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Neurological semiology learning and technological-digital perspectives: a scoping review

Aprendizagem da semiologia neurológica e perspectivas tecnológico-digitais: uma revisão de escopo

Aprendizaje de la semiología neurológica y perspectivas tecnológico-digitales: revisión de alcance

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ABSTRACT

This study aimed to assess the use of digital technologies in teaching neurological semiology to medical students. This scoping review followed the JBI Manual for Evidence Synthesis and PRISMA-ScR Checklist. A comprehensive search was conducted using the PubMed/Medline, LILACS, and SciELO databases to identify relevant articles published in English or Portuguese between 2017 and May 2022. Nine studies were included in the present review. The results suggest an emerging interest in nontraditional methods applied to teaching, such as board games and simulations. The use of alternative resources can improve short-term knowledge retention; however, digital technologies are lacking. This scoping review provides evidence to support the use of simulation in neurological semiology education; however, we found a lack of technological-digital approaches to this matter, a gap that should be studied further, as it could be crucial for solving several problems in neurological semiology education.

Keywords: Medical Education, Experimental Games, Neurology, Neurological Semiology, Simulation

RESUMO

Este estudo teve como objetivo avaliar o uso de tecnologias digitais no ensino de semiologia neurológica a estudantes de medicina. Esta revisão de escopo seguiu o Manual JBI para Síntese de Evidências e a checklist PRISMA-ScR. Uma busca abrangente foi realizada usando as bases de dados PubMed/Medline, LILACS e SciELO para identificar artigos relevantes publicados em inglês ou português entre 2017 e maio de 2022. Nove estudos foram incluídos nesta revisão. Os resultados sugerem um interesse emergente em estudos sobre métodos não tradicionais aplicados ao ensino, como jogos de tabuleiro e simulações. O uso de recursos alternativos pode melhorar a retenção do conhecimento a curto prazo; no entanto, faltam tecnologias digitais. Esta revisão de escopo fornece evidências para apoiar o uso da simulação na educação em semiologia neurológica; no entanto, encontramos uma falta de abordagens tecnológicas-digitais nesta questão, uma lacuna que deve ser estudada mais a fundo, pois pode ser crucial para resolver vários problemas da educação em semiologia neurológica.

Descritores: Educação Médica, Jogos Experimentais, Neurologia, Semiologia Neurológica, Simulação

RESUMEN

Este estudio tuvo como objetivo evaluar el uso de tecnologías digitales en la enseñanza de semiología neurológica a estudiantes de medicina. Esta revisión exploratoria siguió el Manual JBI para la síntesis de evidencia y la checklist PRISMA-ScR. Se realizó una búsqueda exhaustiva utilizando las bases de datos PubMed/Medline, LILACS y SciELO para identificar artículos relevantes publicados en inglés o portugués entre 2017 y mayo de 2022. Nueve estudios fueron incluidos en esta revisión. Los resultados sugieren un interés emergente en estudios sobre métodos no tradicionales aplicados a la enseñanza, como juegos de mesa y simulaciones. El uso de recursos alternativos puede mejorar la retención del conocimiento a corto plazo; sin embargo, faltan tecnologías digitales. Esta revisión exploratoria proporciona evidencia para respaldar el uso de simulación en la educación en semiología neurológica; sin embargo, encontramos una falta de enfoques tecnológicos-digitales en este asunto, una brecha que debería estudiarse más a fondo, ya que podría ser crucial para resolver varios problemas de la educación en semiología neurológica.

Descriptores: Educación Médica, Juegos Experimentales, Neurología, Semiología Neurológica, Simulación

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INTRODUCTION

Neurology is responsible for diagnosing and treating conditions of the central, peripheral, autonomic (or involuntary), and somatic (or voluntary) nervous systems[1], and semiology or propaedeutics is an area in the health sciences related to the study of the signs (everything that is verifiable) and symptoms (everything that the patient reports) of diseases.[2] Semiology is the basis for the diagnosis of most diseases, and it is an essential tool in neurology. However, medical students often consider neurological semiology to be one of the most complex clinical areas of learning, leading to an aversion to this medical field, a phenomenon known as neurophobia.[3]

Generally, university classes are expositive, limiting student participation and active learning.[3] Therefore, to increase their participation and promote a better understanding of neurological semiology, the hypothesis of inserting technology as an aid tool during classes has begun to be tested and has shown promising results so far.[3]

A scoping review is a type of review that can be used to map key concepts, clarify the definitions and boundaries of a topic, and identify knowledge gaps.[4] It has also been referred to as a mapping review or scoping study in the past.[5,6]

The absence of a prior scoping review on this topic, as of May 2022, and the heightened use of technology associated with education, opens the way for this review and for investigating the potential of the association between these two elements, generating an infinite range of forms of learning within the academic environment.

