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Artículo de Reflexión

Bridging the Gap between the Brain and Behavior in Organizations: Perspectives from Organizational Neuroscience and Industrial and Organizational Psychology

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ABSTRACT

This article explores the contributions of organizational neuroscience (ON) to industrial-organizational psychology (IOP) through a literature review of books, professional articles, and peer-reviewed journals from the past decade. The study aims to evaluate the relationship between ON and IOP, highlighting advances, synergies, and multidisciplinary applications. Key areas examined include job analysis, personnel selection, training, leadership, teamwork, coaching, and neuroethics, based on the quantity, quality, and relevance of the literature. Findings reveal that ON has gradually contributed to these areas, yet IOP research shows limited interest in studying brain mechanisms and their influence on workplace behavior. Resistance to incorporating ON knowledge and tools persists, suggesting a need for enhanced training to help I/O psychologists recognize neuroscience's potential. The article calls for exploring ON's applications in emerging fields like neuroeconomics, neuromarketing, neurodiversity, and decision-making, as well as its role in addressing occupational health and safety challenges. The author urges I/O psychologists to embrace ON's insights to enhance understanding of individual, group, and organizational performance and to conduct research on the brain's role in the workplace, fostering a deeper integration of neuroscience within the IOP discipline.

Reduciendo la Brecha entre el Cerebro y el Comportamiento en las Organizaciones: Perspectivas desde la Neurociencia Organizacional y la Psicología Industrial y Organizacional

Palabras Clave:

Cerebro, Comportamiento, Neurociencia Organizacional, Psicología Industrial/ Organizacional, Conducta en las Organizaciones

RESUMEN

Este artículo explora las contribuciones de la neurociencia organizacional (ON) a la psicología industrial-organizacional (IOP) a través de una revisión de la literatura de libros, artículos profesionales y revistas revisadas por pares de la última década. El estudio tiene como objetivo evaluar la relación entre ON y IOP, destacando avances, sinergias y aplicaciones multidisciplinarias. Las áreas clave examinadas incluyen análisis de puestos, selección de personal, capacitación, liderazgo, trabajo en equipo, coaching y neuroética, con base en la cantidad, calidad y relevancia de la literatura. Los hallazgos revelan que ON ha contribuido gradualmente a estas áreas, pero la investigación de IOP muestra un interés limitado en estudiar los mecanismos cerebrales y su influencia en el comportamiento en el lugar de trabajo. Persiste la resistencia a incorporar el conocimiento y las herramientas de ON, lo que sugiere la necesidad de una mejor capacitación para ayudar a los psicólogos I/O a reconocer el potencial de la neurociencia. El artículo pide explorar las aplicaciones de ON en campos emergentes como la neuroeconomía, el neuromarketing, la neurodiversidad y la toma de decisiones, así como su papel para abordar los desafíos de salud y seguridad ocupacional. El autor insta a los psicólogos I/O a adoptar los conocimientos de ON para mejorar la comprensión del desempeño individual, grupal y organizacional, y a realizar investigaciones sobre el papel del cerebro en el lugar de trabajo, fomentando una integración más profunda de la neurociencia dentro de la disciplina IOP.

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Introduction

Industrial and Organizational Psychology (IOP) has traditionally been concerned with observing, understanding, explaining, and predicting human behavior in the workplace (Muchinsky & Culbertson, 2022). From this, professionals in this field have developed theories, models, techniques, and strategies to impact the contexts where human beings organize themselves to achieve different goals and objectives. The primary goal of IOP is to optimize employee performance, satisfaction, and well-being, while ensuring the effectiveness and efficiency of organizations. Key areas within IOP include job analyisis, recruitment, selection, training and development of employees, performance management, motivation, job satisfaction, culture, climate, structure, transformation, and organizational change (Riggio & Johnson, 2022). IOP has been enriched by many psychological schools. Psychoanalysis, humanistic, phenomenological, behavioral, and cognitive social psychology have influenced the theories, models, and applications that are used today in IOP (Bryan, 2020).

In recent years, there has been some interest in integrating neuroscience knowledge into the field of IOP (Budworth & Latham, 2009), giving rise to what is now known as Organizational Neuroscience (ON). Fox and Kotelba (2022) state that this interdisciplinary field seeks to understand the neural bases of behaviors and cognitive processes relevant to the workplace. This interest is a very recent one. The current author reviewed 10 introductory IOP textbooks. It was found that only two of these text mention the concept of ON (Conte & Landy, 2019; Muchinsky & Culbertson, 2022). Muchinsky and Culbertson are the only authors who highlight the importance of I/O psychologists incorporating neuroscience knowledge into their practice. In another search conducted in "The Industrial-Organizational Psychologist (TIP)," which covers the years 2014-2019 and is published by the Society for Industrial Organizational Psychology (SIOP), Division 14 of the American Psychological Association (APA), the author found three opinion articles associated with the topic of ON. The SIOP also publish a peer-reviewed journal title Industrial and Organizational Psychology, where the author conducted a literature review covering the years 2008 through 2024. In this revision, it was found that only one article was published in 2023 (LeFevre-Levy et al., 2023) related to the area of neurodiversity and in the same issue, was preceded by 10 comments by various authors related to the same topic. According to Honeybourne (in Bruyere, 2022) neurodiversity is the diversity of ways in which human brains think, learn, relate to others, and interpret the world. The term "neurodiversity" is attributed to Judy Singer, who, in her book "Neurodiversity: The Birth of an Idea." She talks about how autism has gone from being a clinical diagnosis to becoming a social movement. Neurodiversity is a concept in which neurological differences should be recognized and respected like any other human variation (Singer, 2016). These differences are related to diagnoses such as dyspraxia, dyslexia, attention deficit hyperactivity disorder, dyscalculia, autism spectrum, Tourette's syndrome, and others (Summer & Brown, 2015). This author agrees with the need for I/O psychologists to be aware of the importance of equity and diversity that exists at the cognitive level. Not only it is important to ensure that equity is practiced in the workplace, but that it is capitalized on the talent and capabilities of people with neurodiversity. It is vital for IOP that scientists and practitioners begin to benefit from contributions that ON can make at work and collaborative environments. From this point of view, neurodiversity is not a topic that seems to be associated with the research areas of ON. Even so, it could be understood that there are areas of convergence, but at the moment, they do not seem to be linked form the point of view of the two paradigms: neurodiversity and ON.

On the other hand, ON can be considered as a relatively new subdiscipline within the field of neuroscience (Murray & Antonakis, 2019). Ward et al. (in Waldman & Balthazard, 2015) propose that ON applies the principles and methods of neuroscience to understand the brain mechanisms that underlie organizational behaviors and processes. This approach has made it possible to study how the brain structures and functions influence the recruitment and selection of new employees, training and development, performance management, decision-making, leadership, coaching, change and organizational transformation.

From the author's point of view, the convergence of these two disciplines offers a comprehensive and enriching perspective to address complex organizational phenomena. Also offers scientific insights into IOP not only providing a deeper understanding of the biological underpinnings of organizational behavior, but also opens up new avenues for more precise and effective interventions. Snyder et al. (2017) express that there is not better, or more impactful, example of science and practice 'coming together' today than the increasing frequency with business practices are changed (resulting in higher performance) based directly on research findings in neuroscience. They state that during the last 10 years, ON has had the opportunity to grow in a revolutionary way, impacting private and public organizations, large and small. According to Ward (2017), ON and IOP will have to work in an integrated way since research and market forces will be forcing both disciplines to establish a necessary symbiosis so that the results of the research and the products that emerge are aligned with the science and expertise of both disciplines. Ward says there are companies that are applying neuroscience to the areas of selection and recruiting that turn out to be the expertise of I/O psychologists. This represents a real challenge since the competencies of psychology professionals at work have to be linked to these projects and contribute with their knowledge, skills, and abilities.

This article explores the relationship between IOP and ON, highlighting the recent advances, potential synergies, and practical applications that arise from this interdisciplinary collaboration. Key studies illustrating how neuroscience can inform and improve IOP practices will be examined, as well as the challenges and opportunities this integration presents for researchers and practitioners. When reviewing the literature, the author found many areas where ON can be related to IOP, but for practical reasons the link between both areas in relation to work analysis, selection, training and development, neuroleadership, neurocoaching, teamwork and neuroethics will be discussed.

