

# Head, Heart, and Gut in Decision Making: Development of a Multiple Brain Preference Questionnaire

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## Abstract

There is a growing body of literature that supports the idea that decision making involves not only cognition, but also emotion and intuition. However, following extant “dual-process” decision theories, the emotional and intuitive aspects of decision making have predominantly been considered as one “experiential” entity. The purpose of this article is to review the neurological evidence for a three-factor model of head, heart, and gut aspects of embodied cognition in decision making and to report on a study carried out to design and validate a psychometric instrument that measures decision-making preferences across three separable interoceptive components, representing the complex, functional, and adaptive neural networks (or “brains”) of head (analytical/cognitive), heart (emotional/affective), and gut (intuition). Development and validation of the Multiple Brain Preference Questionnaire (MBPQ) instrument was carried out in three phases. Translational validity was assessed using content and face validity. Construct validity was undertaken via exploratory factor analysis of the results from the use of the instrument with 301 subjects from a global sampling, and reliability tests were performed using internal consistency and test–retest analysis. Results confirmed extraction of three factors (head, heart, and gut) was appropriate and reliability analysis showed the MBPQ to be both valid and reliable. Applications of the tool to coaching and leadership are suggested.

## Keywords

decision making, intuition, interoception, embodied cognition, leadership, coaching

## Introduction

There is now a robust body of research into the nature of decision making and in particular into the roles of cognition, emotion, and intuition in human decision making. This research spans more than three decades (e.g., see Bohm & Brun, 2008; Burke & Miller, 1999; Lerner, Li, Valdesolo, & Kassam, 2015; Schwarz, 2000; Sinclair, 2014). In earlier research, decision theorists suggested there were two dominant systems humans use in decision making: the “analytic system” and the “experiential system” (Gutnick, Forogh Hakimzada, Yoskowitz, & Patel, 2006). Evans and Stanovich (2013) discuss two major channels for decision making within the “dual-process/dual-system” decision theories. These two theories both assert that human information processing is accomplished in two different, but complementary ways (“analytically” or “intuitively”) through two substantially different and differently evolved types of thinking. System 1 is both fast and intuitive and System 2 is much slower and more deliberate in function. System 2, the analytic system, is slower and involves conscious, deliberate cognitive processes and logical, reason-oriented thinking.

In contrast, System 1, the faster experiential system, uses emotion-related associations, intuitions, and “gut instincts” when making decisions (Bechara, Damasio, Tranel, & Damasio, 1997).

This decision model also fits well with work emerging over the last decade from the fields of embodied cognition and interoceptive awareness. Most notably this includes Damasio’s somatic marker theory (Bechara & Damasio, 2005; Damasio, Tranel, & Damasio, 1991), Thayer’s neuro-visceral integration model (Park & Thayer, 2014; Thayer & Lane, 2000, 2009), Craig’s findings on the neurobiological basis of interoceptive awareness (IA; Craig, 2002, 2009, 2014), and Critchley’s work on heart-based viscerosensory signaling (Critchley, 2015; Critchley, Wiens, Rotshtein,

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Ohman, & Dolan, 2004). These models and theories and the research supporting them all suggest that human cognition and decision making are strongly influenced by, or actively involved with, deep somatic and embodied re-representation and interoceptive processing. For example, Damasio's "somatic marker" hypothesis (Damasio, 1994, 1999) states that meta-representation of bodily states constitutes a set of emotional feelings, accessible to consciousness and providing the "gut-feeling" and "heart intelligence" that guides our decision processes.

According to Burr (2017), the older traditional cognitivist account of analytical decision-making "views choice behaviour as a serial process of deliberation and commitment, which is separate from perception and action" (p. 1). However, as Burr points out, recent work in embodied decision making has shown that this account is incompatible with emerging neurophysiological data. For example, current work on embodied decision making (Cisek & Pastor-Bernier, 2014; Lepora & Pezzulo, 2015) indicates that decision making is inextricably intertwined with sensorimotor control such that there is a blurring of the boundaries between perception, action, and cognition, involving reciprocal communication between affective and sensorimotor neural regions.

Burr also highlights that Barrett and Bar (2009) have convincingly argued that neural activity in perception is reflective of ongoing integration of sensory information from exteroceptive cues, with interoceptive information from the body and that this supports the view that when it comes to decisions, the involved perceptual states are "intrinsically infused with affective value," such that the affective or emotional salience is deeply intertwined with its perception. This indicates that far from involving only head-brain based cognitive or logical (System 2) processes, decision making is intrinsically and deeply entwined with emotional and interoceptive bodily sensorimotor (System 1) experiences.

Interestingly, this notion that decision making involves deep aspects of somatic re-representation and embodied "cognition" leads to an important insight. Given our interoceptive processing and embodied cognition emerges up from embodied neural circuits into the deep limbic structures and eventually the frontal lobes of our cranial brain (Critchley, 2009; Critchley & Harrison, 2013), then this neuroceptive processing must deeply involve our system of autonomic afferents (Craig, 2014; Critchley, 2009; Porges, 2001, 2011). And this embodied autonomic and affective processing has two major key neural systems communicating to it and interacting with it within the body: the intrinsic cardiac neural plexus (Armour, 2007) and the enteric neural plexus (Gershon, 1999).

In colloquial terms, humans often ascribe intuitive and informational roles to heart and gut regions of the body. We talk about "gut instincts," "gut feelings," "messages from the heart," and "heart intuitions" (Soosalu & Oka, 2012a). Given that we have two separable and complex neural plexuses in these regions, it may not be surprising then that the importance of the heart and gut in human processes such as

decision making are being validated by a growing list of studies both in the lab and in real-world scenarios.

### *The Intrinsic Cardiac Network*

The heart contains a complex, functional and adaptive intrinsic neural network (Armour, 2007). Intracardiac neurons are concentrated in multiple heart ganglia, and the structure of the interactions between neurons, both within intracardiac ganglia and also between individual ganglia, provide the basis for the complex nervous network of the heart (both anatomically and functionally) and has been labeled by researchers in the new field of neurocardiology as a functional "brain" (Ardell, 2004; Brack, 2014; Kukanova & Mravec, 2006; D. Randall, 2000; C. Randall, Wurster, Randall, & Xi-Moy, 1996).

Dr. J. Andrew Armour (1991), a pioneer in this field, has undertaken extensive research and introduced the concept of the intrinsic cardiac network as a functional "heart brain." His work demonstrated a complex intrinsic nervous system in the heart, that is deemed sufficiently sophisticated to qualify as a "little brain" in its own right (Armour, 2007). The complexity of the neural circuitry in the heart allows independent action, separate from the cranial brain. Armour (1991) has demonstrated the ability of the heart to learn independently, it has its own memories, and it can feel and sense information. This information from the heart is sent to the brain through a variety of different afferents, including autonomic afferents. These afferent nerves enter the brain at the medulla, and from there are dispersed to the higher centers of the brain, where they may have a variety of influences including in the context of perception, decision making, and other cognitive processes (Armour, 2004; Thayer, 2007). In Thayer's (2007) work on neurovisceral integration, he has shown how the heart influences neural structures in the head-brain deeply involved in cognitive, affective, and autonomic regulation.

### *The Enteric Neural Plexus*

The enteric neural plexus consists of approximately 500 million neurons (Cognigni, Bailey, & Miguel-Aliaga, 2011) and is said to be of a similar size and complexity to that of a cat's head-brain (Mosley, 2012; Watzke, 2010). The network of enteric neural tissue is spread across the organs of the gastrointestinal tract, from oral cavity and esophagus to anus. Dr. Michael Gershon (1999) in his groundbreaking work in the field of neurogastroenterology has described the enteric nervous system as "the second brain." Gershon's work, however, follows as a rediscovery, since Byron Robinson, MD, an American medical physician and anatomist working over 100 years ago, published in 1907 a book titled *The Abdominal and Pelvic Brain*, in which he described a complex nervous system or "brain" that he had discovered in the region of the gut (Robinson, 1907).

The enteric brain has been shown to be able to control the gut independently of the cranial brain (Gershon, 1999; Goldstein, Hofstra, & Burns, 2013). Virtually every aspect of gut activity is under the regulatory influence of this independent enteric nervous system (Holzer, 2017; Holzer, Schicho, Holzer-Petsche, & Lippe, 2001). There is also growing evidence that the enteric brain deeply influences head-based affective information processing (Berntson, Sarter, & Cacioppo, 2003; Holzer, 2017). As Mayer (2011) points out in his paper titled “Gut Feelings: The Emerging Biology of Gut-Brain Communication,”

Recent neurobiological insights into this gut–brain crosstalk have revealed a complex, bidirectional communication system that not only ensures the proper maintenance of gastrointestinal homeostasis and digestion but is likely to have multiple effects on affect, motivation and higher cognitive functions, including intuitive decision making. (p. 453)

### *Head, Heart, and Gut in Decision Making*

Thus we see that both of these gut and heart neural systems evince complex processing, learning and appear to be involved in higher order human functioning. That these “brains” or complex, adaptive and functional neural systems are involved in decision making is being uncovered by a growing body of fascinating research. For example, a number of researchers have found that enhanced cardiac perception is associated with benefits in decision making (e.g., see: Dunn et al., 2010; Werner, Jung, Duschek, & Schandry, 2009).

