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The Role of Artificial Intelligence in Neurosciences: An Approach to Neuroplasticity in the Era of AI for Personalized Rehabilitation

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ABSTRACT

The accurate diagnosis of any disease is often a challenging task for healthcare professionals to ensure effective and high-quality patient care. However, with the digitization of health records and the discovery of Artificial Intelligence (AI), possibilities of human error in diagnosing diseases have greatly reduced. Artificial intelligence is the study of methods for developing artificially intelligent machines with certain abilities in problem-solving and self-decision support, just like the human brain. The technology base for the design of AI systems has borrowed most of its concepts from the architecture of the human brain. Neurosciences concentrate on the study of the human nervous system and brain, from disease to structure. Artificial intelligence technologies and algorithms have, in altogether, ushered in a paradigm shift for disease diagnosis that have armed healthcare professionals with valid and effective tools. AI has certainly become an indispensable tool in the field of neurology diagnosis, providing unparalleled capacities for the interpretation and analysis of intricate neurological data. The main goal of this review is to highlight the emerging AI technologies that are revolutionizing the management of neurological disorders and improving patients' overall functional outcomes. Neuroplasticity and AI integrated within Brain-Computer Interfaces (BCIs) embrace a novel paradigm for complex and most dependent rehabilitation. The use of AI is likely to yield massive growth for patients, stabilizing and magnifying the neuroplasticity process, especially for those undergoing rehabilitation.

KEY WORDS: Artificial Intelligence, Neurosciences, Rehabilitation, Neuroplasticity, Brain-Computer Interfaces.

INTRODUCTION

Accurate diagnosis of any disease is very often a huge challenge that the healthcare practitioner has to go through in order to provide proper and quality patient care. The human body comprises a total of seventy-eight primary organs that demonstrate a variety of non-specific signs and symptoms related to various types of diseases. Those diseases can be diagnosed using clinical procedures along with medical diagnosis techniques. A clinical diagnosis is based on history, symptoms presented by the patient, and physical examination findings by the clinician, while a medical diagnosis would be based on the assessment and evaluation of imaging studies, laboratory analyses, and clinical observations. Therefore, the factors and variables surrounding what constitutes the definition of any particular disease are so many; these create avenues to endless possibilities in terms of combinations and permutations. As a result, any physician's mistakes will result in a failure to diagnose the disease accurately at any stage of the diagnosis process.

In general, the practice faces a serious challenge from its complex diagnostic effectiveness. Digitization in healthcare and sluggish but constant integration of artificial intelligence have started slashing major cases by human beings in identifying disease [1]. Due to improvements in AI, improvements in the accuracy and speed of diagnostic methodologies are feasible, and they have transformed the paradigm in diagnostics [2]. Numerous AI-driven methodologies have been developed by researchers, encompassing both deep learning and machine learning approaches, to assist with patient records, improve clinical systems, diagnose diseases, and treat various health conditions [3]. In particular, a rule-based intelligent system is extensively employed within the medical field, which operates by making decisions grounded in established protocols and medical practices.

It is said to be a part of computer science since AI researches into the ways of imitation of human intellect in machines, enabling them to independently perform several types of problems and make decisions worthy of a human brain. Actually, the design of such systems is mostly inspired by the architecture of the human brain. It only depends on the fashionable architecture of artificial intelligence in the brain, acting like a model for an all-encompassing framework that encompasses the perception, planning, and decision-making facets of intelligence [4]. Deep learning was then brought up over traditional machine learning in line with the development of modern hardware technology furthering many widely used applications. Artificial Intelligence grants machines the capability of making intelligent and instinctive decisions within them to solve complex problems [5]. Deep Learning is a subset of Machine Learning, which in turn is a subset of AI, as can be depicted from Figure 1.

Neurosciences is the study of the human brain and nervous system. It studies about anatomy and diseases of the brain and nervous system. It is the scientific study of the brain's anatomy and cognitive functioning, including data processing, decision-making, and interaction with the environment [6]. It combines various fields, including human anatomy, physiology, medicine, mathematics, and computer science [7]. Neuroscientists research both the brain and the nervous system to better understand neurological, psychiatric, and neurodevelopmental diseases [10]. Neuroscience identifies which regions of the human nervous system are most susceptible to diseases, disorders, and injuries, allowing for more effective therapies.