Implications of neurosciences, IOP in JobAnalysis

One of the practices most related to IOP is that of job analysis. The basis for job analysis is observable behavior that is defined through employee performance (Conte & Landy, 2019). This cognitive-behavioral approach allows observing the tasks performed by an employee and inferring the cognitive processes through the behaviors that define the tasks, duties, and responsibilities. This approach has helped define many of the jobs in every type of organization. In addition, it has served for the development of the "Occupational Information Network" (O*NET) which is the most well-known job analysis and career exploration system in the United States and part of the world. Despite these advances that have helped define the ways in which jobs are configured, knowledge of the structure and function of the brain could contribute a lot to the process of job analysis. At the moment, the IOP has done very little to use neuroscientific knowledge to analyze the work. There are some studies in neuroscience that try to explain the behavior of the brain in aspects associated with work and linked to how the brain undergoes changes in aspects of a work-related nature.

Dong et al. (2024) investigated alterations in functional activity and brain connectivity and psychological variables in a group of nurses who worked extended shifts (more than 8 hours) and another group of nurses who held positions in regular hours (8 hours). After assessing the nurses' burnout, perceived stress, anxiety, and depression, analyses of fractional amplitude of low-frequency fluctuations (fALFF) and region-based functional connectivity (HR) were performed to investigate the differences in spontaneous brain activity and functional connectivity between these two groups of nurses. Also, the correlations between brain functional parameters (fALFF and FC) and clinical metrics among the nurses on duty were investigated.

The results suggest that when comparing extended shift nurses with regular shift nurses, the former obtained higher scores for exhaustion, perceived stress and depression, lower fALFF in the right dorsolateral prefrontal cortex (dlPFC), the left and right superior parietal lobes (SPL), the bilateral anterior cingulate cortex (ACC) and higher fALFF in the right superior/middle temporal gyrus, as well as a decrease in HR between the right dlPFC (the selected ROI) and the bilateral ACC, the left and right inferior frontal/orbitofrontal gyres (IFG/IOFG), the right SPL and the left middle occipital gyrus (voxel level $p < 0.001$, cluster level $p < 0.05$, GRF correction). Correlation analyses demonstrated that the fALFF value of the right dlPFC was significantly correlated with burnout and anxiety scores, the HR value of the right dlPFC-right SPL was correlated with perceived stress and burnout scores, and the HR value of the right dlPFC-right IFG/IOFG was correlated with the burnout score in the nurses on duty ($p < 0.05$).

In this study, it is concluded that nurses who work more than 8 hours demonstrated work-related functional alterations and connectivity in the right frontoparietal network, which provides objective and visualized evidence to clarify the dangers of working long-hour shifts in these types of health professionals. These data also provide evidence of how neuroscience can help modify jobs and prevent occupational health risks.

One of the elements that we try to control in the work environment is noise. In places where noise cannot be fully controlled, equipment is used so that employees do not affect their hearing. When employees do not use this equipment or do not use it correctly, hearing is affected, but studies such as Ashmore's (2018) indicate that when the cochlea is affected, inside the inner ear, it is not only hearing that is affected. The cochlea acts as the front part for the analysis of the auditory world by the central nervous system, also affecting balance. These studies have increased the understanding of some of the neural networks in the brainstem and cortical areas responsible for processing information derived from the auditory nerve. I/O psychologists need to be clear that the design of work, facilities, and the work environment has implications not only for efficiency and productivity, but also for the health and safety of employees (Ding et al., (2023).

The way jobs are analyzed and designed also has implications for how employees handle the demands of the position when they have little control over job decisions and outcomes. Jarkoc et al (2013) point out that neuroscientific studies establish that the lack of control in tasks and decisions generates high levels of stress. The physiological impact lies in the fact that the autonomic nervous system is affected due to the alterations experienced by the heart rate, increasing the chances of heart problems and diseases. If stress continues to increase, the frequency and intensity of cortisol in the body will increase (Herr,et al., 2017).

In another study, Kawasaki et al (2015) found negative and statistically significant correlations (−.54, p=.000) between high job demands and low levels of oxygenation in hemoglobin (oxy-Hb) and changes in the frontotemporal cortex were observed in a sample of Japanese employees. The results suggest that work stress seems to be related to the decrease in frontotemporal cortex activation. This in turn can affect executive functions, emotion regulation, working memory, social interaction, and the inability to manage stress.

The Job Analysis process has to consider also two areas that have important implications and effects on jobs. They are multitasking and repetitive tasks. Koch et al (2018) carried out a literature review where they evaluated studies that relate cognitive structure, flexibility and brain plasticity in the performance of tasks that were carried out in a dual way and those that were executed interchangeably. The authors evaluated experimental studies on multitasking according to three complementary perspectives: cognitive structure, flexibility, and brain plasticity. Research on dual task performance and task sharing differs in strength from its inception. Early research on dual tasks was inspired by the metaphor of the "single channel" of information processing, seeking to identify structural bottlenecks. However, cognitive flexibility was also studied, examining how task complexity affects performance when they share limited resources.

In this study, research associated with the paradigm of the psychological refractory period was described. This has focused on discrete reaction time tasks and has emphasized instructions that exclude flexibility, which has led cognitive science to use simpler tasks for better experimental control. Such an approach has been successful in identifying specific processing stages as functional bottlenecks. However, recent research on the effects of practice on dual tasks has demonstrated greater flexibility and cognitive plasticity than predicted by the central bottleneck model, suggesting the need to complement this model with concepts that also consider flexibility and plasticity. On the other hand, research on task switching initially focused on cognitive flexibility, but also adopted the idea of a stage of serial reconfiguration from the structural perspective. The authors examined whether it is possible to reduce or eliminate the costs of task switching through preparation, highlighting the importance of flexibility and dynamics of task sets. In summary, this study reveals that multitasking research can benefit from an integrative position that encompasses all three perspectives and highlights the fundamental similarity between multitasking paradigms both at the dual level and in conjunction with task switching. Instead of focusing on a single theoretical perspective, the way in which psychological, behavioral and physiological aspects work is a complex one.

Worringer et al (2019) argue that although there are well-known limitations of the human cognitive system to perform two tasks simultaneously (dual tasks) or alternately (task switching), the question of whether there is a common or distinct neural basis for these limitations in multitasking remains open. These authors performed two meta-analyses of the activation probability estimation of neuroimaging studies on dual tasks or task switching and tested the similarities and differences in brain regions associated with each domain. To assess the primary effect of dual tasks on brain activity, they conducted a meta-analysis of the 26 dual-task experiments. This analysis revealed significant activation convergence in six bilateral clusters including the dorsal premotor cortex (dPMC), the intraparietal sulcus (IPS), and the frontal operculum (fO) extending into the right anterior insula (aI). In addition, they found consistent brain activation in the left inferior frontal sulcus (IFS) that extends into the middle frontal gyrus (MFG), as well as the left inferior frontal gyrus (IFG) that extends into the anterior part of the left temporal gyrus. To assess the primary effect of task switching on brain activity, they conducted a meta-analysis of the 60 task-switching experiments. This analysis revealed significantly convergent activation in seven bilateral clusters: the anterior insula (aI), the pre-SMA extending into the right anterior median cingulate (aMCC), the inferior frontal junction (IFJ) extending in the left hemisphere forward into the MFG and IFG, as well as the IPS and the adjacent IPL and SPL extending into the left precuneus. In addition, they found a brain activation consistent in the left dPMC. To isolate multitasking-related brain activity regardless of the specific paradigm, they instead conducted a conjunction analysis between the two individual meta-analyses reported above. This conjunction revealed a shared convergence of brain activation in the bilateral mean IPS (mIPS) and the adjacent SPL, in the rostral part of the left dPMC and in the right aI. In addition to the strict conjunction analysis, they performed a separate meta-analysis of the main effect of multitasking in all dual-task and task-switching experiments. This analysis yielded a significant convergence of activation in an extensive fronto-parietal network. The authors conclude that the increase in brain activity during dual tasks, compared to individual tasks, reflects additional or more intense processing, conclude that the usual performance costs incurred by doing two things at once are not only due to structural limitations of the cognitive processing architecture, but also to the demands for additional and laborious processing related to the management of multiple sets of tasks, and the resolution of interference between tasks.

