Suitability of the computer-assisted reading intervention Ekapeli Maahanmuutaja for preschool students with autism spectrum disorders: single-subject experimental piloting study

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ABSTRACT

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Individuals with autism spectrum disorders (ASD) show different aspects and severities of symptoms and comorbidities related to specific areas of learning. Children with ASD however have the potential to achieve full reading acquisition if provided with clear task and phonics instructions, and a suitable learning environment. The aim of this study is to investigate the usage and suitability of Ekapeli Maahanmuutaja, a computer-assisted reading intervention, in four Finnish preschool students with ASD. The data was collected via multiple methods, including questionnaires, Likert scale daily assessments, in-game log data, camera recordings, and eye movement tracking. A descriptive statistics method analysis was used in this study upon the transcription of the data based on the research questions. The findings indicate the potential suitability of the Ekapeli Maahanmuutaja computer-assisted reading intervention for preschool students with lower severity of ASD symptoms, such as the ability to use verbal communication. The participating students showed high levels of on-task behaviour and overall felt mostly satisfied with the intervention experience. Additionally, this study highlighted the individual variability in students with ASD and the connection between the severity of their symptoms and learning outcomes. The results of the study provided additional insights to the already existing information about the usage and effectiveness of the Ekapeli intervention in various groups of children, as well as underlined which used methods are potentially suitable for future research in this area.

Keywords: preschoolers, autism spectrum disorders, computer-assisted reading intervention, Ekapeli, eye movement tracking

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Petra Kucharová

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1 INTRODUCTION

Autism spectrum disorders (ASD) is a neurodevelopmental disorder characterised by difficulties in social behaviour and communication, repetitive behaviours, and other additional issues caused by the initial impairments. There has been an increase in the number of diagnosed children with ASD worldwide (Fombonne, 2018; Nevison, Blaxill, & Zahorodny, 2018; Sun et al., 2019). Delobel-Ayoub et al. (2019) state that the prevalence of ASD in Finland is 0,77% which is significantly lower in comparison with, e.g., Denmark (1,26%). According to the authors, this difference is caused by possible differences in detection of ASD, diagnostic approaches, and autism awareness (Delobel-Ayoub et al., 2019).

The growing number of children diagnosed with ASD requires the development of new learning solutions and the exploration and testing of existing learning platforms that have already proven to be effective within other groups of children with special needs. Numerous computer-assistive interventions are focusing on improving reading in the general population as well as in individuals with special needs (Ecalle, Kleinsz, & Magnan, 2013; Messer & Nash, 2017; Lyytinen, Erskine, Hämäläinen, et al., 2015; Richardson & Lyytinen, 2014; Storey, McDowell, & Leslie, 2019). Some reading interventions have focused mainly on reading acquisition in children with ASD; however, the number of research-based CAIs is still relatively low (Arciuli & Bailey, 2019). Hence, the assessment of already existing computer-based reading interventions on their suitability and effectiveness within children with ASD could bring additional views on how to adjust already existing CAIs to support the reading acquisition of children with ASD (e.g., Plavnick, Thompson, Englert, Mariage, & Johnson, 2016).

One of these already existing CAIs is Ekapeli, in English GraphoLearn. It is a research-based computer-assisted reading intervention that provides gamified letter-sound correspondence learning. The game was designed based on the findings of Jyväskylä Longitudinal Study on Dyslexia and supported by theoretical knowledge on reading development (Lyytinen et al., 2015; Richardson

& Lyytinen, 2014).

Learning with Ekapeli starts with a more distinct (visually and phonetically) type of letters (e.g., a, s, t). When the stimuli get mastered by the user, the algorithm adjusts the triggers and slowly transfers them into more phonetically similar letters (e.g., m, n, l) (Richardson & Lyytinen, 2014). As the game progresses, the single phonemes are introduced, followed by introducing sub-lexical units (syllables and rimes), and finally ends by presenting pseudo- and existing words (Richardson & Lyytinen, 2014).

The fundamental principles of the Ekapeli are immediate feedback response and automatic difficulty adjusting based on the player's skills. The quick feedback response is provided by the right (green) or wrong (red) borders around the stimuli and is accompanied by a correct or wrong sound. Furthermore, the automatic difficulty adjusting is based on individual performances in trials. The player needs to achieve the score of 80% for a specific stimuli in order to pursue towards a new one. This type of adjusting difficulty supports the motivation of individuals in managing challenges enhanced by the ability to succeed. (Richardson & Lyytinen, 2014).

Ekapeli has various existing versions for specific target groups of users based on age, language and is even available to children who use the application as a second-language learning platform. However, to this date, there has been no study directly following a group of children with ASD and their progress or usage of Ekapeli as a learning intervention.

To conclude, there are numerous CAIs focused on different aspects of reading in different populations. However, when it comes to those focused especially on grapheme-phoneme correspondence, which is essential to reading acquisition process in children with ASD, there are only a few such intervention based on existing research implemented in this target group. Hence, it is necessary to provide new views on already existing reading interventions and assess their suitability to children with ASD. In addition to that, the suitability of CAI can vary based on the individual variability in individuals with ASD and the severity of their symptoms or other comorbidities.

In the forthcoming subchapters, the following will be explained: specifics of Finnish reading acquisition in children with ASD, specifics within computer-assisted reading interventions and its usability assessment, difficulties in students with ASD, and the usage of eye-movement tracking in a usability setting. These areas are essential for understanding the results and the discussion of this study.

1.1 Reading acquisition of Finnish language in children with ASD

Reading acquisition is a process that requires mastering different aspects of spoken and written language. Phonics as an essential part of reading is defined as "various approaches designed to teach children about the orthographic code of the language and the relationships of spelling patterns to sound patterns" (Bowey, 2005; Castles & Coltheart, 2004; Stahl, 1992; Stahl, Duffy-Hester, & Stahl, 1998). The development of learning phonics might vary according to the features of concrete language and its orthography (Aro et al., 1999; Ronimus et al., 2019). The Finnish language belongs to transparent orthographies, and therefore, mastering Finnish reading mostly depends on understanding the grapheme-phoneme correspondence of the spoken and written form of letters in the alphabet (Lyytinen, Semrud-Clikeman, Li, Pugh, & Richardson, 2021; Ronimus et al., 2019).

Despite the transparency of the Finnish language, some children might still struggle with literacy acquisition, such as those with ASD (Kuparinen, 2014; Raemae, Pirttimaa, Ojala, Pesonen, & Kontu, 2019). Children with ASD vary in their profiles, and hence studies are reporting both reading struggles and successes (Dynia, Brock, Logan, Justice, & Kaderavek 2016; Macdonald, Luk, & Quintin, 2020). Research suggests that children with ASD can acquire functional reading skills (Dynia, et al., 2016) and can achieve alphabet and lower-print knowledge equal to their typically developing (TD) peers (Dynia et al., 2016; Lanter, Freeman, & Dove, 2012; Macdonald et al., 2020). Dynia, Lawton, Logan

and Justice, (2014) even suggested that children with ASD can acquire better knowledge in letter recognition than typically developing (TD) peers. This early reading ability might be explained by comorbidity commonly associated with ASD, referred to as "hyperlexia" (Cardoso-Martins & Silva, 2010; Silberberg & Silberberg, 1967). Hyperlexia is described by Silberberg and Silberberg (1967) as an intellectual functioning on the spectrum from typical to intellectual impairment with word recognition skills higher than an individual's verbal skills and reading comprehension. Individuals often described as hyperlexia have adequate reading decoding skills but poor listening comprehension (Zhang & Joshi, 2019).

On the other hand, children with ASD, often suffering from additional comorbidities such as severe speech limitations, might not always succeed in literacy acquisition (Benedek-Wood, McNaughton, & Light, 2015). Foley and Wolter (2010) report that 90% of people with severe speech problems (including individuals with ASD) will probably not achieve functional reading skills.

Despite the differences in individuals with ASD, researchers concluded that for those who want to succeed in literacy acquisition, an intensified emphasis on high-quality reading instructions is required (Dynia et al., 2016; Shanahan & Lonigan, 2010). Additionally, in children with ASD, clear phonics instructions embedded within an intervention support the development of phonics skills despite children's IQ scores (Whalon, Otaiba, & Delano, 2008).

Recent studies suggest both weaker (Kimhi, Achtarzad, & Tubul-Lavy, 2018; Knight, Blacher, & Eisenhower 2019) and adequate (Westerveld et al., 2017) phonological awareness skills in children with ASD. It has been discussed whether these opposite results depend on the task complexity and its measurement (Westerveld et al., 2017; Zhang and Joshi, 2019).

1.2 Computer-assisted reading interventions

As successful literacy acquisition plays a vital role in our daily lives and is essential for academic progress and learning, the increased importance of

reading skills has urged researchers to develop and test new technology-assisted reading interventions (Jamshidifarsani et al., 2019; Yakkundi, Dillenburger, Goodman, & Dounavi, 2017). The technology-assisted interventions, such as computer programs, can include learning phonics and high-quality reading instructions essential to literacy acquisition in children with ASD (Lowery, 2017; Ness, Couperus & Willey, 2013; Valencia, Rusu, Quiñones, & Jamet, 2019).

Computer-assisted interventions (CAI) have been proven to be suitable for children with ASD, mainly due to the embedded visual representation of instructions (Ramdoss et al., 2011; Yakkundi et al., 2017). In addition to that, children with ASD struggling with social interactions might benefit from CAI due to the limited complexities of communication between them and their instructor (Pennington, 2010; Ramdoss et al., 2011). Overall, CAI creates an environment that successfully promotes learning in children with ASD (Valencia et al., 2019).

However, it seems that amongst existing applications developed for children with ASD, many have no research background to show their effectiveness in the specific group of users (Adaptive Online Reading Program for Kids, n.d.; Autism Read & Write, n.d.). Henceforth, the focus will be on existing computer-assisted reading interventions with research to support their benefits within their target groups of children (e.g., poor readers, readers at risk). Several interventions were analysed to find standard components and visible commonalities to provide an overall idea of the content and usage of phonics-focused CAI (Table 1).

All the assessed CAIs included gamification as the main component. This type of learning seems to be more engaging to children than the traditional ways of learning (Furió, González-Gancedo, Juan, Seguí, & Rando 2014; Furió, Juan, Seguí, & Vivó, R. 2013). Gamification uses game-like elements to promote engagement and learning with positive outcomes and changes in behaviours (Kapp, 2012). Learning and engagement are also enhanced by providing optimal challenge levels for its players (Jabbar & Felicia, 2015). That can be done by

adjusting the content to an individual's skills and needs, primarily present in all chosen CAIs (Ronimus et al., 2019).

According to Finn and Zimmer (2012), affection in intervention engagement can provide motivational involvement in activities essential to those who might struggle during traditional learning (Ronimus et al., 2019). Preventing negative feelings connected to learning is crucial, especially in those who have lower levels of engagement, such as is common in children with ASD (Dearden, Emerson, Lewis, & Papp, 2016; Kemp, Kishida, Carter, & Sweller, 2013). Learning and positive emotional engagement can be achieved via playful forms of corrective feedback given during the game that has been present in most of the chosen CAIs (Cornillie, Clarebout, & Desmet, 2012).

All three categories common within the CAIs mentioned above are also an essential part of the Ekapeli computer-based reading intervention.

TABLE 1 The computer-based reading interventions comparison

CIAs	Gamification	Corrective feedback	Automatic difficulty adjustement
Lexia Core 5[1]	Yes	Yes	Yes
ABRACADABRA[2]	Yes	Yes	No
Chassymo[3]	Yes	Yes	Not available
On Track ABC[4]	Yes	Yes	No (by teacher)
Headsprouts[5]	Yes	Yes	Yes
Nessy[6]	Yes	Yes	Yes
Ekapeli[7]	Yes	Yes	Yes

Note. Macaruso, Wilkes, Franzén, & Schechter, 2019[1]; Arciuli and Bailey, 2019[2]; Ecalle et al., 2013[3]; Lundetræ, Solheim, Schwippert, & Uppstad, 2017[4]; Plavnick et al., 2016[5]; Brittish Dyslexia Association, 2020[6]; Lyytinen et al., 2015[7]; Richardson & Lyytinen, 2014[7].

Overall, general studies focused on CAIs usage in children with ASD, conducted in recent years, conclude that using CAIs provides an improvement in several skills, including literacy acquisition, and more specifically, phonics

skills (Arciuli & Bailey, 2019; Khowaja, Al-Thani, & Salim, 2018; O'Brien, Tiernan, & Holloway, 2017; Valencia et al., 2019; Wojciechowski & Al-Musawi, 2016; Yakkundi et al., 2017).

However, to assess a CAI in-depth and thoroughly, there is a need for assessment criteria. Kuittinen (1998) has developed such criteria for evaluation of the CAI applications. These criteria state four perspectives to a CAI application: domain-dependent demands, instructional demands, user-interface demands, and pragmatic demands. For this study, domain-dependent needs and instructional demands will be explained below. The domain-dependant demands are all necessary factors that explain how the specific topic of the intervention is studied (in this case, reading acquisition). The instructional demands are then the motivation for using the intervention, interaction and feedback, repetition, and practice. In addition to that, the learning outcomes are essential to evaluate whether the intervention is suitable to the target group of participants. Lastly, with different types of learning, there are various abilities and skills needed for an individual to use the chosen CAI.

1.3 Factors related to learning abilities in students with ASD and eye-gaze tracking

Children with ASD experience difficulties in various areas within the learning process. There is not the only issue with social behaviour, repetitiveness, and communication, as stated in the definition of ASD. Additionally, these students often suffer from impairments in on-task behaviour, motivation, energy levels, visual attention, and length in reaction to a stimulus in children with ASD. These mentioned difficulties in individuals with ASD are just a scope of the overall picture. However, these terms are relevant for this specific study and the understanding of its results.

On-task behaviour have been strongly linked to successful learning in general and particular education settings (Lee & Shute, 2010; Sinatra, Heddy, & Lombardi, 2015). According to the existing studies, children with ASD might show difficulties in on-task behaviour due to their deficits in various areas

including verbal and non-verbal communication, emotion regulations, on-task focus, and not filtering irrelevant information (Mazefsky et al., 2013; Schatz, Peterson, & Bellini, 2016; Sparapani, Morgan, Reinhardt, et al., 2016). According to Sparapani et al. (2016), "*students with ASD spent less than half of the observed time productively and independently participating in classroom activities*" (p. 791). This result is supported by Nicholson et al. (2010), stating that students with ASD spent limited time exhibiting on-task behaviour (31 — 48%). This time limitation within the on-task behaviour might be also possibly connected with decreased reward-related motivational behaviour in students with ASD, poorer motivational functioning (effective making of decisions and reinforcement learning flexibility), and neural responses to rewarding in social and non-social situations (Bottini, 2018; Clements et al., 2018; Finn & Zimmer, 2012; Yeung & Chan, 2020).

Moreover, on-task behaviour is affected by low energy levels and difficulties in attention well known in individuals with ASD (Banire, Al-Thani, Qaraqe, Khowaja, & Mansoor, 2020). In addition, on-task attention is a significant predictor of learning skills development and future academic performance in individuals with ASD (Patten & Watson, 2011; Silva, Da Fonseca, Esteves, & Deruelle, 2015; Tick et al., 2016).

The ability to stay on-task and motivated with efficient energy levels in children with ASD are also affected by the commonly associated sleeping issues. The sleeping difficulties have an exacerbating impact on the main and related symptoms of ASD and are highly reported (44 — 83%) amongst parents of younger children with ASD (Krakowiak, Goodlin-Jones, Hertz-Picciotto, Croen, & Hansen, 2008; Malow et al., 2011). In addition to that, the study of Verhoeff et al. (2018) shows that children with ASD have, compared to their peers, increased sleeping problems at later ages (measured at 1.5, 3, 6, and 8 years of age). The sleeping issues in children with ASD have also been linked to worsening of problematic behaviours occurring in the daytime, such as attention deficit hyperactivity disorder (ADHD) or repetitive behaviours (Goldman et al., 2011).