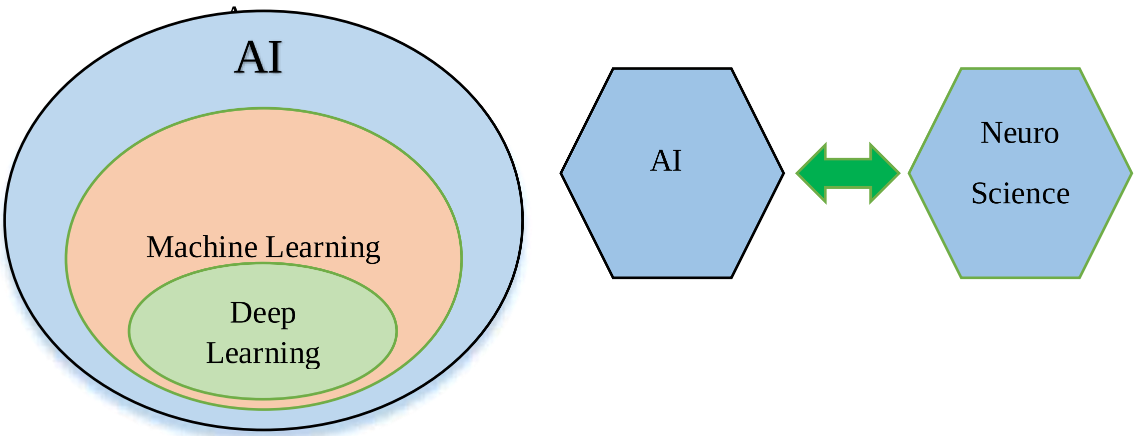

Figure 2: AI and Neuroscience

Nowadays, these two disciplines, AI and Neuroscience, mutually leverage the technical progress made by each other in their own areas, as shown in figure 2. In the healthcare industry, the fusion of AI and neuroscience has resulted in numerous advantages. When machine learning algorithms receive brain data, AI can analyze it and generate more precise responses. This has led to earlier interventions and better patient outcomes. In addition to diagnostics, AI is helpful for treating patients with individualized treatment plans. Sophisticated AI architecture aids in effective disease diagnosis and solves complex data from the nervous system and brain. Neuroscience theory has introduced numerous innovative ideas to the field of AI. The biological neural network enables the development of intricate deep neural network structures necessary for tasks like text processing, object detection, speech recognition, and other multipurpose applications. Furthermore, neuroscience contributes to the validation of the current AI-based models. Computer scientists have developed algorithms for reinforcement learning in artificial systems, allowing those systems to learn complicated tactics without explicit instruction, as a result of their research into human reinforcement learning. This type of learning facilitates the development of sophisticated applications like driverless cars, robotic surgery, and gaming apps, and many more [5]. Similarly, this type of learning enables the deciphering of hidden patterns and the intelligent analysis of complex data.

Neuromorphic engineering and artificial intelligence reflect rapidly developing technologies with regular breakthroughs in neuroscience. Artificial Intelligence has strong and continuous dependency on neuroscience to understand the intricate systems concerned with information processing in the brain. Research in AI is interdependent upon extensions of neuroscience, and the reciprocal relationship holds true [9]. Integration of neuroscience with AI has opened brighter perspectives for personalized, improved health interventions in people affected by neurological disorders [11]. It must be realized that the implementation of AI technologies into patient delivery systems in medicine has really upended personalized health care for some time now [12]. However, this review takes into account the application of neuroplasticity in the light of the AI era for personalized rehabilitation.

Traditional Approach for Medical Diagnosis

A medical diagnosis conventionally followed a scientific approach bolstered by the principles of evidence-based medicine. It integrates clinical experience, patient preference, and the best available research evidence to form the basis of a truly informed decision about the care of individual patients. Most diagnostic work in traditional medical practices therefore essentially encompasses an ample history and careful physical examination, as well as sophisticated medical equipment that includes diagnostic imaging and laboratory tests for precise disease diagnoses [13]. In contrast, traditional medicine is effective for the treatment of acute and serious diseases since it ensures timely and specific interventions together with medications [14]. Another thing is that the evidence-based clinical practice guidelines assist in updating different medical practices, which guarantees proper treatment of the patients as well [15]. The traditional method of diagnosis in medicine has several drawbacks. The risk of diagnostic failure is the notable disadvantage that can lead to incorrect or delayed diagnosis. Besides, the complexity of healthcare increases the diagnostic errors and the reliance on some tests enhances the risk factor [14]. Instead of looking for and fixing the root causes of diseases, traditional medicine may just treat the symptoms. When this method fails to take into account the interconnected nature of a patient's mental, emotional, and spiritual health, it increases the risk that they will not receive adequate holistic care [16].

