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Research of Proprioceptive -Vestibular Sensory Integration on Using Big Data Analysis

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Abstract

This study provides academic implications by considering trends of domestic research regarding therapy for sensory integration intervention based on vestibular-proprioceptive system. For the analysis of this study, text mining with the use of R program and social network analysis method have been used and 53 papers have been collected. In conclusion, this study presents significant results as it provided basic rehabilitation data for sensory integration intervention based on vestibular-proprioceptive system through new research methods by analyzing with big data method by proposing the results through visualization from seeking research trends of sensory integration intervention based on vestibular-proprioceptive system through text mining and social network analysis.

Keywords: Sensory integration, Vestibular, Proprioceptive, Development , Stereotype

1. INTRODUCTION

Sensory integration is the process in which the brain organizes sensory information to create adaptive responses, utilizing both internal and external bodily sensations effectively within the environment [1]. The senses used in sensory integration interventions include vestibular, proprioceptive, tactile, visual, and auditory senses [2]. These diverse senses do not operate independently but are applied simultaneously based on the integration of the primary basic senses proprioception, vestibular, and tactile [3]. Particularly in sensory integration, the integration centered around vestibular and proprioceptive senses is crucial [4]. The vestibular sense plays a crucial role in maintaining balance, regulating eye movements, correcting posture, and modulating muscle tone, which significantly affects bilateral coordination and body schema formation [5]. Proprioception influences overall arousal levels and emotions, and aids in the regulation of hypersensitivity. The integration of vestibular and proprioceptive senses allows children to simultaneously process sensory information from head positions and body orientation during various activities in daily life [6].Thus, proper integration of these senses enhances correct posture control and impacts motor abilities, leading to maintained appropriate muscle tone and improved posture control [7]. Developmentally, the integration of vestibular and proprioceptive senses is essential for the completion of posture, balance, and muscle tone. This integration further contributes to the development of body perception, bilateral

coordination, motor planning, and attention [8] making it vital in sensory integration interventions targeted at children. The effectiveness of sensory integration intervention varies significantly depending on the subjects studied, research methods, interventions, and outcome measurement tools, making it difficult to present the results as objective evidence [9]. Demonstrating intervention effectiveness is essential in the field to enhance the quality and efficacy of treatments, justify the need for therapy, and increase therapists' credibility [10]. Systematic reviews are one research method used to present intervention effects. This process involves gathering related literature, analyzing the findings, and presenting well-founded conclusions [11]. Occupational therapists should extensively examine systematic review studies on occupational therapy to provide efficient interventions [12]. Several systematic review studies on sensory integration interventions conducted in South Korea have been documented [13]. However, these reviews typically categorize the themes, methodologies, and quantities of previous research, leading to conclusions that reflect these classifications. Consequently, there are limitations in these reviews concerning the systematic analysis of the meanings and interconnections of key terms. To supplement, this study uses text mining and social network analysis method to structuralize key topics of studies, and figured out domestic study trends related to sensory integration intervention based on vestibular-proprioceptive system by scientifically analyzing directions and connections of studies by visualizing network structures of major keywords.

2. EXPERIMENTS

2.1 Data Analysis

Especiallyfor data analysis, text mining analysis methods such as term frequency, network analysis, LDA analysis to derive key insight for sensory integration intervention based on vestibular-proprioceptive system [14]. With the advent of big data era, data of various forms have been collected. At times when the formal data used traditionally, but also amorphous data such as image, sound, text has been increasing in its usage, the text mining method uses keyword analysis, keyword frequency analysis, and topic modeling method to extract key information from text data [15] .

2.2 Data Collection

This study collected data by searching for 'sensory integration', 'vestibular sensory', 'proprioceptive sensory' on Korea Educational Information Service, Google academic search on Korean web to analyze study trends for the last decade related to sensory integration intervention based on vestibular-proprioceptive system. The total number of papers searched were 131 papers, and to increase the studies' feasibility and reliability, 53 papers related to sensory integration intervention based on vestibular-proprioceptive system for analysis were used.

2.3 Keyword Analysis

Keyword analysis is the method to figure out key proportion within a document by extracting keywords from specific documents [16]. Keyword frequency analysis is a method to analyze how specific word appears how often within the text and how important it is within the document to figure out the level of interest of relevant issue [17]

2.4 Keyword Network Analysis

Social network analysis is a method to create social graph connected to nodes and links to interpret various sectors for relations of words, and is used to analyze this [18]. Representative social network analysis method is degree centrality, closeness centrality, betweenness centrality, and this study analyzed with connectivity degree similar to degree centrality and closeness centrality, and betweenness centrality [19] . Network analysis is a method to establish and analyze associative word network by extracting words that appeared simultaneously with specific terms [20]. This method is mainly used to save time and effort for

extraction when the size of the data is large.   sensory integration intervention based on vestibular-proprioceptive system marks words as node and word connectivity as Edge, and interpret analysis targets by co-occurrence based on these Edges, and understand the structural characteristics of these created networks [21]. This study uses Python's network module to calculate weight between highly co-occurred words, and visualizes graphs by calculating weight between the words.

