

Document Recommendation for Music Therapists and Patients with Neural Disorders

신경질환 환자들과 음악치료사들을 위한 음악치료 관련 문헌 추천 방법론 제안

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Music therapy has been proved to be effective in treatment of diseases such as Alzheimer's disease. Many studies have investigated the effect of music therapy techniques on symptoms of a given disease but there has been no efforts in classifying those studies by specific symptoms of diseases, although patients, caregivers and music therapists have difficulty in discovering documents that they need to treat certain diseases. Thus, in the study, we propose a method to group music therapy-related publications by the music therapy techniques mainly used for a given disease. We expect that it will help music therapists and patients to find papers to help them to cure a specific disorder.

1. Introduction

Various fields of researchers defined the method of treatments as both the physical and the psychological therapy. They have been also found to be effective impact on patients from these two types of therapies (Barlow, Gorman, Shear, & Woods, 2000). First one is that doctors or therapists perform medical procedures or operations to the specific body part of patients directly. The second is the psychological therapy that helps people mentally. In recent, the scope of the psychological therapy has been expanded its role to reducing an anxiety and relieving a pain for patients by listening to music before or during medical procedures and operations.

Although few researchers argue that the medicine treatment is also an effective way to cure mental disorder, it still has limitations when it comes to pharmacotherapy. For example, while pharmacotherapy

could improve symptoms of mental illness, it is hard to lead patients back to the social community or improved functioning and quality of life (Huxley, Rendali, & Sederer, 2000). Several previous studies tried to identify music therapy has positive effects to mental or psychological treatments than pharmacotherapy. Munro and Mount (1978) suggested that music therapy as the controlled use of music, and define its elements and influences on human beings to aid the physiological, psychological, and emotional integration of the individual during the treatment of an illness or disability. In addition, they concluded that music therapy relieves anxiety from the psychophysiological effects and reduces stress through the relaxation response. Furthermore, Hamel (2001) identified that anxiety and heightened physiological values elicited by stress response are reduced. In addition, he suggested that music therapy is one of the good alternative therapies that could improve physical and

mental health of patients. Therefore, it can become a supplement for other traditional therapies providing patients with integrated body–mind experiences (Guzzetta 1988).

In perspective of music therapy history, it might be known as the new alternative therapy in recent. However, people listened to music for the treatment from historical roots (Alvin 1975). The ancient Egyptians used music to influence the fertility of women and the Persians used the sound of lute to cure illnesses, disorders, and diseases (Podolsky 1954). Music therapy is also known as effective treatment of combat fatigue among soldiers following World War II (Campell 1997). Based on these previous researches, music therapy or intervention played a pivotal role in helping patients from the past. In addition, it is still recognized as an important component of a comprehensive treatment approach (Department of Health, NHS Executive, 1999). Even though it performs a variety of researches that are for an effort on a therapy through music, there are no approaches when it comes to sharing both a specific method and a result to recommend documents to music therapists and patients in the field of music therapy.

Thus, in this study we focused on music therapy from the point of view of psychological method. In

addition, it has a specific goal to recommend documents to each group of patients and therapists who need the musical treatment. To this end, we proposed methodology to match citation documents and major diseases in case of alzheimer’s disease and Autism related to music therapy through the document citation network analysis.

2. Methodology

As a first step of methodology, we collected articles from Web of Science database. The number of collected articles were 1,929 in the field of ‘music therapy’. Then we visualized to see overall status of the field. Using CiteSpace (Chen 2006), we were able to process the data automatically and easily visualize as a network and keyword tree. For the third step, we extracted two important names of disease, alzheimer’s disease and Autism, based on keyword map and citation burstiness analysis for document group recommendation. For the next step, we collected the articles by the extracted disease terms again and parsed them to extract abstract. After extracting abstract from a bunch of documents, we calculated co-occurrence pairs with frequency. After extracting abstract from a bunch of documents, we calculated co-occurrence pairs with frequency