Garner and Dux (2023) posit that humans are capable of quickly performing new tasks, but show widespread performance costs when they try to do two things at once. They point out that, traditionally, empirical and theoretical research on the sources of this type of interference in multitasking has focused on multitasking in isolation from other cognitive functions, characterizing the conditions that lead to declines in performance. These authors conducted a literature review to try to answer the question of whether the costs of multitasking are linked to the system's ability to generalize knowledge, as required to perform new tasks. The researchers, overall, found how a system that rapidly generalizes knowledge can induce multitasking costs due to the sharing of task contingencies between contexts in neural representations encoded in frontoparietal and striatal brain regions. Their findings suggest that prolonged learning segregates such representations by refining the brain's model of task-relevant contingencies, thereby reducing information sharing between contexts and improving multitasking performance, while reducing flexibility and generalization. These proposed neural mechanisms explain why the brain shows rapid comprehension of tasks, limitations in multitasking, and effects of practice. In short, the limits of multitasking are the price employees pay for behavioral flexibility and the ability to generalize knowledge.

Another area of job analysis that is important in neuroscientific processes is how the brain handles the performance of repetitive tasks. Repetitive Transcranial Magnetic Stimulation (rTMS) studies have been used to test the motor imagery hypothesis (Lotze & Halsband, 2006). Motor Imagery (IM) represents the conscious access to the contents of the intention of movement, usually executed unconsciously during motor preparation. The primary objective of this study was to investigate the electrophysiological changes that occurred before and after the application of low-frequency rTMS when comparing three different tasks: execution, action observation, and motor imagery of finger movement. The hypothesis proposed by the authors is that absolute theta power over the frontal regions would change between sensorimotor integration tasks and after the application of rTMS at 1 Hz.

Eleven healthy, right-handed volunteers of both sexes (5 males, 6 females; mean age 28.5 years), with no history of psychiatric or neurological disorders, participated in the experiment. After performing the tasks randomly, the subjects were subjected to 15 minutes of low-frequency rTMS applied to the Superior Pariaetal Cortex (CPS) and performed the tasks again. All tasks were executed simultaneously with electroencephalography (EEG) signal recording. The results show that the frontopolar cortex was more involved with the motor process and showed a main effect for the task and timing. The inferior frontal gyrus showed an involvement with long-term memory retrieval and showed interaction between task and momentum in the left hemisphere, while the right hemisphere showed a main effect for task and timing. The lack of main effect for conditions in the anterior frontal cortex contributes to the hypothesis that an integrated circuit for performance monitoring exists in this region. This means that using rTMS you can activate areas that were working when people perform repetitive tasks.

Another way to study how the brain works when executing repetitive tasks is the repetition suppression paradigm, a technique used in cognitive neuroscience to investigate how the brain processes repeated information (Grill-Spector et al., 2006). This paradigm is based on the observation that the neural response to a stimulus tends to decrease when the stimulus is presented repeatedly. This phenomenon, known as "repetition suppression" or "neural adaptation," provides insight into the sensitivity and specificity of neurons to certain stimuli and how the brain optimizes its information processing.

North et al. (2016) indicate that repetition suppression paradigms allow for a more detailed look at brain functioning than classical paradigms and have been vigorously applied in adult cognitive neuroscience. These paradigms are well suited for studies in the field of developmental cognitive neuroscience, as they can be applied without the need to collect a behavioral response and across all age groups. In addition, repetition suppression paradigms can be employed in various neuroscience techniques, such as functional magnetic resonance imaging (fMRI), functional near-infrared spectroscopy (fNIRS), electroencephalography (EEG), and magnetoencephalography (MEG). This type of study has an impact on how task repetition is associated with and affects areas of the brain and brain changes when performing repetitive tasks in older people who are working.

People improve their ability to handle repetitive tasks when they strengthen their working memory (Constantinidis & Klingberg, 2016). Working memory is the ability to hold and manipulate information over a period of seconds and is a central component of higher cognitive functions. The storage capacity of working memory is limited, but can be extended by training, and the evidence for the neural mechanisms underlying this effect is increasing. Human imaging studies and neurophysiological recordings in non-human primates, along with computational modeling studies, reveal that training increases the activity of prefrontal neurons and the strength of connectivity in the prefrontal cortex and between the prefrontal and parietal cortex. Dopaminergic transmission could play a facilitating role in this process. This process results in people who are trained in strengthening working memory being able to activate their cognitive processes even when they are performing repetitive tasks. Such activation can improve employee efficiency and prevent accidents that affect employee health and safety.

There is a long way to go for I/O psychologists to establish a link between the analysis of work and the results of neuroscience research. This gap will gradually close as interest in linking research and applications of neuroscience in IOP will gradually increase. Although the aforementioned studies are not directly related to work analysis, we cannot lose sight of the fact that poorly designed jobs can generate unnecessary demands on the workplace.

Implications of neurosciences, IOP in Personnel Selection

The selection of human talent is one of the main functions of IOP (Casio & Aguinis, 2025). The use of instruments such as work samples, personality inventories, intelligence tests, attitude scales and structured interviews are the traditional tools in the field of human talent selection. The advent of ON opens the doors to begin to evaluate other possibilities that, together with traditional instruments, can improve the effectiveness of the process. Hills (2012) states that it is of utmost importance today to change the paradigm of personnel selection and add tools that are used to study neuroscience and apply them to the selection of human capital. This author cites the work of Carol Dweck (Murphy & Dweck, 2024), who has been evaluating the concepts of fixed mindset and growth mindset for several years. He indicates that work in the field of neuroplasticity indicates that the brain is designed to grow, learn and develop. This implies that leaders have to stimulate the growth mindset in their employees. As well as introspection and develop your own growth mindset. On the other hand, Hills indicates that having social skills are vital in the selection of leaders. She cites the work of Dr. Matthew Lieberman of UCLA who has found that the brain is a social tool. Lieberman research suggests that the brain circuits to understand ourselves are the same ones we use to understand others. However, when we think about ourselves, or others and we activate the executive circuits and deactivate those of the prefrontal cortex that helps manage socio-emotional aspects. The reality is that, for a leader to be reflective, it is not possible to analyze a business strategy, without ceasing to think about the impact it has on others. In addition, the brain is programmed to look for easy ways to work, ways that reduce the energy and effort needed. Thus, much of what they do becomes routine or habit. If leaders are in the habit of thinking about analytical and strategic problems and are much less accustomed to thinking about how they impact people, it's much harder to switch between the two brain circuits. This will affect the performance as an organizational leader. Lieberman (2013) presents another finding that has implications for how the social aspects of the brain should be considered in talent selection and management. This author found that when people are rejected, areas associated with physical pain are also activated. Leaders who know how to avoid the creation of "in groups" and "out groups" tend to be more effective in managing their work teams.

Finally, Hills states that it is important to identify ways in which, using neuroscience and its techniques, the ability of leaders to manage the threat and reward circuits in the face of change processes can be identified. One of the most challenging areas that leaders have is change and how to manage it both intrapersonally and interpersonally. The threat and reward circuits are activated by hormones and neurotransmitters that have important repercussions on the behavior and attitudes of employees. They also require a harmonization of the prefrontal cortex and the limbic system to improve the decision-making process and that must be taken into consideration when selecting talent (Vorhauser-Smith, 2011). Authors such as Scarlett, (2019) and Sehrawat et al. (2019) express that successful leaders will be those who, using neuroscience, can learn to better use their brain capacities both for change internally, as well as to help others manage organizational change processes. This is the importance of selecting successful employees and leaders.

Pentland (2018) points out that neuroscientific tools such as EEG, fMRI, sensors to measure galvanic responses, and technology to measure eye movement are instruments that can be used to measure variables that are associated with the selection of human capital. Becker and Menges (2013) recognize that the measurement instruments used in personnel selection have been very useful and they call them explicit measures, since they evaluate psychological variables that are collected consciously. On the other hand, the authors understand that these measurements have to be complemented with neuroscientific measures that they call implicit measures. The neuroscientific literature suggests that implicit measures are also representative of people's emotions, attitudes, and behaviors. There are times when implicit measures are decisive in the responses. The fact that implicit measures have an influence beyond the conscious creates a dilemma, in terms of whether conscious measures actually interpret our feelings, attitudes, knowledge, and are representative of behavior. This dilemma is one that I/O psychologists must critically evaluate in such a way that there is congruence between the brain's behavior and the overt behaviors.

Williams and Lewin (2020) carried out an analysis that used neuroscience and its technologies in personnel selection. They point out that the technologies used in neuroscientific research were not necessarily designed to be used as psychological measurements in the workplace. Even so, they accept that the use of these could have benefits over traditional tests. The authors warn us that in order to use several of these instruments, it is necessary to change the traditional view of personnel selection. In addition, the economic investments that would have to be made must be seen as more long-term and not immediately as is traditionally the case.

