University of Tartu

Institute of Psychology

Marianne Saard

Suitability of FORAMENRehab Attention module for 9- to 12-year-old children

Seminar paper

Supervisors: Anneli Kolk, PhD, MD

Mari-Liis Kaldoja, MSc

Tartu 2012

Abstract

Suitability of FORAMENRehab Attention module for 9- to 12-year-old children

Discovering new neurocognitive rehabilitation techniques for children is particularly important, because very few modern and systematically controlled techniques exist. In the current study the FORAMENRehab Attention rehabilitation software is tested in healthy children aged 9-12 to find out how normally developing children perform on these tasks.

The aim of the study is to test the established base levels of this modern computer-based rehabilitation program as the appropriate starting-points for the neurorehabilitation intervention of children. 18 children aged 9-12 participated in the study. We found that the base levels of the Paced search with dual targets task, the Word Recognition task, the Addition task and the Tracking task of the module should be modified, because these levels are too difficult for children to be used at the start of rehabilitation. We also found that the differences between the attentional abilities of boys and girls are not significant when measured with the established base levels, thus different levels do not need to be developed for these groups. Overall, the program is suitable for the rehabilitation of children aged 9-12.

Keywords: FORAMENRehab Attention module, Base levels, Attention, Cognitive rehabilitation

Kokkuvõte

FORAMENRehab tähelepanu mooduli sobivus 9-12 aastastele lastele

Uute lastele suunatud neurokognitiivse rehabilitatsiooni meetodite väljatöötamine on eriti oluline, kuna hetkel leidub väga vähe kaasaegseid ja süsteemselt kontrollitud meetodeid. Käesolevas töös testitakse FORAMENRehab tarkvara tähelepanu moodulit tervete lastega vanuses 9-12 aastat, et saada teada, kuidas normaalselt arenevad lapsed neid ülesandeid sooritavad.

Uuringu eesmärgiks on testida selle kaasaegse arvutipõhise rehabilitatsiooniprogrammi valitud baastasemeid kui sobivaid alguspunkte neurorehabilitatsiooniliseks sekkumiseks lastel. Uuringus osales 18 last vanuses 9-12 aastat. Leidsime, et ajalimiidiga otsimisülesande, sõna äratundmise ülesande, liitmise ülesande ja jälgimisülesande baastasemeid on vaja muuta, kuna olemasolevad tasemed osutusid lastele liiga rasketeks. Samuti leidsime, et erinevused poiste ja tüdrukute tähelepanuvõimes ei ole statistiliselt olulised mõõdetuna olemasolevate baastasemetega. Seega ei ole vajalik nende kahe grupi puhul kasutada erinevaid baastasemeid. Kokkuvõttes on antud programm sobilik 9-12 aastaste laste rehabilitatsiooniks.

Märksõnad: FORAMENRehab tähelepanu moodul, Baastasemed, Tähelepanu, Kognitiivne rehabilitatsioon

Introduction

Attention

Cognitive functions are higher mental processes associated with thinking and cognition. Attention is one of the key components of cognitive functioning. As it affects rehabilitation, the concept of attention has been divided into two broad areas. The behavioral component of attention has been distinguished from the content of attention, which refers to the cognitive component of attention, not just "attentiveness," which simply refers to a behavioral readiness to receive information (Wood, 1988).

Several different definitions of attention could be found from the literature. Attention could be described as processes that enable the person to concentrate on specific cognitive skills, while ignoring others (Loring, 1999). James (1890) has stated that attention "is the taking possession by the mind, in a clear and vivid form, one out of what seems several simultaneously possible objects or trains of thought".

Sohlberg and Mateer (1989) have described attention as a multidimensional cognitive process that directly affects other dimensions of cognition such as new learning, memory, communication, problem solving, and perception.

A number of separate components of attention have been consistently identified in the literature. According to the clinical model of attention by Sohlberg and Mateer, attention is not a single construct or process, but can be seen as five different attentional processes – focused attention, sustained attention, selective attention, alternating attention and divided attention. *Focused attention* is the ability to respond discretely to specific visual, auditory, or tactile stimuli. *Sustained attention* is the ability to maintain attention to a task for prolonged periods. It incorporates many other aspects of the attentional process, namely, selectivity, resistance to distracting influences, attentional capacity, and scanning ability, also factors such as effort and motivation (Wood, 1988). *Selective attention* refers to the capacity to attend to, and focus on, relevant stimuli, while ignoring irrelevant information. It is the process of selecting from among the many potentially available stimuli (e.g. listening to a single voice in a room full of people talking at the same time) (Anderson, 2005; Pashler, 1999). Individuals with deficits at this level are easily drawn off task by extraneous, irrelevant stimuli.

These can include external sights, sounds, or activities as well as internal distractions (worry or rumination) (Sohlber & Mateer, 2001). *Alternating attention* refers to the capacity for mental flexibility that allows individuals to shift their focus of attention and move between tasks having different cognitive requirements, thus controlling which information will be selectively processed (Sohlberg & Mateer, 2001). *Divided attention* is the ability to attend to competing stimuli simultaneously. In a divided attention experiment, the subject would be required to attend to both messages at the same time (Styles, 2005). Two or more behavioral responses may be required, or two or more kinds of stimuli may need to be monitored when using divided attention, e.g. driving a car while listening to the radio or holding a conversation during meal preparation (Sohlberg & Mateer, 2001). Wood (1988) stresses that it is not simply referring to attentional capacity, but also refers to the ability to focus attention, in order to recognize which, out of a number of diverse stimuli are the important cues.

The characteristics of a person's attention develop throughout many years during which teaching and working play an important part (Aru & Bachmann, 2009). The process of brain maturation is long, lasting at least into early adulthood. Behavioral and cognitive capacities follow a developmental sequence from the rudimentary to the complex (Kolb & Fantie, 2009). Anderson *et al* (2005) have indicated that there have been identified different developmental trajectories for specific attentional components. By reviewing different studies, they concluded that the basic selective attention skills have a relatively early development, indicating rapid maturation in infancy and early childhood, while shifting and dividend attention skills progress slowly in early childhood, with more dramatic development into adolescence.

Besides Attention Deficit Hyperactivity Disorder (ADHD), impairments of attention have been found to be characteristical to many different disorders, e.g. epilepsy (Guzeva *et al*., 2009), traumatic brain injury (Laatsch *et al*, 2007), schizophrenia (Cornblatt & Keilp, 1994) etc.

Parts of the brain involved in attentional processes

Attention has been linked to prefrontal lobe function. Frontal lobes are crucial for normal development and attention is often impaired in patients with dysfunctions in these structures (Gur *et al*., 2007; Anderson *et al*., 2005; Absher & Cummings, 1995; Foster *et al*., 1994). Frontal areas involved in attention, executive function and motor coordination develop rapidly through childhood and early adolescence, but mature later compared to parts of the brain associated with more basic functions (Gogtay *et al*., 2004).

Foster *et al*. (1994) concluded in their review on the cognitive neuropsychology of attention that different studies, focused on specific components of attention, have demonstrated that deficits in cognitive processes such as selective attention, sustained attention etc. may be present after focal lesions to the frontal lobes. Similar results were displayed by Anderson *et al*. (2005) who concluded that children aged 7.0–16.11 years with lesions involving prefrontal cortex exhibit attentional impairments when compared with healthy age and gender matched controls. This was evident on psychometric measures as well as for parent ratings of day-to-day function.