The objective of this review was to condense, gather, and find a gap in the literature addressing the relationships between education, health, gamification of the learning process, and technology associated with semiology and neurology that reflect pedagogical possibilities for medical students. Our specific objectives were to elucidate whether there are difficulties in semiological-neurological teaching for medical students and what are these; to estimate how problem-solving and simulations through digital technology are being able to assist in the learning of medical content, mainly directed to our scope; to understand whether simulation through games, in general, has an impact on the teaching of neurological semiology; and to list new possibilities for technological methods to solve and/or assist in the main problems encountered in the traditional teaching of neurological semiology.

METHODS

This review was performed following the JBI Manual for Evidence Synthesis[7] and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist.[8]

Search strategy

To carry out the research, we developed four research questions (RQ), presented in the results section with their respective answers. After that, we conducted a comprehensive literature search in the PubMed/Medline, LILACS, and SciELO databases with the descriptors: "neurological semiology" OR "neurology" AND "learning" OR "teaching" AND "medical education" OR "traditional teaching" OR "expository" AND "app" OR "software" OR "digital" OR "simulation" OR "game."

Source of evidence screening and selection

The authors defined the eligibility criteria for the articles. The inclusion criteria were the work must be in English or Portuguese; must contain the established keywords; and relate the applicability of some technology to the teaching or learning of a medical topic. The exclusion criteria were as follows: more than five years from publication; not related to neurological semiology; not correlating digital technologies, simulation, or games with medical learning; and regarding the surgical area and not the clinical one. There were no restrictions on study design for the selection of the sources of evidence. Two independent authors selected the sources of evidence based on title and abstract examination, followed by a full-text examination, and a third author resolved any conflicts. Finally, the reference list of the included studies was assessed to identify other relevant studies that our strategy missed, following the backward snowballing method.[9]

Data extraction

Two independent authors performed data charting and any conflicts were adjudicated by a third author. This chart, along with the key concepts of each study, is presented in the results section.

Analysis and Presentation of results

The results were presented in a descriptive format that responded to the research questions.

We did not assess the methodological limitations or risk of bias of the evidence included because it is generally performed only if there is a specific requirement owing to the nature of the review.[7]

RESULTS

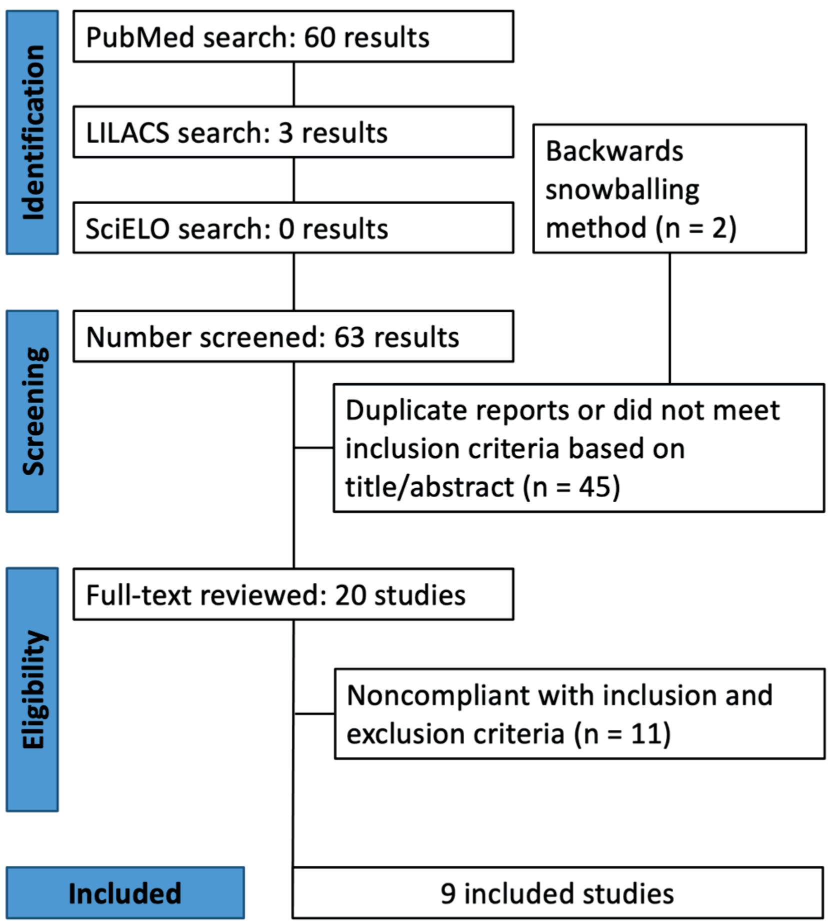
Data collection was conducted in April, and the analysis was conducted in May 2022. We included papers published from 2017 to that date because of the growing relevance of technology to medical education in recent years owing to the COVID-19 pandemic.