In a recent study, Banire et al. (2020) conclude that children with ASD pay significantly lower attention to target stimuli than their TD peers, and state that eye-gaze measurement could become a suitable method for identifying attention impairment in children with ASD. In addition to that, Riby and Doherty (2009) suggest that the eye-gaze fixations of children with ASD on target stimuli are less precise and show different patterns than in the TD peers. In the same study, the children with ASD in the study of Riby and Doherty (2009) took longer time significantly in completing certain parts of the given task and in fixating on target stimuli. Additionally, in the review of Drysdale, Moore, Furlonger, and Anderson (2017), the noticed that atypical eye gaze appeared in situations including dynamic movement. This was however studied in older population and hence the reasoning behing an atypical eye movements in children with ASD may vary. Moreover, Ploog (2010) concluded that individuals with ASD tent to become distracted by extranious objects and movement or dynamics.

As mentioned above, eye-tracking methods are a standard tool used to measure attention to visual stimuli (Fujioka et al., 2016). Eye movements tracking has become a popular tool in recent years in a variety of fields and studies. There are different types of hardware used for eye tracking, such as screen-based eye trackers, eye-tracking glasses, and eye-tracking VR headsets. These are provided by various companies, such as the most well-known Tobii, EyeLink, and SMI. It is important to note that each of the hardware is equipped with plusses and minuses in its functioning, and its choice should be based on the research task (iMotions, 2015).

The gaze direction of the eye movement measurements is predicted based on a calibration process that takes place before every eye tracking session. During the calibration process, the individual is instructed to look at several target points that are later associated with the position of the pupil centre and the centre of corneal reflections (Nyström, Hooge, & Andersson, 2016). Eye gaze fixation is then defined by focusing an individual's eye gaze on a specific area (Pantanowitz Kim, Chewins, Tollman, & Rubin, 2020).

Eye-tracking has been widely used in usability testing of products such as games. This type of testing is an essential technique for obtaining feedback on how users work with chosen product (Bergstrom & Schall, 2014). Users' performance can be measured based on accuracy and efficiency to provide the most effective, efficient, and satisfying user experience (International Organisation for Standardization, 2018; Bergstrom & Schall, 2014). Furthermore, the eye-tracking data can determine whether the design of a particular product is suitable for a specific group of users or not (International Organisation for Standardization, 2018).

To conclude, there are many underlining connections between the symptoms and commorbities of ASD explaning the scope of difficulties in on-task behaviour visible in children with ASD (Trembath & Vivanti, 2013). Amongst others, the attention difficulties occurring in individuals with ASD show significant connection to the lower rate of on-task behaviour (Banire et al., 2020; Goldman et al., 2011). To understand the attention within the ASD, the visual attention patterns and fixations in children with ASD have been successfully measured by eye-movement tracking devices across the existing research (Banire et al., 2020; Drysdale et al., 2017; Ploog, 2010; Riby & Doherty, 2009). This method shows promising results and provides better understanding of the problematics in the visual attention of children with ASD (Banire et al., 2020).

2 RESEARCH QUESTIONS

There is an evidence that children significantly benefit from various forms of reading CAIs, including Ekapeli (Lyytinen et al., 2021; Ramdoss et al., 2011; Valencia et al, 2019). However, this study's main goal is to extend the usage of Ekapeli reading intervention and to study its suitability in children with ASD. There is relatively little research done on applicability of CAIs within the preschoolers with ASD (Arciuli & Bailey, 2019). This is the main reasoning behing the topic and the main goal of this study. Additionally, the goal is for the data to contribute to the previous research on the Ekapeli (GraphoLearn) method, explore a possible usage of this intervention amongst children with ASD, and encourage future research of this topic.

Research questions were as follows:

1. How much progress is made in letter-sound correspondence by the participating students with ASD throughout the computer-based intervention Ekapeli Maahanmuuttaja?

2. To what extent are the students with ASD able to focus on the Ekapeli Maahanmuuttaja computer-based reading intervention?

3. To what extent are the students with ASD satisfied with the Ekapeli Maahanmuuttaja game experience?

4. To what extent are eye gaze accuracy fixations corresponding to the screen's stimuli whilst playing the Ekapeli Maahanmuuttaja computer-based reading intervention?

3 METHODOLOGY

3.1 Research design

The school and participants for this single-subject experimental pilot study were gained via contacting schools and kindergartens in a municipality in central Finland. The criteria for choosing the participating institution were the following: the school/kindergarten had a minimum of four students with ASD; the students with ASD were 5-6 years old.

The chosen school was the only one that decided to participate and fit the criteria simultaneously. Additionally, the students were members of the same classroom and had the same teacher, which was a positive factor for carrying out the study.

Research permission, consent forms and privacy notice material based on the GDPR rules were obtained and created before the study. The consent and privacy notice forms were distributed amongst the parents and were returned before the initial data collection started in February 2019 (see the APPENDIX 3, 7-11).

The study was carried out based on the guidelines of the Ethics Committee of the University of Jyväskylä (www.jyu.fi). The collected data was handled concerning the GDPR rules stated in the privacy notice and was stored on a locked USB disk. In addition to that, all materials and data were safely deleted upon finishing this study.

The nature of the study was intensive similar to ones that were used in the previous studies or various versions of Ekapeli (Carvalhais, Limpo, Richardson, & Castro, 2020; Li et al., 2020; Lyytinen et al., 2021). The only difference between most of the existing studies on Ekapeli (GraphoLearn) was the shorter length than the previous study designs. The choice of the intervention length was due to the complexity of the methods used in this study, specifically related to the eye gaze stimuli accuracy measurements. All the participating preschoolers played Ekapeli Maahanmuuttaja for approximately five minutes a day over eight days

when the first day was removed from the data analysis due to technical difficulties. There were altogether two weeks allocated for this intervention when the first four sessions took place during the first week and the other four during the second week of the intervention.

3.2 Participants

This study aims to bring more knowledge to the usability and suitability of Ekapeli as a computer-based intervention in the chosen group of children with ASD. Ekapeli has not been studied yet in children with ASD despite its positive effects on children with dyslexia or other special needs (Nakeva von Mentzer, Kalnak, & Jennische, 2020; Nakeva von Mentzer et al., 2013; Richardson & Lyytinen, 2014). In addition to that, the lack of research on computer-based interventions concerning children with ASD was another reason to choose this specific group of participants (further referred to as students).

All students are Finnish native speakers and members of the same school and preschool class, where they receive additional support from special education teacher and teacher assistants. Therefore, there are different developmental abilities in chosen student despite the same diagnosis.

The development abilities are assessed via a questionnaire created for this study based on the developmental milestones of typically developing students aged 5-6 (Dosman, Andrews, & Goulden, 2012; Kid Sense, 2017). Based on the data collected via the questionnaires, charts are created to represent the differences between the four participating students visually. The visual representation shows the level of problems in a specific category within the students' developmental abilities. Hence the higher the score, the bigger the issue in the targeted area of developmental abilities (Figures 1. — 4.). See APPENDIX 4 and 5 for more information about the measurement protocol.

In addition to the upcoming measurements, there is narrative information from the teacher's point of view available for this study. This information serves to clarify results in the LCI-T (see APPENDIX 1).

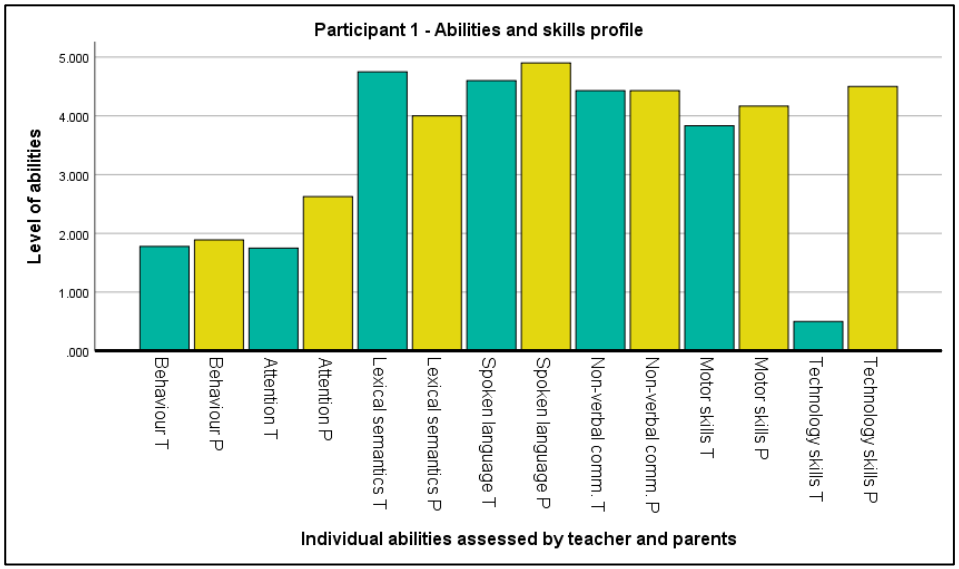

Figure 1 – Student 1 Developmental abilities

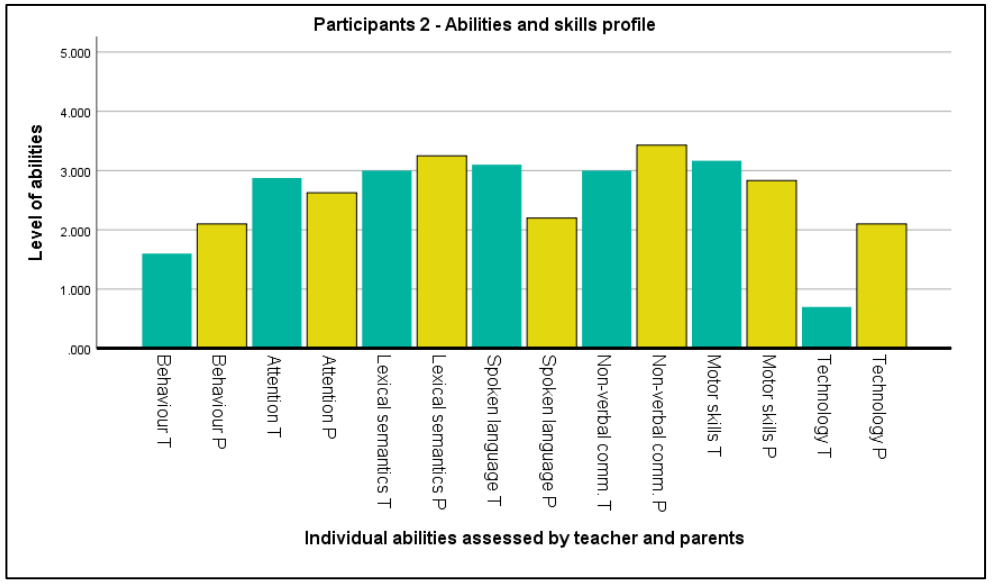

Figure 2 – Student 2 Developmental abilities

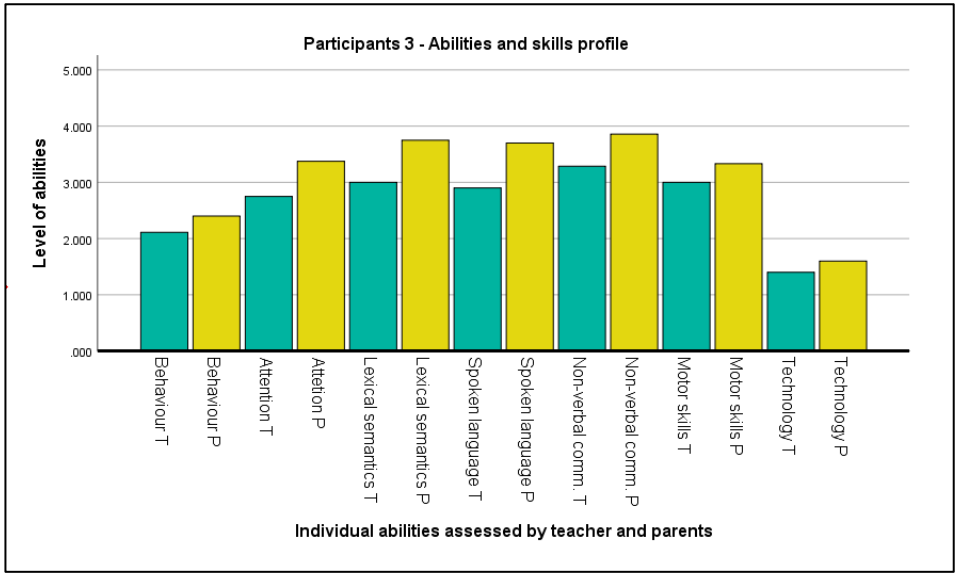

Figure 3 – Student 3 Developmental abilities

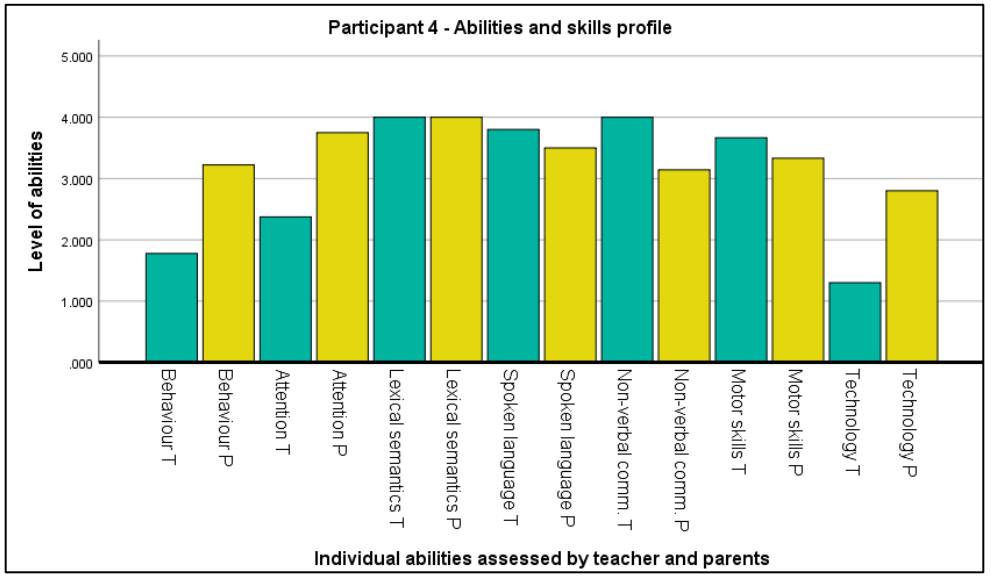

Figure 4 – Student 4 Developmental abilities

3.3 Procedure

All sessions were done during regular school days when students were pulled out of their classes individually. A small room at the school was used for the intervention where tables and chairs were set up before the sessions. The order of the students within the days was based on their teacher's situational assessment to adjust to the individual needs of the participating students. The researcher was present in the room during all play sessions and was accompanied by a teacher assistant during the first day of the data collection.

3.4 Ekapeli Maahanmuuttaja

Ekapeli Maahanmuuttaja is a specific version of Ekapeli that was chosen for this study. This version was selected due to its simplicity before meeting any of the students. Furthermore, choosing this specific version was to prevent any overwhelming content from popping up during the playing time. This was due to the initial goal of the study to analyse whether the essential game elements are not distracting to students with ASD. Hence, Ekapeli can be used within this population group.

Ekapeli Maahanmuutaja requires setting a profile including the student's name and a picture chosen from the bank of images available in the Ekapeli itself. Then, each player starts the game with a simple letter-sound correspondence assessment of all letters in the Finnish alphabet. From this moment onwards, the player progresses through the game with own pace based on the embedded algorithms that establish whether the individual is ready to learn a new stimulus. This individual adaptation of the intervention is a build-in feature that should sustain the player's motivation and prevent disengagement due to too easy or too hard exercises.

There are three types of playing sessions available: level game, training, and other games. The level game has a minimum of two and a maximum of six stimuli

available on the screen. Each level game might include different renewed stimuli choices based on an individual's correct and incorrect answers. The training session looks the same as the game level part of Ekapeli; however, they are significantly shorter, and their function is to adjust the algorithm of the game. Finally, additional games are available as rewards to the players and appear only after a certain number of coins are collected during the game levels. These coins can also be spent on buying a virtual sticker placed on a separate sheet within the game. All the previously mentioned levels do not have a fixed time per session, and they last as long as the individual takes to get through all the exposed stimuli.

