Exploring Older Adults' Views on Health Information Seeking: A Cognitive Load Perspective and Qualitative Approach*

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ABSTRACT

In this study the author examines the health information seeking behavior of older adults from the perspective of cognitive load. Using a qualitative method, based on ground theory, data were collected using in-depth interviews. Twenty-eight participants were participating older adults living in G community city, South Korea who experienced seeking health information. Interview transcripts were analyzed using a qualitative thematic coding framework. Three themes describing older adults' health information seeking behaviors were focused: intrinsic, extraneous, and germane cognitive load. The findings are geared towards the context of older adults' information seeking to support an understanding of successful information seeking behaviors in this population and to contribute to their health and well-being. The intent is to present information on current research in the field of Library and Information Science and to demonstrate how a cognitive load approach can be used to address the problems of older adults' health information seeking behaviors.

Keywords: older adults, information seeking, cognitive load, intrinsic cognitive load, extraneous cognitive load, germane cognitive load

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1. Introduction

As the number of elderly people in the population increases and their dependence on information and communication technology (ICT) increases, multi-disciplinary studies of elderly people and ICT have become necessary. According to the United Nations, an aging society refers to a society in which the population of people aged 65 or over occupies 7% or more of the total population. The next stage, the aged society, refers to a society with a population of over 65% of the total population aged 65 or over. The last stage, the post-aged society, is a society in which more than 20% of the population is 65 or older (United Nations, 2019). It is estimated that people age 65 or older will represent 40.1% by 2060.

Along with the low birth rate, the aging is a social problem that the world is facing. The concept of aging varies. This is because aging has chronological, biological, psychological, social and functional dimensions (Hoyer & Roodin, 2003). As people age, aging weakens their physical and cognitive functions. In addition, the physical and psychological health and social problems can reduce the quality of life of the elderly individual, and the social problems of the elderly, such as the increase in the elderly medical expenses and support, will add to the social burden (WHO, 2015). Maintaining and promoting health is critical to improving the quality of life and reducing the social burden of older people while actively responding to the changes they face in old age.

The cognitive function, which is closely related to the health function, refers to mental and intellectual processes such as impulse, perception, interest, motivation, memory, logic, thinking, learning, problem solving, and judgment (Murray, Huelskoetter, & O'Driscoll, 1980; Tyng, Amin, Saad, & Malik, 2017). Therefore, deterioration of cognitive function is very important in old age in that it cannot only seriously threaten basic life such as consciousness of old people but also lead to senile mental disorder.

Cognitive load is increasingly becoming integral to work, education, and every day search tasks such as health information needs. At the same time cognitive load is becoming more important and the variety of health information resources that are available are increasing at an unprecedented rate. In order to search independently and successfully interact with health information resources people must understand how to assimilate cognitive load into their abilities. This may present a challenge for older adults given age-related changes in functional abilities such as physical demands and cognitive efforts skills. The intent is to present information on current research in the field of Library and Information Science and to demonstrate how a cognitive load approach can be used to address the problems of older adults' health information seeking behaviors.

2. Background

2.1 Cognitive load

Cognitive load theory related to cognitive demands is a theory that is actively studied in the field of

educational engineering and cognitive psychology, which is used to explain and predict how teaching methods and informational materials require working memories of various learners (Merrienboer & Sweller, 2005; Sweller, Merrienboer, & Pass, 1998). Cognitive load refers to the cognitive demands in learning or task solving and it is the total amount of mental effort required when a learner stores or processes information in working memory (Sweller, 1988). Cognitive load theory differentiates cognitive load into three types: intrinsic load, extraneous load and germane load (Sweller et al., 1998). Intrinsic cognitive load refers to the inherent difficulty and complexity of the learning information or the task itself (Chandler & Sweller, 1991). Extraneous cognitive load is caused by the mis-representation of information or generated by the manner of presentation of the information, not the inherent difficulty of the task itself (Chandler & Sweller, 1991). Germane cognitive load is the desired mental effort that learners put into shaping schemas through well-designed lessons and learning materials (Sweller et al., 1998). The ultimate goal of cognitive load theory is to properly manage the intrinsic cognitive load in consideration of the learner's level, reduce the external cognitive load as much as possible, and increase the intrinsic cognitive load as much as possible (Pass, Renkl, & Sweller, 2003).

Cognitive overload occurs when a learning situation attempts to store more information than the learner's working memory can accommodate, or when the learning material is more or faster than the learner's understanding. Thus, the capacity of working memory is closely related to the efficiency of information processing. Factors for assessing cognitive load are mental load and mental effort that indicate the influence of the learner's understanding and teaching methods and materials on learning (Paas & Van Merriënboer, 1994). Specifically, mental load is related to the number and extent of information interactions between work and subject. Due to excessive information interactions, high levels of mental load may result in unsatisfactory learning outcomes (Chandler & Sweller, 1991).

In regard to cognitive load in web search, both search task and system features, to mention one example, affect the demands on cognitive resources in information search process (Gwizdka, 2010). Evaluating the cognitive load on web search is useful for characterizing search system functionality and search tasks in relation to the need for the searcher's mental effort (Gwizdka, 2009a). Previous studies showed that higher cognitive ability searchers tend to put more search effort in time spent on reading results pages than lower ability searchers (Gwizdka, 2009b, 2017). Even though cognitive load in information search has begun to have attention, this review suggests that a few studies have looked at the factors that influence older adults' cognitive load of searching for information.

