

## Bibliometric analysis of cognitive stimulation and movement using primary search engines

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### Abstract:

In recent years, there has been a significant increase in publications exploring the health benefits of cognitive stimulation and movement across various age groups. This study provides a comprehensive overview of current cognitive stimulation and movement research by conducting a bibliometric analysis of significant international papers published between 2012 and 2022. The insights obtained from this study provide valuable guidance for future research initiatives in this area. A total of 72 publications from primary search engines (Web of Science and Scopus) were included in this analysis. Using an ex post facto retrospective design, the information was classified to facilitate subsequent analysis of various variables, including temporal, demographic, linguistic, production, citation, and methodological factors. The primary findings reveal that most publications are focused on the medical domain, with a considerable emphasis on research concerning Alzheimer's disease. Among the countries, England and Switzerland are the most prominent contributors, with Romero-Naranjo being the most prolific author. Noteworthy scholars such as Abraha, Rimland, Trotta, Dell'Aquila, Cruz-Jentoft, Petrovic, Gudmundsson, Soiza, O'Mahony, Guaita, and Cherubini are identified as the most frequently cited. Furthermore, single-category journals and second-order papers are prevalent in the literature. In terms of publication impact, the second quartile (Q2) is predominant, with BMJ Open emerging as the most cited journal. The combination of movement and cognitive stimulation has significant potential for academic advancement, impacting motor skills (such as coordination, balance, or planning) and enhancing the learning process, memory, and concentration across various educational stages. However, the field of education remains relatively underexplored in terms of investigating the influence of cognitive stimulation and movement. Therefore, there is a pressing need for further research in this area.

**Keywords:** Motor skills, rhythm, BAPNE, executive functions, cognitive functions.

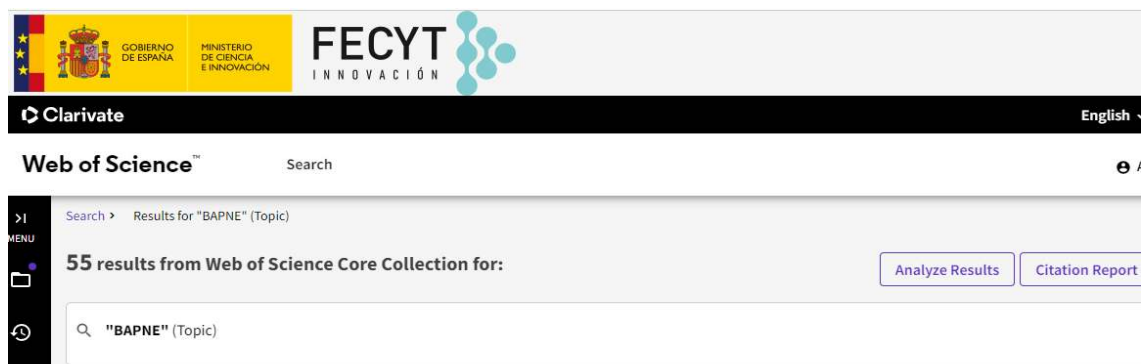
### Introduction

The benefits of movement are increasingly published scientific evidence of the positive health aspects of movement, which is why research in the fields of cognitive stimulation and movement have increased over the last ten years in areas such as cognitive development, mental health and wellness (de Oliveira et al., 2019; Loprinzi et al., 2013; Padilla & Coterón, 2013; Rolland et al., 2008; Wu & Huang, 2017).

Human beings possess a variety of cognitive, functional, motor, emotional and psychosocial skills that facilitate their adaptation to the environment. These skills have the capacity to be enriched through practice and the acquisition of experiences, through cognitive stimulation (Diamond, 2013; Espert & Villalba, 2014; Fuster, 2000).

In the 21st century, technologies limit movement time and social interactions, stimulating a sedentary lifestyle and decreasing cognitive stimulation. For this reason, movement and physical activity help to improve health problems and exercise brain functions (Aguilar et al., 2021; Andreu-Cabrera & Romero-Naranjo, 2021; Arnau-Mollá & Romero-Naranjo, 2024; Andreu-Cabrera et al., 2024; Asurmendi-Telleria & Romero-Naranjo, 2022; Di Russo et al., 2024; Khanjankhani et al. 2024; Kirschenbaum, 2013; Martínez et al., 2021; Mas-Mas et al., 2023; Pacheco et al., 2022; Padial-Ruiz et al., 2022; Palma et al., 2021; Pérez et al., 2022; Romero et al, 2021; Romero-Naranjo & Andreu-Cabrera, 2023a, 2023b, 2023c, 2023d; Zambrano et al., 2022).

Neuromotricity is one of the newly created disciplines concerned with cognitive stimulation through numerous activities and its foundation (Álvarez-Morales & Romero-Naranjo, 2019; Alonso-Marco & Romero-Naranjo, 2022; Alonso-Sanz & Romero-Naranjo, 2015; Arnau-Mollá & Romero-Naranjo, 2022a, 2022b; Di Russo & Romero-Naranjo, 2023; Romero-Naranjo, 2013, 2020, 2022; Romero-Naranjo & Andreu Cabrera, 2023c, 2023d; Romero-Naranjo & Llorca-Garnero, 2023; Romero-Naranjo et al., 2022; Romero-Naranjo, Pujalte-Cantó, et al., 2023; Romero-Naranjo, Sayago-Martínez et al., 2023; Romero-Naranjo et al., 2024). The BAPNE method is the leading producer of high-impact search engine literature on neuromotor skills. Figure 1 shows the number of publications.



**Figure 1.** Number of BAPNE method documents on neuromotricity

The term cognitive stimulation refers to a collection of techniques and approaches aimed at improving the performance of various skills such as perception, attention, reasoning, memory, language and motor skills through specialized training programs. However, cognitive stimulation is not limited only to the cognitive, but also considers emotional, behavioral, social and biological aspects, with the aim of intervening comprehensively in the adult person (Espert & Villalba, 2014).

On the other hand, this definition adds that individuals receive targeted interventions through a wide range of specific activities, which seek to stimulate thinking, concentration and memory in a general way. These interventions usually take place in a social setting, such as a small group, where interaction is encouraged and mutual support is provided among participants (Calatayud et al., 2020).

Following the PRISMA method, we can observe in general terms that there are 2,762 documents on this topic and globally following Web of Science. Even so, a filtering has been carried out between 2012 and 2022, choosing the specific articles on this subject and analysing the data specifically.

