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# Understanding the links between neuroscience and culture through a social network analysis: insights for IS research

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**Abstract.** This study aims to understand the links between neuroscience and culture through a social network analysis. It was conducted a systematic literature review and a bibliometric analysis by using one online database, such as Scopus. A dataset of 78 publications was analyzed through citation and co-citation analysis. Results have shown the existence of a network of the 47 most cited sources and 2 topic clusters: the cluster of the new factors and new technologies to understand and describe the behavior of individuals and groups for the success and the cluster of the factors such as culture, trust, reciprocity, emotions, neural mechanisms, reason, which determine our way of being, our self, our behavior (especially organizational behavior), our choices, our cognitive process, our moral judgment in different situations. This paper contributes to the literature by presenting a comprehensive overview of neuroscience and culture in organization and managerial fields leads to further reflections on the use of information and communication technologies to obtain even more sophisticated and more predictive neuroscientific information of individuals’ behaviors.

**Keywords:** Neuroscience, Culture, SNA, Bibliometric analysis, Citation analysis, Co-citation analysis.

## 1 Introduction

Neuroscience, and in particular cognitive neuroscience and culture are two topics that are increasingly discussed in the managerial and Information Systems (ISs). Neuroscience is a hybrid discipline that ranges from molecular neurobiology studies to those on the structure and function of neurons of the nervous system and then get to the complex psychobiology studies that go as far as the clinical field. It defined as the set of scientifically conducted studies on the nervous system able to reveal, among other more technical information, interesting details on how neural mechanisms can translate into certain behaviors by individuals [1]. The relevance of the discipline certainly also emerges from the enormous interest shown in it at the international level and expressed through the creation of various Institutions actively engaged in research as the Society for Neuroscience, born in the United States of America in 1971, the European

Neuroscience Association born in Europe at the beginning of the 70s and the Italian Society for Neuroscience born in 1983.

In the field of neuroscience, cognitive neuroscience has the ambitious theoretical objective of identifying, understanding, explaining, and possibly modifying the neurobiological mechanisms of the mind that regulate human cognition and mental processes. It is a field of study that can also be considered a branch of psychology as it is possible to notice a strong connection with it, as well as being able to be confined branches of cognitive sciences, computer science and philosophy of mind. Despite being a rather young discipline, it is rapidly becoming one of the most active and most important areas of scientific research for the understanding of mental processes and human behavior starting from the study of the properties of the brain in its interactions with the body and with the external environment, understood in its broadest sense and, therefore, also as a social and cultural environment.

In recent years there was an interesting evolution in neuroscience which increasingly makes it a science of Big Data thanks to the use of modern information and communication technologies (ICTs) for the collection and analysis of neuroscientific data. It is certain that the use of these new technologies will allow us to know, in a more in-depth way, the brain and the neural mechanisms that inform our decision-making processes, our attitudes and our behaviors, but at the same time it is raising strong ethical concerns. Many scholars stressed the links between Neuroscience and Management, giving rise to Neuromanagement. According to Cocco [2]: "It is time for management to update too and undertake a path to innovate the behavioral part and the "managerial mind" by connecting these elements to the developments of recent revolutionary studies and research on the human brain and on the processes of choice and decision. Only by taking note of the actual cognitive, emotional and perceptive resources that human beings possess, will economic operators be able to face the challenges that the globalized economy poses with increasing complexity and ever more widespread threats". In this regard, other research [3] pointed out that Neurodiversity is natural phenomenon and, to ensure the psychological and organizational well-being of neurodivergent workers, there should be an empathic culture accompanied by new management approaches that respect these diversities.

Neuroscience can also help reduce work-related stress. In particular, Chase [4] explained how the results of neuroscience can translate into useful tools to stem the growing wave of stress in the workforce. The Author introduced the concept of aligning workplace practices with biological processes with hope to open a debate around shifting cultural perceptions of what constitutes the real well-being of work forces.

Also, Pirker-Binder [5] shown how it is possible, also using biofeedback testing and training methods, and heart rate variability research, to understand the causes and prevent states of exhaustion, even in business contexts "as social, living systems, prevention is discussed as a management tool in the corporate culture and as a strategic management decision".

Furthermore, other research linked Neuroscience and leadership, giving rise to Neuroleadership, combining the importance of the study of culture. For instance, Pittman [6], developed a leadership model capable of promoting a positive climate in the organization, supported by culture and climate theory research to improve human services.