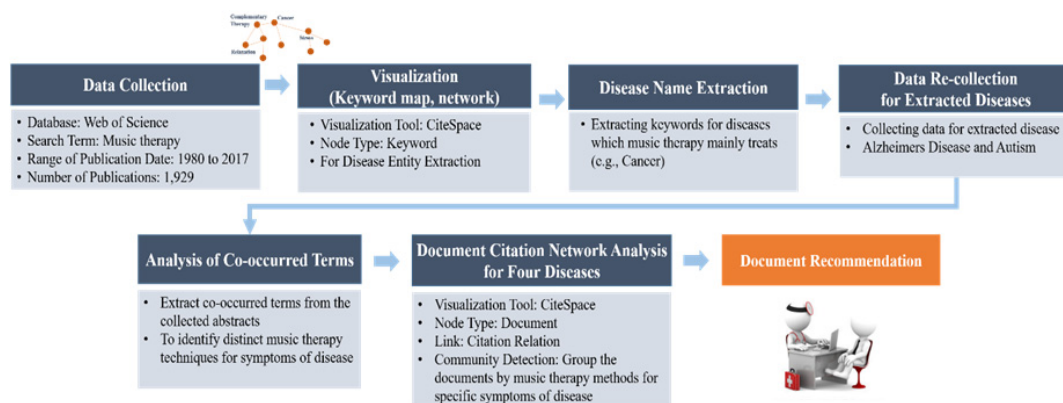


Figure 1 Overall Architecture

to identify distinct music therapy skills for disease symptoms. Then, as a process of document recommendation, we constructed document citation network with timeline. We grouped the documents by music therapy for specific symptoms and finally recommended documents by topical groups.

The keyword for retrieval in Web of Science is ‘music therapy’ and limited only in article with English from 1980 to 2017. Therefore, 1,929 articles fit in our conditions. Collected articles are relatively biased on 2000s while time span is limited in the range of 1980 to 2017.

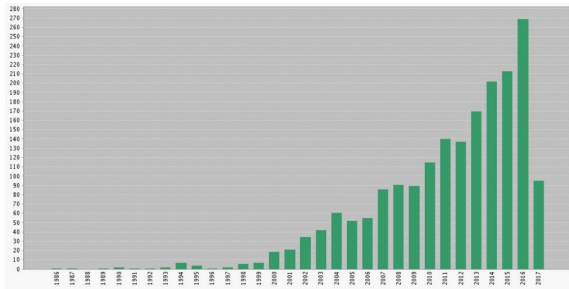


Figure 2 Collected Data: Music Therapy

With the collected data, we constructed a keyword tree and measure network centrality to identify important disease terms in the field of music therapy. In addition, keywords with the strong citation burst were investigated for disease name extraction purpose. We extracted two disease terms, ‘alzheimer’s disease’ and ‘autism’, based on centralities and citation burstiness of keywords.

With the extracted disease names, data were re-collected by each disease name from Web of Science. The number of papers collected by the keyword, ‘alzheimer’s disease’ is 146 and the range of publication date is from 1993 to 2017. In the case of autism-related publication, 96 publications are collected from 2000 to 2017. To explore music therapy techniques that are used for specific symptoms of the two diseases, frequently co-occurred terms

extracted from the collected abstracts were analysed. Before calculating the co-word pairs, we firstly parsed abstract section from all article data. Then we extracted co-occurred word pairs from a sentence and calculate frequency.

For publication recommendation purpose, we constructed a document citation network and community detection algorithm was applied to find well-connected clusters in the network. We increased possibility to find relevant documents by building a citation network. Then we labeled the detected clusters with abstract terms and examined the labels could represent the communities, a group of publications.

3. Results

3.1 Network centrality analysis

Simply in terms of frequency analysis, the most frequently occurred keyword is ‘anxiety’, except for ‘therapy’ and ‘music.’ The terms such as ‘intervention’, ‘depression’ and ‘randomized controlled trial’ frequently appeared. To identify diseases that are mainly studied the field of music therapy, we constructed and visualized a keyword network, and measured network values.

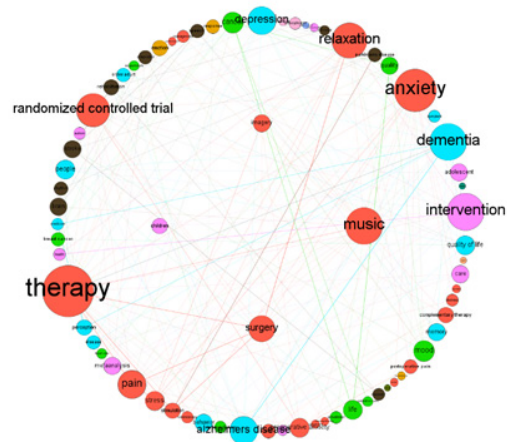


Figure 3 Keyword Network

The network consists of 71 nodes and 200 edges. In average, each node is connected with about 2.81 nodes. The node denotes keywords extracted from title and abstract in collected articles and two nodes are connected when they are co-occurred in abstracts. The size of a given node is determined by its degree centrality. The color means clusters nodes belong to and 11 clusters are detected in the keyword network.