2.2 Older adults' information search behaviors

As for the characteristics of individual searchers' ability to specify information need, cognitive ability in individual differences, novice or expert in in-

formation goal, and experience in using the search system knowledge and domain knowledge were found to determine how effectively the searcher is able to interact with the information system to retrieve information pertaining to the need (Agarwal & Poo, 2007; Ford, Miller, & Moss, 2001; Palmquist & Kim, 2000). The acceptance of information and communication technologies can help designers develop better user interfaces for older adults, thereby increasing interaction and search efficiency (Goldberg et al., 2011; Saha, Mandal, & Pal, 2015; Vaportzis, Clausen, & Gow, 2017). The adoption of technology was mediated with higher cognitive ability, computer self-efficacy and computer anxiety, whereas higher fluid intelligence and crystallized intelligence predicted the use of technology and higher computer anxiety predicted lower use of technology (Czaja et al., 2006). A study examined the relationship between perceived usefulness and perceived ease of use of a computer interface designed for older users and demographic, technology experience, cognitive abilities, personality, and attitudinal variables predicting older adults' perceptions about a computer system for older adults (Mitzner et al., 2016).

Kuhlthau (1991) noted that information search is a learning process that relies on the organization of knowledge of individuals rather than one search that everyone can universally predict. Pirolli and Card (1999) assumed that people modify their strategies or environmental structures to maximize the rate at which they can obtain valuable information when possible. In the light of these two theoretical frameworks, older adults are expected to expend cognitive ability to find the relevant information for them as they learn to obtain health information.

Older adults seeking health information use various methods to obtain the information they need, which might lead to untrusted or unreliable information where the important factors in the search for heath information include computer literacy, mobility, dexterity and others in that the most difficult time and important area for older adults is when they need to judge information validity related to relevance (Manafo & Wong, 2011; Standziano, 2016). Wicks (2003) indicated that it is important when discussing older adults' computer use to distinguish between different stages of older age.

Older adults showed a decreasing trend across reformulations and reformulated queries were far away from the target information, which could result in their lower efficiency (Oostendorp & Karanam, 2016). Studies have shown that older adults spend longer and more time evaluating validity of information they need, use less keywords per query, generate less queries, reformulate less (Chevalier, Dommes, & Marquié, 2015; Dommes, Cheavlier, & Lia, 2011). Huang, Hansen and Xie (2012) reported that the issues of older adults' health information search include insufficient search queries, misunderstanding different Web browser and search tools, extensive reliance on prior knowledge, a lack of ability to evaluate the quality of online health information in performing searches. Flynn, Smith and Freese (2006) explored how patient characteristics are related to seeking health information online and to the timing of these searches in relation to

doctor visits. They have found that among participants with internet access at home or work and years of education were positively associated with searching online for health information irrespective of timing in relation to doctor visits. Turner et al. (2018) studied health information seeking behavior by older adults and involved family and friends and found out that they have a significant need for health information and employ a variety of information seeking practices to ensure they have quality health information available.

Previous studies reported the impact of cognitive aging, the role of prior domain knowledge and the search task difficulty (Sanchiz, Cheavlier, Chin, & Fu, 2016). Studies also showed that timing of information presentation matters (Kester et al., 2004) and the levels of task complexity and the effects of information presentation are important factors on the learning of inference tasks (Hagafors & Brehmer, 2008). There is a relationship between education level and search ability in the elderly where the elderly with higher education are able to search online (Wu & Li, 2016).

While interest in web user behavior has increased over the past decades, few studies have investigated the impact of web information system design evolution on health information search in relation to most especially cognitive load in older people. The purpose of this study is to investigate in depth the perception of health information search experienced by the elderly in relation to cognitive load. After analyzing and discussing the results from the perspective of cognitive load, it is expected that this paper will provide important basic data on the cognitive loads of the elderly in library and information science IR education sites.

3. Methods

This study examines the empirical perceptions of the cognitive load, intrinsic cognitive load, extraneous cognitive load, and germane cognitive load experienced by the elderly in health information seeking. To do this, we conducted individual in-depth interviews and conduct qualitative research on 28 elderly people.

3.1 Participants

The purpose of this study is to examine the perceptions of the elderly in health information seeking from the perspective of cognitive load. To do this, we conducted a personal interview with a total of 28 senior citizens who lived in G city in South Korea in 2019. In order to gather participants, the researchers visited the nursing home and asked the elderly personally. Participants aged 61 to 92 years old (M = 71, SD = 7.71), of which 16 were females and 12 were males. As an interview place, this study proceeded as comfortably as possible by visiting the elderly in welfare centers or senior centers. Interview questions were focused on the perception of the elderly in health information seeking behaviors. The questioning time was made not to exceed 1 hour considering the concentration of the elderly.

3.2 Materials

The individual interview methodology is in line with the theoretical frameworks of berrypicking (Bates, 1989) and information foraging (Pirolli & Card, 1999) and cognitive load theory (Sweller, 1988) undergirding this study. The current study of older adults' health information seeking behavior is built on the premises that information is a learning process and people modify their search preferences and strategies for a maximum goal in that learning process. Therefore, the interviews were a way for us to gain understanding of the process of knowledge in construction as well as experiences in cognitive load for older adults to achieve optimal learning in the process of health information seeking. Such philosophical understanding guided the development of the main question for the interviews. What are the challenges and difficulties that older adults' face in each categories of cognitive load in health information seeking? Therefore, cognitive load experienced by the elderly in health information seeking was categorized into three categories: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load. Table 1 shows the example questions of semi-structured interview.

In this study, the method proposed by Bogdan and Biklen (2007) and thematic coding framework (Gibbs, 2007) were used to analyze the transcribed data. While reading the interviewed contents repeatedly, the important parts and the repeated parts were classified and encoded by subject. Intrinsic cognitive load was categorized and emphasized into prior knowledge and difficulty of information. Extraneous cognitive load was categorized and emerged into information learning method and information presentation method. Finally, germane cognitive load was categorized by the participants' effort to find information. Table 2 shows the summary of the descriptors at each dimension of cognitive load.