Neuroscience and culture are increasingly present also in the corporate organization with relevant contributions that underline the importance of studying this aspect by considering together the concepts, theories and tools of neuroscience and culture at the micro, meso and macro level. For instance, Beugré [7], drawing on neuroscience, organizational neuroscience and cultural neuroscience, has explored aspects such as nepotism and corruption under the lens of organizational neuroscience in the African context. Healey and Hodgkinson [8] developed a general theoretical framework that locates neural processes appropriately within the wider context of organizational cognitive activities by using critical realism and socially situated cognition constructs. According to Authors, “Socially situated cognition connects the brain, body, and mind to social, cultural, and environmental forces, as significant components of complex organizational systems”.

Finally, Lakomski [9] conducted research on organizational change and culture, viewed the culture “as cognitive process based on recent research in both cultural anthropology and the new cognitive science”.

Finally, it was also observed a current trend in IS research toward neuroscience and a new discipline, namely NeuroIS, has developed [10-13]. For instance, Pavlou and colleagues [10] applied cognitive neuroscience theories, methods, and tools in Information Systems (IS) research and proposed a research agenda for exploring the potential of cognitive neuroscience for IS research. They also reported several examples of linking between cognitive neuroscience and IS research on such areas as technology adoption and use, e-commerce, and group support systems. Dimoka and colleagues [11], after reviewing the emerging cognitive neuroscience literature, proposed a framework for exploring the potential of neuroscience for IS research. Brocke and his colleagues [12] supported IS researchers in applying neuroscience theories and tools in design science research. Finally, Quazilbash and Asif [13] conducted a systematic review of the NeuroIS literature being published in IS high impact journals. They analyzed 59 papers and provided a research agenda for the NeuroIS research. However, the consideration of neuroscience is still in its infancy in IS research.

Based on these considerations, it emerges that neuroscience and culture, taken on increasing importance in the Management and IS fields. However, it is important to emphasize, above all, the growing use of new neuroscientific technologies to support business management decisions in an increasingly complex and dynamic context, also favoring a deeper understanding of culture, especially organizational culture.

The purpose of this research is to highlight the developments in the topic “neuroscience and culture in organizational and managerial fields” and to guide academics in identifying possible insights. A Systematic Literature Review and a Bibliometric Analysis was conducted by employing a quantitative approach that involves citation analysis and co-citation analysis (Social Network Analysis). Social Network Analysis is a process of investigating social structures using the theory of networks where the relationships, which can be represented through the connections, also called arcs, between individuals, or nodes, are represented through graphs. In the neuroscientific field, the integration between the studies of social neuroscience and the analysis tools of networks is interesting to understand how the brain influences and is influenced by the social environment by integrating the knowledge developed by neuroscience which, still today, is

limited to studying the brain especially in isolation. The Firstly, it was conducted a systematic search of the literature by using one online database, such as Scopus. This enabled us to obtain a final dataset of 78 publications, that it was then performed through bibliometric techniques of citation and co-citation analysis to explore the foundations and topical connections, in terms of citation structure and cluster formation, of research into neuroscience and culture in organizational and managerial fields.

This research seeks to answer the following research questions:

- RQ1. What is the state of art of research into neuroscience and culture in organizational and managerial fields?
- RQ2. What are the most relevant contributions and topical connections among the cited references?

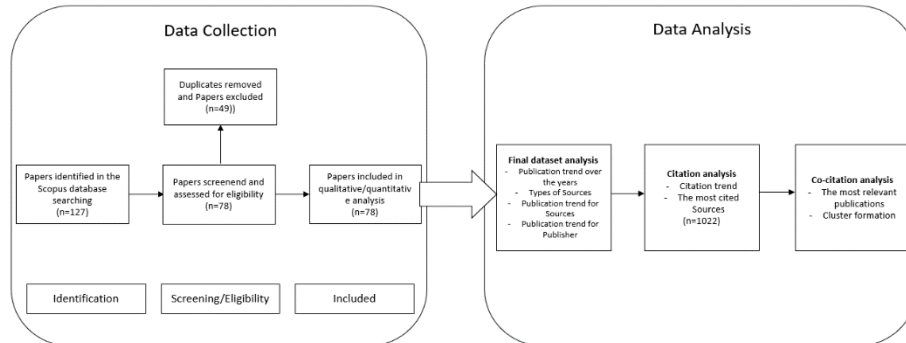
The structure of this paper is as follows. First, the paper highlights a Systematic Literature Review and a Bibliometric Analysis employing a quantitative approach that involves citation analysis and co-citation analysis (Research Methodology). Finally, it discusses the results of the Systematic Literature Review and bibliometric analysis (“Discussion” section).

