Neuroleadership: A Conceptual Analysis and Educational Implications

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Article Info	Abstract
	Interpreting findings in neuroscience by field experts and educators regarding educational processes and transferring them to a practical context is gaining importance. From this aspect, neuroleadership studies with the development of social cognitive neuroscience started to serve as a guide for making sense of educational leaders' behaviors at the biological level. In this study, the term of neuroleadership is analyzed conceptually and its implications for the educational leadership field are explored. To do so, a systematic literature analysis method was employed. Forty-four studies (published between January 2010 and May 2020) were examined as they relate to neuroleadership and its educational and managerial implications. In the light of these studies, the analysis of basic concepts related to neuroleadership has been made, and the neuro-educational leadership implications are listed. In those studies, it is seen that neuroleadership is generally conceptualized as "applying the findings of neuroscience to the leadership area." In addition, the educational and managerial implications of neuroleadership, some of which are multi-tasking, emotion management, optimum learning, psychological basis, are explained under the themes. The findings of this study can help schools take advantage of the opportunities offered by neuroscience and coordinate educational processes with evidence-based approaches.

Introduction

The neuroscientific information acquired with the advances in mathematics, science, and technology, doubled with psychiatry and medical studies, signal new horizons in leadership studies. The developments in the field of neuroscience have not been only in the form of drugs, models, medical and technological interventions that can eliminate the learning difficulties of students or learners, but they also have begun to be developed in a way to support leadership studies for the wellbeing of the organizational members from schools to other sectors. The neuroscience advances into applicable educational fields have been limited (Morris & Sah, 2016), but can be increased with the interdisciplinary works of educational and neuroscience field experts.

Neuroscience, or brain science, opens up new areas for leadership in the educational field by enabling us to better understand the reasons behind the chemical processes occurring in the brain and in administrative steps

such as human motivation and decision-making. Neurological variables can provide more understandable information about "what leaders do and why" (Waldman, Balthazard, & Peterson, 2011a). Already, several initiatives have started under various names, such as Brain, Mind and Education, Neuroeducation, Educational Neuroscience, Brain and Education (Howard-Jones, 2008, p. 361).

Everything a person does and feels is stored in their brain, and so, it is of great importance for a person to understand what the human brain functions are and how possible responses are given (Grah & Dimovski, 2014). This understanding is especially critical because brain functions are among the determinants of leadership behaviors and qualities (Waldman et al., 2011a). According to Gordon (2000, p.1), the human brain employs 100 billion neurons and trillions of connections, responding to the threatening situations of the changing environment, meeting material needs, continuing in a social system, and satisfying its own self and emotions. Although the brain is the core unit that manages the human body, each part of the brain has different functions. Damage to one of the brain's intricate parts can lead to negative consequences physically and mentally. For example, in frontal lobe syndrome, which is generally seen as a result of a traumatic or neoplastic frontal lobe injury (Kokacya & Ortanca, 2020, p.507), patients may have problems such as slowness, reduction of emotion, and apathy (Kartalci, Unal & Ozdemir, 2011, p.160).

The contribution of neuroscience to the interpretation of human behavior can be systematically explained within related models and frameworks. One of the most well-known of these is the SCARF (Status, Certainty, Autonomy, Relatedness, Fairness) model (See, Rock, 2008). This model explains how the motivation in human brain functions regarding reward or threat situations (Rock, 2008). To maintain the person's wellbeing, the brain guides the format and intensity of human behavior according to perceptions of either "reward" or "threat." The SCARF model explains human social experience under five dimensions (Rock, 2008, p.5; Rock & Cox, 2012, p.3): Status is a person's sense of importance and worthiness according to the others (peers, colleagues, supervisors, etc.). Certainty refers to the person's need for clarity and the ability to make accurate predictions. Autonomy means having an impact on one's own behaviors and a sense of control over the events in one's life (getting promoted, finding a partner, etc.). Relatedness expresses a person's sense of attachment to someone else and a sense of bond they have established (for example, whether someone is perceived as a friend or enemy). Fairness emphasizes the feeling of just and non-biased exchange between people (praising or accepting one's efforts, paying equal pay for equivalent work, etc.).

The brain and body activate hormones and neurons in the face of a social stimulus that affects the person's safety, their will, and their feelings of equality. In terms of the SCARF model, verbal stimuli that may harm a teacher's "status" in school or feelings that are not supported by belonging within "relatedness" can cause teachers to adopt defensive structures. As the SCARF model emphasizes, the brain tries to approach if there is a reward or walk away if there is a threat (Rock, 2008). However, reward/threat perceptions may not be solely sufficient to explain the behavior of the human brain in cases of problems and pleasant situations. People can consciously change and even override the instinctive responses to perform behaviors that they think are more efficient and beneficial (Freedman, 2019). As a result, the brain can engage in unpredictable behavior within its multidimensional structure and functions.

The integration of neuroscience and leadership helps leaders understand how the brain's insights and intuition minimize potential threats and maximize reward possibilities to increase motivation, positivity, and workplace engagement (Pope, 2019, p.14). In this regard, neuroleadership findings may answer the following questions in management: To what extent can school principals expect a teacher, who has lost his or her personal autonomy, relatedness, and certainty after some in-school events, to still serve the school's goals? How can leaders at a school satisfy teachers' feelings of status, certainty, relatedness, autonomy, and fairness to trigger the brain's reward systems? To increase compliance and efficiency in the workplace, many developed countries seek answers to explore these types of questions with how biological foundations of human nature carry out brain mapping studies with large-scale budgets (Esmeray-Yogun, 2016). Information on neuroimaging, which can shed light on our understanding of particularly complex human behaviors, may enable the development of more integrated models for brain mapping and the field of organizational behavior (Sezgin & Ucar, 2015). The outcomes of neuroscience promise important implications for educational leadership in general social terms, as well as explaining the brain's working system.

Purpose of the Study

Studies to examine possible relationships between neuroscience, social science, organizational work, and management are increasing (Sułkowski & Chmielecki, 2017). The increasing interest in neuroscience has focused on leadership skills and relational dynamics, focusing on the analysis of components that can support a suitable environment for work and education (Balconi, Fronda, Natale, & Rimoldi, 2017). It is therefore crucial to study how neuroscience can contribute to the domain of educational leadership. In this respect, "the analysis of the concept of neuroleadership" and "the analysis of the neuroleadership implications in terms of educational and school leadership" are the focal points of this study.

