Yayın Geliş Tarihi: 2024-09-11

Yayın Onay Tarihi: 2024-11-23

DOI No: 10.35343/kosbed.1548365

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KOSBED, 2024, 48: 128-145

Analysis of the Relationships Between Heart Rate Variability (HRV) and Intuitive Thinking Skills

Kalp Hızı Değişkenliği (HRV) ile Sezgisel Düşünme Becerileri Arasındaki İlişkilerin Analizi

Abstract

Intuition is generally taken as a belief, experience, and tool for knowledge emergence, often characterized by emotional judgments, sensations or foresight and be classified into various types. Recently researchers have started to search for somatic markers for intuition using EEG and ECG. The objective of this study is to explore the correlations between measurements that serve as indicators of heart rate variability and the strength and kind of intuition based on samples self-reports. The samples are 149 students aged 19-21 at Kocaeli University. Data was collected using KYTO2935 HRV sensors, Elite HRV Bluetooth application and the Intuitive Thinking Scale. Research findings indicate correlations between intuitive thinking skills and certain sub-dimensions and specific heart rhythm indices. These correlations vary in terms of their effect sizes, but it is satisfactory to assert that certain features of ours, which are acknowledged as intuitive thinking abilities, are connected to heart rhythm indices and require more thorough investigations.

Keywords: Intuition, Intuitive Thinking, Types of Intuition, Heart Rate Variability, Heart Brain,

Jel Codes: 2530, 3040, 3550 (APA)

Özet

Sezgi, genellikle duygusal yargılar, duyumlar veya öngörü ile karakterize edilen ve çeşitli tiplerde sınıflandırılan bir inanç, deneyim ve bilgiye ulaşma aracı olarak tanımlanmaktadır. Son yıllarda araştırmacılar sezgi için somatik bazı belirteçler aramaya başladılar. Bu amaçla EEG ve EKG kullanarak, sezginin kalp ve beyin dalgalarıyla ilişkileri araştırılmaktadır. Bu çalışmanın amacı, kalp hızı değişkenliğinin göstergesi olarak hizmet eden ölçümler ile sezginin gücü ve türü arasındaki korelasyonları, örneklemin kendi beyanlarına dayanarak araştırmaktır. Örneklem, Kocaeli Üniversitesi'nde 19-21 yaşları arasındaki 149 öğrencidir. Veriler KYTO2935 HRV sensörleri, Elite HRV Bluetooth uygulaması ve Sezgisel Düşünme Ölçeği kullanılarak toplanmıştır. Araştırma bulguları, sezgisel düşünme becerileri ile belirli alt boyutlarıyla ve bazı kalp ritmi indeksleri arasında korelasyonlar olduğunu göstermektedir. Bu korelasyonlar etki büyüklükleri açısından değişmektedir, ancak sezgisel düşünme yetenekleri olarak kabul edilen belirli özelliklerimizin kalp ritmi indeksleriyle bağlantılı olduğunu ve daha kapsamlı araştırmalar gerektirdiğini ifade etmek için yeterlidir.

Anahtar Kelimeler: Sezgi, Sezgisel Düşünme, Sezgi Tipleri, Kalp Ritim Uyumu, Kalbin Beyni.

Jel Kodları: 2530, 3040, 3550 (APA)

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INTRODUCTION

Intuition is the capacity to comprehend, anticipate, and directly sense reality without depending on prior knowledge or logical reasoning (TDK, 2024). In the field of philosophy, it is defined as a belief, a tendency to believe, an experience similar to perception, a tool that accelerates the emergence of knowledge, comprehending the veracity or fallacy of something without the use of reasoning and inference,, a way of acquiring infallible knowledge as a function of the pure mind, an internal reality that directly grasps the data of consciousness. Knowledge is defined as the capacity to comprehend and grasp information (Akarsu, 1988; Bealer, 1998; Öktem, 2000; Haklı, 2007; Koksvik, 2011; Nado, 2014; Bibika, 2024; Gündoğan, 2024; Soyaslan, 2024).

In the field of psychology, intuition is characterized as emotionally-driven judgments that emerge from quick, unconscious, and comprehensive associations. It is a form of perception that operates unconsciously, generating judgments swiftly and without conscious knowledge. Intuition is an implicit, holistic, automatic, emotional, and unconscious process. It can also be characterized as a sensation, a cognitive capacity, prescience, or foresight that discovers solutions or directs without the need of reasoning or logic (Jung, 1971; Otte, 1990; Bailin, 1991; Hammond, 1996; Hogarth, 2001; Gore ve Saddler-Smith, 2011; Pretz et al., 2014; Cai Shi & Lucietto, 2022).

Intuitions, as a summary of philosophical and psychological definitions can be described as a function of the pure mind that occurs through a rapid, sudden, unconscious, emotional, holistic, implicit and automatic process, as well as instinctive judgments, predictions, comprehension or understanding in finding answers or direction.