3.5 Measurements

Developmental abilities

All students in the study were assessed on their developmental abilities by their guardians and classroom teacher via questionnaires mentioned in the previous section. These questionnaires were distributed to both guardians and the teacher before the in-game assessment took place. The first two questions were open questions that served mainly for the identification purpose of the child, and the rest of the questions were closed questions with five options, each based on a Likert scale (1 — 5). The questionnaires for both the teacher (T) and the guardians (G) were identical in their questions. The questionnaire's inter-rater reliability was somewhat realiabile (see more in the APPENDIX 1).

In-game log data

All the participating students played Ekapeli Maahanmuuttaja and hence participated in the in-game assessment within the intervention. The **progress** through the game, as described previously, is recorded in the game log in the cloud. For this study, data including the **number or stimuli** in each session and the correct and incorrect choices within the sessions were used to analyse the students' progress. In addition to that, the **length of** individual **sessions** and the

type of stimuli (specific letter, syllable, or word) were also recorded for this study to clarify the students' progress.

All the data mentioned above gets automatically recorded into the cloud by the Ekapeli software and was accessible through a log-in on the Lukimat website based on permission given by the Ekapeli creators. However, the data was retained manually, and the only change in the data was done by creating averages of the daily sessions to portrait daily intervention playing progress.

Learning capacity index

All students were daily assessed by their teacher on their learning capacity index (LCI-T): energy levels, behaviour, and attention. This measurement was always done compared to their individual norm in these areas known by their classroom teacher. The teacher was asked to choose from five categories in each area distributed on the Likert scale: 1 — normal, 3 — lower/worse, and 5 —low/bad (see APPENDIX 6).

In addition to that, all students participated in a self-assessment that took place after every individual day of the data collection. The self-assessment consisted of three emojis printed out on a paper indicating positive, neutral, and negative feedback on how the session went (LCI-S).

On- and Off-task behaviour

The on-task behaviour was based on definitions such as (a) eyes on task and (b) completing a task based on the given instructions that were essential for the study (Keen & Pennell, 2014.; Ulke-Kurkcuoglu & Kircaali-Iftar, 2010).

Off-task behaviours were based on the analysis defined for this study as (a) looking away from the intervention screen; (b) playing with the equipment and surrounding; (c) did not want to engage in the intervention task; (d) discussing with the researcher; (e) waiting on purpose for the stimuli to fall to the bottom of the screen; (f) technical issues; (g) random clicking on the screen in the middle of the intervention.

All students were recorded on two cameras (front and rear) during each of the days of the intervention. These recordings were used to measure on-task and off-task behaviour during the intervention sessions. Thus, both on- and off-task behaviour times were taken from each session, starting with the first stimuli appearance and ending with the last stimuli mouse click. Moreover, all breaks and loading screens between the sessions were not accounted for and excluded during the study's analysing phase.

There was no reliability test of the on-task and off-task values since there was no possibility to hire another researcher to re-check the results. Hence, the accuracy of these values is based on the author's perception.

Intervention reaction times

The intervention reaction time is for this study defined as the interval between hearing a sound representing the stimuli and clicking on the visual stimuli on the screen. This was measured in all students for every specific stimulus in the game using the same data collection method as the previous section.

Eye gaze accuracy in a fixation on stimuli

All students were part of the eye movement tracking done by SMI eye-tracking software (iViewX, SMI Experiment centre, and BeGaze), and SMI-RED hardware attached to the bottom of the laptop screen. In addition to that, there was chin support available to prevent the head of participants from moving too much and making it harder for the software to detect the eye gaze. All students had to participate in the calibration of the SMI sensors before every recording. Unfortunately, the whole group had issues with a multiple point calibration, and the number of calibrating points had to be changed to one or zero after the first session.

The main focus of this data collection was to gather eye gaze accuracy data in the fixation on target stimuli, meaning whether the participants looked precisely at the stimuli that they clicked on with the computer mouse. This was achieved by

recording everything happening on the screen while recording the eye movements fixations.

3.6 Data analysis

Firstly, the data measuring developmental abilities via the profiling questionnaires were analysed and used to create graphs visualising the data. As a result, four graphs were created that represent each student's developmental abilities with both teacher and guardians' values.

Secondly, the in-game log data was retrieved from its log cloud. This data included the length of the type and length of the individual sessions, the number of wrong and correct answers in each session, and the same stimuli (letters, syllables, or words) included in each specific session of the intervention. The daily percentage of success was created by calculating the mean of all intervention sessions' progress in one day. This type of data was then used to create a graph representing the percentual progress in each intervention day. In addition to that, this data was combined with LCI-T data. Moreover, the Ekapeli data, including the list of stimuli per each session, were used to create a table illustrating the letter-sound progress in the intervention and specifying the overall improvement in each student.

The upcoming step was to analyse the on- and off-task data, the intervention reaction times, and the eye gaze movements results. The on-task behaviour and off-task behaviour, the types of behaviours during the off-task time, and the intervention reaction times were analysed in ELAN software (www.archive.mpi.nl/tla/elan). This software has been primarily used in language research, but it served well for this study. Each of the analysed categories had its column, in which specific situations and their lengths were marked.

A grid was created on the top of the individual eye movement videos in Adobe Premiere. This grid (6 rows, ten columns) was marked for better identification by a number (1 — 6) when number 1 was the first row on the top

of the screen. Furthermore, the columns were marked by letters of the alphabet (A — J) when A was the first column on the left side of the screen. This grid was used to manually analyse each eye movement video when each eye movement paths of each letter task were marked into ELAN (e.g. H3, J45, C4)[1].

The eye movement paths data and the mouse clicks were used for creating eye gaze heat maps by a code written in TypeScript using Visual Studio Code. Each cell of the grid consists of a number (how many times the eye gaze appears in this area) and a percentage of the overall number of eye gazes. In addition to that, the stronger the colour is shown in each cell, the higher amount of eye gaze is represented. There were tables created for each participant, one showing the target stimuli on the screen (mouse click) and the second showing the eye movement fixations before and when clicking on the stimuli.

[1] In case the specific eye gaze was on the border of two squares, the identification of both squares was used to identify the precise spot. Then J45 was placed in the column J on the border between rows 4 and 5.

4 RESULTS

4.1 Ekapeli Maahanmuuttaja progress in students with ASD

The table below describes general information about the individual progress within the Ekapeli Maahanmuuttaja intervention. There are visible differences between each student related to the categories of on-task and off-task behaviour, average reaction to a stimulus, the number of stimuli, overall success rate, and overall achieved score.

Student 3 spent the most time (28:54 min) by playing the Ekapeli Maahanmuuttaja computer-based intervention when achieving the best percentage in progress (78%) amongst all participants. This student also progressed the fastest through the game by encountering 23 various stimuli (see the APPENDIX 2) and landed an overall score (stimuli x success) of 17.94. The best overall score was achieved despite the difficulties in LCI-T visible in the last two sessions (Figure 5) caused by a change in the student's environment (teacher leaving earlier to see a doctor). This change affected the behaviour and influenced the student's energy levels and attention during the last day of the intervention. As visible in Figures 9, 10, 11, and 12, the success in the knowledge of the letter-sound correspondence within the sessions was fluctuating. The initial progress is not necessarily visible in this figure despite its existence.

TABLE 2 Overall Ekapeli Maahanmuutaja intervention progress

ID	Overall time (min:sec)	Number of stimuli	Overall Success rate	Overall Score (stimuli x success)	On-task behaviour (min:sec)	Off-task behaviour (min:sec)	Average reaction to a stimulus (sec)
1	26:17	6	55%	3.30	22:25	3:52	3.44
2	22:30	10	70%	7.00	17:39	4:51	3.38
3	29:34	23	78%	17.94	23:31	6:03	1.81
4	24:57	21	69%	14.49	16:40	8:17	3.20

The second most successful student (4) spent less time (24:57 min) on the intervention than student 1 (25:37 min) and 3 (28:54 min) but achieved the second-highest score of 14.49 due to the speed of progress through the intervention. Moreover, this student advanced through 21 stimuli, the second-highest amount after student 3 (23) and achieved 69% in the overall success category. There is less fluctuation visible in the success within individual sessions in comparison to student 1. However, there is a visible drop in the success rate in the last two days of the intervention connected to the attention difficulties within the LCI-T. The lower attention ability was not related to any visible specific situation in the previous case.

Student 2 spent the least time (21:9 min) on the intervention and achieved less than half of the overall score (7.00) in the final results compared to student 3 (17.94) and 4 (14.49). That is related to the slow progress through the game when encountering only ten stimuli despite the high success rate of 70%. This student also showed differences in the capacity learning index in the first two days of the intervention. The energy levels were lower during the first day, and the attention was affected during the second day. These changes might have been connected to difficulties in sleeping mentioned by the teacher.

Lastly, student 1 spent the second most time (25:37 min) by playing Ekapeli Maahanmuuttaja, however, achieved the overall the lowest score (3.30), the lowest the success rate (70%), and encountered the least number of stimuli (6) compared to the rest of the peers. The number of stimuli, in this case, shows that this student was not able to pass through the initial criteria for progress in the game (80%) and hence has not encountered any other stimuli during the playing time. However, this child did not show any differences in their daily capacity learning index than the norm assessed by their teacher. The most visible progress is observable in the intervention sessions' visual representations (Figure 9) despite the lowest overall progress score.

The ontask and off-task behaviour lengths are stated in the results purely as a summative index for the sessions' progress. This data cannot be compared

since it is specific to the students and their abilities and does not reflect the level of progress in the game.