4. Results

4.1 Intrinsic cognitive load

Intrinsic cognitive load is a load from the difficulty or complexity of the learning material or task itself. Intrinsic cognitive load may be relative to the weight of the load depending on the difficulty of learning,

〈Table 1〉 Example questions of semi-structured interview

Topic	Example questions
1. Experiences with and perceptions of older adults' health information seeking	What/ how do you approach to search for health information?
2. Learning factors that help and hinder older adults' health information seeking	What/ how do you understand information to fulfill your health information need?
3. Factors that facilitate health information seeking	What/ how do you make an effort to access and use health information?

〈Table 2〉 Summary of the descriptors at each dimension of cognitive load

Themes	Descriptors	Descriptions
Intrinsic cognitive load	Prior knowledge Relative difficulty to understand information Relative complexity of information task	This involved the effort associated with a specific topic or task.
Extraneous cognitive load	Learning methods Information presentation	This involved the way information or tasks are presented to a learner.
Germane cognitive load	Physical efforts Cognitive efforts	This involved the work put into creating a permanent store of knowledge.

which is closely related to the retention of prior knowledge (Sweller, 2010). In order to solve the highly interactive learning materials, acquiring learning concepts and understanding the relationships among them can reduce the work load.

That is, the most relevant to the intrinsic cognitive load in the health information seeking of the elderly is the difficulty and complexity of the information desired by the user and the information itself. In order to understand and solve the information that the elderly wants, they have to understand the concept of the information itself, and to understand the relationships among the concepts, it is possible to increase the intrinsic cognitive load because it requires high interaction. Therefore, since the intrinsic cognitive load may be relative to the difficulty of information, the intrinsic cognitive load may be increased or decreased depending on whether or not there is prior knowledge. Therefore, this study focuses on participants' prior knowledge and difficulty of information regarding intrinsic cognitive load.

4.1.1 Prior knowledge

Participants recognized the need for prior knowledge in addressing health issues, resulting in changes in tone, behavior, and emotion. That is, the positive role of participants' prior knowledge had a direct impact on individual behaviors, confident speeches, or positive expressions in emotional expressions. For example, participant 1 begins with a lack of self-confidence and passive behavior that suggests that specific treatment or prescription behavior is left to her son regarding her health. However, participant 1 said, "I would like to have some prior knowledge" and "It is good to have information…" and that she acknowledged that the presence of prior knowledge is perceived as influencing her specific direction of action.

> *In the case of me, I just take it if my son buys me medicine. If I'm sick, I go to the hospital and get an injection from the hospital. I don't know anything about that information, but I would like some prior knowledge. There are times when my knee hurts and then my back hurts as well. Then I was told to practice doing this and that by raising and pulling this foot. So, when I tried it, it was helpful and beneficial. So, I think that information is good. Information that you can follow while listening… I think it's good because I keep my*

legs softer and softer than when I don't. It's good to have that information. (Participant 1)

Also, Participant 2 expressed that he feels good when the information he already knows matches the information he wants to find. It appeared to a positive expression of emotion when he knew prior knowledge in solving problems to his health need. On the other hand, when he did not know the prior knowledge, he showed that he was thinking about how to solve the problem. Also, the difference between having prior knowledge is that it's easier to find what they already know. It is expected to have a direct impact on future information seeking.

When I have prior knowledge ... If there is anything I know, when I hear it, when it is the same as what I know, it feels good if it is the same as I think. If I came up with something else I didn't know, then I wondered how to do this. If I already know something, then it is easier to find. Isn't it difficult to find information you don't know? It's hard to find information because you don't know ... (Participant 2.)

When looking for information with prior knowledge, I know the title and key words and how to approach it when looking for information needed. But without prior knowledge, uh, I'm afraid how to find this. In that case, I go to the hospital and consult with a doctor, and I report to an expert or a doctor or someone like that. When the information is relatively easy, just ask my kids but if it's difficult, go to the hospital and ask for help (Participant 3).

As such, prior knowledge of the participant 2 leads to the expression of positive emotions, whereas when there is no prior knowledge, she seems to be concerned about information search process. Participant 3 also explained that he could easily approach the problem if he knew the prior knowledge. However, he thinks that knowing prior knowledge can easily access problems, but without prior knowledge, it is difficult to find information. The explanation was focused on his emotions and actions.

Similarly, Participant 4 also expressed that prior knowledge is seen as a trigger to his natural tone or concrete behavior. The help of this prior knowledge has become an important factor in making a direct decision of the participant's first action in his /her information seeking behavior. He also revealed that he had a feeling of worries and burden about how to initiate the first action when not getting the help of prior knowledge.

If I have a health question, I'm going to watch it on TV a lot, talk to friends, and then try to find out if there are good things in the sick area to find out. When I have prior knowledge, I can play YouTube according to that, and even now I studied on Youtube to cook a healthy duck. What if I don't have prior knowledge... If I get sick, I don't know what to eat or what to do … When I know something, I can do something according to that… (Participant 4).

On the other hand, participant 5 explained, "When I don't have any prior knowledge, I don't care when it comes to problem solving." At first, she left it in a somewhat passive state, rather than an active response, and then started searching only when the initial symptoms appeared or when she felt curious. Because she is not an expert, she thinks that she does not need specialized knowledge and tends to solve her curiosity mainly by searching on the Internet. Participant 6 looked for symptoms and gathered related knowledge one by one. In the absence of prior knowledge, he seemed to be trying to gather the information he needed through a wide range of routes. He said, "I ask people around me; I talk to my friends; I look for them on the Internet."