Williams and Lewin (2020) warn that one of the biggest risks of using neuroscience technologies is that consumers generate high and sometimes unrealistic expectations about science and technology and their impact on the selection of human capital. Whether intentional or not, companies looking to make a profit can use collective optimism to increase perceptions of legitimacy, progress, and increase profitability. The reliance on marketing poses the risk of inflating a "neuroscience bubble," which would detract from the compelling applications of this technology in real-world work scenarios. It is therefore crucial that cognitive neuroscientists who apply their research to occupational fields avoid being seduced by marketing and advertising strategies. Ignoring this would imply that professionals develop a high degree of skepticism, reducing the opportunities to move research findings to the field of application.

Even so, they suggest that technologies such as EEG and fNIRS have been improved and are capable of being portable, increasing the possibilities of being used in various situations and places with a minimum of noise. This implies that simulations of situations can be carried out where measures can be taken to evaluate candidates for various jobs.

Of the few studies found linking personnel selection and neuroscience, one is that of Balconi and Cassioli (2022). The authors conducted a study whose objective was to explore the emotional and cognitive processes related to the different phases of a job interview (introductory, attitudinal, technical and conclusion), considering two conditions: face-to-face interview and remote interview, by simultaneously collecting data from a quantitative encephalogram (EEG measuring frequency bands: alpha, beta, delta and theta) and autonomic data (skin conductance level (SCL); skin conductance response, (SCR); and heart rate, (HR) in both candidates and recruiters. The data highlighted widespread alpha desynchronization during the job interview interaction. Recruiters showed increased frontal theta activity, which is connected to social-emotional situations and emotional processing. In addition, the results showed how the face-to-face condition is related to an increase in SCL and theta potency in the central area of the brain, associated with learning processes, through the midbrain dopamine system and the anterior cingulate cortex. They also found a higher heart rate in the candidates. The present results invite us to re-examine the impact of neurosciences applied to the organization, opening opportunities for analysis of job interviews in the various modalities. Balconi et al. (2022) also point out that in order to improve the use of neuroscience-based tools in personnel selection processes, a standard protocol must be developed to conduct job interviews remotely and how the brain interprets this modality in contrast to the face-to-face job interview.

The job interview seems to be one of the techniques that can be complemented with neuroscientific equipment that allows the evaluation of conscious and unconscious aspects of the candidate (Petrou Rammata, 2021; Vorhause-Smith, 2011). In addition to the conscious and unconscious aspects of the neuroscientific aspects of the interview, Cvitkovich (2013) emphasized the need to investigate the relationship between leadership, cultural awareness, and brain functions. The author proposed a hypotheses regarding potential differences in brain functions between leaders with cultural awareness and those with limited cultural awareness during structured interviews.

As can be seen, in the literature review carried out by the author, there are very few recent studies that link personnel selection with neuroscience and the role of I/O psychologists in the relationship between both processes. Rotolo et al (2018) point out that there is a reluctance in the field of IOP to address cutting-edge issues, including the areas of big data and neuroscience, both of which underpin new evaluation and development technologies. In their recent analysis of SIOP's peer-reviewed journal, Industrial and Organizational Psychology: Perspectives on Science and Practice, only 10% of core articles since the journal's inception focused on what they call "cutting-edge" topics—areas of organizational interest that still lack empirical support. The aforementioned fears have been almost ignored. By leaving out future issues, psychologists remain ill-informed and ill-prepared to help organizations make smart decisions about the evolution of their assessment practices. All this misinformation can lead unscrupulous companies to try to sell products that link neuroscience with personnel selection, and if I/O psychologists are unaware of the empirical studies and the functionality of neuroscientific equipment, they will not be in a position to be able to correctly advise their clients and much less to put into practice the use of this equipment and procedures (Díaz and Young, 2022).

Another aspect that may be leading many I/O psychologists to be disconnected from neuroscience applied to personnel selection may be ethical. I/O psychologists have a great responsibility to strictly follow the principles of the American Psychological Association's Code of Ethics and Conduct (2017) and the code that applies to the states and territories where they reside. Banks et al (2022) argue that even in traditional practice, I/O psychologists have had to be careful with the decisions they make in the environments of practice, research, and traditional academia facing all kinds of dilemmas. The authors point out that in the twenty-first century, the practice of this discipline will face several challenges that those who practice this subdiscipline of psychology will have to assume. In their article, the authors present a decision-making framework that can be useful when putting the code of ethics and conduct in the ethical situations that are going to be faced. On the other hand, employment discrimination laws are statutes prohibiting discrimination in employment by using methods that do not possess validity and reliability established by the APA Guidelines for Psychological Assessment and Evaluation (2020) and *Standards for educational and psychological testing* of the American Educational Research Association, American Psychological Association, and the National Council on Measurement in Education, (2019) and the Uniform Guidelines on Employee Selection Procedures (1978). This ethical, legal, and regulatory framework is compelling enough to persuade I/O psychologists to be cautious when conducting personnel selection processes.

Even so, research related to neuroscientists' methods applied to personnel selection will continue to be carried out and advances in technology and research will open the doors for I/O psychologists to develop selection techniques based on neuroscience. The important thing is not to be seduced by theories, models, and techniques that generate neuro-myths that lack an empirical and scientific basis (du Buisson-Narsai et al., 2023). These authors argue that universities and psychology associations will have to educate psychology students and professionals so that they have valid and reliable information on how to apply the principles of neuroscience to industrial and organizational psychology.

Implications of neurosciences, IOP in Training and Development

Training is one of the main human resources activities of large and small organizations, both in the private and public sectors worldwide (Spector, 2021). All employees, from new to experienced, should be trained to ensure they possess the knowledge, skills, and abilities necessary to perform their jobs effectively. Learning in many jobs is a lifelong process as long as people continue to work in organizations and must be part of an organizational culture that promotes continuous learning (Noe, 2022). Using learning theories to develop training programs is one of the competencies of the I/O psychology professional (Aamodt, 2022).

In recent years, neuroscience has dedicated itself to using modern tools to try to understand how brain behavior impacts the cognitive processes of adults (Boyle et al, 2023) and those who are active in the world of work (Fonseca & Heredia, 2020). Many of these studies seek to evaluate how the brain changes through learning experiences, generating neuroplasticity. Ross-Gordon et al. (2017) define neuroplasticity as an infinitely complex network of nerve cells that change in response to certain experiences or stimuli. Bryck and Fisher (2012) state that neuroplasticity has an impact on learning and on the ability of human beings to adapt to different environments and situations. The effectiveness of these neuroplasticity studies has led business leaders to adopt neuroscientific approaches that pursue the effectiveness of human resources and the organization to maintain and develop the workforce in an outstanding way (Lim et al., 2019). However, neuroscience has contributed to the development of educational practices and has played an especially important role in moving from the instructor-centered (teacher) to the learner-centered learning paradigm (Jang et al, 2022). This approach is known as "Brain-Based Learning" (ABC) can advance educational theory and practices when neuroscience and education communicate effectively between disciplines by developing appropriate learning strategies and environments (Lavis et al, 2016). Cozolino and Sprokay (2006) state that recent studies related to brain development and learning suggest that the most effective adult educators may be involuntary neuroscientists who use their interpersonal skills to adapt enriched environments that enhance brain development. The brain is a social organ innately designed to learn through shared experiences (Lieberman, 2013). Brains develop greater neuroplasticity in a context of interactive discovery and through the co-creation of stories that shape and support memories of what is being learned in ways that impact short-term, long-term, and working memory in ways that can achieve deep learning (Dubinsky et al., 2019).

Knowland and Thomas (2014) note that the acquisition of new skills in adulthood can positively affect a person's quality of life, including their earning potential. They say that in developing countries, it can provide a way to try to reduce poverty. In developed countries, retraining in adulthood contributes to the flexibility of labor markets. These authors reviewed the literature and found that adults have difficulties developing knowledge, skills, and strengthening their skills is a myth. Constantinidis and Klingberg (2016) have studied working memory (defined as the ability to hold and manipulate information over a period of a given amount of time) and found that training can increase the activity of prefrontal neurons and the strength of connectivity in the prefrontal cortex and between the prefrontal and parietal cortex. Dopaminergic transmission could have a facilitating role. These changes inform us more generally of the plasticity of higher cognitive functions and the evidence that adequate training transforms neural networks causing neuroplasticity and consequently, learning. On the other hand, research associated with learning cannot lose sight of the role that attention generates in the activation of the prefrontal cortex and cortical cortex (Lenartowicz et al, 2014). These areas help a person to direct their attention to a specific task while ignoring other factors that can serve as distractions and affect memory retention levels.