Method

In the context of the study's two focal points, the purpose of the study has been to review the literature by means of systematic literature analysis. A literature review is an essential feature of academic research; in this method, the construction of knowledge is based on pre-existing studies (Xiao & Watson, 2019). As the first step in the study, regarding the literature review, I aimed to make a conceptual analysis of the term of neuroleadership. The purpose of the conceptual analysis was to define neuroleadership and to clarify its scope. In concept analysis, the analysis is of the various definitions, uses, applications, and other concepts closely related to the focal concept to determine the basic elements that make up the concept (Aydan, 2018, p.78). After examining and explaining the related concepts, the second step of the study is to explore the implications of neuroscientific studies regarding education and school leadership within the systematic literature review methodology.

Approaches to literature review are divided into three forms, namely, a traditional-narrative review, a systematic review, and a meta-analysis (Karacam, 2014). In this study, the systematic literature review method was adopted. A systematic literature review is a type of scientific investigation in which the studies conducted on a particular subject are scanned in detail, and the findings are synthesized after the criteria of exclusion and

inclusion in the collection of related studies (Aslan, 2018). According to Bellibas and Gumus (2019, p. 734), basic topics, research questions, and goals are the starting point for a systematic literature review. Then, the related publications are defined; the selection, evaluation, and interpretation of the studies are based on a conceptual perspective; the sources of the data used and the way they are analyzed and synthesized are clarified, and finally, the findings, limitations, and inferences are discussed. All literature reviews are carried out within a specific stage and steps. Xiao and Watson (2019) recommend three main steps and eight sub-steps for an effective literature review in Table 1.

Table 1. Necessary Steps for Literature Review (Xiao & Watson, 2019)

Processes	Steps	Explanations
Planning the review	Step 1: Formulate the problem	What is neuroleadership? What are the educational implications of neuroleadership for school leaders and teachers?
	Step 2: Develop and validate the review protocol	All the processes, from the goals of the study to reporting. have been designed, and their suitability has been validated.
Conducting the review	Step 3: Search the literature	All studies containing the terms "neuroleadership, neurological leadership" on electronic databases have been scanned.
	Step 4: Screen for inclusion	In addition to searching the related terms in the texts, the summaries and contents of the studies were reviewed. Those suitable for the research purpose were included in the research group.
	Step 5: Assess the quality	The full texts of the studies to be added were read, and the suitability of the contents was checked for the last time. Meanwhile, support was received from another specialist to review the texts.
	Step 6: Extract the data	In selected studies, the conceptual definitions and themes highlighted in the axis of education were formed. A deductive approach has been followed.
	Step 7: Analyze and synthesize the data	Concepts and definitions are selected, and inferences are synthesized.
Reporting the review	Step 8: Report findings	The selected definition, conceptual analyses, and implications are reported.

With the general structure in Table 1, I planned to include the neuroleadership studies published between January 2010 and May 2020 within the scope of the Web of Science Core Collection, Education Resources Information Center (ERIC), Google Scholar, along with a general search. The first step in the data collection process of literature reviews is the determination of keywords in line with the formulation of the problem (Girmen, Kaya, & Kilic, 2018), which were "neuroleadership" and "neurological leadership" in this study. The ten-year time limit was imposed due to the fact that the research is intended to contribute to the educational literature with up-to-date information. Indeed, technological developments relevant to neuroscience after the 2000s have sparked revolutionary innovations and changes.

For the literature analysis, three different databases and general Google searches were preferred. Special attention was given to the fact that the studies for selection in the literature review had to have been done in the last ten years, to have been written in English. These studies are expected to contain information that will shed light on neuroleadership and education leadership studies. Studies that do not meet the requirements, as described, were not included in this study. The sources included in the literature review are designated with an asterisk (*) in the references cited below.

In the first step of collecting data for the systematic literature analysis, the terms "neuroleadership" or "neurological leadership" were searched through the Web of Science Core Collection, and ten studies were found in which the terms searched were found in the title, abstract, or keywords (May 8, 2020). These studies were generally included in the study to explain the concept of neuroleadership and related concepts to educators. In these publications, the focus of their attention is not on the implications for education and school leaders. The aim was to keep the scope wide for a conceptual analysis of the term "neuroleadership."

In the second step, the ERIC database, which is an effective resource for the educational researches, has been researched. To examine educational neuroleadership studies, searches were conducted for the words "neuroleadership" and "neurological leadership" (May 10, 2020). When "neuroleadership" was written in the ERIC database, one study (See Kraus, 2018) was presented. Thirty-five studies were observed when "neurological leadership" was written in the ERIC database. In this screening, attention was paid to these features: the studies must be written in English, published between 2010-2020, and offer practical implications for educational leaders from the neuroleadership findings or conceptual discussions. Only seven studies that meet these requirements in the ERIC database could be included in the research group of this paper. Although most of the studies are excluded due to the year criteria, some studies (e.g., Subramaniam, Oxley, & Kodama, 2013; Walker & Haley-Mize, 2012) were found to have no implications for school leaders regarding neuroleadership.

The third database search was conducted with Google Scholar. In this context, it has been observed that there are 1,590 studies on "neuroleadership" and 34 studies on "neurological leadership" in the relevant database (May 13, 2020). All steps are based on studies that include the target terms. In the first general check, it was seen that the studies were in many different areas, from special education to business. The target contents were partially covered within the scope of different topics (e.g., biology), and the full texts of some studies were in

other languages other than English. Therefore, in accordance with the aim of this study, I made the second database examination on the condition that the titles would include "neuroleadership," and the studies were in English. In this way, 33 studies appeared with "neuroleadership." Ten studies were also found for "neurological leadership." In this screening, "education," "school," "teacher," "school leader," etc. were also searched in the texts. Seven studies from the overall 43 studies were included in the research group as they had implications related to school leadership. Again, studies not meeting the time limit criteria and not providing direct implications about educational leadership and outcomes are not included in the research group.

In the fourth general screening, I examined the studies in the first steps and their references, cited papers in the texts, and the publications of the relevant researchers in these studies. In addition, the keywords were again examined through a Google general search. In this way, 20 studies were found and were added to the research group. Again, in this last literature review, attention was paid to the 2010-2020 year criterion, neuroleadership, school leadership implications, and texts in English.

The data source collection process spanning three weeks was completed with three databases and 44 studies in four steps. The low number of neuroscience, education, and leadership studies at the intersection of neuroleadership can make this number reasonable. The term "neuroleadership" entered the lexicon in 2006 with the work of David Rock (Ghadiri, Habermacher, & Peters, 2013). When systematic literature analyses are checked, the number of studies included varies on the subject and time limit. For example, 31 studies on teaching beliefs were included in the review with an 11-year time limit by Cobanoglu (2015). Wang (2019) has reviewed 73 scientific studies on "neuroscience and education leadership" without a time limit.

