Knowledge Structure of Posttraumatic Growth Research: A Network Analysis

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네트워크 분석을 통한 외상 후 성장 지식구조 연구

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Abstract   Posttraumatic growth literature has been rapidly expanding in multiple academic disciplines. Purpose of this study is to examine the knowledge structure of posttraumatic growth utilizing a network analysis. Papers published between 1996 and 2018 were searched on the Web of Science, focusing on terms related to posttraumatic growth. One thousand six-hundred and fifty-nine keywords were published 6,343 times in 1,780 papers; thus, a total of 322 keywords (5,195 appearances) were selected for the final analysis. The network analysis and network visualization tool used were NodeXL and PFnet, respectively. The keywords which appeared the most frequently were "Posttraumatic growth," followed by "Posttraumatic Stress Disease," "Cancer," and "Trauma." A total of 322 nodes have been reduced to 175 nodes and divided into a total of five groups. The five groups were "Posttraumatic Growth in Cancer, Chronic/Serious Illness, and Disability," "Posttraumatic Growth-related Psychological Variables and Psychotherapy," "Posttraumatic Growth in the Context of Death," "Cognitive Mechanisms of Posttraumatic Growth," and "Vicarious Posttraumatic Growth." This study provides a systematic overview on the knowledge structure of posttraumatic growth by quantitatively network analysis.

Key Words : Posttraumatic growth, Co-word analysis, Network analysis, Knowledge structure

요 약   외상 후 성장 개념은 다양한 분야에서 사용되고 있다. 연구의 목적은 네트워크 분석을 활용하여 외상 후 성장의 지식 구조를 확인하기 위함이다. 1996년에서 2018년 사이에 출판된 국외논문 중 외상 후 성장 키워드를 사용한 논문을 Web of Science에서 검색하여 1,780편의 논문에 1,659개의 키워드가 6,343회 등장하는 것을 확인할 수 있었으며, 최종 분석을 위한 총 322개의 키워드를 선택하였다. 가장 많이 등장한 키워드는 '외상 후 성장', '외상 후 스트레스 장애', '암', '트라우마' 순이었다. 총 322개의 노드 중 175개의 노드로 정리하여 '암, 만성/중증 질환 및 장애에서 외상 후 성장', '외상 후 성장 관련 심리적 변수 및 심리 치료', '죽음의 맥락에서 외상 후 성장', '외상 후 성장의 인지 메커니즘' 및 '대리 외상 후 성장'의 5개 그룹으로 나눌 수 있었다. 본 연구는 정량적 네트워크 분석을 통해 외상 후 성장의 지식 구조에 대한 체계적인 개요를 제공 하였다는데 의의가 있다.

키워드 : 외상 후 성장, 동시단어 분석, 네트워크 분석, 지식구조

1. Introduction

Posttraumatic growth (PTG) is defined as the positive psychological changes that individuals report when they directly or indirectly experience adversity and traumatic life events [1-4]. Since the 1990s, systematic scholarly efforts have emerged to understand the possibility of positive

changes resulting from major life challenges or trauma [5,6]. Studies in the field of trauma have shifted their focus from trauma-related pathologies, such as posttraumatic stress disorder (PTSD), to positive adaptation-related outcomes following adversity, such as resilience, growth, and benefits [7]. The positive psychology movement, which focuses on the advancement in the scientific understanding of positive aspects of human lives, has prompted the development of PTG scholarship [8]. Over the past 30 years, literature on PTG has substantially expanded resulting in the advancement of theories as well as empirical evidence for this topic. To promote a systematic and comprehensive understanding of the existing state of research, and to highlight future research directions in the field of PTG, comprehensive literature reviews on the accumulation of PTG studies are warranted.

