1. Introduction

The daily life of people with acquired brain injury (ABI) is influenced by their cognitive impairments including memory disorder, attention disorder, and executive dysfunction [1]. Wilson and her colleagues have reported the challenges for their patients with ABI in their daily lives, including forgetting where they have placed objects or parked their cars and being unable to manage money or leave the house alone [2]. Others reported that people with ABI have limitations to their level of activity [3] and social adaptation [4]. Many young persons with ABI who live at home need services and supports in their environments [5]. In addition to the inconveniences faced by persons with ABI themselves, there is also extensive burden placed upon caregivers [6, 7]. Cognitive impairment is associated with the loss of social autonomy and an inability to return to work after ABI [8].

For people with ABI to live comfortably at home, it is important to have abilities to handle many everyday technologies (ET). ET has been defined to include a variety of technical, electronic, and mechanical equipment, including both recently developed devices and well-known technology and services [9]. Not only does the use of ET contribute to an improved lifestyle [10], it has also become an integral part of most tasks at home and in society, including the workplace in recent decades [11]. However, the use of ET, even by people without cognitive impairments, can be difficult at times [12], and the benefits that people with ABI, who have various types of cognitive impairment, can gain from ET are even more limited than those without cognitive impairment [13].

Multiple studies have evaluated the relationships between people with ABI and their ET use in everyday life. Lindén and her colleagues have demonstrated that people with ABI have difficulties using everyday technologies, in particular, advanced technology such as computers, telephones, and other electronic systems which require the use of cognitive functions [14]. Fallahpour
and her colleagues have revealed that perceived difficulty in ET use is significantly increased among people with ABI, with severe to moderate disability, compared with controls [15]. Malinowsky and Lund have described the relationship between the perceived difficulty and the observed ability of ET use in people with ABI of working age [16].

Although there are a few studies that evaluated different aspects of ET use in people with ABI, to the best of our knowledge, there have been no studies regarding the relationship between the difficulties using ET and various types of cognitive impairments. Therefore, our study sought to explore the level of the difficulties in using ET among people with ABI and to assess how the level of difficulties is associated with cognitive impairment in people with ABI. Lund et al. also emphasized the need for occupational therapists to evaluate the extent to which people with ABI experience difficulties while using ET as a result of cognitive impairment [17], and occupational therapists need knowledge about the relationship between the difficulties experienced by people with ABI during ET use and their cognitive impairments.

In conclusion, this study aimed to clarify the relationship between various cognitive functional impairments in people with ABI living at home and their perceived level of difficulty of ET use.

2. Participants

Inclusion criteria required that participants in this study (i) had a diagnosis of cognitive impairment caused by acquired brain injury and, (ii) lived at home and, (iii) either had no physical dysfunction or only limited physical dysfunction that scarcely affected their ET use in daily life. Exclusion criteria included (i) a diagnosis of cognitive impairment with no clear cause, (ii) a diagnosis made by someone other than a physician and (iii) those who lacked the communicative ability to undergo interviews. Upon commencing research, requests for research cooperation were sent to eight general hospitals, clinics, community workshops specialized in cognitive disorders and ABI Patient-Family Associations in the Kansai area and Okayama prefecture. People from these institutions and organizations introduced the research to potential participants using written explanations. Twenty-two participants who met the criteria were enrolled (Table 1). The participants, of which 17 were men and five were women, were aged from 20 to 62 years with a mean age of 41.3 ± 13.4 years. Causes of head injuries included head trauma (15 participants), cerebrovascular accident (five participants) and hypoxic encephalopathy (two participants). Two participants lived alone and 20 participants lived with their families. Three participants were in regular employment, nine participants were in assisted employment at welfare facilities, and 10 participants were unemployed (including retirees, housewives and students).

This study proposal was approved by the Ethical Committee of Kobe University Graduate School of Health Sciences. All participants provided written informed consent before data collection.

3. Materials and Methods

Data-collection tools

For collecting information of perceived difficulty in ET use by the participants with ABI, the Everyday Technology Use Questionnaire revised Japanese version (ETUQ-Japan) was used. The original ETUQ is a semi-structured standardized interview questionnaire, developed to investigate perceived difficulties among elderly people with cognitive deficits living at home [9, 12]. The original ETUQ is composed of 93 ET-items organized into 8 domains, namely: household activities (e.g., microwave oven and vacuum cleaner), activities at home (e.g., TV and DVD), personal care (e.g., thermometer and hair dryer), power tools (e.g., lawnmower and electric screwdriver), accessibility (e.g., elevator and intercom), data and telecommunications (e.g., push-button telephone and PC), economy and shopping (e.g., credit card and the Internet banking), transportation (e.g., an automatic turnstile and automatic ticket machine). The ETUQ-Japan was composed of 101 items in the same 8 domains [18–20].

For evaluating cognitive functions of the people with
ABI, we used the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III) for Intelligence, the Wechsler Memory Scale-Revised (WMS-R) for memory functions, and the Behavioral Assessment of the Dysexecutive Syndrome (BADS) for executive function. These cognitive functions were evaluated in the participant’s home, and some was submitted from the cooperating facility with consent.