As Dunn et al. (2010) state,

These findings identify both the generation and the perception of bodily responses as pivotal sources of variability in emotion experience and intuition, and offer strong supporting evidence for bodily feedback theories, suggesting that cognitive-affective processing does in significant part relate to “following the heart.” (p. 1835)

In terms of gut-based functioning, Klarer et al. (2014) examined anxiety and fear learning and decision behaviors in rats that had their gut vagal afferent nerves severed. They found that once the gut vagal neural pathways that subserve “gut feel” had been disconnected, the rats, as compared to sham controls, were no longer able to respond with normal innate anxiety decision-behaviors to fearful stimuli and that fear learning and conditioning was concomitantly affected. As they suggest, “The innate response to fear appears to be influenced significantly by signals sent from the stomach to the brain” (Meyer, 2014, p. 1) and “These data add weight to theories emphasizing an important role of afferent visceral signals in the regulation of emotional behavior” (Klarer et al., 2014, p. 7067).

That similar processes operate in humans is suggested by Mayer (2011) in his examination of the emerging biology of

gut–brain communication and the gut–brain interface. As Mayer points out, “. . . the popular statement that somebody has made a decision based on their gut feelings may have an actual neurobiological basis related to brain–gut interactions, and to interoceptive memories related to such interactions” (p. 463).

Also supporting this notion that there are three separable domains in decision making of head (rational/logic), heart (emotions), and gut (intuitions) is the work of Sadler and Zeidler (2005), who examined patterns of informal reasoning and moral decision making and demonstrated evidence for individual patterns of rationalistic, emotive, and intuitive styles. They found that while some subjects employed all three decision styles, many subjects utilized individual patterns or combinations of these three styles of reasoning.

In the field of leadership decision-making, there is also a growing awareness of the importance of the separable domains of head, heart, and gut (Brack, 2011; Genovese, 2016). For example, Dotlich, Cairo, and Rhinesmith (2006) found that in complex business decision environments, the use of head, heart, and gut in decision styles lead to wiser and more effective decisions. As they point out, “Complex times require complete leaders . . . leaders capable of using their head, their heart, and their guts as situations demand” (p. 1). And backing this up, Heifetz and Linsky (2004) in their work on adaptive leadership claim that

Solutions to technical problems lie in the head and solving them requires intellect and logic. Solutions to adaptive problems lie in the stomach and the heart and rely on changing people’s beliefs, habits, ways of working or ways of life. (p. 35)

Finally, as Markic (2009) points out in her examination of “Rationality and Emotions in Decision Making,”

Decision making is traditionally viewed as a rational process where reason calculates the best way to achieve the goal. Investigations from different areas of cognitive science have shown that human decisions and actions are much more influenced by intuition and emotional responses than it was previously thought. (p. 54)

Showing that there is a burgeoning awareness in the literature that logic, emotion, and intuition are all involved in the process of decision making.

### *Individual Differences*

Given that current research findings suggest that within the body there are three key neural systems, or “brains,” involved in decision making, one in the head, one in the heart, and another in the gut, it would not be surprising then that individual differences, competencies, and preferences might show up in how people use these neural systems in decision making. Indeed, emotions involving the heart and instincts/feelings involving the gut have evolved over time because of

their adaptive functions in both genotypic and phenotypic survival (Haselton & Ketelaar, 2006; Ketelaar, 2004). We also know that the enteric nervous system evolved first before the intrinsic cardiac network and before the encephalization of the head-brain (Bishopric, 2005; Mayer, 2011; Porges, 2001). So it would not be surprising therefore if head, heart, and gut neural intelligences have come to be used for differing aspects of decision making and that thereby different people might have differing propensities and preferences in their use of embodied cognitive functions.

Cardiovascular system research, looking at interoception (Critchley et al., 2004; Katkin, 1985; Pollatos, Herbert, Matthias, & Schandry, 2007; Pollatos, Kirsch, & Schandry, 2005) and the gastrointestinal system (Herbert & Pollatos, 2012; Stephan et al., 2003), demonstrates that there are a range of important interindividual differences in “interoceptive awareness” (IA) and interoceptive sensitivity. As Herbert and Pollatos (2012) indicate, individual degrees of IA can be conceptualized as a trait-like sensitivity toward one’s visceral signals. With, for example, a greater sensitivity to how an individual emotionally responds being related to cardiac awareness, which can be developed through a range of embodied learning processes. In addition, Wiens, Mezzacappa, and Katkin (2000) reported that individuals with heightened IA (as quantified objectively from performance in a heartbeat detection task) report more intense emotional experiences. So it would not be surprising then that such individuals might give more attention or salience to heart-based affective signals during decision making.

From a gut perspective, Riezzo, Porcelli, Guerra, and Giorgio (1996) found that gastric electrical activity as measured by electrogastrography (EGG) was a useful indicator of psychophysiological stress created by activities such as arithmetic tasks and Stroop color–word tests, and that wide interindividual variability was observed during the stress period.

Thus people may have marked individual differences in their awareness of and focus on head versus heart versus gut aspects of decision making. Supporting this idea, Fetterman and Robinson (2013) explored the different ways individuals metaphorically perceived or located the self in either head or heart. In a paper reporting seven studies, Fetterman and Robinson (2013) demonstrated that those individuals described as head-locators perceived themselves to be rational, logical, and interpersonally cold, whereas heart-locators described themselves as emotional, feminine, and interpersonally warm. Head-locators showed more accuracy in general knowledge assessments and obtained higher grade results. Conversely, heart-locators favored emotional rather than rational considerations within the context of moral decision making. Adam, Obodaru, and Galinsky (2015) also examined head versus heart-locators and found strong individual differences among men versus women and in American versus Indian cohorts. These findings show strong support for individual differences in head versus heart preference in decision-making style.

Epstein, Pacini, Denes-Raj, and Heier (1996) and Epstein (1990) in their work on cognitive-experiential self-theory (CEST) and the associated Rational-Experiential Inventory (REI) also showed that people differ in their reliance on the experiential/intuitive system versus the rational/cognitive system. CEST is a dual-process model of perception and cognition that posits that people operate using two separate systems for information processing: analytical-rational and intuitive-experiential. Norris and Epstein (2011), more recently, identified intuitive-experiential system: intuition, emotionality, and imagination as three reliable subfactors, and we can see that these three facets nicely mirror the aspects of head (imagination), heart (emotion), and gut (intuition) that Soosalu and Oka (2012a, 2012b) have highlighted as key functions in decision making of the three brains. The research using the REI has also found strong individual differences in preference for these particular decision styles and that this preference is often associated with a number of meaningful life outcomes (Shiloh, Salton, & Sharabi, 2002; Sladek, Bond, & Phillips, 2010).

### *Intuition and the Conflation of Heart and Gut*

One of the key challenges in the existing decision-making research literature is the conflation or mixing of heart and gut into the “intuitive” domain. Researchers often appear to lump heart, gut, and (general) intuitive labels into their questionnaire instruments. This is not surprising given the focus in decision-making research on the dual-factor theory of System 1 (intuitive/experiential) and System 2 (cognitive/rational).

However, if it is true that embodied cognition utilized in decision making involves separable interoceptive components from the key neural plexuses of the cardiac and enteric regions, then it would be useful for greater theoretical and empirical specificity for the field of decision-making research to begin examining head, heart, AND gut preferences in decision-making mode or style.

To show that heart and gut are often conflated together in studies on intuitive versus cognitive decision making, let us examine some representative research. For example, in a series of studies examining differences in decision modes (intuitive vs. analytical), Weber and Lindemann (2008) used questions such as,

How likely would you be to make this decision based on your immediate *feelings* or *gut reaction* to the situation? (p. 199)

Thus showing that (heart-based) feelings and gut reactions have been conflated or mixed into the one question. Interestingly from an individual differences perspective, the results of their research showed that while many respondents could be influenced into using either the intuitive or analytical modes based on domain and situational compatibility, nevertheless nearly one third of subjects exhibited a chronic

disposition to operate in an affect-based (intuitive) or a calculation-based (analytic) mode, showing that individual differences in decision mode preference can be strong and enduring.

Betsch (2008) also examined chronic preferences for intuition and deliberation in decision making. In her study she developed what she called the “Preference for Intuition and Deliberation Scale (PID).” This scale grouped questions such as the following:

*My feelings play an important role in my decisions.*

*When it comes to trusting people, I can usually rely on my gut feelings.* (p. 246)

And grouped such questions into the single “intuition” (or affective-decision) category, once again mixing and conflating emotional/affective (heart) with gut (visceral) signals. Importantly, however, she found, “People differ in the way they rely on their heads or their hearts. Even though virtually everybody is able to feel and to think, people follow their strategy preferences if they have the chance to” (p. 243). In an earlier series of studies, Betsch (2004) asked people directly which strategy they would rely on in different situations (those requiring intuition or deliberation to different degrees). She found that, beyond the situational requirement, a subject’s preferred strategy significantly explained variance in strategy selection (Betsch, 2004, Study 3), which led people who favored intuition to choose intuition more frequently than deliberation across all scenarios.

A further example of the conflation of heart and gut interoception in decision research is that of the work of Katkin, Wiens, and Ohman (2001). They examined the development of “gut feelings” in subjects presented with fear inducing stimuli through behavioral conditioning; however, they used heartbeat detection as a measure of visceral or gut feeling sensitivity.

In examining decision making in nursing practice, Hams (2000) also looked at intuition as “gut feeling.” However, she then conflated gut instinct with heart-based intuiting, stating that

*For me [the nurse] it’s a physical sensation. I have two kinds of knowing. I have the knowing that comes from my head that is subject to conscious awareness. And I have the knowing that, for me, comes out of my heart which is where I feel it.* (p. 311)

Unfortunately, this mixed focus on head, heart, and gut and the undifferentiated lumping of heart and gut into the appellation “intuition” has led to a number of challenges in the study of individual difference in decision making. Indeed, Appelt, Milch, Handgraaf, and Weber (2011), in their development of a Decision-Making Individual Differences Inventory lamented that “Individual differences in decision making are a topic of long-standing interest, but often yield inconsistent and

contradictory results” (p. 252). One possible reason for such inconsistency in the examination of individual differences is that researchers have tended to contrast decision-making style as either cognitive or intuitive, and have conflated intuitive style with differing focus on heart interoceptive-based intuitions versus gut-feel intuitions. Indeed in numerous studies we see that authors talk about studying intuitive decision making by examining “gut feel” and then use heart interoception monitoring as the experimental measure, thus conflating heart and gut embodiment aspects of interoceptive intuition. In contrast, intuition can be divided into at least three domains of head (based on conscious reasoning or unconscious cognitive heuristics, for example, Gigerenzer & Gaissmaier, 2011; Kahneman, 2011), heart (cardiac interoception), and gut (enteric/visceral interoception).

