JOURNAL OF APPLIED COGNITIVE NEUROSCIENCE
https://revistascientificas.cuc.edu.co/JACN

Original

# Cognitive Load on Leadership Decision-Making: Conscious and Unconscious responses

# Carga cognitiva en la toma de decisiones de liderazgo: respuestas conscientes e inconscientes

**Arnisa Aliqkaj**[1]

**Rubén Carvajal**[2]

For cite this articule:
Aliqkaj, A., & Carvajal, R. (2024). Cognitive Load on Leadership Decision-Making: Conscious and Unconscious responses. *Journal of Applied Cognitive Neuroscience, 5*(1), e5253. https://doi.org/10.17981/JACN.5.1.2024.02

Received: 26-01-2024
Accepted: 24-04-2024

**Abstract**

Cognitive load significantly influences leadership decision-making, particularly in high-pressure scenarios. Despite its pivotal role, the connection between cognitive load, decision-making, and physiological responses among leaders remains inadequately understood. Our study aimed to explore the influence of age, sex, years of experience, educational level, and the interplay of reasoning versus intuition on both conscious and unconscious cognitive load during and after a leadership decision-making simulation task. We utilized Galvanic Skin Response (GSR) to evaluate unconscious responses. Notably, our findings revealed a noteworthy negative correlation between leadership experience and perceived cognitive load ($r = -0.787$, $p < 0.007$), a robust positive correlation between GSR during the task and decision-making ($r = 0.999$, $p < 0.000$), and a significant link between the application of Kahneman's System 2 thinking – characterized by comprehensive analysis and critical thinking – and the quality of decision-making ($r = -0.678$, $p < 0.031$). However, we did not find significant correlations between age, sex, and educational level with perceived cognitive load during and after the decision-making task. In summary, our study suggests that seasoned leaders exhibit superior capabilities in managing cognitive load during complex decision-making scenarios and proposes physiological arousal as a potential indicator of cognitive load during leadership decision-making tasks.

*Keywords:* Cognitive load; Leadership, Decision-making; Physiological arousal; Galvanic skin response; Kahneman's System 2.

**Resumen**

La carga cognitiva influye significativamente en la toma de decisiones de liderazgo, particularmente en escenarios de alta presión. A pesar de su papel fundamental, la conexión entre la carga cognitiva, la toma de decisiones y las respuestas fisiológicas entre los líderes sigue sin comprenderse adecuadamente. Nuestro estudio tuvo como objetivo explorar la influencia de la edad, el sexo, los años de experiencia, el nivel educativo y la interacción del razonamiento versus la intuición en la carga cognitiva consciente e inconsciente durante y después de una tarea de simulación de toma de decisiones de liderazgo. Utilizamos la respuesta galvánica de la piel (GSR) para evaluar las respuestas inconscientes. En particular, nuestros hallazgos revelaron una correlación negativa notable entre la experiencia de liderazgo y la carga cognitiva percibida ($r = -0{,}787$, $p < 0{,}007$), una correlación positiva sólida entre el GSR durante la tarea y la toma de decisiones ($r = 0{,}999$, $p < 0{,}000$), y un vínculo significativo entre la aplicación del pensamiento del Sistema 2 de Kahneman – caracterizado por un análisis integral y un pensamiento crítico – y la calidad de la toma de decisiones ($r = -0{,}678$, $p < 0{,}031$). Sin embargo, no encontramos correlaciones significativas entre la edad, el sexo y el nivel educativo con la carga cognitiva percibida durante y después de la tarea de toma de decisiones. En resumen, nuestro estudio sugiere que los líderes experimentados exhiben capacidades superiores en el manejo de la carga cognitiva durante escenarios complejos de toma de decisiones y propone la excitación fisiológica como un indicador potencial de la carga cognitiva durante las tareas de toma de decisiones de liderazgo.

*Palabras claves:* Carga cognitiva; Liderazgo; Toma de decisiones; Excitación fisiológica; Respuesta galvánica de la piel; Sistema 2 de Kahneman.

1 Arnisa Aliqkaj, Neuro Business School, Barcelona, Spain. ORCID: https://orcid.org/0000-0001-8304-6933 Email: arnisa.aliqkaj@universitetiaab.com

2 Rubén Carvajal, Universidad Católica Andrés Bello, Caracas, Venezuela, and Neuro Business School, Barcelona, Spain. ORCID: https://orcid.org/0000-0002-3039-0922 Email: rcarvaja@ucab.edu.ve.

## Introduction

### *Cognitive load*

Cognitive load can be understood as the extent to which working memory resources are utilized (Orru & Longo, 2019). The cognitive load theory is a widely spread theory that talks about the problem of learning being impaired when the processing amount requirements do exceed the human working memory capacity. The Cognitive load theory also assumes that knowledge can be divided into (i) biologically primary knowledge (related to knowledge we have evolved to acquire) and (ii) biologically secondary knowledge (the type of knowledge important for cultural reasons that requires a larger information store) (Sweller, 2011).

Sources of cognitive load encompass a wide range, spanning from the instructions humans receive—regardless of their value or futility—to the complexity of the tasks that necessitate resolution (Brünken et al., 2010). Cognitive load is therefore divided in three different sources, intrinsic cognitive load (ICL), extraneous cognitive load (ECL), and germane cognitive load (GCL) (Bannert, 2002).

Atiomo (2020) further re-contextualizes this within the framework of Cognitive Load Theory. According to the theory, intrinsic cognitive load (ICL) relates to the inherent complexity of the information being learned. Extraneous cognitive load (ECL), on the other hand, encompasses external factors that have the potential to hinder learning. Lastly, germane cognitive load (GCL) represents the influence of previously acquired patterns from prior learning on the processing of new information.

When examining the Cognitive Load Theory, we encounter recommendations emphasizing the significance of effectively reducing extraneous load, optimizing germane load, and efficiently managing intrinsic load. This is crucial because when the cumulative cognitive load exceeds the limits of working memory capacity, it can have detrimental effects on both learning and performance (Swell, 2021).

In relation to performance, Sweller et al. (2011) highlight the adverse effects of elevated cognitive load on task accuracy. Their research reveals that increased cognitive load corresponds to higher error rates, particularly during periods of intense decision-making and when individuals are required to consider multiple variables simultaneously.

A notable study conducted by Reis et al. (2023) discovered an intriguing association between cognitive load and honesty. Their findings suggest that cognitive load can actually promote honesty, as subjects exhibited increased dishonest behavior under low cognitive load conditions.

The measurement of cognitive load holds substantial theoretical importance, as highlighted by Paas et al. (2003). Moreover, in recent times, measuring cognitive load has gained even more significance within the context of the workplace, playing a vital role in understanding performance and productivity.

Although the statement by Ripp (2021) pertains specifically to healthcare workers, it emphasizes that high cognitive load is consistently linked to burnout regardless of the specialty of the healthcare professional. This underscores the universal impact of cognitive load on well-being in high-demand professions like healthcare.

### *Leadership*

Leadership is a person's ability to develop human potential around him or her (Zak, 2017). Leadership encompasses multiple dimensions and roles. It involves self-awareness and personal growth, as well as a focus on others and their development. Leadership extends to managing processes and driving organizational success. It operates within the context of enterprises and impacts individuals and societies. Leadership involves navigating challenges and conflicts, while also fostering followership. It drives change and is guided by a sense of purpose. Leadership is both direct and paradoxical, embodying a combination of simplicity and complexity. It is a multifaceted and demanding journey, filled with pressures and intricacies that defy comprehensive capture (Luedi, 2022).

Leaders hold a pivotal position within organizations, exerting a substantial impact on the well-being of their employees through their leadership behaviors (Kim & Cruz, 2022). Leaders play a vital role within a team or organization, influencing the psychology and work engagement of employees, which in turn impacts the overall efficiency and innovation of the team or organization.