Gender differences in attentional processes

Different studies have found differences between boys' and girls' performances in attentional measures (Gur *et al*., 2012; Naglieri & Rojahn, 2001; Warrick & Naglieri, 1993). A study comparing children and adolescence aged 8-21 years showed that females were found to be more accurate in the attention tasks, but then males were quicker in reacting to different stimuli (Gur *et al*., 2012). The authors suggested that poorer accuracy in males for attention was consistent with the higher incidence of attention deficit disorder in males, which has been demonstrated by Ramtekkar *et al*. (2010).

Girls also outperformed boys on measures of attention in a study by Naglieri & Rojahn (2001), where the participants were between the ages of 5 and 17 years. The authors claim that the lower scores earned by boys on the Planning and Attention Scales suggest that "these children need to be taught to plan more thoughtfully and be more strategic in the things they do and the extent to which they focus their attention".

Cognitive rehabilitation

Brain lesions in children are frequently accompanied with cognitive impairments in the thinking process, which interferes with individual safety, independence and interpersonal relationships. Problems with cognitive functioning can be exhausting, impacting the person's education and employment (Chamberlain, 1995).

In acquired brain injury (ABI) deficits in attention and memory are the most common cognitive dysfunctions which contribute to significant disability (Beers, 1992; Donders, 1993; Klonoff, Campell, Klonoff, 1995). But attention and memory are crucial for learning and thus deficits in these functions have a major negative influence on academic and social adjustment (Ylvisaker *et al*., 2005). Attention deficit and slow information processing interrupt the development of other cognitive functions (e.g. memory and executive functions) and social competences (Nixon, 2001). With impaired attentional skills, children may be less able to learn and acquire skills from their environment.

Cognitive rehabilitation is thought to be one of the suitable treatment methods that could facilitate the remediation. Cicerone *et al*. (2005) stated that "future research should move beyond the simple question of whether cognitive rehabilitation is effective, and examine the therapy factors and patient characteristics that optimize the clinical outcomes of cognitive rehabilitation". Regardless of the form of the intervention, the aim of cognitive rehabilitation is to improve a person's functioning in their everyday life and increase their ability to do what they would like and need to do, but find difficult to manage because of their cognitive disability (Sarajuuri & Koskinen, 2006; Ylvisaker, 1998). This kind of rehabilitation is a systematic intervention designed to compensate for, or improve the impact of cognitive and/or behavioral difficulties following ABI (Ylvisaker, 1998).

Cognitive rehabilitation may be directed toward many areas of cognition, including attention, memory, visuospatial abilities, communication, executive functioning etc. When reviewing different studies on cognitive rehabilitation, Cicerone *et al*. (2000) found that attempts to remediate impairments of attention have been typically based on practice with exercises designed to address specific aspects of attention (e.g. processing speed, focused attention, divided attention).

Many experiments on attention have used a selective set paradigm, where the subjects prepare to respond to a particular set of stimuli and interventions have mostly used stimulus-response paradigms where subjects identify and select among relevant auditory or visual stimuli (Styles, 2005; Cicerone *et al*., 2000).

Sohlberg and Mateer (2001) have brought out four approaches to managing attention impairments that have emerged from the literature. These include attention process training working on specific components of attention (e.g. sustained attention, divided attention), training use of strategies and environmental support, training use of external aids, and the provision of psychosocial support. Thus the exercises designed to address specific aspects of attention are a crucial part of attention rehabilitation.

According to Cicerone *et al*. (2000) different evidence-based studies have recommended computer-based interventions that include active therapist involvement, because studies have shown that a therapist could help to "promote insight into cognitive strengths and weaknesses of the patient, develop compensatory strategies, and contribute to the transfer of skills into real-life situations".

However, very few modern neurocognitive rehabilitation techniques exist for children and most of the available rehabilitation methods are often versions of material designed for adults. Therefore, it is important to study and adapt rehabilitation methods for the use of pediatric population. Different reviews have pointed out the need for further more accurate and systematically controlled research in the field of cognitive rehabilitation in children (Slomine & Locascio, 2009; Limond & Leeke, 2005; Hooft, 2003; Butler & Copeland, 2002; Prigatano, 2000; Warschausky *et al*., 1999).

New efficient treatment approaches particularly for children are very much needed. Overall, the field of neuropsychological rehabilitation needs guidelines and underlying principles to organize the work of clinicians (Prigatano, 2000).

Computer-based rehabilitation is efficient, because there is a possibility of making the programs more and more interesting and, therefore, attractive to children. It is also possible to eventually use these methods in the child's home environment.

Also, having the computer saving the results, it enables access to different aspects of a person's performance at the same time, e.g. false reactions, missing reactions, reaction time etc. Continuous research on computer-based rehabilitation methods is needed to advance the intervention methods used in attention rehabilitation and to develop new standards.

In the current study the base levels (starting-points) of the FORAMENRehab Attention software are tested with healthy children to find out how children without neurocognitive deficit perform on these tasks. To fully understand the deficit of attentional skills in children with ABI, it is important to have understanding of these abilities of normally developing children.

We examine whether the established base levels of this modern computer-based rehabilitation program would be the appropriate starting-points for the neurorehabilitation of children with ABI. Practical implications for the use of these base levels in future rehabilitation with children are given. The study shows which base levels would be too complicated as the starting-points of attention rehabilitation and should be made easier and also which tasks should be made more difficult or be exchanged. Also, suggestions for new base levels are given if the existing ones turn out to be inappropriate. The optimal base levels of the program would identify the children's strengths and weaknesses in the different components of attention.

The study also investigates whether there would be any significant differences in attention between the boys' and the girls' groups. Differences in the results of these two groups would require setting up different base levels for the rehabilitation of boys and girls.

The aims of the current study are:

1. Assessment of the established base levels of the Foramen Rehab program as the starting-points of attention rehabilitation in children aged 9-12 years.
2. Finding out tasks in the Foramen Rehab Attention module that are unsuitable for children aged 9-12 years.
3. Identifying possible shortfalls and flaws in the Foramen Rehab Attention module.
4. Comparing the performance of the norm group boys and girls in the different subtests of the attention module.

We hypothesize that:

1. Girls aged 9-12 years perform more accurately (make less mistakes) in all the attention tasks compared to boys in the same age range.
2. Boys aged 9-12 years have shorter reaction times compared to girls in the same age range.

Method

This study is part of a bigger project called Rehabilitation of Attention and Visuo-Spatial Deficit in Children with Brain Trauma and Epilepsy Using The Computer-Administered FORAMENRehab Program with Social Competence Evaluation. The project is aimed at testing the effectiveness of the program and utilizing it to train Estonian children with focal epilepsy and mild traumatic brain injury, who have deficits in attention.