The main objectives of this research are focused on:

- Which are the most prominent authors on cognitive stimulation and movement?
- Which are the most representative lines on this subject?
- Which authors have the highest number of citations?

The purpose of this research is to show graphically the documents published per year, per language, the number of citations, publications linked to countries, universities, most relevant authors, as well as the most cited, papers per journal, citations per journal and research areas mainly.

#### ***Cognitive stimulation and movement. A bibliographic approach***

There is a close favorable relationship between movement and cognitive stimulation, implying a number of significant improvements in skills such as attention, memory, problem solving, and executive function (Paquette-Smith et al., 2018). Therefore, motion can be described as the observable transformation that occurs in the position, orientation, or physical state of an object or system over time. This change is the result of the influence of internal or external forces acting on its object, causing a change in location or spatial configuration. To synthesize, all this means that motion involves a discernible variation in the arrangement or shape of a body and its displacement (Broskey et al., 2019).

After a review of the literature on cognitive stimulation and movement, we found a majority percentage of studies that have been conducted to improve the quality of life of people with dementia. Currently, dementias are the fifth most common cause of death worldwide. It should be noted that Alzheimer's disease is the predominant type of dementia and comprises approximately 60% - 70% of cases, there are three other types of dementia that are common, but have received less attention in research, some examples are: vascular dementia, frontotemporal lobar degeneration and Lewy body disease (Krüger et al., 2021).

According to Woods, B. et al. (2023) cognitive stimulation provides notable advantages to people suffering from dementia by promoting substantial improvements in cognitive, functional and quality of life aspects. Cognitive stimulation therapy has been shown to be effective in enhancing memory, attention, language and other cognitive skills in individuals affected by dementia.

A remarkable effect of cognitive stimulation therapy was observed in improving both cognitive ability and functionality in people suffering from dementia. It was also evident that cognitive stimulation also generated a positive impact on the emotional well-being and quality of life of these individuals. These results support the fundamental importance of cognitive stimulation as a highly effective intervention to moderate cognitive and functional symptoms in people with dementia (Woods, R. T. et al., 2012).

Comprehensive epidemiological studies across the life cycle have shown that maintaining a high level of physical activity, especially during adolescence, confers significant benefits on cognitive performance in later adulthood (Voelcker-Rehage & Niemann, 2013). Similarly, high level scientific and prospective follow-up research has corroborated a positive relationship between physical activity during late adulthood and cognitive performance (Barnes et al., 2003). In relation to children and adolescents, numerous studies such as that of Sibley and Etnier (2003) have revealed a connection between physical activity and academic tasks.

Regarding the early care research line, several studies deserve to be mentioned. D'Amico and Guastella (2019) defend that, from multiple experiences, it has been experienced that robotics has a great potential in the field of strengthening the social skills of students with special educational needs or who belong to an early care program, but in this study it is aimed at students with autism spectrum disorder. Although there are few experimental studies that investigate the cognitive improvement and social skills of children with special needs through the use of robotic construction kits, which require both the construction of the robot's body and the programming of its own "mind", triggering a variety of cognitive stimulation and social skills. On the other hand, Chinôme (2017) found a positive relationship between early cognitive stimulation and improved motor and cognitive skills. Furthermore, a proportional relationship was observed, where a higher quantity and quality of cognitive stimulation was related to stronger attention during childhood.

Educational centers have a very relevant role in the holistic development of students, since they support students not only in their academic learning, but also in their personal, relational and proper incorporation into society. The place where students spend the most time is outside schools and institutes, for this reason it is necessary what they do during that time (Kristin-Mikalsen & Arild-Lagestad, 2020).

Teachers are among those who are responsible for the cognitive stimulation of students in schools through movement. Specifically, physical education teachers are in charge of this task, and what they transmit to them can have a positive impact on their development as individuals in different areas. Jordán and Codana (2019) discussed the influence of a teacher who is passionate about his or her students. This research concluded that the motivation of teachers with likable and sympathetic character traits and positive behavioural characteristics enables students to be more motivated and learn more.

A study by (Reina-Reina et al., 2022) focused on the analysis of the importance of cognitive stimulation in the primary education stage, as well as its influence on elementary school readiness. The results obtained revealed a positive relationship between a greater quantity and quality of cognitive stimulation in educational environments and an improved level of preparation for elementary school. In addition, it was observed that those children who received adequate cognitive stimulation demonstrated greater development in key areas such as language, attention and problem solving. These findings highlight the importance of cognitive stimulation in primary education. This suggests the creation of an enriching educational environment, thus fostering optimal development and an excellent transition into elementary school.

#### ***Terminological variants by authors***

In the first place, we find the term "cognitive therapy", one of the authors who uses this term is Martin (2011) and he expressed that evidence from a series of studies showed that cognitive training had a positive influence on the cognitive functioning of the elderly. Secondly, the term "cognitive rehabilitation" is used and according to Bahar-Fuchs et al. (2013), this term defines that they are specific forms of pharmacological intervention that aims to undertake cognitive and non-cognitive outcomes.

Finally, the term used in the search strategy and in the title of this research is "cognitive stimulation". The authors with the largest and most cited publications in the current research have used this term in their publications.

#### **Material & methods**

An ex post facto retrospective design was used according to the classification of Montero and León (2005) in which they present the classification and description of research methodologies in Psychology. On the other hand, a frequency analysis was performed on the selected study variables.

#### ***Sample***

For the present study, a sample of  $n= 72$  documents extracted from the primary search engines Web of Science and Scopus in the temporal period covering the last ten years (2012-2022) was selected. Web of Science was taken as the reference search engine, since the 44 documents selected in Scopus also appeared registered in Web of Science.

#### ***Instruments***

For the search, filtering, selection and extraction of the information, the analysis tools offered by the Web of Science and Scopus engines were used. The bibliographic manager Refworks was used to export references. Finally, Microsoft Excel was used to check for duplicates, as well as for the classification and frequency analysis of the information and the creation of tables and figures.

#### ***Procedure***

The information was searched in all the databases included under the subscription of the University of Alicante in the Web of Science and Scopus search engines between January and February 2023. Specifically, Web of Science contained the databases Web of Science Core Collection, BIOSIS Citation Index, Current Contents Connect, Data Citations Index, Derwent Innovations Index, FSTA® - The food science resource, Inspec®, KCI-Korean Journal Database, Medline®, SciELO Citation Index and Zoological Record. The search strategy was specified in the "Topic" field in Web of Science and in "All Fields" in Scopus.