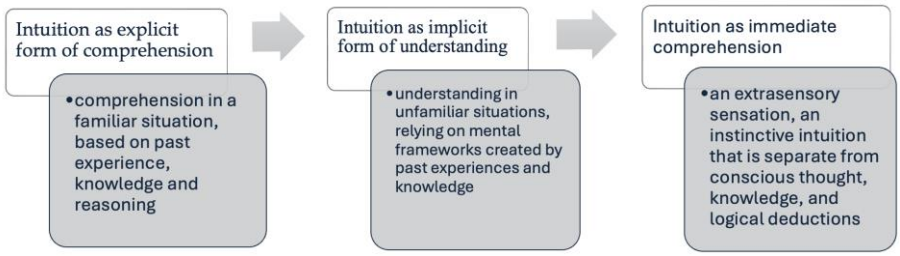
There are studies claiming that intuition is not a singular skill and trying to define different types based on its source and function. According to Pretz et al. (2014), there are three types of intuition: problem solving, moral and creative. Glöckner and Witteman (2010) categorized intuition into four distinct types: relational intuition, matching intuition, cumulative intuition, and constructive intuition. According to Cai Shi and Lucietto (2021), intuition can be divided into 3: inferential, emotional and holistic.

Agyakwa (1988) offers a classification of four different examples of intuitive knowledge: extrasensory perception, self-evident facts, direct grasp of specific situations, and expert insight. According to Gore and Saddler-Smith (2011), three general domain mechanisms of intuition have been proposed: the application of heuristics under uncertainty, the acquisition and activation of complex domain-related schemas, and the involvement of affect in decision making.

According to McCraty (2015), intuition can be categorized into three distinct forms. Implicit knowledge, energy sensitivity, and nonlocal intuition. Implicit knowledge pertains to knowledge that has been previously acquired but subsequently forgotten or not consciously acknowledged. The brain employs neural mechanisms to link patterns of novel problems with implicit memories from prior experiences. Energy sensitivity refers to the ability of the nervous system to detect and react to external stimuli, such as electromagnetic radiation. Nonlocal intuition refers to an insight or perception that cannot be attributed to prior information or external stimuli. Instances of nonlocal intuition encompass scenarios in which parents possess the ability to see events occurring to their children at a remote area or when entrepreneurs exhibit astute decision-making skills in their business endeavors.

According to these classifications, intuition can be understood as follows; an explicit form of comprehension in a familiar situation, based on past experience, knowledge, and reasoning, an implicit form of understanding in unfamiliar situations, relying on mental frameworks created by past experiences and knowledge and last a form of immediate comprehension, particularly in high-stakes and critical situations, characterized by affect, feeling, and somatic signs. The initial two can be referred to as sign or cue interpretation. Sensing is the act of perceiving through the recognition of distinct signals, recognizable cues, or by tapping into subconscious patterns formed from previous experiences. The last can be described as an extrasensory sensation, an instinctive intuition that is separate from conscious thought, knowledge, and logical deductions.

Figure 1: Classification of Definitions of the Concept of Intuition in the Literature



Chudnoff (2019) attempted to demonstrate the resemblances and distinctions between intuition, sensory perception, and explicit reasoning in terms of their content and process, drawing on Kahneman's (2011) work. He states that intuition shares a similar process with sensory perception, but has a wider reach than both sensory perception and reasoning. In contrast to Kahneman, he asserted that sensory perception and intuition have comparable subjective experiences, however originate from distinct cognitive mechanisms, and no specific information can be provided regarding their specific contents.

In most efforts to explain the concept of intuition, a search for grounding it with reason and rational thinking tools is naturally observed. Perhaps for this reason, in many definitions and explanations, intuition is treated as a more or less implicit reading of signs as a result of the senses and experience. As mentioned by McCraty (2015), it may be a frequency, a biological energy or electricity sensing mechanism that are generally associated with telepathy and foresight whose center may be the brain, heart or gut, as a potential power, gift or ability of our nature of creation or of the evolution process that we have not yet been able to name, that we have not experienced concretely until today, that we have not yet realized its existence. If considered from this perspective, it is thought that it is necessary to first study whether it is, rather than what it is.

From another perspective, are our decisions based on reason and logic based on pure knowledge and experience, or is there an intuitive intervention when making the final choice or evaluation after processing all experience and information? A similar comment can be made regarding our senses. Stimuli coming from our senses are not perceived in a mechanical or automatic process. Couldn't there be an intuitive choice in the process of giving meaning to the stimuli by our brain? One of the examples we frequently encounter on social media is about the color of a woman's dress. White gold or blue

black? We look at the same photo but see it differently. Another is a voice recording. While some hear the same voice recording as Yanny, others hear it as Laural. Plato said that the real world we perceive through our senses can only be a reflective image of a higher level of existence. Only with our minds can we understand what the misleading image we perceive with our senses really is. According to Plato, the mind is not just a passive recipient of sensory information but an active contributor in shaping the perception of reality. Using logical thinking, self-reflection and philosophical inquiry, we can transcend the misleading illusions of the material world and understand the true essence of reality. Can we express the proposition that our senses can mislead us, we can only know the truth with our minds, as in Plato's cave analogy, as we notice it with our intuition and make sense of it with our minds?