While previous studies have predominantly focused on the leadership role model, they have overlooked the influential guidance that leaders provide through their diverse efforts including decision-making (Fu, et al. 2022). A new field connecting leadership with neuroscience is emerging and being called neuroleadership.

There is growing interest in exploring the integration of emotion and cognitive process management within the work environment to foster effective leadership and create healthier workplaces. A promising emerging approach is the management of happiness, which emphasizes the importance of promoting well-being. Additionally, the field of neuroleadership offers a fresh perspective on management practices. The combined application of these approaches has the potential to significantly impact business management practices (Ruiz-Rodríguez, et al. 2023).

### *Decision-making*

Decision-making is a problem-solving process aimed at finding an optimal or satisfactory solution (Brockmann & William, 2016). Decision-making is not a simple process. It takes quite some steps starting from having options, weighing the evidence, considering the value, making the choice and evaluating the outcome (Platt, 2020). This study aims to investigate the intricate relationship between cognitive load and leadership decision-making process, and how cognitive load affects both conscious and unconscious leadership decision-making.

Emotions play a significant role in decision-making (Fosslien & West Duffy, 2019). Not only that, leaders within organizations must also assess whether the decision-making environment values diverse evidence and stakeholder perspectives (Turner, et al. 2017). The process of decision-making involves quickly assessing a range of potential outcomes and considering the future consequences linked to each available action (Purves, et al. 2001).

Damasio's "somatic marker hypothesis" (Damasio, 1994) posits that human reasoning and decision-making entail multiple levels of neural functioning, encompassing both conscious and explicitly cognitive processes as well as non-conscious ones.

The hypothesis suggests that conscious cognitive processes heavily rely on sensory representations generated by early sensory cortices. These representations provide

the foundation for higher-level cognitive operations. Additionally, cognitive operations, regardless of their specific content, rely on supporting processes such as attention, working memory, and emotion. These processes play a crucial role in shaping our thinking and decision-making abilities.

Moreover, according to Damasio, reasoning and decision-making are intricately connected to the availability of knowledge pertaining to various aspects such as the situational context, individuals involved, potential courses of action, and the anticipated outcomes associated with those actions. This knowledge base serves as an essential resource that informs our cognitive processes and guides our decision-making.

Overall, Damasio's somatic marker hypothesis offers insights into the multifaceted nature of human cognition, emphasizing the interplay between conscious cognitive processes, supporting mental operations, and the integration of knowledge in reasoning and decision-making. Decision-making plays a vital role in our everyday lives as a fundamental cognitive process and flexible decision requires both: integration between brain and body (Forte, et al. 2021).

### *Conscious and unconscious decisions*

The concept of consciousness remains elusive and resistant to precise definition, challenging both philosophical and scientific endeavors in their attempts to create a measurable framework that accurately captures the intricacies of human experience (Giacino, et al., 2014).

The nature of consciousness remains a topic of ongoing debate, yet numerous scientists and philosophers perceive it as an emergent property arising from the intricate interactions among billions of interconnected neurons in the human brain. Although exclusive self-reporting of consciousness is unique to humans, there is a growing understanding that consciousness exists to varying extents in numerous other organisms. The level of consciousness is believed to be contingent upon the intricacy and arrangement of their respective nervous systems (Liljenström, 2021).

Wang, et al. 2012 suggest that the process of making decisions without conscious awareness may involve the influence of emotional feelings of risk, which are governed by mechanisms separate from those involved in cognitive evaluation of risk.

According to Queen & Hess (2010) unconscious thought is proved to be more suitable when individuals rely on intuitive processing rather than deliberate processing for decision-making, while conscious thought shows an opposite pattern. When we speak of the unconscious, we can connect that to Kahneman's system one, and when we talk about the conscious, we can connect that to system two (Kahnemann, 2011).

System 1 refers to the rapid cognitive processes that involve immediate reactions, such as instinctive responses to stimuli like a person's angry facial expression or a sudden loud noise. These processes occur without significant conscious awareness or deeper contemplation. According to Kahneman, these impressions and emotions play a significant role in guiding routine behaviors in everyday life. For instance, when making judgments about others or deciding whether to continue cooperating with someone, we often rely on our instinctual intuition. Kahneman suggests that many of our daily actions and perceptions are predominantly influenced by System 1 cognition, functioning almost like an automatic pilot (Hartwigsen, et al., 2021).

System 2 thinking is responsible for the cognitive processes that are distinct to humans, such as deliberate reasoning and careful reassessment. It enables us to override instinctive emotional reactions and impulsive behaviors through conscious

effort. System 2 thinking involves engaging in thoughtful rationalization and actively manipulating our own understanding of other people's perspectives and beliefs (Hofman, 2015).

System 1 and System 2 can be likened to operating systems, functioning as software rather than hardware. They utilize the same underlying resources and information, can work simultaneously, and tasks can transition between them. System 1 primarily relies on automatic and mostly unconscious processes associated with associative memory. It produces initial impressions, intuitions, and response tendencies, which are then monitored, occasionally disregarded, and sometimes adjusted through the slower and predominantly conscious operations of System 2 (Morewedge & Kahneman, 2010).

## Objectives

1. To investigate the effects of age, sex, years of experience, and educational level on leaders' performance in a leadership decision-making simulation.
2. To assess the level of cognitive load perceived by leaders after completing a leadership decision-making simulation.
3. To examine the correlation between years of experience in leadership and perceived cognitive load after a leadership decision-making simulation.
4. To determine the effects of cognitive load on leadership decision-making at a unconscious level via physiological responses.
5. To establish the effects of rationalization and intuition on leadership decision-making.

## Material and Methods

### *Sample*

Purposive sampling was used to recruit 10 participants (4 women, 6 men) who held leadership positions in 9 local and 1 international company in Pristina, Kosovo. The participants met specific criteria relevant to the research questions and were representative of the target population. They held a variety of leadership positions, including department director, departmental manager, executive director, and owner. The ages of the leaders ranged from 27 to 56 years old (mean: 43), with experience levels ranging from 3 to 18 years (mean: 7.8). The number of employees under their supervision ranged from 1 to 70 (mean: 20). The types of companies represented included consulting, insurance, telecommunications, and others (Table 1).

### *Decision-making Questionnaire*

Table 2 presents the 10 questions and the four possible answers to the decision-making questionnaire. Each question was scored from 1 (poor decision-making) to 4 (excellent decision-making) using an algorithm created with the help of ChatGPT 3.5. The distribution of the expected answers from options a, b, c, and d, are shown in Table 3.

**Table 1.** Demographics of the sample

| Age | Sex | Education | Years of Experience | Title | Number of employees | Type of orgnization |
|---|---|---|---|---|---|---|
| 27 | F | Master | 3 | Founder | 1 | Consultancy |
| 52 | M | PhD | 4 | Director of Career Center | 3 | University |
| 55 | M | Bachelor | 5 | Department Director | 7 | Insurance |
| 33 | M | Bachelor | 5 | HR Manager | 3 | Telecommunications |
| 33 | F | Master | 5 | CEO | 8 | Social Enterprise |
| 35 | F | Master | 8 | Department Director | 17 | Insurance |
| 37 | M | Master | 8 | Department Chief | 12 | Insurance |
| 51 | M | Master | 10 | Department Director | 70 | Insurance |
| 47 | M | MBA | 12 | CEO | 14 | Consultancy |
| 56 | F | Bachelor | 18 | Institutional Director | 60 | Elderly Home |