In this study, the main themes were formed as a result of the examined papers. Neuroleadership implications regarding school leaders and teachers were included under themes if they were also supported in other examined studies. That is, I did not include all implications; instead, the findings, suggestions, or discussions which were also present in other papers were included so that a more structured paper with a sound background can be presented to the literature.

Results and Discussion

The findings are explained below, according to the two focal points of the study. In the first part, concepts such as neuroleadership, neuroscience, and social cognitive neuroscience are explained for educators. In the second part, the implications of these concepts, along with neuroleadership, on educational processes and school leadership are explained and discussed.

Conceptual Analysis of Neuroleadership

The basic conceptual definitions of the terms for educational leadership from neuroleadership and neuroscience fields are given below.

Neuroleadership and Basic Concepts

The prefix 'neuro-' is faced in many terms like neuropedagogy, neurodidactics (Kraft, 2012). The word neuro comes from "neûron" in ancient Greek and "nervus" in Latin, and these words are known to be related to the nervous system (Yasar, 2019, p. 1178). Billions of neurons (brain cells) in the human brain are the units that receive, evaluate, and transmit information through synapses (Wang, 2019, p. 333). The neurons' interactions in the prefrontal cortex, the CEO of the brain (Goldberg, 2009), in the dopaminergic system, which is the brain's reward provider, in the limbic system, which is the emotion manager of the brain, impact the leadership characteristics of people in the social environment (Wang, 2019). It is claimed that interactions in the right front of the brain paired with social skills, emotional skills, and abilities may be related to inspiring or charismatic leadership behaviors (Waldman, Balthazard, & Peterson, 2011b).

An interest in more basic characteristics, that is, biological factors, in leadership and personality studies, has attracted attention to neuroscience (Waldman et al., 2011a). This interest also paved the way for neuroleadership studies. The concept of neuroleadership was developed under the leadership of David Rock and was documented with sound literature through the "NeuroLeadership Institute" and the "NeuroLeadership Journal" (https://neuroleadership.com). The concept of neuroscience, which is the focus of neuroleadership, is a science that examines the interaction of neurons that form the basis of human behavior and their effects. "*Neuroscience can be defined as the study of how the nervous system and the brain functions*" (Sułkowski & Chmielecki, 2017, p. 52). Social cognitive neuroscience is a field of neuroscience for social and leadership studies. Ochsner and Lieberman (2001) define social cognitive neuroscience as a sub-field of neuroscience that tries to understand human interactions at social, cognitive, and neural aspects.

Neuroleadership can be defined as an applied field of social cognitive neuroscience that aims to analyze and understand leaders' behavior (Liu, Ying, & Gau, 2015, p. 143). Neuroleadership, which is defined as the expertise to coordinate parts of the brain with leadership behaviors (Badenhorst, 2015), aims to strengthen the leadership field with the support of neuroscience findings. Neuroleaders manage their institutions by setting a management strategy based on brain-based findings. Neuroscience offers excellent development potential through the study of biological and chemical processes in the brain for leadership and managerial processes (e.g., decision-making and coordination). Therefore, researchers can produce more informed theories and leadership patterns by researching the neurological basis of behavior (Waldman, Balthazard & Peterson, 2011b). Neuroleadership studies have even advanced to brain–computer interface studies (See, Massaro, 2015).

Neurologists (or neuroscientists) can be defined as scientists who study the optimization of the human brain (Hamlin, 2017). The brain and behavior have a two-way relationship. In other words, they influence each other and develop each other (Edison, Juhro, Aulia, & Widiasih, 2019). In fact, behaviors are the processes directed by the brain, and with their feedback, they become empowering factors for the brain itself. Therefore, exploring this relationship will help school leaders better manage schools and empower all teachers. According to Pittman (2020), neuroleadership has a supportive role in creating a more resistant organizational structure and providing employee retention.

Scientists who study the brain emphasize that it is necessary to pay attention to the behavior, emotions, and motivational stimuli of the employees to achieve the best performance (Babanova, Dolinskaia, & Gorshenin, 2016). The brain displays different levels of waves in different stages and tasks during the day while striving for the best performance. In this context, experts can observe the brain waves through technological tools and techniques. These techniques can be listed as follows (Waldman et al., 2011a, p. 1905): (1) computed axial tomography scan (CT scan or CAT' scan), (2) positron emission tomography (PET), (3) magnetic resonance imaging (MRI), and (4) electroencephalography (EEG).

In general, electroencephalography (EEG) and the neurofeedback method are preferred in the areas of leadership behavior. In the neurofeedback method and training, participants are included in some tasks in environments similar to video games. They are then studied to see if they learn the desired behaviors or responses through operant conditioning by using audio or graphic interfaces (Waldman et al., 2011a). In general, this method is used in groups with specific problems (e.g., attention deficit hyperactivity disorder) with successful results (Başaran, 2019) and signals that it can be used as a mechanism to support leadership development in the future (Waldman et al., 2011a). In fact, the different biological traces of leaders may reveal findings that will lead the way to personal development programs in the future. In the neurofeedback method, alpha, beta, delta, theta, gamma waves, or combinations of these waves can be measured with stimuli that are given through sound and video (Edison et al., 2019). It is possible to determine what waves people exhibit in response to specific stimuli, and it is possible to benefit from the power of the waves by focusing on the moments that reveal them. EEG representations, Hertz frequencies, and descriptions of the waves are shown in Table 2 and Figure 1.

Table 2. Brain Waves and Explanations

Wave Type and Hz	Explanations
Alpha (8–12 Hz)	Alpha waves are associated with a feeling of calm and comfort; They improve memory, mental performance, heal brain trauma, and strengthen creativity. Meditation generally increases alpha waves.
Beta (12–30 Hz)	Beta activities are good indicators for observing mental performances. If the beta is not at the desired values, it can indicate problems, such as physical issues that might cause depression or other mental illnesses.
Delta (0–4 Hz)	These waves can reduce anxiety and improve sleep quality. Delta waves are used to alleviate headaches, brain trauma and injury, learning disabilities, and to improve severe seizures.
Theta (4–8 Hz)	These waves are related to various brain activities, such as memories, emotions, creativity, sleep, meditation, and hypnosis. These waves are associated with the early stage of sleep.
Gamma (> 30 Hz)	These waves have the highest frequency and are related to improving mental acuity, brain activities, and problem-solving activities. If these waves rhythm faster, the speed of remembering an event or something increases.