The main point here is the uniqueness of our senses. Our perceptions may be formed by comparing the stimuli coming from our senses with experience and past information in our brain, but at some point in this process may there be an intuitive choice? In this case, it would not be wrong to think that our intuitive potential may even have an impact on the formation of our rational decisions and concrete senses. Therefore, the paradigms we have developed regarding logic, sensory perception and intuition will need to be re-evaluated. Perhaps the fundamental code behind all human behavior is an ability, capacity or power we call intuition. This may even be the determinant of what we call intelligence. In this case, there may be sub-dimensions of intuitive ability in the capacities we call rational, emotional or social intelligence and similar.

1.1. Heart Brain - 'Little brain'

The heart has universally been recognized as the locus of emotions, passion, and wisdom in nearly all civilizations, devoid of any scientific connotation (Salem, 2009). Love has evolved into a sentiment experienced within the heart and conveyed via it. People feel their love and pain in their hearts. People who act cruelly and callously are described as 'heartless'. Many expressions such as loving from the heart, with my most heartfelt feelings, in the depths of my heart, heartache, breaking the heart, touching the heart, twisting the heart express this. After extensive research, Armour and Ardell (1994) introduced the functional concept of 'heart brain'. Armour and Ardell's studies have revealed that the heart has an internal nervous system consisting of 40 thousand neurites that is so complex that it can be described as a 'little brain' in itself. Armour and Ardell's studies have created the suspicion that these sayings, which are used without foundation in society, may have a basis. The heart transmits significant signals to the brain that serve to inform, as well as to command, regulate, and guide (Lacey and Lacey, 1978). Furthermore, neurophysiologists have noted that communications from the heart to the brain, which traverse various networks and channels, can either amplify or diminish the electrical activity within the brain (McCraty, 2002). To summarize, the cardiac brain influences all of our cognitive and affective functions, and in certain instances, it is said to be more efficient than the cerebral cortex.

Scientific study has demonstrated that affective changes occur simultaneously with predictable alterations in heart rhythm, blood pressure, respiration, and digestive systems. Put simply, the networks located on the left side of our peripheral nervous system, specifically the Sympathetic division of our Autonomic Nervous System, are responsible for activating us during stressful conditions and priming us for conflict. During tranquil circumstances, the parasympathetic division of

our peripheral nervous system induces relaxation and a state of calmness. In summary, our peripheral nervous system, in coordination with the brain, determines how we respond to different stimuli. (Rein et al, 1995).The heart engages in communication with the brain through four distinct mechanisms. One of these is the electromagnetic field. Research has revealed that the heart transmits information to the brain and the whole body through electromagnetic field interactions (McCraty, Bradley & Tomasino, 2004). It has also been determined that there is a cell type known as 'intrinsic cardiac adrenergic' (ICA) cells in the heart. These cells secrete noradrenaline and dopamine neurotransmitters, which were once thought to be produced only by neurons in the brain. The brain detects these hormones secreted by the heart and the changes they cause in the body (Cantin & Genest, 1986). Another form of communication is heart rhythm synchronization. It shows that when heart rhythm patterns are compatible, neural information sent to the brain facilitates cortical function. This effect is often experienced as mental clarity, improved decision-making, and increased creativity. In addition, harmonious input from the heart tends to facilitate the experience of positive emotional states. Thus, the heart appears to be intimately involved in psychophysiological coherence formation (Tille et al., 1996, & McCraty, 2000). The last and most obvious connection between the heart and the brain is neural connections. In addition to the peripheral nervous system, it is stated that the vagus nerves directly connect the heart and the amygdala and affect the formation of our emotions (McCraty, 2002).

1.2. Intuition and Heart

Some researchers state that there is a deep connection, relationship or harmony between our instincts, emotions and our heart (Otte, 1990; Holzer, 2022; Damasio, 1994; Dunn et al., 2010). The heart, on the other hand, is often associated with emotions and empathy. It is considered the center of love, compassion and intuition. When we say "follow your heart" we are usually referring to the guidance gained from our emotional and intuitive senses. It is believed that when we connect deeply with our hearts and are in tune with our emotions, our intuition becomes clearer and more accessible. This alignment allows us to make decisions, make connections, and navigate life in a more authentic and meaningful way (McCraty, 2015; Salem, 2009).