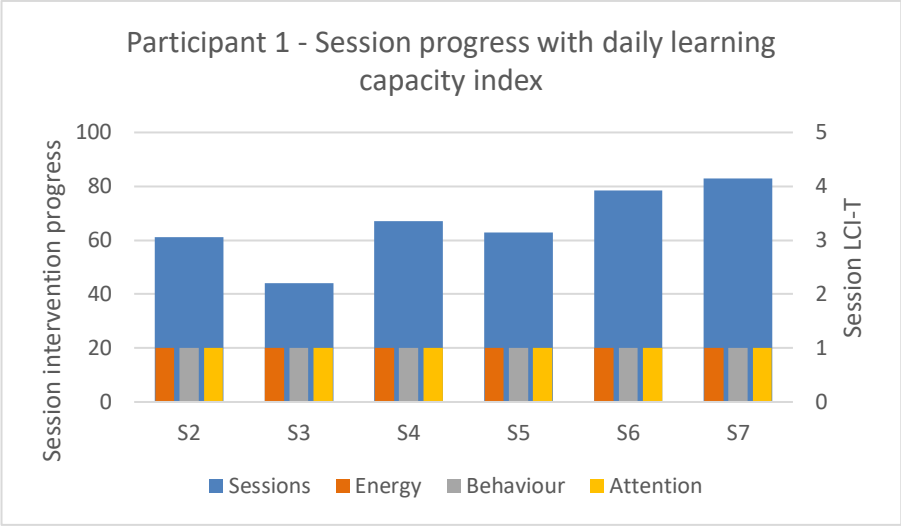

Figure 5 – Student 1 Daily intervention progress and LCI-T

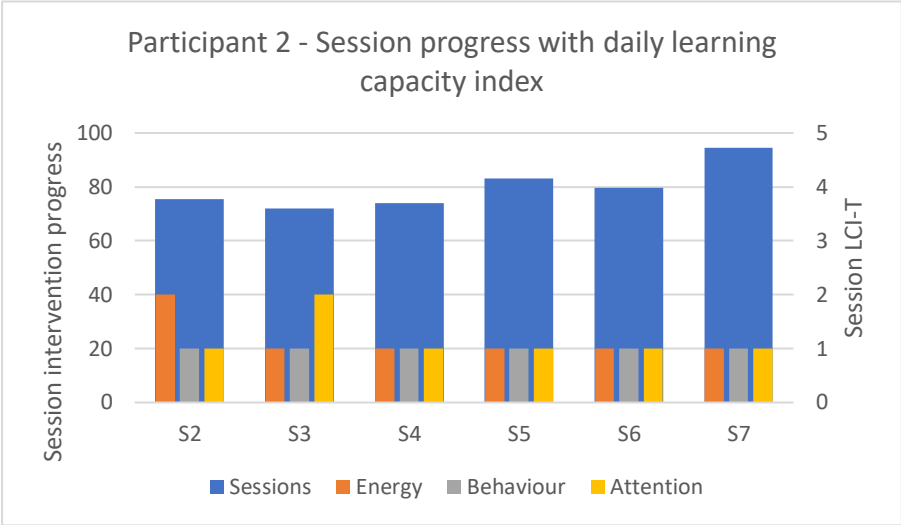

Figure 6 – Student 2 Daily intervention progress and LCI-T

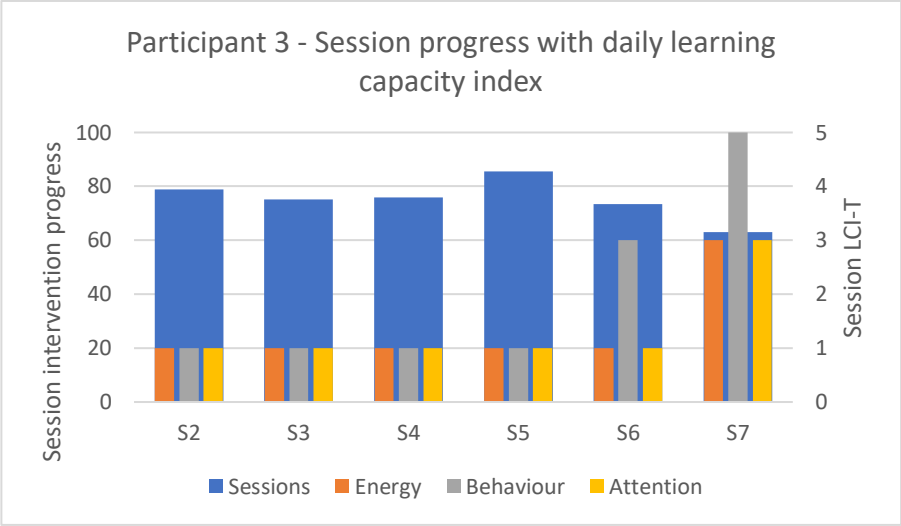

Figure 7 – Student 3 Daily intervention progress and LCI-T

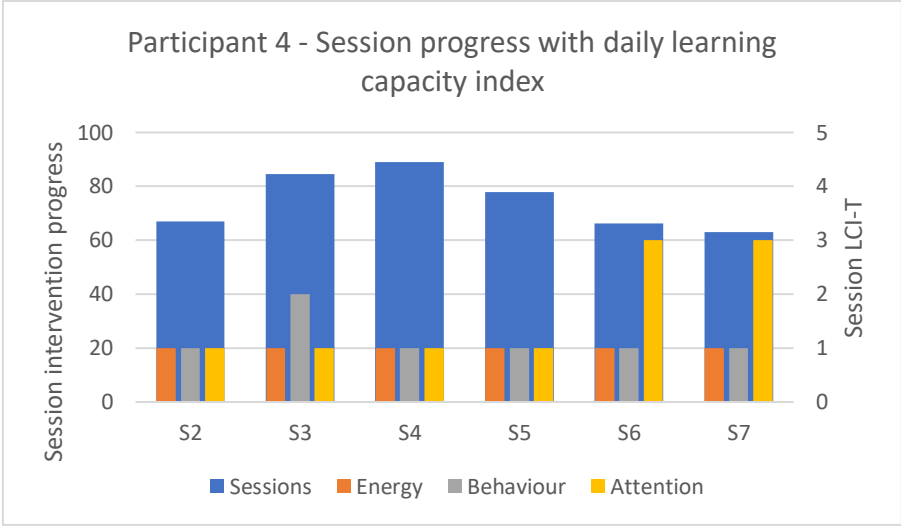

Figure 8 – Student 4 Daily intervetion progress and LCI-T

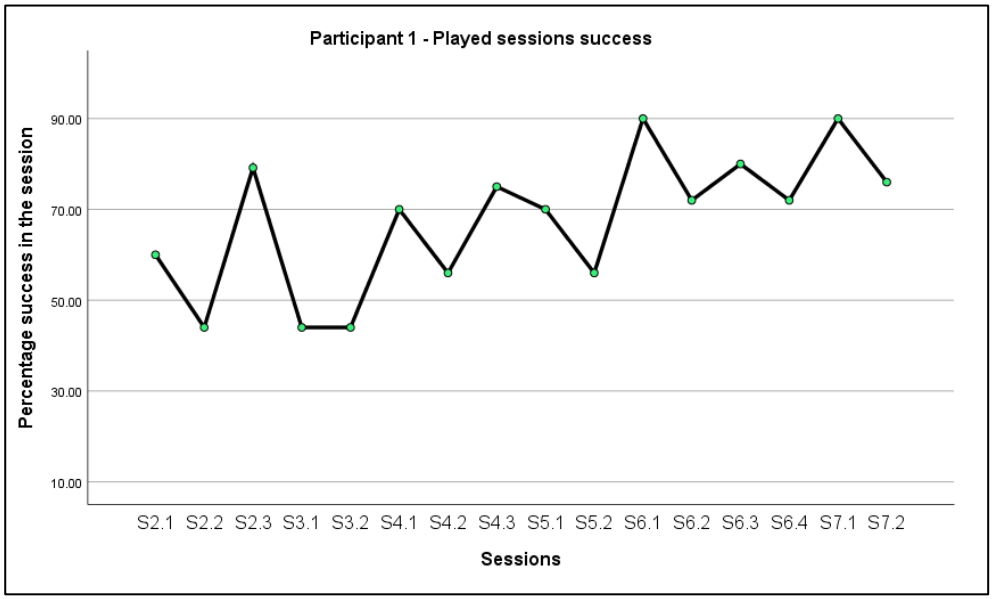

Figure 9 – Student 1 Played sessions success

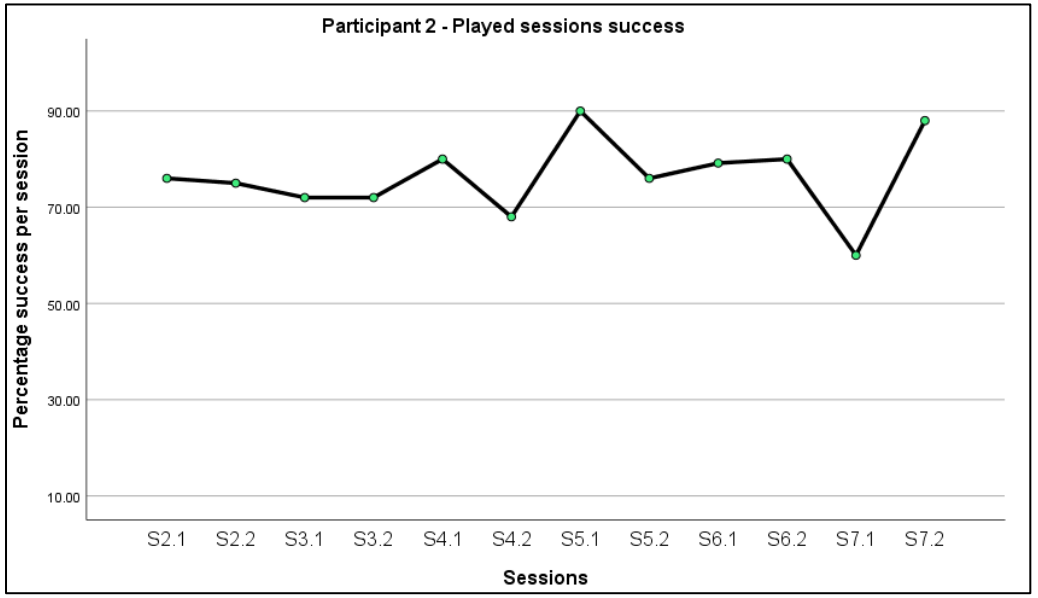

Figure 10 – Student 2 Played sessions success

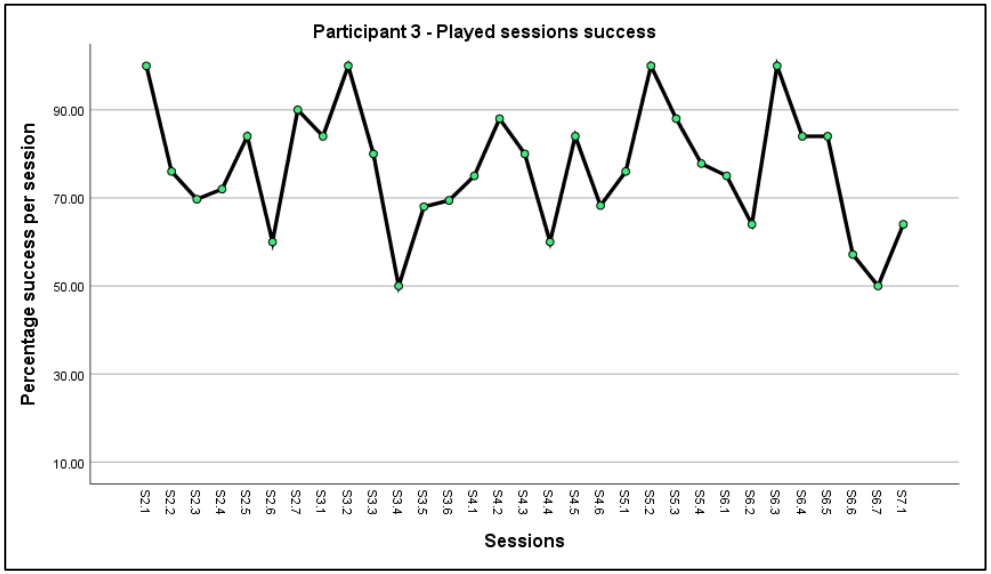

Figure 11 – Student 3 Played sessions success

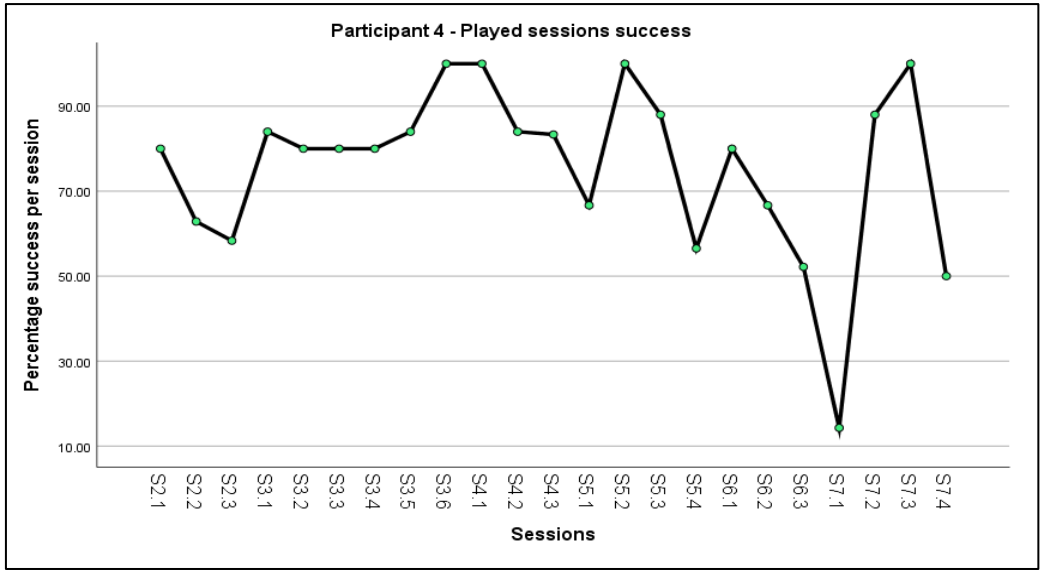

Figure 12 – Student 4 played sessions success

4.2 The focus of students with ASD on the Ekapeli sessions

Student 3 spent the longest time (22:91 min) playing the Ekapeli Maahanmuuttaja whilst being focused on the task and spent 5.63 min (19,73 %) of the overall time (28.54 min) by exhibiting off-task behaviour. This student also had the fastest average intervention reaction (1.81 sec) to the stimuli, almost two times faster than this student's classmates.

The following student with the most progress in the intervention was participant 4. This individual spent 16.40 mins focusing on-task and 8.17 mins (33.25 %) by displaying off-task behaviour. In addition to that, this student showed a remarkably slower average intervention reaction to the stimuli (3.20 sec) compared to the most productive participant 1 (1.81 sec).

Student 2 focused on 17:39 min, which is longer than student 4 (16:40 min) but shorter than student 3 (22:91 min). On the other hand, the time spent on the off-task behaviour was equal to 4.51 min (20.59 %), comparatively shorter than the previous student 4 (8:17 min). Nevertheless, the average intervention reaction time to the stimulus (3.38 sec) was very similar to the previously compared student 4 (3.20 sec).

Lastly, student 1 exhibited on-task behaviour for 21:85 min, which was very close to student 3 and spent the least time on off-task behaviour (3:52 min, 13.87 %) than the rest of the students. Despite the seemingly focused behaviour of this child, this individual spent the longest time during the average intervention reaction to the stimuli (3.44 sec), which might change the perception of the focusing abilities of this student.

4.3 Students' satisfaction with the game experience

The students were mostly satisfied with their game experience, as visible in Figure 13. There were only two times when students stated that they did not enjoy the specific session. This happened on the fourth day of the intervention in

student 2 who stated that he was not satisfied with the session. This student played only two sessions within that day, and there is a visible dip in the success straight on the second session of the day (Figure 10).

Second dissatisfaction with the game is visible in student 4 that reported not enjoying the last day of the intervention. This player was exhausted and bored of the game at the end of the intervention and spent a long time that day aimlessly clicking on the screen, which reflected upon this student's satisfaction. There is a rise in the success between sessions 1 and 2 of the last day of the intervention and a fall in the success between sessions 3 and 4 (Figure 12).

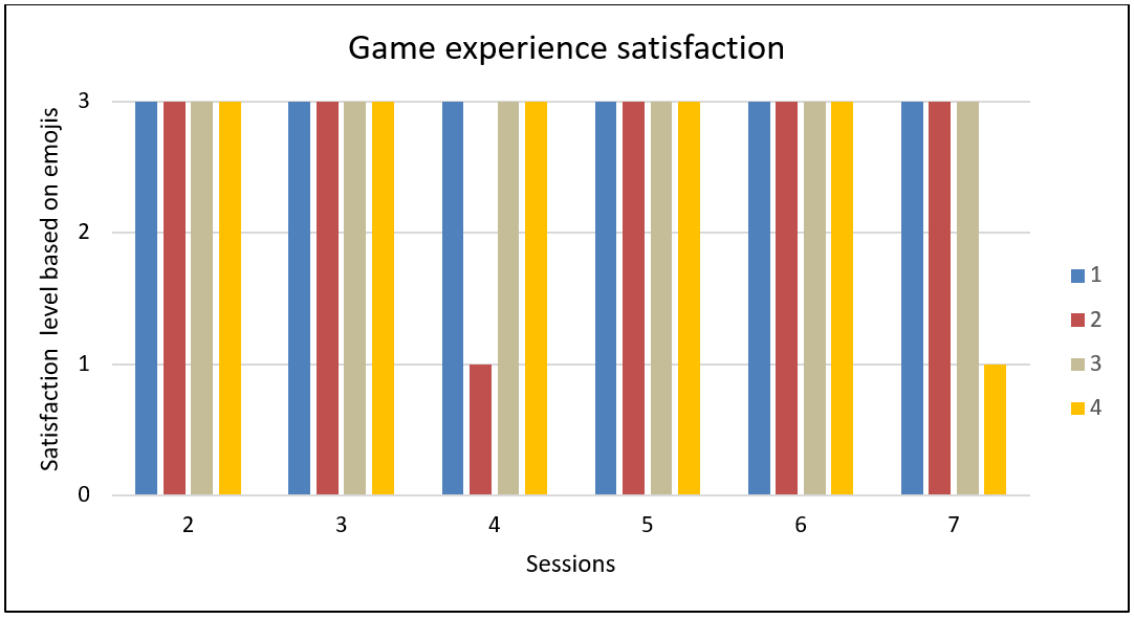

Figure 13 – Game experience satisfaction

4.4 The on-screen eye gaze fixation accuracy in students with ASD

There were differences in all students when it came to eye gaze accuracy fixations and the target stimuli. However, it seems that there was no distraction on the screen that would be targeting the attention of the students participating in this study.

The appearance of the target stimuli in the sessions played by student 1 was on the most on the areas F3, E3, and F4 of the screen grid. In comparison, the eye

gaze fixations of student 1 appeared the most in the regions G4 and G5 that are located to the bottom right from the initial targets.

In student 2, the target stimuli mainly appeared in F3 and F4 as it was in the previous student. However, most of this student's eye gaze fixations were focused on the area H4 that is placed even more further away to the right than in the previous student.

The target stimuli in games played by student 3 appeared the most on the areas F3 and F4 that corresponds with the previously mentioned students. However, the eye gaze fixations were more spread around the grid, appearing primarily in F2, G5, F5 and F3. This means that the student's reactions to the stimuli varied more than in the previous students in reacting quicker or slower to the falling bubbles (stimuli) over the time of the intervention.

Lastly, student 4 viewed the target stimuli mainly around F2 and E2, which again underlines the fast reactions to the falling bubbles (stimuli). This student showed the closest accurate eye gaze fixations amongst all students when focusing primarily on the areas G2 and F2.

TABLE 4 Student 1 - Stimuli on-screen target

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.22%	1 0.22%	2 0.44%	1 0.22%	0 0.00%
2	0 0.00%	4 0.88%	5 1.10%	1 0.22%	18 3.96%	14 3.08%	12 2.64%	13 2.86%	5 1.10%	0 0.00%
3	0 0.00%	21 4.62%	29 6.37%	10 2.20%	39 8.57%	47 10.33%	22 4.84%	31 6.81%	16 3.52%	0 0.00%
4	0 0.00%	16 3.52%	22 4.84%	8 1.76%	30 6.59%	37 8.13%	12 2.64%	22 4.84%	13 2.86%	0 0.00%
5	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.22%	0 0.00%	1 0.22%	1 0.22%	0 0.00%
6	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%

TABLE 5 Student 1 - Eye gaze accuracy fixations

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	3 0.15%	1 0.05%	0 0.00%	1 0.05%	1 0.05%	0 0.00%	1 0.05%	1 0.05%	1 0.05%
2	1 0.05%	10 0.49%	3 0.15%	12 0.59%	15 0.74%	30 1.48%	45 2.21%	33 1.62%	26 1.28%	9 0.44%
3	3 0.15%	4 0.20%	8 0.39%	29 1.43%	26 1.28%	65 3.20%	81 3.99%	69 3.40%	64 3.15%	32 1.57%
4	0 0.00%	4 0.20%	24 1.18%	59 2.90%	68 3.35%	111 5.46%	167 8.22%	137 6.74%	86 4.23%	52 2.56%
5	1 0.05%	6 0.30%	15 0.74%	34 1.67%	57 2.81%	122 6.00%	176 8.66%	121 5.95%	90 4.43%	56 2.76%
6	0 0.00%	1 0.05%	4 0.20%	9 0.44%	5 0.25%	15 0.74%	18 0.89%	6 0.30%	10 0.49%	4 0.20%

TABLE 6 Student 2 - Stimuli on-screen target

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.42%	0 0.00%	2 0.84%	2 0.84%	0 0.00%
2	0 0.00%	0 0.00%	1 0.42%	1 0.42%	0 0.00%	1 0.42%	0 0.00%	2 0.84%	2 0.84%	0 0.00%
3	0 0.00%	6 2.51%	20 8.37%	14 5.86%	19 7.95%	27 11.30%	8 3.35%	13 5.44%	8 3.35%	0 0.00%
4	0 0.00%	6 2.51%	19 7.95%	13 5.44%	19 7.95%	27 11.30%	8 3.35%	12 5.02%	7 2.93%	0 0.00%
5	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	1 0.42%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
6	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%

TABLE 7 Student 2 - Eye gaze accuracy fixations

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	1 0.08%	1 0.08%	0 0.00%	0 0.00%	1 0.08%	4 0.32%	2 0.16%	0 0.00%	0 0.00%
2	0 0.00%	1 0.08%	2 0.16%	1 0.08%	2 0.16%	4 0.32%	4 0.32%	9 0.73%	3 0.24%	1 0.08%
3	0 0.00%	3 0.24%	0 0.00%	5 0.40%	8 0.65%	13 1.05%	25 2.02%	31 2.50%	13 1.05%	15 1.21%
4	0 0.00%	0 0.00%	1 0.08%	25 2.02%	64 5.17%	85 6.86%	114 9.20%	144 11.62%	111 8.96%	67 5.41%
5	0 0.00%	2 0.16%	4 0.32%	10 0.81%	36 2.91%	54 4.36%	97 7.83%	115 9.28%	67 5.41%	31 2.50%
6	2 0.16%	0 0.00%	0 0.00%	1 0.08%	5 0.40%	9 0.73%	18 1.45%	14 1.13%	10 0.81%	4 0.32%