That the field of decision-making research is only now beginning to become aware of the difference in types of intuitive signaling is shown by a very recent study. Sadler-Smith (2016) examined the linguistic structure of human resource practitioners’ experience of intuition. He found that intuitions emerge into consciousness as “bodily awareness” and “cognitive awareness” and that bodily awareness comprised two first-order concepts of “gut reactions” and “feelings.” Such a categorization of intuition specifically into differing elements of cognitive, feeling, and gut reaction is currently relatively rare and a commendable addition to the field of decision-making research. For as Pollatos (2015) in examining cardiac versus gut-based IA and sensitivity points out, these bodily signals represent distinct and separate processes and should therefore not be conflated.

### *Head, Heart, and Gut Preference in Decision Making*

To support the examination of and research focus on head, heart, and gut domains in decision making, in the present study, we developed and validated a psychometric instrument that explores multiple brain (head, heart, and gut) preferences in decision making. While it is expected that people will exhibit individual differences in their preference for head, heart, and gut decision-making patterns, existing research suggests that these neural systems are interconnected and interdependent (Mayer, 2011; Thayer & Lane, 2009). The Multiple Brain Preference Questionnaire (MBPQ) instrument explores individual patterns or preferences for head (analytical/cognitive), heart (emotional/affective), and gut (intuition) based decision-making styles, which accumulatively create an individuals’ holistic and integrated response in decision making.

### **Method**

The MBPQ was developed using a systematic process as articulated by Parsian and Dunning (2009). This process included the following:

- *Translational validity*: content validity and face validity.
- *Construct validity*: factor analysis.
- *Reliability tests*: internal consistency (Cronbach's alpha) and test–retest.

### Initial Questionnaire Development

Academic subject matter experts (SMEs) on questionnaire design and statistical analysis were approached to guide and support the questionnaire construction. Two subject experts were consulted regarding the conceptual framework and the pertinent literature to assist in the development of the initial cohort of items for the questionnaire. This process occurred over a total of three iterations to ensure that the scope and breadth of the field was fully and authentically represented and resulted in an initial cohort of 54 questionnaire items.

### Content and Face Validity (Translational Validity)

Content validity was conducted to demonstrate whether the questionnaire content was appropriate and relevant. Ten SMEs from the field of multiple Brain Integration Techniques (mBIT) Coaching (sampled purposively from the global database of mBIT professionals to signify the leading edge and early innovators in this field) then completed a questionnaire utilizing Survey Monkey to assess content and face validity, including a 4-point Likert-type scale for appropriateness, coverage, and relevancy of each question (from 1 = *not relevant*, 2 = *somewhat relevant*, 3 = *relevant*, to 4 = *very relevant*). A 4-point scale was utilized, as opposed to a 5-point scale with a neutral or undecided option, to ensure that SMEs were obliged to judge the appropriateness and relevance of the questions. In addition, the SMEs assessed appearance, readability, clarity of language, usability formatting and style. Content validity index (CVI) analysis was undertaken to assess the validity of the questions in the survey in line with Lynn (1996).

A face validity check was then undertaken with a further 25 SMEs from a range of cultural backgrounds, recruited by asking for volunteers via the mBIT Coach global Facebook network. Face validity “evaluates the appearance of the questionnaire in terms of feasibility, readability, consistency of style and formatting, and the clarity of the language used” (Parsian & Dunning, 2009, p. 3). A simple face validity evaluation questionnaire was distributed via Survey Monkey to the above (again using a Likert-type scale of 1 = *strongly disagree*, 2 = *disagree*, 3 = *agree*, 4 = *strongly agree*). Coding and thematic analysis was undertaken on the qualitative feedback in each section.

### Construct Validity

Construct validity indicates the degree to which each item is perceived to be relevant to the theoretical construct (DeVon et al., 2007, from Parsian & Dunning, 2009).

A total of 301 subjects (60 male, 241 female, ages ranging from 19 to 85 years old) were recruited voluntarily from Unitec, a tertiary education provider in New Zealand, covering a range of professional disciplines, as well as from Facebook to a global population. Unitec subjects were recruited from the intranet and posters—requesting volunteers to reply by a prescribed date. Additional volunteers were recruited via open Facebook invitation. New Zealand subjects constituted 48.5% of respondents, and the remainder were spread across 20 countries. The question order was randomized to minimize any potential systematic bias due to the ordering of the questions. To ensure that participants were answering the questions in the context of decision making, they were requested at the top of the questionnaire to reflect on the questions in the practice and context of decision making.

At the end of the questionnaire, participants were asked to self-assess their brain preference and offer comment as to which brain(s) they preferred to utilize in decision making. This was requested to provide another layer of validity check and to assess self-awareness of brain preferences.

### Factor Analysis

Factor analysis was performed to explore the relationship between variables and determine construct validity. Factor analysis is a statistical method commonly used for investigating variable relationships for complex concepts and used by researchers in developing and evaluating test or scales (Barholomew, Steele, Galbraith, & Moustaki, 2008). In this process, each factor is interpreted according to the items having a high association with it, summarizing the items into a smaller number of factors. Related items that define part of a construct are usually grouped together and unrelated items are deleted.

In the context of factor analysis, there are two commonly related techniques that can be utilized (Barholomew et al., 2008). In the principal components analysis (PCA) approach, the original variables are transformed and grouped into a smaller set of variables that have very strong linear correlations or combinations. The variance in all the variables is then examined. In the standard factor analysis (SFA) approach, the factors are estimated using a mathematical model. So the only variance that is analyzed is the shared variance instead of the total variance.

For this research article, it was decided that the PCA method was suitably reliable and appropriate and this was used to perform exploratory factor analysis on the questionnaire results.

### Reliability Tests: Internal Consistency (Cronbach's Alpha) and Test–Retest

The MBPQ was tested for reliability to assess how consistently the questionnaire measures the 54 items. Thirty-two

mBIT Coaches were asked to volunteer to undertake the test–retest reliability examination. Coaches were offered the opportunity to remain anonymous by using an alias (and were clearly instructed to use the same alias on both occurrences to ensure the two questionnaires could be used in the test–retest).

## Results

### Content and Face Validity (Translational Validity)

CVI scores ranged from 9 to 10, with a cutoff of 0.87 (DeVon et al., 2007). All question items were valid and therefore retained.

Face validity results showed that on average 95.2% of SMEs agreed that the wording of the items were clear and understandable to the target audience, and 84.7% of SMEs agreed that the layout and style would be acceptable for the target audience. Face validity was also analyzed using a validity ratio similar to that suggested by Rungtusanatham (1998). Under this regime, 52 of the 54 items strongly met the required criteria. For the two items that did not, SME feedback was used to adjust the wording to make the items clear and understandable to meet SME requirements.

In addition, based on SME face validity feedback, the following minor changes were made to the questionnaire:

1. Two minor typographical errors were fixed.
2. The wording of three questions was modified to ensure a clear distinction between factors.
3. Further clarity was offered in the instructions for completion of the questionnaire.

### Factor Analysis

*Assessing the suitability of data for factor analysis.* There are two key issues to be considered in assessing the suitability for factor analysis: sample size and the strength of the relationships among the variables. To enable factor analysis to be reliable, a large sample size is required. While there are different opinions around the number of participants required, many researchers recommend a minimum of five to 10 participants per variable or at least 300 cases or subjects in total (Tabachnick & Fidell, 2012). In this study, we had 301 participants complete the MBPQ and so this meets the first criterion.

In considering the strength of the relationships among the variables, the standard is that the items need to have a bivariate correlation of at least 0.3 or greater for larger sample sizes (MacCallum, Wideman, Zhang, & Hong, 1999). Statistical measures that can be used to inform the appropriateness of the relationships include the following:

1. *Kaiser–Meyer–Olkin (KMO)*—This measure ranges from 0 to 1. A value of 0 indicates that the sum of

partial correlations is large in comparison to the sum of correlations, and indicates diffusion in the pattern of correlation, and that factor analysis is inappropriate (Parsian & Dunning, 2009). It is recommended to accept values  $\geq 0.5$ . Values between 0.5 and 0.7 are described as mediocre, 0.7 and 0.8 as good, 0.8 and 0.9 as great,  $\geq 0.9$  is superb, and 1 as perfect (Kaiser, 1974). In this study, there were 54 variables and on average this yielded five cases per variable. The KMO measure of sampling adequacy was 0.77. This was above the minimum value of 0.5 and fell in Kaiser's good category.

2. *Bartlett's test of sphericity*—This uses a  $p$  value. If the  $p$  value  $\leq 0.05$ , the Bartlett's test is significant and  $\leq 0.01$  the Bartlett's test is very highly significant and it passes the suitability test. In this study, the  $p$  value for Bartlett's test of sphericity was 0.00. This value was considered to be very highly significant and passed the suitability test.

All the conditions met the suitability criteria and enabled factor analysis to be undertaken.

*Factor or component extraction.* This determines the smallest number of items that can be best used to represent the inter-relationships among all items. It is typically up to the researcher to determine the number of factors considered best to describe the underlying relationship; however, two conflicting needs must be balanced. The first of these is to find a simple solution with as few factors as possible while second ensuring as complete a picture is obtained in explaining as much variance in the original data as possible.