Data collection methods

Interviews regarding perceived difficulty in ET use were obtained by conducting the ETUQ-Japan in the participant’s home. These interviews were done by first author. He, as well as the members of the research team, had extensive knowledge about the ETUQ obtained from a workshop on the original ETUQ and work on developing the ETUQ-Japan [20].

In the ETUQ interviews participants were first asked if each ET was “relevant” or “not relevant” for them. If an ET was relevant, then they were asked regarding ease or difficulty of use, which was scored according to the level of perceived difficulty in using it. There were three scoring categories: (i) “use independently without difficulty,” (ii) “use independently with difficulty,” or (iii) “use with assistance of someone else.”

Data analysis

In each participant, a value was obtained by dividing the number of ET included in each category (i, ii, and iii) by the total number of relevant ET. These three values and the number of using ET (relevant ET) were defined as “condition of using ET”.

The condition of using ET and the results of neuropsychological tests (“performance intelligence quotient (PIQ),” “verbal intelligence quotient (VIQ),” “full scale intelligence quotient (FIQ)” of WAIS-III, “verbal memory,” “visual memory,” “total memory” of WMS-R, and BADS score) were analyzed with the Spearman’s rank correlation coefficient in order to clarify the relationship between the various measured cognitive functions and use of ET. All risk ratios were considered significant with scores below 5% based on the two-sided test. For data analysis, the SPSS version 20.0 for windows was used for this study.

4. Results

The relationship between various cognitive and executive functional impairments and perceived level of difficulty of ET use

The mean ± standard deviation for ET used in people with ABI was 34.7 ± 8.3, out of a total of 101 items of the ETUQ-Japan. Neuropsychological test results for subject with ABI are shown in Table 2.

The coefficient ratio of each neuropsychological test and the condition of using ET are shown in Table 3. A positive correlation was observed between “the number of using ET” and the BADS score ($r = 0.466, p < 0.05$). A positive correlation was also observed between “use independently without difficulty” and the BADS score ($r = 0.430, p < 0.05$). A negative correlation was observed between “use with assistance of someone else” and verbal intelligence following WAIS-III “VIQ” score ($r = −0.479, p < 0.05$). A negative correlation was also observed between “use with assistance of someone else” and WMS-R “verbal memory” ($r = −0.570, p < 0.01$), “visual memory” ($r = −0.561, p < 0.01$), “total memory” ($r = −0.568, p < 0.01$), WAIS-III performance intelligence “PIQ” score ($r = −0.613, p < 0.01$), full scale intelligence “FIQ” score ($r = −0.598, p < 0.01$), and executive function BADS score ($r = −0.843, p < 0.01$).

No significant correlation was observed between “use independently with difficulty” and neuropsychological scores.

5. Discussion

A trend of negative correlation was observed between the ratio of ET “used with assistance of someone else” and all of neuropsychological test results. In particular, a strong negative correlation was observed with the BADS score. On the other hand, there was a positive correlation between the BADS score “the number of using ET” and “use independently without difficulty” categories, but no correlations were observed for the condition of ET use and the other neuropsychological tests results, except for the “use with assistance of someone else” category. Therefore, it is believed that the BADS score reflects the condition of ET use and everyday quality of

Table 2. Neuropsychological test results of ABI patients

|                | WMS-R               | WAIS-III          | BADS     |
|----------------|---------------------|-------------------|----------|
|                | verbal memory | visual memory | total memory | VIQ | PIQ | FIQ | BADS score |
| Mean           | 70.9       | 75.1      | 68.5      | 85.7 | 75.5 | 78.5 | 79.0     |
| SD             | 14.9       | 19.2      | 16.1      | 20.8 | 15.9 | 17.6 | 22.8     |
| Median         | 68.5       | 81        | 67        | 85.5 | 75   | 77   | 80.5     |

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Table 3. Relationship between the states of ET use and each score of neuropsychological test (Spearman’s rank correlation coefficient)

| Types of neuropsychological test | the number of using ET (rs) | use independently without difficulty (rs) | use independently with difficulty (rs) | use with assistance of someone else (rs) |
|----------------------------------|-----------------------------|-----------------------------------------|-------------------------------------|----------------------------------------|
| verbal memory                    | 0.364                       | 0.411                                   | 0.167                               | −0.570**                               |
| visual memory                    | 0.409                       | 0.195                                   | 0.339                               | −0.561**                               |
| total memory                     | 0.416                       | 0.355                                   | 0.214                               | −0.568**                               |
| VIQ                              | 0.281                       | 0.360                                   | 0.162                               | −0.479*                                |
| PIQ                              | 0.271                       | 0.382                                   | 0.197                               | −0.613**                               |
| FIQ                              | 0.342                       | 0.397                                   | 0.204                               | −0.598**                               |
| BADS                             | 0.466*                      | 0.430*                                  | 0.371                               | −0.843**                               |

*p < 0.05, ** p < 0.01.

