducted a test of simple slopes to assess the two-way interaction. We found that, for individuals lower on emotion-management ability, SCR was positively associated with risk-taking, *b* = 0.0292, *SE*(*b*) = 0.0141, Wald test = 2.067, *p* = .038, *OR* = 1.030, 95% CI [1.002, 1.059]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 3.0% larger, holding all other variables constant. Whereas, among individuals higher on emotion-management ability, there was no association between SCR and risk-taking, *b* = −0.0182, *SE*(*b*) = 0.0171, Wald test = −1.059, *p* = .289, *OR* = 0.982, 95% CI [0.949, 1.016]. The odds ratio indicates that for a one-unit increase in SCR, the odds of risk-taking are 1.8% smaller, holding all other variables constant.

Discussion

Our findings highlight the role of EI in the relationship between physiological arousal and decision-making about risk. Individuals

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Table 2
Emotional Intelligence (EI) Branches

Measure	Dependent variable: Risk				
	(1)	(2)	(3)	(4)	(5)
Baseline SCL	.007 (.029)	.006 (.027)	−.005 (.026)	.006 (.035)	.008 (.027)
SCR	−.0003 (.012)	.007 (.012)	.004 (.011)	.008 (.015)	.006 (.011)
Emotion-Recognition Ability	−.009 (.008)				
SCR × Emotion-Recognition Ability	−.002*** (.001)				
Emotion-Facilitation Ability		−.010 (.008)			
SCR × Emotion-Facilitation Ability		−.001 (.001)			
Emotion-Understanding Ability (MSCEIT)			−.006 (.006)		
SCR × Emotion-Understanding Ability (MSCEIT)			−.002** (.001)		
Emotion-Understanding Ability (STEU)				−.008 (.020)	
SCR × Emotion-Understanding Ability (STEU)				−.002 (.002)	
Emotion-Management Ability					−.008 (.007)
SCR × Emotion-Management Ability					−.002** (.001)
Constant	−.686*** (.111)	−.683*** (.110)	−.683*** (.112)	−.697*** (.119)	−.683*** (.111)
Observations	5,145	5,145	5,145	4,545	5,145
Log likelihood	−3,145.613	−3,148.361	−3,146.883	−2,781.868	−3,147.187
Akaike inf. crit.	6,307.227	6,312.723	6,309.766	5,579.736	6,310.374
Bayesian inf. crit.	6,359.593	6,365.089	6,362.132	5,631.111	6,362.740

Note. $N = 52$, except for analyses that measured EUA using the STEU (where $N = 46$). For all analyses, there is a random intercept of participant and random slope of SCR. SCL = skin-conductance level. SCR = skin-conductance responses. Values are unstandardized regression coefficients.
* $p < .10$. ** $p < .05$. *** $p < .01$.

with lower EI are more likely to appraise SCRs as "approach" signals, which promote greater risk-taking. By contrast, individuals with higher EI are less likely to exhibit an association between SCRs and risk-taking. We found this pattern of results for total EI and for three of the four EI branches (i.e. emotion-recognition ability, emotion-understanding ability, and emotion-management ability). Furthermore, we found that EI moderates the association between SCRs and risk-taking independently of cognitive ability.

Our results tentatively suggest that individuals with low EI appraise their arousal differently than individuals with high EI. That is, relative to individuals with high EI, individuals with low EI might be more likely to interpret their physiological arousal as excitement, which promotes risk-seeking behavior. One potential explanation for our findings pertains to the attribution of arousal. By misattributing arousal to other factors than the risky decision options, individuals with low EI may be more likely to interpret their arousal as a signal of gambling, which promotes risk-taking. By comparison, individuals with high EI are more likely to interpret their arousal as a signal of danger, but do not reliably reduce their risk-taking. Based on relative outcomes, individuals with low EI are more likely to behave maladaptively than individuals with high EI.

Theoretical Implications

Our research advances the theoretical understanding about individuals' propensity to make risky decisions. Prior research has highlighted the importance of understanding the mechanisms underlying risk-taking by identifying "who takes risks when and why" (Figner & Weber, 2011). Recent research demonstrates that the decision process about risk is influenced by individual's emotions depending on their age (Figner, Mackinlay, Wilkening, & Weber, 2009) and their level of brain functioning (Bechara et al., 1997). However, previous studies have overlooked the role of specific psychological abilities that connect immediate feelings to decision-making behaviors such as EI.

In addition, our findings provide some clarity to the literature about the influence of cognitive ability and emotional abilities on IGT performance. The original formulation of the SMH suggested somatic markers serve as emotional signals that guide decision-making on the IGT (Bechara et al., 1994, 1997). However, recent work suggests that cognitive processes may explain IGT performance more accurately and comprehensively (e.g., Dunn et al., 2006; Maia & McClelland, 2004). Some studies recently suggested that cognitive intelligence is more positively associated with IGT performance than EI (Demaree et al., 2010; Li et al., 2017; Webb et al., 2014). However, an important limitation is that these studies did not simultaneously measure SCRs with IGT performance when contrasting these individual differences. In our work, we measured EI, cognitive intelligence, SCRs, and risk-taking. We found EI moderates the association between SCRs and risky-taking in the IGT. Cognitive intelligence, by contrast, did not moderate the association between SCRs and risk-taking.

This work also contributes to a broader understanding about how integral emotions can drive decision making (Lerner et al., 2015). Previous research has demonstrated incidental anxiety, which is triggered by unrelated situations, reduced risk-taking more strongly among individuals with lower rather than higher levels of emotion-understanding ability, because they misattribute the source of their anxiety (Yip & Côté, 2013). Here, we present evidence that integral emotions show different associations with decision-making depending on levels of EI, such that physiological arousal arising from the judgment at hand leads individuals lower on EI—but not their higher EI counterparts—to approach risk.