Two main criteria are used to determine the number of factors that should be retained, and some statisticians use a third criterion of parallel analysis (Field, 2013):

1. *Kaiser's criterion*—select those factors that have eigenvalue  $\geq 1$ . The eigenvalues represent the amount of the total variance explained by that factor. In this study, 10 factors had eigenvalues  $\geq 1$ . These 10 factors explained a cumulative variance of 61.83%. This is certainly above 50% and falls in the mediocre range. Field (2013) considers a total variance of 50% or more to be reasonable.
2. *The scree test*—this depicts the descending variances that account for the factors extracted in graph form. This involves plotting each of these eigenvalues on each of the items and inspecting the plot to find a point where the shape of the curve starts to change direction (points of inflection) and becomes horizontal. The factors which come before the point where eigenvalues begin to drop can be retained. In this study, the points of inflection occurred at both four and six factors. Therefore, the analysis could justify retaining either three or five factors. Given the large

**Table 1.** The Factor Loadings of the Final PCA With Their Factorial Weights.

Items	Factor 1	Factor 2	Factor 3
When undertaking a task I tend to use a thought-through structured approach	0.667		
I am very head based in my decisions	0.588		
I prefer to think things through to make meaning of them	0.647		
When undertaking a task I don't use a logical head-based approach	0.674		
I am a very logical person	0.625		
I do not let my head lead when I make decisions	0.567		
I am a very creative (imaginative, inventive and/or innovative, etc.) person	0.850		
I trust my gut reactions when making decisions		0.528	
I am self-motivated and get moving easily		0.613	
I do not have strong gut intuitions/instincts		0.410	
I am an action oriented person who gets things done		0.489	
I often lack energy and motivation		0.580	
I am a gutsy courageous person		0.647	
I look after and protect myself		0.489	
I have a very strong core/gut sense of self		0.735	
I am quite warm hearted			0.673
I feel what is important to me in my heart			0.458
I am very compassionate (kind, empathic, loving, etc.)			0.639
I like to connect deeply with people			0.649
My heart feelings are not very important to me			0.483
I do not like to get too close to people			0.507
I always follow my heart			0.319

Note. PCA = principal components analysis.

sample size in the study and that there was consistency between Kaiser's criterion and the scree plot, it was deemed reasonable to extract three factors. This certainly fits with the underlying theoretical model.

3. *Parallel analysis*—used as a quality-control check. The size of the eigenvalues that have been collected from data is compared with the eigenvalues obtained from a randomly generated dataset of the same size. Only the eigenvalues that exceed the randomly generated eigenvalues are retained. This approach is more accurate than the scree test or Kaiser's criterion. In this study, Monte Carlo PCA for parallel analysis was used to randomly generate eigenvalues of a random dataset. For the first three factors, the eigenvalues exceeded the randomly generated eigenvalues. This further confirms that the first three factors should be retained.

In this study, three different methods were used to determine the number of factors to be retained and these three comparisons agreed with one another very well. Thus, a three factor solution with Oblimin rotation was deemed to be most statistically and conceptually appropriate.

*Factor rotation and interpretation.* To undertake the most appropriate interpretation, the loading values were carefully examined using the guidelines for practical significance

published in Parsian and Dunning (2009). A factor loading of  $\pm 0.3$  indicates that the item is of minimal significance,  $\pm 0.4$  indicates it is more important,  $\pm 0.5$  indicates it is significant, and beyond indicates highly significant.

Steven's (2002) guideline of statistical significance for interpreting factor loadings, which is based on sample size, suggests the following statistically acceptable loadings. For 50 participants the loading cutoff is 0.72, for 100 participants 0.51, and for 200 to 300 participants 0.29 to 0.38. The sample size used in the validation process was 301: As a result, all item loadings above the range 0.29 to 0.38 were retained, leaving 22 items from the original 54. The final PCA for the three-factor solution with 22 items accounted for 35.47% of the total variance, while a five-factor solution accounted for 44.87% of the total variance. The factor loadings of the final PCA with their factorial weights for three factors are shown in Table 1.

### Reliability Tests

*Internal consistency reliability.* To explore how well items fit together conceptually, and to examine the inter-item correlations, internal consistency is undertaken (Parsian & Dunning, 2009). This was analyzed using Cronbach's alpha. The Cronbach's alpha for 21 out of 22 questionnaire items ranged from .7 to 1 with only one statement having a value of .3. The overall average Cronbach's alpha was .86,

indicating a good correlation and that the items and the questionnaire are consistently reliable. A Cronbach's alpha value  $\geq 0.9$  is considered as excellent correlation, a value between .8 and .9 as good, and between .7 and .8 as acceptable. Field (2013) suggests .7 as the cutoff point.

**Test-retest.** Thirty-two respondents completed the questionnaire as part of test-retest reliability process over 2 weeks. The test and retest reliability was measured by correlating the scores of the test and retest on a question-by-question basis. This correlation is known as the test-retest reliability coefficient or the intra-class correlation coefficient (ICC). The ICC ranges from a value of 0 to 1 with 1 being a perfect correlation between the test and the retest. A coefficient correlation of 0 indicates that the respondents' scores at test were completely unrelated to their scores at retest; therefore, the test is not reliable. An ICC value  $>0.9$  indicates test-retest reliability is excellent,  $>0.8$  as optimal, and  $>0.7$  as typical.

The ICCs for the 22 statements were statistically significant ( $p \leq .05$ ) and ranged from .7 to 1. One statement had a nonsignificant ICC value of .34. Fifty percent of the statements' test-retest reliability was excellent, 18% optimal, 27% typical, and 5% below typical range. The overall average ICC value was 0.87, which fell in the optimal range.

### Self-Awareness of Brain Preferences

Of the 301 participants in this study, only 266 provided their indication of which brains they believed they preferred to use in decision making. Four subjects did not answer the question regarding this, and 31 indicated they were unsure about what their preference was.

Of the 266 valid responses, matching was performed on the Head-Heart-Gut scores from the three factors against the indicated Head-Heart-Gut stated preference. Only 124 (47%) subjects had a match between the Head-Heart-Gut preference scores from the instrument versus their indicated conscious belief preference. Including those who responded with "Unsure," this equated to a total of 52% of all respondents were not able to accurately assess their measured preference using conscious belief or guessing.

### Brain Preferences Results

The question scores for the three factors were summed and a weighted percentage score computed to produce head, heart, and gut scores that could range from 0 to 100. Of the 301 participants, 27% scored with head as the highest score, 44% with heart as highest, and 29% with gut as highest, the remainder were matched on head, heart, and gut scores. This indicated that heart and gut preferences in decision making were higher in this sample than that of head preference, and also showed that heart and gut were relatively similar in preference, with heart being somewhat more preferred by a larger

number of subjects. For those with head as the highest score, 39% had a head score that was at least 10 points higher than either heart or gut scores. For those with heart as the highest, 50% had a heart score that was at least 10 points higher than the other brains' scores. And for gut as the highest, 31% had a score that was at least 10 points higher than the rest. Also in this sample, only a minimal 4% had balanced scores where head, heart, and gut were equal or within five points of each other, and only 14% had balanced scores within 10 points of each other for head, heart, and gut scores.

### Gender and Age Differences

Analysis of head, heart, and gut scores found that the mean head scores of males and females differed significantly ( $p = .01$ ) from each other with males having higher mean head scores (mean difference = 4.87,  $t$  statistics = 2.591). Heart scores of males and females also were significantly different ( $p = .005$ ) from each other with females having on average a higher mean heart score (mean difference = 5.47,  $t$  statistics = 2.809). Mean gut scores were not significantly different between genders ( $p = .005$ ).

By age group, the mean head scores were not significantly different except for the difference between age groups 41 to 50 and 51 to 60 ( $p = .03$ ) with the 41 to 50 group having a higher mean head score than the 51 to 60 age group (mean difference = 5.46). The mean scores for both heart ( $p = .468$ ) and gut ( $p = .36$ ) were similar across all age groups, showing no significant difference. The majority (68%) of subjects fell into the age groups of 41 to 60, with only 12% of subjects older than 60, 4% younger than 30, and 15% in the 31- to 40-year bracket.

### Discussion

In this study, we developed and validated a psychometric instrument that explores multiple brain (head, heart, and gut) preferences in decision making. Factor analysis found three reliable factors that correlated with head (Factor 1—accounted for 14.6% of total variance and included seven items), gut (Factor 2—accounted for 13.2% of total variance and included eight items), and heart (Factor 3—accounted for 7.6% of total variance and included seven items). Item questions such as "I am very head based in my decisions" and "I am a very logical person" obviously explored preferences for cognitive head-based thinking. Items such as "I feel what is important to me in my heart" and "I always follow my heart" focused on heart-based affective emoting. And items such as "I trust my gut reactions when making decisions" and "I do not have strong gut intuitions/instincts" examined gut-based intuitions and processing.

While the three-factor solution only accounted for 35.47% of the total variance, we chose it because it supported the theoretical model of embodied cognition of head, heart, and gut neural intelligences and kept the instrument scoring

relatively simple and congruent with the theoretical model. It also aligned with the findings of Norris and Epstein (2011). However, it is interesting to consider the five-factor solution to our results which accounted for 44.87% of the total variance. With this solution, we obtained two subfactors for head, two subfactors for gut, and one for heart. The gut subfactors, for example, divided into two classes of gut questions, one around the theme of motility and gutsy action, the other around issues of protection and self-preservation. In their examination of the prime functions of the three brains, Soosalu and Oka (2012a) suggested that each of the brains had three key prime functions of

#### HEAD BRAIN PRIME FUNCTIONS

**COGNITIVE PERCEPTION**—cognition, perception, pattern recognition, etc.

**THINKING**—reasoning, abstraction, analysis, synthesis, meta-cognition etc.

**Making meaning**—semantic processing, languaging, narrative, metaphor, etc.

#### HEART BRAIN PRIME FUNCTIONS

**EMOTING**—emotional processing (e.g., anger, grief, hatred, joy, happiness etc.)

**VALUES**—processing what's important to you and your priorities (and its relationship to the emotional strength of your aspirations, dreams, desires, etc.)