**Table 2.** Decision-making questionnaire with 1 to 4 scoring

| **1. In a high-stakes situation, how would you prioritize between short-term gains and long-term sustainability for your corporation?** | **Score** |
|---|---|
| a) I would prioritize long-term sustainability by considering the potential impacts and consequences of my decisions on the overall health and future prospects of the organization. | 4 |
| b) I would prioritize short-term gains to meet immediate targets and maximize profits, without considering the potential long-term risks or negative effects on the company's reputation or sustainability. | 2 |
| c) I would strike a balance between short-term gains and long-term sustainability, considering both factors equally without giving preference to either one. | 3 |
| d) I would solely focus on short-term gains, disregarding the long-term implications or potential harm it may cause to the company's stability or reputation. | 1 |
| **2. Imagine you have limited time to make a crucial decision for your organization. How would you gather relevant information quickly and efficiently?** | |
| a) I would rely solely on my instincts and previous experience, without investing time in gathering relevant information or seeking input from others. | 2 |
| b) I would identify the key stakeholders, gather available data, consult subject matter experts, and conduct a rapid yet thorough analysis to obtain the necessary information for an informed decision. | 4 |
| c) I would hastily make a decision based on limited information or assumptions, without conducting a comprehensive analysis or considering potential consequences. | 3 |
| d) I would delegate the decision-making process to someone else without actively participating or verifying the information, potentially leading to an uninformed or inadequate decision. | 1 |
| **3. Suppose you encounter a sudden crisis that requires immediate action. How would you manage the decision-making process under intense time pressure?** | |
| a) I would hesitate and delay making any decisions, hoping that the situation resolves itself or that someone else takes charge. | 1 |
| b) I would panic or feel overwhelmed, making impulsive decisions without evaluating the situation or considering the potential consequences. | 2 |
| c) I would remain calm, assess the situation quickly, prioritize the most critical aspects, delegate tasks to capable team members, and make informed decisions based on available information and expertise. | 4 |
| d) I would rely on my gut feelings or intuition, making decisions without fully understanding the complexity or magnitude of the crisis, potentially leading to poor outcomes. | 3 |
| **4. In a complex and ambiguous scenario, what strategies would you employ to analyze and evaluate potential courses of action?** | |
| a) I would rely on a single perspective or my own intuition, without seeking input or considering alternative viewpoints, potentially overlooking important factors or biases. | 2 |
| b) I would quickly choose the most straightforward course of action without conducting a comprehensive analysis or considering potential complexities or nuances. | 3 |
| c) I would postpone the decision indefinitely, hoping that more information or clarity emerges, potentially leading to missed opportunities or detrimental outcomes due to inaction. | 1 |
| d) I would gather diverse perspectives from relevant stakeholders, conduct a thorough analysis of available data, identify risks and uncertainties, and consider multiple potential courses of action before making an informed decision. | 4 |
| **5. How do you balance the need for consensus and collaboration with the need for quick decision-making in a corporate setting?** | |
| a) I prioritize open communication and collaboration, actively seeking input and feedback from relevant stakeholders to ensure a diverse range of perspectives are considered. However, I also understand that in certain situations, swift decision-making is necessary. Therefore, I facilitate efficient and focused discussions, aiming to reach a consensus whenever possible, but ultimately making a decision if consensus cannot be achieved within a reasonable timeframe. | 4 |
| b) I value consensus and collaboration but recognize that quick decision-making is sometimes required in a corporate setting. I strive to engage stakeholders and encourage their participation, aiming for a shared understanding and agreement. If consensus cannot be reached within a reasonable timeframe, I am willing to make a timely decision while considering the input received. | 3 |
| c) I tend to prioritize speed and efficiency in decision-making, acknowledging the importance of time-sensitive situations in a corporate environment. While I appreciate collaboration, I may not always invest sufficient effort in seeking diverse perspectives or building consensus. I aim to make informed decisions based on available information and input from a select few. | 2 |
| d) I rely solely on groupthink and go along with popular opinions without critically evaluating alternatives or challenging the status quo. I avoid taking the lead in decision-making, relying on others to dictate the direction, which may lead to suboptimal or uninformed decisions. | 1 |

| **6. Describe a time when you had to make a decision that challenged your existing assumptions or beliefs. How did you handle it, and what was the outcome?** | **Score** |
|---|---|
| a) I initially held onto my existing assumptions and beliefs, but upon encountering conflicting information or alternative viewpoints, I took the time to reflect and evaluate them. Eventually, I adjusted my beliefs and made a decision that considered the new perspectives, leading to a satisfactory outcome. | 3 |
| b) I actively sought out diverse perspectives and opinions, critically examined my assumptions, and was open to changing my beliefs based on new evidence or insights. The outcome was a well-informed decision that led to positive results and personal growth. | 4 |
| c) I hesitantly questioned some of my assumptions and beliefs but did not fully commit to a thorough analysis or reflection. As a result, my decision may have been influenced by lingering biases or limited understanding, potentially impacting the outcome. | 2 |
| d) I stubbornly clung to my existing assumptions and beliefs, disregarding any conflicting information or alternative viewpoints. The outcome was a decision that was limited in perspective and potentially ineffective or detrimental. | 1 |
| **7. When faced with conflicting opinions from your team members, how do you make decisions that align with the company's objectives and values?** | |
| a) I value diverse opinions and actively seek input from team members, considering their viewpoints in my decision-making process. While I may not always achieve complete consensus, I aim to make decisions that align with the company's objectives and values. | 3 |
| b) I tend to avoid confrontation and conflict, which sometimes leads me to make decisions that maintain harmony within the team. However, I recognize the importance of aligning with the company's objectives and values and strive to find a balance between consensus and decision-making. | 2 |
| c) I actively encourage open and constructive dialogue, listen to all perspectives, analyze the merits of each argument, and strive to find common ground or a solution that aligns with the company's objectives and values. | 4 |
| d) I dismiss dissenting opinions or conflicting viewpoints, preferring to make decisions based solely on my own judgment or the opinions of a select few, potentially leading to a lack of diversity in decision-making and missed opportunities. | 1 |
| **8. Provide an example of a high-stress situation you encountered as a leader. How did you manage your own stress levels while making critical decisions?** | |
| a) I recognized the impact of stress on decision-making and implemented strategies like taking short breaks, engaging in physical activity, or using relaxation techniques to manage my stress levels. These actions allowed me to maintain a clear and focused mindset during critical decision-making. | 3 |
| b) I attempted to manage my stress levels to some extent by occasionally taking breaks or seeking support. However, there were instances where stress influenced my decision-making process, leading to suboptimal outcomes. | 2 |
| c) I allowed stress to overpower me, neglecting my own well-being and failing to implement any effective stress management techniques. This resulted in compromised decision-making abilities and potentially negative consequences for the company or the team. | 1 |
| d) I actively practiced stress management techniques such as deep breathing, mindfulness, and seeking support from colleagues or mentors. By maintaining self-awareness and a calm mindset, I made rational decisions despite the high-stress environment. | 4 |
| **9. How do you ensure that your decision-making process remains unbiased and objective, especially in the face of personal or external pressures?** | |
| a) I actively seek diverse perspectives, consider multiple sources of information, analyze data objectively, and challenge my own biases and assumptions to make decisions based on facts and the best interest of the company. | 4 |
| b) I make a conscious effort to recognize and mitigate my personal biases by seeking input from others, engaging in critical thinking, and considering alternative viewpoints. While I strive for objectivity, there may be instances where biases unintentionally influence my decision-making process. | 3 |
| c) I am aware of the importance of unbiased decision-making; however, there are times when personal or external pressures sway my judgment, leading to decisions that may not be entirely objective. | 2 |
| d) I prioritize personal interests or succumb to external pressures, allowing them to significantly impact my decision-making process. This may result in biased decisions that do not align with the best interest of the company. | 1 |
| **10. Describe a time when you had to make a decision under significant time pressure. How did you balance the need for speed with the need for thorough analysis and evaluation?** | |
| a) I hastily made a decision without considering the need for thorough analysis and evaluation. The time pressure led to a rushed and potentially ill-informed decision, neglecting important considerations and increasing the likelihood of negative outcomes. | 1 |
| b) I recognized the importance of balancing speed and thoroughness in decision-making. I made a conscious effort to gather relevant information quickly and conducted a focused analysis to the extent possible within the time constraints. While the decision may not have been as comprehensive as in ideal circumstances, it was based on a reasonable evaluation given the time pressure. | 3 |
| c) I struggled to find the right balance between speed and thorough analysis under the time pressure. As a result, I may have relied more on intuition or made some assumptions without conducting a thorough evaluation. Although the decision was made within the required timeframe, there could be potential risks or overlooked factors. | 2 |
| d) I prioritized the most critical aspects of the decision and allocated time for rapid yet focused analysis, considering the available information and evaluating potential outcomes. I sought input from trusted colleagues or subject matter experts to gain additional insights and ensure a comprehensive evaluation within the given time frame. | 4 |