First, a search for the words cognitive stimulation and movement was carried out in eight languages other than English to determine the presence of this term in each language. Table 1 shows the results of this search.

**Table 1.** Results obtained in the words cognitive stimulation in different languages

Language	Term	WoS	Scopus
Italian	"Stimolazione cognitiva"	0	1
Chinese	"ÈĪÖªμÁ Ĩ¼σ"	0	0
Korean	"인지 자극"	0	0
Portuguese	"Estimulação cognitiva"	0	16
German	"Kognitive Stimulation"	0	21
Japanese	"'F'm<@'\ŽhEj"	0	0
Polish	"Stymulacja poznawcza"	0	0
Russian	"Когнитивная стимуляция"	0	1
Spanish	"Estimulación cognitiva"	0	48

Subsequently, the search strategy was designed based on the words "cognitive stimulation" and "movement" using the Boolean operators "And" and "Or" to finally add synonyms of each word to broaden the results. the final strategy was ("cognitive stimulation") (topic) and ("\*movement\*" or "\*rhythm\*" or "\*dance\*" or "\*music\*" or "\*motor skills\*" or "\*motor development\*" or "\*motor ability\*" or "\*education\*") (topic).

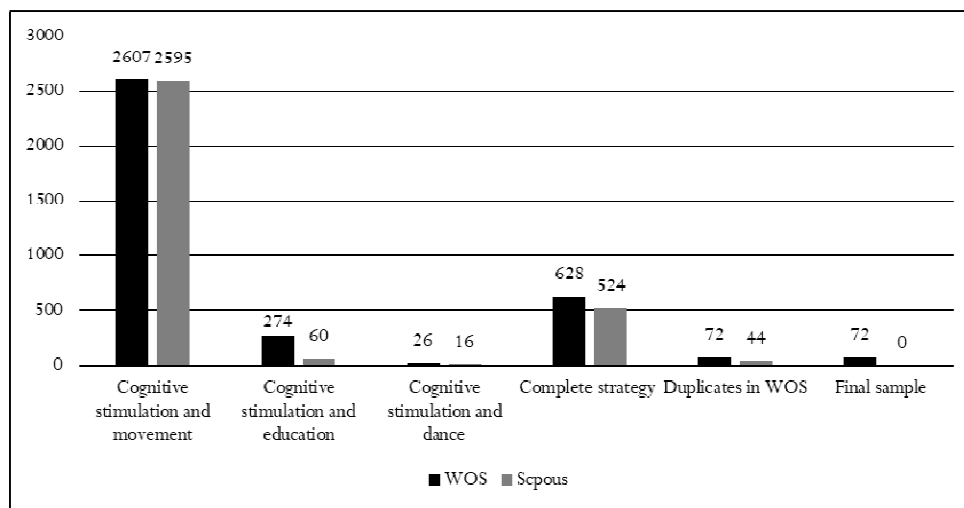
Inclusion criteria were then designed for the selection of documents, which had to meet some of the following criteria:

- Be material published within the 2012-2022 time period.
- Include some term from the search strategy in the title, abstract or keywords.
- Refer to cognitive stimulation in conjunction with education or movement in a meaningful way (first order) or address cognitive stimulation in a generalized way (second order).

It should be noted that in terms of order, the priority of the papers found was divided into two groups. The papers collected as first order were all those whose object of study was cognitive stimulation and movement in the educational setting, regardless of the age of the subjects or the diseases, disorders or syndromes. On the other hand, the publications that were classified as second-order had in common the investigation of cognitive stimulation and movement in a generalized way.

A first screening of the information was then carried out, discarding all those documents that clearly did not fit the inclusion criteria, and then a second screening was carried out to allow us to adjust the selection of the final sample as much as possible. This sample was saved in the lists of results offered by the search engines.

The information was then exported to the bibliographic manager Refworks and to the Microsoft Excel software, where it was compared and duplicates were detected for elimination. Figure 2 shows the information selection process until the final sample was obtained.



**Figure 2.** Document selection process

Finally, a database was created in Microsoft Excel in which the parcelled, ordered and classified information was added for subsequent frequency analysis and the creation of tables and figures.

## Results

### Documents by year

The final sample consisted of 72 documents extracted between 2012 and 2022. An upward trend is observed ranging from one publication in 2013 to 11 publications in 2021 and 2022 being these the years with the lowest and highest number of published papers. Drastic decreases and increases in publications were found. Between the years 2012 to 2013 there was a drop from four to one publication, and between 2018 and 2019 from 10 to four

publications. On the other hand, we found significant publication increases between 2013 and 2014 (from one to six), between 2016 and 2017 (from five to nine), and between 2020 and 2021 (from six to 11). Figure 3 shows in more detail the number of documents by year of publication.

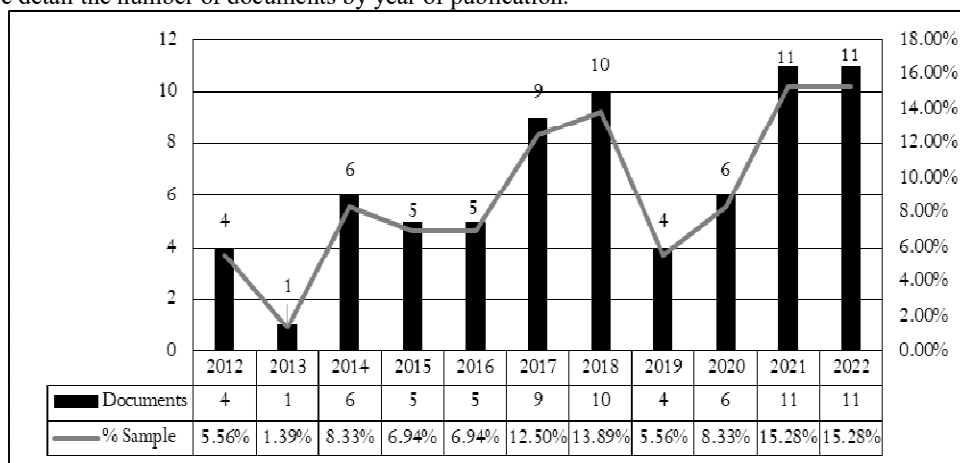


Figure 3. Documents by year

#### Documents by language

A total of seven different languages emerged in the selected sample, with English being the predominant language with 84.72% of the publications (61 papers). The remaining papers ranged from one to three papers per language. Figure 4 shows the number of papers per language.