## **2 Research Methodology**

In order to understand academic contributions to the topic of neuroscience, cognitive neuroscience and culture in organization and managerial fields, we performed a systematic search of the literature. This approach is particularly suitable for collecting, handling, and analyzing quantitative bibliographic data derived from academic articles on a topic. Consistent with prior literature [14-17], this research involved applying a Systematic Literature review method through a quantitative approach that involves citation and co-citation analysis. They are two forms of bibliometrics or quantitative bibliography that involve counting citations to other publications in a body of literature and using these counts to develop statistical distribution [14]. In particular, citation analysis is a bibliometric technique that allows academics to investigate the evolution of knowledge production in a specific context, as well as the relationships between authors, journals, and the sources therein [16]. Co-citation analysis, instead, is a form of document coupling which measures the number of documents that have cited any given pair of documents [14].

As Gundolf and Filser [15] stated, data was performed using the following approach: (1) data collection: papers were added to the dataset by searching and screening one of most important online databases for scientific research; (2) data analysis: the final dataset was descriptively analyzed (dataset analysis) and then performed through bibliometric techniques of citation analysis and co-citation analysis.

The flow chart that reports the different phases of this Systematic Literature review and citation and co-citation network analysis is shown in Fig. 1.



**Fig. 1.** The research methodology flow chart

## 2.1 Data collection

The first step, data collection, involves a suitable source for a systematic search of the literature. We selected one online database, such as Scopus.

Scopus is one of the most powerful and widely used research engines for the academic literature search and selection, on account of their coverage of scientific journals, books, and conference proceedings of peer-reviewed literature. To obtain a comprehensive dataset, we generated a search string by using some subject terms, such as “Neuroscience” (alternatively “Cognitive Neuroscience”, “Neurophilosophy”, “Neurobiology”, “Neuropsychology”, “Neuromarketing”, “Neurocognitive”, “Neurophysiology”, “Neuromanagement”, “Neuroimaging”, “Eye Tracking”, “Facial Emotion Coding System”, “Positron Emission Tomography”, “Heart Rate Variability”, “Galvanic Skin Response”, “Neurodiversity”, “Electroencephalography”, “Heart Rate”, “Event-Related Potentials”, “Magnetic Resonance Imaging”, “Neurotransmitters”, “Neuro-advertising”, “Culture as cognitive process”, “neuroscientific”, “neural network approaches”, “Neurological”, “experimental psychology”, “Neuroaccounting”, “Neuro-science”) and Culture (alternatively “Cross Cultural”, “Societal Culture”), in title, abstract or among keywords. The subject terms were chosen based on the literature about Neuroscience, Cognitive Neuroscience, Culture and Cross-cultural Management. In particular, the terms that indicate the Neuroscience tools were chosen based on Parthasarathi and Kable [18].

This allowed us to identify a total of 127 results in the area of Business, Management and Accounting, corresponding to as many papers published from the starting date of Scopus’ coverage to May 2021. Consistent with the literature on bibliometric methods [19], keywords were stemmed and used in combination with wild cards to include both singular and plural expressions. We then performed the screening and eligibility processes to remove duplicates and to identify papers that were not consistent with our research requirements. In particular, we refined our online search by excluding papers that do not properly match with Business, Management and Accounting subject areas. Furthermore, we also excluded papers that were not written in English language. After the screening and eligibility processes, the final dataset for the subsequent analysis

consisted of 78 publications. It was this set that citation analysis and co-citation analysis (citation structure and cluster formation) was carried out on.

### **3 Results**

We examined the final dataset in three steps: (i) we descriptively analyzed the sample of 78 publications to obtain information on publication trend over the years and on the types of sources; (ii) we descriptively analyzed the sample to obtain information on citation trends over the years, on most cited Sources and on most cited Papers (citation analysis); and (iii) we used SNA tools to reveal the citation network and the topic clusters (co-citation analysis).