To identify key terms in the network, centrality measures were used. Top 10 nodes ranked by degree centrality are listed in table 1 with closeness centrality and betweenness centrality. The name of disease shown in table 1 is ‘dementia’ and ‘alzheimer's disease’, and ‘dementia’ can be taken as one of symptoms of alzheimer's disease. As such, it can be concluded that ‘alzheimer's disease’ is one of crucial keywords in the field of music therapy.

Table 1 Network Centrality

Node	Degree Centrality	Closeness Centrality	Betweenness Centrality
therapy	25	0.5593	445.2296
anxiety	20	0.5197	355.6439
music	17	0.5116	249.5523
dementia	17	0.4962	180.6252
intervention	17	0.5156	238.0954
relaxation	16	0.5156	130.7555
randomized controlled trial	15	0.4925	269.0633
alzheimer's disease	12	0.4714	103.8177
pain	12	0.4748	67.4558
depression	12	0.4925	72.2614

3.2 Keyword analysis

In addition to the centrality measures, the burstiness history of keywords is also examined to identify

keywords that are mainly studied in a certain period of time. To this end, we build keywords' history of burstiness. Through the burstiness history, we can identify which keyword is bursted, become hot topical word and how long the burstiness exist in the limited range of period.

The results show that the strongest bursted keyword is ‘relaxation’ and it bursts from 2001 to 2005. However in terms of disease, the strongest one is ‘breast cancer.’ The keyword shows burstiness in range of 2004 to 2008. It means that the disease is strong topic for music therapy in that periods. In this period, there are trials and pilot studies to measure the therapeutic effects of music therapy for cancer pain. Also, there are co-bursted keywords; ‘prevalence’, ‘complementary therapy’ and ‘postoperative pain.’

The longest bursted keyword is ‘health’ and the second ranked keyword is ‘palliative care’. Specifically, the keyword ‘palliative care’ had been bursted for 9 years. It can be interpreted that the main purpose of music therapy is to give palliative care to patients. When ordered by year, the keyword burstiness started with ‘depression’ and end with ‘symptom’. Burstiness of ‘depression’ started from 1995 and with this start, the burstiness flow goes ‘stimulation’, ‘pain’, ‘perception’, ‘parkinsons disease’ and so on. In the flow of focus in music therapy, we can find some disease names, such as ‘autism’, ‘schizophrenia’, ‘parkinsons disease’, ‘cancer’, and ‘alzheimer's disease.’

The most recently emerged and bursted keywords are ‘trial’, ‘mental health’, ‘symptom’, ‘women’ and ‘recovery’. These keywords have been bursted until 2017. We can infer that the stream of researches had been started with pilot types of study and continued or ended with trial types of study. And of course, the association between ‘mental health’

and ‘music therapy’ is strongly insisted as a mainstream of music therapy field.

Based on the results of the centrality measures and burstiness history of the keywords, we selected two types of diseases such as ‘alzheimer's disease’ and ‘autism.’ Specifically, ‘alzheimer's disease’ is proved to be an important keyword in the field of music therapy by centrality analysis of nodes in the keyword map. In addition, keyword burstiness analysis shows that autism is also one of the crucial keywords in music therapy study. Moreover, it is well known fact that music therapy gives positive effects on patients with Alzheimer or Autism.

After extracting specific disease, we build a tree map to identify associated keywords connected with the diseases. This map is composed of 48,424 nodes and 48,423 edges. Almost all nodes are connected one by one. We selected two disease names (‘Alzheimer's disease’ and ‘Autism’) for further analysis and examined the keywords frequently co-occurred with those two diseases.

When it comes to alzheimer’s disease, 14 words are directly connected with ‘alzheimer’s disease’ as presented in figure 4. Mostly, words related to the stages of the disease are shown in the map such as moderate, severe and last-stage.