**RELATIONAL AFFECT**—your felt connection with others (e.g., feelings of love/hate/indifference, compassion/uncaring, like/dislike, etc.)

#### GUT BRAIN PRIME FUNCTIONS

**CORE IDENTITY**—a deep and visceral sense of core self, and determining at the deepest levels what is “*self*” versus “*not-self*”

**SELF-PRESERVATION**—protection of self, safety, boundaries, hungers and aversions

**MOBILIZATION**—motility, impulse for action, gutsy courage and the will to act

The emergence of subfactors of self-preservation and mobilization for the gut factor items provides some support for Soosalu and Oka's contention and would be a fruitful area for further research.

### *Separating Heart From Gut in Embodied Intuition*

Nearly a decade ago, Bohm and Brun (2008) in summarizing the state of decision research in a special issue of the journal *Judgment and Decision Making* made the following important claim that

In sum, decision research has seen a proliferation of approaches that look beyond rational, deliberate, and purely cognitive processes in decision making and investigate intuitive and emotional judgments in this area. This seemed like a good point in time to reflect the state of this emerging field in a special issue that addresses the question of how intuition and affect are related to each other and how they shape risk perception and decision making. (p. 1)

In doing so they brought attention to the fact that intuition and affect/emotion are not the same thing. As we have discussed here, embodied cognition involves embodied feelings and ways of knowing that involve heart and gut neural signals. Gut feelings and reactions are not the same as heart emotions and heart-based experiencing, and the research in this study has shown there are separable factors for preference in head, heart, and gut. Thus decision making involves not just head-based cognitions, but separate aspects of heart (affective) and gut (intuitive) processing, and in exploring the separable factors of these for decision making we have highlighted a focus that carries forward the ideas of Böhm and Brun and created and validated an instrument that can be used to begin to explore how intuition and affect might both differ and relate to each other and to do so from a neurologically informed stance.

There is little doubt that the heart and gut are involved in the embodied aspects of decision making. As Mayer (2011) points out in his seminal review of “Gut Feelings: The Emerging Biology of Gut-Brain Communication,” there is a close connection between the gut and the brain and this interaction plays an important part in feeling states and intuitive decision making. And in terms of the heart, the following quote from Gomes Silva (2014, p. 97) nicely summarizes the emergent view:

Recent scientific research suggests that consciousness emerges from the brain and body acting together. A growing body of evidence suggests that the heart plays a particular significant role in this process. Far more than a simple pump, the heart, now is recognized by scientists, as a highly complex system with its own functional “brain” (McCraty, 2005; McCraty, Atkinson, Tomasino, & Bradley, 2009).

Indeed, as Sinclair (2010) points out, the view that intuitive/experiential aspects of decision making include an affective component is becoming more widespread.

Thus we suggest that it is time that the field of decision making moves from a two-factor (cognitive and experiential/intuitive) model to a neurologically informed three-factor model of head, heart, and gut.

### *Age and Gender Differences*

The extant literature suggests there are robust age and gender differences between cognitive, intuitive, and emotional decision making. Fetterman and Robinson (2013), for example, explored whether people locate their sense of self in the heart or head, and found gender differences such that 64% of women chose the heart, whereas only 43% of men chose the heart. Norris and Epstein (2011) using the REI found that men assessed themselves as more rational whereas women assessed themselves as more experiential, intuitive, and emotional.

Sladek et al. (2010) also found both significant age and gender differences in rational versus experiential (emotional and intuitive) thinking and decision making. Their results suggested that there was a convergence of the rational and experiential systems in adulthood, but they highlighted that the timing may be different for women and men. In later adulthood, the relationship appeared to diverge again. Mikels et al. (2010) examined health decisions in older versus younger adults and demonstrated that younger adults performed better with a focus on information, whereas in a control group older adults performed better in the emotion-focus condition. This is in accord with the work of Satchell, Akehurst, Morris, and Nee (2017) who found that experiential gut instinct about whether a stranger poses a threat is as good when people are 80 as when they are 18. Older people were as good as young adults at knowing intuitively when someone was potentially aggressive.

Finally, according to Sinclair, Ashkanasy, and Chattopadhyay (2010),

female decision makers appear to rely more heavily on intuition because they can access it more easily through their heightened awareness of emotions. Affective orientation mediates the effect of gender on intuition because its activation is much stronger in female decision makers, possibly for neurobiological and social reasons. (p. 393)

In the current study we found that indeed women had higher mean heart scores than men, and men displayed higher mean head scores compared with women. This concurs with previous studies on gender differences in decision making and lends additional support. However, there was no significant difference between genders in gut scores. Thus our findings bring a more nuanced insight into how the “experiential” aspect of two-process theories (rational vs. experiential) separates out into heart (emotive) versus gut (intuitive) factors of the three-factor model. It appears from the current study that while women are more likely to prefer heart-based emotional decision making, when it comes to gut-based intuitive focus, they are not necessarily likely to differ from males in this regard. This would be a fruitful area for future studies to examine.

In terms of age differences, the current study found that those in middle age group (41-50 years) had significantly higher head scores than the 51 to 60 age group, but no differences were found across age for heart or gut or head for the other age groups. However, the majority of the cohort in this study were in the middle age range, and only 4% were under 30 years of age and 12% above 60 years, so the paucity of data for these outer age ranges may have influenced the results. While this study was unable to validate previous research findings such as those of Mikels et al. (2010), the present findings do lend tentative support, however, to the findings of Satchell et al. (2017), who found that older adults

were just as good as younger adults at gut-level intuitive decision making.

### *State and Context*

One of the limitations of the current study is that we did not control for the affective state of the participants. In addition, while we attempted to control for decision-making context by explicitly asking subjects at the top of the questionnaire wording to answer the item questions with respect to decision making, nevertheless we did not contextualize this to specific decision-making domains such as work, finance, family, relationship, and so on. This may be important because there is some evidence that a person’s domain-general decision style (intuitive vs. deliberative) does not necessarily generalize across decision domains (Pachura & Spaar, 2015). On the contrary, de Vries, Holland, and Witteman (2008) in examining intuitive versus deliberative decision-strategy preferences found that decision-style preferences can be strong and enduring across decision-style context. Given the lack of clarity in the literature on the importance of domain and context specificity, this would be a fruitful area for further research using the instrument developed in the current study.

In our test–retest study there were a small number of items that had below typical or optimal results and one statement that had a nonsignificant result. In informal post hoc discussion with a small number of the test–retest subjects, in particular, those whose responses to the lower reliability items appeared to show mistakes in how they answered the negatively worded questions between test and retest, the subjects expressed that as the retest occurred in the week leading up to the Christmas period, they were feeling quite stressed and mood altered and this may have influenced the accuracy of their responses.

There is a growing body of research evidence that suggests that stress and emotional state can impact decision strategy. For example, moderate degrees of positive mood were found to facilitate intuition (Elsbach & Barr, 1999), whereas negative mood appeared to block it (Sinclair, 2010). Mather and Lighthall (2012) explored decisions made under stress and found that subjects processed information differently in this condition. Furman, Waugh, Bhattacharjee, Thompson, and Gotlib (2013) alternately found that depression can impact the ability to use interoceptive feedback to inform decision making, and Avery et al. (2014) found that depression is associated with abnormal interoceptive representation in the insular cortex, the area responsible for representing embodied heart, gut, and autonomic signals. Finally, George and Dane (2016), in a review of the literature, found that both incidental mood and discrete emotion “play a multitude of nuanced roles in decision-making.”

Therefore, future studies would benefit from examining and controlling affective state before exploring head, heart,

and gut decision preferences to see just how much individuals' preferences are influenced by state and context.

### *Making Wise Leadership Decisions*

In our study we found that 27% of participants scored with head as the highest score, 44% with heart as highest, and 29% with gut as highest, showing that there were more people with a heart or gut (i.e., experiential vs. rational) preference. In contrast, Fetterman and Robinson (2013) explored whether people located their sense of self in the heart or head (forced choice), and found that 52% rated themselves as heart-based and 48% as head-based. It may be that in forcing a choice between head and heart, some of those who were actually gut-based in their preference may have chosen head over heart as their gut-based reaction to this question (as gut and heart are quite different affective domains). If this were true, then our findings would align with those of Fetterman and Robinson.

As indicated above in the section on gender differences, we had a much larger cohort of women than men in our study (60 male, 241 female) and there is evidence to suggest that women are much more emotional and experiential compared with men in their decision styles. This could account for our larger percentage of heart preferrers. In any case, our results showed very small percentages (only 4%) expressed a relatively balanced preference for head, heart, and gut together. Yet there are suggestions from both the leadership decision-making literature and psychiatric literature that effective and wise decisions require a balance and use of all three decision styles (Coget, 2011; Coget & Keller, 2010; Dotlich et al., 2006; Fenton-O'Creavy, Soane, Nicholson, & Willman, 2011) or a balance between rational and experiential/intuitive styles (Dane & Pratt, 2007; Freeman, Evans, & Lister, 2012; Hogarth, 2002; Shapiro & Spence, 1997).