**Table 3.** Distribution of the expected responses in the decision-making questionnaire

| | | | Distribution of the expected response | | | |
|---|---|---|---|---|---|---|
| | | | **a** | **b** | **c** | **d** |
| Type of decision-making | Excellent | **4** | 3 | 2 | 2 | 3 |
| | | **3** | 3 | 4 | 2 | 1 |
| | | **2** | 2 | 4 | 4 | 0 |
| | Poor | **1** | 2 | 0 | 2 | 6 |

## *Perceived Cognitive Load*

After the decision-making task participants were asked to rate their perceived cognitive load on a scale of 1 to 10. This question allowed participants to provide a subjective assessment of the mental effort required to complete the task. The scale ranged from 1 (low perceived cognitive load) to 10 (high perceived cognitive load). The reported cognitive load was then tabulated.

## *Physiological responses during decision-making questionnaire*

A GSR device (Polygraph Bio, https://www.polygraph.bio) was used to measure the level of stress and arousal while corporate leaders were answering the above-mentioned decision-making questionnaire. Figure 1 shows the arrangements of the equipment during the test for two participants.

First, all participants' GSR was measured in a relaxed state. This was done to account for the fact that all participants have different resting GSR levels. To obtain significant measurements, the change in GSR from the relaxed state to the task state was calculated for each individual participant. The mean GSR for the tasks was then correlated with the GSR during decision-making using Pearson's correlation formula.

**Figure 1.** Equipment layout. Polygraph Bio device used to measure the physiological responses (electrodermal activity) of 10 leaders while making decisions at different levels of cognitive load.

The polygraph images were analyzed as follows:

1. Establishing baseline levels to gauge individuals' overall arousal.
2. Tracking GSR and HRV changes in response to different questions.
3. Identifying spikes in GSR and HRV, indicative of increased arousal or stress.
4. Assessing recovery time, indicating individuals' stress management and arousal recovery by observing how quickly GSR and HRV return to baseline levels after each question.

### *Data analysis*

Statistical Package for Social Sciences (IBM SPSS Statistics 21) and Microsoft Excel 2021 (version 2310) were used to process the statistical data.

## Ethical considerations

Prior to conducting the individual interviews and test, informed consent from all participants was obtained. Participants were fully informed about the purpose of the study, the scope of their involvement, and the confidential handling of their data. They were explicitly notified that their participation was voluntary, and they had the right to withdraw at any point without any repercussions.

The processing of data from the Galvanic Skin Response was carried out with strict adherence to ethical guidelines. The quantitative data collected was securely stored on password-protected servers, accessible only to the research team. The data was used exclusively for academic purposes and was not shared with any external parties or organizations.

## Results

### *Effect of age on leadership decision-making*

The ages of the individuals were compared with their corresponding results in the decision-making questionnaire, grouped into two categories: 5 young executives (33.0 ± 3.7 years) and 5 middle-age executives (52.2 ± 3.6 years). No statistically significant differences ($p = 0.5105$) were found between the decision-making questionnaire results of junior executives (3.5 ± 0.7) and senior executives (3.4 ± 0.8) (Table 4).

**Table 4.** Effect of age on leadership decision-making

| | Age (years) | Decision-making score |
|---|---|---|
| Young | 33.0 ± 3.7 | 3.5 ± 0.7 |
| Middle-age | 52.2 ± 3.6 | 3.4 ± 0.8 |

### *Effect of gender on leadership decision-making*

The results of the decision-making questionnaire were compared for male and female executives. The 4 women obtained an average score of 3.3 ± 0.8, while the 6 men obtained an average score of 3.6 ± 0.8. No statistically significant differences were found between the two groups ($p = 0.0678$). Gender was the only criterion that was closer to being statistically significant than the other criteria, with a p-value of 0.0678.

### *Effect of years of experience on leadership decision-making*

The years of managerial experience were compared with the corresponding results in the decision-making questionnaire, in two groups: 7 low-experienced executives (5.4 ± 1.9 years) and 3 middle-experienced executives (13.3 ± 4.2 years). No statistically significant differences were found ($p = 0.4616$) between the decision-making questionnaire results of executives with low experience (3.5 ± 0.8) and those with intermediate experience (3.4 ± 0.8) (Table 5).

**Table 5.** Effect of years of experience on leadership decision-making

| | Management experience (years) | Decision-making score |
|---|---|---|
| Low | 5.4 ± 1.9 | 3.5 ± 0.8 |
| Intermediate | 13.3 ± 4.1 | 3.4 ± 0.9 |

### *Effect of educational level on leadership decision-making*

The educational level of the executives was compared with the corresponding results in the decision-making questionnaire, in two groups: 3 executives with a bachelor's degree and 7 executives with a postgraduate degree (Master's or PhD). No statistically significant differences were found ($p = 0.6662$) between the results of the decision-making questionnaire of executives with a bachelor's degree (3.5 ± 0.7 points) and those with a postgraduate degree (3.4 ± 0.8 points).

### *Conscious Assessment of Perceived Cognitive Load and Decision-Making Score*

Table 6 presents all the variables related to perceived cognitive load and decision-making scores for each participant after completing the 10-question questionnaire. This conscious assessment reflects each individual's deliberate consideration of how the decision-making process impacted their perception of cognitive load.

No significant correlation was found ($R^2 = 0.0008$) between perceived cognitive load and the score obtained in the business decision-making questionnaire. Only years of experience showed a negative and statistically significant correlation with cognitive load as presented in the next section.

**Table 6.** Perceived cognitive load and decision-making score

| Age | Sex | Education | Years of Exp | Title | Decision-Making Score | Declared cognitive load |
|---|---|---|---|---|---|---|
| 55 | M | Bachelor | 5 | Department Director | 3,4 | 4 |
| 56 | F | Bachelor | 18 | Institutional Director | 3,3 | 1 |
| 35 | F | Master | 8 | Department Director | 3,9 | 5 |
| 51 | M | Master | 10 | Department Director | 3,6 | 4 |
| 37 | M | Master | 8 | Department Chief | 3,9 | 5 |
| 52 | M | PhD | 4 | Director of Career Center | 3,5 | 6 |
| 33 | M | Bachelor | 5 | HR Manager | 3,8 | 3 |
| 47 | M | MBA | 12 | CEO | 3,2 | 2 |
| 33 | F | Master | 5 | CEO | 3,0 | 6 |
| 27 | F | Master | 3 | Founder | 2,9 | 5 |

### *Relationship Between Leadership Experience and Perceived Cognitive Load*

The participants' tenure as corporate leaders correlated with their perceived cognitive load during decision-making using Pearson's correlation formula ($r = -0.787$, $p < .007$), suggesting that longer tenure as a corporate leader is associated with lower perceived cognitive load (Table 7).