The results of the search strategy showed an emerging interest in nontraditional methods applied to teaching, such as virtual games and simulations. However, in terms of simulation and serious games contemplating neurological semiology and the inclusion and exclusion criteria for this review, only nine articles were included. All studies excluded from the final analysis did not meet the inclusion or exclusion criteria, as illustrated in Figure 1. The characteristics of these studies are summarized in Table 1.

RQ1: What are the main problems encountered in traditional medical teaching focusing on neurological semiology, and how does this relate to digital technologies?

The study of neurology, which includes neurological semiology, has always been a challenge for students, as this subject is dense and involves complex structures and concepts.(10) The term neurophobia, which describes the fear of some students in this field of medicine, helps to illustrate it.(3,10) Moreover, this phenomenon may be related to pedagogical deficits, since traditional teaching lacks practical integration and clinical appeal to students.(3) Furthermore, the workload of practical activities does not allow students to have contact with all the main pathologies as well as their semiological manifestations, which characterizes another limitation of the traditional teaching model.(3) Our analysis shows that the lack of innovation in didactics presented to students and insufficient practical workload are obstacles to overcome to improve the teaching of neurological semiology in medical schools.(3) In this sense, the use of technological resources, such as board games and simulation apps, facilitates contact with a greater variety of signs and diagnoses, stimulates the active study of neurology, and allows a higher fixation of knowledge.(10,11,12) Therefore, innovations and the use of new technologies that consolidate student-centered teaching can be powerful alternatives to this problem.

Figure 1. PRISMA Flow Diagram of study screening and selection.



RQ2: How has the resolution of problems and simulations through digital technology been helping the learning of medical content, mainly directed to the area of neurology?

Digital technologies help improve learning in several ways, such as through the efficiency of short-term retention of knowledge of neurological syndromes and the satisfaction of academics after using these technologies. This is exemplified by the card game "Neurospeed," declared effective by 20 multiple-choice questions before and after the game was played, resulting in a significant improvement in the score for correct answers ($p < 0.001$) after the game. Furthermore, it improved student satisfaction, and students classified the game as playful, stimulating, or useful in learning neurological semiology. Therefore, the game 'Neurospeed' helps solve the problem of neurophobia and improves short-term learning.(10) In addition, by increasing the ability and confidence of neurology residents to perform a fundoscopy examination, the intervention group that received simulation-based training had significant increases in fundoscopy skills and confidence in practice compared to the control group that received only lecture-based training.[11]

This helps fill the gaps in the clinical experiences of students. Many medical schools use only traditional teaching of neurological emergencies, often through inauthentic learning environments such as classroom lectures. However, neurological simulations are used to demonstrate the clinical signs and medical history of patients because the diagnosis depends on the correct interpretation of the history and parts of the neurological physical examination, such as speech, visual fields, pupil symmetry, facial weakness, and coordination, which can be presented through games and simulations.[13] Simulations can also improve the coordination and door-to-needle (DTN) time of neurology residents in stroke care because the integration of simulation-based medical education for stroke was associated with a 9.64-minute reduction in DTN time.[14]

Finally, the 14% improvement in long-term retention of the medical students' knowledge, and late recovery of neurological semiology from students who received "The Move" training, which simulates neurological syndromes, compared to students who did not receive the training[12] shows that the use of games, simulations, and nontraditional teaching methods, such as problem-solving, can increase academic satisfaction and bring better results when analyzing not only short-term memory but also long-term knowledge retention, besides decreasing the time to diagnosis of neurological syndromes. Furthermore, these methods can assist in the absence of clinical reasoning exercises and help combat neurophobia.[3]

RQ3: Does the introduction of simulation through games in general have a relevant impact on teaching neurological semiology?