TABLE 8 Student 3 - Stimuli on-screen target

	A	B	C	D	E	F	G	H	I	J
1	**0** 0.00%	**3** 0.34%	**12** 1.36%	**12** 1.36%	**59** 6.67%	**43** 4.86%	**6** 0.68%	**3** 0.34%	**1** 0.11%	**0** 0.00%
2	**0** 0.00%	**12** 1.36%	**28** 3.16%	**21** 2.37%	**77** 8.70%	**64** 7.23%	**11** 1.24%	**17** 1.92%	**11** 1.24%	**0** 0.00%
3	**0** 0.00%	**9** 1.02%	**22** 2.49%	**21** 2.37%	**80** 9.04%	**97** 10.96%	**10** 1.13%	**17** 1.92%	**9** 1.02%	**0** 0.00%
4	**0** 0.00%	**6** 0.68%	**14** 1.58%	**16** 1.81%	**85** 9.60%	**94** 10.62%	**8** 0.90%	**9** 1.02%	**3** 0.34%	**0** 0.00%
5	**0** 0.00%	**1** 0.11%	**1** 0.11%	**1** 0.11%	**0** 0.00%	**0** 0.00%	**1** 0.11%	**1** 0.11%	**0** 0.00%	**0** 0.00%
6	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%	**0** 0.00%

TABLE 9 Student 3 - Eye gaze accuracy fixations

	A	B	C	D	E	F	G	H	I	J
1	**0** 0.00%	**3** 0.10%	**5** 0.17%	**26** 0.88%	**119** 4.02%	**88** 2.97%	**11** 0.37%	**7** 0.24%	**0** 0.00%	**2** 0.07%
2	**0** 0.00%	**8** 0.27%	**23** 0.78%	**53** 1.79%	**196** 6.62%	**319** 10.77%	**117** 3.95%	**39** 1.32%	**10** 0.34%	**2** 0.07%
3	**1** 0.03%	**3** 0.10%	**24** 0.81%	**62** 2.09%	**85** 2.87%	**243** 8.21%	**151** 5.10%	**40** 1.35%	**15** 0.51%	**4** 0.14%
4	**0** 0.00%	**0** 0.00%	**4** 0.14%	**17** 0.57%	**31** 1.05%	**64** 2.16%	**60** 2.03%	**28** 0.95%	**13** 0.44%	**8** 0.27%
5	**0** 0.00%	**5** 0.17%	**10** 0.34%	**45** 1.52%	**63** 2.13%	**247** 8.34%	**274** 9.25%	**103** 3.48%	**29** 0.98%	**11** 0.37%
6	**0** 0.00%	**6** 0.20%	**6** 0.20%	**7** 0.24%	**17** 0.57%	**98** 3.31%	**107** 3.61%	**35** 1.18%	**9** 0.30%	**8** 0.27%

TABLE 10 Student 4 - Stimuli on-screen target

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	1 0.38%	4 1.53%	3 1.15%	10 3.82%	17 6.49%	0 0.00%	1 0.38%	1 0.38%	0 0.00%
2	0 0.00%	4 1.53%	12 4.58%	8 3.05%	24 9.16%	29 11.07%	2 0.76%	9 3.44%	8 3.05%	0 0.00%
3	0 0.00%	4 1.53%	10 3.82%	6 2.29%	23 8.78%	23 8.78%	2 0.76%	11 4.20%	10 3.82%	0 0.00%
4	0 0.00%	1 0.38%	3 1.15%	2 0.76%	14 5.34%	15 5.73%	1 0.38%	2 0.76%	2 0.76%	0 0.00%
5	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%
6	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%

TABLE 11 - Student 4 - Eye gaze accuracy fixations

	A	B	C	D	E	F	G	H	I	J
1	0 0.00%	0 0.00%	0 0.00%	3 0.21%	2 0.14%	8 0.56%	6 0.42%	3 0.21%	1 0.07%	0 0.00%
2	1 0.07%	5 0.35%	4 0.28%	30 2.11%	39 2.74%	125 8.77%	129 9.05%	40 2.81%	42 2.95%	12 0.84%
3	0 0.00%	3 0.21%	18 1.26%	32 2.25%	33 2.32%	69 4.84%	89 6.25%	37 2.60%	33 2.32%	19 1.33%
4	0 0.00%	3 0.21%	5 0.35%	36 2.53%	46 3.23%	58 4.07%	60 4.21%	41 2.88%	27 1.89%	15 1.05%
5	0 0.00%	0 0.00%	9 0.63%	27 1.89%	42 2.95%	59 4.14%	60 4.21%	44 3.09%	23 1.61%	9 0.63%
6	1 0.07%	2 0.14%	9 0.63%	2 0.14%	11 0.77%	14 0.98%	21 1.47%	10 0.70%	3 0.21%	5 0.35%

5 DISCUSSION

5.1 Main results and their significance

The study's primary purpose was to test the suitability of the computer-assisted reading intervention Ekapeli Maahanmuutaja for preschool students with ASD and to trial the methodological applicability of chosen measuring instruments and choices developed for this study. The research was approached as a single subject experimental pilot study with multiple methods usage, which were interpreted in a descriptive statistics type of analysis. The results of this study indicate that the chosen reading intervention Ekapeli Maahanmuutaja, might be beneficial for improving phonemic awareness in preschool students with ASD. Furthermore, the study has underlined the connection between the level of severity in ASD and the learning outcomes of the participating individuals. Overall, this experimental pilot study has shown the potential suitability of Ekapeli as a possibly effective intervention in children with ASD and has shown which methodological approaches might be or not be suitable for such a study.

The results of the in-game log data showed possible similarities with other studies on Ekapeli (in English Graphogame) that suggested the potential benefits of Ekapeli intervention in children with poor reading skills, at risk of dyslexia, with Down Syndrome, and hearing impairment using cochlear implants or hearing aids (Nakeva von Mentzer et al., 2020; Nakeva von Mentzer et al., 2013; Richardson & Lyytinen, 2014). Moreover, the eye-gaze fixations recorded for the study showed a difference in each individual regarding the preciseness of the fixation points onto the target stimuli. This, however, might be explained by findings in Drysdale et al. (2017) that proposed abnormal patterns occurred during the eye-gaze in individuals with ASD during dynamic scenes.

The time spent on the on- and off-task behaviours in students with ASD are, according to recent studies, possibly caused by the level of verbal and non-verbal communication, ability to sustain attention, low energy levels, and more (Banire et al., 2020; Nicholson et al. 2010; Silva et al., 2015). In addition to that, Schatz et

al. 2016 and Sparapani et al., 2016 stated that children with ASD tend to spend less than a half of the task time on on-task behaviour. Despite these findings, this study has shown a significantly higher amount of time spent on the on-task behaviour in each student (approximately 86 −67% of the overall time). Moreover, there is no clear conclusion regarding the relationshop between off-task behaviour and difficulties in non-verbal and verbal communication in this research. This is visible in the cases of participant 1 and 4. Participant 1, with the lowest percentage of off-task behaviour, was assessed with the most severe verbal and non-verbal difficulties. On the other hand, participant 4 had the second most severe verbal and non-verbal communication skills with the highest rate of off-task behaviour.

These differences in the duration of the off-task behaviour might be related to each participating students' attention. Additionally, they could be also explained by the attention difficulties in participants 3 and 4. Both of these participants spent around 20% of the overall time on off-task behaviour. When it comes to participant 4, the attention skills in the comprehensive evaluation seemed to be on a better level than in the previously mentioned peers. However, this child experienced difficulties in attention in the last two sessions of the intervention, which is visible in the sessions' progress data. These results are supported by the recent study by Banire et al. (2020), who stated that attention difficulties are a well-known cause of lower ability to focus attention on-task.

In this study, however, the attention was measured with the consideration of the time spent on-task behaviour and the speed of reaction to the stimuli and the preciseness of the eye-gaze of the children with ASD. Three out of four participants in this study showed a similar reaction speed to an on-screen stimulus except for participant 3, who reacted to the stimuli almost double the speed. In addition to that, all the participating students with ASD were assessed to have a similar level of attention difficulties. Despite the literature stating that children with ASD most likely have issues with attention to the target area and are on average slower than their peers with on target area focusing (Banire et al.,

2020; Riby & Doherty, 2009), this study shows that there are visible individual variabilities in the skills and abilities in children with ASD.

The individual variabilities aspect also applies to the relationship between the developmental abilities' profiles created for this study and the personal progress in the intervention. This is the most related to the severity of ASD symptoms in all the participants. It is visible from the results of this study that the student who achieved no progress in the Ekapeli intervention had the most severe symptops assessed by the teacher and the guardians compared to then eers. Additionally, this student was also the only one with no verbal communication skills, and despite the apparently good listening comprehension, there was no learning progress visible from the data. Regardless of the lack of progress in this preschooler, it is important to state that learning is a process and despite no learning exhibited in the intervention results, there was much learning done during the intervention sessions. This child did not know how to click on a mouse before the intervention started and by the end, this student was capable of performing mouse clicks independently. Moreover, this child learned how to turn on and off a camera, and to navigate in this new version of the Ekapeli intervention. And finally, this student together with his peers managed to successfully participate in the intervention and follow all of the instructions that were given to them. All of this is considered learning and some individuals might need a slower pace or even a whole new area of learning if needed.

To conclude, this study has provided more information on the suitability of Ekapeli, specifically the version of Maahanmuutaja, for the preschool students with ASD. This research also showed that the attention to the playing task was more significant than in the previous studies of on-task behaviour in children with ASD. Hence, the intervention seems to be engaging enough for this specific group of preschoolers. In addition to that, this study underlined the variability in children with ASD and the impact of the severity of autism on their learning.

5.2 Limitations and future research

There are a few limitations that should be considered when understanding the results of this study. Firstly, the multiple method design of this study might have prevented the author from looking deeper into specific areas targeted in this research. However, this step was taken to provide an overall picture of the Ekapeli playing experience and provide the most detainable information to the reader and for future research.

Secondly, due to the experimental and piloting character of the study, the length of the Ekapeli intervention was chosen to be shorter than in already existing studies focusing on the Ekapeli intervention and its effectiveness in children at risk from reading difficulties and special needs (Nakeva von Mentzer, Kalnak, & Jennische, 2020; Nakeva von Mentzer et al., 2013; Richardson & Lyytinen, 2014). In addition to that, the sample of the children involved in the study is small and cannot be applied to a whole population. However, both limitations were intentional due to the goal to analyse the suitability of the Ekapeli intervention for this target group.

Moreover, there are some limitation related to the eye-tracking device and its usage that created the most complications during the study process. Firstly, it is necessary to mention that the research was conducted with the help of SMI eye-tracking software and hardware, which were at the point of data collection already at the end of its licence period. That caused the author troubles with the analysis related to the eye-gaze tracking. Hence, since all the data was manually analysed, there is a possibility of invalid results. Nevertheless, the data was checked multiple times to prevent such a situation from happening and were analysed with precision.

The limitations of this study nonetheless advise future research on what should be improved and how the applied features of this research design should or should not be implemented. This applies especially to the methodological design and the data collection process. Future research might focus on deeper understanding of the progress within the Ekapeli intervention with a more

significant sample of participants with ASD. On the other hand, the suitability aspects of the game, such as already mentioned "falling bubbles" and other adjustable features of Ekapeli, should be studied to provide specific guidelines on which features should or should not be adjusted upon the usage in children with ASD.

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APPENDICES

APPENDIX 1

ID	Be1	Be2	Be3	Be4	Be5	Be6	Be7	Be8	Be9	Column average
1	0	0	0	1	0	1	0	0	0	0.22
2	1	0	1	0	0	3	1	1	1	0.89
3	2	0	1	1	0	1	1	2	1	1.00
4	3	0	0	2	2	2	1	1	2	1.44
Row average	1.5	0	0.5	1	0.5	1.75	0.75	1	1	
Category reliability index										0.89

ID	Att1	Att2	Att3	Att4	Att5	Att6	Att7	Att8	Att9	Column average
1	1	1	1	1	1	1	1	1	0	8
2	2	3	1	3	1	1	3	2	1	17
3	0	0	0	1	1	0	1	1	1	5
4	0	1	1	1	4	3	0	1	2	13
Row average	0.75	1.25	0.75	1.5	1.75	1.25	1.25	1.25	1	
Category reliability index										1,19

ID	Wo1	Wo2	Wo3	Wo4	Column average
1	4	2	2	3	2.75
2	2	2	1	2	1.75
3	0	0	0	2	0.50
4	0	0	1	0	0.25
Row average	0.75	1.25	0.75	1.5	
Category reliability index					1,31

ID	La1	La2	La3	La4	La5	La6	La7	La8	La9	La10	Column average
1	1	1	1	1	1	1	1	1	0	1	0.8
2	2	3	1	3	1	1	3	2	1	2	1.5
3	0	0	0	1	1	0	1	1	1	0	0.3

4	0	1	1	1	4	3	0	1	2	1	1
Row average	1.25	1.25	0.25	0.5	1	1	1	0.75	1		
Category reliability index											0,9

ID	Non1	Non2	Non3	Non4	Non5	Non6	Non7	Column average
1	0	0	1	0	1	0	0	0.29
2	2	0	2	2	0	0	0	0.86
3	1	0	1	1	1	1	0	0.71
4	1	2	2	2	1	1	0	1.29
Row average	1	0.5	1.5	1.25	0.75	0.5	0	
Category reliability index								0.79

ID	Mo1	Mo2	Mo3	Mo4	Mo5	Mo6	Column average
1	1	0	1	1	0	0	0.50
2	1	1	1	0	0	0	0.50
3	0	0	1	1	1	0	0.50
4	0	0	0	0	1	0	0.17
Row average	0.5	0.25	0.75	0.5	0.5	0	
Category reliability index							0.42

ID	Te1	Te2	Te3	Te4	Te5	Te6	Te7	Te8	Te9	Te10	Column average
1	4	2	3	5	3	5	4	3	5	5	3.9
2	4	0	0	1	0	0	2	0	2	4	1.3
3	1	0	0	0	0	0	0	0	1	1	0.3
4	2	2	0	4	2	0	1	1	3	2	1.7

Row average	2.75	1	0.75	2.5	1.25	1.25	1.75	1	2.75	
Category reliability index										3.27

APPENDIX 2

Participant 1

S21	**S2.2**	**s2.3**	**s3.1**	**s4.1**	**S4.2**	**s4.3**	**s5.1**	**s5.2**	**s6.1**	**s6.2**	**s6.3**	**s6.4**	**s7.1**	**s7.2**
0:00:31	0:02:20	0:01:28	0:02:34	0:00:27	0:01:59	0:00:24	0:02:01	0:01:30	0:00:24	0:02:22	0:00:23	0:01:40	0:00:23	0:02:18
A	M	I	A	S	S	A	S	L	O	A	S	M	O	A
M	O	A	O	O	A	S	A		S	S	A	A	A	S
S	S	T	S	M	O	O	O		A	O	O	O	M	
	A													

Participant 2

s2.1	**s2.2**	**S3.1**	**S3.2**	**S4.1**	**S4.2**	**S5.1**	**S5.2**	**S6.1**	**S6.2**	**S7.1**	**S7.2**
0:01:48	0:01:46	0:02:47	0:00:41	0:01:50	0:00:34	0:02:03	0:01:24	0:01:48	0:00:54	0:02:13	0:01:41
A	I	M	M	A	M	N	A	N	M	K	N
E	S	N	N	M	N	M	I	O	K	G	L
F	T	R	A	F		A	S	T	N	O	K
O	U	E		R		E	O	M		M	M
S	N	O		T		T	E	N		L	J
R		T		S		R	N	P		N	
M		S		O		O		K		J	
T		R		N		F					
N		A									
		F									

