The Effect of Language Environment on Learning the Letter-sound Correspondence through Graphogame

– Case Stories of Eight Immigrant Children in Finland

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ABSTRACT

This study examined the effect of language environment on how 6 to 8 years old Russian immigrant children living in Finland benefit from a computer-based grapheme-phoneme training game called Graphogame (Ekapeli in Finnish). Several previous studies have shown that understanding the principle of letter-sound correspondence is one of the key elements for learning to read. The utility of Graphogame has been shown in previous studies and a pilot study conducted in 2008 indicated that Russian-speaking immigrant children can benefit from playing the game when learning to read in Finnish.

In this study four boys and four girls played Graphogame for immigrants at school during a period of approximately 3 weeks. The game results were recorded and analyzed in detail, and then compared with the information about the players' language environment. The players' language environment was investigated with the help of a questionnaire completed by the children's parents. The focus of interest was to find out up to what extent the children were exposed to Finnish in their home environment. In addition, the parents were asked to evaluate their children's language skills in speaking, understanding, reading and writing in both Finnish and Russian. At the end of the intervention the teachers were also asked to complete a questionnaire about their estimations of the benefit of the intervention.

The study results indicate that Russian-speaking immigrant children benefit from playing Graphogame, but each child to a different extent. There was no direct connection between the amount of input in Finnish and the game results. However, social immersion was shown to play an important role in acquiring the language of the broader community and catching up with peers in reading acquisition. By contrast, the effect of Russian was clear in the game results. The study revealed that the graphemes having a different counterpart in Russian compared to Finnish were difficult for all the children coming from Russian speaking families, regardless of their language background. Therefore, further research and supplementary training methods would be needed in order to support Russian speaking children in blocking the transfer from Russian when learning to read in Finnish.

Keywords: Russian immigrants in Finland, second language acquisition, bilingualism, reading acquisition, second language literacy acquisition, letter-sound correspondences, phonological awareness, phonological training, *Graphogame*

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TIIVISTELMÄ

Tämä tutkimus tarkasteli kieliympäristön vaikutusta siihen, kuinka Suomessa asuvat 6–8 -vuotiaat venäjänkieliset maahanmuuttajalapset hyötyivät kirjain-äännevastaavuuksia harjoittavan Ekapelin pelaamisesta. Lukuisat aiemmat tutkimukset ovat osoittaneet, että kirjain-äännevastaavuuksien periaatteen oppiminen on yksi lukemaan oppimisen avaintekijöistä. Ekapelin hyödyllisyys on näytetty aiemmissa tutkimuksissa ja vuonna 2008 toteutettu pilottitutkimus osoitti, että myös venäjänkieliset maahanmuuttajalapset voivat hyötyä pelin pelaamisesta opetellessaan lukemaan suomeksi.

Tässä tutkimuksessa neljä poikaa ja neljä tyttöä pelasi koulussaan Ekapelin maahanmuuttajaversiota noin kolmen viikon ajan. Pelitulokset tallennettiin ja niitä tarkasteltiin yksityiskohtaisesti, verraten niitä lopulta pelaajien kieliympäristöön. Pelaajien kieliympäristöä kartoitettiin vanhempien täyttämän kyselylomakkeen avulla. Mielenkiinnon kohteena oli selvittää, kuinka paljon lapset olivat altistuneet suomen kielelle kotiympäristössään. Lisäksi kysyttiin vanhempien arvioita lastensa kielitaidosta suomen ja venäjän kielen puhumisessa, ymmärryksessä, kirjoittamisessa ja lukemisessa. Intervention lopuksi lasten opettajia pyydettiin täyttämään kyselylomake liittyen heidän arvioihinsa intervention hyödyllisyydestä.

Tulokset viittaavat siihen, että venäjänkieliset maahanmuuttajalapset hyötyvät Ekapelin pelaamisesta. Suoraa yhteyttä pelitulosten ja suomen kielelle altistumisen määrän väliltä ei löytynyt. Sosiaalisella kanssakäymisellä näytti olevan kuitenkin tärkeä rooli laajemman yhteisön kielen oppimisessa ja luokkatovereiden saavuttamisessa lukemaan oppimisen suhteen. Sitä vastoin venäjän kielen vaikutus tuli selkeästi näkyviin pelituloksissa. Tutkimus osoitti, että kirjaimet, joilla on erilainen foneeminen vastine venäjän kielellä suomen kieleen verrattuna, olivat vaikeita kaikille venäjänkielisistä perheistä tuleville heidän kielitaustastaan riippumatta. Lisätutkimusta ja uusia harjoitusmenetelmiä tarvittaisiin lasten tukemiseksi venäjän kielen vaikutuksen estämisessä heidän opetellessaan lukemaan suomeksi.

Avainsanat: venäläiset maahanmuuttajat Suomessa, toisen kielen oppiminen, kaksikielisyys, lukemaan oppiminen, toisella kielellä lukemaan oppiminen, kirjain-äännevastaavuudet, fonologinen tietoisuus, fonologinen harjoitus, Ekapeli

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1. INTRODUCTION

With an increasing number of immigrants moving to Finland, education is facing a new challenge of finding ways to support the development of the foundational literacy skills of immigrant children whose first language is other than Finnish. The majority of immigrants in Finland come from Russian speaking areas. There are also a large number of families in which one of the parents is Russian. Children of these families usually go to Finnish schools and they receive additional support in improving their language skills. When it comes to reading acquisition, it is important to take into account that learning to read demands a much greater effort from children lacking capacities in the language in question. Reading acquisition, for one, is a process that requires phonological awareness, letter knowledge, language decoding skills, cognitive skills and linguistic comprehension. Therefore, giving additional support to immigrants in learning to read in Finnish is indispensable.

Graphogame is a computer-based training game that helps learning letter-sound correspondences. Several former studies have shown that *Graphogame* provides support for children who are facing difficulties in acquiring the basic skills of learning to read (Lyytinen et al. 2005, Lyytinen et al. 2007, Lyytinen 2008, Lyytinen et al. 2009, Hintikka et al. 2005). The aim of this study is to examine how Russian immigrant pupils benefit from playing the game and second, how their language environment affects their game results.

1.1. Russian immigrants in Finland

Russian speakers account for the fastest growing immigrant population in Finland: the size of the Russian speaking population has more than doubled during the last decade. While in 1998 there were 24,000 Russian speaking inhabitants, in 2008 the number of Russian speakers was 48,740 (Tilastokeskus, 2008). According to the definition of Finnish National Board of Education, the concept of immigrant includes both the children who were not born in Finland and those whose parents were not born in Finland (Opetushallitus, 2009). Moving to another country or just being raised in a culturally and linguistically different environment can create challenges for developing

children, when they start to go to a public school. Starting school imposes on immigrant pupils a new set of cultural values, behavioural models, social rules, often even a new language. According to the Finnish National Board of Education (Opetushallitus, 2009), the aim of the education is to integrate the immigrant pupils into the Finnish school system while embracing their cultural and linguistic heritage.

1.1.1. Education of immigrant pupils

The proportion of immigrant pupils is increasing in Finland and in urban areas more than half of the pupils may be from an immigrant background. Education aims to provide immigrant pupils with practical skills and theoretical knowledge to enable them to function as equal members of the Finnish society (Opetushallitus, 2009). According to the Finnish Elementary School Law 35, the immigrant children, who live in Finland and whose nationality is other than Finnish have the same right for education as Finnish children (Rekola, 1994). They are usually placed in a grade according to their knowledge and skills (Rekola, 1994). Immigrant pupils may also be placed in a preparing class, in which their acculturation is supported and they acquire aptitudes to follow the teaching in Finnish (Opetushallitus, 2009). This kind of teaching may last from 6 months to a year or more if necessary.