McCraty et al. (2004a) study, 30 calm and 15 emotionally arousing images were shown to 26 individuals in two experimental conditions: a baseline condition representing normal psychophysiological functioning and a condition promoting physiological consistency. The main measurements used are (electroencephalogram) EEG and (heartbeat-evoked potentials, electrocardiogram) ECG to obtain heart decelerations/accelerations. The researchers summarized the findings as follows: Contrary to expectations, the heart responds to intuitive information, a significant decrease in heart rate is observed before encountering emotionally charged stimuli, and gender differences are observed in the processing of information before the stimuli are presented.

McCraty et al. (2004b) conducted another study where they measured brain response (EEG) and heart-rhythm activity (ECG) while participants were shown randomly selected photographs that were either emotionally arousing or calming. The study was based on Radin's protocol, which aimed to elicit an emotional response. The researchers discovered that both the brain and heart received information about the upcoming emotional picture approximately 4 to 5 seconds before it was randomly selected by the computer. Interestingly, the heart received this information about 1.5 seconds before the brain did.

Essentially, the relationship between intuition and the heart is a profound connection that spans our emotional, intuitive, and spiritual abilities. By maintaining a connection with our emotions and being attuned to our instinctive understanding, we may tap into profound depths of wisdom and make decisions that are in harmony with our own identity.

1.3. Heart Rate Variability (HRV)

Heart rate variability (HRV) refers to the beat-to-beat variation in heart rate or duration of the R-R interval (heart period) (Billman, 2011 and Cygankiewicz & Zareba, 2013).

It is a measure of the level of coordination and harmony in the heart's activity. Similarly, heart rate coherence or cardiac coherence refers to a state in which the heart rhythm becomes more synchronized and consistent and may reflect changes in cardiac autonomic regulation (McCraty et al., 2009). Physiological coherence refers to the regularity in the oscillatory outputs of regulatory systems at any given time period. It represents the measure of stability and harmony. Physiological coherence is associated with increased heart rate variability (HRV) and is linked to self-regulatory capacity, emotion regulation, social interactions, and cognitive performance. The autonomic nervous system (ANS) plays a role in regulating cardiac coherence, as stated by Tiller et al. (1996) and McCraty and Zayas (2014). Reduced heart rate variability (HRV) is linked to a poorer state (physically, emotionally, psychologically) in various medical disorders, but maintaining R-R compliance within the normal range generally indicates excellent health and well-being..

The objective of this study is to explore the correlations between measurements that serve as indicators of heart rate variability and other indices of heart rate and the strength and kind of intuition based on individuals' self-reported experiences. Hence, the investigation will ascertain the potential correlation between our intuition, which is purportedly influential in our decision-making and learning endeavors, and the functioning of the heart and the resulting sinus rhythm. If these links are discovered, a biological indicator for human intuition may be acquired, offering a fresh outlook on the processes of learning and decision-making.

2. METHODS AND MATERIALS

The research was carried out with the endorsement of the ethics committee of Kocaeli University's Social and Human Sciences department, as well as the consent of the dean of the faculty where the research took place (Decision no: 20, made during the meeting on 07.06.2024, and numbered 2024/07). For writing the report of the research, the Quillbot artificial intelligence application was utilized to a limited extent, specifically for tasks such as literature review, paraphrasing, and translation.

2. 1. Research Design

The study is a descriptive research conducted using a relational approach. It involved analyzing the relationship between the HRV (Heart Rate Variability) indicators, measured during rest, and the scores obtained from various dimensions of the intuitive thinking scale developed by Berkant et al (2022).

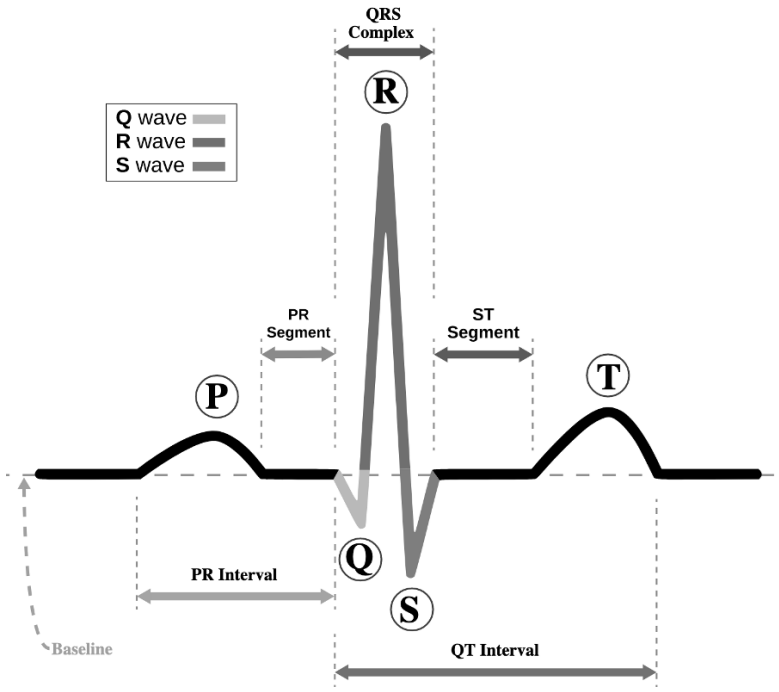
2. 2. Population and samples of the research