**Table 7.** Correlation between leader experience and perceived cognitive load

| Correlations | Time being in a lead position |
|---|---|
| **Perceived cognitive load** | |
| **Pearson Correlation** | -.787** |
| **Sig. (2-tailed)** | .007 |
| **N** | 10 |

**. Correlation is significant at the 0.01 level (2-tailed).

To predict perceived cognitive load from leadership duration, a simple linear regression was calculated. A significant regression equation was found for the impact of leadership duration on perceived cognitive load ($F=13.032$, $p<.007$). Therefore, leadership duration can predict 49% of the variance in perceived cognitive load.

### *Effects of cognitive load on leadership decision-making at unconscious level*

We measured the effects of cognitive load on decision-making at unconscious level. Figure 2 shows one participant's physiological responses during the polygraph test. Both the GSR and the HRV increased throughout the test. This suggests that the participant became more aroused as the test progressed.

The graph also shows that the participant's GSR and HRV spiked at certain points during the test. These spikes may be indicative of increased arousal or stress. This could be because the participant was asked a particularly difficult or challenging question at that time.

Overall, the graph suggests that the participant experienced increased arousal and stress throughout the polygraph test. This could be due to a variety of factors, such as anxiety, stress, deception, or the difficulty of the questions.

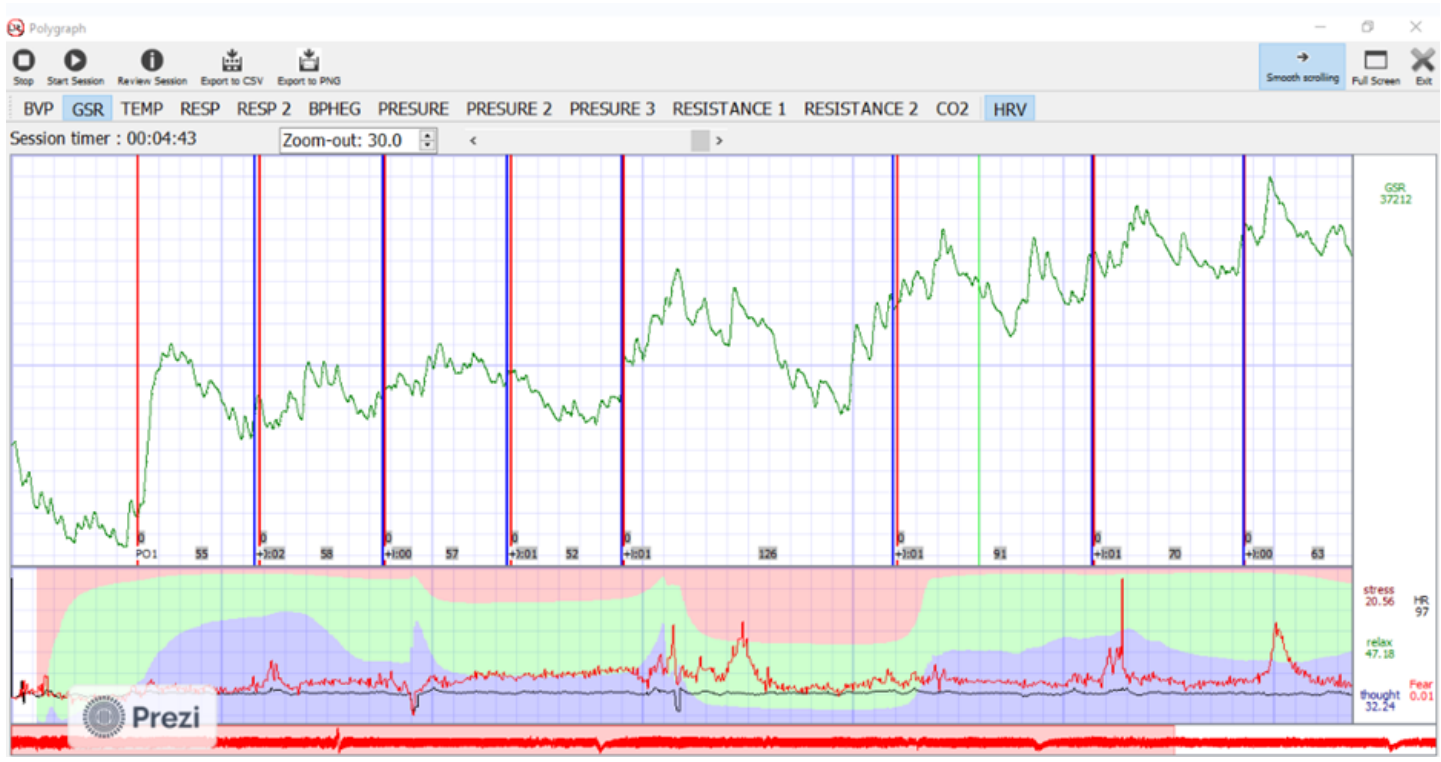


**Figure 2.** One participant's physiological responses. GSR and HR during the polygraph test.

Correlating the mean GSR for the tasks with the GSR during decision-making revealed a very strong and significant correlation ($r = 0.999$, $p < .000$), suggesting that unconscious cognitive load is associated with changes in GSR (Table 8, Figure 3).

**Table 8.** Correlation between mean GSR during task and GSR during decision-making

| Correlations | GSR mean during task |
|---|---|
| **GSR during decision making** | |
| **Pearson Correlation** | .999** |
| **Sig. (2-tailed)** | .000 |
| **N** | 10 |

**. Correlation is significant at the 0.01 level (2-tailed).

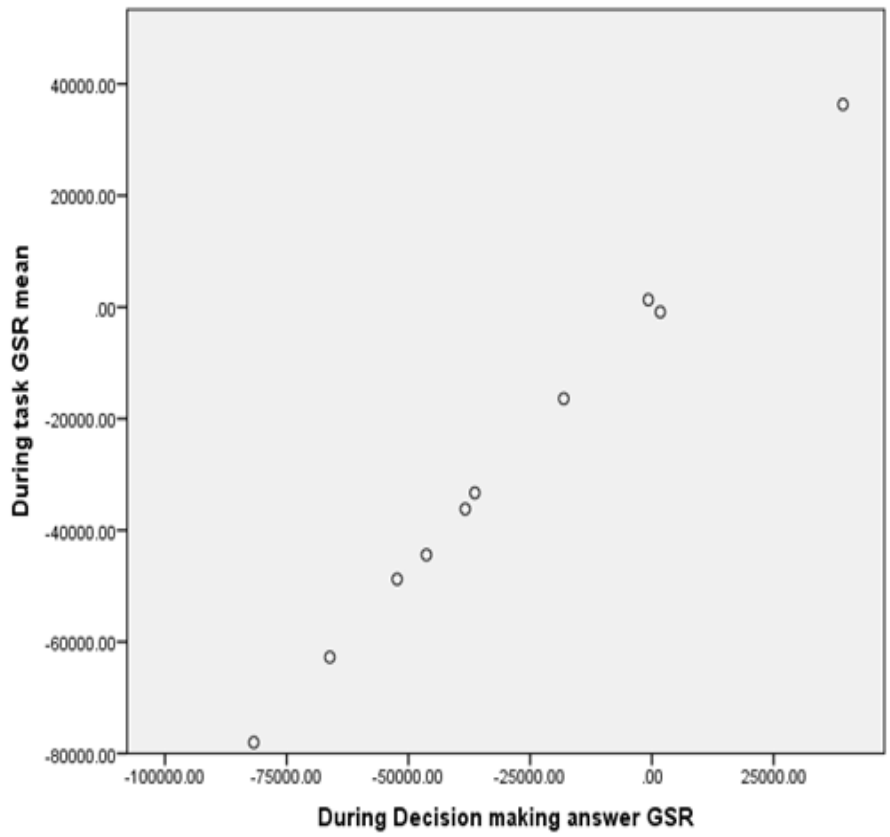


**Figure 3.** Correlation between GSR mean during task and GSR during decision-making.

## *Effects of rationalization and intuition on leadership decision-making*

Descriptive analysis revealed that participants with lower GSR levels during decision-making (Table 9) were more likely to be using Kahneman's System 2 thinking.