This study integrates a co-word analysis and a network analysis in order to investigate the knowledge structure created by journal articles on PTG. A co-word analysis and a network analysis are two of the novel techniques of a systematic literature review which quantitively analyze massive amount of studies in a given field in order to explore knowledge components, knowledge structures, and research trends in greater detail. Researchers are increasingly adopting this approach because the methods of co-word analysis and network analysis complement traditional literature review approaches [9]. A meta-analysis and meta-synthesis are widely used traditional literature review methods, yet these approaches are useful in addressing only specific areas of PTG research rather than focusing on PTG in its entirety. For instance, a literature review regarding PTG-related factors and the application of this in particular contexts currently exists [10], as well as a meta-analysis on psychosocial interventions and PTG [11]. Further, reviews of PTG among refugees [12], PTG among individuals with

HIV/AIDS [13], and PTG in cancer [14] also all exist within the literature. To include a large number of studies, utilizing this method would consume an enormous amount of time and energy, lacking efficiency and inevitably limiting the scope of the studies covered. Literature reviews involving a small number of studies may be able to provide in-depth knowledge regarding a certain area of research, but may fail to represent a comprehensive picture of a given field. Additionally, PTG literature has been rapidly expanding in multiple academic disciplines. Therefore, it is difficult for researchers in one field to obtain a comprehensive overview of existing PTG research from various academic fields, ultimately resulting in unintended duplicate research topics, failure in selecting important study variables, or a lack in integration of previous research. A co-word analysis and a network analysis can reveal the overall picture and broad landscape and boundaries of a given field by using a quantitative approach. Despite the rapidly increasing number of PTG studies, it continues to be difficult to understand the knowledge structure of PTG research as a whole. In order to develop further studies, and to refine understandings of PTG, there is a call to understand important research topics and their context, comprehensive research trends, along with the relationship of studies in a given field.

Thus, the present study aims to provide a systematic overview of the knowledge structure of PTG by quantitatively analyzing the knowledge structure of PTG. In this study, knowledge structure refers to the organization of pieces of information or relationships between different parts of knowledge, allowing researchers the ability to understand major themes and trends of a field of study. Further, this study proposes two research questions. First, this study seeks to understand what are the important research keywords that have been studied in published PTG

articles from 1996 to 2018. Second, this study aims to examine the main themes of PTG research based on published articles from 1996 to 2018.

2. Methods

2.1 Study design

The number of published papers on PTG has been steadily increasing, from 4 studies in 1996 to 225 studies in 2018 (Fig. 1).
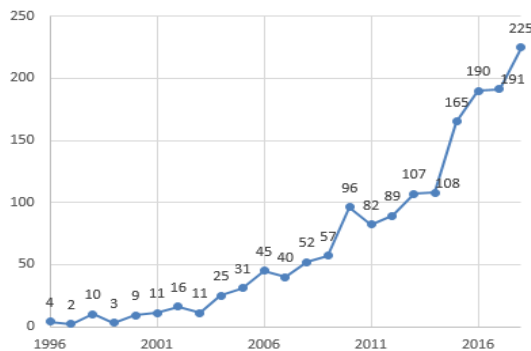
Fig. 1. Changes in the number of papers on posttraumatic growth by year

In order to select and analyze PTG-related ones among many papers, we first considered how to collect knowledge structures. In general, the subject of knowledge structure collection in a certain academic field is divided into two major methods. One method involves collecting all articles from journals published in a specific field and the analysis of keywords, titles, and abstracts to understand the knowledge structure. The second method is to collect all of the papers corresponding to the search results based on terminology closely related to the field being analyzed, and then to analyze the keywords, title, and abstract [15]. In order to examine the knowledge structure of "Posttraumatic Growth," we used a co-word analysis and a network analysis, both of which are widely used methods for the analysis of knowledge structure. More specifically, a

co-word analysis is one of the content analysis techniques used to identify key topics [16]. Utilizing patterns of co-occurrence in pairs of words or phrases in a corpus of texts, this technique calculates the frequency of occurrence of two keywords at the same time within the subject areas presented in the text. This technique then computes the similarity of words from the frequency, and classifies the subject area of the field.

Network analysis is a technique that quantitatively analyzes the structure of a network by organizing the relationships among people, organizations, objects, ideas, or keywords. A network analysis can extract research topics from the subject content of text based on a co-occurrence of words, and then finds a connection between them. This technique is a useful way to grasp the development process and structural relationship of scientific knowledge, as well as the boundary between the development of knowledge. A network in a network analysis consists of a set of nodes and links. The nodes represent the components and the links stand for relationships between the nodes. In the current study, we have generated a network of keywords based upon PTG research in which the nodes are the keywords and the links represent the co-occurrence of these keywords. The number of times that a pair of words co-occurs in multiple articles constitutes the weight of the link connecting the pair. The network constructed in this manner represents the cumulative knowledge of a domain and helps to uncover components of meaningful knowledge as well as insights based on the patterns and strength of links between keywords appearing in the literature.