The clinical experiences of the applicability of FORAMENRehab software in Finnish TBI and stroke patients have been promising (Koskinen & Sarajuuri, 2004). The hypothesis of the project is that by using the FORAMENRehab program we could improve the overall neurocognitive performance in children with mild traumatic brain injury (mTBI) and epilepsy who follow the intervention in comparison to controlled children. The participants of the current study form a control-group for the pilot project. The Research Ethics Committee of the University of Tartu has approved the project. The testing of the children for the current pilot study lasted from September 2011 to April 2012 and was conducted by Marianne Saard and Külli Siimon.

Participants

20 children (10 boys and 10 girls) participated in the attention functions training study. The results of one boy and one girl were left out of the current study, because of an error of the program in saving the results. The age of the participants ranged from 9-12 years. Mean age for the boys was 10.6 years (SD=0.66) and for girls 10.8 years (SD=0.71). The participants were recruited from two ordinary schools in Tartu and they attended grades from 3rd to 5th. The participants' parents were all handed materials introducing the study and an informed consent was received from each of the parent.

An assent for participation was received from each child. Children with any known neurologic or psychiatric diagnosis were excluded from the study.

Apparatus

The FORAMENRehab Cognitive Rehabilitation Software (FORAMENRehab) was used in this study. The software consists of four different modules: attention, executive functions and problem solving, visual perception and visuospatial functions and memory (FORAMENRehab, 2011).

FORAMENRehab cognitive software is a tool for cognitive rehabilitation and developed in Finland by Sarajuuri and Koskinen in 2000. Due to the variability of the tasks the software can be used with children with acquired or developmental disorders (FORAMENRehab, 2011). The software is easy to handle and operates in Windows environment. The Attention module and the Visual Perception and Visuospatial Functions module of the software have been translated into Estonian. The program consisting of these two modules was installed into a laptop of the Tartu University Hospital Children's clinic.

In the current study the FORAMENRehab Attention module was used. The module is designed for the cognitive remediation of attention disorders. The base levels for each task were established, which would be used as the starting points for attention rehabilitation in children. These base levels were tested in this study.

Different components of attention are assessed with the program. The tasks are divided into four categories – focused attention, sustained attention, complex attention and tracking (for details see table 1). For the current study eight tasks were chosen from the module, which are playful and of short duration, lasting from 1 to 4 minutes.

Table 1. *Tasks under the different categories based on the components of attention.*

Focused attention	Sustained attention	Complex attention	Tracking
Visual Reaction Time	Symbol Search	Paced Search; Dual Targets	Tracking
Auditory Reaction Time	Figure Series Search	Word Recognition	
	Addition		

An example of a task under the focused attention category is the Visual Reaction Time task where the child has to monitor the screen, while waiting for a red circle (stimulus) to appear. When the stimulus appears, he/she has to click the space bar as quickly as possible. A feedback signal is heard, when the circle disappears.

In the sustained attention category, one of the tasks is the Symbol Search II task, where the screen will be filled with symbols and the child has to select all the symbols that are the same as the target symbol by clicking on the symbols as quickly as possible. There is also the choice of deselecting a symbol.

In the current study the tasks on divided attention are placed under the complex attention category. An illustrative example is the Word recognition task, where a row of letters will roll across the screen. As soon as the child finds a noun to be completely in the red target box, the space bar is pressed. Therefore, attention would be divided between the two rows.

An example task under the tracking category is the Tracking task, where a circle (stimulus) is moving around across the screen. The participant has to press the space bar as quickly as possible when the circle changes its appearance.

Procedure

All 20 participants underwent a base level assessment with the FORAMENRehab Attention module and the Visual Perception and Visuospatial Functions module. The base levels were set by examining all the levels of each task one by one and deciding which level would be an appropriate starting point for attention rehabilitation.

Each participant was met separately for one time. The meeting took place after classes at the child's school and lasted for 45 minutes. Completion of the tasks in the Attention module lasted for about 25 minutes. The appointments were previously concurred with the participants' parents. Each participant accomplished all eight tasks under the four categories.

A model animation of the upcoming exercise was shown and instructions were given to the participants before starting with each task. The participants were advised to start the tasks only when they had understood their assignment.

Data analyses

The results are analyzed with statistical data analysis program SPSS 20 (Statistical Package of the Social Science). Outcomes of the boys' and girls' groups are compared using the Wilcoxon–Mann–Whitney two-sample rank-sum test.

Results

The mistakes made in the tasks are analyzed, which include the false responses and the missing responses added together. In the Word recognition task only the false reactions are included into the data analyses and the missing reactions are left out, because of a saving error of the program.

The 80 and 50 per cent limits are set up for evaluating the appropriateness of the base levels. If more than 80 per cent of the children performed 100 per cent correctly on the task, then the particular task level is considered too easy to be added into the rehabilitation process. If less than 50 per cent of the children complete the task without any mistakes, then the difficulty level of the task is considered to be too complicated and should be made easier, because the particular level requires some previous training. The task is set up as a suitable starting point for the following rehabilitation, if about 50-80 per cent of the participants go through the task without making any mistakes.

In the rehabilitation process the patients will move to the next difficulty level, if they perform correctly on the task. Thus the zero mistake indicator was used to classify the base levels as appropriate. The tasks in the rehabilitation are divided into 3 difficulty levels: easy (I), medium (II) and advanced (III). The established base levels will be the easiest level of the training.

Visual Reaction Time

Mean number of mistakes made in the Visual reaction time task is 0.50 (SD=0.618). 55.6 per cent of the children performed the task with zero mistakes and 38.9 per cent made one mistake. The maximum number of mistakes made is 2.

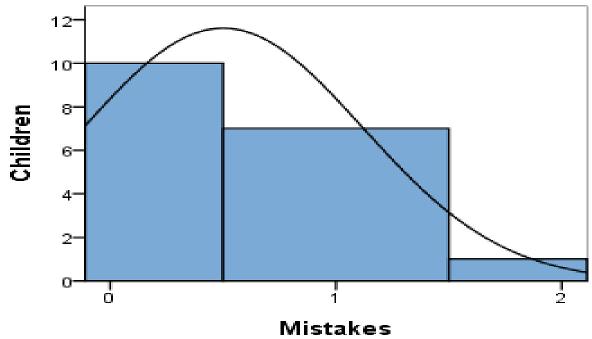

Figure 1. *Mistakes made in the Visual reaction time task*

The results of the test are in the expected direction as girls made averagely (M1=0.44, SD1=0.527) slightly less mistakes than boys (M2=0.56, SD2=0.726). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the visual reaction time test is not statistically significant (Z= -0.201, p=0.841). Mean reaction time in this task for boys is 0.387 sec (SD=0.048) and for girls 0.355 sec (SD=0.038). This difference is not statistically significant (Z= -1.810, p=0.070).

Auditory Reaction Time

Mean number of mistakes made in this task is 0.50 (SD=0.924). 72.2 per cent of the children performed the task without making any mistakes. The maximum number of mistakes made is 3.