2.5 Topic Modeling

This study derived appropriate topic title which enabled classification of data related to 'sensory integration intervention based on vestibular-proprioceptive system' using topic modeling method based on LDA (Latent Dirichlet Allocation). LDA is a method to cluster relevant subjects and mainly utilized to analyze unstructured text [22]. This study uses Python's genism and scalar library and proceeded the topic modeling. Selection of appropriate number of topic need to avoid range duplication, and utilized Coherence value and perplexity value to choose the most optimal number of topic.

3. RESULTS

3.1. Keyword Analysis

For the visualization of text, total of 37,510 words were collected from selected papers, and these words were visualized through word cloud method (Figure 1). The analyzed data were all used without pre-processing, and the word 'sensory integration intervention' which was one of the search words in this study recorded the most usage rate.

Figure 1. Word cloud

Total of 6,037 words were extracted from text mining of major words as a result of abstracts and keywords for papers targeted from this study. Out of the extracted words, excluding the keywords related to papers' unique characteristics, top 10 keywords showed sensory Integration, proprioceptive, vestibular, intervention, development, improvement, behavior, stereotypic, treatment, control in order, and this is showed in <Table 1>.

Table 1. Key word frequency

Ranking	keyword	Frequency	Ranking	keyword	Frequency
1	Sensory Integration	312	6	improvement	103
2	proprioceptive	298	7	behavior	97
3	vestibular,	282	8	stereotypic	83
4	intervention	198	9	treatment	81

| 5 | development | 175 | 10 | control | 79 |

3.2. Result of Social Network Analysis

The social network analysis method using R program is abbreviated as SNA method and used to seek for relevance between major keywords. There are various sectors which attempts to use SNA method to analyze research trends, and this study seeks to understand research trends of sensory integration intervention based on vestibular-proprioceptive system through network analysis of keywords [23]. The result of SNA method visualizes node and link, and here the node indicates each keywords and link indicates the bridge between node implying the relations between each keyword. The result is derived as a network map that implies the connectivity between major keywords from research of sensory integration intervention based on vestibular-proprioceptive system is shown in <Figure 2>. The result that derives the network map of connectivity between major keywords from research of schizophrenia and psychosocial therapy is shown as following image presents. The connectivity index verified in the network map is related to number of links connected to nodes, and the font size of node indicates the frequency of major keywords mentioned in each study. In Figure 2., the keyword with highest closeness centrality was 'sensory integration intervention and development, vestibular-proprioceptive system and behavior' and it could be determined that studies mentioned this keyword as the major keyword in studies as it was showed to have high centrality for connected keywords.
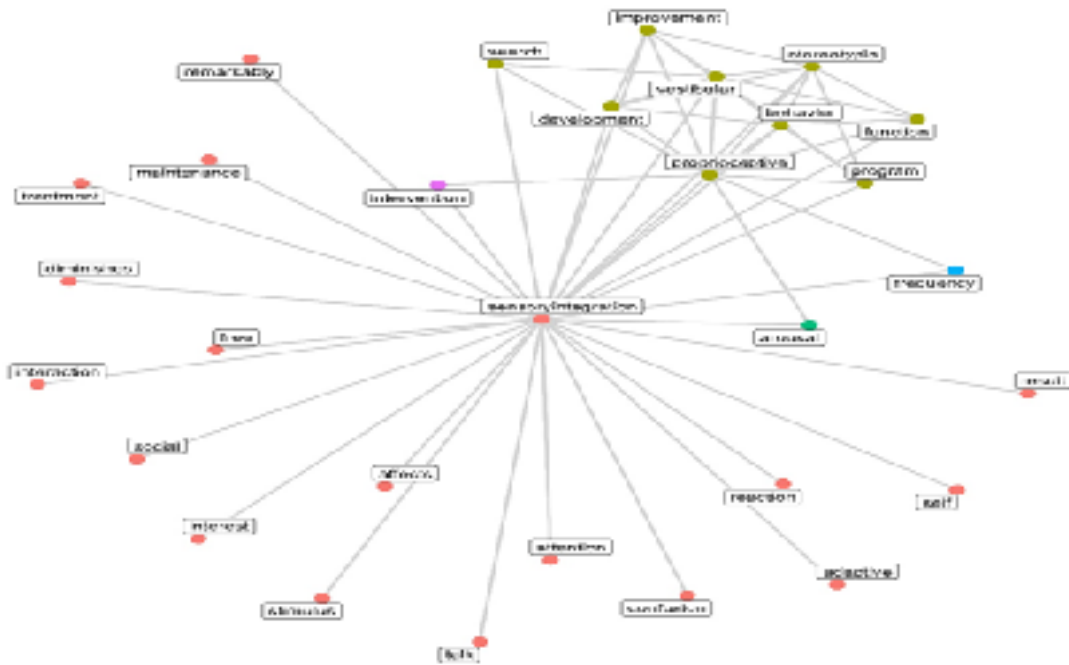