Patient-Physician Interaction Time

According to recent empirical research on 'time motion study of internal medicine residents', 13% of the average day is spent on face-to-face interactions with patients, with the remainder spent on writing patient notes and maintaining patient records in the hospital [17]. There is a need to automate the tedious process of clinicians inputting unique diagnosis codes, which now number approximately 70K. The use of AI in other functions, such as pre-authorization, can significantly reduce physicians' involvement. Eventually, AI could help to promote transparency among all stakeholders in the health care system, allowing physical workers to devote their time to more meaningful and relevant reviews.

Benefits of AI in Health Care

Using AI technology, patient-physician interaction time can be increased by lowering the physician's administrative workload. AI technology has the potential to improve medical care and minimize administrative costs. Different companies are working to automate a physician's clinical practice. Ultimately, clinicians can analyze documents generated utilizing AI technology rather than spending more time on patient notes in the traditional way. Automation in clinical practice can boost patient satisfaction. Many companies have attempted to automate physicians' note-taking processes. Eventually, physicians' time spent on record keeping should migrate to technology, reducing the strain on practitioners. Thus, clinicians may devote the time saved by using technology to patient visits, resulting in more interaction time with patients, which leads to greater patient satisfaction and better and more efficient treatment [17].

Nevertheless, the benefits of AI for patients and physicians should not be undervalued. AI has the capacity to transform the provision of care by enhancing the capabilities of physicians and healthcare teams, leading to better treatment and substantial cost savings. If the field freaks out and disregards the possibilities of AI, it will lose an opportunity to revolutionize healthcare. Advanced AI technology provides valuable decision support, allowing physicians to make precise diagnoses and thereby delivering more efficient care to patients. Advancements in technology have equipped clinicians with supplementary diagnostic tools, therefore enhancing their productivity and consistency.

AI offers numerous benefits in the field of medical diagnosis. This approach's inherent advantage is its ability to improve diagnosis precision. Machine-learning-based AI systems demonstrate outstanding precision in analyzing extensive volumes of medical data [18]. Furthermore, AI is quite proficient in managing extensive datasets. It is capable of handling a wide variety of healthcare data and offers healthcare professionals a plethora of valuable insights to make well-informed decisions [19]. Another compelling feature is the prospective revolution it presents for the treatment of neurological diseases, with uses in precise neurology and the formulation of novel protocols. The integration of machine and deep learning into AI has the potential to revolutionize the provision of medical treatment for neurological disorders [12].

ROLE OF AI IN HEALTH CARE SECTOR

The introduction of artificial intelligence (AI) in the 1950s was a watershed moment in healthcare because it combined machine learning with precision medicine and radically altered diagnostic processes, medical imaging, and treatment planning. AI in healthcare has evolved from a knowledge-based system based on medical norms and expertise to one that uses Artificial Neural Networks (ANNs) and statistical methods for illness detection and treatment. AI in healthcare has expanded due to IoT, Big Data, data mining, and machine learning. The Internet of Things (IoT) connects physical things to computer systems, minimizing human-to-human and human-to-machine interaction and storing massive amounts of data. AI and machine learning techniques are needed to fully analyze and integrate these data.

AI advanced from machine learning to deep learning in the late 2000s, characterized by convolutional neural networks (CNN). These networks can classify medical information and provide outcomes without manual input or expertise [20]. Deep learning has become popular in disease prognosis, imaging, and medication response prediction despite computer limitations. CNNs are popular for image processing in the AI era because they interpret input hierarchically from deep layers that mimic brain neurons. They are accurate, similar to human expertise [12], and may use spatial recognition to assess imaging modalities like X-Ray and CT scans to facilitate diagnosis [21]. Thus, AI in medicine has advanced beyond its constraints over decades.

AI technologies and algorithms have revolutionized illness diagnosis by giving healthcare providers precise and efficient tools. The combination of AI and conventional medical imaging techniques has accelerated disease diagnosis. AI in health care evaluates medical data for illness prevention, diagnosis, patient monitoring, and the development of new protocols [22]. Clinicians today have to deal with a lot of data, but AI could help ease their workload [23]. AI helps clinicians extract only clinically relevant information from vast amounts of data. AI algorithms have been used to create predictive models for illness progression and treatment response. These models utilize extensive datasets to detect patterns and biomarkers related to the course of the disease [24]. Further, the expansion of artificial intelligence technologies, in which therapeutic strategies are framed based on various patient characteristics, genetic profiles, and biomarker signatures, is under inclusion in the field of precision medicine [25]. AI algorithms can analyze all kinds of ultrasound, MRI, CT, and DXA imaging modalities that help medical experts diagnose several diseases. Fuzzy Logic, ANNs, RNNs, and Logic Regression (LR) can effectively diagnose intricate health conditions [12].
Some of the advantages that artificial intelligence-enabled automatic diagnosis techniques bring are speed, precision, and low costs, with huge volumes of medical data being processed quickly. However, AI adoption in health still has its challenges and concerns. Data privacy and security are among the most important concerns associated with the use of AI in health care. These are topics that institutions in health should treat with care, as information relating to any patient used in the training of the AI algorithms must be well anonymized and shielded from any form of breach. Overcoming bias in these algorithms in AI requires creation of several representative datasets together with intensive test processes that shall reveal unfair outcomes for correction [26]. AI application in disease diagnosis proves to be very prospective according to recent and future healthcare developments. By the application of its strengths, through solution-finding and observance of values of ethical nature, artificial intelligence can register tremendous improvements in diagnostic accuracy, patient outcomes, and overall effectiveness in health care.

