MedUNAB
ISSN: 0123-7047
ISSN: 2382-4603
medunab@unab.edu.co
Universidad Autónoma de Bucaramanga
Colombia

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The convergence between neuroscience and education: a pending challenge
MedUNAB, vol. 27, núm. 3, 2024, Diciembre-Marzo 2025, pp. 258-261
Universidad Autónoma de Bucaramanga
Santander, Colombia

DOI: https://doi.org/10.29375/01237047.5345

Disponible en: https://www.redalyc.org/articulo.oa?id=71982434006

REVISTA DE LA FACULTAD
DE CIENCIAS DE LA SALUD
Vol. 27(3):258-261, December 2024 - March 2025
i-ISSN 0123-7047 e-ISSN 2382-4603

Perspective

The convergence between neuroscience and education: a pending challenge

La convergencia entre neurociencia y educación: un desafío pendiente

A convergência entre neurociência e educação: um desafio pendente

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ARTICLE INFORMATION:

Article received: December 16, 2024
Article accepted: March 18, 2025
DOI: https://doi.org/10.29375/01237047.5345

How to reference. Maldonado-Arbogast P. The convergence between neuroscience and education: a pending challenge. MedUNAB [Internet]. 2024;27(3):258-261. doi: https://doi.org/10.29375/01237047.5345

ABSTRACT

Neuroscience and education have long been seeking collaboration, with neuroscience offering insights into the brain's mechanisms that impact learning. Despite this, the integration of these fields has not kept pace with the demands of modern education. Advances in neuroscience have revealed key processes like brain development, neuronal plasticity, learning, memory, and the effects of sleep and exercise, which significantly influence the educational process. These insights underscore the biological diversity in classrooms, where students' cognitive abilities vary due to biological and experiential factors. Understanding neurodevelopment is crucial for designing effective educational strategies. However, differences in how neuroscience and education conceptualize knowledge and goals hinder collaboration between these fields. For successful integration, neuroscientists and educators must manage realistic expectations and work together to apply neurobiological insights in real-world classroom settings. This collaboration can enrich teaching practices, addressing diversity while promoting the well-being of students.

Keywords:
Neuronal Plasticity; Behavior; Students; Methods; Knowledge

RESUMEN

Introducción. Se ha buscado desde algún tiempo la colaboración entre la neurociencia y la educación, ya que la neurociencia ofrece conocimientos sobre los mecanismos cerebrales que influyen en el aprendizaje. **Objetivo.** A pesar de ello, la integración de estos campos no ha seguido

Med UNAB
ISSN 0123-7047 Impreso
ISSN 2382-4603 Electrónico

Author Contributions

PMA. *Conceptualization, writing - original draft, writing - review & editing.*

el ritmo de las exigencias de la educación moderna. **Temas de reflexión.** Los avances en neurociencia han revelado procesos clave como el desarrollo cerebral, la plasticidad neuronal, el aprendizaje, la memoria y los efectos del sueño y el ejercicio, que influyen significativamente en el proceso educativo. Estos conocimientos subrayan la diversidad biológica en las aulas, donde las capacidades cognitivas de los alumnos varían debido a factores biológicos y experienciales. Comprender el neurodesarrollo es crucial para diseñar estrategias educativas eficaces. Sin embargo, las diferencias en la forma en que la neurociencia y la educación conceptualizan el conocimiento y los objetivos dificultan la colaboración entre estos campos. **Conclusiones.** Para que la integración sea exitosa, los neurocientíficos y los educadores deben manejar expectativas realistas y trabajar juntos para aplicar los conocimientos neurobiológicos en escenarios reales del aula. Esta colaboración puede enriquecer las prácticas docentes, atendiendo a la diversidad y promoviendo al mismo tiempo el bienestar de los estudiantes.

Palabras clave:
Plasticidad Neuronal; Conducta; Estudiantes; Métodos; Conocimiento

RESUMO

Introdução. A colaboração entre neurociência e educação é buscada há muito tempo, pois a neurociência oferece conhecimentos sobre os mecanismos cerebrais que influenciam o aprendizado. Objetivo. Apesar disso, a integração desses campos não acompanhou as demandas da educação moderna. Tópicos para reflexão. Avanços na neurociência revelaram processos importantes como o desenvolvimento cerebral, a plasticidade neuronal, a aprendizagem, a memória e os efeitos do sono e do exercício físico, que influenciam significativamente o processo educacional. Esse conhecimento destaca a diversidade biológica nas salas de aula, onde as habilidades cognitivas dos alunos variam devido a fatores biológicos e experienciais. Compreender o neurodesenvolvimento é crucial para a elaboração de estratégias educacionais eficazes. No entanto, as diferenças na forma como a neurociência e a educação conceituam o conhecimento e os objetivos dificultam a colaboração entre essas áreas. Conclusões. Para que a integração seja bem-sucedida, neurocientistas e educadores devem definir expectativas realistas e trabalhar juntos para aplicar o conhecimento neurobiológico em ambientes reais de sala de aula. Essa colaboração pode enriquecer as práticas de ensino, abordando a diversidade e promovendo o bem-estar dos alunos

Palavras-chave:
Plasticidade Neuronal; Comportamento; Estudantes; Métodos; Conhecimento

Introduction

Neuroscience and education have had a mutual interest for many decades, given that neuroscientific knowledge can impact the educational field. The educational field provides an environment of exciting learning phenomena for neuroscience. Despite this mutual interest that has been going on for a long time, the convergence between these two areas of knowledge has yet to advance at the appropriate pace for current demands. Neuroscience during the last decades has advanced in the understanding of the neurobiological mechanisms of behavior that can significantly impact the educational process; among them, we can mention the development of the brain, neuronal plasticity, the neurobiology of perception, learning mechanisms, memory, neurobiology. of sleep, physical exercise as a brain modulator, among others.