The research focuses on the population of students enrolled in the Faculty of Education at Kocaeli University. The research sample consists of 149 male and female students, primarily in the 1st and 2nd grades, aged 19-21, from various departments. These students were told about the research and chose to participate voluntarily. The abbreviated version of the general health scale, as created by Demiral et al. (2006), was used on the samples with proper authorization. Any samples that exhibited health levels below the reference values and were diagnosed with psychological or other problems were excluded. Analyses were performed on the remaining 105 individuals. In addition, certain data points that deviated significantly from the norm were excluded from the analyses. Additionally, some outliers were removed from the analyses. 56 of these students were fasting and 45 were not. The number of students who were not fasting or menstruate is 33.

2. 3. Heart Rate Indices

ECG recordings are commonly used to observe heart rate. Every stage of this sinus rhythm corresponds to a distinct function and phase.

Figure 2: Sinus Rhythm



Source: Wikipedia

Table 1: Heart Rate Indices

Time Domain Indices
• RMSSD: Root mean square of successive RR interval differences
• SDNN: Standard deviation of NN intervals
• lnRMSSD: Natural Logaritm of Root mean square of successive RR interval differences
• PNN50: Percentage of successive RR intervals that differ by more than 50 ms
• MRRINT: Mean of *interbeat intervals between all successive heartbeats*.
Frequency Domain Indices
• ToPow: Total *Power* is the signal energy found within a frequency band
• LF/HF: Ratio of LF-to-HF power
• LFPow: Relative power of the low-frequency band (0.04–0.15 Hz) in normal units
• HFPow: Relative power of the high-frequency band (0.15–0.4 Hz) in normal units
• LFPeak: Peak frequency of the low-frequency band (0.04–0.15 Hz)
• HFpeak: Peak frequency of the high-frequency band (0.15–0.4 Hz)
Heart Rate Indices
• HRMean: Heart rate mean
• HRVmean: Heart rate variability mean

Schafer and Ginsberg (2017)

2. 4. Data Collection Tools

2. 4. 1. Kyto2935 HRV Sensors

The sensor used to measure heart rate variability is Kyto2935, the operation frequency is 2402–2480 MHz, the modulation type is GFSK, Bluetooth version 4.0, the bitrate of the transmitter is 1 Mbps, and it has 40 channels. Shenzhen Asia Test Technology Co., Ltd. tested the device for validity and reliability. It is found to accomplish FCC standards, part 15.247 (FCC ID: 2ALC3KYT02935). The report number is ATT-2017SZ0217856F (the link for the report is in reference section). The summary of the report mentions that the device described above has been tested by ATT, and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. The test procedure is ANSI C63.10-2013. It passed all standard sections like 'Conducted Emission', '6dB Bandwidth', 'Peak Output Power', 'Radiated Spurious Emission', 'Power Spectral Density', 'Band Edge Emission', and 'Antenna Requirement'. And last, the level of confidence was found to be 95%. In the literature review, many research papers on HRV were found using the Kyto2935 device, like Cheng et al. (2019) and Laurman (2023).

2. 4. 2. Elite HRV Bluetooth APP

The Elite HRV Bluetooth App computes several HRV indicators by directly extracting the R-R intervals, which are the time intervals between consecutive heartbeats, from compatible devices. There are scholarly investigations that examine the accuracy and consistency of the application. Furthermore, it has been observed that it has been employed in numerous research investigations.

Chhetri, et al. (2022) and Ramon et al. (2022) evaluated the Elite HRV Bluetooth app's accuracy in measuring time-domain heart rate variability (HRV) indices during rest, comparing it to the Polar V-800 heart rate monitor. The study found that the Elite HRV application provided reliable data that aligned with the data from the Polar V800 heart rate monitor. Perrotta et al. (2017) investigated the correlation and agreement between rMSSDln obtained from Elite HRV and Kubios HRV 2.2 using Pearson product-moment correlation and a Bland-Altman Plot. They found a highly significant and strong correlation between the two. Himariotis et al. (2022) found no significant differences in lnRMSSD data between the software in the seated position and inconsequential differences in the supine position when artifact correction was not used. However, when using Very Low, Low, or Automatic artifact-correction filters, the data did not show any discernible changes in either the seated or supine positions. Ramon et al. (2022) conducted a comparative analysis of heart rate variability data obtained from an ECG, Elite HRV, and Welltory. They found no differences in supine or seated positions, strong to almost perfect correlation levels, and no discernible distinctions between measures of short duration (5 minutes) and observations of ultra-short duration (1 minute). Both smartphone applications can be used to monitor HRV in elite endurance athletes using short and ultra-short readings. Guzik et al. (2017) found that the "ELITE HRV" app yields divergent outcomes compared to traditional HRV methods, suggesting caution in its usage.