Participant 3 – part 1

S2.1	**s2.2**	**S2.3**	**S2.4**	**S2.5**	**S2.6**	**S2.7**	**s3.1**	**s3.2**	**s3.3**	**s3.4**	**s3.5**	**s3.6**	**s4.1**	**s4.2**	**s4.3**
0:00:48	0:00:21	0:01:04	0:00:15	0:00:45	0:01:24	0:00:34	0:00:11	0:01:14	0:00:30	0:00:15	0:00:45	0:00:57	0:01:19	0:00:19	0:00:44
M	N	G	K	G	N	I	M	M	J	AASI	MO	O	O	ÄÄRI	G

P	K	M	N	N	D	NÄ	O	O	K		B	U	AASI	ÄÄNI	K
R	M	K	M	D	M	U		T	G		K	B	M		T
N	T	R	G	E	G	MO		I	MO		V	M	ÄÄNI		M
O	D	V		P	T			V	AASI		N	N	N		ÄÄRI
K		I		K	I			B	B		T	KI	K		K
G		T		M	S			ÄÄNI	P		O	TE	L		Ä
D		J			O			N			A		J		R
T		N			J			J			Ä		E		A
		O			V			PA			E		L		N
		F			P			KE			M		I		
		P			L			EE							

Participant 3 – part 2

s4.4	**s4.5**	**s4.6**	**s5.1**	**s5.2**	**s5.3**	**s5.4**	**s6.1**	**s6.2**	**s6.3**	**s6.4**	**s6.5**	**s6.6**	**s6.7**	**S7.1**
0:00:15	0:00:34	0:02:03	0:00:34	0:02:03	0:00:59	0:00:21	0:00:34	0:01:43	0:01:08	0:00:13	0:01:07	0:01:51	0:01:30	0:01:14
M	E	U	E	U	M	TRAKTORI	N	ORI	P	ALA	ELI	Y	I	D

G	II	Y	II	Y	N	TUOLI	II	OVI	FI	ILO	U	T	E	RIMA
N	N	IILI	N	IILI	G	TAKKI	E	SI	I		I	D	IL	AASI
P	AASI	H	AASI	H	B	TALO	I	Ö	G		SATU	Ö	B	EE
	M	AASI	B	AASI	ÄÄRI		EE	U	ISO		F	R	D	ALLA
	B		G		ii		M	ILO	E		EU		G	II
	G		P		OSA		B	Y	M		E			B
	P		IILI		M		ISO		A		V			OI
	IILI				H		P		B		IE			G
	I				II		OVI		JE		B			SIMA
					P				ENO		D			A
											AN			ITU
											O			I
											Ö			K

Participant 4 – part 1

s2.1	**s2.2**	**s2.3**	**s3.1**	**s3.2**	**s3.3**	**s3.4**	**s3.5**	**s3.6**	**s4.1**	**s4.2**	**s4.3**	**s5.1**	**s5.2**	**s5.3**
0:02:17	0:01:55	0:02:00	0:01:22	0:01:04	0:00:19									
O	T	U	M	M	M	M	F	E	G	UU-MA	M	M	M	ee
M	P	T	T	N	N	N	M	U	K	UU-SI	G		I	M

T	L	I	A	A	A	A	G	Y	D		K		T	I
A	J	S	N	S	S	S	N	V	V		N		N	D
S	H	O	K	I	I	I	D	Ä	T		I		D	TE
Ö	A	A	L	O	O	O	K		I		J			B
I	I	N		T		T			UU-SI		D			J
P	S			L		L			GO		P			AAMU
L	R			F		F			U-NI		L			P
R	Ö										A			URA
	O										T			SU
														EE

Participant 4 – part 2

s5.4	**s6.1**	**s6.2**	**s6.3**	**s7.1**	**s7.2**	**s7.3**	**s7.4**
ELI	J	F	N	S	N	OKA	B
Ä	P	N	M	R	S	OSA	L
D	I	J	U		M	ORI	D
B	KI	I	K		R		V

U	B		S		K		O
O	M		R		F		R
T	F		V		G		K
ENO	G		P		J		E
E	N		G		I		T
RU	T		J		B		A
	O		A		OMA		N
	V		L		ALA		J
			E				G

APPENDIX 3

[redacted]
Sivistyksen toimiala
Kehittämisyksikkö

Tutkimuslupahakemus

09.01.2019

Anomus varhaiskasvatuksesta, perusopetuksesta tai nuorisopalveluista kerättävien tietoja hankintaan ja käyttöön tutkimuksessa tai selvityksessä

Tutkimuksen nimi	Petra Kucharová
Tutkimuksen toteuttaja, tekijät ja ohjaajat (oppilaitos, tutkimuksen tekijä, ohjaaja, kaikkien yhteystiedot: osoitteet, sähköposti, puhelin)	Petra Kucharová, [redacted] Markku Leskinen (supervisor), markku.leskinen@jyu.fi, 0408053621 University of Jyväskylä, Seminaarinkatu 15, Jyväskylä, 40014
Tutkimuksen tausta, tarkoitus ja ajankohta (Lyhyt selvitys tausta ja tarkoituksesta. Laajempi tutkimussuunnitelma erillisenä liitteenä, graduissa tiivistettynä kahdelle sivulle)	The need for new supportive learning tools for children with Autism Spectrum Disorders (ASD) is increasing with the number of diagnosed children. Ekapeli could be one of such tools and nowadays helps typically developing children and children with dyslexia in improving their reading skills. The purpose of the research is to examine whether could be Ekapeli used in children with ASD to improve their reading skills. In addition to that, this study's purpose is to research what might be the problem behind the potential issues whilst playing Ekapeli by children with ASD. The data collection will take part in February and March 2018, and the research should take less than one year.
Tutkimusaineisto (Kuvaus tarvittavista tiedoista riittävästi yksilöityinä. Selvitys myös, kuinka kauan tutkimusaineistoa käytetään.)	The research will be pursued as a case study and focus on the overall picture of a small number of children with ASD in the first and second grades of the primary school. Video recording, observation notes, questionnaires for parents and teachers, SMI eye movement tracking, game data, screen recordings, and reading fluency tests (words, pseudowords) will be used to create the overall picture and to provide the best possible information for drawing conclusions of the research. These tentative measurements will be used only for the purpose of the research and will be kept for approximately 1 year from the data collection, or until the thesis is finished.
Tutkimusaineiston suojaus, säilyttäminen ja hävittäminen (Miten tutkimusaineisto suojataan, säilytetään ja hävitetään. Selvitys myös, että samaan tutkimukseen lupaa hakeneet eivät välitä salassa pidettäviä tietoja sähköpostilla toisilleen)	The collected anonymised data will be safely stored on the server of the University of Jyväskylä and on encrypted USB flash drive. The data from Ekapeli collected during the playing are stored online on Lukimat.fi and is protected by password and accessed only by the research. After the research is completed and the thesis published, all the research material will be safely deleted from the above-mentioned devices. There will be no confidential information passed via e-mail since all the data collections will be executed at the school and questionnaires will be held in a paper form.
Palaute tuloksista (Miten [redacted] varhaiskasvatukseen, perusopetukseen tai nuorisopalveluihin annetaan tietoa tutkimustuloksista)	The research results will be published as a masters' thesis and will be accessible at the library of the University of Jyväskylä and of course provided if asked for and will as well serve to Ekapeli for a future development of the game.

Sitoumukset (liitettävä hakemukseen)	Sitoudun siihen, että en käytä saamiani tietoja muuhun kuin tutkimustarkoitukseen. En myöskään käytä saamiani tietoja asiakkaan tai hänen läheistensä vahingoksi tai halventamiseksi taikka sellaisten etujen loukkaamiseksi, joiden suojaksi on säädetty salassapitovelvollisuus. En luovuta henkilötietoja sivulliselle. Tietoja käytän vain kohdassa 4 määriteltynä aikana ja suojaan, säilytän ja hävitän tiedot edellä kuvatusti.
Päiväys 09.01.2019	Allekirjoitus Kuhaimel
Tutkimuslupapäätös voidaan postittaa vain yhdelle henkilölle. Jos tutkimuslupaa hakee useampi hakija, lähetetään päätös osoitteeseen (vastaanottajan nimi ja osoite)	
Tutkimuslupa myönnetty [redacted]	Tuija Rasinen PERUSOPETUKSEN PALVELUJOHTAJA Päivi Koivisto, palvelupäällikkö

LISÄTIETOJA:

TUTKIMUKSEN (PRO GRADU) AINEISTON KERUU-PROSESSISTA OPISKELIJA HUOLEHTII ITSE. OPPILAIDEN OSALLISTUMISEEN TARVITAAN HUOLTAJAN LUPA/SUOSTUMUS.

Tuija Rasinen

APPENDIX 4

Questionnaire for guardians

1. Please state your and your child's information

Guardian's name	
Child's name	
Child's age	
Age at the start of the first grade	
School's name	
Grade (first, second,..)	

2. State your child's diagnoses (e.g. Asperger's syndrome, epilepsy, intellectual disability....) CAN BE WRITTEN IN FINNISH

_____

_____

_____

_____

_____

3. To what extend do statements below describe your child:

	Not Descriptive	Somewhat Descriptive	Descriptive	Very Descriptive	Exactly Descriptive
Agressive behaviour towards peers	☐	☐	☐	☐	☐
Agressive behaviour towards family members	☐	☐	☐	☐	☐
Unusual and intensive interests in specific topics (e.g. trains, timetables..)	☐	☐	☐	☐	☐
Repetitive behaviour (e.g. swinging or hand flapping)	☐	☐	☐	☐	☐
Strictly followed daily routines	☐	☐	☐	☐	☐
Causing a scene in case of breaking daily routines	☐	☐	☐	☐	☐
Over-sensitive towards sounds	☐	☐	☐	☐	☐
Over- sensitive towards light	☐	☐	☐	☐	☐
Over-sensitive towards materials	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

4. How much do you agree with these statements about your child:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Can focus on a paper task for 10 minutes without loosing attention	☐	☐	☐	☐	☐
Can focus on a computer task for 10 minutes wihout loosing attention	☐	☐	☐	☐	☐
Has difficulty with sustaining attention during task	☐	☐	☐	☐	☐
Gets easily distracted by surrounding (people talking, bird signing, etc.)	☐	☐	☐	☐	☐
Has difficulty to remain seated (gets up, moves around, etc.)	☐	☐	☐	☐	☐
Has difficulty to wait for his/her turn during group sessions	☐	☐	☐	☐	☐
Often looks like he/she is daydreaming	☐	☐	☐	☐	☐
Lacks energy, seems slow	☐	☐	☐	☐	☐

5. To what extend is your child capable of forming:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Synonyms (words of the same meaning, e.g. pienni = pikku)	☐	☐	☐	☐	☐
Antonyms (words of the opposite meaning, e.g. iso - pieni)	☐	☐	☐	☐	☐
Homonyms (the same word but different meaning, e.g. kurkku = cucumber or throat)	☐	☐	☐	☐	☐
Categories and assign words (e.g. cucumber is vegetable, a chair is furniture)	☐	☐	☐	☐	☐

6. To what extend is your child capable of:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Finding a root of words (e.g. kirjasto, the root is kirja)	☐	☐	☐	☐	☐
Telling a short story	☐	☐	☐	☐	☐
Re-telling a short story (e.g. after reading summarise what was it about)	☐	☐	☐	☐	☐
Naming most objects and items around him/her	☐	☐	☐	☐	☐
Being understood by unfamiliar people	☐	☐	☐	☐	☐
Finding the right words for describing an object/item	☐	☐	☐	☐	☐
Following instructions	☐	☐	☐	☐	☐
Responding to a question without repeating the question	☐	☐	☐	☐	☐
Giving expected answers to questions	☐	☐	☐	☐	☐
Recognising a letter based on its sound (saying "L", writing or pointing at "L")	☐	☐	☐	☐	☐

7. To what extend is your child capable of:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely capable
Imitating other person's facial expression	☐	☐	☐	☐	☐
Using posture to express themselves (sad = eyes looking down, body not straightened)	☐	☐	☐	☐	☐
Using adequate facial expressions (when being sad - a sad face)	☐	☐	☐	☐	☐
Establish eye contact when interacting with other person	☐	☐	☐	☐	☐
Understanding other person's social cues (tone of voice, gesture, facial expression)	☐	☐	☐	☐	☐
Understanding other person's feelings	☐	☐	☐	☐	☐
Verbally explaining emotions when being bored, feeling lonely	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

8. To what extend can your child manage:

	Not at All	Very Little	Somewhat	Quite succesfully	Succesfully
Cut a simple shapes out of paper	☐	☐	☐	☐	☐
Write most letters and numbers correctly	☐	☐	☐	☐	☐
Use a three-fingered grasp on pen	☐	☐	☐	☐	☐
Build Lego or other blocks	☐	☐	☐	☐	☐
Tie shoelaces	☐	☐	☐	☐	☐
Draw a basic picture	☐	☐	☐	☐	☐

9. To what extend is your child capable to:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Control tablet (tap where he/she wants)	☐	☐	☐	☐	☐
Find an application he/she is looking for	☐	☐	☐	☐	☐
Using mouse to control the cursor on the screen	☐	☐	☐	☐	☐
Launch (start) and quit programs	☐	☐	☐	☐	☐
Read normal-size letters on the screen	☐	☐	☐	☐	☐
Use headphones	☐	☐	☐	☐	☐
Turn on/off tablet	☐	☐	☐	☐	☐
Turn on/off computer	☐	☐	☐	☐	☐
Write on the keyboard	☐	☐	☐	☐	☐
Identify space, arrows, escape, delete on the keyboard	☐	☐	☐	☐	☐

APPENDIX 5

Questionnaire for teachers

1. Please state your and your student's information:

Teacher's name	
Student's name	
School's name	

2. State your student's diagnoses (e.g. Asperger's syndrome, epilepsy, intellectual disability....)

_____

_____

_____

_____

_____

3. To what extend do statements below describe your child:

	Not Descriptive	Somewhat Descriptive	Descriptive	Very Descriptive	Exactly Descriptive
Agressive behaviour towards peers	☐	☐	☐	☐	☐
Agressive behaviour towards family members	☐	☐	☐	☐	☐
Unusual and intensive interests in specific topics (e.g. trains, timetables..)	☐	☐	☐	☐	☐
Repetitive behaviour (e.g. swinging or hand flapping)	☐	☐	☐	☐	☐
Strictly followed daily routines	☐	☐	☐	☐	☐
Causing a scene in case of breaking daily routines	☐	☐	☐	☐	☐
Over-sensitive towards sounds	☐	☐	☐	☐	☐
Over- sensitive towards light	☐	☐	☐	☐	☐
Over-sensitive towards materials	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

4. How much do you agree with these statements about your student:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Can focus on a paper task for 10 minutes without loosing attention	☐	☐	☐	☐	☐
Can focus on a computer task for 10 minutes wihout loosing attention	☐	☐	☐	☐	☐
Has difficulty with sustaining attention during task	☐	☐	☐	☐	☐
Gets easily distracted by surrounding (people talking, bird signing, etc.)	☐	☐	☐	☐	☐
Has difficulty to remain seated (gets up, moves around, etc.)	☐	☐	☐	☐	☐
Has difficulty to wait for his/her turn during group sessions	☐	☐	☐	☐	☐
Often looks like he/she is daydreaming	☐	☐	☐	☐	☐
Lacks energy, seems slow	☐	☐	☐	☐	☐

5. To what extend is your student capable of forming:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Synonyms (words of the same meaning, e.g. pienni = pikku)	☐	☐	☐	☐	☐
Antonyms (words of the opposite meaning, e.g. iso - pieni)	☐	☐	☐	☐	☐
Homonyms (the same word but different meaning, e.g. kurkku = cucumber or throat)	☐	☐	☐	☐	☐
Categories and assign words (e.g. cucumber is vegetable, a chair is furniture)	☐	☐	☐	☐	☐

6. To what extend is your student capable of:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Finding a root of words (e.g. kirjasto, the root is kirja)	☐	☐	☐	☐	☐
Telling a short story	☐	☐	☐	☐	☐
Re-telling a short story (e.g. after reading summarise what was it about)	☐	☐	☐	☐	☐
Naming most objects and items around him/her	☐	☐	☐	☐	☐
Being understood by unfamiliar people	☐	☐	☐	☐	☐
Finding the right words for describing an object/item	☐	☐	☐	☐	☐
Following instructions	☐	☐	☐	☐	☐
Responding to a question without repeating the question	☐	☐	☐	☐	☐
Giving expected answers to questions	☐	☐	☐	☐	☐
Recognising a letter based on its sound (saying "L", writing or pointing at "L")	☐	☐	☐	☐	☐

7. To what extend is your student capable of:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely capable
Imitating other person's facial expression	☐	☐	☐	☐	☐
Using posture to express themselves (sad = eyes looking down, body not straightened)	☐	☐	☐	☐	☐
Using adequate facial expressions (when being sad - a sad face)	☐	☐	☐	☐	☐
Establish eye contact when interacting with other person	☐	☐	☐	☐	☐
Understanding other person's social cues (tone of voice, gesture, facial expression)	☐	☐	☐	☐	☐
Understanding other person's feelings	☐	☐	☐	☐	☐
Verbally explaining emotions when being bored, feeling lonely	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

8. To what extend can your student manage:

	Not at All	Very Little	Somewhat	Quite succesfully	Succesfully
Cut a simple shapes out of paper	☐	☐	☐	☐	☐
Write most letters and numbers correctly	☐	☐	☐	☐	☐
Use a three-fingered grasp on pen	☐	☐	☐	☐	☐
Build Lego or other blocks	☐	☐	☐	☐	☐
Tie shoelaces	☐	☐	☐	☐	☐
Draw a basic picture	☐	☐	☐	☐	☐

9. To what extend is your student capable to:

	Not Capable	Somewhat Capable	Capable	Very Capable	Completely Capable
Control tablet (tap where he/she wants)	☐	☐	☐	☐	☐
Find an application he/she is looking for	☐	☐	☐	☐	☐
Using mouse to control the cursor on the screen	☐	☐	☐	☐	☐
Launch (start) and quit programs	☐	☐	☐	☐	☐
Read normal-size letters on the screen	☐	☐	☐	☐	☐
Use headphones	☐	☐	☐	☐	☐
Turn on/off tablet	☐	☐	☐	☐	☐
Turn on/off computer	☐	☐	☐	☐	☐
Write on the keyboard	☐	☐	☐	☐	☐
Identify space, arrows, escape, delete on the keyboard	☐	☐	☐	☐	☐

APPENDIX 6

Daily individual assesment _____

1.