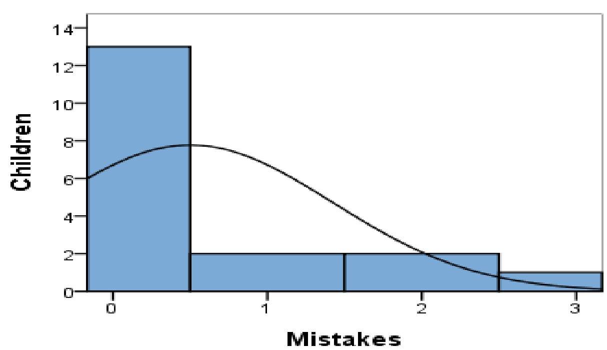

Figure 2. *Mistakes made in the Auditory reaction time task*

The results of the test are not in the expected direction as girls made averagely (M1=0.78, SD1=1.202) more mistakes than boys (M2=0.22, SD2=0.441). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the auditory reaction time test is not statistically significant (Z= -0.840, p=0.401).

Mean reaction time for boys is 0.362 sec (SD=0.032) and for girls 0.351 sec (SD=0.032). Similarly, this difference is not statistically significant (Z= -0.839, p=0.402).

Symbol Search

Mean number of mistakes made in this task is 0.67 (SD=0.767). 50.0 per cent of the children performed the task without making any mistakes and 33.3 per cent made one mistake. The maximum number of mistakes made is 2.

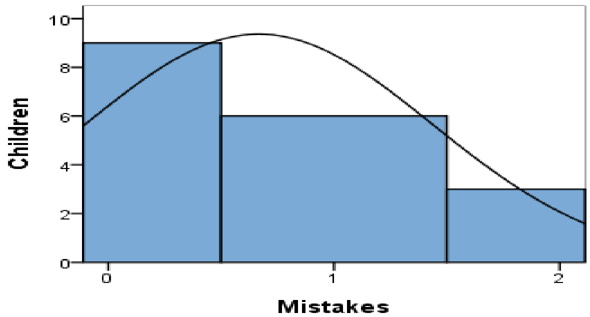

Figure 3. *Mistakes made in the Symbol search task*

The results of the test are in the expected direction as girls made averagely (M1=0.56, SD1=0.726) less mistakes than boys (M2=0.78, SD2=0.833). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the symbol search test is not statistically significant (Z= -0.450, p=0.652). Neither differed the time used to complete the task statistically (Z= -1.634, p=0.102). Mean time for boys is 160.67 sec (SD=27.249) and for girls 145.33 sec (SD=14.133).

Figure Series Search

Mean number of mistakes made in this task is 0.67 (SD=1.372). 72.2 per cent of the children performed the task without making any mistakes. The maximum number of mistakes made is 5.

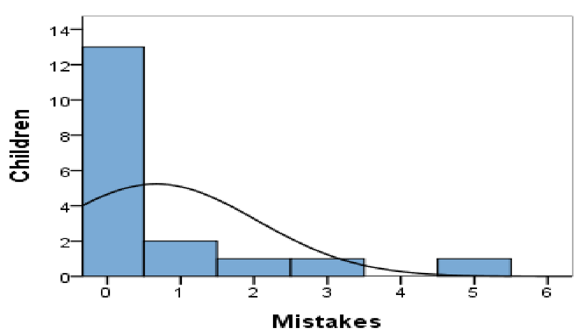

Figure 4. *Mistakes made in the Figure series task*

The results of the test are not in the expected direction as girls made averagely (M1=0.67, SD1=1.118) the same number of mistakes as boys (M2=0.67, SD2=1.658). When comparing the results of the two groups with the Mann-Whitney test, it shows that there are not statistically significant differences between the boys' and girls' groups (Z= -0.447, p=0.655). Mean time used to complete this task for boys is 142.22 sec (SD=43.646) and for girls 166.22 sec (SD=86.273). This difference is not statistically significant (Z= -0.442, p=0.659).

Paced search with dual targets

Mean number of mistakes made in this task is 52.33 (SD=11.183). None of the children performed the task without making any mistakes, but instead all of them made more than 30 mistakes. The minimum number of mistakes made is 34 and the maximum number of mistakes is 78.

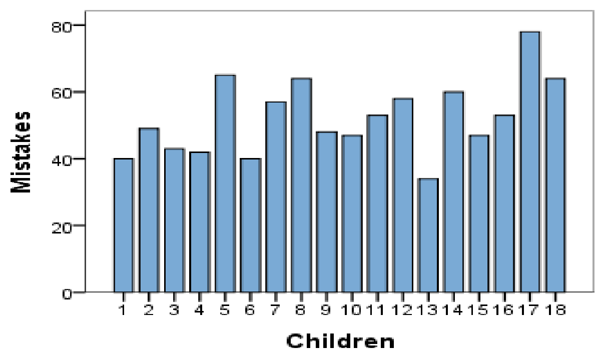

Figure 5. *Mistakes made by each child*

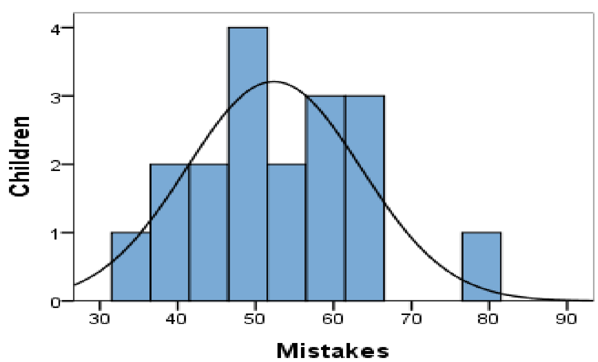

Figure 6. *Mistakes made in the Paced search with dual targets task*

The results of the test are in the expected direction as girls made averagely (M1=50.0, SD1=11.180) less mistakes than boys (M2=54.67, SD2=11.336).

The Mann-Whitney test shows that this difference between the boys' and girls' performances in this divided attention test is not statistically significant (Z= -0.619, p=0.536).

Word recognition

Mean number of mistakes made in this task is 3.06 (SD= 4.917). 27.8 per cent of the children made no mistakes in this task. 50 per cent made at least 1 mistake. The maximum number of mistakes made in this task is 21.

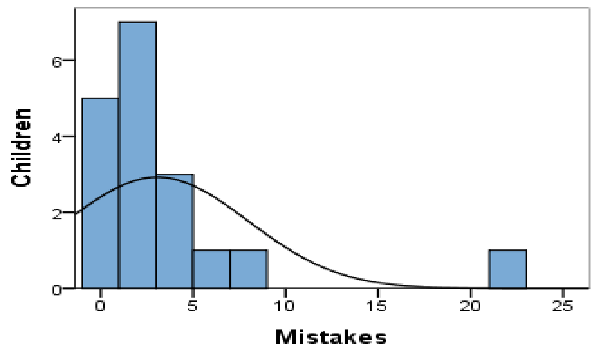

Figure 7. *Mistakes made in the Word recognition task*

The results of the test are not in the expected direction as girls made averagely (M1=3.89 SD1=6.827) more mistakes than boys (M2=2.22, SD2=1.787). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the task is not statistically significant (Z= -0.450, p=0.652).

Addition

Mean number of mistakes made in this task is 1.44 (SD=1.580). 44.4 per cent of the children performed the task without making any mistakes. The maximum number of mistakes made is 5.