Note: Hz values are taken from Zhang et al. (2019); explanations were adapted from the literature review study in Edison et al. (2018, pp. 51-52).
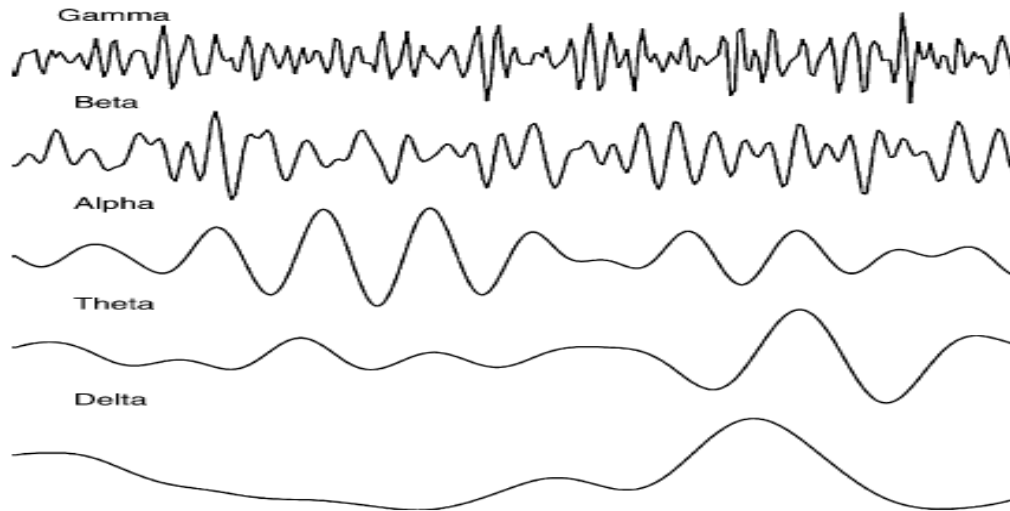
Figure 1. Visual representations of the most common EEG frequencies (taken from Pineda et al, 2014, p. 443)

Teacher studies based on EEG frequencies and brain waves can guide researchers in the area of education management and present solid results for leader development in schools.

Neuroleadership Studies: Implications for Education and School Leadership

With the increase of brain-based findings on learning, attention was drawn to transferring these findings from neuroscience to the field of education (Broomfield & D'Amato, 2018). Kraus (2018) emphasizes that neuroleadership is applicable in the field of educational leadership in his study on school and education administrators. Pope (2019) proposes a neuro-educational leadership model for the effectiveness of school leadership in the 21st century. Wang (2019) states that despite the interdisciplinary nature of educational leadership, little effort has been made to apply natural science to educational leadership. In fact, neuroscience is an area that can reveal important implications for educational leadership with its natural science background. In this study, the neuroscience findings were examined regarding the aspects of neuroleadership that affect school leadership; thus, the search terms leading to neuroleadership studies revealed several qualities of neuroleaders that can be transferred to school leadership.

Neuroleaders avoid multitasking.

School processes may require many tasks to be done simultaneously, and successful school principals are the people who manage the institution with a sequential task logic that makes the distribution of tasks effective. As a matter of fact, it is not possible for people to focus on many things at the same time with the same level of interest. While people focus on only one task, they can follow the simple ones that are of lower importance and require little attention (Shipley, 2017a). In this respect, an implication of the neuroleadership approach for school leaders is that leaders list their tasks in order of their importance and carry out the relevant actions in sequence. Focusing on different tasks at the same time will activate the autopilot feature of the brain, and leaders can make decisions that they are not really aware of in line with ready-made experiences (Shipley,

2017a, p.39). Indeed, multitasking is an obstacle to learning and a distraction (Davachi, Kiefer, Rock, & Rock, 2010; Gherri & Eimer, 2011)

Neuroleaders learn how the brain works and spread it to others.

Neuroleadership in education should not be considered with the focus of transferring related studies to educational management. Teaching or informing learners on how the brain performs learning can provide more effective steps in learning processes (See, Blackwell, Trzesniewski & Dweck, 2007; Dubinsky, Roehrig & Varma, 2013; Dubinsky et al., 2019; Fitzakerley, Michlin, Paton, & Dubinsky, 2013). As these studies show, raising awareness of students, teachers, and learners about how the brain develops and learns can speed up learning or development (Halvorson, Cox, & Rock, 2016). Neuroscience knowledge that teachers acquire affects their pedagogical knowledge and teaching skills (Schwartz, Hinesley, Chang, & Dubinsky, 2019).

Understanding people's biological foundations strengthens management.

One reason for the need of neuroleadership studies in education is to learn how much a human being is affected by the non-social, biological part of a human being. According to Lafferty and Alford (2010), our mind is the source of our behavior, decisions, and choices, a black box that we know only by interpreting input and output. However, with the technological advances available today, these processes have become more transparent and explainable on a biological basis. According to Du Plessis and Badenhorst (2016), the effectiveness of leadership development efforts can be significantly increased by defining the biological traces of leaders' behavior.

Some prerequisites must be met for learning in terms of biology (Carskadon, 1999). For example, one of them is sleep. According to Ringleb, Rock, and Ancona (2012), lack of sleep may lead people to make risky decisions. The appropriate level of sleep affects student motivation, awareness, and mood (Allison & Schumacher, 2011). It is generally known that eight hours of sleep is sufficient for young students. Education leaders with neuroscience awareness know the benefits of sleep and understand the causes of stress in their absence (Hamlin, 2017). In addition, neuroscience provides information that stress at low levels triggers a dopamine release. That release facilitates learning and development, but the intensity and chronic stress shrink the hippocampus area of the brain (Yasar, 2019). According to Pope (2019), when people think they have control over decisions and choices in their work environment, there is a decrease in the release of the stress hormone cortisol. Leaders are expected to be aware of such biological findings. Teachers who are aware of this type of biological properties can help students more effectively in their development.

Neuroleaders are aware of the context and the human factor.

Leadership behaviors depend on the personal orientation of the leaders and their environment (Wang, 2019). This means that in terms of educational leadership, a person can be a good leader with a good education and with the contribution of contextual factors. However, a person's genetics, hormonal, physical development, and

maturity of the person will affect the quality of their leadership as well. Neuroscience sheds light on the partially closed area of leadership development since it is related to a person's tendency, genetics, and physical development. According to Lafferty and Alford (2010), neuroscience-based knowledge can be used to broaden leadership theory and practice. However, the fact that excessive data dependency occurs in decision-making processes in schools and the examination of all processes in the context of data actually emphasizes instrumentality (Wang, 2019). It is also essential for school leaders to be aware that there are emotions apart from genetic features, and humans have contradictions. Decisions should be made on evidence-based strategies but consider the humane side.

Neuroleaders conduct emotion management effectively.