2. 4. 3. Intuitive Thinking Scale

The scale was established by Berkant et al (2022) and has four distinct dimensions: Determination, inner certainty, emotional literacy, and implicit knowledge. The factor loadings for the first factor range from 0.67 to 0.57, for the second factor they range from 0.83 to 0.64, for the third factor

they range from 0.54 to 0.68, and for the fourth factor they range from 0.71 to 0.58. The Cronbach's alpha reliability coefficient for the complete scale was determined to be 0.80. The authors were contacted to gain the required permissions.

2. 5. Data Collection

Prior to the data collecting procedure, all people were administered the abbreviated version of the General Health Inventory, as established by Demiral et al. (2006). Due to the inability to promptly assess their health condition, all participants underwent heart rhythm measures and thereafter completed Berkant et al.'s (2022) Intuitive Thinking Scale. Data for those who were below reference health values and had a diagnosed condition were excluded from the analyses.

HR recordings were collected by measuring the right ear using KYTO2935 finger and ear sensors for 5 minutes in a specially prepared unoccupied room. Participants were instructed to assume a relaxed posture, breathe effortlessly, and maintain their typical body position and breathing pattern. The measurements were primarily taken during the daytime, specifically between the hours of 11 and 17. Throughout the procedure, the measurements of each person were documented following a brief period of acclimation lasting 10-15 seconds. Throughout the procedure, no practices that could divert or draw the attention of persons were permitted or deliberated.

The values obtained as a result of heart rate measurements were instantly recorded on the forms and then the sample was asked to fill out the Intuitive Thinking Scale. The entire data collection process took approximately 30 minutes for each individual. Then, heart rhythm values and intuitive thinking ability data were transferred to the computer and cross-verified by two individuals to ensure accurate data entry. Analyzes with these data were carried out using the SPSS statistical program, version 27.

3. RESULTS

3. 1. HRV and Intuitive Thinking Skill Relationships with All Student (Healthy) Data

Table 2: Statistics for healthy individuals, fasting and non-fasting, and the entire sample with and without menstruation.

		Intuitive Thinking Total Points	Intuitive Thinking Determination
Frequency Domain:	r=	.221*	.207*
Low Frequency Total Power (LF Power)	Sig.	.023	.034
	N	105	105

LF (Low frequency) refers to the magnitude of low frequency waves generated by the sympathetic nervous system. Low-frequency power is linked to the functioning of the baroreflex. The baroreflex can be conceptualized as a mechanism that regulates heart rate by decreasing it in response to high blood pressure, and increasing it by reducing baroreflex activity when blood pressure is low. Reduced blood pressure leads to a decrease in baroreflex activation, resulting in an increase in heart rate and the restoration of blood pressure levels (Rahman et al., 2011).

The results indicate a significant correlation between the overall scores of intuition and the scores of determination subscale, and the low frequency power (LF power) in the low and medium level band, based on the Cohen effect size standards. Put simply, as the total score for Intuitive Thinking and the scores for the determination subscale increase, there is also an increase in low frequency power. To summarize, a rise in intuitive thinking ability is accompanied by an increase in baroreflex function and a decrease in heart rhythm. The following list comprises the items that pertain to the determination sub-dimension of Berkant et al.'s (2022) intuitive thinking scale.

1. I act with my logic in the face of events.
2. I take different opinions into account when making a decision on an issue.
3. I believe that decisions should be made based on evidence.
4. I analyze the events happening around me by considering the evidence.

When these items are examined, it can be seen that they describe rational, logical and scientific thinking. Since these items are reverse coded in the scale, it can be said that as the individual's logical, rational and scientific thinking skills decrease, baroreflex function (LF power) increases and heart rhythm decreases. In this case, the assumed intuitive thinking skill (at least for the determination sub-dimension) seems to be inversely related to the rational and logical thinking skill.

3. 2. The Relationship between HRV and Intuitive Thinking Skill with data from Non-Fasting (Healthy) Samples

Table 3: Statistics with the data from non-fasting healthy samples

		Intuitive Thinking: Determination	Intuitive Thinking: Implicit Knowledge
lnRMSSD:	r	.335*	.319*
	Sig.	.026	.033
	N	44	45
Mean R-R interval	r	.347*	.338*
	Sig.	.021	.023
	N	44	45
LF Power	r	.317*	.273
	Sig.	.036	.069
	N	44	45
Heart Rate Mean (a minute)	r	-.326*	-.338*
	Sig.	.031	.023
	N	44	45

RMSSD represents short-term rapid changes in heart rate, which can only occur under the influence of the parasympathetic nervous system (Schafer and Ginsberg, 2017). Researchers agree that RMSDD is a measure of vagus-mediated control of the heart. The activity of the vagus nerve reduces heart rate and increases blood flow to the heart.