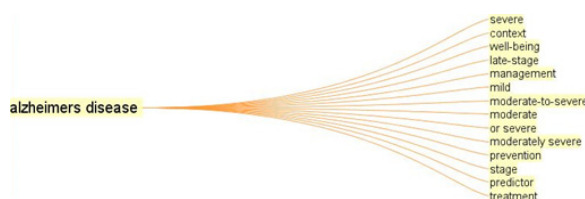


Figure 4 Keyword tree: ‘Alzheimer’s Disease’

Figure 5 shows the keyword map of ‘autism’ and it is shown that the word, Autism, is linked to the keywords that mainly shows the symptoms and stages of the disease.

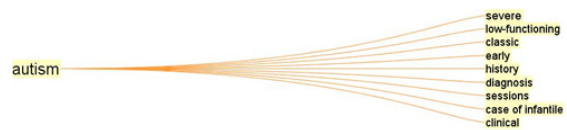


Figure 5 Keyword tree: ‘Autism’

However, with these maps, it is difficult to obtain details on what music therapies are used for the specific symptoms of a given disease. The keyword maps of the two diseases are connected to broad terms such as diagnosis, clinical and treatment not to the techniques of music therapy for the diseases.

To identify the music therapy techniques mainly used for the diseases, we extracted words from the abstracts collected by disease name and analyzed the frequency of co-occurred word pairs. Top twenty word pairs frequently co-occurred in the abstracts of alzheimer’s disease-related publications, are listed with frequency in table 2. The results were interpreted based on content analysis.

Table 2 Top 20 co-occurred words: Alzheimer’s disease

Rank	Word	Word	Freq.
1	Music	Dementia	1152
2	Music	Intervention	819
3	Music	Group	709
4	Music	Cognitive	521
5	Dementia	Intervention	516
6	Intervention	Group	416
7	Agitation	Music	345
8	Dementia	Care	336
9	Sessions	Music	292
10	Scale	Music	283
11	Music	Control	275
12	Cognitive	Group	270
13	Music	Memory	266
14	Cognitive	Intervention	265
15	Music	Emotional	261
16	Cognitive	Dementia	259
17	Anxiety	Music	246
18	Music	Social	226
19	Music	Nursing	223
20	Music	Depression	212

Firstly, the results show that music therapy is mainly utilized to improve the symptoms of disease such as dementia, agitation, anxiety and depression caused by alzheimer's disease. Especially, the word, dementia, appears 4 times and thus it can be assumed that music therapy study has mainly focused on its application to dementia.

When it comes to the techniques of music therapy, the keyword such as music, group, cognitive and intervention is frequently co-occurred with one another, which denotes that music intervention therapy is conducted in group, and used to improve the symptoms listed above. More specifically, cognitive intervention methods based on music therapy are frequently applied to the treatment of alzheimer's disease. In addition to that, the word pairs that are not listed in table 3 show more specific techniques of music intervention such as music listening and singing, music training for caregivers, and using different scale of classic music. Moreover, the results also show specific effects of music therapy on the symptoms of alzheimer's disease. Specifically, music can have positive influence on memory, emotional and cognitive status, and social communication of alzheimer's patients based on the keywords, memory, social and cognitive.

Table 3 Top 20 co-occurred words: Autism

Rank	Word	Word	Freq.
1	Music	Children	881
2	ASD	Music	680
3	Children	Therapy	514
4	ASD	Children	447
5	Music	Autism	444
6	Music	Social	391
7	Children	Autism	387
8	Sessions	Music	332
9	Therapy	Autism	328
10	ASD	Therapy	314
11	Sessions	Therapy	275
12	Social	Therapy	253

13	Children	Social	241
14	Music	Spectrum	238
15	Music	Communication	225
16	Sessions	Children	203
17	Music	Attention	182
18	Music	Musical	173
19	Music	Intervention	165
20	Skills	Social	164

On the other hand, different characteristics were identified in the case of autism. The top 20 most frequently co-occurred word pairs are listed in table 3. The results show that 'music' and 'children' are most frequently co-occurred words, which implies that treatment for autism is mostly focused on children. For children patient, sympathy skill is important, so that the words 'social', 'communication', 'speech' are occurred frequently. Music therapists have to be trained not only for music, but also for communication skill with children. For patients, music therapy is composed of group sessions and for each session, therapists have to consider musical training and social development. Communication skill, interaction, speech skill and response can be important factors for therapy due to the patients' age.

For music training session, therapists need to prepare broad spectrum of music. For autism patients, it might be good for listening or training with various types of music. In addition, leading the attention or response from children is also essential. To do this, musical training and speech sessions are actively utilized for autism therapy. In the course of training, parent-included session is also one of the important factors for autism patients' music therapy. Lastly, it can be interpreted that music therapists who help to cure autism patients, need to balance between music and social training, then music can be the bridge and intervention for society and autism children.