According to the Finnish National Board of Education (Opetushallitus, 2009), immigrant pupils' background, first language, culture, the reason for their immigration and the time they have stayed in Finland should be taken into account when integrating them into the Finnish school system. Immigrant pupils can receive additional tuition of Finnish/Swedish as a second language, if necessary and in addition, they can benefit from supportive teaching in different subjects, possibly even in their first language. It is important that immigrant pupils have the right to study their first language in school. One's identity is greatly based on their first language and it is the first language in which one most frequently operates and based on which one conceptualizes the world. The tuition of immigrants' first language is believed to strengthen their self-esteem and identity and make them aware of their cultural heritage (Rekola, 1994). Tuition of the first language is also seen to be a basis for learning Finnish and the child's other studies as well. Learning Finnish, in the first case, is often a condition to be fully able to function in the Finnish society. According to the Finnish National Board of Education the aim is that immigrants would reach the level of either first or

second language in Finnish (Opetushallitus, 2009). The general objective is that they would be able to participate in tuition in Finnish.

1.1.2. Finnish as a second language

The level in Finnish is the most important factor in terms of the child's school success (Uusitalo, 2007). In the teaching of Finnish as a second language, the main purpose is to provide the child with an adequate knowledge of Finnish in order for them to function and study in Finnish (Rekola, 1994). Some children keep learning Finnish as a second language throughout the elementary school, while others catch up with Finnish children and start learning Finnish as a first language (Rekola, 1994). Finnish as a second language – tuition's purpose lies both in systematically teaching Finnish to immigrants and on supporting the learning of other subjects (Talvitie, 1996). The aim is to teach children the basic construction of Finnish, because the immigrants often have not had the opportunity to start learning it from birth. The teaching focuses on the most consistent grammar and lexicon, which will enhance immigrants' conversational and reading comprehension related skills. The difference between spoken and written language should be made clear to the immigrants but at first it is important to focus on improving the child's spoken language skills (Talvitie, 1996). Acquiring lexicon should be made a daily habit and it should be related to school subjects and to the Finnish cultural knowledge. In elementary school, the emphasis is on supporting the language the child produces themselves (Talvitie, 1996).

1.2. Second language acquisition and bilingualism

It is estimated that more than half of the human population lives in a bilingual or multilingual environment (Hoff 2006; Pearson, 2007). Different bilingual environments produce bilingual children 75% of the time (Pearson, 2007; de Houwer 2007). Bilingual language use can be balanced or one of the languages may dominate over the other one (Hoff, 2006). There are several factors that influence a child's language development, such as the child's personality and language abilities, language status, the language used at home and schooling. A strong predictor of a level achieved in a certain language is the age of exposure to it: The general rule is that the earlier a child

is exposed to a language, the better (Pearson, 2007; Hoff, 2006). The effect of age operates through biological and social factors (Hoff, 2006): there is a critical or sensitive period for language acquisition and all in all young children are more flexible learners, and in addition they are also socially more open to new experiences.

According to Pearson et al. (1997), the number of acquired words correlates with the estimates of language input in the given language. Children learning two languages tend to have smaller vocabularies in each of their languages (Oller & Eilers, 2002). However, according to Oller and Eilers (2002), bilinguals' language knowledge is "distributed" between their two languages according to the situations the languages are used. Bilingual children's total productive vocabulary may be equivalent to that of their monolingual peers (Pearson, 1997), and monolinguals' language proficiency is not superior in comparison with that of bilinguals (Cobo-Lewis et al. 2002). The similarity or the difference between the child's two languages also influences their second language acquisition: The smaller the difference between the first and the second language, the more relevant the prior knowledge is to the learner (Ringbom, 1986).

When it comes to explaining the pace and the quality of children's bilingual language development, there are no specific factors that alone could explain the differences between children's language levels. Earlier studies on bilingual development emphasized the theory of one parent–one language (OPOL), according to which parents could raise their children bilingual having each parent speak a certain language and not mixing languages at all. The theory has since been shown neither to be a necessary nor a sufficient condition of children's bilingual proficiency (de Houwer, 2007; Pearson, 2007). Children's language development is not an automatic, simple process and it requires a favourable environment, a sufficient amount of input and innate human abilities to start with.

1.2.1. Phonological development in early infancy

Due to the nature of phonological development, the earlier an infant is exposed to a language, the easier they will achieve a native level in that language. Infants can hear and distinguish voices prenatally and they start detecting phonetic units in speech from birth. The neurological development of babies happens very rapidly, because new social experiences change the function of their neural system, and new synapses come into being in their brain. Therefore, exposure to a specific language during the first 6 months alters an infant's phonetic perception (Kuhl et al., 1992).

Even at 4 months, babies exposed to two prosodically similar languages (Spanish and Catalan) can tell them apart (Bosch & Sebastián-Galles, 2001). The more the child is exposed to a native language, the more the child's neurological system changes. This leads to the child producing representations for language and developing a language-specific pattern of phonetic perception (Kuhl et al., 1992), which in turn, directs their attention to recognize certain sounds and to categorize them. During the first year, infants' phonemic perception is tuned to distinctions that are relevant in the target language and they continue to be sensitive to different sound patterns through mid infancy (Hoff, 2006; Kuhl et al., 1992; Bosch & Sebastián-Gallés, 2003). Sometimes bilingual babies retain the ability to hear contrasts that monolingual babies lose, but not always (Werker, et al., 2006).

Children exposed to two languages either develop two phonetic categories or they can process both of the languages through a single phonological system (Hoff, 2006; Werker et al., 2006). Using only one phonological system can refer to one language being more dominant than the other (Werker et al., 2006). Werker et al. (2006) compared several studies and concluded that even if bilinguals succeed equally well in some sort of tasks of phonetic perception, there are differences in how well some deeper processing tasks are mastered. According to the studies of Bosch and Sebastián-Gallés (1997), infants in bilingual environments have longer reaction time when recognizing one of their familiar languages. Bosch and Sebastián-Gallés suggest that this is due to the fact that bilinguals use a different processing mechanism compared to monolinguals because they have to deal with two languages instead of one. Studies also report that infants' utterances are based on the phonemic pattern of their environment. For instance, Saaristo-Helin et al. (2006) reported the phonological mean length of utterance being longer for Finnish infants compared to English data and that consonants used were mostly only stops and nasals. These results can be understood by taking into account that Finnish words are generally longer than English words and vowels play a more significant role in words compared to consonants. Kuhl et al. (1992) suggest that native-language focus in phonetic perception can help in explaining, why second language learners may have difficulty in discriminating speech sounds.

1.2.2. Language environment – social aspect of language

All human environments support language acquisition and they do so to a different extent according to the resources available. In order to acquire two languages, children need to be directly exposed to

them (Hoff, 2006; Pearson, 1997) and the input needs to be sufficient: less than 25% is not enough (Hoff, 2006). In order to acquire a language, children need a language model – providing information about speech segmentation – and communicative opportunities (Hoff, 2006). Input plays thus the most important role in children's language development (Pearson, 2007; Hoff, 2006). In addition, the attitudes and language patterns of parents, siblings and peers can add or subtract value to a language, which in turn, can lead to the child either learning the language faster or not wanting to learn the language at all (Pearson, 2007).

According to De Houwer (2007), parental language patterns play a significant role in children's language development. In her study, when there was a minority language spoken in the family, parents succeeded in transmitting the language to their children with the probability between 35.7–96.92% according to the parental input patterns. Supporting factors were that both parents spoke the minority language and that only one parent spoke the majority language. It is thus the minority language that is in risk of not being used. However, when families make an effort in order for their child to learn the minority language, children respond by learning it (Pearson, 2007). A greater amount of input leads to greater proficiency, which leads to more language use.