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Finally, our research is the first to find evidence linking EI, physiological responses, and decision-making. Prior work has shown that EI is associated with the subjective experience of self-reported and expressed emotions (see Mayer et al., 2008, for a review). However, SCRs represent a different channel by which individuals experience emotion. We find that individuals with low EI misinterpret their physiology as a source of information when making decisions, compared to individuals with high EI.

Limitations and Future Directions

Several limitations point to directions for future research. First, we found that EI moderates the SMH for total EI and three separate branches of EI (i.e. emotion-recognition ability, emotion-understanding ability, and emotion-management ability) but not for emotion-facilitation ability. This is consistent with growing evidence that has questioned the construct validity of emotion-facilitation ability. Emotion facilitation ability is the second branch of the Mayer and Salovey (1997) ability model of EI and involves generating and using emotions to guide thinking. Joseph and Newman (2010) conducted a meta-analysis of EI and chose to exclude emotion-facilitation ability from their cascading model of EI (see also Legree, Psotka, Robbins, Roberts, Putka, & Mullins, 2014; MacCann, Joseph, Newman, & Roberts, 2014). There is conceptual redundancy of the emotion-facilitation ability with the other emotional abilities. Furthermore, factor analyses revealed poor fit for models that included emotion-facilitation ability, but superior fit for models that excluded emotion-facilitation ability (Gignac, 2005; Palmer, Gignac, Manocha, & Stough, 2005; Rossen, Kranzler, & Algina, 2008). Future research should investigate the theoretical meaning and predictive validity of emotion-facilitation ability.

Second, we used the IGT to elicit SCRs and to measure subsequent risk-taking. Support for the association between physiological responses and risk avoidance has largely been drawn from data using the IGT as an established research paradigm (Bechara et al., 1997). The decision-making task operates on the assumption that riskier choices are correlated with overall losses (Bechara et al., 1994; Dunn et al., 2006). If the contingencies in IGT were reversed so that higher risk is associated with greater gains, SCRs would reflect excitement rather than anxiety. In this instance, our theory would predict that individuals with low EI could exhibit a negative association between SCR and risk-taking because they are more likely to misinterpret SCRs as anxiety. Future work needs to consider whether low EI decision-makers may reduce risk-taking when riskier choices correspond to overall gains.

Third, we used SCRs to assess physiological arousal. Although SCRs are a common measure of general arousal (e.g., Akinola, 2010; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005; Pennebaker, Hughes, & O'Heeron, 1987; Russell, 2003), SCRs do not differentiate the anticipated valence of outcomes. Instead, SCRs index the magnitude of arousal (Bechara, 2016). Thus, although we theorize that individuals with lower EI are more likely to misinterpret somatic markers as signals of excitement, and that this misinterpretation promotes risk approach, we acknowledge that we did not obtain a direct measure of self-reported emotional experiences. To address this limitation, future research should consider measuring self-reported emotional states in addition to physiological arousal.

Fourth, we focused on our investigation involving decisions about financial risk. Future research is needed to understand whether EI aids decision-making in social contexts. For example, EI may play an important role in mitigating conflict when counterparts express anger (Yip & Schweinsberg, 2017) or when competitors engage in trash-talking (Yip, Schweitzer, & Nurmohamed, 2018). Another fruitful avenue of research may be exploring whether lie detection accuracy is a function of EI. Although there are obvious advantages of detecting lies accurately, evidence abounds that humans are poor lie detectors (e.g., Bond & DePaulo, 2006; Minson, VanEpps, Yip & Schweitzer, 2018; Yip & Schweitzer, 2015). Recent work demonstrates that individuals experience more physiological arousal while observing liars versus truth-tellers (ten Brinke et al., in press; ten Brinke, Vohs, & Carney, 2016). Individuals with low EI may be poor at detecting deception because they incorrectly identify this arousal as excitement, encouraging them to approach liars.

Fifth, our investigation focused on risky decisions with immediate outcomes. Future research could examine whether our findings can be extended to risky decisions that are related to future financial outcomes because prior research has shown that individuals make different decisions when the decision outcomes are immediate instead of delayed (Lee & Zhao, 2014; Okdie, Buelow, & Bevelhymer-Rangel, 2016; Trope & Liberman, 2003).

Conclusion

Prior research has assumed that, when individuals generate physiological arousal that is integral to the decision options, they rely on their physiological arousal to make adaptive decisions (Bechara et al., 1997). Importantly, our research qualifies this assumption. Our evidence suggests that lower levels of EI guide individuals to misinterpret their physiological arousal to maladaptively approach a situation, stimulus, or person that is risky.

In conclusion, individuals with high EI develop better social relationships (Lopes, Brackett, Nezlek, Schütz, Sellin, & Salovey, 2004), achieve better job performance (Côté, & Miners, 2006; Elfenbein et al., 2007), and enjoy greater psychological well-being (Matthews et al., 2006), whereas individuals with low EI report higher drug and alcohol abuse (Brackett, Mayer, & Warner, 2004), engage in more deviant behavior (Brackett & Mayer, 2003), and are rated as more aggressive (Mayer, Perkins, Caruso, & Salovey, 2001). We demonstrate that individuals with low EI maladaptively utilize somatic markers to approach risky situations, compared to individuals with high EI. Our work offers preliminary evidence that somatic markers reflect a microprocess through which EI relates to broad life outcomes.

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