While Ghadiri, Habermacher, and Peters (2013) stated that fear and negative emotions cause negative effects, the reward mechanism has a positive effect on one's health, especially one's mental health. Based on their research, Lafferty and Alford (2010, p. 34) state that having a positive mood before problem-solving situations requiring creativity and foresight has a beneficial effect on problem-solving. Meshanko (2013) states that respecting employees leads to the highest performance in the human mind. Likewise, it can be said that the same effect will be created by the emotions of a teacher who respects students. For this reason, leaders should be aware of the emotional and cognitive states of the people they are responsible for and be able to regulate their emotions (Grah & Dimovski, 2014). Also, neuroleaders can shape workplace commitment through emotional intelligence and deep awareness (mindfulness), taking leadership of biological health, including diet, sleep, and exercise, using the SCARF model, and establishing an organizational growth mindset (Zwaan, Viljoen, & Aiken, 2019).

Neuroleaders are aware of the processes that make learning poor.

The integration of the world of technology with education facilitates education. Smartphones and similar systems make life easier for us. However, are they really beneficial for brain development? Emde (2011) states that being connected to a continuous type of technology reduces a leader's (or any person's, for that matter) intellectual ability by an average of 15 IQ points. An education leader who is aware of such findings encourages a healthy use of technology and a higher awareness of education. The above-mentioned multitasking, sleep, emotions, stress also offer important implications for the quality of teaching and learning processes(See, Allison & Schumacher, 2011; Davachi, Kiefer, Rock, & Rock, 2010; Gherri & Eimer, 2011; Pope, 2019)

Neuroleaders use solutions that will provide optimum learning.

The trend in general education is to do more to get more, such as increasing a course's total hours for more information. Is there any way to do more with less (Hamlin, 2017)? In an effective learning organization, the leader acts according to the principles of neuroleadership and increases the level of learning and knowledge of the people around by processes such as meta-thinking, decision making, emotion regulation, increasing cooperation, and facilitating change (Grah & Dimovski, 2014, p. 6). According to Badenhorst (2015),

neuroscience provides theorists with evidence-based strategies in developing their leadership skills; effective leaders use these strategies to create an optimal learning environment.

Learning can be improved by understanding how the human brain works (Grah & Dimovski, 2014). A "spacing" between learning and review sessions is an important feature in terms of learning quality (Davis, Maite, Rock, McGinniss, & Davachi, 2014). It may be more useful to regularly work with spacing in the last weeks of an exam instead of getting confined to home for weeks. Long-term retention of information can be enhanced with the spacing of learning sessions (Morris & Sah, 2016). Based on the work of Davachi et al. (2010), Davis et al. (2014) propose to work by drawing attention to "attention" in addition to keeping the spacing rule, to change focus every 20 minutes and not to focus on many tasks at the same time. Educational scientists should be aware of these educational implications, and even the issues of increasing break hours and shortening lessons should be tested based on neuroscience.

Neuroleaders direct change by taking into account implicit variables.

Neuroleadership also guides us about the attitudes that administrators must adopt for change in schools. School leaders who want change should create work environments that minimize the sense of threat by providing certainty and clarity for high expectations (Pope, 2019). Leaders may sometimes need to take into account issues such as membership, gender, nationality, and belief before presenting the desired innovative changes in the institution. Actually, a change seen as useful may not have the same meaning in employee rationality, where complex biological processes are also effective; it may even be threatening. According to Lighthall et al. (2012), even the gender factor can make a significant difference in the reactions in itself. For example, while men under stress make quick decisions, women under stress can make relatively slow decisions. So, leaders should know their group and understand their reactions.

Kuhlmann and Kadgien (2018) think that a leader's focus on open attitudes rather than implicit biases about change could be a reason why change cannot be effectively implemented. Badenhorst (2015) gives an example of stress that may be implicit in change processes; therefore, all stress factors should be taken into account in advance. Identifying possible sources of obstacles is important for every attempt. Allison and Schumacher (2011) describe how the proven school time change attempt from early hours to later, based on the benefits and neurological foundations of sleep's effect on student achievement, has resulted in problems with unexpected reactions from the public.

Neuroleadership studies can show the way in the selection and training of leaders.

Neuroleadership studies also include some recommendations for teacher and leader training programs. Leader and teacher preparation programs should focus on active candidates who can manage under conditions that may be stressful, understand stress and cognition biologically, love working in groups, embrace change, and do active research (Hamlin, 2017). Leading in educational processes may require administrators who have the ability to manage their emotions and are aware of the factors that may affect people's decision-making

processes along with expert knowledge in their fields.

Humans are intelligent beings, but they can react quite differently to an event with different characteristics from their genes and environment. The example of Shipley (2017b, p. 25), in this regard, can provide implications for leaders. In an anagram game (obtaining a new word by replacing the letters of a word or phrase) that seemed easy for participants, they were first interested and entertained. Then, the participants were disappointed when they could not group letters properly and listed many factors as excuses. In fact, the participants made optimum efforts, and the person who set up the game knowingly placed a difficult option later in the game. Neither language skills nor intragroup relationships would have an impact on solving this problem, but the group found excuses regardless. In this respect, one of the implications that neuroscience-based training can offer leaders is that persons need to develop the ability to think mindfully and be aware of their thinking, i.e., meta-thinking.

Neuroleaders know the psychological state of the groups they serve.

According to Pope (2019), effective school leaders establish relationships through empathy, communication, and collaboration. When school leaders provide a sense of belonging among teachers, they feel a higher level of trust and empathy for those they work with. Neuroleadership emphasizes the need to understand the physical development, brain chemistry development, and the needs of the groups a leader serves, not only from the administrative point of view. According to Rebora (2019), schools should have environments that support students' development, rather than ignoring their neurological development, particularly in youth. Lack of emotion and impulse control in youth are normal states of adolescence. Educators should think about identifying adolescents who may have serious mental or emotional problems (Perkins-Gough, 2015). Guidance and coaching, which require interpersonal relationships, are the processes involving neurological and biochemical factors. Both positive and negative emotions can be traced to a person's genes (Hollywood, Blaess, Santin, & Bloom, 2016). For this reason, school leaders should know how to communicate with students in case a problem arises and should be able to tell the difference between normal behavior and serious situations.

Policymakers should benefit from neuroscience for education.

Educators should concentrate on neuroscience and biology studies to shape policies and practices and should also transfer their knowledge of neuroscience to the field of education. Neurological information on learning and leadership processes is increasing. Therefore, it becomes important to interpret, transfer, and test this information in the education field. The distribution of Mozart music CDs to new mothers in Georgia (USA) in 1998 is an example of the reflection of cognitive neuroscience studies on education. CD distributions were made with the hope of playing classical music to accelerate the newborns' brain development (Leisman, 2012).