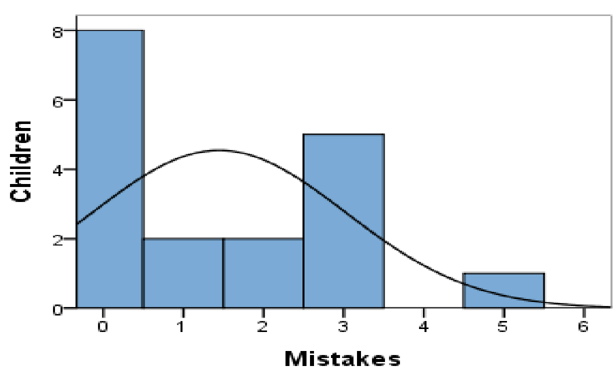

Figure 8. *Mistakes made in the Addition task*

The results of the test are in the expected direction as girls made averagely (M1=0.89 SD1=1.364) less mistakes than boys (M2=2.00, SD2=1.658). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the task is not statistically significant (Z= -1.591, p=0.112).

Tracking

Mean number of mistakes made in this task is 2.39 (SD=2.227). 11.1 per cent of the children performed the task without making any mistakes. The maximum number of mistakes made is 7.

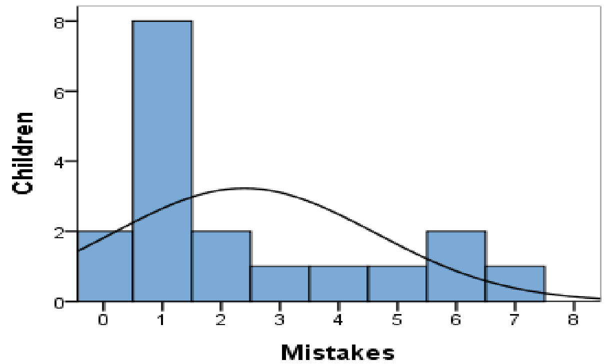

Figure 9. *Mistakes made in the Tracking task*

The results of the test are not in the expected direction as girls made averagely (M1=2.67 SD1=1.936) slightly more mistakes than boys (M2=2.11, SD2=2.571). The Mann-Whitney test shows that this difference between the boys' and girls' performances in the task is not statistically significant (Z= -0.972, p=0.331).

Mistakes added together

Mean number of mistakes made in all the tasks together is 61.50 (SD=13.622).

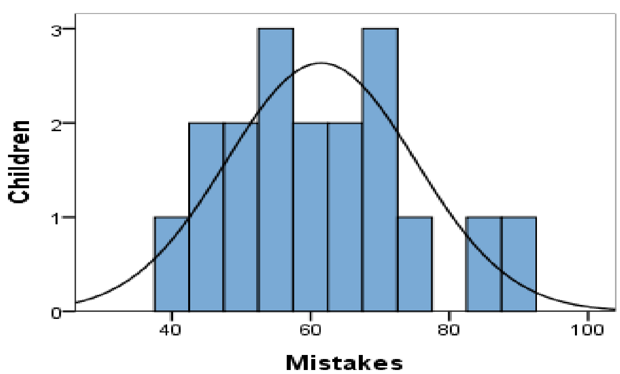

Figure 10. *Mistakes made in all the tasks*

Mean number of mistakes in boys' group is 63.11 (SD=15.219) and in girls' group 59.89 (SD=12.524). The results of the test do not show significant differences between the two groups (Z= -0.221, p=0.825).

Shortfalls and flaws of the Attention module

- *Scores not displayed correctly*

The program saves the results incorrectly for the Word recognition task and thus all of the results from that task could not be used in this study. In the results section under the missing responses row also the correct double responses are saved as negative scores. In a single row the missing responses as positive scores and the double responses as negative scores are added together, thus cancelling each other out. This makes it possible to have negative scores under the row where all the mistakes are added together (wrong responses and missing responses). The wrong responses are saved correctly and are used in the analyses of the current study.

- *Graphical flaws*

In the Figure series search task under the sustained attention category, some of the figures are placed outside the active screen area. Therefore, the correct figures could not be chosen and are considered as mistakes.

This only applies to the more difficult levels of the task and not the simple level used in the study.

- *Methodological problems*

1. Difficulty levels are non-distinctive for tasks under the sustained attention category. The different levels are not informative enough for the rehabilitation to evolve and become more difficult, because the structure is the same for all the levels.

In the Repeated pairs search tasks if the level is changed from easy to difficult, the levels still look identical and do not have any difference.

In the Series search tasks, the symbols that are included with more difficult levels do not make the task more difficult as the combination is probably still identified by the first symbols, no matter how many symbols come after.

2. It is ambiguous why the tasks under the four categories are divided in the way they exist in the program. Some of the tasks do not seem to fit into the particular categories. For example, Tracking, the last category in the attention module, besides the Tracking task also includes exercises like PASAT (Paced Auditory Serial Addition Test), which doesn't fall under the tracking category.

3. The translation into Estonian should be corrected. In the Estonian program, the names of the categories of attentional tasks are different from those in English. The complex attention category is translated as divided attention and is misleading, because the category includes also other tasks besides the tasks on divided attention.

Discussion

This was the study to test the suitability of the chosen base levels in the FORAMENRehab attention module for 9- to 12-year-old children. We found that in the Visual reaction time task, the Auditory reaction time task, the Symbol search task and the Figure series task, the chosen base levels are suitable for 9- to 12-year-olds, whereas the Paced search with dual targets task, the Word recognition task, the Addition task and the Tracking task of the module are considered unsuitable and need further modification.

The *Visual reaction time task* was performed close to the 50 per cent limit and it should be considered whether to classify it as suitable or too difficult. But most of the children, who did not pass the task without mistakes, had only one mistake and thus the task level could be used as an appropriate base level.

The *Auditory reaction time task* is appropriate and could be added to the base levels as most of the children made zero mistakes, but the percentage did not exceed the upper limit of 80 per cent.

The *Symbol search task* was performed on the 50 per cent line and it could be considered whether suitable or too difficult. However, the rest of the children mostly made only one mistake and therefore, this level of the task could be considered to be an appropriate starting-point.

In the *Figure series task* the level of the task used in the present study is considered a suitable base level, as the children's performance was within the specified limits.

Most of the children made zero mistakes, but the task is not too easy, because there were still a considerable number of children who did not perform a 100 per cent correctly on the task.

The *Paced search with dual targets task* is too complicated when used with the established settings as the starting point. The settings for the base levels could be changed so that the rows move in the same direction, instead of moving in the opposite directions. With rows moving in the same direction, the children are capable of dividing their attention between the rows more correctly, but this easier level also requires training before moving on to the more difficult levels of the opposite moving rows.

Although "perceptual machinery" seems capable of identifying more than one object at a time, it is subject to capacity limits that become evident when the stimulus load is increased beyond a modest level (Pashler & Johnston, 1999). Also the moving speed of the rows could be made slower and by that making it easier to follow the letters.

The task would be appropriate for the baseline assessment as the results most likely show the difference between boys and girls better than other tasks, because this task is the most difficult one and therefore, the results are better linked to the children's attentional ability. The other tasks are rather easy and therefore, the results are non-distinctive between the two groups.