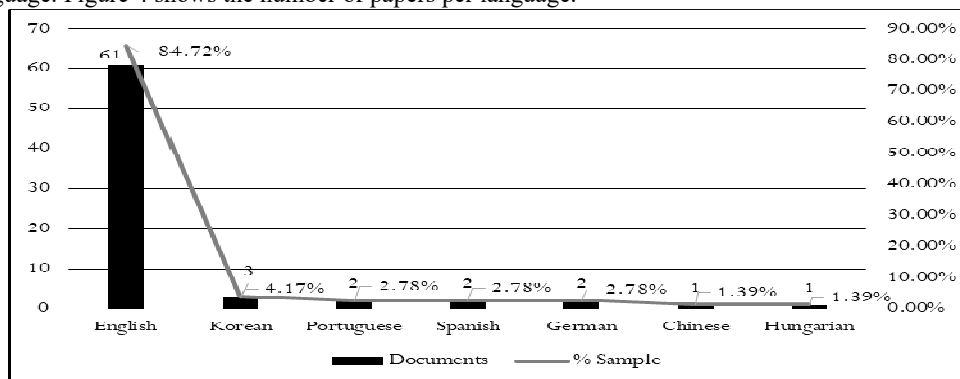


Figure 4. Documents by language.

#### Appointments per year

In the time period from 2012 to 2022 the selected sample received a total of 1049 citations. Citations per year ranged from four in 2013 to 350 in 2012. 60.25% of the citations were concentrated in two years, 350 in 2012 and 282 in 2017. With more than 100 citations, two years were found, 2015 with 111 and 2016 with 101. On the other hand, the last five years (2018-2022) collected 14.11% of the 1049 citations in the sample (148 citations). Figure 5 shows the number of citations per year of the selected sample.

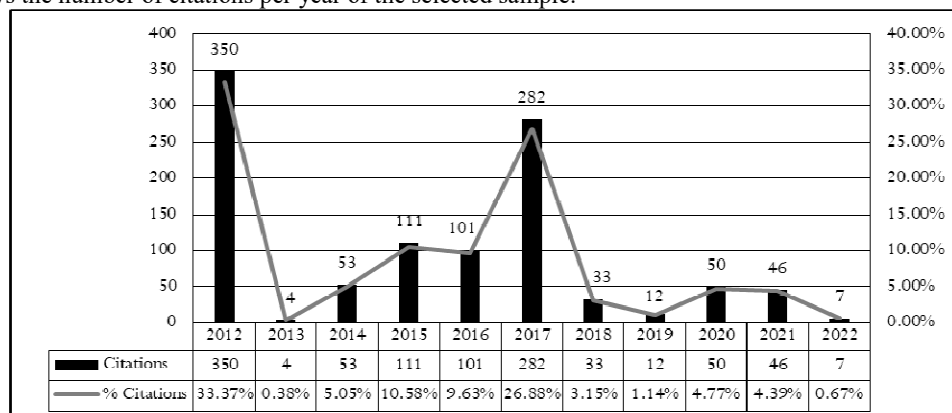


Figure 5. Academic citations per year

#### Citations per document

The range of citations per document is between 0 and 210. Papers without citations predominate, occupying 30.56% of the sample (22 documents), while the highest concentration of citations (39.94%) was observed in two

documents, one with 210 and the other with 209. 44% of the sample (32 documents) that collected 12.11% of the citations (127 citations); between 11 and 37 citations per document, 18.06% of the sample (13 documents) with a total of 293 citations (27.93%); and between 51 and 93 citations per document, 4.17% of the sample (3 documents) with a sum of 210 citations in total (20.02%). Table 2 shows the ratio of citations per document.

**Table 2.** *Number of citations per document*

Citations	Documents	% Sample	Sum of citations	% Total citations
0	22	30.56%	0	0.00%
1	6	8.33%	6	0.57%
2	4	5.56%	8	0.76%
3	2	2.78%	6	0.57%
4	7	9.72%	28	2.67%
5	6	8.33%	30	2.86%
6	3	4.17%	18	1.72%
7	2	2.78%	14	1.33%
8	1	1.39%	8	0.76%
9	1	1.39%	9	0.86%
11	1	1.39%	11	1.05%
12	1	1.39%	12	1.14%
13	2	2.78%	26	2.48%
17	2	2.78%	34	3.24%
20	1	1.39%	20	1.91%
27	1	1.39%	27	2.57%
29	2	2.78%	58	5.53%
31	1	1.39%	31	2.96%
37	2	2.78%	74	7.05%
51	1	1.39%	51	4.86%
66	1	1.39%	66	6.29%
93	1	1.39%	93	8.87%
209	1	1.39%	209	19.92%
210	1	1.39%	210	20.02%
Total	72	100.00%	1049	100.00%

**Documents by country**

A total of 22 countries were found that published between one and 16 papers per country. England, Switzerland and the USA stood out as the most productive countries, accounting for 54.17% of the final sample with 16, 12 and 11 documents, respectively. On the other hand, seven countries published between two and four papers each (21 papers) making up 29.17% of the sample. Finally, 54.55% of the countries (12 countries) wrote one paper each (16.67% of the sample).

Regarding the number of citations per country, we found a range between zero and 614. The most cited countries accounted for 86.94% of the citations, with England with 614, the USA with 179 and Switzerland with 119. Table 3 shows in more detail the number of documents and countries participating in the final sample.

**Table 3.** *Documents and citations by country*

Countries	Documents	% Sample	Citations	% Citations	Mean citations by document
England	16	22.22%	614	58.53%	38.38
Switzerland	12	16.67%	119	11.34%	9.92
USA	11	15.28%	179	17.06%	16.27
Korea	4	5.56%	1	0.10%	0.25
Brasil	4	5.56%	4	0.38%	1.00
Spain	3	4.17%	7	0.67%	2.33
Turkey	3	4.17%	9	0.86%	3.00
Germany	3	4.17%	51	4.86%	17.00
New Zealand	2	2.78%	42	4.00%	21.00
Netherlands	2	2.78%	4	0.38%	2.00
Bangladesh	1	1.39%	1	0.10%	1.00
Slovakia	1	1.39%	0	0.00%	0.00
Portugal	1	1.39%	0	0.00%	0.00
Colombia	1	1.39%	0	0.00%	0.00
Costa Rica	1	1.39%	0	0.00%	0.00
Taiwan	1	1.39%	2	0.19%	2.00
Chile	1	1.39%	4	0.38%	4.00
Austria	1	1.39%	4	0.38%	4.00
United Kingdom	1	1.39%	0	0.00%	0.00
Hungary	1	1.39%	8	0.76%	8.00
Argentina	1	1.39%	0	0.00%	0.00
Italy	1	1.39%	0	0.00%	0.00
Total	72	1	1049	100.00%	14.57

**Papers and citations by university**

The analysis showed a total of 48 universities that published 77.78% of the papers (56 documents). The

universities that registered a single document predominated, that is, 91.67% of the universities (44) published 61.11% of the final sample (44 documents). The University of Alicante was the most prolific with five publications (6.94%) followed by the University of London with 3 (4.17%) and the universities of Michigan System and Manchester with 2 (2.78% each).