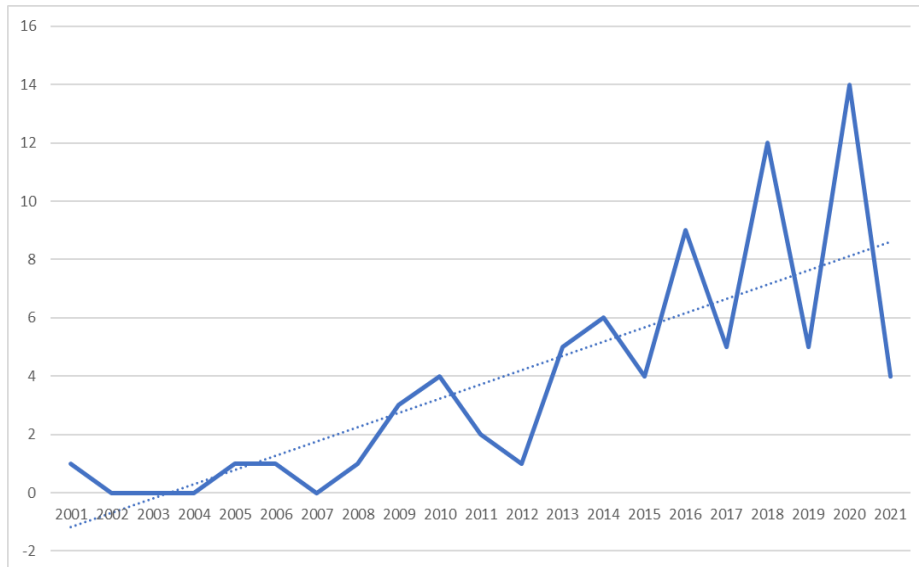
In what follows, we present the results of final dataset analysis (“Dataset Analysis” section), citation analysis (“Citation Analysis” section), and co-citation analysis (“Co-Citation Analysis” section).

#### **3.1 Dataset Analysis**

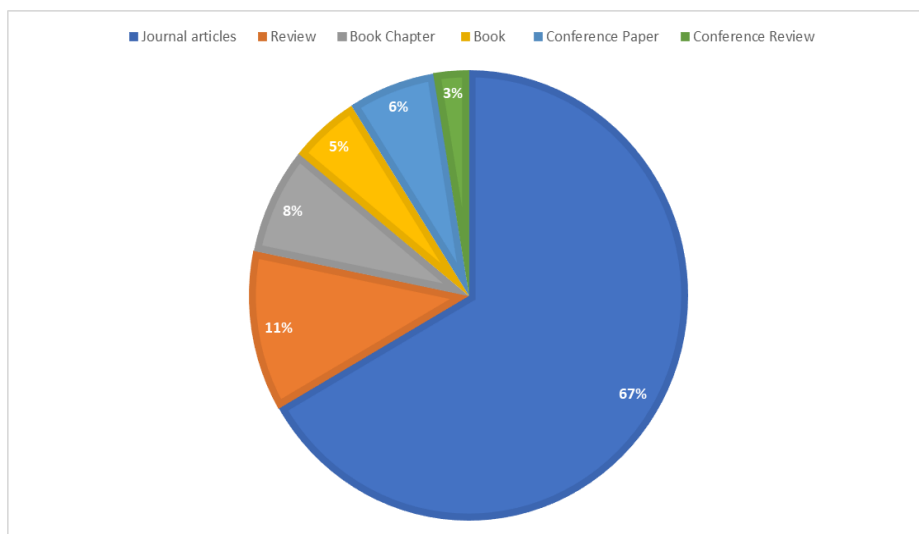
After data collected, the final dataset of 78 publications was analyzed to obtain descriptive data on publication trend over the years and on types of sources.

Figure 2 shows a substantially increasing trend since 2001 in the research field of neuroscience and culture in organizational and managerial fields, with a peak in 2018 with 12 publications, and a new peak in 2020 with 14 publications after a decline in 2019.

While Figure 3 shows the types of sources in the original dataset. In particular, these are mainly Journal articles (67%), followed by Review (11%), Book Chapter (8%), Conference Paper (6%), Book (5%) and Conference Review (3%).



**Fig. 2.** Publication trend over the years (n=78)



**Fig. 3.** types of sources (n=78)

### 3.2 Citation Analysis

Citation analysis is the second part of our data analysis and deals with the yearly trend in citations (Figure 4) and the most active Sources (Figure 5).