The *Word recognition task* performed with the current settings is too complicated to be added to the base levels. The task could be made easier by lowering the speed of the row of letters moving across the screen and thus giving the child more time to react to the important stimuli and also by replacing some of the words. The words used in the tasks are too difficult for children to grasp. Many of the words (e.g. Gulo) under the different categories (e.g. animals, cities) should be exchanged with more simple words. Some of the words presented should not be placed under the particular categories they have been placed, because the category specifies the words the children should look for and therefore, they could miss the words that they do not think fit under the category. Also, the names of cities should be exchanged, because the children are not familiar with the cities of other countries. The suggestion would be to replace these names of foreign cities with the names of Estonian cities.

In the *Addition task* less than half of the children performed without making any mistakes, thus the task on the current level is too difficult for being a starting-point of rehabilitation. The task could be made a little easier by lengthening the time for how long the numbers that are to be added are seen on the screen.

The *Tracking task* is considered a little too difficult, because a small percentage of the participants passed the task with zero mistakes. The current task could be made easier by making the stimuli moving slower across the screen, so that the changes in its appearance could be perceived more easily.

When comparing with literature, the tasks under the four categories should be divided differently. It is somewhat unclear why the exercises have been divided into the given categories. The categorization should be corrected relying on the existing attention theories. Thus the names of the categories should be exchanged to cover the tasks they include or the tasks should be redistributed between the categories.

As the program was at first developed for adults, some of the tasks require modifications. However, there do not seem to be any particular tasks that need to be taken out of the program. The 100% compliance confirms that the training program is suitable for children.

Interestingly, we found that girls did not outperform boys in all of the attention tasks, but did make fewer mistakes than boys in half of the exercises (Visual reaction time task, Symbol search task, Paced search with dual targets task, Addition task). Still, in some of the tasks boys outperformed girls (Auditory reaction time task, Word recognition task, Tracking task). But none of these differences are statistically significant.

Furthermore, boys did not have shorter reaction times compared to girls. Previously, males have been found to be quicker in reacting to different stimuli (Gur *et al*., 2012), but this was not evident in the current study. Although statistically not significantly, girls had slightly shorter reaction times in the Visual reaction time task and in the Auditory reaction time task. Girls also used less time completing the Symbol search task, but boys were quicker than girls only in the Figure series search task.

Differences between the attentional abilities of boys and girls are not significant when measured with the established base levels of the program.

Also, the sample of the current study may be too small for showing the differences. However, it can be concluded that the tasks are appropriate for boys and girls and different base levels do not need to be developed for these two groups for the rehabilitation with the FORAMENRehab Attention module.

The repetition of the study in a larger sample would be recommendable as it could better bring out the differences between the boys' and girls' performances.

Implications for future research

Base level should be differentiated from baseline assessment, for in our pilot study they are considered as the same. Thus different explanations should be made. *Base level* as the starting point of rehabilitation would be the easiest levels of the tasks used at the beginning of the training. *Baseline assessment* as the evaluation of the child's performance on the tasks at the beginning and after the rehabilitation, which show the child's progress in the specific attentional components and which aspects improve due to the attention training. The participant would go through the baseline assessment on the first meeting and again at the end of the rehabilitation. In the baseline assessment more difficult levels of the tasks should be used than in the base level, so that the differences would be seen between the performances at the beginning and after the training. The tasks used during the rehabilitation period should be different from those used in the baseline assessment so that the improvement in the content of attention, as far as performance on the computer is concerned, would not be task specific.

More specific instructions for the people administering the tests should be constructed, e.g. in the Word recognition task, it should be considered whether to specify the word category to the child. The existing literature emphasizes the importance of correct instructions. In a review by Sohlberg, Ehlhardt & Kennedy (2005) they conclude that there is increasing evidence that learners with severe cognitive impairments can learn new skills and information when provided with systematic instruction. One of the instruction components given is to "develop simple, consistent instructional wording and scripts to reduce confusion and focus learner on relevant content".

In conclusion, the FORAMENRehab Attention module is a suitable method for the rehabilitation of children aged 9-12 years. We found that the base levels of the Paced search with dual targets task, the Word Recognition task, the Addition task and the Tracking task of the module should be modified, because the established base levels are too difficult for children to be used at the start of rehabilitation and thus require previous training at simpler levels.

We also found that the differences between the attentional abilities of boys and girls are not significant when measured with the established base levels, thus different levels do not need to be used in these two groups. After the modifications suggested in the current study are applied, the program would be appropriate to be used in the neurorehabilitation of 9- to 12-year-old children with ABI.

References

Absher, J. R. & Cummings, J. L. (1995). Neurobehavioral examination of frontal lobe functions. *Aphasiology*, 9 (2), 181-192.

Anderson, V., Jacobs, R., Harvey, A.S. (2005) Prefrontal lesions and attentional skills in childhood. *Journal of the International Neuropsychological Society*, 11 (7), 817-831.

Aru, J., & Bachman, T. (2009). Typological and individual qualities of attention. In J. Aru & T. Bachman (Eds.), *Attention and Consciousness* (p. 152). Tallinn: Tänapäev.

Beers, S. R. (1992). Cognitive effects of mild head injury in children and adolescents. *Neuropsychology Review*, 3 (4), 281–320.

Butler, R.W., & Copeland, D.R. (2002). Attentional processes and their remediation in children treated for cancer: a literature review and the development of therapeutic approach. *Journal of International Neuropsychological Society*, 8 (1), 115–124.

Chamberlain, M.A. (1995). Head injury – the challenge: Principles and practice of service organization. In M.A. Chamberlain, V. Neumann, & A. Tennant (Eds.), *Traumatic brain injury rehabilitation*. London: Chapman & Hall Medical.

Cicerone, K.D., Dahlberg, C., Malec, J.F., Langenbahn, D.M., Felicetti, T., Kneipp, S., Ellmo, W., Kalmar, K., Giacino, J. T., Harely, J. P., Laatsch, L., Morse, P. A., Catanese, J. (2005). Evidence-based cognitive rehabilitation: Updated review of the literature from 1998 through 2002. *Archives of Physical Medicine and Rehabilitation*, 86 (8), 1681–1692.

Cicerone, K. D., Dahlberg, C., Kalmar, K., Langenbahn, D. M., Malec, J. F., Bergquist, T. F., Felicetti, T., Giacino, J. T., Harley, J. P., Harrington, D. E., Herzog, J., Kneipp, S., Laatsch, L., Morse, P. A. (2000). Evidence-based cognitive rehabilitation: Recommendations for clinical practice. *Archives of Physical Medicine and Rehabilitation*, 81 (12), 1596–1615.

Cornblatt, B. A. & Keilp. J. G. (1994). Impaired attention, genetics, and the pathophysiology of schizophrenia. *Schizophrenia Bulletin*, 20 (1), 31-46.

Donders, J. (1993). Memory functioning after traumatic brain injury in children. *Brain Injury*, 7 (5), 431-437.

FORAMENRehab kognitiiviset kuntoutusohjelmat: http://www.foramenrehab.info/ (visited on September 12th, 2011).

Foster, J. K., Eskes, G. A., Stuss, D. T. (1994). The cognitive neuropsychology of attention: a frontal lobe perspective. *Cognitive Neuropsychology*, 11 (2), 133-147.

Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K.M., Greenstein, D., Vaituzis, A. C., Nugent, T. F., Herman, H. D., Clasen, L. S., Toga, A. W., Rapoport, J. L., Thompson, P. M. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, 101 (21), 8174-8179.

Gur, R. C., Richard, J., Calkins, M. E., Chiavacci, R.; Hansen, J. A., Bilker, W. B., Loughead, J., Connolly, J. J., Qiu, H., Mentch, F. D., Abou-Sleiman, P. M., Hakonarson, H., Gur, R. E. (2012). Age group and sex differences in performance on a computerized neurocognitive battery in children age 8−21. *Neuropsychology*, 26 (2), 251-265.

Gur, R. C., Turetsky, B. I., Loughead, J., Waxman, J., Snyder, W., Ragland, J. D., Elliott, M. A., Bilker, W. B., Arnold, S. E., Gur, R. E. (2007). Hemodynamic responses in neural circuitries for detection of visual target and novelty: An event-related fMRI study. *Human Brain Mapping*, 28 (4), 263-274.

Guzeva, V.I., Belash, V.O., Guzeva, V. V., Guzeva, O.V., Anastazi, O.I.E. (2009). Characteristics of cognitive functions in children with epilepsy. *Neuroscience and Behavioral Physiology*, 39 (9), 885-889.

van't Hooft, I., Andersson, K., Sejersen, T., Bartfai, A., von Wendt, L. (2003). Attention and memory training in children with acquired brain injuries. *Acta Paediatrica*, 92 (8), 935-940.

James, W. (1890). *The principles of psychology* (p 403). New York: Holt.

Klonoff, H., Campbell, C., Klonoff, P. S. (1995). Outcome of head injuries from childhood to adulthood: a twenty-three year follow–up study. In S. H. Broman & M. E. Michel (Eds.), *Traumatic head injury in children* (p. 219–234). New York: Oxford University Press.

Kolb, B. & Fantie, B. (2009). Development of the Child's Brain and Behavior. In C. R. Reynolds & E. Fletcher-Janzen, *Handbook of clinical child neuropsychology* (p. 17-41). New York and London: Plenum Press.

Koskinen, S., & Sarajuuri, J. (2004). Computer-administered cognitive remediation in a frame of holistic neuropsychological rehabilitation: FORAMENRehab programs. *Svensk Neuropsykologi*, 4, 10–11.

Laatsch, L., Harrington, D., Hotz, G., Marcantuono, J., Mozzoni, M. P., Walsh, V., Hersey, K. P. (2007). An evidence-based review of cognitive and behavioral rehabilitation treatment studies in children with acquired brain injury. *Journal of Head Trauma Rehabilitation*, 22 (4), 248–256.

Limond, J., & Leeke, R. (2005) Practitioner review: Cognitive rehabilitation for children with acquired brain injury. *Journal of child psychology and psychiatry and allied disciplines*, 46 (4), 339-352.

Loring D. W. (1999). *INS dictionary of neuropsychology* (p. 24). New York: Oxford University Press.

Naglieri, J. A. & Rojahn, J. (2001). Gender differences in planning, attention, simultaneous, and successive (PASS) cognitive processes and achievement. *Journal of Educational Psychology,* 93 (2), 430-437.

Nixon, E. (2001). The social competence of children with attention deficit hyperactivity disorder: A review of the literature. *Child Psychology & Psychiatry Review*, 6 (4), 172-180.

Pashler, H. E. (1999). Selective Attention. In H. E. Pashler (Ed.), *The psychology of attention* (p. 37-100). A Bradford Book. Cambridge: The MIT Press.

Pashler, H.E. & Johnston, J.C. (1998). Attentional limitations in dual-task performance. In H.E. Pashler (Ed.), *Attention* (p. 155-190). A Bradford Book. Cambridge: The MIT Press.

Prigatano, G.P. (2000). A brief overview of four principles of neuropsychological rehabilitation. In A. L. Christensen & B. P. Uzzell (Eds.), *International Handbook of Neuropsychological Rehabilitation* (p. 115-125). New York: Kluwer Academic/Plenum Publishers.

Ramtekkar, U. P., Reiersen, A. M., Todorov, A. A., Todd, R. D. (2010). Sex and age differences in attention-deficit/hyperactivity disorder symptoms and diagnoses: Implications for DSM-V and ICD-11. *Journal of the American Academy of Child and Adolescent Psychiatry,* 49 (3), 217–228.

Sarajuuri, J., & Koskinen, S. (2006). Holistic neuropsychological rehabilitation in Finland: The INSURE program - a transcultural outgrowth of perspectives from Israel to Europe via the USA. *International Journal of Psychology*, 41 (5), 362–370.

Slomine, B. & Locascio, G. (2009). Cognitive rehabilitation for children with acquired brain injury. *Developmental Disabilities Research Reviews,* 15 (2), 133-143.

Sohlberg, M. M., Ehlhardt, L., Kennedy, M. (2005). Instructional techniques in cognitive rehabilitation: a preliminary report. *Seminars in Speech and Language,* 26 (4), 268-279.

Sohlberg, M. M. & Mateer, C. A. (2001). Improving attention and managing attentional problems. Adapting rehabilitation techniques to adults with ADD. *Annals Of The New York Academy Of Sciences*, 931, 359-375.

Sohlberg, M.M. & Mateer, C.A. (1989). Introduction to cognitive rehabilitation. New York: The Guilford Press.

Styles, E. A. (2005). Early work on attention. In E. A. Styles (Ed.), *The psychology of attention* (p. 10-25). Hove, UK: Psychology Press.

Styles, E. A. (2005). Introduction. In E. A. Styles (Ed.), *The psychology of attention* (p.1-9). Hove, UK: Psychology Press.

Warrick, P. D., & Naglieri, J. A. (1993). Gender differences in planning, attention, simultaneous, and successive (PASS) cognitive processes. *Journal of Educational Psychology*, 85 (4), 693-701.

Warschausky, S., Kewman, D., Kay. J. (1999). Empirically supported psychological and behavioral therapies in pediatric rehabilitation. *Journal of Head Trauma Rehabilitation*, 14 (4), 373–383.

Wood, R., L. (1988). Attention disorders in brain injury rehabilitation. *Journal of Learning Disabilities*, 21 (6), 327-332, 351.

Ylvisaker, M., Turkstra, L. S., Coelho, C. (2005). Behavioral and social interventions for individuals with traumatic brain injury: a summary of the research with clinical implications. *Seminars in Speech and Language*, 26 (4), 256-267.

Ylvisaker, M., Szekeres, S. F., Haarbauer-Krupa, J. (1998). Cognitive rehabilitation: organization, memory and language. In M. Ylvisaker (Ed), *Traumatic brain injury rehabilitation: children and adolescents (Revised Edition)*(p. 181–220). Boston: Butterworth-Heinemann.

Appendix

UURITAVA INFORMEERIMISE JA TEADLIKU NÕUSOLEKU LEHT

Uuringu nimetus

Epilepsia ja ajutraumaga laste kognitiivsete võimete rehabilitatsioon FORAMENRehab arvutiprogrammiga.