In terms of the number of citations, the 48 participating universities received 97.52% of the citations in the final sample (1023). Fourteen of the 48 universities (29.17%) did not record any citations, while another 17 (35.42%) collected 8.10% of the citations in the final sample (85), distributed between two and nine citations per university. On the other hand, 13 of the 48 universities hosted 31.109% of the citations (318) ranging from 12 to 51 citations per university. Finally, four of the 48 universities (8.33%) accounted for 60.61% of the citations (620), with Ghent university being the most cited (210) followed by the universities of Sao Paulo (209), London (209) and Bangor (93). Table 4 shows the number of papers submitted and citations received by each participating university.

**Table 4. Documents and citations by university**

University	Documents	% Sample	Citations	% Citations sample
Ghent University	1	1.39%	210	20.02%
Universidade de Sao Paulo	1	1.39%	209	19.92%
University of London	3	4.17%	108	10.30%
Bangor University	1	1.39%	93	8.87%
Queens University - Canada	1	1.39%	51	4.86%
Sapienza University Rome	1	1.39%	37	3.53%
University of Michigan System	2	2.78%	31	2.96%
Johns Hopkins University	1	1.39%	31	2.96%
Michigan State University	1	1.39%	29	2.76%
McGill University	1	1.39%	29	2.76%
University of Manchester	2	2.78%	25	2.38%
La Trobe University	1	1.39%	17	1.62%
Universidade Estadual de Campinas	1	1.39%	17	1.62%
University of Hong Kong	1	1.39%	13	1.24%
University of Miami	1	1.39%	13	1.24%
Universitat of Alicante	5	6.94%	13	1.24%
Univ Vechta	1	1.39%	12	1.14%
17 universities with 1 paper and less than 10 citations (2-9)	17	23.61%	85	8.10%
14 universities with 1 document without citations	14	19.44%	0	0.00%
Total: 48 universities	56	77.78%	1023	97.52%

**Papers by category, type of papers and order of processing**

In terms of number of papers and citations, 2nd order publications predominated with 49 papers (68.06%) that received 901 citations (85.89%) compared to 23 1st order papers (31.94%) that received 148 citations (14.11%).

Four different types of documents were found. The article prevailed with 52 papers (72.22%) and 597 citations (56.91%); followed by the review format with 11 papers (15.28%) cited 384 times (36.61%); proceedings papers with seven printings (9.72%) and 68 citations (6.48%); and two conferences papers (2.78%) that did not receive any citations.

On the other hand, five categories emerged. In terms of production, the literature on Alzheimer's disease stood out with 21 papers (29.17%); followed by dementia with 20 papers (27.78%); early care with 15 papers (20.83%); education with 12 printings (16.67%); and Parkinson's with four papers (5.56%). On the other hand, in terms of the number of citations received, this order was altered with 449 citations for dementia (42.80%), 233 for Alzheimer's disease (22.21%), 219 for Parkinson's disease (20.88%), 82 for education (7.82%) and 66 for early intervention (6.29%). Table 5 presents in more detail the documents and citations received in terms of order of treatment, type of document and category.

**Table 5. . Documents and citations by processing order, document type and category**

Categories	Document type	1st Order				2nd Order				Total			
		Docs.	% Sam.	Cit.	%Cit.	Docs.	% Sam.	Cit.	%Cit.	Docs.	% Sam.	Cit.	%Cit.
Alzheimer		5	6.94%	51	4.86%	16	22.22%	182	17.35%	21	29.17%	233	22.21%
	Article	3	4.17%	22	2.10%	11	15.28%	59	5.62%	14	19.44%	81	7.72%
	Conference Paper	1	1.39%	0	0.00%	0	0.00%	0	0.00%	1	1.39%	0	0.00%
	Proceedings Paper	0	0.00%	0	0.00%	2	2.78%	53	5.05%	2	2.78%	53	5.05%
	Review	1	1.39%	29	2.76%	3	4.17%	70	6.67%	4	5.56%	99	9.44%
Dementia		2	2.78%	6	0.57%	18	25.00%	443	42.23%	20	27.78%	449	42.80%
	Article	1	1.39%	0	0.00%	12	16.67%	164	15.63%	13	18.06%	164	15.63%
	Review	1	1.39%	6	0.57%	6	8.33%	279	26.60%	7	9.72%	285	27.17%
Early care		5	6.94%	9	0.86%	10	13.89%	57	5.43%	15	20.83%	66	6.29%
	Article	4	5.56%	9	0.86%	10	13.89%	57	5.43%	14	19.44%	66	6.29%
	Conference Paper	1	1.39%	0	0.00%	0	0.00%	0	0.00%	1	1.39%	0	0.00%
Education		11	15.28%	82	7.82%	1	1.39%	0	0.00%	12	16.67%	82	7.82%
	Article	7	9.72%	67	6.39%	0	0.00%	0	0.00%	7	9.72%	67	6.39%
	Proceedings Paper	4	5.56%	15	1.43%	1	1.39%	0	0.00%	5	6.94%	15	1.43%
Parkinson		0	0.00%	0	0.00%	4	5.56%	219	20.88%	4	5.56%	219	20.88%
	Article	0	0.00%	0	0.00%	4	5.56%	219	20.88%	4	5.56%	219	20.88%
General total 4 types of documents		23	31.94%	148	14.11%	49	68.06%	901	85.89%	72	100.00%	1049	100.00%

**Number of authors per document**

The selected sample was written by a range of between one and 44 authors. Regarding the number of authors per paper, papers written by three authors predominated with 18 papers (25.00%), followed by those created by two authors with 12 papers (16.67%). The sum of papers written by four to 12 authors amounted to 39 (54.17%). It should be noted that only one paper (1.39%) was written by 11 authors and another by 44 authors (1.39%), as well as two papers written alone (2.78%). The five papers written by seven authors (6.94%) received a total of 225 citations (21.45%); followed by the paper written by 11 authors (1.39%) with 210 citations (20.02%); the 18 papers written by three authors (25.00%) with 163 citations (15.54%); and the five papers written by 12 authors (6.94%) with 139 citations (13.25%). The remaining collaborations produced 43 papers (59.72%) and received a total of 312 citations (29.74%). Finally, the collaboration index between authors in the final sample resulting from dividing the sum of documents produced in collaboration by the total number of documents was 0.97. Table 6 shows the number of authors per document, the citations they received and the total number of author participations in these documents.