Peers can affect children's attitudes towards acquiring a certain language. In addition, peers are a unique source of language socialization opportunities and through interaction with other children, immigrants become members of the community. According to Hoff (2006), peer impact has not yet been measured in terms of language acquisition and the research has focused on what kinds of activities occur in children groups. However, it is clear that interacting with peers is highly motivating for children and thus, one could presume that acquiring the language of the broader community would be important for immigrant children. Nevertheless, children's personality also has a strong effect on their way of socialization. Children who are timid can find having to learn a new language in order to communicate with others an insurmountable challenge. As a result, timid bilingual children may be dependent on the language input and instruction provided by their teachers.

1.3. Reading acquisition

1.3.1. Components of reading

Learning to read is a process of connecting a spoken language to its written forms. That process requires several abilities, including cognitive abilities, short-term and long-term memory, linguistic abilities, motor skills, attentiveness and phonological awareness. Understanding the principle of phonological awareness is one of the key elements for learning to read and write. Phonological awareness means that one is able to segment speech into discrete phonemic units and to blend them (Hoover & Gough, 1990). There are several subskills in phonological awareness, including rhyme-detection, phoneme deletion, syllable-deletion and phoneme-identification. According to the study of Aro (2004), out of the phonological subskills, syllable-deletion and phoneme-identification were the strongest predictors of reading acquisition, whereas other abilities developed gradually during the reading instruction. In addition to skills related to phonological decoding, reading acquisition is based on alphabetical mapping. Children have to learn the letter names and the letter sounds (phonemes), which in alphabetical languages (such as Finnish) resemble one another.

According to the simple view of reading (Hoover & Gough, 1990), reading consists of only two important components which are decoding and linguistic comprehension. Hoover and Gough claim that those two components have an equal value and are not sufficient alone. On the other hand, according to Lyytinen et al. (2009), poor phoneme perception is the strongest predictor of reading acquisition. They suggest that there are signs from very early on indicating the possible difficulties that a child might face later on when starting to acquire reading skills. In their studies of dyslexia, they found out that the most acute problem of dyslexic children was their lack in phoneme perception. The second important factor of reading difficulties was the automatization of reading (Lyytinen et al., 2009). The results of Hoover and Gough (1990) indicate that at first when a child goes to school, speech decoding correlates more strongly with reading comprehension than the second factor of linguistic comprehension. Their study gives support to the assumption of Lyytinen et al. in terms of the need of breaking speech into smaller units first in order to start learning to read. Hoover and Gough argue that in order to become a good reader the child needs to go from code reading to cipher reading. The child does not only read codes by the help of selective association and by breaking words into smaller units, but they also have to have knowledge about the relationship between printed and spoken word. There are certain prerequisites in order to acquire

cipher reading: one must have access to sufficient amount of pairs of printed and spoken words, one must discover the letter-sound relationship and have awareness of the alphabetic units in the printed word and of the phonemic units in the spoken word. Lyytinen's method of *Graphogame* game fills these requirements and thus, we could presume that it underpins children's cipher reading skills and not only their code reading capacities. *Graphogame* will be introduced in detail in an upcoming paragraph.

Finnish children, in average, already have some foundational literacy skills before entering school and do not need much instruction in order to reach the cipher reading (Aro, 2004). Out of Aro's sample, children already knew 16 out of 23 letters on average when starting school and over a third of them read at an accuracy level of 90%. Aro concluded that the best predictors of literacy skills at school entry were phoneme identification, letter knowledge and non-word repetition. This finding coheres with the findings of Lyytinen et al. (2009) in terms of the importance of phoneme identification, with the findings of Treiman et al. (1998) and Foy and Mann (2006) when it comes to letter knowledge (presented in the chapter 1.4. Phonological awareness and phonological training), and with the studies of Seymour et al. (2003) and Wimmer and Goswami (1994) regarding non-word repetition (presented in the next chapter). Based on his study, Aro (2004) also concluded that Finnish children only need 10 weeks of instruction to outperform English speaking second graders in non-word reading accuracy. Aro's study thus showed there to be remarkable differences in breaking the orthographic code between different languages.

1.3.2. Differences in syllabic structure and orthography depth between languages

Research has shown that languages differ in terms of the complexity of their syllabic structure and their orthographic depth. This variation results in differences between languages in the way and the pace of learning to read. In the very alphabetic (consistent) Finnish language, for instance, the letters correspond almost directly to the sounds and learning to read is a process of learning to blend sounds. By contrast, in languages with deep orthographies, such as English or French, each letter has several phonetic representations depending on the context and vice versa: phonemes can also have several written forms. It is estimated that in English the number of the different possible connections between spoken and written English is close to 2000, whereas the same number for Finnish is less than 30 (Lyytinen, 2009). Therefore, in deep orthography languages, reading acquisition involves word recognition processes in addition to phonemic skills.

Seymour et al. (2003) made comparisons between European languages concerning the acquisition rate of the foundation literacy components. Their research showed that reading familiar words was faster for children who spoke shallow orthography languages (such as Finnish, Greek, Italian, Spanish and German) than for children speaking deep orthography languages (French, English, Danish and Portuguese). This was the case both in the languages with simple and complex syllable structure. In terms of reading non-words, reading was less accurate in deep orthography languages with complex syllabic structures. Aro's (2004) and Wimmer and Goswami's (1994) studies showed the same phenomenon. These results indicate that letter-sound decoding is more difficult to acquire in languages with a complex phonology. This is because deep orthography languages, such as French and Danish, contain inconsistencies and complexities, multi-letter graphemes, context dependent rules, irregularities and morphological effects (Seymour et al. 2003). In these languages reading requires orthographic and alphabetic processes whereas in shallow orthographies only the alphabetic process is needed (Duncan & Seymour, 2000; Wimmer & Goswami, 1994). Logographic process includes the recognition and storage of words with the help of initial and final letters whereas the alphabetic process means that one is able to decode words based on blending letter-sound correspondences. In the study of Seymour et al. (2003) English and Danish (languages with syllabic complexity and orthographic depth) differentiated from other languages both in logographic processes (word reading) and alphabetic processes (non-word reading). Seymour et al. claim this to be due to the fact that attention and processing resources are divided between the two processes. Wimmer and Goswami (1994), on the contrary, argue based on their studies that German children (shallow orthography language) rely on blending pronunciations when performing reading tasks, whereas English children rely more on a direct recognition of the word –strategy. All in all, most European languages are somewhat shallow orthographies in general, and the automatization of word recognition and simple decoding are acquired by the end of the first grade, whereas English-speakers require more than twice as long of literacy instruction to master these skills (Seymour et al. 2003; Aro, 2004).

1.3.3. Learning to read in two languages

According to Pearson (2007) reading skills transfer from one language to another. The child does not have to learn the basic process all over again, only the particular details of a second spelling system or a second script. Learning a script means learning representations for phonemes

(alphabetic languages) or morphemes (character languages) (Bialystok, 2006). Moreover, according to the research of Cobo-Lewis et al. (2002), reading and writing are cross-language interdependent skills. While language achievement in their study seemed independent across languages, literacy skills cohered across languages. Cobo-Lewis et al. suggested that this may be because reading and writing are school-learned skills and depend on instruction rather than exposure to language models. That is, there is a greater difference between children in their exposure to a certain language leading to differences between oral language skills; however, there is more equal access to reading and writing through school instruction, which, for one, can create a natural tie between literacy in the two languages of bilingual children. However, results of Cobo-Lewis et al. did not directly prove that competence in one language fosters competence in the other, but the important finding was that bilingual children did not tend to excel in one language at the expense of the other.