If you just type in the Internet, you're curious about, don't you think everything comes out there? I don't care when I don't have any prior knowledge. With or without such a symptom, I just look at it once when I'm curious, and if a symptom appears, I search for it on the Internet and search for it again in detail. When is it difficult to solve the problem? What's a difficult word? I'm not an expert. Just looking for the initial symptoms, expertise comes out there again, and hitting it on the Internet again solves the curiosity (Participant 5).

My knee hurts little by little, so I just look for it. I'm just looking for it because it hurts. When you're not sick, squatting down is bad, and you know this is bad, right? What is good? What is a good exercise? What is good food? I look for information something like this. When I want to know, I just say I'm sick to a doctor, and when I don't know, I'm looking for it extensively. Well, in that case I ask many people, talk to my family, talk with my neighbors, talk with friends, and watch the internet (Participant 6).

Participant 7 had a clear direction of action according to the presence or absence of prior knowledge. He explained that the presence or absence of prior knowledge about words or medical terms makes a lot of difference when searching for information, adding, "If you don't know where, what is it, it would be difficult to use it even if you have good information." He emphasized the recognition of prior knowledge plays an important role in predicting and acting on new knowledge content.

In my case, I know a lot of prior knowledge. It makes a lot of difference. It may be difficult to find information without it. First, you don't know what keyword search words are, and then you don't know which site to go to and what to search for. So, I think there is a lot of difference in time and effort. If you have a little knowledge, it is more complementary, it is easy to find, and you can go to various sites to find a lot of information (Participant 7).

In the case of participant 9, it should be noted that when there is prior knowledge, it is an effort to cooperate with each other to solve problems by searching for more relevant knowledge and watching

more types of videos, comparing the information found, or by asking children or acquaintances. Likewise, when there is prior knowledge, it shows the act of actively searching for more relevant data, as in the case of participant 7, and the act of accumulating new knowledge in the existing knowledge structure through the act of comparing.

> *Um... When I have prior knowledge, I first search through a smartphone or computer, then search for related knowledge, and also look for videos of related experts. Somehow, it is difficult for me to discriminate on my own, and it is said that I seek professional help to get more accurate information. Instead, the information we know is used to watch a wider variety of videos or to compare. When I want to find information that I don't know very well, I get help from my son or daughter or close acquaintances (Participant 9).*

> *Finding it without knowing it is something I feel satisfied now. I found this and now I know it, so I feel more satisfied. When you look for information you don't know at all, aw, it's just annoying (laughs) and it's annoying. I think I can feel that kind of information that is easy at my level... I'm looking for it myself now... Even difficult information... It's the internet. It's all internet. Or call the hospital or health center to find out (Participant 14).*

As such, prior knowledge becomes an important key in grasping the meaning of new information. This is because prior knowledge plays an important function for learners to understand learning content, predict new content, and act on the basis of prior knowledge. Therefore, it can be said that it is very important to look at the behavior of the elderly depending on the presence or absence of prior knowledge. This is because prior knowledge, like a roadmap, allows us to predict what we will do in the future and what goals we will go forward with (Renkl & Atkinson, 2003). As seen above, prior knowledge is a very important factor in reducing the intrinsic cognitive load, and furthermore, it can be a factor that triggers the initiation of positive and successful information seeking behavior.

4.1.2 Learning health information

Kulthau (1991) defined information retrieval as a learning process. That is, many things that happen in the search process do not end with a single total search. Even in the berrypicking theory, information retrieval was viewed as a series of learning processes, and likened to picking fruits here and there; learning took place here and there. Depending on the learning information, that is, the degree of difficulty of the health information problem, a learner's intrinsic cognitive load may have a different weight. Since even the same learning health information task can show different intrinsic cognitive loads according to the learner's individual competency, it is necessary to manage the level of difficulty of the learning information task according to the learner's level.

Considering the difficulty of the learning information task and classifying the actions taken by

the participants, it can be summarized into three categories. First, they try to solve the problem themselves. In the first case, the difficulty of the task seems to be low. Second, they try to solve the problem by cooperating with the help of close acquaintances, family members, friends, and relatives. In the second case, the difficulty of the task or assignment is difficult for the person to understand and thus asks for help. Third, they go to experts to consult and get help to solve the problem. The third case seems to be a case where the difficulty of the task is high, and also a case where an expert opinion is needed for the suitability and reliability of information in problem solving. It seems the most important factor is that it is difficult to understand the health information itself.

Understanding of health information is relative depending on the inherent difficulty of the information task itself and the presence or absence of prior knowledge. While it is easy to understand the relevance of easy information with prior knowledge, difficult information without prior knowledge of information makes it difficult to understand the information itself. This is because in order to acquire high learning materials related to health information, listening to expert explanations and understanding the relationship between information concepts can reduce the intrinsic cognitive load.

Participant 10 showed a tendency to try to solve the problem alone when the complexity of the learning information task was relatively easy, whereas when the degree of complexity of the learning information task was relatively difficult, she seemed to try to solve the problem by receiving help from the surroundings.

First of all, when the health information I need to find is easy, I try to solve it myself with a simple search using a smartphone. Instead, when information is difficult, um, I also look for related professional books and get help from close acquaintances. The reason is probably because the difficulty of the information is different (Participant 10).

In my case, I want to leave it to a professional doctor rather than a friend or something like this. Still, I think that people who are doctors with specialized knowledge know a lot of information that I want to know. The rest are often misrepresented by stories from friends or through internet sites (Participant 11.)