**Table 6.** Number of authors per document, citations received and authorship participation

Authors	Documents	% Sample	Citations	% Citations	Total authors
1	2	2.78%	3	0.29%	2
2	12	16.67%	53	5.05%	24
3	18	25.00%	163	15.54%	54
4	7	9.72%	76	7.24%	28
5	8	11.11%	81	7.72%	40
6	4	5.56%	41	3.91%	24
7	5	6.94%	225	21.45%	35
8	4	5.56%	31	2.96%	32
9	3	4.17%	15	1.43%	27
10	2	2.78%	11	1.05%	20
11	1	1.39%	210	20.02%	11
12	5	6.94%	139	13.25%	60
44	1	1.39%	1	0.10%	44
Total	72	100.00%	1049	100.00%	401

**Documents per author**

A total of 374 different authors were found of which 351 (93.85%) participated in a single paper, and 22 authors (5.82%) in two papers each (61.11%). The most productive author was Francisco Javier Romero-Naranjo who participated in six papers (8.33%). Table 7 shows the papers by author and the citations received.

**Table 7.** Documents by author and citations received

Authors	Documents	% Sample	Citations	% Citations
Romero-Naranjo, Francisco Javier	6	8.33%	16	1.53%
Abraha, I	2	2.78%	210	20.02%
Arnaú-Molla, Antonio Francisco	2	2.78%	1	0.10%
Blessano, Elena	2	2.78%	11	1.05%
Casseb, Raphael Fernandes	2	2.78%	17	1.62%
Castellano, Gabriela	2	2.78%	17	1.62%
Cozzutti, Giorgio	2	2.78%	11	1.05%
de Almeida, Debora Queiroz	2	2.78%	17	1.62%
de Campos, Brunno Machado	2	2.78%	17	1.62%
de Ligo Teixeira, Camila Vieira	2	2.78%	17	1.62%
Forlenza, Orestes Vicente	2	2.78%	17	1.62%
Masci, Ilaria	2	2.78%	5	0.48%
Mavilidi, Myrto Foteini	2	2.78%	5	0.48%
Mazzoli, Emiliano	2	2.78%	5	0.48%
Pesce, Caterina	2	2.78%	5	0.48%
Schmidt, Mirko	2	2.78%	5	0.48%
Scibinetti, Patrizia	2	2.78%	5	0.48%
Spector, Aimee	2	2.78%	42	4.00%
Tocci, Nicoletta	2	2.78%	5	0.48%
Trotta, Fabiana Mirella	2	2.78%	210	20.02%
Vicentini, Jessica Elias	2	2.78%	17	1.62%
Weiler, Marina	2	2.78%	17	1.62%
Wong, Gloria H. Y.	2	2.78%	18	1.72%
351 authors with 1 document	1	1.39%	0-210	0.00%-20.02%

**Citations by author and most cited papers**

Among the 374 authors found in the final sample 85 of them (22.73%) did not receive any citations, while 66 (17.65%) were cited only once. On the other hand, 185 of the authors (49.47%) received between two and 42 citations. Finally, the remaining 38 authors (10.16%) coincided as authors of the five most cited papers receiving between 51 and 210 citations each. It should be noted that of these 38 authors, 36 participated in only one paper,



except for Abraha, I. and Trotta, F. M. who participated in two. Table 8 shows the five most cited articles with their respective references.

**Table 8. Most cited documents**

References	Citations	% Citations
Abraha, I., Rimland, J. M., Trotta, F. M., Dell'Aquila, G., Cruz-Jentoft, A., Petrovic, M., Gudmundsson, A., Soiza, R., O'Mahony, D., Guaita, A., & Cherubini, A. (2017). Systematic review of systematic reviews of non-pharmacological interventions to treat behavioural disturbances in older patients with dementia. <i>The SENATOR-OnTop series. BMJ open</i> , 7(3), e012759. <a href="https://doi.org/10.1136/bmjopen-2016-012759">https://doi.org/10.1136/bmjopen-2016-012759</a>	210	20.02%
Pompeu, J.E., dos Santos Mendes, F.A., da Silva, K.G., Lobo, A.M., Oliveira, T.P., Zomignani, A.P., & Pimentel Piemonte, M.E., (2012). Effect of nintendo wii (TM)-based motor and cognitive training on activities of daily living in patients with parkinson's disease: A randomised clinical trial. <i>Physiotherapy</i> , 98(3), 196-204. <a href="https://doi.org/10.1016/j.physio.2012.06.004">https://doi.org/10.1016/j.physio.2012.06.004</a>	209	19.92%
Woods, R. T., Bruce, E., Edwards, R. T., Elvish, R., Hoare, Z., Hounscome, B., Keady, J., Moniz-Cook, E. D., Orgeta, V., Orrell, M., Rees, J., & Russell, I. T. (2012). REMCARE: Reminiscence groups for people with dementia and their family caregivers-Effectiveness and costeffectiveness pragmatic multicentre randomised trial. <i>Health Technology Assessment</i> , 16(48). <a href="https://doi.org/10.3310/hta16480">https://doi.org/10.3310/hta16480</a>	93	8.87%
Bedford, R., Saez de Urabain, I. R., Cheung, C. H., Karmiloff-Smith, A., & Smith, T. J. (2016). Toddlers' fine motor milestone achievement is associated with early touchscreen scrolling. <i>Frontiers in psychology</i> , 7, Article 1108, 1-8. <a href="https://doi.org/10.3389/fpsyg.2016.01108">https://doi.org/10.3389/fpsyg.2016.01108</a>	66	6.29%
Cuddy, L. L., Sikka, R., & Vanstone, A. (2015). Preservation of musical memory and engagement in healthy aging and Alzheimer's disease. <i>Annals of the New York Academy of Sciences</i> , 1337(1), 223–231. <a href="https://doi.org/10.1111/nyas.12617">https://doi.org/10.1111/nyas.12617</a>	51	4.86%

**Papers per journal**

A total of 59 journals were found of which 49 (83.06%) published a single paper each (68.08% of the sample) and received a total of 608 citations (57.96%). On the other hand, seven journals (11.86%) printed two papers each (19.44%) receiving in total 114 citations (10.87%), and three other journals (5.08%) produced three papers each (12.50%) obtaining 327 citations in total (31.17%). The most prolific and most cited journal was Bmj Open with three papers (4.17%) and 214 citations (20.40%). In Table 9 we can observe the relation of documents per journal and their respective citations.

