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Effects of technological memory aid on activities and participation, independence, quality of life and mood

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TIIVISTELMÄ

Tekniset apuvälineet, jotka antavat auditiivisia ja visuaalisia muistutuksia tiettynä ajankohtana, parantavat tutkitusti tehtävien suorittamista ajallaan. Tämän tutkimuksen tavoitteena oli tutkia, miten älypuhelimen kautta saadut muistutukset vaikuttavat laajemmin suorituksiin ja osallistumiseen, itsenäisyyteen, elämänlaatuun sekä mielialaan henkilöillä, joilla on muistin ja toiminnanohjauksen vaikeuksia. Tutkimus toteutettiin osana kliinistä kehittämisprojektia, jossa pyrittiin löytämään uusia välineitä käytännön kuntoutustyöhön asumispalveluyksikössä. Tutkimukseen osallistui 14 henkilöä, joilla oli neurologiseen sairauteen liittyviä muistin tai toiminnanohjauksen vaikeuksia. He saivat 10-12 kk ajaksi käyttöönsä älypuhelimen, johon oli asennettu muistutuksia antava sovellus. Muistutukset asennettiin jokaiselle osallistujalle yksilöllisesti osallistujien toiveiden mukaisesti. Suorituksia ja osallistumista tutkittiin ICF-viitekehyksen näkökulmasta. Omista tavoitteista suoriutumista, tyytyväisyyttä omaan suoriutumiseen, arkitoimintojen itsenäisyyttä, elämänlaatua ja mielialaa arvioitiin ennen apuvälineen käyttöönottoa, 6 kk käytön jälkeen sekä jakson lopuksi 10-12 kk jälkeen. Jakson aikana osallistujien arvio omista tavoitteistaan suoriutumisesta sekä tyytyväisyys omaan suoriutumiseen koheni. Arjen toimintakyvyssä tapahtui lievää kohenemista jakson loppupuolella. Elämänlaadussa tai mielialassa ei todettu muutosta tutkimusjakson aikana. Tutkimuksen tulokset tukevat aikaisemmissa tutkimuksissa saatua näyttöä siitä, että teknisten apuvälineiden käyttö muistin tukena voi olla hyödyllinen keino muistin ja toiminnanohjauksen vaikeuksien kuntoutuksessa.

Avainsanat:

Tekninen apuväline, muistivaikeudet, toiminnanohjauksen vaikeudet, aktiivisuus ja osallistuminen, elämänlaatu, mieliala

INTRODUCTION

Difficulties of memory and executive functions are cognitive deficits that appear frequently in neurological conditions. They have a remarkable effect on individuals' ability to work, live independently and participate in social activities (1). Cognitive deficits are also related to depression (2, 3), decrease of independence, and quality of life (4). Executive functions is an umbrella term used for a wide range of cognitive processes including planning, inhibition, initiation and monitoring of action, mental flexibility and working memory (5). Difficulties in maintaining goals, prioritizing activities and initiating actions may lead to passivity or difficulties in everyday functioning. Correspondingly, the term memory covers a wide range of different subfunctions. Remembering things, we have heard or seen before requires retrospective memory. The type of memory we use to remember to perform an intended action at a specific time in the future - for example, paying bills or taking medication in time - is called prospective memory. Prospective memory deficits are frequently described in neurological conditions (6, 7, 8). Successful prospective remembering requires functioning of the retrospective or autobiographical memory as well as enough executive skills (9). If a person has problems in either of these areas, he or she may benefit from support in remembering to perform everyday actions. One possible way to provide this support is the use of external aids like calendars, checklists or electronic devices (10, 11).