When it's easy, I ask my daughter or friends, and when it's difficult, I ask a specialist. When I look for information I know a little, all I look for information that I know is correct, but when I look for information I don't know, it's difficult how to find it. (Participant 12)

When it's easy, I know it through TV, and when I don't know, I just ask my daughter or aunt. Or ask my son. I go to the doctor once every 6 months, so go to the doctor and ask. I ask siblings or children for easy information, but I ask an expert (doctor) for health information that feels

difficult (Participant 13).

Participant 21 revealed in the interview process the embarrassment and fear resulting from the unfamiliarity of health information that was not known and prepared in advance. Like this, when problem solving was difficult, there were many expressions of negative emotions. In addition, the elderly participating in the health information problem, the higher the level of difficulty, the more cooperative information behavior to seek help from the surrounding area. In terms of social networks, there was a tendency to go from people with close intimacy (e.g., family, relatives, and friends) to people with distant intimacy (e.g., professionals, nurses, and doctors). That is, there was a tendency to change the information behavior from independent single information behavior to cooperative group. This implies a large role of interaction, and it seems that the more difficult it was to solve the problem, the more interaction was needed.

It's just really bad. My leg hurts a lot even now, but I don't know if I should go to a big hospital or go to the nearest xx hospital. I'm taking medicine and if I keep getting sick, I have to have surgery, but I'm just worried (Participant 21).

I'm just asking people if I need some information, I don't know where to get information I need, and there's no such thing. Because I'm sick like this, I'm asking if it's okay with me. If you don't know or it's difficult to find the answers, you just go to the hospital (Participant 19).

When it's easy information, I search it on YouTube and ask my friends when I don't know what to do… People you know, talk to this person and ask that person...Ah, go to the hospital first when emergencies. If it hurts, check why it hurts... so I run to the hospital (Participant 15).

Terminology is difficult to understand and hard to remember, so I'll look it up again. I look for that difficult term again. When it's easy, just understand it and move on to next question with the common sense I know (Participant 16).

In sum, the presence or absence of prior knowledge and the difficulty of learning information, which can significantly affect the intrinsic cognitive load felt and experienced by the participants, were expressed in a tone with confidence in respondents, and at the same time expressing some positive or some negative emotions. It can be said that they have also become the basis for practical actions to find action methods necessary for the search.

As such, prior knowledge and complexity or task difficulty of learning information, which are factors that have an important influence on the intrinsic cognitive load, cannot be simple for the elderly who participated, and are difficult but critical to predict and acquire. In addition, because the elderly participants have different final educational backgrounds, economic environments, and social positions and responsibilities, there may be more differences in controlling the two. It is believed that these influencing factors can determine the behavior of the elderly

and predict the direction of their behavior. Even for learning information tasks of the same content, different learners may cause an intrinsic cognitive load differently, so the level of prior knowledge of the learner must be considered. This is because the intrinsic cognitive load can be relative according to the difficulty of learning, and it can be said to be related to the retention of prior knowledge (Renkl & Atkinson, 2003).

Substantial evidence has established that prior knowledge and difficulty of information influence on information search behavior (Kerstetter & Cho, 2004; Khosrowjerdi & Iranshahi, 2011). These two factors appear to involve the consumption of intrinsic cognitive load, in which prior knowledge influences on a tone of speech while also enhancing the directions to behavioral action and emotion. Therefore, preferably, in order to manage or reduce the intrinsic cognitive load of the elderly as much as possible, it is believed that through prior knowledge education and education sites, the elderly must find opportunities to accumulate practical knowledge by finding coping methods necessary for their health information literacy skills.

4.2 Extraneous cognitive load

An extraneous cognitive load is generated by the way in which relevant information is presented to learn the content of the task rather than the difficulty of the health task to be studied. If a health information task has particularly high intrinsic cognitive loads, that is, if it is difficult to solve the problem, then the relevant informational material should try to reduce the extraneous cognitive load. That is, the most relevant to this ineffective cognitive load in the health information seeking of the elderly is the difficulty in understanding the data or information presented they are looking for the problem solving. This extraneous cognitive load can be managed by design for presentation of learning materials.

Mayer and Moreno (2003) proposed the theory of multimedia learning and said that humans have separate systems for processing pictures and data. Each channel has a limited amount of data that can be processed at one time, so exceeding this amount leads to cognitive overload. In solving the learning information task, the learning method and data presentation for problem solving, not the learning information task difficulty itself, plays a very important role in managing extraneous cognitive load.

That is, when presenting learning materials among learning methods, extraneous cognitive load can be minimized if visual or auditory information is appropriately adjusted and presented. In cognitive load theory, human working memory has a plurality of information processing channels, so that learning contents entered through sensory organs through the learner's hearing and vision are stored in the short-term memory device, and then transferred to the long-term memory device and stored.

4.2.1 Learning method

Participants who know how to use ICT to some extent showed active information behavior by actively trying to find and understand information for problem solving on their own, while participants

who do not know how to use ICT are passively receiving help from their surroundings. It seems that the use of ICT adds to the external human resource load that understands the content of learning information, and another extraneous cognitive load that must be known when using ICT devices. It can be seen that an increase in the external load occurs in addition to judging the suitability and reliability of information.

Therefore, there are two ways to learn the participants' health information. The first is the case of learning by asking for help from the surrounding area, and the second is to learn information for problem solving by collecting prior knowledge, such as the Internet, and further, by asking questions from experts if necessary. That is, the first case showed a rather fragmentary and limited tendency in the way participants learn, and it is a case that mainly requests cooperation from surrounding people. The second case was that the methods of learning by the elderly participated in a complex and multifaceted trend. The difference between the two behaviors was found to be asking for help because they felt limited in solving problems related to knowledge.