By contrast, the studies done by Bialystok et al. (2005; Bialystok, 2006) did not provide support for the hypothesis of literacy skills being cross-language interdependent skills: there was no correlation between reading scores in different languages. Therefore, Bialystok (2006) set out to analyze the different effects of bilingualism on reading acquisition. In terms of oral skills bilinguals develop a smaller vocabulary in each of their languages (Oller & Eilers, 2002), which should hinder reading. By contrast, they have an advantage compared to monolinguals in terms of learning reading-related symbolic concepts and sometimes also a slight advantage when it comes to their phonological skills. Bialystok et al. (2005) claimed that the decoding skill develops separately for each language based on proficiency and instruction of the language and does not transfer to another language. According to Bialystok (2006), however, bilingual children outperformed monolinguals in language decoding, even when they used two different scripts. Nonetheless, the extent of the advantage for bilinguals depended on the similarity between the two writing systems. Bialystok (2006) also found out that phonological awareness is a general cognitive ability, and not only related to alphabetical languages. However, there are different levels of phonological awareness needed in acquiring decoding skills in each language: Bilingual children learning to read in two alphabetic languages benefit from transfer of skill across languages. That is because phonological awareness is a cognitive ability that is more vital to alphabetic languages than to character languages. In addition, competence in a language is an important factor when it comes to learning to read in that language: Chinese children with poor language skills in English used memorization and pattern analysis in learning to read in both their languages (technique commonly used in Chinese reading instruction), whereas proficient bilinguals use different learning patterns for the two languages, which is required for real development of literacy abilities (Bialystok, 2006; Bialystok et al., 2005). All in all, Bialystok has shown that bilingualism has no overall effect on reading

acquisition but that rather instructional matters and different features of languages are to be taken into account in order to evaluate the effect of bilingualism.

1.4. Phonological awareness and phonological training

Phonological awareness has been shown to have at least a reciprocal relationship with literacy experience and literacy instruction (Aro, 2004). However, it has not yet been proved that there is a causal link between phonological awareness and learning to read (Castles & Coltheart, 2004). While Elbro (1996) suggested that phonological awareness is the strongest predictor of reading development, the meta-study of Bus and van Ijzendoorn (1999) did not give support to this hypothesis. Ehri (1979), on the other hand suggested that the causal relation operates inversely. Bus and van Ijzendoorn (1999) concluded in their meta-study that the causal relation can go both ways. The acquisition of phonological awareness is associated with being exposed to literacy and developing phonological representations (Foy & Mann, 2006). The awareness of phonemes is considered the most important phonological skill in reading acquisition (Aro, 2004). Several studies have shown that segmentation and blending of phonemes has a stronger connection with the acquisition of literacy skills than other exercises of phonological awareness (rhymes, syllables, recognition of the first phoneme). According to Bus and van Ijzendoorn (1999) phonetic training should be combined with letter-sound relations in order for children to better acquire the pronunciations for words. They claimed that children need additional support in order to link phonological awareness to reading. The importance of phonological awareness is highlighted not only in reading acquisition studies, but also in studies examining the familiar risk of dyslexia and its effect on children. For instance, in the studies of Snowling et al. (2003) children who were at high-risk of dyslexia and had impaired literacy skills did not perform well on tests of phonological awareness and phonological processing. This result indicates that phonological awareness plays an important role in learning literacy skills. Therefore, one can assume that phonological skill instruction enhances children's reading skills. Wimmer and Goswami (1994) suggest that giving phonemic instruction and teaching grapheme-phoneme conversions to children is important and that the advantage from this kind of teaching is more obvious in regular orthography languages.

In the English language there is a distinction between letter names and letter sounds. English speaking children tend to learn letter names first and they use this knowledge, together with phonological awareness in order to learn letter sounds (Treiman et al., 1998; Foy & Mann, 2006).

Phonological awareness is needed in order to benefit from clues from letter-names in learning the sounds that letters represent (Treiman et al., 1998). In addition, according to Ehri et al. (1988), written letters can be useful for pre-readers who know letter-sound relationships, because they can use spellings as maps for pronunciation. In other words, letters can help them to remember the sounds they are segmenting. Foy and Mann (2006) argue that mastering diverse letter-name and letter-sound relationships also predicts deeper levels of phonological awareness. Treiman et al. (1998) suggest based on their findings that actually letter-sound knowledge and phonological awareness are intimately related, instead of being two separate foundations of literacy. This assumption is coherent with studies emphasizing the role of letter-sound correspondences in phonological training programs.

When it comes to the Russian language, according to Kerek and Niemi (2009), the structure of Russian orthography is at the same time both complex and consistent in its complexity, due to the predictability of its irregularities. Russian uses a Cyrillic script which is read from left to right, with a space separating each word, and it contains both capital and lower case letters (Nakanishi, 2003). Russian contains several regular phoneme-grapheme connections but it includes several irregularities as well. Russian is, however, more regular in comparison with English, in which the phoneme-grapheme correspondences are very irregular and change depending on the context. Nevertheless, in Russian the context plays an important role as well in regards to defining the letter-sound connections: the preceding and/or the following letter has/have to be taken into account in order to find the phonemic counterpart of the grapheme (letter) or the morpheme (syllable) in question (Kerek & Niemi, 2009). There is a debate in terms of whether the syllables or the small phonemic units with alternating values should be seen as the most important small unit in reading Russian (Kerek & Niemi, 2009). Russian has 42 phonemes and the consonants play a more important role than vowels. The vowels in consonant-vowel syllables have the important role of defining whether the consonants are hard or soft. In fact, the distinction between the soft (palatalised) and the hard consonants in Russian is one of the most fundamental characteristics of the Russian consonant system (Kerek & Niemi, 2009). Therefore, reading acquisition involves focusing on a consonant-vowel syllable, blending sounds inside the given syllable and then adding the remaining consonant clusters to be blended with the consonant-vowel unit. Another perplexing issue in Russian orthography is the presence of stress. The stress determines the position (strong or weak) of the vowels in a word (Kerek & Niemi, 2009). The reader has to read the whole word in order to define the placement of the stress. The stress is marked with a specific sign for children learning to read. Russian pupils are expected to acquire syllabic reading by the end of the first grade and then to advance in more fluent reading. The Russian writing system has been said to be easy for

advanced readers but very challenging for beginners, who have to learn all the different rules in order to learn the consistency of the language.

Russian immigrants often face difficulties in Finnish, because Finnish is different from Russian in several ways. When it comes to Finnish language, there are very many vowels, long words and variations in phonemic duration, compared to other languages (Geber, 1996). Whereas in Russian there are 6 vowel phonemes, in Finnish there are 8 short (single) and 8 long (double) vowel phonemes (de Silva & Ullakonoja, 2009). There are three vowel phonemes that do not have an equivalent in Russian, they are the front vowels / æ Ø y / (de Silva & Ullakonoja, 2009). In addition, as mentioned before, the number of Russian consonant phonemes is greater than in Finnish due to the oppositions of voiced-unvoiced and soft and hard consonants: A typical Russian syllable consists of one vowel, but it may include several consonants so that there can be consonant clusters of up to 5 consonants (Bondarko, 2009). In these clusters, each grapheme generally has its separate phoneme counterpart (Kerek & Niemi, 2009). According to Lieko (1992), when speaking Finnish, Russian immigrants confuse the sounds of the letters for those used in Russian and they use sounds from Russian in their speech. They do not pronounce the H in the beginning of a word or at the end of a syllable, they emphasize the endings of words and mix up long (double vowel or double consonant) and short phonemes (Geber, 1996). On the other hand, they are used to words being lengthened by prefixes and suffixes, which occur also in Russian (Geber, 1996). There are also some words in Finnish that are derived from, or otherwise resemble Russian, such as *ikkuna – okno* (‘window’), *sisar – sestra* (‘sister’). However, learning Finnish is not a simple task for Russians due to the considerable difference in the construction of these two languages.