Indeed, Zhong (2011) found that a focus on head-based rational, deliberative decision making alone increased unethical behaviors, increased deception, and decreased altruism especially when it overshadowed implicit, intuitive influences on moral judgments and decisions. And this was backed up by the work of Feinberg, Willer, Antonenko, and John (2012) who found that people with a preference for cognitive reappraisal have diminished emotional intensity and make more deliberative moral judgments, leading them to find moral dilemmas less immoral than people with a preference for emotional judgment. Supporting this, Soosalu and Oka (2012a, 2012b) in action research found that wise and effective leadership decision making requires a balanced mix of head, heart, and gut reasoning, appraisal and decision making.

Given the findings in the current study, that only a small percentage of subjects displayed balanced preference for head, heart, and gut decision-strategy, one important application of the MBPQ instrument developed in this study may be to utilize it to coach people to become more balanced in their

use and preference of all three factors. Also, a fruitful area for future research would be to examine those with a balanced versus unbalanced preference for the three factors with respect to decision effectiveness and quality.

### *Conscious Awareness of Strategy*

Research has shown that the majority of people exhibit decision-making bias blindspots and are consciously unaware of their own judgmental biases and preferences (Scopelliti et al., 2015). In addition, people can exhibit low levels of meta-awareness with respect to IA as shown by studies such as those by Azevedo, Agliotti, and Lenggenhager (2016), who found that while subjects had above chance recognition of their own heart cardiodynamics, their metacognitive awareness of interoceptive signals was exceedingly poor. Leach and Weick (2018) also found that people's beliefs in their intuitions were not reflective of actual performance, and Sobyra (2010) in her study of the accuracy of self-reported intuitive and analytic ability reported that self-reported rationality was significantly correlated with cognitive performance, but that participants struggled with accurately reporting their intuitive ability. Finally, Norris and Epstein (2011) examined self versus other ratings of rational versus experiential thinking styles and found that people overestimated their rational thinking and underestimated their experiential thinking, while McNulty, Olson, Metzler, and Shaffer (2013) found that newlywed's automatic attitudes measured using an associated priming task, and not their conscious ones, predicted changes in marital satisfaction over a 4-year period.

In alignment with this, the current study found that 52% of respondents were not able to accurately predict their head, heart, gut decision-preference. This means that over half of those in our study believe they are using a decision-preference that does not conform with what the instrument found as their likely preference. As discussed above, if it is important for wise decision-making that people utilize all of their conscious and intuitive intelligences (head, heart, and gut) in balance, then it could be important for people to learn what their actual underlying preferences are and learn ways to rebalance their decision-strategies.

Research has shown that people can be trained to shift their decision-strategies and overcome their implicit preferences and biases; however, it takes a combination of awareness, learning, and support (Devine, Forscher, Austin, & Cox, 2012). Also, there is growing evidence that personal beliefs play an important role in emotional processing and may modulate interoception and the perception of emotional cues (Paulus, 2011; Ring, Brener, Knapp, & Mailloux, 2015). Therefore, people's beliefs about the importance of cognition, intuition, or emotion in decision making may setup self-fulfilling loops that lead them to value and utilize interoceptive cues over head-based cognitive rational processing or vice-versa in their decision-making strategies. Thus coaching and

training using the current instrument may be a powerful and useful application that can support more accurate awareness of metacognitive processes, a shift in personal beliefs about decision preference and the learning of wiser decision-making strategies.

### Conclusion and Summary

As we have seen in this article, emerging sources of evidence from the fields of neurocardiology and neurogastroenterology are showing that both the heart and gut regions have complex, adaptive and functional neural networks or what the researchers in these fields are calling “brains.” There is also a substantive body of work that strongly suggests that cognition and decision making is embodied and involves neuroception and interoception from embodied neural systems. Work on the embodiment of metaphor also supports that people imbue a sense of self in areas such as the head, heart, or gut, and that this focus on these regions influences decision making. In the work presented in the current study, based on the notion that there are three key areas of embodied neural intelligence—head, heart, and gut—we have developed and validated a questionnaire instrument (MBPQ) for examining individual’s preferences for head, heart, and gut focus in decision making. It is of course worth reiterating here that the head, heart, and gut are within one complex adaptive human body or system that behaves in response to the integrated decision made. The benefit of specifying the source of the decision-making activity to head, heart, or gut enables skilled professionals to work specifically with people to change decision making with even finer distinction: to give an even deeper awareness and understanding of how decisions are being made so that people can reflect on and evaluate that for wisdom and effectiveness, and make specific changes if desired at an individual head, heart, and gut aspects of the whole.

In summary, we’d like to conclude with a wonderful quote from Loewenstein:

With all its cleverness, however, decision theory is somewhat crippled emotionally, and thus detached from the emotional and visceral richness of life.

(George Loewenstein, 1996, p. 289; in Shiv & Fedorikhin, 1999)

And as we have attempted to do in this current research, we hope that by bringing a focus onto the three separable (and neurologically based) aspects of head, heart, and gut in decision making, and providing a psychometrically validated tool for examining these, we can begin, in the field of decision making, to honor the importance of all of the multiple embodied neural components of how humans make wise decisions.

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### Ethical Statement

This research was conducted in accord with American Psychological Association (APA) ethical principles and was approved by the Unitec Research Ethics Committee (UREC)—Ethics application number: 2013-1073.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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### References

- Adam, H., Obodaru, O., & Galinsky, A. (2015). Who you are is where you are: Antecedents and consequences of locating the self in the brain or the heart. *Organizational Behavior and Human Decision Processes*, *128*, 74-83.
- Appelt, K., Milch, K., Handgraaf, M., & Weber, E. (2011). The Decision Making Individual Differences Inventory and guidelines for the study of individual differences in judgment and decision-making research. *Judgment and Decision Making*, *6*, 252-262.
- Ardell, J. (2004). Intrathoracic neuronal regulation of cardiac function. In J. A. Armour & J. L. Ardell (Eds.), *Basic and clinical neurocardiology* (pp. 118-152). New York, NY: Oxford University Press.
- Armour, J. (1991). Anatomy and function of the intrathoracic neurons regulating the mammalian heart. In I. H. Zucker & J. P. Gilmore (Eds.), *Reflex control of the circulation* (pp. 1-37). Boca Raton, FL: CRC Press.
- Armour, J. (2004). Cardiac neuronal hierarchy in health and disease. *American Journal of Physiology, Regulatory, Integrative and Comparative Physiology*, *287*, R262-R271.
- Armour, J. (2007). The little brain on the heart. *Cleveland Clinic Journal of Medicine*, *74*, S48-S51.
- Avery, J., Drevets, W., Moseman, S., Bodurka, J., Barcalow, J., & Simmons, W. (2014). Major depressive disorder is associated with abnormal interoceptive activity and functional connectivity in the insula. *Biological Psychiatry*, *76*, 258-266.
- Azevedo, R., Agliotti, S., & Lenggenhager, B. (2016). Participants’ above-chance recognition of own-heart sound combined with poor metacognitive awareness suggests implicit knowledge of own heart cardiodynamics. *Scientific Reports*, *6*, Article 26545.
- Barholomew, D., Steele, F., Galbraith, J., & Moustaki, I. (2008). *Analysis of multivariate social science data: Statistics in the*