InRMSSD is the natural logarithm of this value. It is stated that it is used to bring the data into a more understandable range. It would not be wrong to expect a perfect correlation between RMSSD and InRMSSD.

In healthy and non-fasting individuals, determination subdimension scores increase significantly as (InRMSSD) the square root (natural logarithm) of the mean of short-term rapid changes in heart rate increases ($r=.335$, $n=44$, $p<.05$). Considering that the scores are reverse coded, it can be said that as the individual moves away from rational, logical thinking skills, the InRMSSD value increases, parasympathetic system activity increases and heart rate decreases. As the InRMSSD value increases, the implicit understanding in intuitive thinking also increases ($r=.319$, $n=45$, $p<.05$). If intuitive thinking is considered an implicit understanding, it has a positive correlation with medium effect size with InRMSSD, that is, short-term changes in heart rate. In other words, if the intuitive thinking skill is considered the opposite of rational and logical thinking, it is related to the average of short-term changes in heart rate.

MRRINT, the average of R-R intervals in heart rate, is also correlated to determination sub-dimension in intuitive thinking ($r=.347$, $n=44$, $p<.05$) and implicit understanding scores ($r=.338$, $n=44$, $p<.05$). It has a moderate positive significant correlation. In other words, if the average of the R-R beat intervals is high, the heart beat intervals are wide and the number of heart beats per minute is low. It means as the number of heart beats per minute decreases, determination subscale score in intuitive thinking and implicit comprehension subscale scores increase. As observed for all healthy individuals in the previous section, low frequency power also increases as determination subscale scores increases among non-fasting individuals ($r=.317$, $n=44$, $p<.05$). In other words, when baroreflex function increases and heart rhythm decreases, determination in intuitive thinking increases. The average heart rate per minute (HR mean) shows a negative correlation with medium effect size and determination subscale in intuitive thinking and implicit understanding. This finding is naturally consistent with previous findings on R-R interval mean, INRMSSD, and RMSSD.

3. 3. Relationships Between HRV and Intuitive Thinking Skills with the data from Non-Fasting and Non-Menstrual (Healthy) Samples

Table 4: Statistics with the Data from Non-fasting and Non-menstrual Healthy Samples

		Intuitive Thinking: Determination	Intuitive Thinking: Implicit Knowledge
RMSSD:	r	.398*	.387*
	Sig	.024	.026
	N	32	33
lnRMSSD:		.445*	.416*
	Sig.	.011	.016
	N	32	33
Mean R-R Interval	r	.387*	.520**
	Sig.	.028	.002
	N	32	33

LF Power	r	.379*	.316
	Sig.	.032	.073
	N	32	33
HF Peak	r	-.328	-.358*
	Sig.	.067	.041
	N	32	33
Heart Rate Mean	r	-.338	-.513**
	Sig.	.058	.002
	N	32	33

In the analyzes conducted with the data of healthy individuals who do not fast or menstruate, it can be seen that the degree and type of relationships increase. RMSSD, the mean of the square roots of consecutive time differences between heartbeats and InRMSSD, the natural logarithm of the mean of the square roots of consecutive time differences between heartbeats and heart rate mean have significant relationships with medium and large effect sizes with both the determination subscale and the implicit comprehension scores. As in previous analyses, low frequency power have significant relationships with medium effect size only with the determination sub-dimension. In healthy, non-fasting and non-menstrual individuals, significant negative relationships of medium effect size were also observed between the high frequency peak value and heart rate mean with the implicit comprehension sub-dimension. As the heart rate average and high frequency peak value decrease, the implicit comprehension scores increases.

All this information mostly shows that intuitive thinking skills improve as the heart rhythm becomes regular and calm and it is consistent with the findings of McCraty et al. (2004a). It is also observed that irregularities such as fasting and menstruation cause a decrease in some sub-dimensions of intuitive thinking skills in healthy individuals.