	Normal		Lower/Worse		Low/Bad
Energy level	☐	☐	☐	☐	☐
Behaviour	☐	☐	☐	☐	☐
Attention	☐	☐	☐	☐	☐

2.

	Normal		Lower/Worse		Low/Bad
Energy level	☐	☐	☐	☐	☐
Behaviour	☐	☐	☐	☐	☐
Attention	☐	☐	☐	☐	☐

3.

	Normal		Lower/Worse		Low/Bad
Energy level	☐	☐	☐	☐	☐
Behaviour	☐	☐	☐	☐	☐
Attention	☐	☐	☐	☐	☐

4.

	Normal		Lower/Worse		Low/Bad
Energy level	☐	☐	☐	☐	☐
Behaviour	☐	☐	☐	☐	☐
Attention	☐	☐	☐	☐	☐

APPENDIX 7

UNIVERSITY OF JYVÄSKYLÄ

consent for scientific research

I have been requested to participate in the following study: **Experiencing computer-assisted reading intervention by children with autism spectrum disorders: a case study.**

I have read the privacy notice (information letter) and have received sufficient information on the study and its implementation. The content of the study has also been explained on paper (privacy notice) and verbally if requested. I have received proper answers to all my questions concerning the study. The clarifications were provided by Petra Kucharová. I have had sufficient time to consider participating in the study.
I understand that it is voluntary to participate in the study. I have the right to interrupt my participation or cancel my consent at any time and without explanation during the study. Interruption of participation or cancellation of consent for the study have no negative consequences for me. Data collection procedures are very similar to any other daily activities at school, hence situations when insurance is needed are dealt with at the school level.

I will not participate in measurements when I have a flu or fever, or when I am recovering from an illness or otherwise do not feel well.

By signing the consent document, I accept that my and my child's information is used for the research described in the privacy notice.

☐ Yes

I also agree that my child can participate in the research described in the privacy notice and I accept that the collected data (video recordings, eye movement recordings, game data, and data from fluency reading test) will be used for the research.

☐ Yes

In addition, I accept that personal data collected via questionnaires (answered by you and your child's teacher) concerning my child's medical, psychological, educational and social background will be processed for the research.

☐ Yes

Also, I'm giving a permission to the teacher of my child _____, to fill in questionnaire regarding my child's educational background, behaviour, reading skills, communication and motor skills, interests, routines, eye-contact, attention, and a usage of electronic devices at school.

☐ Yes

With my signature, I confirm my and my child's participation in the study and permit the matters mentioned above.

_____ _____
Signature *Date*

_____
Printed name

_____
State your email address, in case you want to have a pdf copy of the final theses

Consent received by researcher

_____ _____
Signature of the consent recipient *Date*

_____
Printed name

The original signed document remains in the archive of the scientist-in-charge and a copy is given to the research subject. The consent is stored as long as the data is in a format that includes identifiers. If the material is anonymised or discarded, there is no longer need to store the consent.

This consent has two copies, one for the guardians, and one for the researcher.

APPENDIX 8

UNIVERSITY OF JYVÄSKYLÄ

consent for scientific research

I have been requested to participate in the following study: **Experiencing computer-assisted reading intervention by children with autism spectrum disorders: a case study.**

I have read the privacy notice (information letter) and have received sufficient information on the study and its implementation. The content of the study has also been explained on paper (privacy notice) and verbally if requested. I have received proper answers to all my questions concerning the study. The clarifications were provided by Petra Kucharová. I have had sufficient time to consider participating in the study.
I understand that it is voluntary to participate in the study. I have the right to interrupt my participation or cancel my consent at any time and without explanation during the study. Interruption of participation or cancellation of consent for the study have no negative consequences for me. Data collection procedures are very similar to any other daily activities at school, hence situations when insurance is needed are dealt with at the school level.

I will not participate in measurements when I have a flu or fever, or when I am recovering from an illness or otherwise do not feel well.

By signing the consent document, I accept that information provided by me as a teacher are used for the research described in the privacy notice.

☐ Yes

In addition, I accept that personal data collected via questionnaire concerning my teaching bacground and my student's educational background, behaviour, reading skills, communication and motor skills, interests, routines, eye-contact, attention, and a usage of electronic devices at school, will be processed for the research.

☐ Yes

With my signature, I confirm my and my child's participation in the study and permit the matters mentioned above.

_____ _____
Signature Date

_____
Printed name

_____
State your email address, in case you want to have a pdf copy of the final theses

Consent received by researcher

_____ _____
Signature of the consent recipient Date

_____
Printed name

The original signed document remains in the archive of the scientist-in-charge and a copy is given to the research subject. The consent is stored as long as the data is in a format that includes identifiers. If the material is anonymised or discarded, there is no longer need to store the consent.
This consent has two copies, one for the teacher, and one for the researcher.

APPENDIX 9

General Data Protection Regulation (679/2016) articles 12-14, 30

UNIVERSITY OF JYVÄSKYLÄ

PRIVACY NOTICE FOR RESEARCH SUBJECTS' GUARDIANS

Participation in the research is voluntary and the subject's guardian is required to submit data via questionnaire. Participation can be cancelled.

☐ The privacy notice has been submitted directly to the research subject

☐ I have understood the information below and want to participate in the research

_____

Place and date:

_____

Signature:

_____

Printed name:

_____

1. NAME AND DURATION OF THE RESEARCH

The purpose of the research is to examine whether could be Ekapeli (computer-based reading intervention) used in children with ASD to improve their reading skills. In addition to that, this study's purpose is to research what might be the problem behind the potential issues whilst playing Ekapeli by children with ASD. The data collection will take part in January and February 2018, and the research should take less than one year. There will be 7 meeting sessions with each child when each of the 5 sessions will last for 10 minutes, and two remaining sessions will be used for fluency reading skills testing. These meetings will take a part at each individual's school and will be adjusted according to child's timetable.

2. LEGAL BASIS FOR THE PROCESSING OF PERSONAL DATA

EU's General Data Protection Regulation, Article 6, Paragraph 1 (select one reason for each purpose of use):

☒ The consent of the research subject
☐ Compliance with a legal obligation to which the controller is subject to

Regulations:

☐ Task carried out in the public interest/exercise of official authority vested in the controller
☒ Scientific or historical research purposes or statistical purposes
☐ Archiving of research data and cultural heritage data
☐ For the purposes of the legitimate interests pursued by the controller or by a third party

The legitimate interest in question:

EU's General Data Protection Regulation, Articles 6 and 9 (specific categories of personal data):
☒ The research subject's explicit consent
☐ Other justification (e.g. processing for scientific research in the public interest, and the processing relates to personal data which are manifestly made public by the research subject)
☐ Processing relates to personal data which are manifestly made public by the data subject
☐ Archiving purposes in the public interest, scientific or historical research purposes or statistical purposes

3. CONTROLLER, SCIENTIST-IN-CHARGE AND CONTACT PERSON

Scientist in charge of the research: Petra Kucharová, [redacted] Seminaarinkatu 15, 40014. This person is responsible for the implementation of the study and for ensuring that the regulations for processing personal data are followed.

Contact person(s): Petra Kucharová, [redacted], Seminaarinkatu 15, 40014. Research data contact person who, if necessary, answers research subjects' questions on the research.

Implementers of the research. Petra Kucharová, [redacted], Seminaarinkatu 15, 40014. Person, who have the right to process personal data during the research

Recipients of personal data. Petra Kucharová, [redacted] Seminaarinkatu 15, 40014.

Transfer of data outside the EU or EEA and appropriate safeguards. Personal data will not be transferred outside the EU or EEA.

Processors of personal data. University of Jyväskylä, Seminaarinkatu 15, P.O. Box 35, 40014. Switchboard (014) 260 1211, Business ID 0245894-7**.** Data protection officer of the University of Jyväskylä: **tietosuoja@jyu.fi**, tel. 040 805 3297.

4. BACKGROUND AND PURPOSE OF THE RESEARCH

The purpose of this research is to explore to explore how suitable is Ekapeli for children with autism spectrum disorders. In addition, the purpose is to clarify how applicable and to what degree the intervention benefits children with autism spectrum disorders.

Persons at the age of 6 to 8 who have been diagnosed with autism spectrum disorders or other form of autism are requested to participate in the research List possible exclusion criteria: Participation in the research is not possible if the child has no form of autism and is younger or older than early stated age. The research will include around 3 to 5 research subjects.

The personal data used for the research consist of medical, educational, behavioural, psychological and social information collected by questionnaires, eye movement data collected during playing Ekapeli, video recordings of each playing session, and the game data. The format of data is: video recordings,

SPSS/Excel worksheets, notes, log data from the game. The sources of personal data are: research subjects, their guardians and teachers.

5. PRACTICAL IMPLEMENTATION OF THE RESEARCH

It will take about 7 meeting sessions, 7 days in a duration of 4 weeks to participate in the research.

There are a few different research methods used in this research: contact information, questionnaires, fluency reading test, data collected through playing the game, eye movement recording during playing the game, video recordings of each session, and observational notes. All sessions will be adjusted to the personal timetable of each research subject to provide the easiest and least stressful participation.

The research is implemented so that personal cases are randomised right after each session and fully randomised after the last session is over. There will be no names or other personal signs, such as is the name of school mentioned in the published results that could potentially lead to identifying research subject.

The research includes 7 research visits (game playing and fluency reading test), meeting with parents and teachers, and questionnaires filled during own time by parents and teachers of research subjects.

The first session with your child will focus on getting acquainted with the researcher and to perform fluency reading test. Next 5 sessions will be repetitive to its core. Each of these sessions will starts by calibration of the eye movement tracker (SMI), followed by approximately 10 minutes of playing Ekapeli when the last playing task must be always completed before ending the session. In the first and the last playing session the assessment of the letter knowledge will be included in the game. The last seventh session will focus again on performing the fluency reading test.

In case your child will not be able to come to school and participate in agreed session, please contact the researcher through via:
[redacted]

6. POTENTIAL BENEFITS AND DISADVANTAGES TO SUBJECTS

The research produces information on applicability of Ekapeli in children with autism spectrum disorders and on the benefits might or might not come with this intervention.

Hence the eye movement tracking device requires quite stable posture, there might be prolongation caused by not succesfull calibration or not correctly

collected data. In such a case, the session would need to be repeated or in cases such as children with hyperactivity, the data collection methods adjusted.

7. PROTECTION OF PERSONAL DATA

The data collected during the research and the research results are processed confidentially in compliance with the data protection legislation. It will not be possible to identify you from the research results, clarifications or publication.

The following have been considered when designing the research:
☒ The use of the personal data file is based on an appropriate research plan

☒ There is a designated person or a group of persons responsible for the research;

☒ The personal data file is used only for purposes of historical or scientific research and the procedure followed is also otherwise such that

☒ The data pertaining to a given individual are not disclosed to outsiders

☒ After the personal data are no longer required for the research or for the verification of the results achieved, the personal data file is destroyed or transferred into an archive, or the data in it are altered so that the data subjects can no longer be identified;

☒ Pseudonymisation of personal data

☒ Encryption of personal data

☒ Data secured working environments (systems) and services related

Processing of direct identifiers

☒ Direct identifiers are removed in the analysis phase but the code key is retained

In research results and other documents, the only reference to you is an identification code. The identification code key that enables connecting your personal data to the identification code is held securely and will be disposed right after the data analysis.

The research data is stored in accordance with the University of Jyväskylä's data security practices for processing research data.

8. INFORMATION RECEIVED FROM ELSEWHERE

Your child's personal information that is necessary for the research can also be collected from other personal (your child's teacher). In all cases, your data will be processed confidentially.

9. RESEARCH RESULTS

The research will be published as a master's theses at the University of Jyväskylä. The research subject's guardian will have an option to be informed about the study results by stating his/her email address in the consent form. After the master's theses will be completed a pdf version of the document will be send to previously stated email address.

10. RESEARCH COSTS AND FINANCIAL CLARIFICATIONS

Participation in the research will not result in costs to you.

The research is supported by the University of Jyväskylä (provided equipment: video recording equipment and eye movement tracker laptop, fluency reding tests).

11. RIGHTS OF THE RESEARCH SUBJECT AND DEVIATION FROM THEM

The research subject has the right to cancel his/her consent if the processing of personal data is based on consent.

A research subject has the right to lodge a complaint to the office of the Data Protection Ombudsman if the research subject considers that the processing of personal data relating to him/her infringes the valid data protection legislation. (Read more at http://www.tietosuoja.fi).

12. STORAGE AND ARCHIVAL OF PERSONAL DATA

Storage

The register is safely stored on the server of the University of Jyväskylä and on encrypted USB flash drive. The data will be anonymised when stored and after the thesis publication the data will be safely deleted.

13. IMPLEMENTING THE RIGHTS OF DATA SUBJECTS

If you have questions on the rights of data subjects, please contact the master's thesis supervisor Markku Leskinen, email: markku.leskinen@jyu.fi. All requests concerning the implementation of the rights must be submitted to the Registry Office of the University of Jyväskylä. Registry Office and Archive, P.O. Box 35 (C), 40014 University of Jyväskylä, tel. 040 805 3472, email: kirjaamo(at)jyu.fi. Visiting address: Seminaarinkatu 15, Building C (the Main Building), 1st floor, room C 140.

14. INSURANCE COVERAGE OF RESEARCH SUBJECTS

Data collection procedures are very similar to any other daily working activities at school. The researcher or the University of Jyväskylä do not provide insurance coverage to the research subjects.

APPENDIX 10

Tietosuoja-asetus (679/2016) 12-14, 30 artikla

JYVÄSKYLÄN YLIOPISTO

TIETOSUOJAILMOITUS TUTKIMUKSESTA TUTKIMUKSEEN OSALLISTUVALLE

Tutkimukseen osallistuminen on vapaaehtoista, eikä tutkittavan ole pakko toimittaa mitään tietoja, tutkimukseen osallistumisen voi keskeyttää.

☐ Tietosuojailmoitus on toimitettu suoraan tutkittavalle

☐ Olen ymmärtänyt alla olevat tiedot ja haluan osallistua tutkimukseen

_____

Paikka ja aika:

_____

Allekirjoitus:

_____

Nimenselvennys:

_____

1. TUTKIMUKSEN NIMI, LUONNE JA KESTO

Tämän tutkimuksen nimi on ”Tapaustutkimus tietokoneperustaisen intervention soveltuvuudesta autismikirjon häiriön omaavien lasten lukutaidon kehittämiseen.”