Active student-centered teaching has grown in relevance in universities in recent years and is associated with better results for the retention and application of knowledge than traditional passive teaching.[3] The investment of medical schools in simulation centers is growing, enabling the early and sustained development of practical skills of healthcare students.[15] Although scenarios such as cardiac arrest and sepsis management are widespread in simulated environments, other areas of medicine, such as neurology, still have little or no workload with this teaching tool.[15]

However, there are less expensive alternatives to stimulate learning, such as simulated games, which can enable students to carry out active study with relatively simple equipment, such as smartphones or notebooks. In this sense, using a card game for teaching neurological semiology was classified as productive and fun, and aided in the learning of the students submitted to the study, causing a relevant impact on their medical training.[3] Furthermore, virtual simulation of a scenario in which the student must diagnose a subarachnoid hemorrhage can increase the retention and confidence of future physicians in the management of pathologies with high mortality and/or difficult diagnosis[13]. Furthermore, a study that analyzed the association between practical simulated teaching as a booster for theoretical classes obtained positive results for a group that received only traditional passive theory training. In a residency service that sought to teach fundoscopy, a fundamental component of neurological semiology, there was a significant increase in students' ability to perform and interpret fundoscopy after association with simulated training.[11]

Hence, new techniques of active teaching and learning can impact the field of medical education, especially the teaching of neurological semiology, which has been slightly explored in the literature.[3] However, the existing works neither allow us to affirm the degree of relevance of its contributions nor was it possible to certify that simulated teaching could replace traditional theoretical education, which is why more studies are needed.[3,12,15]

RQ4: Are there new possibilities for technological methods to solve and/or assist in the main problems encountered in the traditional teaching of neurological semiology?

The "Neurology Hat Game" is a card and mime-based game that aimed to be a student-centered, playful, and complementary method for traditional lectures. It showed a benefit in short-term memorization but was not able to prove its efficacy in long-term memory.[16] And, "Neuropoly" is a board game to enhance the neurological semiology abilities of neurology residents, although it is a viable and inexpensive approach to target neurophobia[17], all the games we found in this review are, except for the virtual simulation for the diagnosis of subarachnoid hemorrhage[13], in person and made of physical materials. Hence, we found a lack of technological and digital solutions to aid in traditional neurological semiology teaching.

Table 1. Characteristics of the studies included in the review and summary of its results