4.2.1.1 Limited and fragmentary learning experiences

Among the participants, the participants with little or no prior knowledge about the task to be solved had uncertainty about how to behave in the use of devices using information that is unfamiliar to them and inexperienced ICT. This, in turn, has resulted in embarrassment and sometimes fears for them. As mentioned earlier, it was shown that the ability to properly use ICTs plays an important role in learning methods. It seems that the transition from digital divide to digital opportunity is necessary for the elderly.

Participant 19 said, "I just don't know… follow them around and do what they tell me to do." As she moved the center of health information activities from her to her surroundings, she felt and realized that she was unfamiliar and unconfident with the learning experience. When it comes to health, family and close friends are the first to face, talk, and discuss, and they are the most important people to interact with.

I just don't know how to use ICT devices, so I ask my son or daughter and they take me to the hospital and follow them around and do what they tell me to do. I can't go anywhere alone. I can't even do anything alone because I can't understand what people are saying. That's why I have to ask my son or daughter for explanation (Participant 19).

I don't know technologies, is there more than going to the hospital? If you are in a hurry, you go to the hospital... Well, how do you know if it's right or wrong information even if you found something on the machine... I don't know, just, I follow the hospital doctor's instructions. If the doctor tells you to do this, you will follow the instructions (Participant 21).

The fastest way is to go to the hospital and talk

to my doctor. I go to the hospital well and sometimes I call my son and ask. The best way to understand the information is to ask my son, ask my brother, and consult a doctor when I don't know more. Most often I consult with a doctor, and I often come home and talk with my children (Participant 23).

Participant 25 did not know how to handle machines, so she learned in a way that was familiar and easy to her by seeking help from people around her. The main method she uses to find information is to ask around, because she does not know how to use information technology. She believes that it is appropriate information if she feels it is plausible.

I'm not good at machines, so I just ask a lot of people, ask the people around me. Um... The reason why I do that is because I don't know how to use a cell phone for things like the internet. Since I can't use the Internet, I know it through TV and ask others. It's easy for me to do that. When I hear about it, it seems like it is the right part. I just thought so. Then, there was such a person around me, and she said this and that, and ah... so it's easier to understand if I take an example (Participant 25).

I'm just trusting and following the doctor's guidance. I would be grateful if the doctor explained well so that I could understand it, I can do it accordingly. I don't know even if I look at such pictures and videos on the computers, so just telling me it seemed more relevant (Participant 27).

Due to the rapid and continuous development of technology, older people must learn to interact with many new skills. This can increase extraneous cognitive load of the elderly, and that the participants could have performed limited and fragmentary information seeking behavior. Since this is another difficulty in addition to intrinsic cognitive load for the elderly, more efforts to lower extraneous cognitive load are required.

4.2.1.2 Multifaceted and complex learning experiences

Previously, it was shown that prior knowledge and experience of using ICT contributed positively to the interaction of information seeking behavior. The use of prior knowledge and ICTs appeared to have contributed to complex and multifaceted behaviors in information activities as a learning method to solve the information demand for health information.

The participants who are capable of using ICT are learning while searching for information on the Internet using their smartphones, and not only there, but further expanding the area of information activities to the surroundings and experts. Participant 22 used to find health information on the Internet using a smartphone, asking aunts together, and getting information from a health program through TV. Participant 24 used the Internet to collect prior knowledge of health information he needed and then asked a professional.

I go to Naver a lot with that smartphone. Everything came out when I went there. If I think it's right,

I take it that way. If I'm a little suspicious, I'll ask my aunts. And if you look at the TV, there are a lot of health information, right? 'Ask anything' or 'My body manual' Looking at that, there are a lot of health information I can take. But now that the smartphone is small so I can't see the text well. So, my husband bought many books that related to my health. He told me to open the book and ask me to do this and that (Participant 22).

First, I look for it on my smartphone. In my opinion, Daum or Naver will explain the information well. After having some prior knowledge, I ask a professional again. However, listening to doctors leads to more trust in professionals, whereas the internet is universal (Participant 24).

Participant 28 and 27 argued that what the doctors said was the fastest and easiest for them to understand, but they did not believe everything they heard. It can be seen that they tried to approach multifaceted learning while searching for information with people around them and the Internet. Participant 28 said that she used the Internet to see comments, share opinions with friends later, and share information to identify the pros and cons.

Browse the internet because it's the easiest. I also ask the doctors to find out, but sometimes they don't answer sincerely. Haha… We're comparing each other, we're not blindly convinced of it, and we've got fakes on the Internet, and we don't believe all the information itself. That's why we review it objectively to some extent, ask other people around it, and use various methods (Participant 28).

The fastest way to understand is to just see and face to face with words. Ah, it's much faster for us to get information face-to-face with the doctor directly, no matter how good the internet is (Participant 27).

Participant 18 used the Internet to search for information in order to verify the knowledge he already knew, and consulted a doctor or a person with expertise for crucial information. It was found that the acquisition of information through the Internet, where related information knowledge came out, served as a great advantage for the elderly. Participant 18 thought that he needed to consult a doctor at the moment when making an important decision. In addition, when the participant 20 judged the suitability of the information and wanted to check whether there was any missing information, the participant asked adult children of the participant to confirm.

The main method I use is to search the Internet to check what I know once again, and then consult with the doctor in charge or a person who has the knowledge of the doctor to solve the question. The things that go around on social media these days are a bit unreliable. So, as I said before, I'm consulting with doctors with expertise when making important decisions (Participant 18).

First of all, I search using a smartphone or computer

because it is convenient and I can get a variety of information. I find a variety of related information first and then ask my adult children to judge whether the information found is appropriate. It helps a lot because I can check again through my children if there is any information that I have missed (Participant 20).