2.2 Data collection

In the field of medicine where vocabulary is controlled, such as MeSH (Medical Subject Headings), researchers use the term MeSH for the

objects and concepts they are trying to describe. This also applies when selecting the keywords for an article. However, in general, other disciplines do not use controlled vocabularies, which causes researchers to use different methods (spacing, hyphens, abbreviations, etc.). Even though they are the same concept, they are used in different words depending on the field of study. For example, in the case of the word "Posttraumatic," the morphological aspects were found to be used in combination with "Posttraumatic," "Post traumatic," and "Post-traumatic." In this study, the term "Posttraumatic Growth" was selected from the preliminary survey, with the search term being retrieved from the Web of Science (WoS) on November 25, 2018. There were 4,182 cases of Facet's results which were similar to the morphological changes of "Posttraumatic Growth." Next, a search related to "PTSD," a frequently mentioned concept related to "Posttraumatic Growth," was conducted with 1,244,610 cases found. As a result of examining the articles' content, it was found that many articles were not related to "Posttraumatic Growth"; thus, the results were derived by combining the search results (i.e., # 1 AND # 2)(Table 1). After excluding various papers, 1,780 papers were selected dating between 1996 and 2018.

2.3 Data analysis

2.3.1 Stemming

A network analysis requires a pre-processing procedure. More specifically, the author's keywords are characterized as an uncontrolled vocabulary. Therefore, this makes the "stemming" process a very important process for the consistency of the analysis. In result, we conducted a formal standardization process to correct for errors, special characters, parentheses, foreign language, misspellings, blank spaces, and idioms. Further, term refinement was conducted through a semantic standardization process (i.e., singular, plural, and synonyms).

2.3.2 Keyword frequencies

One thousand six-hundred and fifty-nine keywords appeared 6,343 times in 1,780 papers. This was refined to a total of 322 keywords (5,195 appearances) for the final analysis, excluding for scenarios of one-time occurrences and inappropriate keywords. In general, the scope of a network analysis is limited to the frequency of occurrence of keywords. This is often because it is difficult to derive meaning from all of the keywords on the network, making it difficult to form a proper analysis. However, because it is important to select the appropriate frequency of keyword occurrence, we applied the criterion according to the keyword distribution. For example, when we examined the distribution of the frequency of the keywords, about 20% of the keywords (322: 19.4%) follow the Pareto principle, which accounts for 80% (5195: 81.8%) of the total frequency of occurrence. In other words, the keyword that occupies 80% of the total frequency of occurrence is considered to be an important keyword to be included in the analysis. The occurrence frequency for these keywords was two or more times. Based on this criterion, we selected 322 keywords.

Table 1. Search Queries and Results from Web of Science

| No.	Facet	Query	Search Results hits (S#)
1	Posttraumatic Growth	"Posttraumatic Growth " or "Post-traumatic Growth" or "Post Traumatic Growth" or "PTG" or "Personal Growth" or "Stress Related Growth" or "Adversarial Growth" or "Benefit Finding"	4,182 (S1)
2	PTSD	"Posttraumatic Stress Disorder" or "Stress" or " PTSD"	1,244,610 (S2)
3		S1 and S2	1.695 (S3)

2.3.3 Network Analysis and Visualization

A network analysis was performed to examine the knowledge structure. The network analysis should precede a co-word analysis, and a co-occurrence matrix should be created for this. In result, a matrix normalized by the cosine similarity coefficient was calculated using the COOC (Co-occurrence Matrix Generation Program) v.0.4. In the network analysis, methods such as degree centrality and betweenness centrality were used to identify the network structure. Degree centrality stands for the number of nodes that are directly connected to a node; the greater the number of nodes, the higher the connectivity of centrality. Additionally, betweenness centrality increases as one node is located in the way which other nodes have to go through, serving a 'mediator' or 'bridge' role in a network [17]. The network analysis and network visualization tool used NodeXL (http://nodexl.codeplex.com/). PFnet (pathfinder network) was used to implement a graph drawing algorithm.