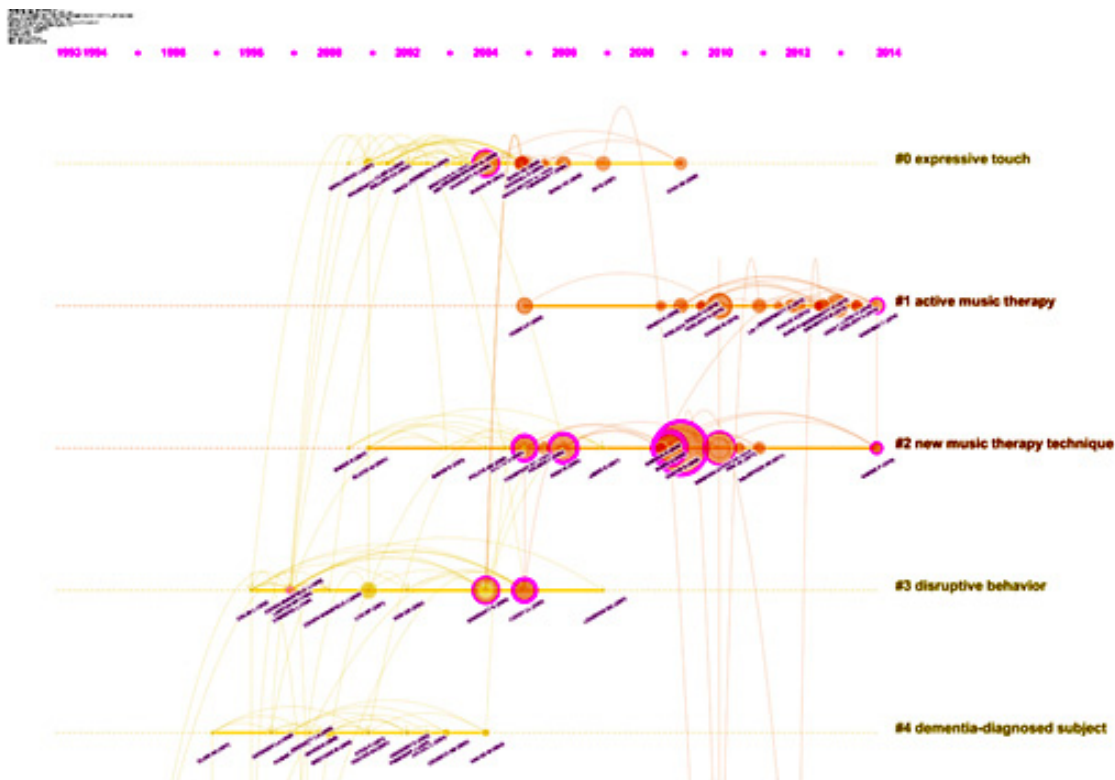


Figure 6 A part of the Citation Network with timeline view: Alzheimer's Disease

3.3 Document citation network analysis for article recommendation

For paper recommendation for patients and music therapists, we constructed a citation network based on the collected publications related to Alzheimer's disease. By constructing the citation network, it is expected that other relevant publications with citation relationship can be discovered. The citation networks generated from publications of Alzheimer's disease and autism respectively, were analyzed and communities were detected in the networks for the paper recommendation purpose.

Firstly, the citation network of Alzheimer's disease was constructed from 146 records and 5007 references ranging from 1994 to 2017, using CiteSpace. 24 clusters of the network were detected and labeled with abstract terms of the publications that were

used to build the network. Figure 6 shows a portion of the constructed citation network in a timeline view.

A node denotes each publication and the publications are grouped under the cluster label. The nodes represented as a pink circle show papers with strong citation burst. Information on top 5 clusters ranked by the number of publications is detailed in table 4. The largest clusters are cluster 0 and 1 having 19 publications and labeled with expressive touch and active music therapy respectively. The content analysis of the abstracts of documents was conducted for three clusters, 0, 1 and 2, to check if the label covers topics of documents belonging to each cluster.

First of all, the label of 0 cluster is expressive touch, however, the result of content analysis shows that common topics of the publications are the use

of music therapy to alleviate agitated behavior in the older with dementia.