The International Classification of Functioning, Disabilities and Health (ICF) describes functioning in different health states. Functioning is an umbrella term for body functions, body structures, activities and participation. It denotes the positive aspects of the interaction between an individual with a health condition and that individual's contextual factors (12). For rehabilitation, participation and environmental factors are crucial constructs (13). The ICF defines "participation" as "involvement in a life situation" (12). Environment refers to the physical, social and attitudinal environment in which people live and conduct their lives. These can be either barriers to or facilitators for the persons functioning. One example of environmental factors are assistive products and technologies which can be used to assist people in daily living (12). Brain injury or other neurological condition can lead to participation restrictions and activity limitations, which affect every day functioning and social relations in crucial areas of life. These limitations are often related to deficits in memory and executive functions. By actively affecting the environmental factors or by using assistive products, it is possible to facilitate participation and quality of life, which is the purpose of all rehabilitation (14). Although assistive technology is classified in the Environmental Factors domain of the ICF, its value is determined by its impact on daily activities and participation in community life. Technologies go often unused, because they do not fit with user capabilities, preferences, or habits (15). Therefore, it is essential to investigate, what kind of users benefit from different forms of assistive technology, and how do they experience their usage.

A growing amount of evidence shows that external cuing by electronic memory aids may be efficacious in compensating prospective memory problems and executive deficits (11, 16, 17, 18, 19, 20, 21, 22, 23). Today different portable electronic devices are popular aids in organizing and remembering our everyday plans and appointments. During the last decade, the use of technological memory aids has become much more common among people with acquired brain injury (24). In a recent interview study (25), people with brain injury reported audible and visual reminders, all-in-one device, connectivity, and mobility as most important advantages of smartphones, when using them as memory aids.

In contrast battery life and concerns about loss or failure of the device were mentioned often as disadvantages. Smartphones are often seen less stigmatizing than devices specifically developed for people with cognitive deficits (26). Despite of all documented advantages, the use of smart phones or other forms of assistive technology has not yet been systematically implemented in cognitive rehabilitation.

One of the most elaborately studied assistive devices is a pager-based reminder system NeuroPage (20, 21). It is based on a simple commercial pager, which is used as the reminding component of an electronic reminder system. The working mechanism of a pager is relatively simple: it beeps or vibrates when a message is received, and the message appears on the screen. In NeuroPage, a central computer database stores the messages that are entered into the computer, and from then on users receive the messages automatically. On the appropriate date and time, NeuroPage accesses the user's data files, determines the reminder to be delivered, and transmits the information via a paging company (21). This pager-based system has been shown to improve timely task completion rates both in case studies (27) and in group studies (28). NeuroPage has been successfully used in Great Britain already for more than ten years. Since 2007 the users have had the possibility to use their mobile telephones instead of the pagers to receive the messages. Some users choose this opportunity; some still prefer the simpler pager (29).

Multiple randomised controlled studies have shown promising results on the use of mobile devices, such as personal digital assistants (PDA) and web-based calendar applications in patients with acquired brain injury. Dowds et al. (18) compared timely completion rates for assigned memory tasks under four randomly assigned memory conditions in adults with traumatic brain injury. Significantly higher completion rates were found when using either of two different PDA devices, when compared with a combined baseline and paper memory aid condition. The PDAs in this study were commercially available, unmodified consumer devices without any specialized adaptive features. Another study examined the effectiveness of a customised PDA with Planning and Execution Assistant and Trainer (PEAT) software compared to a control group receiving paper-and-pencil aids (17). Both groups showed a significant increase in individualised goal attainment, with no significant difference between the groups. Customised PDA was concluded to be a useful alternative when choosing the optimal rehabilitation strategy. McDonald et al. (19) studied a group of people with acquired brain injury, who used either a diary or the Google Calendar to support their prospective memory for five weeks and then changed for the other supportive method for another five-week period. They found that web-based Google Calendar with text message reminders in mobile phone was more effective than a standard diary in enhancing prospective memory performance.

The aim of our study is to examine a mobile application as one element in the ICF's Environmental Factors, and its effects on the activity and participation as well as the quality of life of persons with problems in memory and executive functions. The goal is to evaluate the effects comprehensively and not only to focus on remembering to perform a specific action. The study is a part of a clinical developmental project, where the goal is to find useful rehabilitation tools for the habitants of a sheltered accommodation unit.

The hypotheses are:

1. Participants' activity and participation will improve in domains which they themselves have indicated as important life areas.
2. Participants' level of independence will increase in everyday life tasks.