**Table 9.** Mean GSR during decision-making for all participants

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | -81751.60 | 1 | 10.0 | 10.0 | 10.0 |
| | -66136.70 | 1 | 10.0 | 10.0 | 20.0 |
| | -52312.50 | 1 | 10.0 | 10.0 | 30.0 |
| | -46291.30 | 1 | 10.0 | 10.0 | 40.0 |
| | -38335.00 | 1 | 10.0 | 10.0 | 50.0 |
| | -36364.40 | 1 | 10.0 | 10.0 | 60.0 |
| | -18102.80 | 1 | 10.0 | 10.0 | 70.0 |
| | -731.20 | 1 | 10.0 | 10.0 | 80.0 |
| | 1730.80 | 1 | 10.0 | 10.0 | 90.0 |
| | 39248.20 | 1 | 10.0 | 10.0 | 100.0 |
| | Total | 10 | 100.0 | 100.0 | |

Descriptive analysis revealed that participants using Kahneman's System 2 thinking in decision-making had higher quality decision-making outcomes (Table 10). Pearson's correlation analysis confirmed a significant correlation between utilizing Kahneman's System 2 and decision-making outcome quality ($r = 0.678$, $p < .031$).

A simple linear regression model was used to predict decision-making outcome quality based on Kahneman's System 2 thinking. A significant regression equation was found for the impact of using Kahneman's System 2 on decision-making outcome quality ($F=6.823$, $p <.031$), with an $R^2$ of 0.460. This indicates that 46% of the variance in decision-making outcome quality can be predicted by Kahneman's System 2 thinking (Table 10).

**Table 10.** Correlation between Kahneman's system 2 and decision-making quality

| Correlations | Decision making quality |
|---|---|
| **Using Kahneman's system 2** | |
| **Pearson Correlation** | .678* |
| **Sig. (2-tailed)** | .031 |
| **N** | 10 |
| *. Correlation is significant at the 0.05 level (2-tailed) | |

## Discussion

Measuring cognitive load has gained even more significance within the context of the workplace, playing a vital role in understanding performance and productivity. Our primary focus was to investigate how cognitive load impacts decision-making outcomes, both at the conscious and unconscious levels, for leaders in various professional settings.

The data collected from the participants' responses to the 10 questions, carefully designed to increase their cognitive load and test their decision-making abilities under pressure, has provided us with valuable insights. By measuring the level of stress and arousal through galvanic skin response, we gained an understanding of the physiological responses that accompany decision-making in leadership roles.

### *Differences in cognitive load management strategies and decision-making outcomes*

Our findings revealed a remarkably strong and significant positive correlation between cognitive load during task and during decision-making ($r = 0.999$, $p < .000$). This indicates that an increase in cognitive load during the task, which involved answering 10 questions with four possible options in increasing order of difficulty, was directly associated with elevated cognitive load responses during decision-making. This finding corroborates that high cognitive load during task significantly impacts a leader's cognitive load during decision-making, leading to increased physiological response rates.

Elevated cognitive load during task suggests that leaders' working memory resources are being extensively employed to process information, evaluate options, and formulate decisions. This intensified cognitive load during task can persist into the subsequent decision-making stage. Consequently, several factors contribute to the robust positive correlation observed between cognitive load during task and during decision-making.

Challenging questions can induce emotional arousal in leaders as they face heightened cognitive load during the task. This can affect their decision-making process and result in increased physiological reactions and cognitive load in subsequent decisions.

Leaders' working memory resources are extensively engaged in processing information, evaluating options, and making decisions during the task, resulting in elevated cognitive load. This high cognitive load can carry over to the subsequent decision-making stage. Therefore, cognitive load during task and during decision-making are strongly and positively correlated.

Another possibility is that high cognitive load during the task can create heightened perceptual expectations in leaders about the complexity and difficulty of the subsequent decision-making. These expectations can produce a self-fulfilling prophecy, where they experience the decision-making process as more demanding and cognitively taxing.

In conclusion, the strong positive correlation between cognitive load during the task and during decision-making suggests that the cognitive demands of the task spill over into the decision-making process. Leaders who experience high cognitive load during the task are more likely to encounter increased cognitive load during decision-making, resulting in higher physiological response rates. These findings support the fact that high cognitive load during task significantly impacts the leader's cognitive load during decision-making.

Regarding the relationship between cognitive load and years of experience in leadership positions we examined how time spent in a leadership role influences perceived cognitive load during decision-making deepens our understanding of the decision-making process as leaders gain expertise over time. Leaders with more experience in leadership positions reported lower perceived cognitive load during decision-making. This finding is supported by a significant negative correlation between time spent in a leadership position and perceived cognitive load ($r = -0.787$, $p < .007$).

Our findings indicate that leaders with more experience in leadership positions reported lower perceived cognitive load during decision-making. A linear regression analysis revealed that time spent in a leadership position can predict 49% of the variance in perceived cognitive load.

These findings can be attributed to several factors that influence the relationship between time spent in a leadership position and perceived cognitive load during decision-making. One key factor is accumulated experience and expertise. As individuals gain more experience in leadership roles, they develop a deeper understanding of decision-making processes and acquire effective strategies for handling complex tasks. This accumulated knowledge and expertise enable them to navigate decision-making scenarios with greater ease, resulting in a lower perceived cognitive load.

Prolonged exposure to decision-making challenges fosters the development of enhanced decision-making skills in leaders. They cultivate a sharper intuition, enabling them to make decisions with greater ease, often with a quick assessment. Additionally, leaders gain a deeper understanding of their strengths and weaknesses, empowering them to approach decision-making tasks with greater confidence and efficiency.

This increased confidence can alleviate the cognitive load associated with decision-making. Over time, as is characteristic of human nature, leaders may develop adaptive cognitive processes that enhance their ability to process information efficiently and make streamlined decisions. They may refine cognitive shortcuts or mental models that enable them to rapidly assess situations and make judgments, thereby reducing the cognitive burden.

Moreover, as leaders accumulate experience, they develop a deeper familiarity with the contexts in which decisions are made. This familiarity empowers them to anticipate potential challenges and identify relevant information more efficiently. Consequently, the decision-making process becomes more focused and less taxing.

Generally, experienced leaders often face high-stakes and time-sensitive decisions. This is why they may develop coping mechanisms to handle pressure and stress more effectively. As a result, they may perceive decision-making situations as less burdensome, contributing to a lower perceived cognitive load. Overall, the combination of accumulated experience, improved decision-making skills, adaptive cognitive processes, familiarity with decision contexts, reduced perceived pressure, and continuous learning likely contributes to the observed negative correlation between time spent in a leadership position and perceived cognitive load during decision-making.

### *Comparative Analysis of Rationalization and Intuition in Leadership Decision-Making*

Analyzing the effects of rationalization (Kahneman's System 2) versus intuition (Kahneman's System 1) on decision-making outcomes revealed a significant positive correlation between employing System 2 and decision quality ($r = 0.678$, $p < .031$). This indicates that participants who engaged more deeply in analytical and critical thinking processes achieved better decision-making outcomes. These findings support that Kahneman's System 2 plays a positive role in influencing a leader's decision-making outcomes, leading to more informed and effective decisions. Additionally, a simple linear regression analysis indicated that System 2 utilization can predict 46% of the variance in decision-making outcomes.