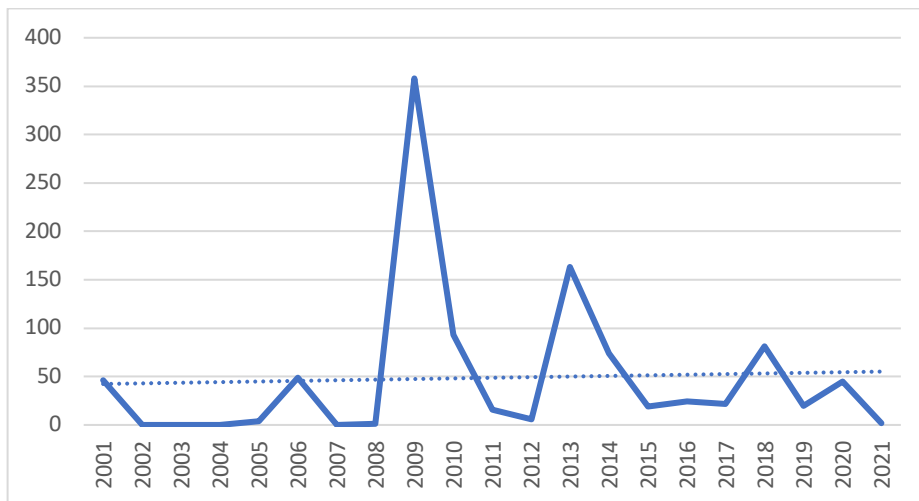


Consistent with our research aim, we built upon the publications within our original database to create a basis for cluster development. Our dataset consists of 78 sources in Scopus. The number of citations, in the citations ranges from 0 to 358 in the period range from 2001 to 2021(considering 2001 first year with a publication in Scopus in this research Topic) is 1023, while the average number of citations per document is 13.11.

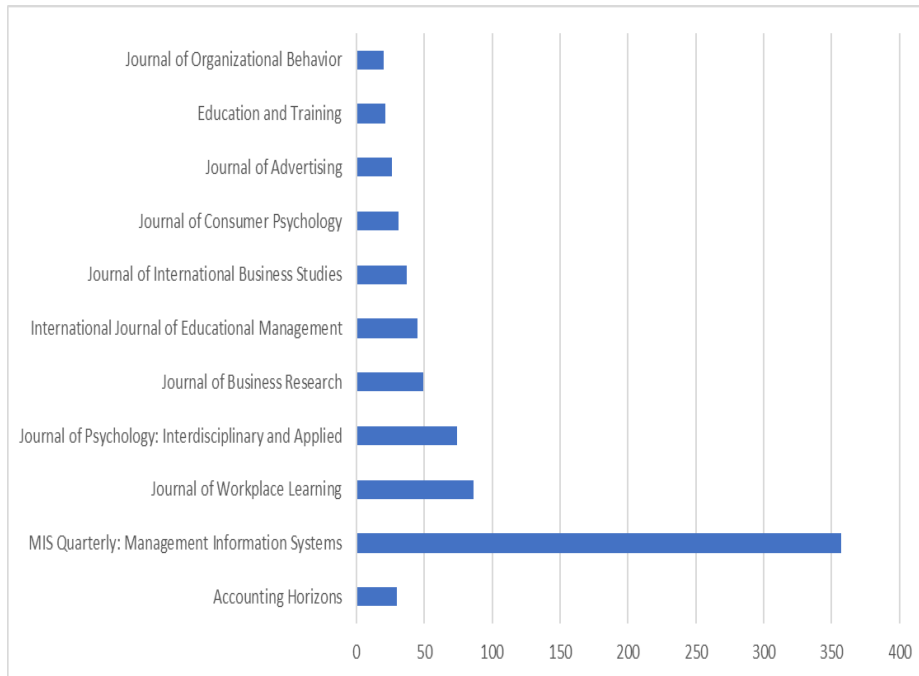
As shown by Figure 4 the citations trend has a non-linear trend with 46 citations in 2001, a tendency to decline until 2006 (the year in which the number of citations increases again), to then reach two peaks in 2009 (358 citations) and in 2013 (163 citations). Subsequently, the trend was non-linear with, for example, 81 citations in 2018, 20 citations in 2019 and 45 citations in 2020.

We further identified the most frequently cited sources (Figure 5). As shown by Figure 5, the most active sources were MIS Quarterly: Management Information Systems (358), followed by Journal of Workplace Learning (86), and Journal of Psychology: Interdisciplinary and Applied (74).

Figure 5 also shows the relevance of research on “neuroscience and culture in organizational and managerial fields” published by sources dealing with the Business and Management (such as Journal of Business Research (49), International Journal of Educational Management (45) and Journal of International Business Study (37)), with the Consumer psychology (such as Journal of Consumer Psychology (31)), with the Accounting (such as Accounting Horizons (30)), with the Marketing (such as Journal of Advertising (26)), with the Education and training (such as Education and Training (21)) and with the Organizational Behavior (such as Journal of Organizational Behavior (20)).