3. Participants' self-reported quality of life and mood will improve.

METHODS

Participants

A total of 14 persons with acquired brain injury used smartphone with a reminder application for 10-12 months. This was a convenience sample from persons living in Validia Living Services or having a rehabilitation contact to Validia Rehabilitation Services. Inclusion criteria for the participants were 1) clearly detectable deficit in memory or executive function related to a neurological condition, 2) sufficient motor skills for smart phone use. In addition, participant's own motivation to take part into the intervention was regarded crucial and it was assessed by interviewing the participants and the care home staff. Exclusion criteria were 1) severe sensory deficit, 2) severe aphasia, 3) severe apraxia, 4) acute problematic alcohol or substance use. Twenty-three participants were recruited, of whom 14 participants continued in the project until the last outcome measures. Five participants dropped out, because they were dissatisfied with the telephone or the reminder application. Four participants dropped out

Table 1. Charasteristics of the participants (N=14)

Variable	Statistics
Age mean (range) years	42.3 (23-69)
Diagnosis (N)	
Traumatic brain injury	6
Epilepsy	4
Alzheimer's disease	1
Stroke	2
Anoxic encephalopathy	1
Living arrangements	
Home (independently or assisted by relatives or personal assistant)	7
Sheltered accommodation	7
Education	
Elementary school (9 years)	3
Vocational school (12 years)	4
High school (12 years)	6
More than high school (more than 12 years)	1
Employment status	
Retired	14
Life-time working history	
Several years in regular employment	9
Irregular supported working periods	2
No working experience	3
Current computer use	
Regular	10
No active computer use	2
Unknown	2
Current mobile phone use	
Basic communication functions only (calls, text messages)	8
Basic communication and other functions (calendar, reminders, games, internet)	4
Unknown	2

for personal reasons unrelated to the project. Descriptive characteristics of the participants are presented in table 1.

The deficits in memory and executive functions were verified by a neuropsychological assessment before the participants were accepted to the intervention. The methods included: Trail making test (31), Stroop (7), Rey auditory verbal learning test (RAVLT) (31), semantic and phonologic fluency (7), Consortium to Establish a Registry for Alzheimer's Disease (CERAD) (32) and parts of the Wechsler Adult Intelligence Scale III (WAIS-III) test battery: similarities, digit span, symbol search and digit symbol-coding (31). The Patient Competency Rating Scale (PCRS) (33) was used to evaluate participants' self-awareness and their subjective view of functioning. The subject's responses were compared to those of a significant other who rated the subject on the identical items. All subjects had deficits in at least two of the cognitive tests. Variability in participant's cognitive performance was large, ranging from moderate deficits in two of the tests to strong deficits in most of the tests.

Outcome measures

COPM

Canadian Occupational Performance Measure (COPM) (34) was used to find out the life areas which the participants themselves indicated as important domains in their lives. COPM is a half-structured interview method which assess participant's occupational performance in everyday life tasks and their satisfaction with that performance. During the COPM interview, each participant self-identifies occupational tasks in his or her everyday life where he or she hopes some improvement. Maximum of five most important tasks are picked up and then assigned a number from 1-10 to each task, rating how well he or she performs that task (1 = not at all, 10 = independently) and how satisfied he or she is with that level of performance (1 = very unsatisfied, 10 = completely satisfied). COPM is linked to ICF categories in the area of activities and participation (35). The more accurate linking to specific categories depends on the tasks, which the person chooses to be the most important targets of improvement.

ASTA

ASTA is a 99 item measure of everyday performance in daily living activities based on the ICF (36). It was used to describe the participant's independent performance in everyday tasks. The items are divided to four scales: taking care of meals and eating, taking care of oneself, housework, and activities and participation outside home. Responses are given on a 9-point scale: (a) independent, (b) satisfyingly independent, (c) needs a little verbal assistance, (d) needs a little physical assistance, (e) needs a lot verbal assistance, (f) needs a lot physical assistance, (g) needs a little both verbal and physical assistance, (h) completely dependent on help of others, (i) cannot be assessed. ASTA is linked to ICF chapters d5 Self-care, d6 Domestic life, and d9 Community, social and civic life (36).