Table 4 Top 5 Cluster's Information

Cluster ID	Label	# of Pub.
0	Expressive touch	19
1	Active Music Therapy	19
2	New Music Therapy Technique	17
3	Disruptive Behavior	13
4	Dementia diagnosed Subject	13

As such, we concluded that the 0 cluster should be re-labeled with music therapy to relieve agitation of the older with dementia. As such, a group of the publications in 0 clusters could help music therapists and caregivers to treats agitation caused by dementia as well as old patients who suffer from the symptom.

When it comes to the second ranked cluster 1, it is composed of 19 publications. The abstracts of the documents include common keywords such as

psychological and physiological health, depression and emotional and social benefits, which is shown that the papers belonging to the cluster 1 focus on psychological and physiological health of patients with alzheimer's disease.

Moreover, in the case of cluster 2, the common terms shown in the publications are cognitive performance, memory improvement, classic music and music mnemonics. Based on the keywords, we can assumed that papers in the cluster 2 are useful to people who need information on music therapy methods to improve memory of patients with alzheimer's disease.

The citation network about autism was constructed from 96 records and 3549 references ranging from 2001 to 2015 with 15 clusters labeled using abstract terms. The network consists of 92 nodes and 191 links. Figure 7 shows top 5 clusters in timeline view and cluster information in table 5.

The largest cluster is cluster 0 (19 publications) labeled as 'social engagement.' In this research field, the major patient is children and they need to train social development to treat autism. The second largest one is labeled as 'speech output', including

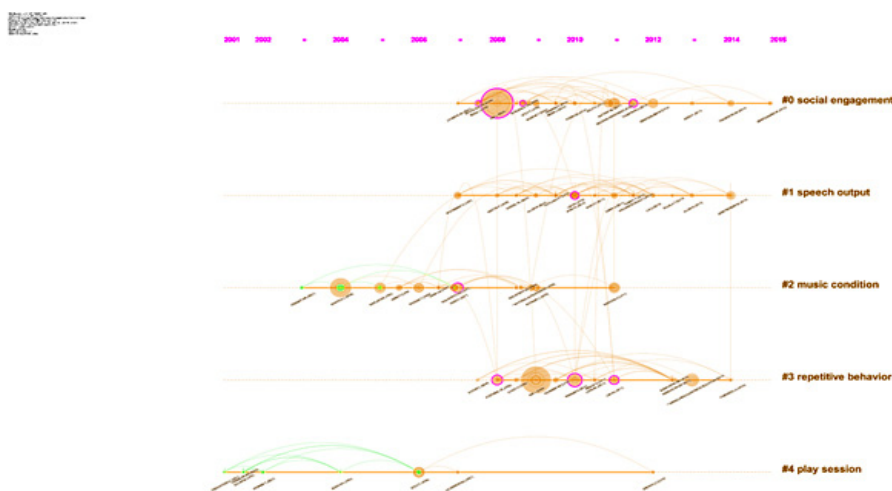


Figure 7 A part of Citation Network with timeline view: Autism

17 publications. This topic cluster is in the stream of ‘social engagement.’ As one of the training session, music therapists use speech training for autism children. Other clusters are also in the same stream. Because of the characteristics of autism, the way of therapy and research stream is mostly focused on developing sociality of children. Additionally in recent, there is an increase in research regarding ‘repetitive behavior’, connected with ‘speech output’-related research.

However, the research topic ‘play session’ (8 publications) is not actively studied in the field of music therapy these days. Thus, we can apply timeline view to the citation network to read the trend of research and recommend the documents further.

Table 5 Top 5 Cluster’s Information

Cluster ID	Label	# of Pub.
0	Social Engagement	19
1	Speech Output	17
2	Music Condition	15
3	Repetitive Behavior	14
4	Play Session	8

4. Conclusion

In this research, we presented a method to recommend music therapy-related publications for music therapists and patients with neural disorders. To this end, we analyzed frequently co-occurred word pairs to identify disease names that are mainly studied in the field of music therapy. Moreover, using these disease names as keywords, we collected papers related to these names respectively, and utilized CiteSpace to recommend the document groups as well as to read the trend based on the citation networks.

The proposed methodology can be applied to identify techniques for treatment of other diseases, so that it can recommend relevant documents to people who need these publications such as patients, doctors, or therapists.

However, as a limitation, we only presented document clusters, instead of providing information on each document. The list of documents grouped by the cluster would not be provided because meaningful information such as title or DOI is missing in CiteSpace.

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