Neuroleadership studies can offer some implications not only for educators but also for educational leadership researchers and policymakers. In general, neuroscience-based studies can be added to studies that measure school leaders. Aside from using surveys and interviews, more comprehensive assessments can be made (Waldman et al., 2011b). As the accessibility to technology keeps increasing, more effective assessment

methodologies of cognition, emotion processing, and associated functions of several brain systems and circuitries have begun to come onto the scene (da Motta et al., 2019)

Education is for the whole person, so the development of both the right and left brain should be supported.

One of the implications for educators is that educational institutions attach importance to the functions of the left brain in students. Unfortunately, their right-brain function does not get as much attention during school activities. Leaders should also consider implementing activities that will ensure the development of both the right and left brain when creating their lesson plans. According to Leisman (2012), educational institutions give importance to verbal and numerical issues in students, while visualization, imagination, sensory, and perceptual abilities, all functions of the human right brain, are not usually supported. In general, textbooks emphasize linear thought processes (left-brain functions) and ignore intuitive, analogical, and figurative thinking. As a matter of fact, most skills that employ the right part of the brain are acquired outside school. As a result of the interviews made with young students by Cushman (2013), it was stated that the students' sports, arts, and community achievements were generally realized outside the school. Teachers and administrators should adopt a holistic development as neuroleaders and design educational experiences that will activate many areas of the human brain to encourage their students' holistic development. In addition, separating the human brain into right and left can be as misleading as separating rational and aesthetic fields in education. Interactions in the brain are affected by neuron interactions in many different areas of the brain.

Conclusions

The results of this study can be briefly summarized around the definition of neuroleadership, as well as educational and managerial outcomes regarding neuroscience. In this context, the concepts of neuroleadership and neuroscience were explained, and then neuroleadership and educational and managerial implications in the target research group were examined. In a general sense, neuroleadership refers to the realization of neuroscience-based findings in institutions within effective leadership. Increasing studies on the subject and explanation of learning processes in light of their biological basis have produced evidence-based strategies for leaders to manage their teaching and management processes more effectively. In fact, the examination of leadership behaviors classified on indicators in terms of processes in the brain will reveal more concrete results regarding what should be done in education. These results can be revealed by methods such as EEG, neurofeedback and may contribute to well-informed management practices.

It is still debated how much of the human brain can be understood (Huang & Luo, 2015). However, investigations by social scientists on how behaviors occur in the brain and how these behaviors affect brain development will support more discoveries in this field. These developments will also continue to be transferred to the leadership field by social-cognitive neuroscience studies. Indeed, neurotechnology, along with artificial intelligence, promise to bring in fast projections and developments in neuroscience topics (Rainey & Erden, 2020).

Consistent with the findings in the study, it can be said that the implementation of neuroleadership studies in schools can provide optimization in learning, relationship skills, and motivation. In this regard, the implications found in the study can be strengthened by new experimental studies. New findings can provide an evidence-based neurocognitive perspective in the implementation of teaching and leadership in schools. School leaders who understand these perspectives can contribute to their schools. For this reason, policymakers should focus on training education leaders who understand behavior's biological foundations. With this knowledge, schools can take advantage of the opportunities offered by neuroscience, know the most effective educational processes, manage implicit variables, become aware of biological and environmental factors, understand the psychological status of the groups they serve, coordinate educational processes in both aesthetic and linear aspects, and manage evidence-based approaches.

The study briefly includes the following basic implications for educational leaders: School leaders as neuroleaders are expected to avoid assigning multiple tasks, given the findings of neuroscience concerning multitasking. They apply emotion management effectively, are aware of the biological and sociological effects of sleep, stress, motivation, reward and threat, and then act accordingly. Those institutional leaders who know the biological foundations of behavior can employ their knowledge to change their schools' initiatives. With their knowledge about how the human brain functions, neuroleaders can transfer that knowledge to their students to increase their awareness. Policymakers should evaluate these basic findings with increasing studies and try to offer a wide range of developmental programs in educational settings – all based on neuroscience findings.

Recommendations

The study was designed as a systematic literature analysis. The entire research group (articles, books, and paper) was determined in line with several criteria, i.e. texts in English language. Those were included or excluded in the study according to the steps specified in the literature search in the method section. Thus, next studies in form of literature analysis can contribute into the literature more with fewer criteria.

In some studies examined, leadership characteristics and brain waves were seen to be observed by EEG in neuroleadership studies. With an interdisciplinary approach, researchers can conduct similar studies on basic leadership behaviors in school, their biological foundations, and their implications for education. Neuroleadership gives school leaders an opportunity to understand the motivation required for employee engagement and participation (Pope, 2019). With this knowledge, the school's leaders can optimize teacher effectiveness and satisfaction. The SCARF model can serve as a guide for schools in this interpretation process. In subsequent studies, it is beneficial to focus on this issue within the SCARF model.

References

*Allison, B., & Schumacher, G. (2011). Learning research and community decision making. *Journal of Cases in Educational Leadership*, *14*(4), 10-21.

Aslan, A. (2018). Systematic Reviews and Meta-Analyses. *Acta Medica Alanya*, 2(2), 62-63.

Aydan, S. (2018). Whistleblowing: a concept analysis. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 15* (41), 78-100. Retrieved from https://dergipark.org.tr/en/pub/mkusbed/issue/36823/339366

*Babanova, Y.V., Dolinskaia, A.Y., & Gorshenin, V.P. (2016). Main aspects of company's success: an effective leadership or the ability to manage employees' emotions. In Soliman, K.S. (ed) *Innovation Management and Education Excellence Vision 2020: From Regional Development Sustainability to Global Economic Growth*. International Business Information Management Assoc. Milan, ITALY

*Badenhorst, C. (2015). *Identifying and managing the impact of NeuroLeadership during organisational change* (Master's thesis). Unitec, New Zealand.

*Balconi, M., Fronda, G., Natale, M. R., & Rimoldi, E. (2017). Why generating leadership. The contribute of neuroscience. *Ricerche Di Psicologia*, (3), 365-383. DOI:10.3280/RIP2017-003007

Başaran, M. (2019). *Estimation of attention deficit and hyperactivity disorder (adhd) with artificial neural networks using eeg* (Master's Thesis), Kütahya Dumlupınar Üniversitesi/Fen Bilimleri Enstitüsü.

Bellibaş, M. Ş., & Gümüş, S. (2019). A systematic review of educational leadership and management research in Turkey. *Journal of Educational Administration*. 57(6), 731-747. https://doi.org/10.1108/JEA-01-2019-0004

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child development, 78* (1), 246-263.