Kaygisiz (2022) states that learning is a process that causes neurophysiological changes in the brain due to electrochemical reactions. Therefore, it is crucial to consider knowledge of the system through which the human brain operates for effective instructional design and skill development. Another interesting aspect raised by the author is that people actively use knowledge from different disciplines when designing teaching processes and determining pedagogical strategies. In this context, using findings from neuroscience studies for the design of teaching processes will provide information to all fields related to teaching, from the creation of course content to the design of materials, the identification of possible problems for people with learning difficulties and the suggestion of solutions for them.

Foster et al. (2016) conducted a study where they explored the effect of incorporating neuroscience precepts into a social constructivist learning theory on the performance of college students in an introductory marketing course. The researchers taught a class in an inverted format (Flip Classroom) and it included strategies based on neuroscientific evidence such as dual coding, working memory, activation of prior knowledge and practice in the design of the course. The other group received a traditional lecture that lasted three hours. The independent group t test ($t(224) = 505$, $p=.000$) indicates that those in the pilot class ($M=71.9$, $SD= 11.6$) significantly outperformed those in the class that took the traditional lecture ($M=64.0$, $SD= 11.3$) on the comprehensive final exam. The authors conclude that it is the attention to neuroscience in the pilot course design that contributes to the success of student achievement.

In another study, Ward et al. (2017) conducted a study evaluating the impact of intervention modalities, such as computer-based cognitive training, physical training, and non-invasive brain stimulation, and whether such interventions synergistically improve cognition. To investigate this topic, they conducted a laboratory study with two randomly selected and assigned samples from 318 young, healthy adults. The control group only participated in computer-based cognitive training on six adaptive tests of executive function. The experimental group underwent five interventions: (1) Computer-based cognitive training on six adaptive executive function tests; (2) Cognitive and physical training; (3) Cognitive training combined with non-invasive brain stimulation and physical training; (4) Active control training in adaptive visual search and change detection tasks; and (5) Passive control. The study was conducted over a period of 4 months. The findings demonstrate that multimodal training significantly improved learning (compared to computer-based cognitive training alone) and provided an effective method to promote skill learning across multiple cognitive domains, encompassing executive functions, working memory, planning, and problem-solving. These results help establish the beneficial effects of multimodal intervention and identify key areas for future research in the ongoing effort to improve human cognition.

Stikic et al. (in Waldman & Balthazard, 2015) established an innovative and paradigmatic concept in what training for the organizations of the future may be. The authors call it neuro- optimization. This concept looks like a radical one, but it is already being applied in various ways in the processes of treatment of conditions associated with the brain and that seek to generate neuroplasticity. They propose that non-invasive neurooptimization can be done to help improve the way in which employees who do not have conditions associated with the brain perform their tasks in roles and occupations. They define neuro-optimization as the application of neuroscience-based concepts and practices to directly improve brain function and/or cognitive performance, and it has already begun to take many different forms that have the purpose of generating neuroplasticity in normal people who are part of the working world. These strategies may have potential implications for employee and team development, as well as organizational neuroscience. One of the most widely used tools are transcranial stimulation machines. These are designed with a series of magnets that stimulate areas of the brain in a direct and non-invasive way that have been affected by injuries and that are linked to the origin of epileptic seizures. Several studies (McKinley et al., 2013; Meinzer et al., 2012; Zimerman et al., 2013) found that transcranial stimulation sessions directly to the brain increase performance and neuroplasticity in tasks that improve perceptual, cognitive, behavioral functions and motor learning in normal patients. Another technique suggested by the authors is game-based brain training applications. These computer applications have been used as techniques to increase self-awareness through meditation, mindfulness, and guided relaxation. The literature review indicates that the evidence of effectiveness of these applications is mixed. In addition, there are few studies that indicate the effectiveness of these exercises, and even recommend the use of exercise apps, since exercises help improve cognitive functions (Melvy-Lervag & Hulme (2014). The authors note that, with the advent of miniaturized sensors and fast processors capable of supporting complex real-time signal processing techniques, more systematic applications involving neurofeedback-driven computer-based interventions are being developed. The studies explored the temporal sequences of physiological changes comprising patterns that could predict performance through the analysis of brain waves, (Spears et al., 2024). Brainwave behavior can be used to improve employee performance by teaching employees how to control mental states and behaviors associated with work-related tasks by improving attention, managing stress, and developing mindfulness of employees and work teams (Ming at al., 2023). This is the essence of biofeedback and the benefits for people of being able to take control of how brain waves work and their association with behavior.

Another area of research that links neuroscience with learning and IOP is the one that relates emotions to learning. Ali and Tan (2022) conducted a bibliographic study of research linking the relationship between neuroscience, learning, and emotions in the International Journal of Lifelong Learning of articles published in the past 40 years. They found that this journal published 1,059 articles. These mention the topics of emotions, learning and neuroscience. Studies fluctuate between literature reviews, qualitative, quantitative, and neuroscientific studies. All of the articles highlight the importance of how emotions impact both positively and negatively learning in adults. So important is the relationship between emotions and learning that an area of research and application called affective neuroscience has been created (Immordino-Yang, 2015). Martin and Ochsner (2016) state that emotions can improve or impede learning, the ability to regulate one's own emotions and those of others can facilitate successful educational outcomes. According to them, emotional regulation is a type of emotion-cognition interaction where cognitive control systems are believed to help attenuate or enhance negative and positive emotions. Since brain regions associated with cognitive control structures, such as the prefrontal cortex, may have a slower maturation trajectory relative to structures associated with emotional response, such as the amygdala and ventral striatum. Gupta (2019) states that positive emotions stimulate the generation of dopamine in the brain, which in turn stimulates learning and memory. On the other hand, Collins (2023) indicates that emotional regulation helps control the behavior of the threat and reward circuits, allowing the adult to get more out of the learning experience. The author also argues that adult education designs should create environments that stimulate creativity, curiosity and persistence.

As can be seen, there is vast evidence of how neuroscience helps to understand learning processes in adults, which, in turn, facilitates training processes in organizations. There are many psychology professionals who have collaborated in these efforts. The IOP has yet to have a greater presence in ON studies in the areas of learning and development. In the same way that this discipline has carried out many studies in the areas of analysis of training needs, theories and methods of adult learning and evaluation of training and development programs, I/O psychologists need to train and carry out neuroscientific studies that complement the research and applications they currently carry out. These efforts will help improve training and human capital development practices in organizations.

Implications of Neuroscience, IOP, and Leadership

Leadership is one of the topics that has been most studied from various angles and perspectives in many disciplines, including IOP, (Zaccaro et al., in Bryan, 2020). In the field of IOP, there is not a single textbook that does not mention the topic of leadership. It is one of the most studied topics in this field, to the extent that there have recently been criticisms of the way in which leadership is being researched, especially after the COVID-19 pandemic (Rowley et al., 2021). It can be said that much of the study of leadership that is carried out in IOP is not related to neuroscience. This has led to the applications of neuroscience to the concept of leadership being capitalized on commercially by other professionals. A market for books, articles and training has developed. neuroleadership, where some of these are not based on scientific research. On the other hand, there are genuine efforts to investigate the functioning of the brains of people in leadership positions and the impact on decision-making. The purpose of this article is to highlight some of these studies and visualize how IOP can contribute to improving this field of research and application.

How did the concept of neuroleadership come about? In 2006, Dr. David Rock coined the term "neuroleadership" (Ghadiri et al., 2015). Dr. Rock has dedicated himself to advising executives and leaders using the results of neuroscience research and how this knowledge can help them be better leaders in their organizations. He created the Neuroleadership Institute and published a journal titled the Neuroleadeship Journal. It was at this institute that he developed the SCARF model. The acrostic SCARF relates to the following dimensions: S for Status: Individuals pay more attention to determining their social status in the environment in order to understand their influence compared to others, C for Certainty: People need clarity and predictability by avoiding ambiguity, which activates threat circuits in the brain and blocks the pre-frontal lobes, A for Autonomy: Autonomy allows a person to establish a sense of control over events, R for Relationship: A basic human need is to be part of a social environment and activate the body's oxytocin levels and F for Fairness: Fairness has to do with a person's perception of how available sources are distributed among the other members of the group to which he or she belongs. The SCARF model has been thoroughly researched, producing several studies that empirically validate the relationship between its dimensions and its impact on leadership (Agbenyega et al, 2021, Brown, 2018 & Sommers, 2018).