AI diagnostic technologies, including machine-learning and deep-learning algorithms, have garnered significant attention in the healthcare industry. These technologies exploit the inherent capacity of AI to handle and evaluate vast amounts of medical data, including imaging, patient records, and other relevant information. Visual data interpretation, namely through the use of images or videos, poses specific difficulties. Proficiency in the discipline necessitates extensive training over many years and ongoing knowledge updates to stay current with emerging research and information. Nevertheless, there is an increasing demand and need for more specialized knowledge in the sector. Thus, it is necessary to develop creative solutions, and AI seems to be a very promising instrument for closing this disparity in expertise [27].

Limitations of AI in Health Care Sector

Presently, AI technology, which relies on machine learning, includes certain constraints. The primary constraint relates to the inherent heterogeneity in the examination and detection equipment used in different countries, regions, and healthcare institutions [12]. As a result, the obtained images exhibit fluctuations in quality and resolution, which unavoidably impact the precision of image processing as well as the accuracy of diagnostic conclusions.

An inherent drawback is the absence of human comprehension and discernment. Unlike human decision-making, AI lacks intuitive comprehension, clinical judgment, and common sense, which could result in shortcomings in decision-making. Dependence on training data presents additional issues. When the training data lacks diversity and representativeness, AI machine-learning algorithms have the potential to provide biased results [51]. Furthermore, the widespread usage of AI gives rise to issues regarding data security and privacy, especially in the lack of appropriate safeguards [28].

One further limitation of machine-learning-based AI technology is its currently unsatisfactory diagnostic capabilities for rare disorders. Given the rarity of these diseases, there are not enough cases to meet the training and verification requirements. In order to improve the identification of rare diseases, it is necessary to optimize machine-learning algorithms [12]. Forecasting the future of AI-guided diagnosis Several countries that support the development of advanced technologies are formulating governance frameworks, including legislation, policy, technical guidelines, and standards, to facilitate the effective use of the rapid advancements in AI. These frameworks serve as preparatory measures as they embrace the impending era driven by AI.

ROLE OF AI IN NEUROSCIENCES

There is an inextricable link between AI and neuroscience. Neuroscience studies the brain's structure and function to discover and diagnose neurological illnesses. In neurology, AI has quickly emerged as a transformational technology with several applications across multiple domains, transforming the landscape of disease diagnosis, prediction, and treatment [30]. One major field of AI application is neuroimaging analysis, which uses advanced machine learning algorithms to understand complicated imaging data such as magnetic resonance imaging (MRI), computed tomography (CT), and positron emission tomography (PET) images [31]. With high accuracy and speed, these AI-powered methods may find small changes in structure and function that are signs of neurological diseases like Alzheimer's, Parkinson's, multiple sclerosis, and brain tumours [32].

Neurological diseases encompass deviations from normal structure, biochemistry, or electrical functioning of the brain, spinal cord, and nerves. Several problems arise with the present neurology in terms of diagnostic and therapeutic methods. They span from very simple issues, such as the definition of conditions for healthy sleeping, to more complicated ones—such as early detection and reducing the length of stay in the rehabilitation of acute ischemic stroke; rare forms of epilepsy diagnosis; and Sudden Unexpected Death in Epilepsy (SUDEP) prevention. This also considers that epilepsy is a multifactorial pathology and the variability of EEG signals between individual reviewers [35]. In neurology, various data are coming up every year; these require deep learning methodologies to structure this information so that neurologists can use it for quick diagnoses and proper treatment of patients.

AI has become an indispensable tool in the field of neurology diagnosis, providing unparalleled capacities for the interpretation and analysis of intricate neurological data [31]. Advanced AI systems, trained on extensive collections of neuroimaging scans like MRI and CT scans, have the ability to accurately and efficiently identify minor patterns and abnormalities that are suggestive of neurological diseases. Furthermore, AI-powered diagnostic systems combine several data modalities, including clinical symptoms, genetic information, and biomarker profiles, to produce comprehensive diagnostic evaluations tailored specifically for each patient [33]. AI provides doctors with improved diagnostic capabilities, facilitating more precise and prompt diagnosis by augmenting healthcare professionals' experience. Consequently, this leads to superior patient outcomes and improved quality of care in the field of neurology.