- social and behavioral sciences series* (Vol., 2nd ed.). Oxford, UK: Taylor & Francis.
- Barrett, L., & Bar, M. (2009). See it with feeling: Affective predictions during object perception. *Philosophical transactions of the Royal Society of London, Series B: Biological Sciences*, 364, 1325-1334.
- Bechara, A., & Damasio, A. (2005). The somatic marker hypothesis: A neural theory of economic decision. *Games and Economic Behavior*, 52, 336-372.
- Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science*, 275, 1293-1295.
- Berntson, G., Sarter, M., & Cacioppo, J. (2003). Ascending visceral regulation of cortical affective information processing. *European Journal of Neuroscience*, 18, 2103-2109.
- Betsch, C. (2004). Präferenz für Intuition und Deliberation. Inventar zur Erfassung von affekt- und kognitionsbasiertem Entscheiden [Preference for Intuition and Deliberation (PID): An inventory for assessing affect- and cognition-based decision-making]. *Zeitschrift für Differentielle und Diagnostische Psychologie*, 25, 179-197.
- Betsch, C. (2008). Chronic preferences for intuition and deliberation. In H. Plessner, B. Betsch, & T. Betsch (Eds.), *Decision making in intuition in judgment and decision making* (pp. 231-248). Mahwah, NJ: Lawrence Erlbaum.
- Bishopric, N. (2005). Evolution of the heart from bacteria to man. *Annals of the New York Academy of Sciences*, 1047, 13-29.
- Bohm, G., & Brun, W. (2008). Intuition and affect in risk perception and decision making. *Judgment and Decision Making*, 3, 1-4.
- Brack, A. (2011). *Intuitive intelligence: Accessing the wisdom of head, heart and hara. Review of the intuitive intelligence framework and key practices*. Integral Sustainability Center. Retrieved from [http://iah.commonweal.org/wp-content/uploads/sites/2/2012/08/Brack\\_2011\\_Accessing\\_Intuitive\\_Intelligence\\_20120223.pdf](http://iah.commonweal.org/wp-content/uploads/sites/2/2012/08/Brack_2011_Accessing_Intuitive_Intelligence_20120223.pdf)
- Brack, K. (2014). The heart's "little brain" controlling cardiac function in the rabbit. *Experimental Physiology*, 100, 348-353. doi:10.1113/expphysiol.2014.080168
- Burke, L., & Miller, M. (1999). Taking the mystery out of intuitive decision making. *Academy of Management Perspectives*, 13, 91-99.
- Burr, C. (2017). Embodied decisions and the predictive Brain. In T. Metzinger & W. Wiese (Eds.), *Philosophy and predictive processing* (p. 7). Frankfurt am Main, Germany: MIND Group. doi:10.15502/9783958573086
- Cisek, P., & Pastor-Bernier, A. (2014). On the challenges and mechanisms of embodied decisions. *Philosophical transactions of the Royal Society of London, Series B: Biological Sciences*, 369, 1655.
- Coget, J. (2011). *The critical decisions vortex—Interplay of intuition, reason and emotion: Comparison of three dynamic industries*. Northampton, MA: Edward Elgar.
- Coget, J., & Keller, E. (2010). The critical decision vortex: Lessons from the emergency room. *Journal of Management Enquiry*, 19, 56-67.
- Cognigni, P., Bailey, A., & Miguel-Aliaga, I. (2011). Enteric neurons and systemic signals couple nutritional and reproductive status with intestinal homeostasis. *Cell Metabolism*, 13, 92-104.
- Craig, A. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience*, 3, 655-666.
- Craig, A. (2009). How do you feel—Now? The anterior insula and human awareness. *Nature Reviews Neuroscience*, 10, 59-70.
- Craig, A. (2014). *How do you feel? An interoceptive moment with your neurobiological self*. Princeton, NJ: Princeton University Press.
- Critchley, H. (2009). Psychophysiology of neural, cognitive and affective integration: fMRI and autonomic indicators. *International Journal of Psychophysiology*, 73, 88-94.
- Critchley, H. (2015). *Interoception, emotion and self: How the heart gates feelings and perceptions*. Retrieved from <http://www.rotman.uwo.ca/events-2/hugo-critchley-interoception-emotion-and-self/>
- Critchley, H., & Harrison, N. (2013). Visceral influences on brain and behavior. *Neuron*, 77, 624-638.
- Critchley, H., Wiens, S., Rotshtein, P., Ohman, A., & Dolan, R. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience*, 7, 189-195.
- Damasio, A. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York, NY: Putnam.
- Damasio, A. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York, NY: Harcourt Brace.
- Damasio, A., Tranel, D., & Damasio, H. (1991). Somatic markers and the guidance of behavior: Theory and preliminary testing. In H. S. Levin, H. M. Eisenberg, & A. L. Benton (Eds.), *Frontal lobe function and dysfunction* (pp. 217-229). New York, NY: Oxford University Press.
- Dane, E., & Pratt, M. (2007). Exploring intuition and its role in managerial decision making. *Academy of Management Review*, 32, 33-54.
- Devine, P., Forscher, P., Austin, A., & Cox, W. (2012). Long-term reduction in implicit race bias: A prejudice habit-breaking intervention. *Journal of Experimental Social Psychology*, 48, 1267-1278.
- DeVon, H., Block, M., Moyle-Wright, P., Ernst, D., Hayden, S., & Lazzara, D. (2007). A psychometric toolbox for testing validity and reliability. *Journal of Nursing Scholarship*, 39, 155-164.
- de Vries, M., Holland, R., & Witteman, C. (2008). Fitting decisions: Mood and intuitive versus deliberative decision strategies. *Cognition and Emotion*, 22, 931-943.
- Dotlich, D., Cairo, P., & Rhinesmith, S. (2006). *Head, heart & guts—How the world's best companies develop complete leaders*. Hoboken, NJ: John Wiley.
- Dunn, B., Galton, H., Morgan, R., Evans, D., Oliver, C., Meyer, M., . . . Dalgleish, T. (2010). Listening to your heart: How interoception shapes emotion experience and intuitive decision making. *Psychological Science*, 21, 1835-1844.
- Elsbach, K., & Barr, P. (1999). The effects of mood on individual's use of structured decision protocols. *Organization Science*, 10, 181-198.
- Epstein, S. (1990). Cognitive-experiential self-theory. In L. A. Pervin (Ed.), *Handbook of personality: Theory and research* (pp. 165-192). New York, NY: Guilford Press.
- Epstein, S., Pacini, R., Denes-Raj, V., & Heier, H. (1996). Individual differences in intuitive-experiential and analytical-rational thinking styles. *Journal of Personality and Social Psychology*, 71, 390-405.

- Evans, J., & Stanovich, K. (2013). Dual-process theories of higher cognition advancing the debate. *Perspectives on Psychological Science*, 8, 223-241.
- Feinberg, M., Willer, R., Antonenko, O., & John, O. (2012). Liberating reason from the passions: Overriding intuitionist moral judgments through emotion reappraisal. *Psychological Science*, 23, 788-795.
- Fenton-O'Creedy, M., Soane, E., Nicholson, N., & Willman, P. (2011). Thinking, feeling and deciding: The influence of emotions on the decision making and performance of traders. *Journal of Organizational Behavior*, 32, 1044-1061.
- Fetterman, A., & Robinson, M. (2013). Do you use your head or follow your heart? Self location predicts personality, emotion, decision making and performance. *Journal of Personality and Social Psychology*, 105, 316-334.
- Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London, England: Sage.
- Freeman, D., Evans, N., & Lister, R. (2012). Gut feelings, deliberative thought, and paranoid ideation: A study of experiential and rational reasoning. *Psychiatry Research*, 197, 119-122.
- Furman, D., Waugh, C., Bhattacharjee, K., Thompson, R., & Gotlib, I. (2013). Interoceptive awareness, positive affect and decision making in major depressive disorder. *Journal of Affective Disorders*, 151, 780-785.
- Genovese, M. (2016). *The leadership toolkit, in becoming a better leader: Applying key strategies*. Abingdon, UK: Routledge.
- George, J., & Dane, E. (2016). Affect, emotion, and decision making. *Organizational Behavior and Human Decision Processes*, 136, 47-55.
- Gershon, M. (1999). *The second brain—A groundbreaking new understanding of nervous disorders of the stomach and intestine*. New York, NY: Harper Perennial.
- Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology*, 62, 451-482.
- Goldstone, A., Hofstra, R., & Burns, A. (2013). Building a brain in the gut: Development of the enteric nervous system. *Clinical Genetics*, 83, 307-316.
- Gomes Silva, S. (2014). *Engaging touch and movement in somatic experiencing trauma resolution approach*. Retrieved from <https://traumahealing.org/wp-content/uploads/2016/04/engaging-touch-and-movement-in-se-trama-resolution-approach-dissertation-bySoniaGomes-2014.pdf>
- Gutnik, L., Forogh Hakimzadeh, A., Yoskowitz, N., & Patel, V. (2006). The role of emotion in decision-making: A cognitive neuroeconomic approach towards understanding sexual risk behavior. *Journal of Biomedical Informatics*, 39, 720-736.
- Hams, S. (2000). A gut feeling? Intuition and critical care nursing. *Intensive and Critical Care Nursing*, 16, 310-318.
- Haselton, M., & Ketelaar, T. (2006). Irrational emotions or emotional wisdom? In J. P. Forgas (Ed.), *Affect in social thinking and behavior* (pp. 21-39). New York, NY: Psychology Press.
- Heifetz, R., & Linsky, M. (2004). When leadership spells danger. *Educational Leadership*, 61(7), 33-38.
- Herbert, B., & Pollatos, O. (2012). The body in the mind: On the relationship between interoception and embodiment. *Topics of Cognitive Science*, 4, 692-704.
- Hogarth, R. (2002, October). *Deciding analytically or trusting your intuition? The advantages and disadvantages of analytic and intuitive thought* (UPF Economics and Business Working Paper No. 654). Retrieved from <https://ssrn.com/abstract=394920>
- Holzer, P. (2017). Interoception and gut feelings: Unconscious body signals' impact on brain function, behavior and belief processes. In H. F. Angel, L. Oviedo, R. F. Paloutzian, A. Runehov, & R. J. Seitz (Eds.), *Process of believing: The acquisition, maintenance, and change in creditions* (pp. 435-442). Basel, Switzerland: Springer.
- Holzer, P., Schicho, R., Holzer-Petsche, U., & Lippe, I. (2001). The gut as a neurological organ. *Wiener klinische Wochenschrift*, 113, 647-660.
- Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus and Giroux.
- Kaiser, H. (1974). An index for factorial simplicity. *Psychometrika*, 39, 31-36.
- Katkin, E. (1985). Blood, sweat, and tears: Individual differences in autonomic self-perception. *Psychophysiology*, 22, 125-137.
- Katkin, E., Wiens, S., & Ohman, A. (2001). Nonconscious fear conditioning, visceral perception, and the development of gut feelings. *Psychological Science*, 12, 366-370.
- Ketelaar, T. (2004). Ancestral emotions, current decisions: Using evolutionary game theory to explore the role of emotions in decision-making. In C. Crawford & C. Salmon (Eds.), *Darwinism, public policy and private decisions* (pp. 145-168). Mahwah, NJ: Lawrence Erlbaum.
- Klarer, M., Arnold, M., Gunther, L., Winter, C., Langhans, W., & Meyer, U. (2014). Gut vagal afferents differentially modulate innate anxiety and learned fear. *Journal of Neuroscience*, 34, 7067-7076.
- Kukanova, B., & Mravec, B. (2006). Complex intracardiac nervous system. *Bratislavske Lekarske Listy*, 107, 45-51.
- Leach, S., & Weick, M. (2018). Can people judge the veracity of their intuitions? *Social Psychological and Personality Science*, 9, 40-49. doi:10.1177/1948550617706732
- Lepora, N., & Pezzulo, G. (2015). Embodied choice: How action influences perceptual decision making. *PLoS Computational Biology*, 11(4), e1004110. doi:10.1371/journal.pcbi.1004110
- Lerner, J., Li, Y., Valdesolo, P., & Kassam, K. (2015). Emotion and decision making. *Annual Review of Psychology*, 66, 33.1-33.25.
- Loewenstein, G. (1996). Out of control: Visceral influences on behavior. *Organizational Behavior and Human Decision Processes*, 65, 272-292.
- Lynn, M. (1996). Determination and quantification of content validity. *Nursing Research*, 35, 382-385.
- MacCallum, R., Wideman, K., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, 4, 84-89.
- Markic, O. (2009). Rationality and emotions in decision making. *Interdisciplinary Description of Complex Systems*, 7, 54-64.
- Mather, M., & Lighthall, N. (2012). Both risk and reward are processed differently in decisions made under stress. *Current Directions in Psychological Science*, 21, 36-41.
- Mayer, E. (2011). Gut feelings: The emerging biology of gut-brain communication. *Nature Reviews Neuroscience*, 12, 453-466.
- McCraty, R. (2005). Enhancing emotional, social and academic learning with heart rhythm coherence feedback. *Biofeedback*, 33, 130-134.