Figure 2. Network connection of sensory integration intervention

3.4 Result of Topic Modeling

Topic modeling is a method to analyze the text data, and is the technology to derive and show the topic of document by determining which document is containing which content [24]. Topic modeling analysis creates a topic by linking related keywords within the texts, which accounts for a high proportion of words arranged

at the top of the generated topic. In this study, researchers generated three topics and analyzed the common points of the topics to give topic names, and the result is shown in <Table 2>. As a result of keyword topic modeling, Topic 1 is composed of the result of intervention which are sensory integration, vestibular, proprioceptive, development, improvement. This indicates that as a result of intervention, the symptom reduces and development, improvement is increased and shows what the related papers are proposing. Topic 2 was composed of behavior, stereotype, function, program, which indicates that the study was based on determining the topics to figure out the condition of subjects as a subject of papers.

Table 2. Topic modeling

Keywords	Topic
Sensory Integration, Proprioceptive, Vestibular, Development,	Result
Behavior, Stereotype, Function, Delay	Subjects

4. DISCUSSION

This study seeks to determine the research trend of by sensory integration intervention based on vestibular-proprioceptive system utilizing big data. Also, seek for research trends related to activity participation, treatment, and mediation to provide academic implications. First, there were 53 papers collected which were related to sensory integration intervention based on vestibular-proprioceptive system in the last decade of domestic academic studies. Out of these 53 papers, 37,510 words were collected for text visualization and the visualization was done by word cloud method (Figure1). The analyzed data were used without pre-processing, and the word 'sensory integration' recorded highest in usage. Second, final extraction of top 10 keywords via text mining of the abstract and keyword of papers, the result showed sensory integration intervention based on vestibular-proprioceptive system research, intervention, development, improvement, ability in order. Sensory integration therapy is designed to offer a variety of adjusted sensory experiences that meet the neurological needs of the individual, thereby facilitating normal neuromotor development [25]. This indicated that studies were ongoing focusing on intervention, psychosocial society, intervention effect for studies related to schizophrenia and mental society. Third, the social network analysis results derived connectivity, closeness centrality, betweenness centrality. These results show that study was based on the 'sensory intervention' keyword were centered and connected other topics. Fourth, LDA (latent Dirichlet allocation) topic modeling result showed that classified into 2 keywords: Result, Subjects of sensory integration based on vestibular-proprioceptive system. This is a modeling of the key research trends related to the subject of this study which is a potential allocation of the categories of papers related to sensory integration intervention based on vestibular-proprioceptive system over the past decade. Vestibular-proprioceptive stimulation is a crucial component in sensory integration therapy. It provides information about the position of the body and limbs, as well as information on movement, which plays a significant role in the development of body schema and motor planning. Additionally, it aids in arousal regulation, reducing excitability and promoting calmness, contributing to emotional stability [26]. It is of great value for academic evidence for further research directions such as intervention method of sensory integration intervention based on vestibular-proprioceptive system effect of intervention method, ability improvement, etc. Therefore, we suggest that research is important to establish the basis for integration intervention based on vestibular-proprioceptive system which is effective for negative symptoms and cognitive disorders and that it is important for researchers to prove the intervention effect. This shows that papers based on this study allocates effect and function as parameters to connect various dependent variables related to intervention and that the index to support to create evidence for effects after intervention is shown as a result. There are

limitations to this study. First limitation is that this study carries out research based on limited studies listed on Korean journals, and that it does not include research trends of migration related published on foreign academic journals, indicating that it is difficult to generalize the results. This limitation will be further supplemented through other studies. Second, as the research analyzes integration intervention based on vestibular-proprioceptive system related abstracts quantitatively using big data to seek for factors and its relations, later research will need qualitative research. Also, by analyzing schizophrenia and mental society factors with big data method, the study seeks to provide basic rehabilitation data for integration intervention based on vestibular-proprioceptive system with new research methods.

5. CONCLUSION

We seek to figure out trends of domestic studies about intervention based on vestibular-proprioceptive system. Analysis were done with R program using text mining and social network analysis method. Collected data were visualized with word cloud method after analysis for keywords, and frequency analysis result showed that sensory integration, research, patient, program, effect, society, mental, ability, function recorded with high frequency. Social network analysis results derived keywords of connectivity, closeness centrality, betweenness centrality Topic modeling result showed classification was made with 3 keywords of intervention result, intervention goal, intervention subjects. In conclusion, we bring significant conclusion as it examines research trends related to sensory integration intervention based on vestibular-proprioceptive system through text mining and social network analysis method, and by visualizing the results, provided basic rehabilitation data for sensory integration intervention based on vestibular-proprioceptive system through new research methods by analyzing sensory integration based on vestibular-proprioceptive system via big data methods.

5. ACKNOWLEDGEMENT

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