1.5. Graphogame

1.5.1. What is Graphogame?

Graphogame is a learning game for children over 6 years old that supports children in learning to read (Lyytinen et al. 2007; Lyytinen, 2008; Lyytinen et al., 2009). The game was first developed at the University of Jyväskylä and its aim was to effectively observe the basics of reading acquisition (Lyytinen et al. 2009). It played an important role in the Jyväskylä Longitudinal study of Dyslexia (JLD) in which it was used to identify children with familial risk of dyslexia and to give them

preventive training (Lyytinen, 2008; Lyytinen et al. 2009). The game has since been found to be useful to complement literacy teaching for without-risk groups of children as well. There are different versions of the game for children of different ages. According to Lyytinen et al. (2009), there are more than 50,000 children in Finland who have played the game. Besides Finland, *Graphogame* is being implemented in UK, Switzerland and Holland, and there are secondary collaborations being done in Zambia, Estonia and Chile (Lyytinen, 2008). The current study uses the version of *Graphogame for immigrants.* The version will be introduced later in this chapter.

The main problems for children with dyslexia lie in their lack of phoneme perception and the slow automatization of reading (Lyytinen et al. 2009). *Graphogame,* being based on research done on dyslexia, trains children to learn phoneme-grapheme connections, to understand the principle of syllables and to enhance fluency of reading (www.lukimat.fi). In addition, the game is constructed around the principle of repetition. Playing the game makes the short-term memory process the phoneme-grapheme connections and this leads to them being stored in the long-term memory for efficient retrieval. This, in turn, helps to improve the automatization of reading. When taking into account that Finnish is a language with a transparent, shallow orthography, in which the phonemes almost directly correspond to their written counterpart, it is easy to understand why phoneme-grapheme correspondences play such an important role in learning to read in Finnish. For many children, learning just a couple of these correspondences is a sufficient element that enables them to internalize the alphabetic principle (Lyytinen et al., 2007). According to Lyytinen et al. (2009), the basics of reading in these kinds of transparent languages can be learned by storing 20–40 letter-sound connections for fluent retrieval. In addition, being exposed to letters seems to improve children's phonemic awareness (Lyytinen et al., 2005).

Graphogame (sometimes also called *Literacy* in English) can be downloaded from the Internet (www.lukimat.fi) for free, provided that children who play the game have their parents' written approval. After a short introduction given by an adult, the child can play the game independently with minimal supervision (Lyytinen et al., 2008). The game-like nature of *Graphogame* includes addictive features such as rewards, time-limitations and vivid design. The player's task is to listen to sounds (first phonemes, then syllables and finally words) via headphones and then catch a falling ball that includes the matching grapheme (letter, letter string or a word) before the ball has reached the bottom of the screen. There are up to eight distracter balls and if the child chooses the wrong one, they are shown the right ball and the sound stimuli is simultaneously repeated via the headphones. The game has a dynamic character, so that when the child progresses in the game, the stimuli become more and more complex and the number of distracters increases. In contrast, if the player does not succeed, the difficulty level of the game becomes lower. The subsequent level of the

game can be attained when the player has identified correctly 80% of items. The most motivating reward for children is the experience of success. Therefore the progress of the game is computationally controlled so that for all of the tasks the child will have about 80% of correct answers. The child also gets continuously encouraging feedback via the headphones.

1.5.2. Research on the effectiveness of *Graphogame*

There are several studies showing the effectiveness of *Graphogame.* According to the study of Hintikka et al. (2005), *Graphogame* offers an extensive way to practice the memorizing of letter-sound correspondences. In their study, an intervention was carried out for a sample of 22 non-reading first graders (with a control group of 22 pupils). The intervention group played *Graphogame* for approximately 170 minutes over a 6-week period. In spite of the fact that the post-tests showed that the intervention had no direct connection with reading acquisition, playing *Graphogame* was shown to provide remarkable help for children in learning letter names. Especially children with poor letter knowledge who also had poor short-term memory span and children with attention problems and poor phoneme awareness got more benefit from the intervention compared to attending only ordinary reading instruction.

Jyväskylä longitudinal study of dyslexia (Lyytinen et al., 2007) had a sample of over 200 children with and without familiar risk of dyslexia. In the study, several elements of early identification of dyslexia were introduced. Even if there can be visible signs referring to a possible later reading difficulty even in infants, the letter knowledge assessed between the ages from 4 to 6 was shown to be the strongest predictor. This supports the interpretation that children who have difficulty in learning letter names have trouble in storing them in the long-term memory (Hintikka et al., 2005). *Graphogame* was shown to be especially useful for children with problems of decoding who did not have problems of comprehension.

1.5.3. Graphogame for immigrants

In the present study we wish to investigate, if non-native speakers of Finnish, and more specifically Russian speakers, benefit from playing *Graphogame* in terms of gaining phonemic awareness in

Finnish. A former experiment constructed by Niilo Mäki Institute and University of Jyväskylä (Rantanen et al., 2008) was promising: there was a significant increase in the phoneme-grapheme awareness of the players. This result was congruent with the estimations of the teachers, of whom 73% reported having noticed some or significant increase in the player's phoneme-grapheme awareness as a result of the intervention. The experiment was carried out using a sample of 21 Russian speaking children between the ages 6 and 8. The game version used was *Graphogame* adapted to the Russian immigrants (Ekapeli-MAMU). According to the game data, the most difficult letters for Russian speakers were the ones that have a different phonemic counterpart in Russian compared to Finnish (B, D, F, G, H, N, P and R). These results were later used in order to create a new version of *Graphogame for immigrants* for a more extensive use. As a result, the new version, used in the present study, puts an extra focus on these most difficult phoneme-grapheme correspondences for Russian speakers. In addition, the new version of the game includes Russian instructions that the player can choose to listen to if they do not understand what they are supposed to do. This minimizes the risk of wrong answers caused by comprehension problems.

1.6. Research questions

The purpose of the present study was to find out whether Russian speaking first and second graders profit from computer based phoneme-grapheme training using an application of *Graphogame* designed for Russian speakers. Further, we hypothesized that the children's language environment would affect their game results. We anticipated that when the child is exposed to Finnish in their language environment, they would, at the beginning of the game, be ahead of their peers who hear and speak only Russian outside of school. The hypothesis is based on the general knowledge that the more a child is exposed to a language the more they gain information about the phonemic construction of that language. Since *Graphogame* is built to help children practice phoneme-grapheme correspondences, we presume that the acquisition of these correspondences happens more rapidly for children who already know Finnish language very well. Thus, these children should learn to read at approximately the same pace as Finns. The study also aimed to discover what kind of factors in the language environment turn out to be the most relevant in terms of the development of a child's phonological skills. In order to answer the research questions, a further analysis is done on eight subjects and their game results. The case stories will be explored in terms of the children's language backgrounds and their process of learning through the *Graphogame*.

2. METHOD

This study is a sub-study of a larger research called Maahanmuuttajahanke (immigrant project) that started in the autumn 2009 in Jyväskylä, Finland and is conducted by Niilo Mäki Institut (Rantanen, V., in progress). The whole sample consisted of 55 first or second graders coming from Russian speaking families. Out of the sample, 8 subjects were chosen as case stories for deeper analysis for this study. The purpose of the study was to test a version of *Graphogame* for Russian immigrants already piloted in 2008 (Rantanen et al.). The study was conducted in Finnish schools in the autumn of 2009 and in spring 2010, where children played *Graphogame* under the supervision of their teachers who had agreed to participate in the study. The teachers' role was to see that the parents of the children gave a written approval, to carry out the written tests, to download *Graphogame* and to register as its users. The teachers also organized and supervised the playing sessions of their pupils. The focus of the study was on investigating the connection between the language environment and the game results of the 8 case stories.