Recent developments in neuroimaging technologies have significantly enhanced our knowledge of the brain's anatomy and functions [37]. Indeed, the progress of neuroscience has been propelled by breakthroughs in instruments and technology, which have facilitated the investigation of the brain at both high resolution through the analysis of genes, chemicals, synapses, and neurons, and at low resolution using whole-brain imaging [39]. Radiologists have applied convolutional neural networks, with their numerous hidden layers, to analyze pictures using high-level reasoning for detection and prediction tasks [40]. In addition, the acquisition of significant insights and their data storage, manipulation, visualization, and management are enabled by computer-based systems neuroimaging techniques [41].

It is anticipated that cognitive neuroscience will eventually be capable of elucidating the algorithms that govern the structural brain components responsible for the physiological processes leading to perception, cognition, and potentially even consciousness. The collaboration of AI and neuroscience has the potential to yield insights into the brain mechanisms responsible for human cognition. This is because AI and computer capabilities allow for extensive simulations of neural processes that lead to intelligence. Indeed, neuroscience serves as the fundamental foundation for the development of artificial neural networks (ANNs), comprised of nodes arranged into input, hidden, and output layers [29].

AI is an ideal approach for processing very intricate neuroscience data. Massive AI simulations enable neuroscientists to empirically evaluate their hypotheses. An AI system using a brain interface can extract brain signals and generate corresponding directives from these signals. Devices like a robotic arm input these commands to facilitate the motion of immobilized muscles or other anatomical components. Also, telemedicine platforms powered by AI have made specialized neurological care more accessible by letting patients with neurological problems get consultations, monitoring, and treatment from afar, especially in areas that don't have enough services or are geographically isolated [42].

The future of AI in various domains is increasingly promising, particularly in the field of neurosciences. This includes the ability to predict the outcomes of seizure disorders, grade brain tumours, improve neurosurgical procedure skills, provide rehabilitation for stroke patients, and enable smartphone applications to monitor patient symptoms and progress. The main goal of this critical analysis is to highlight the emerging AI technologies that are revolutionizing the management of neurological disorders and improving patients' overall functional outcomes.

Overview The field of AI has exerted a significant impact on several facets of human existence, including neuroscience. The objective of this paper is to provide areview on the pertinent elements of AI, namely machine learning and deep learning. It aims to examine the progress of technological growth that incorporates AI and clarify the potential of machine learning to transform the treatment of neurological disorders.

AN APPROACH TO NEUROPLASTICITY IN THE ERA OF ARTIFICIAL INTELLIGENCE FOR PERSONALIZED REHABILITATION

Neuroplasticity and AI integrated within Brain-Computer Interfaces (BCIs) embrace a novel paradigm for complex and most dependent rehabilitation. Neural plasticity, a phenomenon by which neurons of the brain strengthen or form new connections throughout areas affected by injury or learning defines strategies of extended therapeutic strategies. BCIs can tap into this inherent ability of neural plasticity when the issue is direct communication between the brain and the outside world. As shown in figure 3, the signalling process between the brain and BCI can be connected either in an open-loop system or in a closed loop system. In closed loop system, BCI sends back feedback signals to the brain and accordingly changes control signals based on the inputs received from the feedback of BCI. These interfaces when supported by AI could potentially improve rehabilitation outcomes tenfold due to the ability of creating rehabilitation strategies specific to the neural patterns. Earlier developed counselling styles tend to be quite conventional, allowing therapists to apply standardized practices that may not be responsive to clients' neurological disorders [43].

While conventional BCIs rely on fixed stimulation parameters on the base of the general knowledge of human brain's functioning, AI-driven BCIs can analyze patient's neural impulses with increased rate and precision, thus providing a more effective rehabilitation. These systems which employ machine learning algorithms, can gain more experience with the patient's brain behaviour and adapt therapeutic procedures to the new state of the brain. Adaptive learning not only expedites the attainment of rehabilitation objectives but also ensures that the rehabilitation process aligns with the specific requirements of the neurological system [44].