The observed differences in decision-making outcomes can be attributed to the distinct cognitive processes associated with Kahneman's System 2 (rationalization) and System 1 (intuition). When leaders prioritize System 2, they engage in more in-depth analysis, critical thinking, and systematic information processing, which can lead to better-informed and more effective decision-making outcomes.

The observed differences in decision-making outcomes can be attributed to the distinct cognitive processes associated with Kahneman's System 2 (rationalization) and System 1 (intuition). When leaders prioritize System 2, they engage in more in-depth analysis, critical thinking, and systematic information processing, which can lead to better-informed and more effective decision-making outcomes.

Understanding the neuroscientific foundation of Kahneman's System 2 is crucial in elucidating how this approach improves decision-making. System 2 requires training or experience, and its effectiveness is influenced by genetic, environmental, and educational factors. Further research should explore how these factors interact to shape the development and utilization of System 2, ultimately enhancing decision-making proficiency in leaders.

Kahneman's System 2 engages in deliberate and rational analysis of available information, carefully considering potential consequences and meticulously weighing various options. Leaders who prioritize this approach are more likely to make decisions grounded in objective assessments and thorough evaluations, ultimately leading to superior decision quality.

Analyzing the effects of rationalization (Kahneman's System 2) versus intuition (Kahneman's System 1) on decision-making outcomes revealed a significant positive correlation between employing System 2 and decision quality ($r = 0.678$, $p < .031$). This indicates that participants who engaged more deeply in analytical and critical

thinking processes achieved better decision-making outcomes. These findings support that Kahneman's System 2 plays a positive role in influencing a leader's decision-making outcomes, leading to more informed and effective decisions. Additionally, a simple linear regression analysis indicated that System 2 utilization can predict 46% of the variance in decision-making outcomes.

The observed differences in decision-making outcomes can be attributed to the distinct cognitive processes associated with Kahneman's System 2 (rationalization) and System 1 (intuition). When leaders prioritize System 2, they engage in more in-depth analysis, critical thinking, and systematic information processing, which can lead to better-informed and more effective decision-making outcomes. Understanding the neuroscientific foundation of Kahneman's System 2 is crucial in elucidating how this approach improves decision-making. System 2 requires training or experience, and its effectiveness is influenced by genetic, environmental, and educational factors. Further research should explore how these factors interact to shape the development and utilization of System 2, ultimately enhancing decision-making proficiency in leaders.

Kahneman's System 2 engages in deliberate and rational analysis of available information, carefully considering potential consequences and meticulously weighing various options. Leaders who prioritize this approach are more likely to make decisions grounded in objective assessments and thorough evaluations, ultimately leading to superior decision quality.

In conclusion, the significant positive correlation between utilizing Kahneman's System 2 and the quality of decision-making outcomes strongly suggests that leaders who engage in rational analysis and critical thinking tend to make better decisions. The application of Kahneman's System 2 positively influences decision-making outcomes, leading to more informed and effective decisions. These findings support that rationalization positively influences a leader's decision-making outcomes, with the utilization of Kahneman's System 2 predicting 46% of the variance in decision quality. The primary contribution of this research lies in the comprehensive understanding it provides of how cognitive load, rationalization (Kahneman's System 2), and accumulated leadership experience influence decision-making outcomes among leaders. By investigating these factors, the study sheds light on the intricate interplay between cognitive processes, decision-making, and leadership performance.

### *Limitations*

While our study contributes valuable insights into the relationship between cognitive load and decision-making among leaders, it is essential to acknowledge its limitations. The small sample size and lack of diversity in our participant pool may restrict the generalizability of our findings to a broader population of leaders. Future research endeavors should prioritize recruiting a larger and more diverse sample to enhance the external validity of the results and facilitate broader applicability in various professional settings.

Furthermore, our study's cross-sectional design captures data at a single point in time, limiting our ability to assess how decision-making processes may evolve over time. Longitudinal studies could provide a more comprehensive understanding of the dynamic nature of decision-making and the influence of cognitive load across different stages of leadership experience.

Our study's sample size may limit the generalizability of the results to a broader population of leaders. Future research with a larger and more diverse participant pool would enhance the study's external validity. Our research utilized a cross-sectional design, which only captured data at a single point in time. Longitudinal studies could provide a more comprehensive understanding of how decision-making processes change over time and how cognitive load may impact decision outcomes across different stages of leadership experience.

Despite these limitations, our research may contribute to the growing body of knowledge on decision-making under cognitive load in leadership roles. Future studies addressing these limitations can build upon our findings and provide a more comprehensive understanding of how cognitive load impacts decision outcomes in diverse leadership settings.

Another option could be conducting longitudinal studies that follow leaders over an extended period can provide valuable insights into how decision-making processes evolve and change with experience. This approach can offer a more comprehensive understanding of the long-term effects of cognitive load on leadership decisions. Also, the designing and implementing interventions or training programs aimed at improving decision-making under cognitive load can be beneficial. Evaluating the effectiveness of such interventions can also offer practical implications for leadership development.

In terms of study design incorporating further Neuroscientific approaches such as functional magnetic resonance imaging (fMRI) or electroencephalogram (EEG), can provide neurobiological insights into the brain mechanisms involved in decision-making under cognitive load. Also, team decision-making, by investigating how cognitive load impacts decision-making in team settings can provide valuable insights for collaborative decision-making processes. According to Johannessen et. al. (2020) multiple physiologic measures should be employed for a more accurate measurement of cognitive load in a real-world setting.

While our study provides valuable insights into the relationship between cognitive load and decision-making among leaders, it is essential to consider potential confounding variables that may affect decision-making outcomes. Although participants were presumed to have been selected through standard psychological tests to ensure they met the study's criteria, factors such as anxiety, depression, bipolar disorder, or fatigue were not directly assessed. These factors have been shown in previous research to impact cognitive function and decision-making abilities (Berggren & Derakshan, 2013; Eysenck et al., 2007; Gotlib & Joormann, 2010; Lorist & Tops, 2003).

Anxiety, for example, can lead to cognitive biases and impairments in information processing, potentially resulting in suboptimal decision-making under high cognitive load. Similarly, mood disorders such as depression or bipolar disorder can influence individuals' cognitive processes, affecting their ability to evaluate options and make decisions effectively. Additionally, fatigue, whether physical or mental, can compromise attentional control and executive functioning, leading to errors in judgment and decision-making (López et al., 2016).

Considering the potential impact of these factors is crucial for interpreting the study's findings accurately. Future research endeavors should incorporate measures to assess participants' mental state and psychic abilities comprehensively, ensuring that these extraneous variables are controlled for effectively. By addressing these potential confounds, future studies can provide a more nuanced understanding of the interplay between cognitive load and decision-making in leadership contexts.

## Conclusions

This research holds significant potential for both academic and practical implications. Academically, it contributes to the burgeoning field of neuroleadership by examining the relationship between cognitive load and leadership decision-making through measuring physiological responses. As an exploratory study, it lays the groundwork for future investigations in this area, encouraging further research and scholarly discourse.

Practically, this research aims to equip leaders with valuable insights into their decision-making processes. By understanding how cognitive load impacts decision-making outcomes, leaders can tailor their approaches to handle high-pressure situations effectively. Additionally, organizations can utilize these findings to design better decision support systems, enhance leadership training programs, and optimize decision-making processes.

While our study provides valuable insights into the cognitive processes underlying decision-making among leaders, there are opportunities for further investigation to enhance the depth of understanding in this area. In future research endeavors, the incorporation of additional neuroscientific methodologies, such as EEG or functional magnetic resonance imaging (fMRI), could offer valuable insights into the neural mechanisms underlying decision-making under cognitive load. These neuroimaging techniques can provide real-time data on brain activity, allowing for a more nuanced exploration of how cognitive processes unfold during decision-making tasks.