2.1. Participants

The sampling method used was to contact cities in Finland in order to find out whether they had schools with Russian speaking pupils. Rantanen et al. then contacted the principals of these Finnish schools who gave the names of the teachers who might want to participate in the study. The teachers were then contacted by e-mail and by phone in order to find out if they were willing to participate. The instructions and materials were then sent to the participating teachers, who, after getting the written approval from their pupils' parents, organized the playing sessions during school days. There were all in all 55 participants who played the game and 17 participants who completed at least the first three assessment fields of the game. There were eleven participants who were excluded from the data due to the fact that they had not played the game for long enough or because the exposition to the game was short implying that the player had not focused enough on the game. Because of the heterogenic nature of the sample, eight case stories were chosen in order to get a more profound understanding of individual learning paths. The similarities between the case stories are discussed in the summary of the results. The sample of case stories was chosen based on the following criteria variables:

The time the participant had lived in Finland. Assessed in years in the questionnaire for parents (N=32), then rated on a scale from 1 to 5. Out of the participants, 15 pupils were born in Finland and 9 had arrived to Finland less than a year ago. The case stories include four pupils who were born in Finland, two pupils who had spent less than a year in Finland and two pupils who had lived from 4 to 6 years in Finland.

The amount of exposure to Finnish language at home, as a percentage estimated by the parents in the questionnaire (N=29). The case stories represent cases of 50%, 2%, 85%, 0% (2 cases), 7%, 60% and 5% of Finnish language exposure at home.

The languages of the parents. In 23 families both parents' first language was Russian. In 5 families the mother spoke Russian and the father Finnish. In 25 families only Russian was spoken at home. The case stories include four cases in which the father is Finnish and the mother is Russian and in three of these cases both Finnish and Russian are spoken at home, however in one of these cases only Russian is spoken at home. In four cases the first language of both of the parents is Russian and only Russian is spoken at home.

Participation in Finnish kindergarten or preschool. In seven out of the eight cases the pupil had attended Finnish kindergarten or preschool. In one case the pupil had not attended kindergarten or preschool, probably due to having lived less than a year in Finland.

The age of the participants. 14 participants were born in 2001. 27 participants were born in 2002. 2 participants were born in 2003. The case stories consist of six participants born in 2002, one born in 2001 and one born in 2003 in order to represent all the age groups.

The sex of the participants. Participants consisted of 21 girls and 23 boys. The case studies represent stories of four girls and four boys.

Language related and other problems. One case story was chosen based on the fact that the pupil was diagnosed with dysphasia and he also has attention problems. Four of the other cases were also reported facing language problems, albeit rarely, related mostly to reticence, difficulty of finding words or difficulties with certain phonemes.

Total playing time and density of playing. The more the players played *the Graphogame,* the better. However, only the results of the first three weeks of playing time are taken into account in this study. In addition, the density of playing is also an important factor to take into account since it relates to the effectiveness of the game. Therefore, 5 out of the 8 cases had played *the Graphogame* for more than 3 hours. Two cases had played the game for more than two hours and one player only for an hour, but they were chosen because the relation between the background elements and game results was interesting. The variable of playing density includes weekends. In the most of the case stories the median density of playing was about every 2-3 days, however, in two cases the median playing density was around every 5 to7 days, but the cases could not be excluded from the case sample due to their informative nature in terms of the relation between the background information and the game results.

Results of the assessment fields. The result of each assessment field could be divided into three levels: 1.) poor level, with a score from 1 to 15, 2.) middle level, with a score between 16 and 20. 3.) high level with a score between 21 and 23. The case stories consist of three stories that had a poor level in each of the assessment fields, one pupil who had a middle level in all of the assessment fields and two pupils who had a high level in each of the assessment fields. In addition, one of the case stories represents development from the poor to the middle level and one case represents the development from the poor to the high level.

Table 1: Participants of the study

Name*	**Sex**	**Age****	**Time lived in Finland**	**Language(s) spoken at home**	**Exposure to Finnish at home**	**Daycare of preschool**	**Playing time**
Jelena	girl	7	born in Finland	Finnish & Russian	50%	yes	4h32 min
Mihail	boy	9	born in Finland	Russian	2%	yes	2 h20 min
Vera	girl	7	born in Finland	Finnish & Russian	85%	yes	16h50min
Vitali	boy	7	less than a year	Russian	0%	no	3h13min
Irina	girl	7	4 to 6 years	Russian	7%	yes	2h47min
Juri	boy	7	born in Finland	Russian (Finnish father)	0%	yes	5h49min
Tamara	girl	8	4 to 6 years	Finnish & Russian	60%	yes	1h8min
Pavel	boy	7	less than a year	Russian	20%	no	4h42min

* Names are changed

** Age of the participant during the playing period

2.2. Assessment methods

The study consisted of cognitive-linguistic tests, *Phonological awareness test*, *Dynamic learning test* and *Graphogame* practice fields and assessment fields. This study focuses on the results of *Graphogame* with its assessment fields and of *Phonological awareness test* – a voluntary reward field of *Graphogame* – since they gave the most relevant information concerning the phonological skills of the participants. In addition, a questionnaire was completed by the parents of the children at the beginning of the study and a final questionnaire was completed by the teachers of the children.

2.2.1. Graphogame

The children played the game during a period of approximately 3 weeks. The *Graphogame* records everything the player does when playing the game. The development in children is assessed by measuring their letter-sound knowledge on different trials and assessment fields. In the practice fields the player practices a number of letter-sound connections depending on their skills: if they give a wrong answer the letter-sound connection appears again until they get it right. *Graphogame* records the number of correct and wrong answers given by the player and the total number of trials completed during the playing time. In terms of specific letter/syllable-sound connections, *Graphogame* also offers a table with the percentage of correct answers (recognition of the target sound) during the 7 first and the 7 last trials and the overall percentage of correct answers made by the player. The overall percentage can be misleading if the player has only learned the letter-sound connection at the end of the playing time. Moreover, the table does not give information about the distracter sounds among which the target sound has or has not been recognized. Detailed information about the distracters and their meaning is given by the *Daisygraph.*

Daisygraph demonstrates the degree of accuracy in which the child can recognize the target sound from the distracters (in levels of 0%, 50%, 75% and 100%). There are petals for each distracter that has appeared together with the target sound. The number of the sound pair appearing together is indicated next to the petal in question. When two sounds have appeared together only rarely, the petal is very thin and it indicates that probabilities of performance cannot be calculated. The outermost circle represents the level of 100% and the innermost circle the level of 0%. Therefore, when the widest part of a petal is very close to the center, it means the player prefers the distracter. The green color of the petal refers to good performance (more than 80% of correct answers), red to bad performance (less than 50% of correct answers) and brown to average performance.

The assessment fields give the most valuable knowledge about the development of players' skills and therefore it is used as the most important assessment variable. The maximum score for each assessment field is 23, referring to the number of the existing letter-sound connections in Finnish. The assessment fields consist of a screen full of letters (23 letters), the player hears sounds from the headphones and they need to find the matching letter for them. They do not get feedback during these assessment fields. The field appears first at the very beginning of the game, then after every 15 practice fields. *Graphogame* offers a table of results of the assessment fields of each player, indicating whether the specific target sounds have been recognized by the player during the

assessment fields. For instance it can demonstrate that a player has recognized the letter-sound connection "A" in every assessment field. The table can also be read in order to find out which letter-sounds have or have not been recognized by the player in a certain assessment field. Out of the case stories, one pupil completed four assessment fields, four pupils completed three fields and three completed two fields.

Phonological awareness test. This voluntary reward field of Graphogame tests the player's knowledge of breaking words into smaller (phonemic, syllable, word) units. It consists of 20 words and images, so the maximum score is 20. The players have to find, for instance, the word "jalka" in the word "jalkapallo", or the syllable "me" in "omena" or the suffix "t" in "autot". Most of the players (N=31) and six out of the eight case stories completed this field. The test correlates positively with the sum variable of *Oral knowledge in Finnish* (0.611, p=0.026).