There are many definitions of the term neuroleadership. Below are two that are most closely linked to the relationship between neuroscience and leadership. Liu et al. (2015) define neuroleadership as an applied field of social cognitive neuroscience that aims to analyze and understand the behavior of leaders (p. 143). Neuroleadership can also be defined as the experience to coordinate parts of the brain with leadership behaviors and that aims to strengthen the field of leadership with the support of neuroscience findings, (Badenhorst, 2015).

Neuroscience offers potential for development through the study of biological and chemical processes in the brain for leadership and managerial processes such as decision-making and coordination (Gocen, 2021). Varón-Sandoval and Zapata-Castillo (2021) suggest that the application of neurosciences can help learn how people lead and manage teams, the human factor, and the general problems of organizations. In addition, it is possible to know how attention, motivation, emotion, cognition and the brain mechanisms that underlie these psychological dimensions work.

Ruiz-Rodríguez et al. (2023) carried out a bibliometric and category analysis of research related to the field of neuroleadership and other topics associated with management, psychology, neuroeconomics, organizational behavior, neurocoaching, and neuromarketing, among others. The authors found a wealth of empirical research on the topic of neuroleadership, as well as the applications of neuroscience to leadership in organizations. They suggest that neuroleadership can be very useful in the development of "happy" and self-sustainable organizations. The following observations can be deduced from their findings. (1) The literature on neuroleadership has been mainly based on the theoretical approaches of the philosophy of science and education in Mental Health, (2) Neuroleadership research can be complemented with management strategy and neuroeconomics approaches to better adapt to the future challenges of the work place, (3) The literature on neuroleadership has been oriented towards the analysis of training, cultural diversity, emotion in research processes and experiential learning, (4) The main purposes of neuroleadership in companies have been decision-making and conflict resolution, and (5) The adoption of neuroleadership in companies is challenging, and its research is a developing topic. Below are some future trends expressed by the authors: (1) Research on neuroleadership has the challenge of showing the importance of its implementation to adapt companies to the modern industry, and mitigate the effects of massive resignations of human capital after the pandemic, (2) Research on neuroleadership can be enriched by considering the role of the various constituents in its implementation in organizations, (3) Research in neuroleadership can delve into the role of the cognitive process in operational and strategic decision-making in companies, (4) Research on neuroleadership can delve into the causes and consequences of its application for happiness management in companies, and (5) Neuroleadership research can delve deeper into the study of its impact on organizational success, developing measurement indicators and analyzing its value creation.

In another bibliographic and morphological study, Cyril-Issac and Gregor-Issac (2019) analyzed research associated with neuroscience and leadership topics. Among the results obtained, it can be highlighted that, of the 100% of the articles that are associated with both topics, 54% were produced in the United States, 25% in the United Kingdom and the remaining 21% in European countries. The authors recommend that more studies be carried out on the subject of neuroleadership that involve the use of technologies such as fMRI, EEG and Transcranial Stimulation Equipment among others, since much of the research lies in the applications of laboratory studies in neuroscience and how these results are related to the behaviors and attitudes of leaders. These are extrapolations of results that merit further investigation.

As can be seen in the last two studies, neuroleadership has been associated with many variables, making it a very diverse, varied and interesting field. Now, one of the issues that deserves attention is the need to relate the results of neuroscientific studies with psychological theory associated with leadership. Suruhan (2023) addresses this observation and argues that organizational neuroscience has a lot of potential to better understand how leaders' brains work. On the other hand, the functioning of brain structures, which results in the observation of leaders' behavior, can be strengthened with the use of leadership models and theories developed in psychology. He points out that an excellent theoretical approach that can be combined with the results of neuroscientific studies is the theory of self-determination of Edward L. Deci and Richard M. Ryan. Deci and Ryan's (2000) theory of self-determination (SDT) is a theoretical framework that focuses on human motivation and personality development. It distinguishes between different types of motivation based on the different degrees of self-determination that each type entails. The SDT proposes that the motivation of individuals varies on a continuum from intrinsic motivation to extrinsic motivation, and states that for a person to develop optimally and maintain their well-being, three basic psychological needs must be satisfied: (1)Autonomy: The need to feel that one is in control over one's own actions and decisions; (2) Competence: The need to feel effective and capable of achieving the desired results; and (3) Relationship: The need to feel a connection and belonging with others. This includes feeling supported and valued in social relationships and having a sense of community. Surujan also states that the TAD is directly related to the SCARF model developed by Rock (2020).

This is one of the areas where I/O psychologists can contribute. There are many leadership theories developed and validated in the IOP. Behavior professionals at work can conduct studies that relate leadership theories to neuroscientific findings of leader behavior. Then, they can develop applications that allow them to impact leaders and organizations.

The most prominent I/O psychologist in the field of organizational neuroscience and neuroleadership studies is Dr. David A. Waldman, a professor and researcher at the University of Arizona. Dr. Waldman and Dr. Pierre A. Balthazard published in 2015 one of the most important books in the field of organizational neuroscience (ON) entitled "Organizational Neuroscience". The book presents an introduction to the concept of ON, the neural aspects and ON, the relationship between tasks, roles and occupations in ON, the technologies used in research, teamwork processes and ON, emotions, affect and their relationship with ON, the moral and ethical aspects of ON, organizational justice and theoretical aspects to conceptualize ON. In the text, Waldman and Balthazard (in Waldman & Balthazard, 2015) write a chapter dedicated to neuroleadership. In it, the authors begin by criticizing traditional research methods in the field of leadership. On the other hand, they explain that leadership studies present difficulties in evaluating the leader's management with organizational results. In addition, they propose that all leadership theories turn out to be explicit measures of behavior and that neuroscientific studies are needed to serve as mechanisms of construct validity and predictive of leadership. The authors cite a 2012 study (Balthazard, Waldman, Thatcher, & Hannah, 2012) where, using qEEG, they found neurological differences in brain activation of transformational leaders vs. non-transformational leaders. The authors observed increased activation in the prefrontal lobes. The authors divided 200 participants, where 135 were community and business leaders and the remaining 65 were U.S. Army officers. To divide the participants, they were administered the short version of the Multifactor Leadership Questionnaire (MLQ) developed by Drs. Bruce J. Avolio and Bernard M. Bass. The 100 people with the highest scores were defined as the group with high transformational leadership and the group of the 100 people with the lowest scores as the one with the lowest transformational leadership. This was complemented by the fact that four people, either subordinates or peers of each participant, were asked to answer questionnaires on how they viewed the leadership of each participant. Participants in each group were placed in a face-to-face session with a 19-electrode qEEG on their scalp and typical neurological measurements were collected to identify frequency bands, including: delta, theta, alpha, beta and gamma. An EEG segment of at least 3 minutes was recorded at a scanning rate of 128 Hz during a resting condition with eyes closed (but alert) for all participants. Each EEG recording was visually examined and then edited to remove artifacts and noise with the Neuroguide® software program. A spectral analysis was performed to study the segments of the waves that correlate with behaviors: measures of potential or amplitude and measures of network connection. A discriminant analysis was then carried out that involved a two-step process of reduction and selection of neural variables. This was 92.5% accurate in its ranking of leaders. Patterns of spectral measures of leaders' brains, including neural network dynamics and activity metrics, were evaluated as potential correlates of transformational leadership behavior. The current work provides a better understanding of the latent and dynamic neurological mechanisms that can underpin individuals' transformational leadership qualities. The primary findings of the discriminant analysis, which was significant at a significance level of .05, was that highly transformational leaders demonstrated greater activity in the prefrontal lobes, compared to non-transformational leaders. Highly transformational leaders demonstrated greater activity in areas associated with executive functions such as control of behavior and emotions, working memory, decision-making and judgment, personality and social behavior, motivation and initiative, motivation and initiative, planning and organization, and cognitive flexibility. These levels of activation are congruent with how transformational leaders operate strategically in organizations. This study is one of the most elaborate in the field of neuroleadership and organizational neuroscience led by an I/O psychologist according to the literature reviewed. This was carried out in 2012, which implies that 12 years have passed, and no similar studies have been reproduced. This represents an area of great opportunity for IOP professionals. Importantly, this research clearly demonstrates the need to apply neuroscience technologies to understand leaders' behavior and mental processes.