Tutkimuksen tarkoituksena on tarkastella, voisiko Ekapeliä (tietokoneperustainen lukutaitointerventio) hyödyntää kehittämään autismikirjon häiriön omaavien lasten lukutaitoa. Tutkimuksen tarkoituksena on myös kartoittaa mahdollisia haasteita, joita autismikirjon häiriön omaavilla lapsilla ilmenee Ekapelin pelaamisen aikana. Aineiston keruu suoritetaan tammi- ja helmikuussa 2018. Tutkimuksen arvioitu kesto on alle yksi vuosi. Jokaisen tutkimukseen osallistuvan lasten kanssa pidetään yhteensä 7 tapaamista. Tapaamisista 5 on kestoltaan 10 minuuttia, kun taas loput kaksi käytetään lukutaidon arviointiin. Tapaamiset sijoittuvat kunkin osallistujan koululle ja mukautetaan lapsen aikatauluun.

2. MIHIN HENKILÖTIETOJEN KÄSITTELY PERUSTUU

EU:n yleinen tietosuoja-asetus, artikla 6, kohta 1 (valitse yksi peruste kuhunkin käyttötarkoitukseen):

☒ rekisteröidyn suostumus

☐ rekisterinpitäjän lakisääteisen velvoitteen noudattaminen
säädökset:

☐ yleistä etua koskeva tehtävä/rekisterinpitäjälle kuuluvan julkisen vallan käyttö
☒ tieteellinen tai historiallinen tutkimus tai tilastointi
☐ tutkimusaineistojen ja kulttuuriperintöaineistojen arkistointi

☐ rekisterinpitäjän tai kolmannen osapuolen oikeutettujen etujen toteuttaminen
mikä oikeutettu etu on kyseessä:

EU:n yleinen tietosuoja-asetus, artiklat 6 ja 9 (erityiset henkilötietoryhmät)
☒rekisteröidyn nimenomainen suostumus
☐ yleisen edun mukainen tieteellinen tai historiallinen tutkimus
☐ yleisen edun mukainen arkistointi

☐ käsittely koskee henkilötietoja, jotka rekisteröity on nimenomaisesti saattanut julkisiksi;

3. TUTKIMUKSESTA VASTAAVAT TAHOT

Tutkimuksen vastuullinen johtaja: Petra Kucharová, [redacted] Seminaarinkatu 15, 40014. Eli henkilö joka on vastuussa tutkimuksen toteuttamisesta ja henkilötietojen käsittelyä koskevien säännösten noudattamisesta.

[Tarvittaessa]Yhteyshenkilö(t): Petra Kucharová, [redacted] Seminaarinkatu 15, 40014. Tutkimusaineiston yhteyshenkilö eli henkilö, joka vastaa tarvittaessa tutkittavan tutkimusta koskeviin kysymyksiin.

Tutkimuksen suorittajat: Petra Kucharová, [redacted] Seminaarinkatu 15, 40014. Tässä kerrotaan ne henkilöt, joilla on tutkimuksen kuluessa oikeus käsitellä henkilötietoja. Vaihtoehtoisesti voidaan todeta, että henkilötietoja käsittelevät ovat sopimussuhteessa yliopistoon (mahdollisesti tarkempi yksikkö ja henkilöiden lukumäärä). Lisätietoja henkilöistä saa tutkimuksen johtajalta.

[Tarvittaessa] Henkilötietojen luovuttaminen: Petra Kucharová, [redacted] Seminaarinkatu 15, 40014. Esim. tietoja voidaan myös luovuttaa (*toiselle tutkijalle, tutkimusyhteistyökumppanille)* alkuperäistä tarkoitusta varten. Siinäkin tapauksessa kaikkia osapuolia sitovat salassapitovelvollisuudet. Tiedot luovutetaan koodattuina (perustele, jos luovutus tapahtuu ilman pseudonymisointia). Luovuttaminen tarkoittaa sitä, että nämä tahot käsittelevät itsenäisesti saamiaan henkilötietoja (henkilötietojen hyödyntäminen niiden omiin tarkoituksiin) esim. tutkimuksen tilaaja, joka vastaanottaa henkilötietoja.

Henkilötietojen siirto ETA:n ulkopuolelle ja asianmukaiset suojatoimet.

Henkilökohtaisia tietoja ei siirretä EU tai EEA –alueen ulkopuolelle.

Henkilötietojen käsittely. Jyväskylän yliopisto, Seminaarinkatu 15, PL 35, 40014. Vaihde (014) 260 1211, Y-tunnus 0245894-7. **Jyväskylän yliopiston tietosuojavastaava:** tietosuoja@jyu.fi**, puh. 040 805 3297.**

4. TUTKIMUKSEN TAUSTA JA TARKOITUS

Tutkimuksen tarkoituksena on selvittää, kuinka sopiva Ekapeli on autismikirjon häiriön omaaville lapsille. Lisäksi tarkoituksena on selventää, miten hyvin interventio soveltuu ja hyödyttää autismikirjon häiriön omaavia lapsia.

Tutkimukseen pyydetään osallistumaan 6-8-vuotiaita henkilöitä, joille on diagnosoitu autismikirjon häiriö tai muu autismin muoto. Tutkimukseen osallistuminen ei ole mahdollista, mikäli lapsella ei ole diagnosoitu mitään autismin muotoa tai mikäli lapsi on nuorempi kuin 6 tai vanhempi kuin 8 vuotta. Tutkimukseen tulee osallistumaan yhteensä noin 3-5 tutkittavaa.

Tutkimusta varten kerättävä aineisto koostuu tutkittavien terveystiedoista, kasvatuksellisesta ja käyttäytymistä koskevasta aineistosta sekä psykologisesta ja sosiaalisesta informaatiosta. Aineiston keruussa tutkimus hyödyntää kyselylomakkeita, silmän liikkeiden rekisteröintiä Ekapelin aikana, pelisessioiden videointeja ja pelituloksia. Kerätty data sisältää videoäänityksiä, SPSS/Excel-tiedostoja, muistiinpanoja ja pelin keräämää lokidataa.

Henkilötietojen lähteet ovat: tutkittavat sekä heidän huoltajansa ja opettajansa.

5. TUTKIMUKSEN TOTEUTTAMINEN KÄYTÄNNÖSSÄ

Tutkimukseen osallistumiseen kuuluu noin 7 tapaamiskertaa, jotka järjestetään 7 eri päivänä 4 viikon ajanjakson sisällä.

Tutkimuksessa käytetään muutamia eri tutkimusmenetelmiä: yhteystietoja, kyselyjä, lukutaitotestejä, pelin keräämää lokidataa, silmän liikkeiden tallentamista pelaamisen aikana, kunkin tapaamisen videointia ja havaintomuistiinpanoja. Kukin tapaaminen mukautetaan osallistujan oman aikataulun mukaan mahdollisimman helpon ja stressittömän osallistumisen mahdollistamiseksi.

Tutkimus toteutetaan siten, että henkilökohtaiset tapaukset satunnaistetaan heti tapaamisten jälkeen ja täysin viimeisen tapaamisen päätyttyä. Nimiä tai muita tunnistamisen mahdollistavia tietoja (kuten osallistujan koulun nimi) ei julkaista tutkimuksen tulosten yhteydessä.

Tutkimus sisältää 7 tutkimustapaamista (pelaamista ja lukutaitotestin suorittamista), vanhempien ja opettajien tapaamisia sekä tutkittavaa koskevia kyselyjä, jotka vanhemmat ja opettajat täyttävät omalla ajallaan.

Ensimmäisen tapaaminen lapsesi kanssa keskittyy tutkijan kanssa tutuksi tulemiseen ja lukutaitotestin suorittamiseen. Seuraavat 5 tapaamista ovat keskenään samanlaisia. Jokainen näistä tapaamisesta alkaa silmän liikkeiden tunnistuslaitteen kalibroimisella. Tätä seuraa noin 10 minuutin Ekapelin pelaaminen siten, että pelaamista jatketaan, kunnes pelin viimeinen tehtävä on suoritettu. Ensimmäisellä ja viimeisellä pelaamiskerralla peliin sisältyy kirjainten tunnistamisen arviointi. Viimeinen tapaaminen keskittyy taas lukutaitotestin suorittamiseen.

Mikäli lapsesi ei pysty tulemaan kouluun tai osallistumaan sovittuun tapaamiseen, otathan yhteyttä tutkijaan sähköpostitse:
[redacted]

6. TUTKIMUKSEN MAHDOLLISET HYÖDYT JA HAITAT TUTKITTAVILLE

Tutkimus tuottaa tietoa Ekapelin soveltuvuudesta autismikirjon häiriön omaaville lapsille ja sen mahdollisesti tuottamista hyödyistä intervention seurauksena.

Koska silmän liikkeiden tunnistuslaite vaatii suhteellisen vakaan asennon, saattaa kalibroimisen tai aineiston keräämisen epäonnistuminen tuottaa pelisession pitkittymistä. Tällaisissa tapauksissa pelisessio joudutaan toistamaan, tai hyperaktiivisten lasten tapauksessa aineistonkeruumenetelmää mukauttamaan.

7. HENKILÖTIETOJEN SUOJAAMINEN

Tutkimuksessa kerättyjä tietoja ja tutkimustuloksia käsitellään luottamuksellisesti tietosuojalainsäädännön edellyttämällä tavalla. Tietojasi ei voida tunnistaa tutkimukseen liittyvistä tutkimustuloksista, selvityksistä tai julkaisuista.

Henkilötietojen suojaamiseksi käytetään seuraavia suojatoimia

☒ tietosuojavastaavan nimittäminen;

☒ rekisterinpitäjän ja käsittelijän sisäiset toimenpiteet, joilla estetään pääsy henkilötietoihin;

☒ henkilötietojen pseudonymisointi;

☒ henkilötietojen salaaminen;

☒ tietoturvalliset henkilötietojen käsittely-ympäristöt;

Suorien tunnistetietojen käsittely

☒ Suorat tunnistetiedot poistetaan analysointivaiheessa, mutta koodiavain säilytetään

Tutkimustuloksissa ja muissa asiakirjoissa sinuun viitataan vain tunnistekoodilla. Tunnistekoodiavainta, joka mahdollistaa henkilötietojenne yhdistämisen tunnistekoodeihin säilytetään tietoturvallisesti, ja se hävitetään (milloin).

Tutkimusaineistoa säilytetään Jyväskylän yliopisto tutkimusaineiston käsittelyä koskevien tietoturvakäytänteiden mukaisesti.

8. SINULTA SUORAAN KERÄTTYJEN HENKILÖTIETOJEN YHDISTÄMINEN MUUALTA SAATUIHIN TIETOIHIN

Lapsesi tutkimuksen kannalta oleellisia henkilötietoja saatetaan kerätä muista lähteistä (lapsesi opettajalta). Tietoja käsitellään luottamuksellisesti kaikissa tapauksissa.

9. TUTKIMUSTULOKSET

Tutkimus julkaistaan pro gradu –tutkielmana Jyväskylän yliopistossa. Tutkittavan huoltajalla on mahdollisuus saada tieto tutkimuksen tuloksista jättämällä sähköpostiosoite lupalomakkeeseen. Pro gradu –tutkielman valmistuttua pdf-versio dokumentista lähetetään edellä mainittuun sähköpostiosoitteeseen.

10. TUTKIMUKSEN KUSTANNUKSET JA TALOUDELLISET SELVITYKSET

Tutkimukseen osallistuminen ei tuota osallistujalle rahallisia kuluja.

Tutkimusta tukee Jyväskylän yliopisto (yliopiston tarjoama laitteisto: videon äänityslaitteisto ja silmän liikkeiden tunnistukseen tarvittava kannettava tietokone, lukutaitotestit).

11. TUTKITTAVAN OIKEUDET JA NIISTÄ POIKKEAMINEN

Tutkittavalla on oikeus peruuttaa antamansa suostumus, mikäli henkilötietojen käsittely perustuu suostumukseen.

Tutkittavalla on oikeus tehdä valitus Tietosuojavaltuutetun toimistoon, mikäli tutkittava katsoo, että häntä koskevien henkilötietojen käsittelyssä on rikottu voimassa olevaa tietosuojalainsäädäntöä. (lue lisää: http://www.tietosuoja.fi).

Rekisteröidyn muista tietosuoja-asetuksen mukaisista oikeuksista ei poiketa tässä tutkimuksessa.

12. HENKILÖTIETOJEN SÄILYTTÄMINEN JA ARKISTOINTI

Henkilötietojen rekisteri säilytetään turvallisesti Jyväskylän yliopiston serverillä ja suojatulla USB–muistitikulla. Aineisto anonymisoidaan sen tallettamisen yhteydessä. Pro gradu –tutkielman julkaisemisen jälkeen aineisto poistetaan turvallisesti.

13. REKISTERÖIDYN OIKEUKSIEN TOTEUTTAMINEN

Jos sinulla on kysyttävää rekisteröidyn oikeuksista voit olla yhteydessä tutkielman ohjaajaan, Markku Leskinen, e-mail: markku.leskinen@jyu.fi. Kaikki oikeuksien toteuttamista koskevat pyynnöt toimitetaan Jyväskylän yliopiston kirjaamoon. Kirjaamo ja arkisto, PL 35 (C), 40014 Jyväskylän yliopisto, puh. 040 805 3472, e-mail: kirjaamo(at)jyu.fi. Käyntiosoite: Seminaarinkatu 15 C-rakennus (Yliopiston päärakennus, 1. krs), huone C 140.

14. TUTKITTAVIEN VAKUUTUSTURVA

Aineistonkeruun menettelytavat ovat hyvin samanlaisia koulun muuhun päivittäiseen työskentelyyn verrattuna. Oppilaiden vakuutussuoja on koulun normaali vakuutussuoja. Tutkija tai Jyväskylän yliopisto ei tarjoa tutkittaville vakuutussuojaa.

APPENDIX 11

TÄMÄ LOMAKE PALAUTETAAN OHJAAJAN ARKISTOITAVAKSI

Ekapeli, LukiMat-hanke
Niilo Mäki Instituutti ja Jyväskylän yliopisto
ekapeli@nmi.fi

Tällä lomakkeella annatte lapsellenne luvan pelata Ekapeliä muualla kuin kotona. Tällä lomakkeella ei voi pyytää peliä kotiin pelattavaksi.

Lomakkeen käsittelyohje:
1. **Ohjaaja toimittaa nämä lomakkeet huoltajalle sähköpostitse tai tulosteena.**
2. **Huoltaja täyttää lupalomakkeen (sivu 2) ja palauttaa sen ohjaajalle (opettaja tai vastaava). Ohjesivu (sivu 1) jää huoltajalle.**
3. **Ohjaaja siirtää lupalomakkeen tiedot Ekapeliin ja arkistoi lupalomakkeen itselleen.**

Lupalomake

☐ **Lapseni pelaa/on pelannut Ekapeliä aiemmin.**

Ohjaaja ja pelaamispaikka: _____

Lapseni saa pelata Ekapeliä ja pelitietoja saa käyttää tutkimukseen. *

☐ Kyllä ☐ Ei

* luvan voi peruuttaa milloin tahansa ilmoittamalla siitä sähköpostitse: ekapeli@nmi.fi

Lapsen nimi: _____

Lapsen syntymäaika (päivä, kuukausi ja vuosi): _____

Lapsen syntymäpaikkakunta: _____

Opettaja saa luovuttaa yhteystietoni Ekapeli-tutkijoille, jotta minulta voidaan kysyä lisätietoja lapsesta Ekapelin kehittämiseen liittyviä tutkimuksia varten.*

☐ Kyllä ☐ Ei

* luvan voi peruuttaa milloin tahansa ilmoittamalla siitä sähköpostitse: ekapeli@nmi.fi. Tietoja ei luovuteta muuhun tarkoitukseen. Voitte myös jättää haluamanne yhteystiedot tyhjäksi.

Huoltajan nimi: _____

Huoltajan sähköpostiosoite: _____

Huoltajan postiosoite: _____

Huoltajan puhelinnumero: _____

Paikka ja päivämäärä: Huoltajan allekirjoitus:

_____ ____/____/20____ _____

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