Making technology more useful and useable to older adults is critical to address the problems of extraneous cognitive load. As seen above, participants use a variety of methods to obtain information they need. Some of these methods lead to unpleasant or reliable results. However, if factors such as literacy, digital literacy (e.g., computer and ICTs), or mobility are resolved in the process of information search, extraneous cognitive load will be reduced resulting in successful information search experience for older adults.

4.2.2 Information presentation

Extraneous cognitive load is generated by the way information about the task to be learned is provided. Therefore, this load is highly dependent on the design of the information presentation of learning materials. This is especially true when the level of the task to be learned is difficult. Visual, auditory and cognitive skills are important considerations when presenting information to the elderly (Morrell & Echt, 2015). Sweller (1988) stated that when a learner processes information to be learned, complex, unnecessary, or obstructive factors increase human cognitive load. As a result, it was argued that the higher the cognitive load, the more difficult the learner practiced and remembered with attention, and the learning effect decreased.

There are various types of information presentation using visual images, textual text, and audio-visual multimedia. In one study, information presentation can reduce the audience's extraneous cognitive load through slides with clear and concise content that are more dependent on visual effects and less dependent on complex text (Mayer & Moreno, 2003). In another study, when learners read learning materials, the order in which information is presented influences and is important to learners (Mayer & Pilegard, 2014). For the elderly, the more difficult the problem level of health information to learn is, the more important it is to design and show the method of presenting information to reduce extraneous cognitive load.

Participants recognized that the most important thing about how information is provided is easy to understand and therefore easy to follow information as good information and reliable information. In addition, as the preferred type of information presentation, data in the form of using both visual and auditory at the same time are the easiest to understand for them. It can be seen that they do not want another cognitive difficulty to occur when the understanding of information is put into action.

I think it's better to have the information in text, visual and audio mode, and it's also posted in various places like YouTube. You can see and follow those things. It's most reliable to show a video or something and then later the doctor

explains. While showing the video, I see that part and feel it visually, so I can understand and trust (Participant 16).

I think the best understanding is probably the way to view information through videos. It's much easier to understand because audio-visual materials that can be seen and heard are provided at the same time (Participant 17).

As for the method of presenting information on the reduction of extraneous cognitive load, the participant 14 emphasized the understanding and said that information that is easy to understand and easy to follow is good information.

As such, information that I cannot follow, no matter how good the information is presented, is not very good information for me. It could be useful information though. It is good information if I don't think deeply and I just understand the way it sounds (Participant 14).

I like videos and statistics. In the case of video, I can understand it right away by looking at it with my own eyes. Yes, I can see it with my own eyes and hear it at the same time (Participant 9).

I think the fastest way to understand is to watch a video using a computer. If I'm good at smartphones, I can be better searching for information I need any time. I've applied for learning now, but if that doesn't work, I should use a computer (Participant 5).

In short, among the participants, the method of presenting information materials with narration using video was recognized as high-quality information. That is, when visual data processing information with eyes and auditory data processing information with ears coexist, cognitive load of the elderly was considered low. The task to learn health information itself can increase or decrease intrinsic cognitive load of the elderly, and the task to be learned remains the same, but extraneous cognitive load may be large or small depending on how the information material to be learned is presented. As a result, one of the important problems of health communication and health information technology seems to present information that minimizes the amount of extraneous cognitive load required for the elderly to learn and understand health information. Even if older adults are asked to learn the same content at the same time, the amount of processing of learning information may differ depending on the individual elderly's cognitive ability and the severity of cognitive load and effective information presentation.

It is believed that if the learning method and information presentation types are properly designed and chosen in consideration of cognitive load of the elderly, it will be helpful for the improved elderly health information behavior. Some individual differences, such as ICT and digital literacy, point to the existence of divides in information source access, use and learning among participants. Interventions can be designed in user interface design or in-

formation search systems to bridge these gaps to mitigate extraneous cognitive load. Information presentation that should reduce extraneous load works differently for individuals with low versus high expertise. The idea of the expertise effect is that intrinsic load decreases with increasing expertise. Therefore, it is necessary to consider a method of presenting learning information that prevents overloading as much as possible in the process of processing information.

4.3 Germane cognitive load

Germane cognitive load is a mental effort to integrate new information into an existing knowledge system. That is, germane cognitive load can be said to be a load related to the mental effort of the learner for the structure of the existing knowledge system schema and the integration system of new information.

Cognitive load may not occur if the learner is presented with too low or high level of learning materials. However, if the learner is provided with learning materials at an appropriate level, the learner makes a mental effort to solve the problem (Renkl & Atkinson, 2003; Sweller, 1994). Therefore, germane cognitive load that occurs at this time is the cognitive load that must be promoted in the learning context, unlike the intrinsic cognitive load and the external cognitive load (Bannert, 2002).

Germane cognitive load of the participants could be divided into two categories. The first is the type of participant who tries to find the information they are looking for and related information. The second is the type that doesn't even try to find it from scratch. In the first type, an ICT device such as a smartphone is used to search for necessary information and then collaborate with a specialist or other people. That is, it seems that they tend to ask the person they trust and depend on first. It seems that the participants who do not even try to search for their need from the beginning do not have any ICT devices and prior knowledge. A further look at the first case is as follows.

It was found that among the elderly who participated, they understood health information, and based on that understanding, they made mental efforts for actions necessary for health promotion behavior. Effective use of ICT technology can reduce the extrinsic cognitive load of the elderly and promote better knowledge of chronic disease management, thereby promoting intrinsic cognitive load. The process of generating germane cognitive load seemed to occur as the elderly tried to find the most appropriate information for them.