Implications of Neurosciences, IOP and Coaching

Management coaching has become an essential tool in the development of skills and competencies of administrators, leaders, and in the improvement of productivity and other organizational results (Jordan, 2024). This approach facilitates the personal and professional growth of managers, promoting a more effective and collaborative work environment.

According to the International Coaching Federation (ICF), coaching is defined as a "partnership with clients in a creative and stimulating process that inspires them to maximize their personal and professional potential" (International Coaching Federation, 2020). Through coaching techniques, managers can identify areas for improvement, set clear goals, and develop strategies to achieve them, which not only benefits individuals but also the organization as a whole. The IOP has contributed a lot to the understanding of the theoretical and empirical bases of the topic of coaching (McKenna, & Davis, 2009). Many of the cognitive behavioral coaching approaches have helped to understand the applied aspects of how the capabilities of the person receiving the service can be developed. As well as improving strategies on how to evaluate the impact of interventions of this type.

On the other hand, neurocoaching is an approach that integrates neuroscience principles to optimize personal and professional development (Rock & Page, 2009). This approach is based on understanding how the brain works and how neural processes influence behavior, decision-making, and productivity, among others. In addition, it uses this understanding to design coaching interventions and techniques that promote sustainable and effective changes in individuals, improving their cognitive, emotional, and behavioral skills. Thus, neurocoaching is a synergistic tool in the management of organizations and specifically of human talent, becoming a vital element of the new boss-leader that organizations must have today to lead effective teams (Serrano-Mantilla, 2021). Neuroscience can shed light on the underlying mechanisms of coaching and provide important insights to facilitate development. These insights offer benchmarks for a more effective and interactive coaching process that is most successful when it remains fluid, responsive, and client-centered (Boyatzis & Jack, 2023). Next, the results of some studies associated with the topic of neurocoaching and applied aspects of it will be presented.

Previous studies have found that one of the most important keys to the success of a coaching program is the quality of the relationship between the coach and the client. This has not been evaluated much from a neuroscientific and objective perspective. Valesi et al., (2023) conducted a pilot study, where they adopted a neuroscientific approach to introduce measures of the relationship between the coach and the coachee throughout a three-phase coaching session associated with career guidance and selection: Phase 1. A relationship is created between the coach and the client; Phase 2. The coach evaluates the objectives and goals of the coaching process; and Phase 3. The client discusses their feelings related to the session. A sample of 14 college students and a professional coach participated in coaching sessions while their affective states were measured by recording brain (EEG) and physiological (skin conduction) activity. Electroencephalographic and skin conduction indicators of valence, arousal, and involvement demonstrated statistically significant differences between phases of sessions 1 and 2 and 2 and 3, but not in phases 1 and 3. These results shed light on the fact that the nature of the coaching phases, based on the different techniques used by the coach, is the cause of the relational differences between the coach and the client that can be estimated through neurophysiological techniques. In addition, the absence of the gender effect on clients supports the interpretation that the results observed in the research depend on the neurocoaching approach used. These results provide initial and preliminary evidence that neurophysiological activity can be considered a way to understand differences in the coach-client relationship, thus providing information on the effectiveness of coaching interventions and facilitating a better transition from school life to work.

Jack et al. (2013) investigated the effects of positive emotional attractors-focused coaching (PEA) and negative emotional attractors-focused coaching (NEA) in college students using fMRI techniques to measure brain activity. The results indicated that PEA coaching, which focuses on participants' personal vision and dreams, activated areas of the brain related to motivation, visual imagination, and social connection, such as the lateral visual cortex, ventral striatum, and medial parietal cortex. In contrast, NEA coaching, which focuses on current challenges and expectations, activated regions associated with stress response and self-awareness, such as the para-cingulate cortex. The study suggests that PEA coaching is more effective in motivating individuals and opening them up to new ideas, while NEA coaching can induce a defensive posture and decrease motivation. This same study was reproduced by Passarelli et al. (2015) and the results found were the same. PEA coaching appears to be a more effective strategy and impacts areas of the brain that receive high levels of dopamine and derive better results to those who receive the coaching.

Coumans and Wark (2024) investigated the importance of creating a safe and collaborative environment in problem-based learning (PBL) and neurocoaching. They express that tutors should encourage student socialization and use the SCARF model to address social experiences. In addition, they underscore the need to integrate neuroscience knowledge to improve the effectiveness of academic coaching and facilitate students' transition to their "ideal self" through positive emotional attractors (PEA). The authors emphasize that an emotionally safe and challenging environment is crucial to generate optimal neuroplasticity and improve academic performance, also considering factors such as gender, neurotransmitters, and hormones that influence behavior, attitudes, and learning. In the same vein, Spagnola and Yagos (2021) argue that coaching that uses the fundamentals of neuroscience can greatly help young adults who face many fears in the university experience. The mere fact that students learn how to manage the threat and reward circuits will help them a lot to face fears, which well analyzed by him and his coach are irrational in nature, decreasing cortisol levels and increasing dopamine and serotonin levels.

It is understood that, after having carried out the literature review of neuroleadership, I/O psychologists can help with their competencies to strengthen this field of research together with other professionals. The IOP has developed a broad field of research on psychological theories and their application to coaching. Now, the discipline needs to enter into the use of neuroscientific tools that allow establishing this link in such a way that neurocoaching is strengthened as areas of research and application. On the other hand, they must critically analyze the tendencies to generate neuromyths and evaluate the data that supposedly validate these practices. Neurocoaching is a very large industry and there is a lot that psychological science can do to ensure the quality and usefulness of the products that are generated.

Implications of Neuroscience, IOP and Teamwork

The IOP, as a scientific discipline has focused on observing, describing, understanding, explaining, and predicting human behavior in the work environment, with teamwork being one of the crucial aspects for the success of organizations. Recent studies have shown that well-developed teams can significantly improve productivity, innovation, and employee well-being (Salas et al., 2018). The integration of IOP theories and practices into teamwork makes it possible to address complex problems through collaboration and the effective use of individual skills and competencies within a group. Recent research points to the importance of factors such as cohesion, effective communication, and transformational leadership in team performance (Mathieu et al., 2019). Likewise, IOP-based interventions, such as interpersonal skills training and the implementation of organizational support structures, have been shown to improve team efficiency and satisfaction (Kozlowski & Chao, 2018). The increasing interdependence of tasks in the modern work environment makes teamwork an essential area of study for IOP, and its research-informed practice continues to evolve to meet contemporary workplace challenges.

On the other hand, ON has emerged as a promising field with the potential to provide a deeper understanding of how brain processes influence behavior and performance in teamwork. Recent research has revealed that neural synchronization among team members can predict group performance, highlighting the importance of cohesion and effective communication for successful collaboration (Kinreich et al., 2017). In addition, some research has shown that empathy and perspective-taking, critical skills for teamwork, are associated with the activation of specific neural networks that facilitate understanding and cooperation among teammates (Singer & Klimecki, 2014). Integrating these neuroscientific findings into organizational practices can help design more effective interventions that foster collaboration and improve team performance (Waldman et al., 2011). For example, training in socio-emotional skills and the use of neuro-monitoring technologies can enhance team cohesion and efficiency, leading to more positive organizational outcomes.

One of the biggest challenges that neuroscientific research associated with teamwork has faced is how to evaluate the neural functioning of all members of a team (Waldman et al., 2017, in Waldman & Balthazard). The authors state that technologies are gradually improving, and they understand that in a short time these machines will be able to more accurately capture the neurological behavior of the members of a team performing tasks of various kinds. On the other hand, Stevens and Galoway (2017) point out that it is also important to develop theoretical concepts associated with the neurological measurements of work teams, so that they can understand the behavior of the brains of team members in an optimal way. They have developed the concept called neurodynamics. They express that neurodynamics occurs when the combined measurements of a work team reach the level of imbalance or entropy, then their performance can be clearly observed. Entropy will occur when the operational rhythm of a work team requires greater efforts due to the level of complexity of the task. Once the efforts in the performance of the task are reorganized, the team's measurements are balanced. This theory presents the situation that defining the complexity of the task will depend on the type of task and the context where the teams execute it.