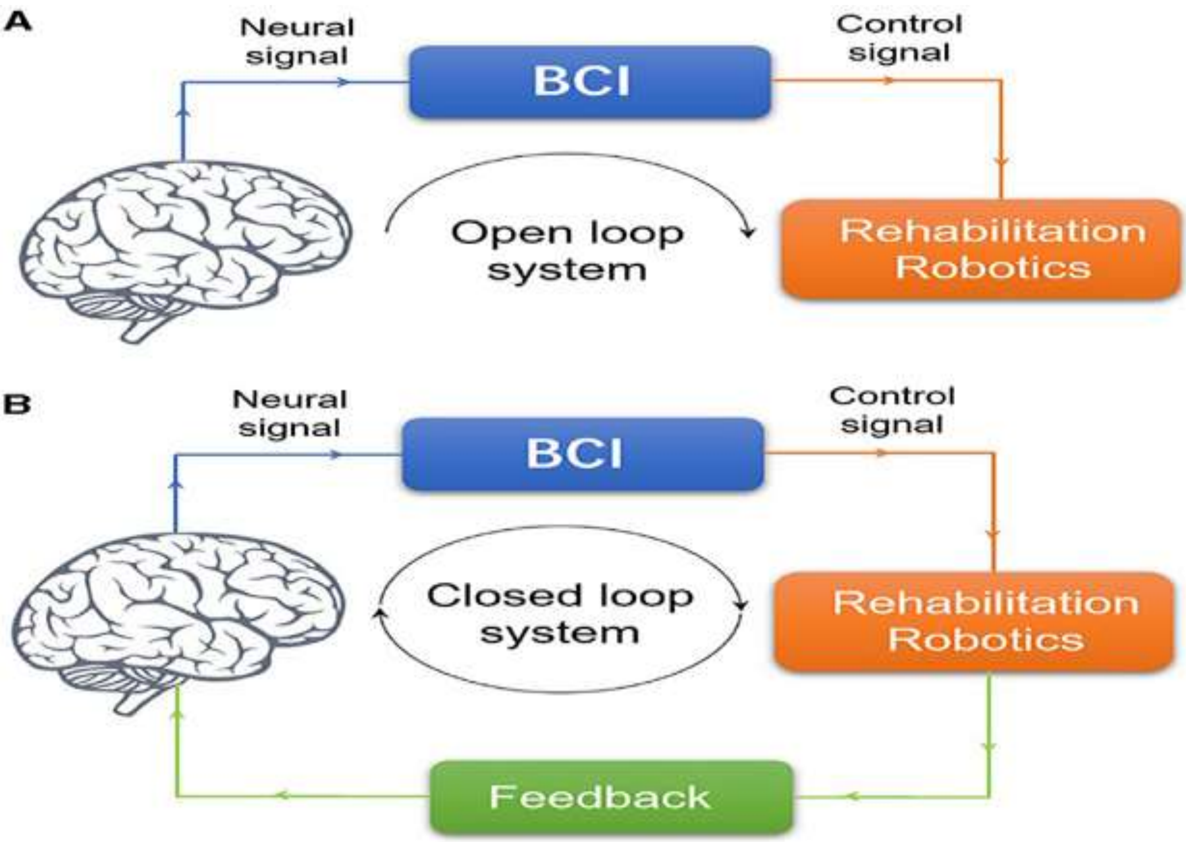

Figure 3: Brain Computer Interface Open and Closed Loop System (Mang et al., 2023)

The application of neuroplasticity principles in combination with AI in BCIs can change approaches to managing various neurological problems such as stroke, spinal cord injuries, and neurodegenerative diseases. The role and interplay of these domains, particularly the need for adaptive learning mechanisms in BCIs, can enhance neuroplasticity processes and lead to improved rehabilitation approaches. Adaptive learning systems for BCIs in personalized rehabilitation have, therefore, attracted a lot of attention in the recent past. In this domain, principles of neuroplasticity work with sophisticated AI algorithms to develop more effective and personalized rehabilitation procedures. Mitsopoulos et al. (2023) introduced NeuroSuitUp as a wearable robotics and serious games system for motor rehabilitation. The system architecture integrates feedback and a reimbursement mechanism to tailor rehabilitation sessions to the patient's progress.

This work also emphasizes the potential of intelligent systems for dynamic adaptation of rehabilitations to make sure therapy still matches a patient’s further needs [45]. Rojek et al. (2024) investigated real-time decision support intelligent systems in Industry 4. 0 and 5. No paradigms were found, especially for developing 3D-printed hand exoskeletons in manufacturing. Its strategy involves the application of AI in the design and manufacturing of the exoskeletons in order to meet the specific needs of patients. Despite the fact that their goals are based in manufacturing, concepts of adaptive learning and real-time feedback are very applicable to neurorehabilitation, where individualization of therapy is an important aspect of the treatment [46].