**Fig. 4.** Citation trend, in Scopus, over the years (n=1023)



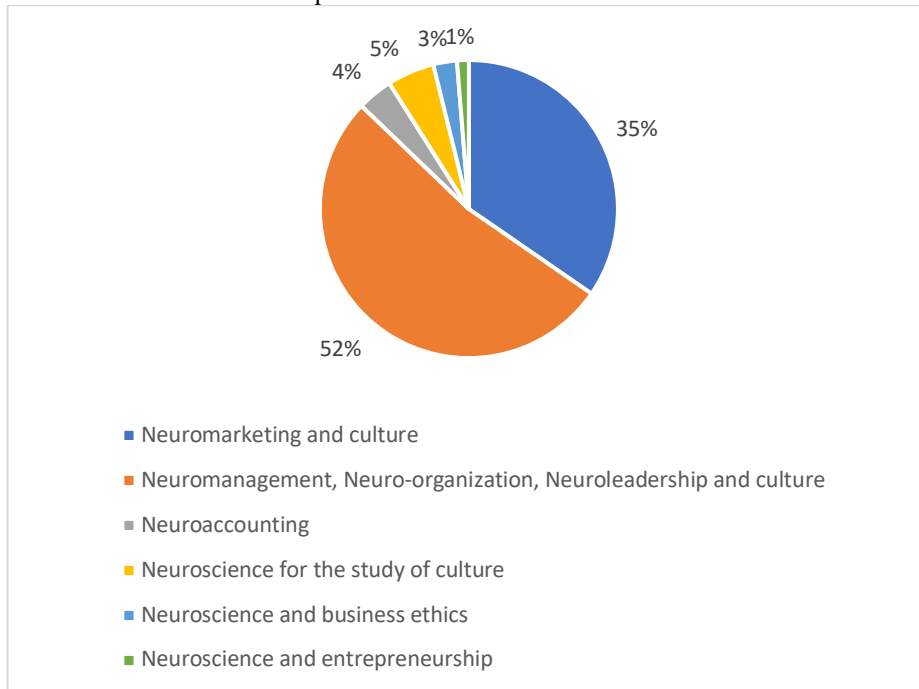
**Fig. 5.** The most active sources (n=1023)

Considering the heterogeneity of the journals that make up the sample considered in our analysis, it is interesting, at this point, to aggregate the data relating to the published papers and the topic analyzed by each of them, to understand the prevailing context in which neuroscience is used in business environment.

On the basis of the data collected, it emerged that the journals and proceedings considered were mainly concerned with Neuroscience and management, Neuroscience and organization, Neuroscience and leadership together with culture with 41 papers and a percentage of the total of 52%, as can be seen from graph 6; of Neuromarketing and culture with 27 papers and a percentage of 35%; of Neuroscience for the study of culture with 4 papers and a percentage of 5%; of Neuro-accounting and culture with 3 papers and a percentage of 4%; of Neuroscience, business ethics and culture with 2 papers and a percentage of 3% and, finally, of Neuroscience, entrepreneurship and culture with 1 paper and a percentage of 1%.

Therefore, it is possible to note how the papers dealing with Neuroscience, management, organization, leadership and culture impact the most on the results of our analysis and, to a lesser extent, albeit predominantly, the papers dealing with Neuroscience, marketing and culture. A very low contribution is instead that of the remaining papers in which the Authors combine Neuroscience with different aspects of the business.

Figure 6 indicates the frequency with which the journals of the sample published papers relating to the different ways in which neuroscience has been considered in combination with business and cultural aspects.



**Fig. 6.** Percentage of publication for topic

### 3.3 Co-Citation Analysis

The third part of our research concerns analysis of co-citations and topical connections. We conducted a co-citation analysis by considering a total of 78 publications on the topic of “neuroscience and culture in organizational and managerial fields”.

Consistent with Abrahamson and Rosenkopf [20] and Agrifoglio and colleagues [21], we used a network density, the ratio of the actual to the maximum number of links between actors in a network, as a measure for verifying network health and effectiveness. Data analysis shown that our network is composed by 47 nodes and 697 edges, while the density ratio is 0.645 ( $p \geq 0.50$  is considered as high).