The most significant impact of this new knowledge has allowed us to understand and appreciate how these phenomena contribute to the biological diversity that exists in the classroom and that it is a critical aspect of facing different educational strategies. Biological diversity is manifested not only in the physical aspects of students, such as height and weight but also in cognitive abilities, which are often expected to occur homogeneously in the classroom when fundamental differences come from biology. Understanding the development processes of the nervous system provides critical knowledge for designing educational strategies. Also, it contributes to understanding how different cognitive processes are related to the maturity of the nervous system. The development of the nervous system is based on a structural and genetic development plan, which is partly independent of experience in all brains. There is an essential development of connectivity between neurons in which one finds the maximum number of synapses between the first and second year of life, which is then refined into different motor and sensory systems. Cognitive, the speed of change differs in these other systems, observing that in sensory systems, maturation is early, as does motor systems, but cognitive systems require more time, and it is considered that the complete maturity of complex mental functions does not occur until later of 20 years of life (1).

Topics for Reflection

Modifying synaptic connections and neuronal plasticity is a fundamental part of these changes. Not only do

these plastic changes arise due to genetically determined factors, but to a large extent, the connectivity structure in the brain occurs through experience-dependent modifications. Neuronal plasticity is a trait that allows excellent modifications in the structure and function of the nervous system but has the critical characteristic of decreasing with age, so neuronal plasticity is more significant in young people than in adults and older people. This plasticity can be manifested through dramatic changes such as what occurs, for example, in people who were born deaf in which the auditory cortices take on a visual functional role (2) or, as happens in people who were blind from birth in which the different components of those of the visual system acquire a different functionality at early ages (3), the reorganization of the connectivities and functionality of the brain neurons is therefore very powerful and a relevant factor of change during early experience. In adult humans, plasticity continues throughout life, and the primary mechanism is based on changes in connectivity as a result of experience, that is use. Many experiments have shown that activating synaptic connections strengthens structurally and electrophysiologically the strength of these synaptic connections, refining the circuits to acquire the most frequently performed sensory-motor and cognitive skills. In this way, people's different life experiences modify the neural circuits to be recruited in those tasks or activities we do more regularly (4). Considering that life experiences are different, the mechanisms of neuronal plasticity contribute significantly to the diversity found in the classroom. People's brains will differ considerably due to these different individual experiences and the tasks each one of the students has done in her previous life.

A second aspect of neurobiological knowledge that contributes very relevant to diversity in the classroom is the perceptual experience or the construction of a model of the world. Our brain cannot faithfully capture the physical aspects of the world, but rather, through our personal experience, we build a model of the world. The neuroscience of perception has shown that aspects of our daily lives, such as color, are a mental construct that the brain creates by combining the activity of receptors in the eye. It has been shown that different people have different receptors, so the sensory experience cannot be similar to others, generating diverse sensorimotor experiences. "Reality" as we experience it is a Construction (mental model) made by the brain that combines the interaction with the physical environment and the brain's ongoing activity. The "reality" of different people is similar because we have similar brains, but it also differs because the brain's ongoing activity depends on experience.

Other knowledge related to sleep and the consolidation of learning is very relevant to evaluating sleep hygiene in students. The same occurs with the understanding of the neurobiology of exercise, where today, we know that it promotes mechanisms of relevant plasticity and the well-being of our brain. This acquired knowledge of neuroscience contrasts with the limited expertise of most teachers who have captured inappropriate or false beliefs about the brain, called neuro myths, that must be examined through neuroscience education.

Why has this non-knowledge not been quickly transferred to the classroom? The purposes of neuroscience and education are different. On the one hand, neuroscience seeks to understand the neural mechanisms that underlie an individual's behavior. At the same time, education aims to train people or allow them to acquire skills to function in the society in which they live. The purposes differ, and the phenomenological levels at which this different knowledge occurs in neuroscience (5). Knowledge is based on understanding mechanisms that appear at the level of genes, cells, tissues, or neuronal systems but do not go beyond an individual. At the same time, the science of education seeks to understand phenomena from a divided environment, how it interacts with the rest of society, and what the objectives are as a country. This difference in phenomenological levels makes it difficult to converse between cognitive domains such as neuroscience education. Finally, the exaggerated use of medical aspects in situations of learning difficulties also tends to segregate and reduce appreciation for diversity in learners' cognitive abilities. Biological diversity manifests as a variation of a more frequent characteristic, but it will always exist. There are people with distant traits but still part of a non-pathological situation. This is in contrast to many educational systems' need to identify disorders to obtain institutional support.

Conclusions

Consequently, educators and neuroscientists must have realistic expectations of each other for a successful convergence (5). On the one hand, neuroscience cannot be prescriptive because it should not deliver suggestions or interventions based on knowledge obtained in the laboratory in restricted situations but instead only provides information on mechanisms that must then be examined in classroom situations to see their effectiveness or to know how these environments impact or relate to the neuroscientific knowledge obtained in controlled conditions. Neuroscientists and educators should work together studying neurobiological phenomena in the classroom, to obtain combined knowledge that truly impacts educational processes.

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