Informatsioon uuritavale

Uuringu antud osa keskendub tervete laste uurimisele, et moodustada kontrollgrupp ja leida Eesti normid 9-12.a. laste tähelepanu ja ruumitaju võimete kohta. Kontrollgruppi kuuluvad terved lapsed, kelle kognitiivsed võimed ei ole eelnevalt häiritud. Uuringu tulemusena saab võrrelda tervete laste ja patsientide andmeid omavahel ja leida erinevusi kognitiivsete võimete osas, mis on olulised ja vajaksid haigetel lastel spetsiaalset treenimist.

Kognitiivsed võimed on mõtlemise ja tunnetusega seotud aju funktsioonid. FORAMENRehab on arvutipõhine treeningprogramm, välja töötatud Soomes 2004.a., mis võimaldab arendada nii tähelepanu kui ruumitaju oskusi.

Uuringu eesmärgiks on luua lastele sobiv arvutipõhine metoodika FORAMENRehab tarkvara baasil tähelepanu ja visuaal-ruumiliste võimete treenimiseks. Uuringu teises etapis treenitakse närvisüsteemi haigustega lapsi ja hinnatakse nende paranemise määra. Patsientide võimete paranemist võrreldakse kontrollgrupi laste tulemustega.

Uuringu õnnestumisel lülitatakse FORAMENRehab programm laste neuroloogilise taastusravi kavasse.

Uurimistöö sisuks on tähelepanu ja visuaal-ruumilisi võimeid arendavate harjutusete tegemine FORAMENRehab arvutiprogrammiga. Uuring viiakse läbi lapse koolis pärast tunde ning toimub lapsele ja vanemale sobival koolivälisel ajal. Kokkusaamine toimub ühekordselt ja selle kestus on orienteeruvalt 45 minutit.

Last juhendavad kokkusaamise ajal Tartu Ülikooli psühholoogia üliõpilased Marianne Saard ja Külli Siimon. Uuringu juhiks ning tulemuste analüüsi ja tõlgendamise eest vastutajaks on lasteneuroloog, vanemarst-õppejõud dr. Anneli Kolk, Tartu Ülikooli Kliinikumi Lastekliiniku neuroloogia ja neuro rehabilitatsiooni osakonnast.

Kokkusaamine on jaotatud erinevateks osadeks. Sissejuhatavale vestlusele järgneb FORAMEN Rehab arvutiprogrammiga harjutuste tegemine. Arvutiprogrammi abil uuritakse erinevaid tähelepanu aspekte (keskendumine, tähelepanu säilitamine, jagamine ja seiramine) ja visuaal-ruumilisi võimeid. Harjutuste vahel on üks puhkepaus (1-2 minutit). Uuring ei ole lapsele kurnav, kuna harjutused on mängulised ning lühiajalised (1-4 minutit).

Uuring on:

1) vabatahtlik ja uuringust võib loobuda igal ajal;

2) saadud andmeid kasutatakse anonüümselt uurimistöös;

3) uurimistööga ei kaasne mingeid ohte ega kahju lapse tervisele (võimalikud on vaid minimaalsed arvutikasutamisega seotud negatiivsed mõjud, nagu silmade väsimus).

Uuringutest saadav kasu

Uuringus osalemisega annate omapoolse panuse 9-12.a. laste eakohaste kognitiivsete normide leidmiseks tähelepanu ja ruumitaju osas Eestis, lisaks närvisüsteemi kahjustusega (epilepsia ja ajutraumaga) laste kognitiivsete võimete kaasaegse rehabilitatsiooniprogrammi väljatöötamisse .

Lastele enamasti meeldib arvutiga aega veeta, kuid võrreldes tavalise arvutikasutamisega on FORAMENRehab'il lapse vaimseid võimeid arendavad omadused, kuna treening toimub juhendaja kaasabil ja kindlate raskusastmete vaheldumisel. Nii saab laps aega, mida ta tahaks arvutis veeta, kasulikumalt rakendada.

Epilepsia ja ajutraumaga laste jaoks on FORAMENRehab arvutiprogramm kasulik, kuna aktiivne tegelemine lapse kognitiivsete võimetega tõotab paremat toimetulekule nii kodus kui koolis. Tähelepanufunktsioonide treening aitab lastel tõhusamalt kontrollida oma impulsse ja planeerida tegevust.

Hästi arenenud visuaal-ruumiliste võimetega laps suudab paremini hakkama saada ümbritsevas keskkonnas ning edukamalt lahendada ülesandeid, kus on oluline asjade omavahelise vahemaa ja asetus (näiteks käelist osavust nõudvad ülesanded). Regulaarsed harjutused aitavad lapsel oma probleeme teadvustada ning neidänguliselt lahendada.

Kui olete nõus, et Teie laps osaleb antud uuringus kontrollgrupi lapsena, siis palume Teil täita järgnevad nõusolekuvormid, millest ühe tagastab laps klassijuhataja kätte. Teine nõusolekuvorm jääb Teile. Nõusoleku korral lepime kokku lapsele sobiva kohtumise aja. Soovi korral anname ka tagasisidet teie lapse uuringutulemuste kohta.

Täpsustavate küsimuste tekkimise korral palume võtta ühendust uuringu läbiviijatega, kas helistades või e-maili teel.

Kontakt:

Külli Siimon

Telefon: 5328-5323

E-mail: kylli.siimon@gmail.com

Marianne Saard

Telefon: 5553-9070

E-mail: mariannesaard@gmail.com

NÕUSOLEKUVORM

Nõusolekuvorm uuringule „Epilepsia ja ajutraumaga laste kognitiivsete võimete rehabilitatsioon FORAMENRehab arvutiprogrammiga" - tervete laste kontrollgrupis osalemiseks.

Uuringus osalemine on vabatahtlik ja osavõtu kohta ei anta infot kõrvalistele isikutele

Mina, ..., olen informeeritud ülalmainitud uuringust ja olen teadlik läbiviidava uurimistöö eesmärgist, uuringu metoodikast ja kinnitan oma nõusolekut selles osalemiseks allkirjaga.

Tean, et uuringute käigus tekkivate küsimuste kohta saan mulle vajalikku täiendavat informatsiooni uuringu teostajalt.

dr. Anneli Kolk

SA TÜK Lastekliinik, lasteneuroloog

neuroloogia ja neurorehabilitatsiooni osakonna juhataja, ülikooli vanemteadur neuropsühholoogias

Lunini 6,
Tartu 51014
telefon 7319580
e-mail: anneli.kolk@kliinikum.ee

Uuritava lapse nimi……………………………………………………………

Uuritava lapse sünnikuupäev……………………………………………………

Uuritava lapsevanema allkiri ....

Kontakttelefon ....

Kuupäev, kuu, aasta ....

Uuritavale informatsiooni andnud isik ....

Allkiri ....

Kuupäev, kuu, aasta ....

Käesolevaga kinnitan, et olen korrektselt viidanud kõigile oma töös kasutatud teiste autorite poolt loodud kirjalikele töödele, lausetele, mõtetele, ideedele või andmetele.

Olen nõus oma töö avaldamisega Tartu Ülikooli digittaalarhiivis DSpace.

/Marianne Saard/