Additionally, complementing traditional cognitive assessments with measures of executive functions could provide a comprehensive understanding of the cognitive resources involved in decision-making among leaders. By employing a multi-method approach that integrates neuroscientific techniques with behavioral assessments, future studies can gain a more holistic understanding of the interplay between cognitive load, decision-making processes, and leadership performance.

As noticed, there are opportunities for further research. For other researchers interested in further exploring the topic of decision-making and leadership under cognitive load, there are several valuable avenues to consider. While our research provides valuable insights into the relationship between cognitive load and decision-making in leadership roles, it is essential to acknowledge its limitations to ensure the validity and generalizability of the findings.

## Conflicts of Interest

Authors reports no conflicts of interest to report in relation to this study.

## Acknowledgments

To Professor Ilir Mazreku, Department of Biology, University of Hasan Prishtina in Prishtina, Kosovo, for allowing us to use the physiological equipment described in this work.

## Contributor Roles

Arnisa Aliqkaj: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft.

Rubén Carvajal: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Supervision, Validation, Software, Visualization, Writing – review & editing.

## References

Atiomo, W. (2020). Cognitive load theory and differential attainment. *BMJ*, m965. doi:10.1136/bmj.m965

Berggren, N., & Derakshan, N. (2013). Attentional control deficits in trait anxiety: Why you see them and why you don't. Biological Psychology, 92(3), 440-446.

Brockmann, Erich N.; Anthony, William P. (December 2016). Tacit knowledge and strategic decision-making. *Group & Organization Management*. 27 (4): 436–455. doi:10.1177/1059601102238356. S2CID 145110719

Brünken, R., Seufert, T., & Paas, F. (2010). *Measuring cognitive load*. In Cognitive Load Theory (pp. 181-202). Department of Psychology, Education and Child Studies. Cambridge University Press.

Damasio AR (1994). *Descartes' error: emotion, reason, and the human brain*. New York Grosset/Putnam.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. Emotion, 7(2), 336-353.

Forte, G., Morelli, M., & Casagrande, M. (2021). Heart Rate Variability and Decision-Making: Autonomic Responses in Making Decisions. *Brain Sciences*, 11(2), 243. doi:10.3390/brainsci11020243

Fosslien, L., & West Duffy, M. (2019). *No Hard Feelings*. New York, NY: Portfolio/Penguin, an imprint of Penguin Random House LLC.

Fu, X., Li, C., & Fu, J. (2022). The experimental research on leaders and cooperative behavior. *Frontiers in Psychology*, 13, 944498. https://doi.org/10.3389/fpsyg.2022.944498.

Giacino, J. T., Fins, J. J., Laureys, S., & Schiff, N. D. (2014). Disorders of consciousness after acquired brain injury: the state of the science. *Nature Reviews Neurology*, 10(2), 99-114. doi: 10.1038/nrneurol.2013.279

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. Annual Review of Clinical Psychology, 6, 285-312.

Hartwigsen, G., Bengio, Y., & Bzdok, D. (2021). How does hemispheric specialization contribute to human-defining cognition? *Neuron*, 109(13), 2075–2090. doi:10.1016/j.neuron.2021.04.024

Hofman, M.A. (2015). *Evolution of the human brain: from matter to mind*. In Handbook of Intelligence: Evolutionary Theory, Historical Perspective, and Current Concepts, S. Goldstein, D. Princiotta, and J.A. Naglieri, eds. (Springer Science+Business Media), pp. 65–82.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Kim, H. D., & Cruz, A. B. (2022). Transformational Leadership and Psychological Well-Being of Service-Oriented Staff: Hybrid Data Synthesis Technique. *International Journal of Environmental Research and Public Health*, 19(13), 8189. https://doi.org/10.3390/ijerph19138189

Liljenström, H. (2021). Consciousness, decision-making, and volition: freedom beyond chance and necessity. *Theory in Biosciences*. Advance online publication. https://doi.org/10.1007/s12064-021-00346-6

López, R., Capitán, J. L., García, A. M., Fernández, S., & del Pozo, F. (2016). Fatigue recognition based on EEG signals and subjective reports. International Journal of Neural Systems, 26(6), 1650014.

Lorist, M. M., & Tops, M. (2003). Caffeine, fatigue, and cognition. Brain and Cognition, 53(1), 82-94.

Luedi, M. M. (2022). Leadership in 2022: A perspective. Best Practice & Research Clinical Anaesthesiology, 36(2), 229-235. https://doi.org/10.1016/j.bpa.2022.04.002

Morewedge, C. K., & Kahneman, D. (2010). Associative processes in intuitive judgment. *Trends in Cognitive Sciences*, 14(10), 435–440. doi:10.1016/j.tics.2010.07.004

Orru G., Longo L. (2019). *The Evolution of Cognitive Load Theory and the Measurement of Its Intrinsic, Extraneous and Germane Loads: A Review*. Human Mental Workload: Models and Applications. H-WORKLOAD 2018. Communications in Computer and Information Science, Springer, Cham. Communications in Computer and Information Science. 1012: 23–48. doi:10.1007/978-3-030-14273-5_3. ISBN 978-3-030-14272-8. S2CID 86587936

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. M. (2003). Cognitive Load Measurement as a Means to Advance Cognitive Load Theory. *Educational Psychologist*, 38(1), 63–71. doi:10.1207/s15326985ep3801_8

Platt, M. (2020). *The Leader's Brain: Enhance Your Leadership, Build Stronger Teams, Make Better Decisions, and Inspire Greater Innovation with Neuroscience*. Wharton School Press.

Purves, D., Augustine, G. J., Fitzpatrick, D., Katz, L. C., et al. (Eds.). (2001). *Neuroscience*. Sunderland, MA: Sinauer Associates.

Queen, T. L., & Hess, T. M. (2010). Age differences in the effects of conscious and unconscious thought in decision-making. *Psychology and Aging*, 25(2), 251–261. doi:10.1037/a0018856

Reis M, Pfister R, Foerster A. Cognitive load promotes honesty. Psychol Res. 2023 Apr;87(3):826-844. doi: 10.1007/s00426-022-01686-8.

Ripp. (2021). Cognitive Load as a Mediator of the Relationship Between Workplace Efficiency and Well-Being. *The Joint Commission Journal on Quality and Patient Safety*, 47(2), 74–75. https://doi.org/10.1016/j.jcjq.2020.12.002

Ruiz-Rodríguez, R., Ortiz-de-Urbina-Criado, M., & Ravina-Ripoll, R. (2023). Neuroleadership: A new way for happiness management. *Humanit Soc Sci Commun*, 10(1), 139. doi: 10.1057/s41599-023-01642-w.

Sewell, J. L. (2021). Going with the cognitive (load theory) flow. *Medical Education*, 55(7), 770–772. doi:10.1111/medu.14533

Sweller, J. (2011). *Cognitive Load Theory*. In Psychology of Learning and Motivation (Vol. 55,pp. 37-76). Retrieved from https://doi.org/10.1016/B978-0-12-387691-1.00002-8

Sweller, J., Ayres, P., & Kalyuga, S. (2011). Measuring Cognitive Load. *Cognitive Load Theory*, 71–85. doi:10.1007/978-1-4419-8126-4_6

Turner, S., D'Lima, D., Hudson, E., Morris, S., Sheringham, J., Swart, N., & Fulop, N. J. (2017). Evidence use in decision-making on introducing innovations: a systematic scoping review with stakeholder feedback. *Implementation Science*, 12(1). doi:10.1186/s13012-017-0669-6

Wang, S., Krajbich, I., Adolphs, R., & Tsuchiya, N. (2012). The Role of Risk Aversion in Non-Conscious Decision-making. *Frontiers in Psychology*, 3. doi:10.3389/fpsyg.2012.00050

Zak, P. J. (2017). *Trust Factor: The Science of Creating High-Performance Companies*. American Management Association.