3. Results

3.1 Descriptive Statistics

A visualization of all of the terms appearing in the paper is very complicated due to the large number of nodes. Therefore, we examined the knowledge structure of PTG research through PFnet, which created only one important link for each node. For this purpose, a co-occurrence matrix generated by COOC was input into a WNET (Weighted Network Analysis) in order to generate a PFnet. As a result, a total of 322 nodes were reduced to 175 nodes and divided into a total of 12 groups. An attempt was made to re-categorize the 12 groups as some of the groups shared common research themes which could be collapsed into the same category. After recategorizing the research theme clusters, a total of five groups were generated. While this recategoriza-

tion approach may have been useful in obtaining a more concise outlook of the knowledge structure of PTG, it may have been arbitrary. To complement this limitation, the authors attempted to not divide the same-colored keywords into different categories. Further, the current study requested four experts in the field of PTG to rate their agreement on the final categorization. Taking the experts' feedback into consideration, the clusters of PTG research themes were finalized into five groups. Details are provided in Fig. 2.
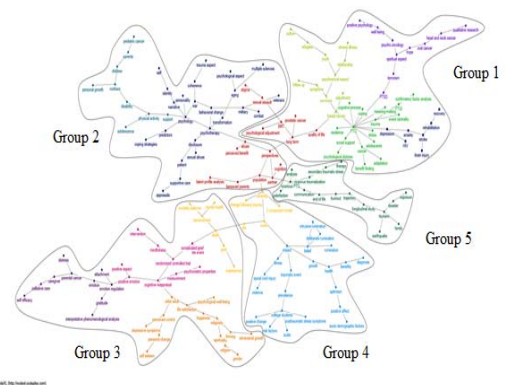
Fig. 2. Visualization of PFNET (q = n−1, r = ∞) of 322 node co−occurrence networks related to posttraumatic growth

The keyword that appeared the most frequently was "Posttraumatic Growth," followed by "Posttraumatic Stress Disorder'' and "Cancer." Following this was "Trauma," "Coping," "Breast Cancer," "Resilience," "Social Support," "Benefit Finding," and "Adjustment."

Keywords with the highest degree centrality included "PTG," "Trauma," "PTSD," "Breast Cancer," and "Adjustment," indicating that these keywords have a direct or indirect link with many other keywords and occupy a central position in the network of PTG research [18]. The keyword "Adjustment" ranked 10th in frequency, but 5th in degree centrality, suggesting that the concept of adjustment has been studied together with other keywords and is influential in comparison to oth-

er keywords with higher frequency in PTG research.

Keywords with the highest rTBC in the network were "PTG," "Trauma," "PTSD," "Resilience," and "Social Support," indicating that these keywords mediate keywords found in other studies. For example, the keyword "Resilience" ranked 4th in rTCB, yet was lower in degree centrality, suggesting that the concept of resilience plays a mediating role in PTG studies.

3.2 Clusters of research themes

The clusters of PTG research themes were finalized into five groups. Each cluster is labeled as the following:
- Group 1: PTG in Cancer, Chronic/Serious Illness, and Disability
- Group 2: PTG-related Psychological Variables and Psychotherapy
- Group 3: PTG in the Context of Death
- Group 4: Cognitive Mechanisms of PTG
- Group 5: Vicarious PTG

4. Discussion

This study was conducted to analyze PTG research in order to understand the flow of knowledge structure within PTG research, and to suggest PTG-related research directions for the future. As a result of a Web of Science search using the PTG term, 322 keywords were selected from a total of 1,780 papers. A co-word analysis and a network analysis were performed with these keywords to find the knowledge structure of the final five PTG studies.