Authors	Year, country	Study type	Population	N total	N intervention	N control	Aims	Methods	Intervention	Control	Outcomes	Key findings
Gupta et al.[11]	2017, USA	Prospective single-blind study	Neurology Residents.	48	24	24	To evaluate the utility of a simulation-based me-thod and the traditional lecture-based method for assessment and teaching of fundoscopy.	Baseline and post-intervention assessments were performed using questionnaire, survey, and fundoscopy simulators.	Simulation-based training consisted of an instructor led, 1-hour, hands-on workshop about fundoscopy.	Both groups initially received lecture-based training.	Post-intervention changes in fundoscopy knowledge, skills, and total scores.	Supports the use of a simulation-based me-thod as a supplementary tool to the lecture-based method.
Wijdicks et al.[15]	2018, USA	Review	MS.	-	-	-	To find (and to prove) a better way of teaching than carefully running through case scenarios using Socra-tic teaching methods.[a]	Pure descriptive.	Simulation.	-	Validation of simulation in acute neurology.	Simulation of acute neurology has a bright future if there is sustai-ned commitment.
Mehta et al.[14]	2018, USA	Quasi-ex-perimental Study	Patients trea-ted by 1st year neurology residents, and nursing staff.	448	276 patients treated after intervention (July 1, 2011–September 31, 2014).	172 patients treated before intervention (October 1, 2008–July 1, 2011).	To improve coordination and door-to-needle time for AIS care.	Trained live actors, who portrayed stroke vignettes in the presence of a board-certified vascular neuro-logist. A retro-spective analysis of DTN was carried.	Acute stroke simulation before the treatment of patients.	No AIS before the treatment of patients.	Door-to–IV-tPA time.	Reduction in the mean door-to-IV-tPA time by 9.64 minutes.
Shelley et al.[3]	2018, India	Review	MS.	-	-	-	To explore plausible factors that contribute to neuro-phobia and multi-faceted strategies to nurture interest in neurosciences and pro--vide possible solutions.	Pure descriptive.	Various, including the sugges-tion of technology enhanced learning.	-	Exploration of ways to promote neurophilia.	Remodeling and reinven-ting neurology education for the undergraduate curriculum will not be effective using a "one-si-ze-fits-all" approach.
Roze et al.[12]	2018, France	RCT	3rd year MS.	638	186	452	To test the effect of the intervention on long-term retention and delayed recall of neurological semiology.	Comparison between two classes of medical students 30 months after intervention.	MS received standard classes and were trained in a mime-based role-play to simulate the patient or phy-sician. And winners were se-lected based on originality and accuracy of the mime.	Only standard neurological se-miology classes.	Performance in a neurological semiology paper-based test.	Improvement of long-term retention and delayed recall of NS.
Garcin et al.[16]	2019, France	Prospective observatio-nal study	2nd year MS.	371	112	259	To propose an interes-ting, student-centered, playful, and complemen-tary method to lectures.	There are three rounds of the game, the first two focusing on cards and verbalization, and the third on a mime-based turn.	A card game to learn NS.	Only standard neurological se-miology classes.	Performance in mul-tiple choice questions before and after the game, and in the final exam.	The "Neurology Hat Game" had a benefit on short-term memori-zation, and possibly also on longer term memorization.
Harris; Sheppard[13]	2021, Canada	Technical Report	Preclinical MS.	-	-	-	To fill a gap in the simu--lation-based learning to access clinical scenarios during times of limited access to hospitals.	The simulation is 15 minutes long and requires one standardized patient and one evaluator.	A virtual simulation of subara-chnoid hemorrhage.	-	Performance in a post--simulation survey, and learner's perceptions.	Using virtual simulation--based learning to fill the gap in MS knowledge may help mitigate future harm.
Raskurazhev et al.[17]	2021, Russia	Prospective observatio-nal study	1st and 2nd year neurolo-gy residents.	51	51	-	To enhance motivation in the learning of NS.	A board game consisted of three decks of 30 cards, with four ques-tions, each, two dice and players' characters.	An educational board game.	-	Pre- and post-play questionnaire scores.	Board games, such as "Neuropoly", are a viable and inexpensive approach to aid complex disciplines.
Zeidan et al.[10]	2022, France	Prospective observatio-nal study	3rd year MS.	148	148	-	To find alternative ways to teach neurological semiology.	A deck of 78 cards was designed with a neurological sign or symp tom written on each card. MS play for at least three cards showing a sign or symptom that constitutes a neurological syndrome.	A card game to learn neurologi-cal syndromes.	MS that partici-pated in another game in previous years.[16]	Performance in mul-tiple choice questions before and after the game.	The "Neurospeed" game is an interesting tool as a complement to traditional lectures.

Abbreviations: USA, United States of America; RCT, Randomized Controlled Trial; N, number; MS, medical students; NS, neurological semiology; AIS, acute ischemic stroke; IV, intravenous; tPA, tissue plasminogen activator.

[a] A method in which probing and leading are employed to make connections between certain pieces of information.[15]

DISCUSSION

This scoping review has found that the traditional teaching of neurology is mostly passive, based on lectures, assigned reading, self-directed, or in-person, but simulation-based education is learner, experience, and reflection-focused.[15] Yet, it has downsides, when simulation scenarios are in person most students will undergo some level of embarrassment.[15]

Learning neurological semiology is difficult for medical students.[10] This problem is accentuated by what is known as neurophobia, which is a preconceived feeling of aversion to neurological knowledge.[3] Unfortunately, this prejudice is real in medical education and directly affects many students and professionals. Regarding neurological semiology learning, we can suppose that with the help of digital simulation methods and games, performance can improve if digital elements are combined with traditional teaching methods. However, this topic is recent and there are only a small number of studies on it.