*Broomfield A.M., D'Amato R.C. (2018) Neuroeducation. In: Kreutzer J.S., DeLuca J., Caplan B. (eds) *Encyclopedia of Clinical Neuropsychology*. Springer, Cham https://link.springer.com/referenceworkentry/10.1007/978-3-319-57111-9_9154

Carskadon, M. A. (1999). Adolescent sleep patterns versus societal demands. Phi Delta Kappan, 90, 348-353.

Cobanoğlu, R. (2015). A Review of Research in Turkey on Beliefs about Teaching. *Hacettepe University Journal of Education*, *30*(3), 48-59.

*Cushman, K. (2013). Minds on fire. *Educational Leadership*, *71*(4), 38-43.

da Motta, C., Carvalho, C.B., Castilho, P. *et al.* (2019). Assessment of neurocognitive function and social cognition with computerized batteries: Psychometric properties of the Portuguese PennCNB in healthy controls. *Curr Psychol*.https://doi.org/10.1007/s12144-019-00419-2

*Davachi, L., Kiefer, T., Rock, D., & Rock, L. (2010). Learning that lasts through AGES: Maximizing the effectiveness of learning initiatives. *NeuroLeadership Journal*, 3, 53-63.

*Davis, J., Maite, B., Rock, D., McGinniss, P., & Davachi, L. (2014). The Science of Making Learning Stick: An Update to the AGES Model. *NeuroLeadership Journal,* 5, 1-15.

*Du Plessis, A., & Badenhorst, C. (2016). Managing the impact of NeuroLeadership during organisational change. Under New Management Innovating for sustainable and just for futures 30th Anzam Conferences 6-9 Dec, Australia

*Dubinsky, J. M., Guzey, S. S., Schwartz, M. S., Roehrig, G., MacNabb, C., Schmied, A., ... & Ellingson, C. (2019). Contributions of neuroscience knowledge to teachers and their Practice. *The Neuroscientist*, *25*(5), 394-407.

*Dubinsky, J. M., Roehrig, G., & Varma, S. (2013). Infusing neuroscience into teacher professional

development. *Educational Researcher*, *42*(6), 317-329.

*Edison, R. E., Juhro, S. M., Aulia, A.F., & Widiasih, P.A. (2019). Transformational Leadership and Neurofeedback: The Medical Perspective of Neuroleadership. *International Journal of Organizational Leadership, Forthcoming*.

*Emde, M. J. (2011). The role technology plays in generating insight for effective decision making: a NeuroLeadership approach to using technology more effectively. *Management Today*, *29*(9), 52-55.

Esmeray-Yogun, A. (2016). Organizational neuro studies and ethical considerations. *Electronic Journal of Social Sciences. 15*(56), 207-215. https://doi.org/10.17755/esosder.97952

*Fitzakerley, J. L., Michlin, M. L., Paton, J., & Dubinsky, J. M. (2013). Neuroscientists' classroom visits positively impact student attitudes. *PloS one, 8*(12). 1–14. https://doi.org/10.1371/journal.pone.0084035

*Freedman, B. D. (2019). Risk factors and causes of interpersonal conflict in nursing workplaces: Understandings from neuroscience. *Collegian*, *26*(5), 594-604. https://doi.org/10.1016/j.colegn.2019.02.001

*Ghadiri, A., Habermacher, A., & Peters, T. (2013). *Neuroleadership: A journey through the brain for business leaders*. Springer Science & Business Media.

Girmen, P., Kaya, M.F. & Kilic, Z. (2018). Violence at primary schools and its reflections on the press and the visual media in Turkey. *International Journal of Research in Education and Science, 4*(2), 703-713. DOI:10.21890/ijres.438383

*Gherri, E., & Eimer, M. (2011). Active listening impairs visual perception and selectivity: An ERP study of auditory dual-task costs on visual attention. *Journal of Cognitive Neuroscience, 23*(4), 832-844

Goldberg E. (2009). *The executive brain. Frontal lobes and the civilized mind.* New York: Oxford University Press.

Gordon, E. (2000). *Integrative neuroscience: Bringing together biological, psychological and clinical models of the human brain*. CRC Press. https://books.google.com.tr/books?hl=en&lr=&id=cEtT6vEum6AC&oi=fnd&pg=PR7&ots=hMNA9zsI1x&sig=7tIoMe8THTOoNZk-N0v9q5cVOIg&redir_esc=y#v=onepage&q&f=false

*Grah, B., & Dimovski, V. (2014). Neuroleadership and an Advanced Learning Organization. *E-Leader http://www.g-casa.com/conferences/milan/paper/Grah.pdf*

*Halvorson, H. G., Cox, C., & Rock, D. (2016). *Organizational growth mindset*, NeuroLeadership Journal. https://declare.roswellstudios.com/wp-content/uploads/2019/07/NLI_Organizational_-Growth_Mindset.pdf

*Hamlin, C. R. (2017). *Neuroscientific strategies for managing stress related to pervasive change in public education* (Order No. 10286846). Available from ProQuest Dissertations & Theses Global. (1941084403). Retrieved from https://search.proquest.com/docview/1941084403?accountid=11301

*Hollywood, K. G., Blaess, D. A., Santin, C., & Bloom, L. (2016). Holistic Mentoring and Coaching to Sustain Organizational Change and Innovation. *Creighton Journal of Interdisciplinary Leadership*, *2*(1), 32-46.

Howard- Jones, P. (2008). Philosophical challenges for researchers at the interface between neuroscience and education. *Journal of Philosophy of Education*, *42*(3- 4), 361-380.

Huang, Z. J., & Luo, L. (2015). It takes the world to understand the brain. *Science*, *350*(6256), 42-44.

Karacam, Z. (2014). Sistematik derleme metodolojisi: Sistematik derleme hazırlamak için bir rehber[Systematic

Review Methodology: A Guide for Preparation of Systematic Review]. *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi*, *6*(1), 26-33.

Kartalcı, S., Ünal, S., & Özdemir, S. (2011). Adli yönden frontal lob sendromu: Bir olgu sunumu/Forensic aspect of the frontal lobe syndrome: a case report. *Anadolu Psikiyatri Dergisi*, *12*(2), 160-162

Kokacya, M. H., & Ortanca, İ. (2020). Frontal Lobe Syndrome and Its Forensic Psychiatric Aspects. *Current Approaches in Psychiatry*, *12*(4), 507-518. doi: 10.18863/pgy.657546

Kraft, V. (2012). Neuroscience and education: Blind spots in a strange relationship. *Journal of Philosophy of Education*, *46*(3), 386-396.