QOLIBRI

The participants' self-reported quality of life was assessed with QOLIBRI (Quality Of Life after Brain Injury) questionnaire. It was chosen to this study because, in contrast to more general quality of life instruments, it includes the cognitive component. The QOLIBRI consists of 37 items in six scales: cognition, self, daily life and autonomy, social relationships, emotions, and physical problems. The first four scales contain "satisfaction" items, and the last two scales contain "bothered" items; responses are made on a 5-point scale from "not at all" to "very". (30, 37, 38). QOLIBRI is linked to ICF chapters: b1 Body functions, b2 Sensory functions and pain, b7 Neuromusculoskeletal and movement-related functions,

d1 Learning and applying knowledge, d3 Communication, d4 Mobility, d7 Interpersonal interactions and relationships, d8 Major life areas, d9 Community, social and civic life, and e4 Attitudes (39).

R-BDI

Revised Beck's Depression Inventory (R-BDI) was used to assess changes in participant's mood during the intervention. R-BDI is a 14 item self-report measure of depression that assesses various cognitive, behavioural and physiological symptoms associated with depression. On the measure, the participant is asked to choose a sentence from a group of choices that best reflects his or her experience over the past two weeks. Different versions of BDI are well examined in neurological patients (39). R-BDI is linked to ICF chapters: b1 Mental functions, b5 Functions of the digestive, metabolic and endocrine systems, d1 Learning and applying knowledge, d7 Interpersonal interactions and relationships, and d8 Major life areas (40).

Intervention procedure

The intervention was accomplished using a mobile application based on the Android operating system (the Vivago Reminder). The application was in developing phase and tested in this project. Reminders were set into the application via computer, and the reminder time table could be seen on the computer screen. The upcoming reminders were marked with blue colour and they turned green when the user had acknowledged them. If the reminders were not acknowledged, they turned red. A caretaker, therapist or in this case project staff could follow if the reminders were acknowledged and contact the user if needed. The staff members in this project were rehabilitation professionals (two physiotherapists and one occupational therapist), who had experience in working with persons with deficits in memory or executive functions. When a reminder turned on, the alarm in the user's smart phone started ringing and a visual symbol appeared on the smart phone screen with the reminder text. When the reminder was noticed, it could be acknowledged by touching a sign on the screen. If the reminder was not acknowledged, it could be repeated a chosen amount of times in chosen intervals. It was possible to set different alarm tones and different visual symbols for different kind of reminders, so that also the alarm tone could function as a clue to the content of the reminder. There were eight different basic types of reminders available: (1) alert; (2) attention; (3) food; (4) medication; (5) notice; (6) taxi; (7) wake up; and (8) walking. Each reminder type had its own specific visual symbol, and it was possible to choose a specific text and alarm tone for each reminder.

The reminder application was installed in Samsung X-Cover smart phones that the participants got in their use during the intervention. Participants used the smartphone with the reminder application for 10-12 months. Every participant had a personal contact person in the staff, who taught him or her how to use the Samsung X-Cover smart phone and how to acknowledge the reminders by touching the screen. The reminders were discussed and set together with the participant and he or she could choose, what kind of reminders were taken in use. Some had only reminders to take their medication at a specific moment; some wanted also activating reminders like "figure out some nice activity for next week". If the participant couldn't figure out the things he or she would like to be reminded about, family and care takers could also take part in setting of the reminders. The goal was that each participant would have several reminders weekly. Participants could contact the project staff every working day during the whole project if they wanted to modify the reminders or had any problems related to the project.

In addition to the smart phone, the participants used a wellbeing watch (Vivago Wellbeing watch) during the intervention. The watch collected information about their body movements and body temperature, in order to get objective information of changes in the participants' activity level. The watch had also a safety alarm button, which could be activated to send messages to relatives, according to the participant's wishes. The alarm could also be sent automatically if the body temperature lowered or there was no movement for a longer period. However, there were so many missing periods in the data collected from the wellbeing watch, that it was not possible to compare quantitatively the activity levels before and during the intervention. Therefore, the data of the wellbeing watch is not analysed in this study.

Data collection

The assessments were made at three timepoints: at baseline, after 6 months of intervention (1st outcome), and after 10-12 months = at the end of the intervention (2nd outcome). The measures used at each point are presented in table 2.