The lack of learning in neurological semiology is evident, which translates to a great need for current students and future physicians. Often, this content has not been adequately addressed using traditional teaching methods in medical courses.[3] Simulation methods have yielded excellent results when used in addition to regular teaching.[11] One of the difficulties faced by the students, the long-term retention of neurological knowledge, diminished when an interactive method was used.[12]

The results of this review allow us to verify that innovative methods within the reality of the medical teaching of neurological semiology can contribute to medical education. It also demonstrates that in some cases, learning through technological tools is superior to traditional learning.[11,14] The potential of introducing technology in learning neurological semiology has not yet been extensively evaluated, but the initial sampling is considered promising.[13]

According to the articles analyzed, technological tools come into play to complement the foundation already provided by traditional medical education, strengthening theoretical and practical concepts that have already been approached conventionally. In summary, technology can strengthen and facilitate learning while providing a greater chance for students to retain knowledge through repetition and simulation.[18] Digital methods bring content closer to medical students, a strategy that could help overcome the problems of neurophobia.[13] Thus, with students closer to the subject, their knowledge of neurological semiology would be better understood and established.[18] This would facilitate an understanding of the key concepts of neurology that are necessary for the formation of physicians.

It became clear that games, applications, and other technological tools have a promising area of expansion for future medical teaching in neurological semiology, which characterizes them as a viable space for new research projects. However, some questions remain: Can all neurological semiology skills be addressed using technological tools? Could the development of theoretical concepts through technology harm their practical application? How would traditional teaching interact with digital methods within the faculty? Would the adoption of digital content in medical courses be easy to implement?

The teaching of neurological semiology is complex, pertaining to the pedagogical part, which is not the focus of this scoping review but is also crucial for knowledge retention in medical schools, considering that the learning of neurological semiology is often overshadowed by neurophobia. Thus, it was necessary to conduct this study to identify promising technological alternatives intended to assist in the teaching and learning of this theme.

Neurophobia and lack of sufficient practical activities to establish knowledge were the main problems encountered (RQ1).[3,15] However, academic satisfaction and statistical evidence that role-play, card, and board games help with short-term memorization indicate that these resources have been improving the teaching and learning of neurological semiology (RQ2).[10,12,16,17]

In general, simulation through games or workshops has yielded encouraging results in teaching and learning neurological semiology; however, it is still impossible to accurately quantify this relevance (RQ3).[11,14]

Technology reinforces and facilitates learning, bringing the academic closer to the practical subject, even outside the hours of a traditional class, a class too focused on a teacher and his exposure.[3]

With the certainty that simulation helps in medical learning and that table games have been statistically successful in bringing simulation beyond the classical approach, it is necessary to investigate the insertion of games into digital media with the same or similar goals, as this shows a promising hypothesis but has not yet been validated (RQ4).[3,13,15]

Bringing simulations closer to academics helps the consolidation of knowledge by repetition and problem-solving, which relates to our long-term memory, that is, our memory, which, due to continued use, we retain for longer, while when practice lacks, we store the things learned only in short-term memory, which is known as working memory, what we use but do not keep.[18]

Therefore, the use of digital technologies should be an insurmountable step in disseminating simulation in the teaching of neurological semiology, and is what seems to be the way to answer the following questions: How could we bring the simulation to the daily life of students without the barriers of physical space? Is it possible to measure learning progress using electronic simulation games? Can digital simulation games increase long-term memory consolidation and improve academic performance? Which data can justify its implementation? Would digital technologies be aligned with traditional methods, or would they conflict? Further experimental studies are required to address these questions.

This scoping review has limitations, such as the timeframe. Although the search strategy used in this review was extensive, relevant studies may have been missed and some of the included studies may have had biases or methodological issues that could have influenced the results and were not evaluated.

CONCLUSION

The high cost and embarrassment possibility of in-person simulation, little-known long-term memory effects, and the critical need to integrate basic neuroscience knowledge into clinical scenarios with frequent and effective exposure since the first years of medical school to reduce neurophobia[3] could possibly be solved by serious mobile games, the gap encountered in this review. Thus, the design and validation of technological-digital approaches for neurological semiology learning need to be elucidated in further studies.

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