Further information on the influence of different sources is shown by network analysis of the co-citations, the results of which are shown in Figure 7 (the nodes refer to the cited papers and the arcs indicate a co-citation between two papers).

The Figure 7 shows that the relationships between the most cited 47 sources can be explained as 2 clusters with 697 links and a total link strength of 1265. The first cluster (in red) is composed of 34 Items, while the second cluster (in green) is composed of 13 Items.



## 4 Discussion

This study has analyzed citations and publications trends in order to come to a better understanding of the topic of “neuroscience and culture in organizational and managerial fields”.

An initial result is that the number of articles in this stream of research has tended to increase since 2002, reaching an important peak in 2016 with 9 publications, another peak in 2018 with 12 publications, after a slight decline in 2017, and a peak in 2020 with 14 publications, after a sharp decline in 2019. For 2021 there were only 4 publications, but we are still in May.

Moreover, analysis of the citations and publication trends indicates that this is a current topic, and one that is especially relevant to researchers in the fields of Business and Management, of Marketing, of Consumer Psychology, of accounting and in the fields of Organizational Behavior.

Our contribution offers a broad overview of the relevant literature, analyzing the most influential sources and classifying them in two main Clusters: 1) the cluster of new technologies and new factors to understand and describe the behavior of individuals, individually and in groups, and to explain the functioning of groups and organizations such as businesses; 2) the cluster of factors such as culture, trust, reciprocity, emotions, neural mechanisms, reason, which determine our way of being, our self, our behavior, our choices, our cognitive process, our moral judgment in different situations, even in those characterized by risk and uncertainty.

Cluster 1 contains articles that indicate new factors and new technologies to understand and describe the behavior of individuals and groups for the success. In particular, these are articles that focus on the concept of neuroscience and organizational neuroscience to understand behaviors also in companies, and on the use of neuroscience tools to understand different forms of leadership [22-39]. Babiak and Hare [40] examined how psychopaths work in the corporate environment with a must read for anyone in the business world; Clark [41] offers a tour of a new field that describe thought and reason as in some way inextricably tied to the details of our gross bodily form, our habits of action and intervention, and the enabling web of social, cultural, and technological scaffolding in which we live, move, learn, and think; while Healey, Vuori and Hodgkinson [42] propose a new typology for analyzing shared cognition in workgroups and teams that differentiates reflective mental models formed through reasoning and deliberation from reflexive representations that are more automatic, intuitive, and affective in nature; Hodgkinson and Healey [43] review major developments from 2000 to early 2007 in the psychological analysis of cognition in organizations; Hutchins [44] presents a theoretical framework explicitly cognitive in that it is concerned with how information is represented and how representations are transformed and propagated in the performance of tasks considering that, normally, the outcomes of interest are not determined entirely by the information processing properties of individuals; Sparrow and Hodgkinson [45] consider the important contribution of different areas of psychological inquiry that might contribute to understanding managerial and organizational processes and performance; Smith and Semin [46] analyze the role of Social cognition and the necessity of a fuller integration with the broad intellectual movement emphasizing situated

cognition and Barsalou [47] reviews theories of grounded cognition, as are origins of the area and common misperceptions of it. There are also many Authors who consider the impact of factors and technologies, mentioned above, on entrepreneurship and the creation, management and support of new business [48-50]. Finally, among the most relevant references, belonging to cluster 1, we find: Beilock and Goldin-Meadow [51] that show how gesture introduces action information into speakers' mental representations, which, in turn, affect subsequent performance; Bhaskar [52] that discusses about the possibility to study society in the same way as nature; Campbell [53] that analyzing themes he shares with Schneirla, in particular an effort to reconcile the autonomy of each level of organization with the fact that, in biological systems at least, wholes are a determinant of the nature of parts, as well as parts being the determinants of the nature of the wholes; Hackman [54] that suggests how robust understanding of social and organizational dynamics requires attention to higher as well as lower levels of analysis and Postrel and Rumelt [55] that considers the source of the value added by organization pointing out two leading explanations are coordination of specialized efforts and control of opportunistic behaviour. Both explanations assume that humans are boundedly rational, unable to process large amounts of information, to foresee all possible events, or to ferret out the facts known by others.