Table 2. Baseline and outcome measures

Measure	Baseline	1st outcome (6 months)	2nd outcome (10-12 months)
COPM	X	X	X
ASTA	X	X	X
QOLIBRI	X	X	X
R-BDI	X	X	X

Data analysis

Results were analysed in IBM SPSS statistics version 21. Friedman's test was used to find significant changes in the results of COPM, QOLIBRI, R-BDI and ASTA. For significant findings comparisons were made between baseline, 1st and 2nd outcome measures. Missing values were replaced with the mean value of the variable.

RESULTS

Reminders

The participants had the smart phone with the reminder application in use on average for 383.5 days (sd 105.90, range 112-505). They received on average 1.13 reminders a day (sd 0.89, range between participants 0.05-3.34). The most often used reminder was the "medication" reminder (46 % of all reminders), followed by reminders "attention" (27 %)," food" (10 %), "walking" (7 %)," alert" (4 %)," wake up" (4 %) and "taxi" (3 %).

Personal goals named in COPM

Participant's occupational performance in self-selected everyday life tasks and their satisfaction with that performance was assessed with COPM interview. The COPM was used to determine the participants' own goals for the intervention. These goals were then linked to the domains of life classified in the ICF component Activities and participation (d). Linking was carried out by two of the authors, SD and SK. Both linked the answers to the ICF codes first independently using the linking rules by Cieza et al (41,42). If the linking of the same action was different between the two lists, it was discussed together to find the code that suited best. The participant's answers and the corresponding ICF-codes are summarized in table 3.

All the domains of Activities and participation were named in the participants' own goals (Figure 1). The most common goals were related to domestic life (doing house work and caring for household objects) followed by learning and applying knowledge (remembering and finding things, taking care of official affairs). Self-care and major life areas (finances, handling bills) were also frequently mentioned while only one goal was related to communication (writing e-mail).

Table 3. Participant's goals named in COPM interview linked to the ICF categories

Participant's goals in their own words	Nr of items	ICF code
		d1 Learning and applying knowledge
Understanding entities	1	d163 Thinking
Filling official papers	1	d170 Writing
Remembering things, finding things, taking care of the official issues.	5	d179 Applying knowledge, other specified and unspecified
		d2 General tasks and demands
Going out	1	d210 Undertaking single task
Scheduling	1	d230 Carrying out daily routine
Tolerating the dog's barking	1	d240 Handling stress and other psychological demands
		d3 Communication
Writing e-mail	1	d360 Using communication devices and techniques
		d4 Mobility
Functioning of the hands	1	d440 Fine hand use
Moving outside, crossing road, finding places	4	d460 Moving around in different locations
		d5 Self-care
Oiling the psoriasis	1	d520 Caring for body parts
Getting trousers on correctly	1	d540 Dressing
Eating	1	d550 Eating
Remembering meal times, sufficing of the mental and physical resources, sleeping difficulties	3	d570 Looking after one's health
		d6 Domestic life
Getting to the shop	1	d620 Acquisition of goods and services
Cooking	1	d630 Preparing meals
Cleaning up, laundering regularly, washing dishes, taking carpets out, washing windows, using the washing machine, getting started with house hold actions	8	d640 Doing housework
Taking care of the dog, walking the dog, repairing cars, taking care of buildings	4	d650 Caring for household objects
		d7 Interpersonal interactions and relationships
Personal chemistry	1	d720 Complex interpersonal interactions
Creating social network, secluding oneself	2	d750 Informal social relationships
		D8 Major life areas
Utilising metal work skills in this environment, voluntary work	2	D855 Non-remunerative employment D860 Basic economic transactions
Taking care of finances, handling bills, controlling finances	4	
		D9 Community, social and civic life
Exercising, starting suitable hobbies, dancing, playing piano	5	D920 Recreation and leisure