**Table 9. Documents by magazine**

Journals	Docs	% Sample	Cit	% Cit	Mean cit. by doc
Bmj Open	3	4.17%	214	20.40%	71.33
Erpa International Congress on Education (Erpa Congress 2014)	3	4.17%	42	4.00%	14.00
Frontiers in Aging Neuroscience	3	4.17%	71	6.77%	23.67
Clinical Interventions in Aging	2	2.78%	26	2.48%	13.00
Dementia- International Journal of Social Research and Practice	2	2.78%	9	0.86%	4.50
Figshare	2	2.78%	9	0.86%	4.50
Frontiers in Psychology	2	2.78%	1	0.10%	0.50
International Journal of Geriatric Psychiatry	2	2.78%	22	2.10%	11.00
Journal of Advanced Nursing	2	2.78%	0	0.00%	0.00
Retos-Nuevas Tendencias en Educación Física. Deporte y Recreación	2	2.78%	47	4.48%	23.50
49 journals with 1 document	49	68.06%	608	57.96%	12.41
Total: 59 Journals	72	100.00%	1049	100.00%	14.57

**Citations per journal**

Regarding the number of citations per journal, it was found that 18 of the 59 journals (30.51%) received no citations; another five (8.47%) were cited only once (0.48%); and 19 journals (32.20%) received a total of 94 citations (8.96%) distributed between two and nine citations each journal. On the other hand, 15 journals (25.42%) received a total of 527 citations (50.24%) ranging from 11 to 93 citations each. The most cited journals are Bmj Open with 214 citations (20.40%) and Physiotherapy with 209 (19.92%). Table 10 details the citation ratio by journal.

**Table 10. Citations by journal**

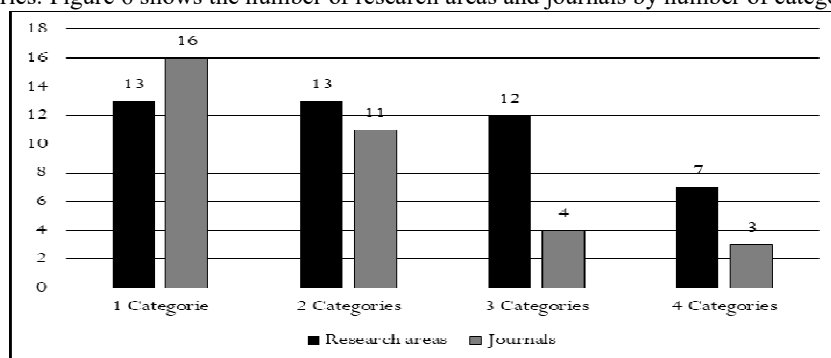
Journals	Docs.	% Sample	Cit.	% Cit.
Bmj Open	3	4.17%	214	20.40%
Physiotherapy	1	1.39%	209	19.92%
Health Technology Assessment	1	1.39%	93	8.87%
Frontiers in Psychology	2	2.78%	71	6.77%
Neurosciences and Music v: Cognitive Stimulation and Rehabilitation	1	1.39%	51	4.86%
Journal of Advanced Nursing	2	2.78%	47	4.48%
Clinical Interventions in Aging	2	2.78%	42	4.00%
Cognitive Processing	1	1.39%	37	3.53%
Harvard Review of Psychiatry	1	1.39%	31	2.96%
Frontiers in Neuroendocrinology	1	1.39%	29	2.76%
Journal of Developmental and Behavioral Pediatrics	1	1.39%	29	2.76%
Frontiers in Aging Neuroscience	3	4.17%	26	2.48%
Dementia-International Journal of Social Research and Practice	2	2.78%	22	2.10%
Plos One	1	1.39%	13	1.24%

Gerontologist	1	1.39%	13	1.24%
Zeitschrift fur Gerontologie und Geriatrie	1	1.39%	12	1.14%
Bmj Clinical Evidence	1	1.39%	11	1.05%
19 journals between two and nine citations	24	30.56%	94	8.96%
five magazines with one citation	6	8.33%	5	0.48%
18 uncited journals	19	23.61%	0	0.00%

**Research areas and journals by number of categories**

Of the 59 journals found in the final sample, 34 (57.63%) presented JCR categories; 33 (55.93%) JCR and JCI; one (1.69%) only JCR; seven (11.86%) only JCI; and 18 did not present any category.

A total of 57.63% of the journals (34) published 43 papers (59.72%) that received 1005 citations (95.81%). These journals presented between one and four JCR categories. There was a predominance of journals with only one category, 16 (27.12%). Regarding the research areas, the highest number (13) was found in journals with one and two categories. Figure 6 shows the number of research areas and journals by number of categories.



**Figure 6.** Research areas and journals by number of categories

In the journals with one JCR category, the research areas Medicine, General & Internal and Gerontology stood out, appearing in five and three journals, respectively. Regarding journals with two JCR categories, the research areas Nursing (6), Neurosciences (5) and Geriatrics & Gerontology (4) predominated. As for journals with three JCR categories, the 12 emerging research areas appeared only once. Finally, in journals with four JCR categories, the research area Psychiatry predominated (6). Table 11 shows in greater detail the number and names of the research areas found in journals with between one and four JCR categories.