Cluster 2 refers factors such as culture, trust, reciprocity, emotions, neural mechanisms, reason, which determine our way of being, our self, our behavior (especially organizational behavior), our choices, our cognitive process, our moral judgment in different situations [56-64]. Interesting also contributions of: Boyatzis et al., [65] that design an exploratory study to assess the neural mechanisms involved in memories of interactions with resonant and dissonant leaders to explain the behavior of subjects in advanced professional roles; Taras, Steel & Kirkman [66] evaluate the extent to which political boundaries are suitable for clustering cultures and Waldman Wang and Fenters, [67] consider how recent advances in technology have made it possible to use brain imaging in organizational settings at relatively little expense and in a practical manner to further research efforts. Finally, it's interesting the contribution of Stahl and Tung [68] that offers an integrative framework within which both positive and negative effects of cultural differences can be understood and provide a road map for future research on culture in IB.

It is interesting to note how 3 papers act as a point of contact between the two clusters. In particular, Ashkanasy, Becker and Waldman [56] exalt organizational neuroscience and promise for advancing organizational research and practice; Becker, Cropanzano and Sanfey [57] analyze organizational neuroscience as an emerging area of scholarly dialogue that explores the implications of brain science for workplace behavior; Waldman, Wang and, Fenters [67] study the advantages and disadvantages of neuroscience applications to organizational research. These 3 contributions, as a sort of bridge between the two clusters, underline the centrality of neuroscience and, in particular, of organizational neuroscience as a point of contact and connection between the clusters themselves.

## 5 Research Implications

This study has focused on an innovative trend, that of neuroscience and culture in organizational and managerial fields, which offers new and challenging insights for scholars and manager, pushing forward the need for the next research agenda on this topic. It is interesting to note the growing trend in the number of studies with reference to the topic “neuroscience and culture in organizational and managerial fields”, from 2001 to the present, with different peaks and periods of decline. The trend of citations is not linear with an important peak in 2009 (358) and another peak in 2013 (163), but an increase in the number of citations is also expected given the growing trend in the number of publications from 2001 to today.

This analysis has identified several clusters of research domains, each a possible locus for further integrations and cross fertilization.

The first cluster contains studies that talk about Neuromarketing and culture to provide companies with innovative tools and options to understand the choices and behavior of consumers also from a perspective of cultural differences to allow more rational operational and strategic marketing choices in a neuroscientific perspective.

The second cluster contains more specific Neuromanagement studies, combined with observations on culture and on neuro-organizational culture, to provide companies with innovative tools and options to understand and to manage managerial aspects and organizational aspects.

The third and last cluster includes studies related to accounting and cultural aspects analyzed and developed through neuroscience for a new corporate accounting and new culturally evolved accounting principles.

Evidently, this study provides interesting implications and insights for scholars and manager. In terms of theoretical implications, it provides a synoptic picture of the current diffusion of knowledge on the new topic of “neuroscience and culture in organizational and managerial fields”, highlighting the most relevant issues, which can be brought back to a more general conceptual framework.

Scholars can take inspiration from the emerging theme of “neuroscience and culture in organizational and managerial fields”, using the present review analysis as a place to start their in-depth research.

In terms of managerial implications, the study highlights the most relevant research domains on which manager can focus in facing the question of the use of knowledge and tools of Neuroscience and Culture together, for a development of the knowledge and management options available.

## 6 Future research and limitations

Our findings suggest that there are fruitful opportunities for future development. In particular, a possible future study could be directed towards a greater deepening of the study and understanding of culture (at the micro, meso and macro level), through the theories, knowledge and direct and indirect tools of neuroscience, to develop a new

perspective of analysis and observation of culture together with traditional methodologies and traditional models of analysis.

Our findings also suggest the critical role of ITC for neuroscience, so contributing to the NeuroIS research. In particular, we believe that further IS research could be aimed at a greater understanding of how information and communication technologies can be further developed to obtain even more sophisticated and more predictive neuroscientific information of individuals' behaviors, such as Eye tracking or emotion detection able to capture aspects and information not yet detectable today.

Of course, this research is not free from limitations. The first limitation is linked to the use of a single online database; therefore, it is necessary to extend the research using other online databases. The second limitation is related to non-definitive nature of this study so, as a subject still in an initial phase, in continuous evolution, the contribution will require to be constantly updated. More in general, this study can nonetheless serve as an advantageous starting point for scholars, who can move with their research along the lines proposed above. Future research should certainly focus on enriching the framework.

Our analysis represents a starting point in the ongoing debate on the topic of “neuroscience and culture in organizational and managerial fields” and, also with its limitations, we believe this contribution can serve as a reference point, offering a guide to scholars interested in approaching the research stream of neuroscience and culture together in companies, stimulating and addressing the further research.

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