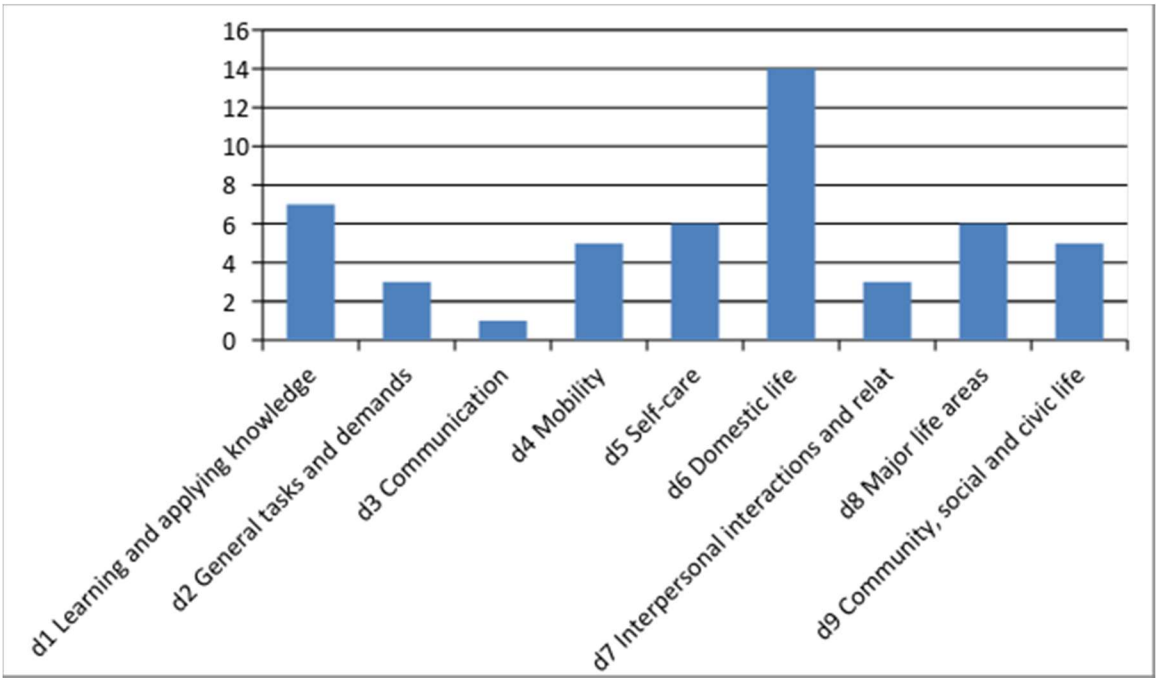

Figure 1. Participants' goals in different domains of life

In the outcome measures (Table 4), the most significant changes after the intervention were found in the COPM, where the participants' ratings increased both in their self-assessed performance in their self-selected everyday life tasks, as well as in their subjective satisfaction with their performance. Self-assessed independent performance in everyday tasks measured by ASTA increased significantly between the 1st and the 2nd (final) outcome measure. In contrast between the baseline measure and either of the outcome measures no significant change was detected.

In self-assessed quality of life measured by QOLIBRI no significant change was detected between baseline and outcome measures. Neither was there significant change in the subscales measuring satisfaction to cognition, self, daily life and autonomy, social relations or emotions. In depression measured by R-BDI, no significant change was detected between the baseline and the outcome measures.

DISCUSSION

Our first hypothesis was that participants' functioning in the domains of activities and participation would improve in life areas which they themselves had indicated important. This hypothesis was supported by the improvement in subjective performance and satisfaction ratings in the COPM interview. COPM was used as a tool to assess subjective view of activities and participation. When considering participation in the ICF context, the subjective view is essential in assessing the success of the intervention (13, 43). A person can only participate in a limited number of situations and personal preferences are significant in choosing these situations. The participants in this study were all retired and half of them lived in a sheltered accommodation, which probably affected their choice of the tasks mentioned in the COPM interview. Most of the tasks they chose for their goals belonged to the category of domestic life. Also, the categories of learning and applying

Table 4. Results of the outcome measures

Method	N	Baseline	1st outcome measure	2nd outcome measure	Fr	Df	Sig
COPM							
Self-assessed performance in self-selected areas of life/ mean (sd)	12	4.17 (2.14)	5.73 (1.84)	5.93 (1.91)	7.19	2	.027*
Satisfaction with performance/ mean (sd)	12	4.47 (2.04)	5.59 (2.12)	6.41 (1.80)	7.48	2	.024*
ASTA							
Self-assessed independent performance/ mean (sd) (% of assessed functions)	10	60 %	60 %	68 %	8.36		.015*
QOLIBRI							
total/mean (sd)	14	3.42 (0.95)	3.57 (0.70)	3.64 (0.74)	0.57	2	.751
R-BDI							
mean (sd)	13	31.15(12.55)	26.31 (8.09)	26.78 (8.44)	3.36	2	.186

*Statistically significant result on the significance level .05

knowledge, self-care, and major life areas were represented several times. Tasks in the working life or hobbies outside home were not even available for some of the participants. With more independent participants the subjective participation goals would probably be different as well as the situations where they would choose to use the reminders.