*Kraus, G. (2018). *An action research to explore district administrators and board member communication in public schools* (Order No. 10745359). Available from ProQuest Dissertations & Theses Global. (2015561438). Retrieved from https://search.proquest.com/docview/2015561438?accountid=11301

*Kuhlmann, N., & Kadgien, C. A. (2018, May). Neuroleadership: Themes and limitations of an emerging interdisciplinary field. In *Healthcare management forum* (Vol. 31, No. 3, pp. 103-107). Sage CA: Los Angeles, CA: SAGE Publications.

*Lafferty, C. L., & Alford, K. L. (2010). NeuroLeadership: Sustaining research relevance into the 21st century. *SAM Advanced Management Journal*, *75*(3), 32.

*Leisman, G. (2012). Children's Language Production: How Cognitive Neuroscience and Industrial Engineering Can Inform Public Education Policy and Practice. In *Forum on Public Policy Online* (Vol. 2012, No. 1). Oxford Round Table. 406 West Florida Avenue, Urbana, IL 61801.

*Lighthall, N. R., Sakaki, M., Vasunilashorn, S., Nga, L., Somayajula, S., Chen, E. Y., ... & Mather, M. (2012). Gender differences in reward-related decision processing under stress. *Social cognitive and affective neuroscience*, *7*(4), 476-484.

*Liu, Y. Z., Jing, Y. D., & Gao, M. (2015). Transformational Leadership: From the Perspective of Neurological Leadership. *Open Journal of Leadership, 4,* 143-152. http://dx.doi.org/10.4236/ojl.2015.44013

*Massaro, S. (2015). Neurofeedback in the workplace: from neurorehabilitation hope to neuroleadership hype?. *International Journal of Rehabilitation Research*, *38*(3), 276-278.

*Meshanko, P. (2013). The respect effect: using the science of neuroleadership to inspire a more loyal and productive workplace. *Cell*, *216*, 513-8740. http://respecteffectbook.com/RespectEffect-WhitePaper.pdf

Morris, J., & Sah, P. (2016). Neuroscience and education: Mind the gap. *Australian Journal of Education*, *60*(2), 146-156.

Ochsner, K. N., & Lieberman, M. D. (2001). The emergence of social cognitive neuroscience. *American Psychologist, 56*(9), 717- 734.

*Perkins-Gough, D. (2015). Secrets of the Teenage Brain: A Conversation with Frances E. Jensen. *Educational Leadership*, *73*(2), 16-20.

Pineda, J. A., Juavinett, A., & Datko, M. (2014). Rationale for neurofeedback training in children with Autism. *Comprehensive guide to Autism*, 439-460.

*Pittman, A. (2020). Leadership Rebooted: Cultivating Trust with the Brain in Mind. *Human Service Organizations: Management, Leadership & Governance*, *44*(2), 127-143. https://doi.org/10.1080/23303131.2019.1696910

*Pope, S. N. (2019). A systematic literature review of school leadership intelligences for the development of

neuro-educational leadership. (Doctoral thesis). College of Graduate and Professional Studies, The University of New England

Rainey, S., & Erden, Y. J. (2020). Correcting the Brain? The Convergence of Neuroscience, Neurotechnology, Psychiatry, and Artificial Intelligence. *Science and Engineering Ethics*, 1-16.

*Rebora, A. (2019). Honoring the Teen Brain: A Conversation with Thomas Armstrong. *Educational Leadership*, *76*(8), 24-27.

*Ringleb, A. H., Rock, D. & Ancona, C. (2012). NeuroLeadership in 2011 and 2012. *NeuroLeadership Journal*, 4, 1-35.

Rock, D. (2008). SCARF: A brain-based model for collaborating with and influencing others. *NeuroLeadership journal*, *1*(1), 44-52.

*Rock, D. (2011). NeuroLeadership. *Leadership Excellence, 28*(8), 11–12.

*Rock, D., & Cox, C. (2012). SCARF in 2012: Updating the social neuroscience of collaborating with others. *NeuroLeadership journal*, *4*(4), 1-16.

*Schwartz, M. S., Hinesley, V., Chang, Z., & Dubinsky, J. M. (2019). Neuroscience knowledge enriches pedagogical choices. *Teaching and Teacher Education*, *83*, 87-98.

Sezgin, O. B., & Uçar, Z. (2015). Reflection of Neuroscience on Organizational Behaviour: Orgazational Neuroscience. *Ege Akademik Bakış Dergisi*, *15*(3), 353-366.

*Shipley, J. (2017a). The Mindful Leader - Focusing Your Attention on What Matters In: Amann, W; Kruckeberg, K (eds). *Advanced Leadership Insights: How to Lead People and Organizations to Ultimate Success.* Information Age Publishing.

*Shipley, J. (2017b). Leadership and Neuroscience - An Inconvenient Truth In: Amann, W; Kruckeberg, K (eds). *Advanced Leadership Insights: How to Lead People and Organizations to Ultimate Success.* Information Age Publishing

*Sułkowski Ł., Chmielecki M. (2017) Application of Neuroscience in Management. In: Nermend K., Łatuszyńska M. (eds) *Neuroeconomic and Behavioral Aspects of Decision Making*. Springer Proceedings in Business and Economics. Springer, Cham

*Waldman, D. A., Balthazard, P. A., & Peterson, S. J. (2011a). Social cognitive neuroscience and leadership. *The Leadership Quarterly*, *22*(6), 1092-1106.

*Waldman, D. A., Balthazard, P. A., & Peterson, S. J. (2011b). Leadership and neuroscience: Can we revolutionize the way that inspirational leaders are identified and developed?. *Academy of Management Perspectives*, *25*(1), 60-74.

*Wang, Y. (2019). Pulling at your heartstrings: Examining four leadership approaches from the neuroscience perspective. *Educational Administration Quarterly*, *55*(2), 328-359.

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, *39*(1), 93-112.

Yasar, O. (2019). Managerial decisions and cognitive flexibility: how do managers make decisions? What does neuroscience say about?. *Electronic Journal of Social Sciences*, *18*(71), 1176-1194.

Zhang, R. V., Featherstone, R. E., Melynchenko, O., Gifford, R., Weger, R., Liang, Y., & Siegel, S. J. (2019). High-beta/low-gamma frequency activity reflects top-down predictive coding during a spatial working memory test. *Experimental brain research*, *237*(7), 1881-1888.

*Zwaan, L.A., Viljoen, R., & Aiken, D. (2019). The role of neuroleadership in work engagement. *SA Journal of Human Resource Management/SA Tydskrif vir Menslikehulpbronbestuur*, *17*(0), a1172. https://doi.org/10.4102/sajhrm.v17i0.1172

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