Participant 20 tried to learn how to use and obtain more necessary information by using a smartphone in order to obtain more information that he needs through the applications. He was just getting health information through the hospital app and insurance company app. He was also searching the Internet using his smartphone and learning new health information through e-mail. It was confirmed that Participant 20 could acquire health information through various methods such as Internet search using a smartphone or PC, information exchange with nearby people, Internet mail, and health-related applications.

I use my cell phone, use health information from occasional emails, and try to find out what I need. What happened recently was the qualifications for the elderly to use nursing hospitals, what documents are prepared there, etc. We can't go to the hospital to find out what we do, so we can go to the health insurance evaluation or something like that, but the easiest thing is to get information from the app because the app has improved a lot these days. There are hospital apps, insurance company apps, and many apps because we use it a lot since we are in the smart phone era, so most people use it there (Participant 20).

So far, what we can rely on is that we use the smartphone or PC to search, access, and use data about it within the framework of the basic degree that we can access as socially as we are. I'm diabetic, so I consult a doctor about diabetes, and now I search the internet and search for apps, and I look for everything that's good for diabetes (Participant 4).

Participant 6 said that he thought and judged himself based on the information found after searching for information using the Internet to find the information he needed and the most suitable. It was found that germane cognitive load of the participant 6 was high through the effort to search for and judge data for the information needed. That is, participant 6 was looking for related information with more effort when the red light of health was turned on, and after finding the health information, when he felt that he was not feeling well and felt scared, he visited a specialized hospital and consulted with a doctor.

When I have a health problem that I feel with my body, I work harder and harder to find information. I am happy when I find the health information I want to find, and when I feel there is no problem with my health, I am satisfied there now. So, finding information also stops there. If I am not in good shape, even though I have found information, when I think I am not feeling well, then I go to a specialized hospital and consult a doctor (Participant 6).

For participant 5, it is important to find information related to health problems directly felt. It was found that if she couldn't make her own judgment on her health condition, she would go to an expert to get more detailed consultation and diagnosis.

Unlike usual, when I feel serious, I go to the hospital right away. When I feel serious, it's time my doctor explains my illness, so these days I go to a lot of hospitals for health. Because doctors know a lot about disease, I visit to see doctors. Since I lived apart from my family, I tend to go to the hospital as often as possible because I don't understand the disease by myself (Participant 5).

Germane cognitive load can happen when older adults have to think hard to solve the problems in searching for relevant information needed. A recent

study by Endres and Renkl (2015) examined the testing effect under a range of conditions and concluded that testing tasks should be used that require learners to invest substantial mental efforts. They pointed out that a more difficult task leads to more elaboration as long as it can be solved successfully. Pass and Gog (2006) investigated worked example instruction for different ways to increase germane cognitive load. They pointed out that worked examples decrease extraneous load by stimulating the allocation of working memory and thus increase germane cognitive load. According to CLT framework (Sweller, 1988), low performance could be explained by a rise of extraneous in parallel with a decrease of germane load. Gwizdka (2010) stated that "when a user is not burdened with high cognitive load, they may be willing to provide additional information to the system."

Studies examining age differences in the use of interactive phone menu systems suggest that using this type of system may be more difficult for older people (Czaja et al., 2006). Findings in this study suggest that older adults are willing and able to learn and use ICT devices and search systems. However, they may have more difficulty adapting to ICT and these systems than younger populations. Importantly, most of these problems can be solved with education such as digital literacy education in libraries or health literacy, or interface design interventions for the elderly. Solving such problems will eventually provide an opportunity to lower intrinsic and extraneous cognitive load but increase germane cognitive load. Given the current popularity of internet and smartphones, special efforts using germane cognitive load can be made to explore more relevant information to better support personalized information delivery.

5. Conclusion and Implications

Cognitive load theory has undoubtedly given research questions to many researchers and has been great research area for educational research. In this paper, however, some critical questions were posed concerning how each type of cognitive load relates to health information seeking behaviors of older adults. In so doing, no attempt was made to measure each type of cognitive load. Instead, by interviewing 28 older adults and illustrating these with considerations and results from this field of information seeking behavior research, three fundamental approaches in the cognitive load area have been highlighted. Here a short synthesis of these approaches is presented together.

The basic idea of this article is that health information search tasks should always be combined with search systems that induce germane cognitive load, such as mental effort and physical performance or feedback (van Merrienboer, Kester, & Pass, 2006). From a user interface design point of view, "it is important to consider extraneous and germane cognitive load as communicating vessels, because the reduction of extraneous cognitive load can free cognitive resources for an increase in germane cognitive load" (Pass, Renkl, & Sweller, 2003).

This study provides insights into older adults'

health information seeking behaviors from the perspective of cognitive load. Cognitive load factors, search difficulties and challenges in information search process are identified among older adults, which have implications for a better user interface design, implementation and user experience on health information systems for older adults.

6. Limitations and future directions

In this paper, this study has some limitations. First, the behavior of health information seeking may vary greatly depending on the final education level of the elderly. However, this paper did not focus on the final education level of the elderly. Second, we did not ask participants to order their source preferences when they searched for multiple sources to complete their search need; thus, we do not know which sources were preferred sources and which were secondary or tertiary. Obtaining this information could help us better interpret and understand users' rationale for source selections.

The approach to generalization seems to be better to approach with more subjects and quantitative research in the future. Fourth, the study did not focus on the differences between older adults and younger adults. To do this, future studies will focus on the differences. Lastly, cognitive load was not directly measured by the participants but was rather explored in three types of cognitive load in relation to health information seeking by participating older adults.

This paper served to amplify the question of social collaborative information seeking. As a follow-up to this paper, it would be useful to conduct a series of studies on the role of social collaborative information seeking behavior among the elderly, communication methods of peers, and timing of expert intervention in the future.

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