2.2.2. Questionnaire for parents (appendix 1)

The parents of the children completed a questionnaire with 23 questions related to the language environment and the estimates of their child's language skills (oral, comprehension, reading, writing) in both Russian and Finnish. The questionnaire was structured with some open questions. Most of the questions were to be answered on a scale from 1 to 5 (5 being the highest), for instance: "*The child speaks Finnish: 1.) not at all 2.) a little 3.) to some extent, 4.) a lot, 5.) always*". A sum variable could be formed for *Oral language in Finnish* (oral and comprehension skills, Cronbach's alfa 0.94), for *Oral language in Russian* (Cronbach's alfa 0.87) and for *Literacy skills in Finnish/Russian*. The number of questionnaires returned was 32 and the case stories only include cases with a questionnaire returned.

2.2.3. Questionnaire for teachers (appendix 2)

After the intervention period the teachers completed a questionnaire with 9 questions related to the possible gain they estimated to have been reached through the intervention. The questionnaire also gave them the chance of reporting any inconveniences occurred during the playing period. The majority of the questions were to be answered on a scale from 1 to 5, for instance: "*I would estimate*

that the pupils found playing the game: 1.) very pleasant, 2.) pleasant, 3.) indifferent, 4.) somewhat unpleasant, 5.) unpleasant". The number of questionnaires returned was 6 and they covered the information concerning 23 players and four out of the eight case stories.

3. RESULTS

3.1. Jelena

Jelena is a 7-year-old girl who was born in Finland. Jelena played *Graphogame* for a total of 4 hours and 32 minutes (16293,1 seconds) in 17 playing sessions. Jelena reached level 9 of the game and completed the first three assessment fields during the first three weeks of the playing period. The median of her playing density is every 26 hours, which is very good, when taking into account that the median includes weekends.

Language background

Jelena's mother's first language is Russian and father's Finnish. Her parents estimate that 50% of input at home is Finnish. Jelena has attended Finnish kindergarten or preschool and she currently attends Finnish as a second language teaching. She also has a social hobby that she participates in once a week. She has more than eight Finnish friends and plays with them daily. At home she uses media and reads or is read to in both Finnish and Russian. Her parents estimate that she understands both Finnish and Russian perfectly and speaks both these languages very well (*Oral Knowledge in Finnish* 4.5. *Oral Knowledge in Russian* 4.5, on a scale from 1 to 5*)*. When it comes to her reading and writing skills her parents report that she writes both Russian and Finnish neither well nor bad and reads Finnish better than Russian (*Literacy skills in Russian* 3 and *Literacy skills in Finnish 3.5*).

Learning process

At the beginning of the game Jelena's letter-sound knowledge was on the 2nd level as she recognized 16 out of 23 letters (A, E, H, I, K, M, N, O, R, S, T, U, V, Y, Ä, Ö). In the second assessment field Jelena scored 21 and had learned all the letters she got wrong in the first field (B,

D, F, G, J, L, P) but had relapsed in M and N, due to having mixed them up. In the third field Jelena gave an incorrect response for F (S), N (M) and Ö (H), thus scoring 20 out of 23. In her results of the assessment fields, Jelena stayed on the average level.

When it comes to the letters Jelena had trouble with in the assessment fields (B, D, F, G, J, L, P, N, and Ö), during the 7 first trials she recognized them under 80 % of the time, except for J and P which she recognized 86% of the time. The initial results indicate that Jelena might have trouble with the letters A (43%), B (71%), D (57%), F (71%), G (43%), L (57%), N (71%) and V (71%). However, during the game, Jelena managed to improve her score for all of these letters. Interestingly, she managed to improve her score the most for the most difficult letters A and G, in which she did not make any errors at the end of the game.

Daisygraph shows why these letters have been difficult. There are several letters that have occurred together too rarely in order to calculate the percentage of their distracting effect. Target A occurred 61 times and it has been mixed up with distracters O, F and D, especially with O. Target B has been mixed up with P and D. Target D has been mixed up with B, P and especially with T, which can be seen by the presence of the red color.

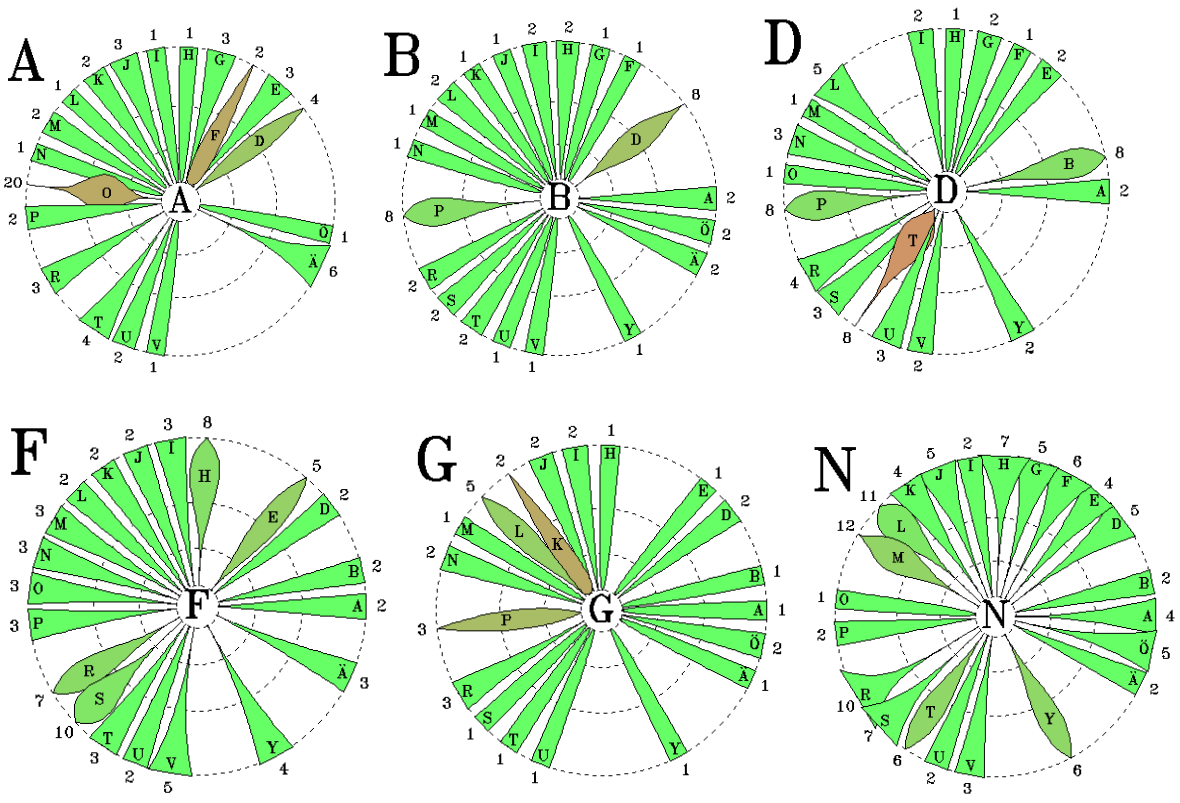


Illustration 1: Jelena, Daisygraph showing difficulty in targets A, B, D, F, G and N.

During the game Jelena made in total 1650 correct and 350 incorrect selections. However, she got a score of 20 out of 20 in *Phonological awareness test*. The common trend was thus that Jelena progressed and learned to give more and more correct answers during the game. She also progressed in her results for syllables and words. When it comes to recognizing words, for instance, the word U-NI appeared 17 times and at the beginning Jelena recognized it correctly 29% of the time and in the end 71% of the time. The word UU-HI appeared 19 times and at first Jelena recognized it 43% of the time and in the end in 100% of the trials. However, there were some stimuli in which her responses weakened. For instance, at the beginning of the game Jelena recognized the syllable NA (19 times) at 57% accuracy level and at the end at 29% accuracy level. The word UU-MA she recognized perfectly (100%) at the beginning and 86% of the time in the end. It is impossible to explain this kind of negative progress. It may be due to fatigue, lack of motivation or it can be a pure mistake. All in all, however, there was more progress in Jelena's results compared to deterioration.