**Table 11.** Detail of the research areas of the journals according to their number of categories

1 Category	Jour.	2 Categories	Jour.	3 Categories	Jour.	4 Categories	Jour.
Medicine, General & Internal	5	Nursing	6	Pediatrics	1	Psychiatry	6
Gerontology	3	Neurosciences	5	Psychology, Experimental	1	Geriatrics & Gerontology	3
Geriatrics & Gerontology	2	Geriatrics & Gerontology	4	Psychology, Developmental	1	Gerontology	3
Psychology, Multidisciplinary	2	Psychiatry	2	Chemistry, Analytical	1	Engineering, Multidisciplinary	1
Multidisciplinary Sciences	1	Psychology, Developmental	2	Instruments & Instrumentation	1	Physics, Applied	1
Psychology, Experimental	1	Education & Educational Research	2	Computer Science, Interdisciplinary Applications	1	Chemistry, Multidisciplinary	1
Neurosciences	1	Clinical Neurology	1	Psychology, Applied	1	Materials Science, Multidisciplinary	1
Computer Science, Artificial Intelligence	1	Rehabilitation	1	Computer Science, Software Engineering	1		
Rehabilitation	1	Gerontology	1	Psychology, Educational	1		
Public, Environmental & Occupational Health	1	Education, Special	1	Engineering, Electrical & Electronic	1		
Health Care Sciences & Services	1	Tropical Medicine	1	Behavioral Sciences	1		
Clinical Neurology	1	Parasitology	1	Imaging Science & Photographic Technology	1		
Cell Biology	1	Endocrinology & Metabolism	1				

Note: Jour. (Journals).

In total, 35 research areas were found in the 34 journals with JCR categories. 65.71% of the research areas (23) appeared only once; five areas (14.29%) twice each; one area (2.86%) three times; another area (2.86%) five times; and two more (5.72%) six times each. The most significant research areas were Geriatrics & Gerontology (9), Gerontology (8), and Psychiatry (7). The main research areas are presented in Figure 7.

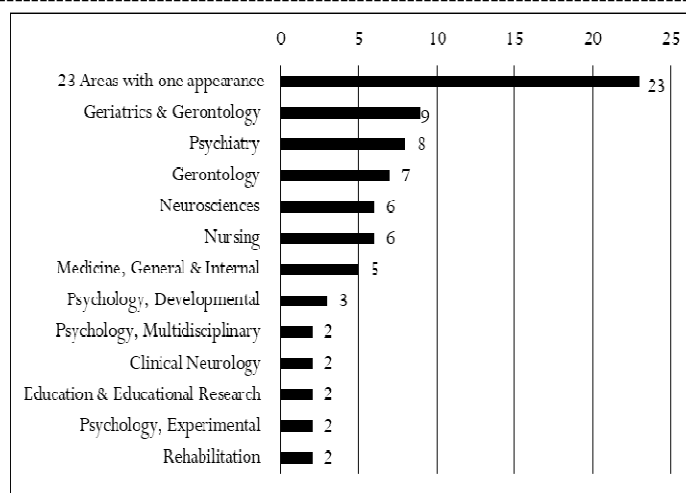


Figure 7. Main research areas

**Quartile of journals by research areas**

Of the 34 journals that presented JCR categories, 14 were classified in Q2 (41.18%), 10 in Q1 and Q3 (29.41% in each quartile), and eight in Q4 (23.53%). It should be noted that each journal could contain several categories. Among the journals with one or three categories, Q2 predominated (five and three journals, respectively); among those with two categories, Q1 (6 journals); and among those with four categories, Q2 and Q3 (3 journals in each quartile). Figure 8 shows the quartiles of the journals according to the number of journal categories.

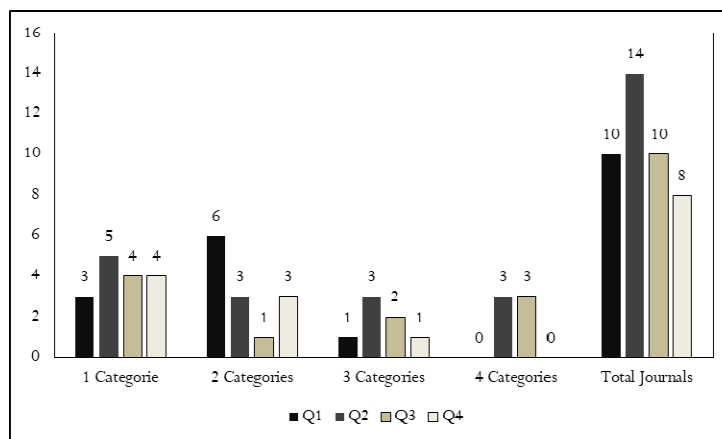


Figure 8. Quartile of journals according to journal categories

**Conclusions**

Until now there was no bibliometric study that investigated cognitive stimulation and movement. The vast majority of publications on this topic are oriented to the field of medicine, many experimental investigations can be found that aim to improve the quality of life of people with dementia or children who have some kind of syndrome. However, in the field of education there is not much research that studies the influence of cognitive stimulation and movement in students of different existing educational stages.

As main results, it is shown that cognitive stimulation and movement began to be investigated at a scientific-academic level in 2012 and that the years with the highest activity are 2021 and 2022 with 11 articles each. The publications are written in 7 languages and four different types of documents, thus highlighting articles with 52 publications and reviews with 11 studies.

Geographically, there are 22 countries that are part of the sample, with 12 being the maximum number of countries that have only published one research. The countries with the highest literature production are England with 16 studies and Switzerland with 12 studies. In terms of research areas, there are five areas such as dementia, Alzheimer's, education and Parkinson's. The area with the highest number of publications is dementia, Alzheimer's, education and Parkinson's disease. The area with the highest number of publications is dementia with 20 studies.

One of the main reasons why more research should be conducted in the educational field is because of the great benefits in motor skills, since cognitive stimulation promotes the development of motor skills in infants, as well as eye-hand coordination, balance and motor planning (Best, 2010). In addition, cognitive stimulation along with movement can have a positive impact on academic performance, such as improvements in the learning

process, concentration and memory (Hillman et al., 2009). We should also not forget that it can help the development of brain plasticity and facilitate cognitive development in areas such as attention, memory and executive functions (Diamond & Ling, 2019). On the other hand, the combination of cognitive stimulation and movement can favor stress reduction and improve the emotional well-being of students by finding a balance between physical activity and cognitive skills (Pesce et al., 2013).

Therefore, and given that cognitive stimulation and movement is a recurring theme in recent years, it would be helpful for researchers and teachers to promulgate research in the educational field to increase the number of high-impact publications.

Some possible lines of future research could be to know in depth the state of the art of cognitive stimulation and movement, on the one hand, using only and exclusively scientific literature found in secondary search engines. Discarding all the documents collected for this study. On the other hand, to perform an analysis of the two studies as a whole in order to obtain a segmented and global overview that shows a current understanding of this research topic.

Another possible line of research would be an experimental study on the subject of the study, that is, to contribute to educational research in this area. For this purpose, a research would be proposed in which cognitive stimulation and movement would be worked with students in kindergarten, primary or secondary education. With the aim of analyzing the motor and cognitive benefits that these produce in the students.

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