- McCraty, R., Atkinson, M., Tomasino, D., & Bradley, R. (2009). The coherent heart: Heart-brain interactions, psychophysiological coherence, and the emergence of system-wide order. *Integral Review*, 5(2). Retrieved from <https://www.heart-math.org/assets/uploads/2016/04/coherent-heart-integral-review-2009.pdf>
- McNulty, J., Olson, M., Meltzer, A., & Shaffer, M. (2013). Though they may be unaware, newlyweds implicitly know whether their marriage will be satisfying. *Science*, 342, 1119-1120.
- Meyer, U. (2014, June 11). *That "gut feeling" explained*. Retrieved from <https://www.labnews.co.uk/news/that-gut-feeling-explained-11-06-2014/>
- Mikels, J., Lockenhoff, C., Maglio, S., Goldstein, M., Garber, A., & Castensen, L. (2010). Following your heart or your head: Focusing on emotions versus information differentially influences the decisions of younger and older adults. *Journal of Experimental Psychology: Applied*, 16, 87-95.
- Mosley, M. (2012, July 11). *The second brain in our stomachs*. Retrieved from <http://www.bbc.com/news/health-18779997>
- Norris, P., & Epstein, S. (2011). An experiential thinking style: Its facets and relations with objective and subjective criterion measures. *Journal of Personality*, 79, 1044-1080.
- Pachura, T., & Spaar, M. (2015). Domain-specific preferences for intuition and deliberation in decision making. *Journal of Applied Research in Memory and Cognition*, 4, 303-311.
- Park, G., & Thayer, J. (2014). From the heart to the mind: Cardiac vagal tone modulates top-down and bottom-up visual perception and attention to emotional stimuli. *Frontiers in Psychology*, 5, 278.
- Parsian, N., & Dunning, T. (2009). Developing and validating a questionnaire to measure spirituality: A psychometric process. *Global Journal of Health Science*, 1, 2-11.
- Paulus, M. (2011). *Anxiety as a gut feeling: Understanding interoception* (Presentation of the April 2011 Warren Neuroscience Frontiers in Neuroscience Lecture). Retrieved from <https://brainposts.blogspot.com.au/2011/04/anxiety-as-gut-feeling-understanding.html>
- Pollatos, O. (2015). The role of the body from the inside for embodied cognition. In *Perceptual and emotional embodiment: Foundations of embodied cognition*. Abingdon, UK: Routledge.
- Pollatos, O., Herbert, B., Matthias, E., & Schandry, R. (2007). Heart rate response after emotional picture presentation is modulated by interoceptive awareness. *International Journal of Psychophysiology*, 63, 117-124.
- Pollatos, O., Kirsch, W., & Schandry, R. (2005). On the relationship between interoceptive awareness, emotional experience, and brain processes. *Brain Research. Cognitive Brain Research*, 25, 948-962.
- Porges, S. (2001). The polyvagal theory: Phylogenetic substrates of a social nervous system. *International Journal of Psychophysiology*, 42, 123-146.
- Porges, S. (2011). *The polyvagal theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation*. New York, NY: W.W. Norton.
- Randall, C., Wurster, R., Randall, D., & Xi-Moy, S. (1996). From cardioaccelerator and inhibitory nerves to a "heart brain": An evolution of concepts. In J. T. Shepherd & Stephen F. Vatner (Eds.), *Nervous control of the heart* (pp. 173-199). Reading, UK: Harwood.
- Randall, D. (2000). Towards an understanding of the function of the intrinsic cardiac ganglia. *Journal of Physiology*, 528, 406.
- Riezzo, G., Porcelli, P., Guerra, V., & Giorgio, I. (1996). Effects of different psychophysiological stressors on the cutaneous electrogastrogram in healthy subjects. *Archives of Physiology and Biochemistry*, 104, 282-286.
- Ring, C., Brener, J., Knapp, K., & Mailloux, J. (2015). Effects of heartbeat feedback on beliefs about heart rate and heartbeat counting: A cautionary tale about interoceptive awareness. *Biological Psychology*, 104, 193-198.
- Robinson, B. (1907). *The abdominal and pelvic brain with automatic visceral ganglia*. Chicago, IL: Franz Betz Hammond Ind.
- Rungtusanatham, M. (1998). Let's not overlook content validity. *Decision Line*, 29, 10-13.
- Sadler, T., & Zeidler, D. (2005). Patterns of informal reasoning in the context of socioscientific decision-making. *Journal of Research in Science Teaching*, 42, 112-138.
- Sadler-Smith, E. (2016). "What happens when you intuit?" Understanding human resource practitioners' subjective experience of intuition through a novel linguistic method. *Human Relations*, 69, 1069-1093.
- Satchell, L., Akehurst, L., Morris, P., & Nee, C. (2017). Staying streetwise: Accurate judgments of approaching aggression in older age. *Europe's Journal of Psychology*, 14, 44-53.
- Schwarz, N. (2000). Emotion, cognition and decision making. *Cognition and Emotion*, 14, 433-440.
- Scopelliti, I., Morewedge, C., McCormick, E., Min, H., Lebrecht, S., & Kassam, K. (2015). Bias blind spot: Structure, measurement, and consequences. *Management Science*, 61, 2468-2486.
- Shapiro, S., & Spence, M. (1997). Managerial intuition: A conceptual and operational framework. *Business Horizons*, 40, 63-68.
- Shiloh, S., Salton, E., & Sharabi, D. (2002). Individual differences in rational and intuitive thinking styles as predictors of heuristic responses and framing effects. *Personality and Individual Differences*, 32, 415-429.
- Shiv, B., & Fedorikhin, A. (1999). Heart and mind in conflict: The interplay of affect and cognition in consumer decision making. *The Journal of Consumer Research*, 26, 278-292.
- Sinclair, M. (2010). Misconceptions about intuition. *Psychological Inquiry*, 21, 378-386.
- Sinclair, M. (2014). *Handbook of research methods in intuition*. London, England: Edward Elgar.
- Sinclair, M., Ashkanasy, N., & Chattopadhyay, P. (2010). Affective antecedents of intuitive decision making. *Journal of Management & Organization*, 16, 382-398.
- Sladek, R., Bond, M., & Phillips, P. (2010). Age and gender differences in preferences for rational and experiential thinking. *Personality and Individual Differences*, 49, 907-911.
- Sobyra, J. (2010). *The Accuracy of Self-Reported Intuitive and Analytical Ability* (Honors projects, Paper 140). Retrieved from [http://digitalcommons.iwu.edu/psych\\_honproj/140](http://digitalcommons.iwu.edu/psych_honproj/140)
- Soosalu, G., & Oka, M. (2012a). *mBIT and leadership*. Retrieved from <http://www.mbraining.com/mbit-and-leadership>
- Soosalu, G., & Oka, M. (2012b). *mBraining: Using your multiple brains to do cool stuff*. Loch Sport, Victoria, Australia: TimeBinding Publications.
- Stephan, E., Pardo, J., Faris, P., Hartman, B., Kim, S., Ivanov, E., . . . Goodale, R. (2003). Functional neuroimaging of gastric distention. *Journal of Gastrointestinal Surgery*, 7, 740-749.

- Stevens, J. (2002). *Applied multivariate statistics for the social sciences*. Mahwah, NJ: Lawrence Erlbaum.
- Tabachnick, B., & Fidell, L. (2012). *Using multivariate statistics* (6th ed.). Boston, MA: Pearson Education.
- Thayer, J. (2007). What the heart says to the brain (and vice versa) and why we should listen. *Psychological Topics, 16*, 241-250.
- Thayer, J., & Lane, R. (2000). A model of neurovisceral integration in emotion regulation and dysregulation. *Journal of Affective Disorders, 61*, 201-216.
- Thayer, J., & Lane, R. (2009). Claude Bernard and the heart-brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience Biobehavioral Review, 33*, 81-88.
- Watzke, H. (2010, October). *The Brain in your gut*. Retrieved from [http://www.ted.com/talks/heribert\\_watzke\\_the\\_brain\\_in\\_your\\_gut/transcript](http://www.ted.com/talks/heribert_watzke_the_brain_in_your_gut/transcript)
- Weber, E., & Lindemann, P. (2008). From intuition to analysis: Making decisions with your head, your heart, or by the book. In H. Plessner, C. Betsch, & T. Betsch (Eds.), *Intuition in judgment and decision making* (pp. 191-207). Mahwah, NJ: Lawrence Erlbaum.
- Werner, N., Jung, K., Duschek, S., & Schandry, R. (2009). Enhanced cardiac perception is associated with benefits in decision-making. *Psychophysiology, 46*, 1123-1129.
- Wiens, S., Mezzacappa, E., & Katkin, E. (2000). Heartbeat detection and the experience of emotions. *Cognition and Emotion, 14*, 417-427.
- Zhong, C. (2011). The ethical dangers of deliberative decision making. *Administrative Science Quarterly, 56*, 1-25.

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