Therefore, when these people perceive any difficulties at the time of ET use, they tend to give up or depend on others, rather than trying to solve the problems by themselves through trial and error. This is thought to be characteristic of “use with assistance.” Furthermore, in that study there were some problems, such as “spend a day without adjusting the air conditioner according to the room temperature” or “often use the hair dryer when reminded by the caregiver and get told that the time for drying is not enough.” The present study’s results support the notion that for people with executive dysfunction, difficulties arise when they start or continue operating ET, and then it is necessary for someone to watch and tell them what to do at the time of their ET use.

Regarding these problems that he/she cannot start or continue operating ET, the use of assistive technology that prompt his/her actions is thought to be effective. The paging system designed by Wilson and her colleagues is an assistive technology for memory impairment, but can also be used to give cues regarding initiating actions [27]. As for a trial to replace caregivers with assistive technology, Tanemura and her colleagues have developed a daily life management application named “Arata,” which achieved good results [28].

In a study of mental health and related factors, Suzuki and his colleagues indicated that memory disorder was less related to mental health, and it was executive dysfunction and social behavior disorder that were associated with mental health [29]. In addition, they pointed out that the number of prompting and time spent watching over a person with executive dysfunction required for each occupational performance process in everyday life may affect the mental health of caregivers. Based on the results of that study and the present study, it seems that with executive dysfunction increasing so does the tendency to depend on others when using ET, and as a result the burden on caregivers is increasing. Decreasing the need for prompting and watching over required for

life of patients with ABI. Furthermore, there is a greater likelihood of requiring assistance, especially when the BADS score is low. BADS was developed by Wilson and her colleagues as a standardized battery for evaluating executive dysfunction [21] and was thought to be an effective tool for evaluating the ability to perform an action independently and efficiently [22]. Executive functions are the controlling mechanisms of the brain and include the processes of planning, initiation, organization, inhibition, problem solving, self-monitoring and error correction [23]. People with executive dysfunction lack the ability to create ideas and build practical strategies, have difficulties in starting and maintaining actions, as well as taking independent actions [1, 22]. In conclusion, occupational therapists should heed BADS scores as indicating the possible existence of difficulties with using ET.

No previous research makes explicit reference to the relationship between ET use and executive dysfunction; but several studies have suggested the relationship. Organizing or sequencing steps and actions in a logical order may affect using ET in daily activities [24]. Also, Larsson and colleagues reported one of the response actions while using ET being random and inflexible repeating [17]. Kassberg et al identified that people with ABI require varied support to identify their problems and goals related to ET use [25]. In a recent research we conducted, we characterized the difficulties faced by people with ABI in daily life, by classifying the encountered difficulties [26]. According to that research, various types of level of perceived difficulties among people with ABI were identified, such as, “pressing the buttons of DVD player at random, due to having difficulty in recording” or “being unable to distinguish the difference between the ways of cooking on the rice cooker.” These difficulties are classified as “cannot correct one’s error when using ET” and “inflexible in changing one’s correspondence according to each device.” These difficulties are thought to be caused by executive dysfunction.
each occupational performance process in everyday life might result the reduction of caregiver burden. Also, assistive technology that prompts the actions of people with executive dysfunction instead of caregivers is useful for the reduction of caregiver burden.

Executive dysfunction is also said to have a mutual relation with social participation [30]. Executive function is associated to the abilities of planning efficiently to do daily routines skillfully and to adjust well with the surrounding people to solve social problems [31]. The result of this study indicated that there is a relationship between ET use and executive dysfunction. We have to focus both on the situation of using ET and the level of executive dysfunction to understand the daily life of the people with ABI from their ADL to social integration.

Study limitations

We looked at the influence of cognitive impairment, however there are many other influences. It is known that personal identification and environmental factors affect the difficulty of ET use [33]. Considering these factors is necessary when providing interventions for people with ABI.

The surveyed area of this study was limited in the Kansai region and Okayama prefecture. Accordingly this study’s findings might not reflect geographical differences that might influence the use of ET and the relationship between client and caregiver.

Even though the participants did not have difficulty with physical function, it is well-known that people with ABI have additional problems, not only with memory disorder and executive function, but also with motivation and personality. Taking such problems into consideration might lead to different findings regarding cognitive impairment and conditions of ET use. For instance, there is a possibility that motivation and personality are more important than executive function.

Conclusions

The level of perceived difficulties in ET use by people with ABI were explored and revealed. The results suggest that the quality of executive function influence the ability of an individual to use ET. People with ABI have many difficulties in ET use, and they might have a need for support from others in many cases. Consequently, difficulties of using ET not only impedes the use of ET in clients, but also hinders their participation in society and places burdens on caregivers. It is necessary for occupational therapists who are involved in the home life of patients with ABI to pay attention to the patient’s ability to use ET as well as their executive dysfunction.

Acknowledgements: We would like to thank all clients and their caregivers who participated in this study. Also, we would like to thank general hospitals, clinics, regional workshops specializing in cognitive disorders and patient–family associations which gave us their cooperation when we were recruiting participants.

Declaration of interest: The authors indicated no potential conflicts of interest.

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