

Impact and Optimization of BCIs on Neuroplasticity for Rehabilitation in Neurological Disorders



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Introduction

Brain-computer interfaces (BCI) is a system that analyzes brain signals and translates them into the desired action. With the advancement of technology, BCIs have been integrated into neurological disorder treatments. BCI aims to treat neuromuscular disorders and other neuroplasticity-related conditions by analyzing signals from neural pathways, decoding through the BCI, and translating the signals into actions.

Objectives

The primary goal of this project is to investigate and map the current landscape of BCI technologies used in the rehabilitation of neurological diseases. We aimed to analyze the efficacy of BCI systems in the rehabilitation of various neurological conditions, explore the relationship between interdisciplinary collaboration, and to uncover potential gaps in this field. Along with its effects on different brain processes, our objective was also to distinguish a method of optimizing BCIs for neurorehabilitation and restoration of functions in patients suffering from neurological diseases or neurotrauma.

Methods

Literature searches using Web of Science databases were conducted to recognize brain-computer interface articles and their effects on rehabilitation and neurological diseases. An in-depth search yielded a total of 214 preliminary results post-1997. Screening guidelines were set to be English-written papers with greater than 2 citations. 104 results were eliminated, while 110 were considered eligible. There were 77 articles, 4 proceeding papers, and 29 review papers from this eligible pool. Bibliometrix (R programming) was used for complex mapping analysis graphs as well as graphs based on the screened 110 papers.

Results

Figure 1: Most Relevant Sources & Number Of Documents Written Between 1997-2023

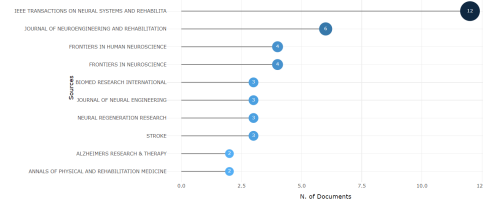


Figure 1: The most pertinent sources are displayed along with the number of documents that use each source from 1997 to 2023. Among the most cited articles on brain-computer interface, the top ten sources that occur most often are IEEE Transaction on Neural System And Rehabilitation, Journal of Neuroengineering and Rehabilitation, Frontiers in Human Neuroscience, Frontiers In Neuroscience, Biomed Research International, Journal Of Neural Engineering, Neural Regeneration Research, Stroke, Alzheimer's Research & Therapy, and Annals Of Physical And Rehabilitation Medicine. Figure # shows the IEEE Transaction Of Neural System And Rehabilitation occurring most often out of the top 10 sources in 12 documents and shows Alzheimer's Research & Therapy, and Annals Of Physical And Rehabilitation Medicine occurring least often out of the top 10 sources in 2 documents.

Figure 2: Top 20 Most-Cited Authors And Their Number Of Citations Between 1997-2023

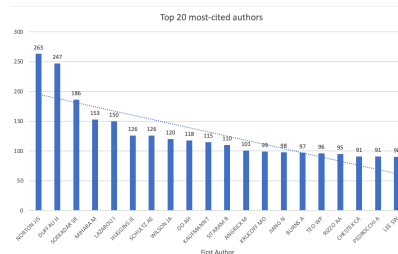


Figure 2: The graph above shows the top 20 most-cited authors, with the highest cited number of 263 by Norton JJS. We can thus conclude that the top 2 authors: Norton JJS from the neuroscience program of the University of Illinois Urbana, and Duffau H from CHU MONTPELLIER, France, notably have the most influence in research areas of brain-computer interface, rehabilitation, and disease.

Figure 3: Production of Affiliation Over Time From 1997 To 2023

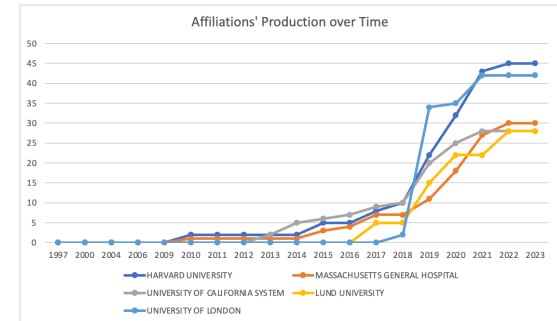


Figure 3: In addition to the authors, we traced back to their affiliations. We selected the top 5 institutions: Harvard, Massachusetts General Hospital, University of California System, Lund University, and University of London with the highest number of productions in 2023, and traced back their production over time. Productions began around 2010 significantly increased between 2018-2020. The number of productions from these leading institutions stabilized between 2021 to 2023.

Conclusion

We predict that advancements in healthcare technology, along with increased funding and accessibility, have facilitated BCI research worldwide, especially since 2018. We also observe that current trends within BCI revolve around patient rehabilitation and recovery, and we anticipate that this will persist as interest in healthcare technology continues to grow.

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