In their prospective study, Valero-Cuevas et al. (2024) stressed the significance of more complex modelling in neurorehabilitation and called for the idea of fusing AI data-driven models with conventional rehabilitation procedures. In light of this, Valero-Cuevas et al. (2024) are currently undertaking work under the NSF DARE program to redesign current neurorehabilitation models, incorporating AI into the prognosis of patient outcomes. The current study, which aims to apply AI to harness neuroplasticity for personalized rehabilitation, aligns well with the technical potential of AI to enhance the effectiveness of neurorehabilitation strategies [47]. In their work, Viruega and Gaviria (2022) offered a critical review of the neurorehabilitation advances achieved over the last 55 years and doubted the path on which future research is embarked upon. They said that while the progress has been massive, there is still a need to come up with other techniques for handling patient needs in health facilities that can transform over time to meet evolving patient needs. Incorporating adaptive learning systems into BCIs, as shown in figure 4, is crucial, as they have the potential to adjust rehabilitation schedules based on patient data, addressing the criticism of conventional neurorehabilitation's stagnation [48].

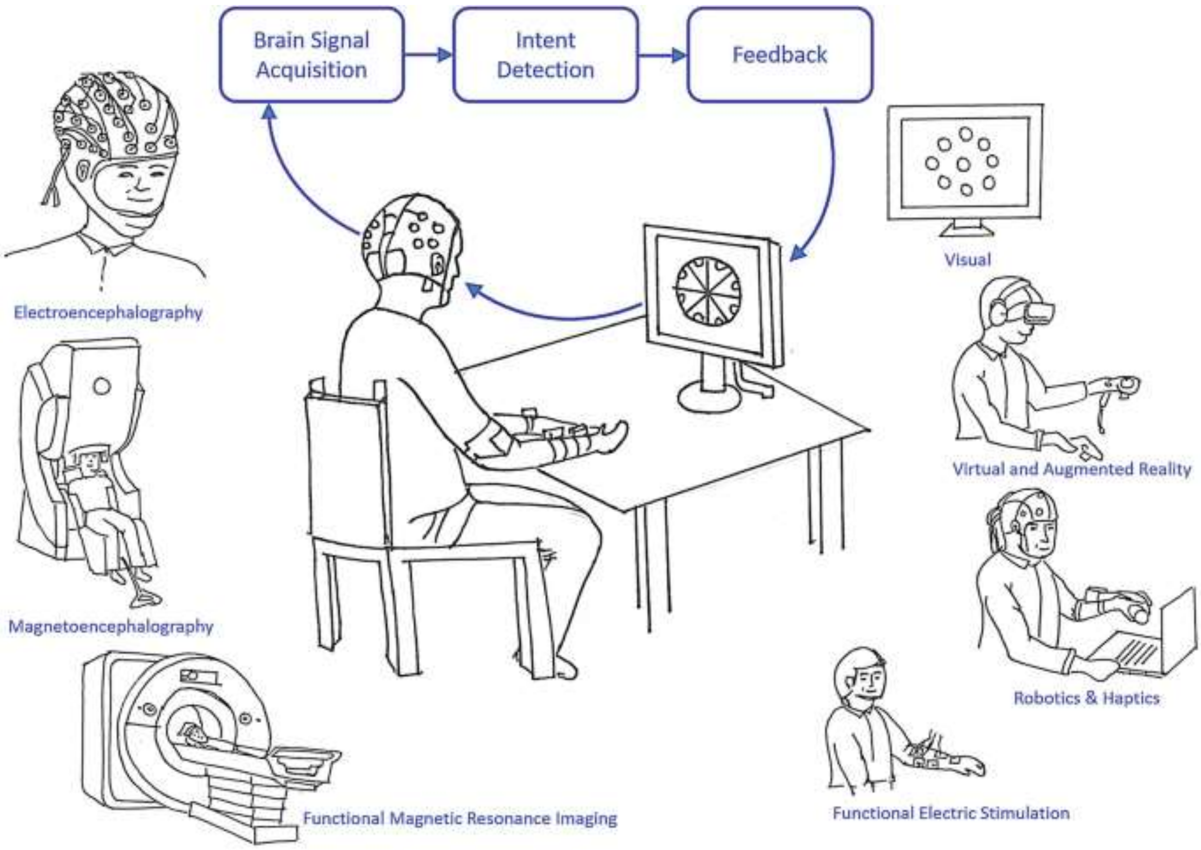

Figure 4: Brain-Computer Interface System Architecture Model Diagram (Mane et al., 2020)