Our second hypothesis was that the participants' level of independence would increase in everyday life tasks. This hypothesis was supported in some degree, as the level of independent performance measured by the ASTA-questionnaire increased especially between the first and the second outcome measure. Probably participants needed time to learn to use the new smart phone and the reminders fluently. It is possible, that the learning process, which took place between the baseline measure and the first outcome measure, could have even increased the need of help. Benefits from the reminders in everyday life may have appeared only after this leaning period. Compared to COPM- interview, ASTA provided a more objective view of activity and participation, as the assessed life areas and activities were defined in the questionnaire. The objectivity was though limited, because we did not get enough answers from relatives or caretakers to the questionnaire in the outcome measures to make any analysis of them. Most of the information was self-assessed by the participants, which provides still a very subjective view of the functioning. These more objective assessments of persons functioning in everyday activities would be important in assessing interventions, where the goal is to reduce the person's need of help and make financial savings in care services.

Our third hypothesis was that the participants' self-reported quality of life and mood would improve during the one-year use of the assistive device. There was no convincing support for this hypothesis. Mood and quality of life are probably so wide and multidimensional domains that it is relatively challenging to affect them significantly by changing only one environmental factor. Effects on quality of life might be larger if the assistive device would be part of a more comprehensive rehabilitation setting. The executive problems might make it difficult

to find ways to use the device so creatively that it would help in improving quality of life. A psychologist or occupational therapist, who knows the participant well, could help in this. Some of our subjects used the reminders to remember to plan some nice activities for the next week. This kind of activating and creative reminders could possibly help to improve quality of life in the longer time span. Some people with brain injury need help to find more versatile ways to use the reminders. Many of our subjects used them spontaneously only to remember to take their medication.

One significant limitation in this study was the lack of control group, which makes it difficult to evaluate, what part of the improvement was related to the assistive device, and how much did other aspects of the intervention affect. The study was a part of a clinical developing project, which restricted the possibilities of recruiting more participants. Another limitation was the high rate of participants who chose to drop out from the project. Some dropped out because of the personal reasons not related to the project, but some found the use of the smartphone so demanding, they did not want to continue it. This reminds us that technical devices that are used to help persons with cognitive problems, should be easy to use, and not be a remarkable cognitive challenge themselves. There are still also people, who do not feel familiar with smartphones or similar technical devices and might prefer more traditional assistive tools, like paper-and-pencil-aids. The lack of follow-up after stopping the use of the reminders was a limitation as well. Also, the heterogeneity of the participant group was a challenge. We wanted to study people with different neurological conditions, but the variability of their cognitive deficits made it challenge to design the intervention to serve them all and to examine the changes in the group level. Our purpose was to get objective information of the changes in participant's activity level from the wellbeing watch, but there were so many long missing periods in the activity data, that it was not possible to make any statistical analysis of the results.

As a conclusion, this study shows that assistive technology with reminders may work as a facilitating environmental factor for people with problems of memory or executive functions in achieving their participation goals. This study also establishes the view that in planning any rehabilitative interventions, it is important to emphasize the subjective goals of the person for whom the intervention is designed. Individual's current goals, past experiences with the use of technologies and other supports should be considered when choosing the assistive device and taking it into use. Integrating the use of assistive technology in a more comprehensive rehabilitation setting could be useful in selecting the appropriate device for each user. Technical applications might be frustrating to use for some people with acquired brain injury, and in these cases some other tool should be considered. Assistive technology is developing constantly and many problems that came up in this study may possibly be solved in the future applications. ICF offers a structured framework to examine the usefulness of the assistive tools as environmental factors.

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