Cha and Lee (2019) conducted a study where they combined hyperscanization with electroencephalogram (EEG). They hypothesized that neural synchronization in EEGs would increase when team members' communication was effective, and teamwork was being carried out in the best way. They quantified the EEG signal for multiple subjects using a representative method of EEG quantification and studied the changes in brain activity that occur during the collaboration. The proposed method quantified neuronal synchronization between subjects through bispectral analysis. They found that phase synchronization between EEGs from multiple subjects increased significantly during periods of collaborative work. This same finding was found by Liu et al., (2021), with the differences that multiple teams were evaluated simultaneously.

Becker (2018) points out that another area of neuroscientific research related to work teams that requires more attention is how leaders manage "In groups" and "Out groups" where it seems that organizational power and politics can give rise to perceptions of competitive or antagonistic relationships between co-workers and between leaders and subordinates. The author points out that these perceptions can lead to unconscious categorizations of outgroup status. A better understanding of the effects this can have could explain the prominence of abusive supervision, sexual harassment and workplace harassment that continue to plague organizations. It can also inform research on organizational justice and ethics by emphasizing the importance of emotions and the impact of internal and external groups on emotional processing and subsequent unethical behavior. This line of research can increase the understanding of the impact of social categorization on employee selection and promotion. These are lines of research, where I/O psychologists can also contribute a lot, since this topic has been investigated from the perspective of attitudes, cognitive and behavioral.

Another topic that should be studied from the perspective of neuroscience, work teams, and IOP is competence from a perspective of social comparison theory (Tor & García, 2023). The authors propose that knowledge can be obtained about the neuroscience of social judgment and decision-making under uncertainty. It is important to assess how individuals seek and evaluate information about similarities or differences between others and themselves, largely to improve their self-evaluation. Studying the development of social comparison and competence in the light of behavioral evidence reveals numerous questions that deserve further investigation and can be helped to be answered by neuroscience. Other topics that deserve to be studied from the perspective of neuroscience and teamwork are emotions, decision-making, conflict, trust, cooperation, and the habits of collective memory (Freedman, 2019; Fisher, & O'Mara, 2022; Luterbacher, 2016; Wertsch, & Jäggi, 2022; Zac, 2018).

As can be seen, many efforts have been made to improve teamwork neuroscience research technologies. In addition, there are many topics that have to be investigated since teamwork behavior is not one focused on the behaviors performed by the members of a work team. Factors such as psychological variables, intelligence, personality and attitudes, among others, affect collective behavior. Not to mention the tasks they perform, the equipment they use, the type of organization where they work, the type of team it is and the circumstances in which they do the work make neuroscientific studies in work teams complex, but at the same time interesting. I/O psychologists should be inserted in this process since they have the necessary competencies to strengthen these studies since they can combine the traditional tools of the discipline with neuroscientific ones. The future of IOP will be linked to this type of approach that is so necessary to understand human complexity in the world of work.

Implications of Neuroscience, IOP, and Neuroethics

Every field of knowledge has to be based, not only on scientific or methodological guidelines, but also on ethical ones. Organizational neuroscience is no exception. With the rapid progress in neuroscientific technologies such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) come important questions about privacy, informed consent, confidentiality, competence and anonymity among others. Neuroscience and cognitive sciences have shown rapid growth in research and knowledge development over the past two decades. With this increase in knowledge and research, multiple ethical questions arise when considering the paradigms of neuroscience research. Neuroethics is a term coined as a subset of bioethics to understand and unravel the complex ethical questions surrounding the ability of new technologies to investigate and intervene in the brain (D'Sousa, 2020).

According to Illes and Lombera (2019), neuroethics provides a framework to address these issues, ensuring that the principles of justice, respect for autonomy, and beneficence are considered in the application of neuroscientific technologies. In addition, neuroethics plays a fundamental role in the education and training of researchers and professionals, promoting responsible and ethical practices in the research and application of neuroscience.

In the organizational context, neuroethics acquires particular relevance due to the possible implications in the monitoring and possible manipulation of employees' brain activity using transcranial stimulation. Recent studies have highlighted the need to establish clear and precise protocols on the collection and use of neuroscientific data in the workplace to protect employee privacy and rights. The implementation of robust ethical guidelines can help neuroscientific practices in organizations to be carried out in a fair and equitable manner (Martineau & Racine, 2020).

Pavarini and Singh (2018) argue that in order for neuroethics to have a substantive purpose, it has to adopt a pragmatic approach. According to the authors, pragmatic neuroethics unites philosophy and the social sciences. They consider that ethics is not dissociable from lived experiences and daily moral decisions. They establish that it is necessary to reflect on the integration between empirical methods and normative questions, using as a platform recent bioethical and neuropsychological research on cognition, action and moral experience. The authors recommend using a pragmatic approach following the philosophy of John Dewey. For Dewey, the task of pragmatic philosophy is to identify the moral issues at stake in a particular context and to ask what forms of social life foster human prosperity. Dewey believed that a "common good" can be achieved, but that it requires systematic methodological inquiry and that the methodological approach must unite philosophy and the social sciences, as follows: (1) Identify an "experienced difficulty", (2) Describe its location and definition, (3) Suggest a possible solution, (4) Develop through reasoning the consequences of the suggestion (5) Engage in further observation and experimentation that leads to acceptance or rejection of the suggested solution. This view allows the ethical issue to be one that is evaluated from the same perspective as one as a human being. Not from the point of view of the observer and the issue. The observer must internalize the issue as if the ethical problem were happening to him or her.

Shook and Gierdano (2016) state that neuroethical practices should follow four principles: (1) Self-creativity: The right of people to recreate themselves to enrich their lives, (2) Non-obsolescence: The duty to avoid the creation of obsolete people, (3) Empowerment: The duty to increase people's capacities to live autonomous and full lives, and (4) Citizenship: The duty to promote a free, equal, law-abiding and participatory citizenship. Although neuroethics is spoken of as a scientific and research problem, the key according to the authors is to be a better person in the work of the discipline and that is fundamental when one as a scientist practices and research in any discipline.

Hannah and Waldman (2015) point out that research on behavioral ethics in the field of management is booming. While many advances have been made, applying an organizational neuroscience approach to this area of research has the potential to create significant theoretical, empirical, and practical contributions. The authors argue that neuroethics research needs to address the issues of cognition and moral conation, and the existing applications of neuroscience to moral cognition (moral conscience, moral judgment/reasoning, effects of moral emotions on moral reasoning, and ethical ideology). The authors conclude that, in addition to practicing neuroethics, the aspects of the brain that are associated with ethical and moral behaviors and attitudes must be investigated. Voegtlin et al (2019) propose that ethical leadership studies should evaluate the aspects of the brain associated with self-understanding, understanding of others, and the relationship between self and others. They also consider it relevant for ethical leadership to investigate self-reflection, self-regulation, theory of mind, empathy, trust, and justice.

The application of ethical principles in neuroscientific research are the same principles that I/O psychologists apply in their research. The IOP can contribute a lot in the study of how the behavior and attitudes of ethical leaders in organizations are studied in the way they have traditionally done. It is important that they combine cognitive and behavioral work with neuroscientific work to have a clearer picture of how to combine the study of the brain in organizations. Nor can we think that the ethical behavior of leaders is the only thing that should be studied. There are many constituents whose ethical behavior affects organizations and are found at all levels within an organization. Decisions in an organization come from different constituents and it is thought that the only ones who make decisions and who should behave ethically are the people in leadership positions. Neuroscientific research must also move in this direction.

Conclusions

In this article, the relationship between ON, IOP and the areas of work analysis, personnel selection, training and development, leadership, coaching and ethical aspects was discussed. Research in neuroscience has come a long way. The IOP has a lot to contribute in the field of ON. At the moment, there are many areas of opportunity in the discipline, as has been observed in this article. I/O psychologists have many opportunities for research and application in their relationship with organizational neuroscience. All areas of IOP can be studied from neuroscience. Only a few were discussed in this article, but the literature review reveals other important ones such as neuroeconomics, neuromarketing, neurodiversity, and the relationship of neuroscience with change, decision-making, and health and safety. Professionals in psychology applied to work have to visualize neuroscience as an important discipline and one of development in the future. In the same way, universities have to emphasize the preparation of psychologists, the importance of neuroscience as an area of research and application. On the other hand, organizations must be open to neuroscientific research that allows them to understand work dynamics from a real perspective. This author understands that the number of studies in the field of ON will increase as technologies will become more accessible and disciplines will have to develop greater openness to brain research.

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