Yin, Gao, and Zheng (2023) have provided a bibliometric analysis of BCI studies over the last three decades, with a focus on the use of BCIs for rehabilitation purposes. Their study found that mini- and micro-trends relate to improving the BCIs' adaptability and individualization, especially by using AI. This is in line with the current understanding of rehabilitation cost and efficiency, where ongoing research has examined the potential of AI-based adaptive learning. It remains that the work of Yin et al. offers a clear review of the field's development and notes the trend towards more individual and flexible BCIs in neurorehabilitation [49]. Zhang et al.'s bibliometric analysis (2022) focused on the analysis of global studies on rehabilitation robots over the past two decades. They demonstrated that there is a growing trend in the application of AI in rehabilitation robots, particularly in the improvement of system flexibility. Trends in the field explain this shift by using AI to develop more individualized and interactive rehabilitation programs. Zhang et al.'s current work aligns with the current literature on 'AI in Neuroplasticity for Rehabilitation', which explores the integration of robotics and AI in the neuro-rehabilitation domain to develop tomorrow's systems [50].

BCIs in neurorehabilitation, supported by neuroplasticity and AI-driven adaptive learning systems, represent a significant milestone in the advancement of neurorehabilitation. By utilizing AI algorithms, this method offers a customized treatment plan that adapts to the patient's requirements and evolves over time, thereby enhancing the effectiveness and calibre of the implemented rehabilitation programs and interventions. BCIs, with their real-time feedback and adaptive learning systems, regularly check and adjust rehabilitation protocols to patient progress, ensuring patient-centred therapy. Comparing this approach to other works in the same field shows that it is relevant and can help not only current neurorehabilitation projects but also new ones that are aimed at making treatments more personalized, sensitive, and cost-effective.

In this regard, the use of AI is likely to yield massive growth for patients, stabilizing and magnifying the neuroplasticity process, especially for those undergoing rehabilitation. The use of adaptive learning in BCIs is a major achievement for the integration of AI into rehabilitation, as traditional behaviours are insufficient to offer effective therapy practices tailored to each patient's deficits. This study opens up avenues for future research that may bring about radical changes in neurorehabilitation processes and optimize care for patients all over the world.

CONCLUSION

Accurate disease diagnosis is a challenging task for healthcare professionals, but the rise of AI has significantly reduced the likelihood of human error in diagnosis. Traditionally, most diseases are intrinsically enveloped with fine nuances in diagnoses that make for overwhelming activities with any healthcare professional; one cannot rule out chances of human errors. This has markedly improved in terms of accuracy and speed regarding these diagnostic methods, subsequently reducing this margin of error and therefore acquiring more reliable diagnoses. Artificial intelligence, especially in its ability to mimic some human cognitive abilities and processes, has an inherent and crucial role within the health care sector. With that kind of capability, AI systems are thereby able to learn huge datasets with amazing accuracy by extracting patterns and anomalies, which maybe human clinicians could miss. In neuroscience, which is a field dealing with the structure and function of the nervous system and the brain, AI inventions have come up with a new platform. More importantly, such technological advances spur improved diagnosis with a more profound understanding of neurological disorders.

More importantly, AI opens synergy with the neuroscience base in the betterment of patient-related outcomes through the application of different AI tools and algorithms. These steps will lead to further development of capabilities for many earlier times in life, for the diagnosis of neurological disorders, thereby making timely interventions possible. Such timely intervention may lead to more effective treatment and better management of neurological diseases, thereby improving the quality of life of patients. Finally, the integration of artificial intelligence with the concept of neuroplasticity in rehabilitation processes will surely transform those practices. Neuroplasticity is the neuropsychological ability of the brain, which is expressed by the reorganization of the brain through new neural connections. Artificial intelligence exploits this ability by making use of a brain-computer interface that serves to connect the brain with other external devices. BCIs can, using AI, assess and analyze neural impulses and responses accurately to optimize rehabilitation programs according to individual patient needs.

This trailblazing method paves the way for new therapeutic approaches that are individualized yet can be modified in real-time, depending on the improvement recorded by the patient. Artificial intelligence within BCI not only boosts the process of rehabilitation but also supports and amplifies the neuroplasticity effects to an even greater level. Therefore, this enabling approach is highly promising and contributes largely to the functional recovery of patients with neurological diseases. Thus, in the future, the application of artificial intelligence in neuroscience and patient care systems will be ground-breaking for making major strides in the management of conditions such as these. In turn, artificial intelligence will critically handle complex data in the future, predict disease onset, and personalize treatment methods while designing healthcare. This would lead to a new range of rehabilitation treatments, more accurate diagnostics, and possibly most importantly, better patient outcomes for neurological health. Influence from AI in the domain of neuroscience and neurological disorder management can be huge. Such progress is land-marking a key transition towards better diagnostic precision, customized therapeutic strategy, and newer rehabilitation modalities that together constitute a more functional and patient-centric model of healthcare.

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