First, with the exception of "PTG," "Trauma," and "PTSD," the most frequently occurring keyword was "Cancer," with "Breast Cancer" ranked as the highest in degree centrality. This result indicates that the majority of PTG research has been conducted in the context of cancer. Further, the keywords "Adjustment," "Resilience," and "Social Support" also ranked high in frequency,

degree centrality, and rTBC, implying that the majority of PTG research has focused on coping and the adjustment process for those with cancer. These results are in line with the burgeoning psycho-oncology research over the past few decades which addresses the psychological impact of a cancer diagnosis and treatment. Further, the findings also confirm that researchers have been increasingly paying attention to the impact of cancer, not only from the perspective of viewing it as a potentially traumatic experience for patients, but also as an adversity that can contribute to positive psychological changes. Research has reported that most cancer patients begin to appreciate and re-evaluate priorities in their lives, and in doing so, they begin to feel increased personal strength. In addition, patients generally tend to be closer to loved ones and others [19]. PTG has served as a useful theoretical framework in understanding how cancer patients make sense of their cancer experience, cope with potentially traumatic life events, maintain and increase their mental health, and achieve personal growth and positive change. Reflecting on the PTG researchers' strong attention to cancer, several attempts have been made to publish systematic reviews related to PTG with cancer, although the majority have been to address breast cancer [14,19-22]. The results of this study indicate that cancer, particularly breast cancer, has been the main context within which individuals report PTG experiences. This may be due to the increasing number of individuals diagnosed with cancer as well as an awareness of the psychological impacts, not only negative but also positive, of the illness.

The summary and suggestions of the current study is as follows. First, although many previous PTG studies have been conducted in the context of cancer, PTG research covers a wide range of different topics, including various types of traumatic life events that have impacted diverse

populations. Interestingly, studies of children and adolescents ranked 15th and 18th according to the keyword frequency analysis in this study. This shows that although the target of PTG studies has mainly focused on adults thus far, some research has examined PTG experience for that of children and adolescents. This finding reflects a growing interest in PTG research among children and adolescents in recent years. Due to the belief that PTG is accompanied by in-depth cognitive processing and changes in life schematics, there was a negative perception about whether children and adolescents with low levels of cognitive development could experience PTG [23,24]. However, as the results show that children and adolescents are experiencing PTG (as an understanding and contemplation of the situations are steadily accumulated), there has been support for the stance that individuals can experience growth after traumatic events, even at a young age [23,25-27]. Given the lasting impact of traumatic experiences faced by children and adolescents on an individual's life as a whole, PTG, which alleviates trauma-induced pain and promotes positive adaptation, can be of greater significance for this population. In measuring traumatic events for children and adolescents, there were limitations in objective measurement through the use of a self-report methodology. Therefore, it is necessary to confirm the validity of these findings through the use of a scale such as the Posttraumatic Growth Inventory for Children. Further, it is important to conduct additional research to examine differences according to culture, growth process, personality, and environment.

Second, most PTG studies appear to examine PTG at an individual level. There are also studies analyzing trauma and PTG in individuals, such as those who have experienced wars or natural disasters. However, in the keywords derived for this study, there were no keywords related to a social transformation, such as "Group," "Society," and "Country." Since December 2019, the life-threatening COVID-19 virus is now a major public threat worldwide. Currently, many journals are reporting various forms of trauma as well as the mental health status of COVID-19 patients and healthcare professionals across various countries. PTG is defined as more than simply returning to your existing balance after undergoing trauma. Since PTG is related to a positive re-evaluation of life, future research should pursue whether PTG has occurred for situations that have changed due to the COVID-19 pandemic. It is also necessary to identify coping strategies that can predict growth to protect many people from the negative consequences of COVID-19 and promote PTG [28]. In other words, there may be situations where the COVID-19 pandemic leads to personal growth. Therefore by considering the COVID-19 pandemic as a global trauma which society is experiencing as a whole, researchers will be able to examine PTG on a larger scale.

The current study has several limitations. First, the current study extracted articles from multiple databases, but did not contain any non-English publications. Also, data collection occurred prior to the outbreak of COVID-19, which significantly affected individuals worldwide; thus, future research must include publications regarding the potentially traumatic experiences associated with the current pandemic. Second, although the current study has made a significant effort in the keyword stemming process in order to maintain the original meaning of the keywords, the stemming process is not free from the authors or indexers' arbitrary selection of keywords or controlled vocabulary process. Therefore, it is recommended that future research consider various strategies to improve the stemming process.

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