3. 4. Analysis of Differences between HRV and Intuitive Thinking Skills of Fasting and Non-Fasting (Healthy) Samples

In the analyzes carried out to see whether fasting caused a difference in HRV values, significant differences were observed in the Mean R-R Interval and Heart Rhythm Average (HR) values. For the mean R-R Interval, the average of 56 people who fasted was 760.55, and the average of 45 people who did not fast was 719.91. The obtained t=-2.105 for the significance of the differences, the probability is .038 ($p<.05$) at 99 degrees of freedom. For the effect size, Cohen's d -.421 shows an effect size close to the medium level. For heart rate mean (HR mean), the average of 56 people who fasted was 80.43, and the average of 45 people who did not fast was 85.78. The t=2.516 obtained for the significance of the differences has a the probability of .013 ($p<.05$) at 99 degrees of freedom. For effect size, Cohen's d .504 indicates a medium effect size. While the average heart rate intervals of fasting people are higher than those who are not fasting, the average heart rate per minute is lower. Fasting causes a decrease in heart rate and an increase in its intervals. However, heart rates are low and the increase in intervals does not show a relationship between intuitive intelligence and its sub-dimensions as expected. Only low and

high frequency rates show a low-medium level significant relationship with the determination sub-dimension in intuitive thinking ($r=.280$, $n=55$, $p<.05$).

SUMMARY AND DISCUSSION

Low frequency power (LF power) has a notable and consistent positive correlation with the sub-dimension of determination in intuitive thinking across all individuals, including those who are not fasting and those who are not fasting and menstruation. When individuals who are not fasting are chosen, positive correlations with medium effect size between the dimensions of determination in intuitive thinking and implicit understanding, and InRMSSD and Mean R-R Interval, in addition to low frequency power are observed. Furthermore, notable inverse correlations were found between determination and implicit understanding scores and the mean heart rate (HR) in non-fasting participants. In addition to all the above relationships increase in individuals who do not fast and do not menstruate, the high frequency peak value also shows significant, medium effect size relationships with the implicit understanding sub-dimension. The findings of this research, decrease in heart rate and increase in R-R interval improves intuitive thinking skills, is consistent with the study of McCraty et al. (2004a) in respect to significant decrease in heart rate is observed before encountering emotionally charged stimuli.

Research findings indicate that there are some correlations between intuitive thinking skills and certain sub-dimensions, as reported by individuals, and specific heart rhythm indices. These correlations vary in terms of their effect sizes. These associations do not provide sufficient evidence to assert that the heart is the source of intuitive thinking or that the heart has an impact on our intuitive thinking abilities. Nevertheless, it is satisfactory to assert that certain features of ours, which are characterized or acknowledged as intuitive thinking abilities, are connected to heart rhythm indices and require a more thorough investigation.

All findings show that as the average heart rhythm decreases in healthy individuals, intuitive thinking skills based on the individual's self-report improve. Relationships improve when situations that disrupt the individual's routine, such as fasting and menstruation, are eliminated.

Although there is no agreed definition in the literature on intuition. However, it can be categorized as either an explicit form of interpreting signs and understanding in familiar situations based on knowledge and reasoning, or as an implicit understanding in unfamiliar situations aided by mental frameworks formed from past experiences and knowledge. Additionally, intuition can be described as an affective, emotional, or bodily sensation, particularly in high-risk and crucial circumstances.

The first of them can be understood as a sophisticated demonstration of logical reasoning and rational thought. The second can be expressed as a kind of association based on past lives and experiences. The third can be characterized as a sensation, an intuitive perception, that cannot be rationalized by logic and reason, and is unaffected by knowledge and experience.

Thus, due to the absence of a precise definition of intuition and objective measures for it, researchers have created scales that rely on one or more of these measures. These scales mostly rely on individuals' self-reports. The individual responds to inquiries regarding a notion that he lacks a precise definition of and possesses incomplete knowledge of. Moreover, it is possible that there could be

disparities between an individual's self-perception and the way they label their feelings, as well as their true identity and emotional state. The conceptual level raises questions about the validity and reliability of the intuition measures, making them a subject of debate. Further investigation is required to fully comprehend and quantify the phenomenon of intuition. Prior to anything else, it is deemed necessary to conduct further empirical investigation into the nature of intuition, including its origins and many manifestations. Furthermore, it is believed that tests incorporating several performance indicators are necessary in conjunction with declaration-based scales for accurate measurement. During the developmental phase of these scales or tests, it would be more advantageous to employ various instruments to scrutinize each assumption and diverse performance measurements to substantiate them, rather than assessing numerous interpretations of the presumed notion of intuition using a solitary scale.

ETHICAL STATEMENT

The author(s) declare that all processes of the study comply with research and publication ethics, adhering to ethical rules and principles of scientific citation.

Prior to conducting the research, ethical approval and institutional permission were obtained from the Ethics Committee of Social and Human Sciences at Kocaeli University with decisions dated 07/03/2024 (No. 3) and 07/06/2024 (No. 7). Written and verbal consent was obtained from all participants before the study commenced.

AUTHOR CONTRIBUTIONS

Since the study has a single author, the author's contribution rate is 100%.

FINANCIAL SUPPORT

This study has not received any financial support.

CONFLICT OF INTEREST

There is no conflict of interest regarding the study

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