All in all, Jelena managed to progress in her game results and did not present any major difficulties. This may be due to the fact except for her home, she lives in a fairly Finnish environment, goes to Finnish school, has a social hobby once a week and plays with her Finnish friends daily. It must be taken into account that Jelena was learning to read and write in both Finnish and Russian. The letter-sound connections that she found difficult were mostly the ones that have a different phonemic counterpart in Russian compared to Finnish (B, D, F, G, N), which explains her difficulty in these letters. Interestingly, the letter A was difficult for her in the beginning even if it occurs constantly in Finnish language. It would have been interesting to find out if Jelena is receiving any Russian lessons and if she is, whether it involves reading tuition or not. It is possible that she is learning to read in Russian at home. However, possibly due to her participation in reading lessons in Finnish at school make her parents estimate her skills to be better in Finnish compared to Russian. All in all, Jelena's game results are promising. The fact that she got the maximum score of *Phonological awareness test* also supports the hypotheses that playing *Graphogame* contributed to her learning.

3.2. Mihail

Mihail was born in December 2001 in Finland. Mihail had already played a version of *Graphogame* for first graders in the spring 2009, so he was already familiar with the concept of the game before participating in this study. In 2009 his game results were altogether very good. In spring 2010 he played *Graphogame for immigrants* for 2 hours and 20 minutes (8409 seconds) in 8 sessions reaching the 8th field of the game. Mihail completed the first three assessment fields. His playing density was every 7 days.

Language background

Mihail's parents are both Russian speaking and only Russian is spoken at home (his parents report an input of 2% in Finnish). Mihail has attended Finnish kindergarten or preschool and has not attended Finnish as a second language teaching. Russian was evaluated as a stronger language by the parents, who added that Mihail does not speak much and has difficulties in finding words (*Oral Knowledge in Finnish* 3,5. *Oral Knowledge in Russian* 4,5, on a scale from 1 to 5). However, the parents reported these problems to occur only rarely. They estimate that it is highly important for Mihail to learn the Finnish language. Mihail attends a social hobby every second day. He has two to three Finnish friends that he spends time with twice a week. At home Mihail reads and uses media in both Finnish and Russian. His *Literacy skills in Russian* were evaluated to be 4.5 and his *literacy skills in Finnish* 4.

Learning process

At the beginning of the game, Mihail's letter-sound knowledge skills were on the highest level, since he reached the maximum score of 23. In the second assessment field he reached again the maximum score of 23 letters. In the last assessment field he seems to have forgotten two letters: L (mixed up with Y) and Ö (mixed up with E). Mihail's results thus remained very good.

At the beginning of the game, during the first 7 trials, Mihail scored lower than 100% in the following targets: Ö (71%) and D, E, H, I and L in which he still reached 86% of correct answers. During the game, he managed to progress in some of his results for the letters that he did not fully know at the beginning of the game: Ö (86%), E (100%), H (100%), I (100%). On the contrary, during the 7 last game trials his score for L and D stayed at 86%, which is very good but it can cause trouble in reading for children of Mihail's age.

When looking at the Daisygraph, the only letters Mihail has mixed up with distracters are D (mixed up with E), E (mixed up with T), H (mixed up with F) and Ö (mixed up with F and O). However, as it can be seen from the Daisygraphs, there had not been enough exposure to the most of the letter pairs in order to calculate the mixing effect of the distracters.

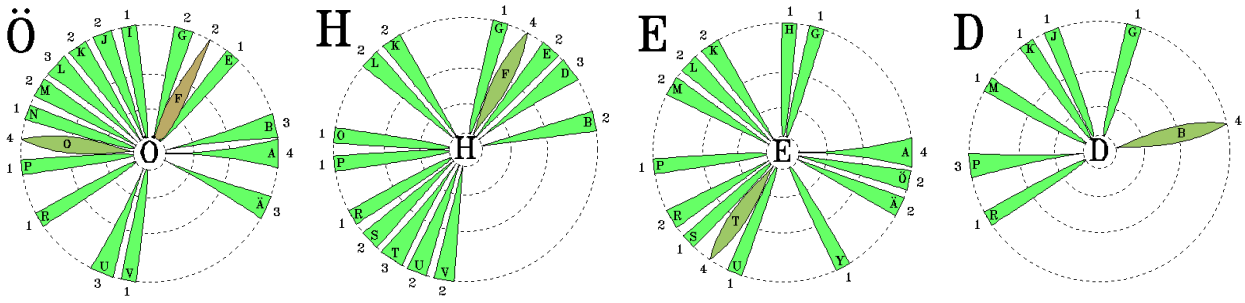


Illustration 2: Mihail**,** Daisygraph illustrating the difficulty in targets Ö, H, E and D.

In *Phonological awareness test* Mihail reached the score of 18 out of 20. All in all, he made 1050 correct and 133 incorrect choices in the game. On the contrary, he had trouble in syllables: TEIN (43%), KÄH (71%), LOUR (57%), LYIP and NYRT (71%). In addition, he had trouble with reading words: UU-NI, EUK-KO, KÄÄN-TÖ (71%) and JÄ-NIS (57%).

Mihail had good results throughout the game. He knew all the letters considerably well when starting to play the game, which is understandable because Mihail is an 8-year-old. On the contrary, Mihail showed difficulty in reading and in recognizing syllables and this difficulty persisted throughout his playing. For instance, he only recognized the syllable TEIN in 43% of the time and the syllable LOUR 57% of the time. In terms of reading words, he could recognize words UU-NI, EUK-KO and KÄÄN-TÖ at 71% accuracy level. During the seven last trials of the game, Mihail had only managed to boost his result for the syllables II and OOP (from 86% to 100%) and for the word JÄ-NIS (from 57% to 100%). These results indicate that Mihail has not greatly benefited from playing the game in terms of learning syllables and words: his reading difficulty persists. The reading difficulty can be due to the fact that Russian is his stronger language and he can already read in Russian. It can take time to learn to block the Russian influence on his reading in Finnish. His good letter-sound knowledge in Finnish should help him in reading acquisition in Finnish,

however, reading acquisition demands also good language skills and understanding of the alphabetic principle. According to his parents, Mihail has moderate oral language skills in Finnish and he is sometimes uncommunicative. It would have been interesting to know why Mihail has not attended Finnish as second language tuition. It is possible that direct teaching could help him to block the negative transfer from Russian when it comes to reading in Finnish. Interestingly, however, *Graphogame* could not make him progress with its method of repetition.

3.3. Vera

Vera is a 7-year-old girl who was born in Finland. She played the game for a total of 16 hours and 50 minutes (57896,5 seconds) in 68 playing sessions. She played the game about every day. During the playing period Vera completed the six first assessment fields, of which the first three were completed during the first three weeks and are thus the ones taken into account in this study.

Language background

Vera's father's first language is Finnish and her mother's first language is Russian. Her parents estimate that 85% of the input at home is in Finnish but both languages are used. Vera has attended Finnish kindergarten or preschool and her parents estimate that her Finnish language is stronger than her Russian. Vera has four to five Finnish friends with whom she plays a couple of times per week. She sometimes has linguistic problems, related to some concepts being incorrect. Her *Oral skills in Finnish* is 5 and in *Russian* 2.5. When it comes to her *Literacy skills,* her parents estimated her skills in Finnish to be 2.5 and in Russian 1. She reads to or is read to in both Finnish and Russian.

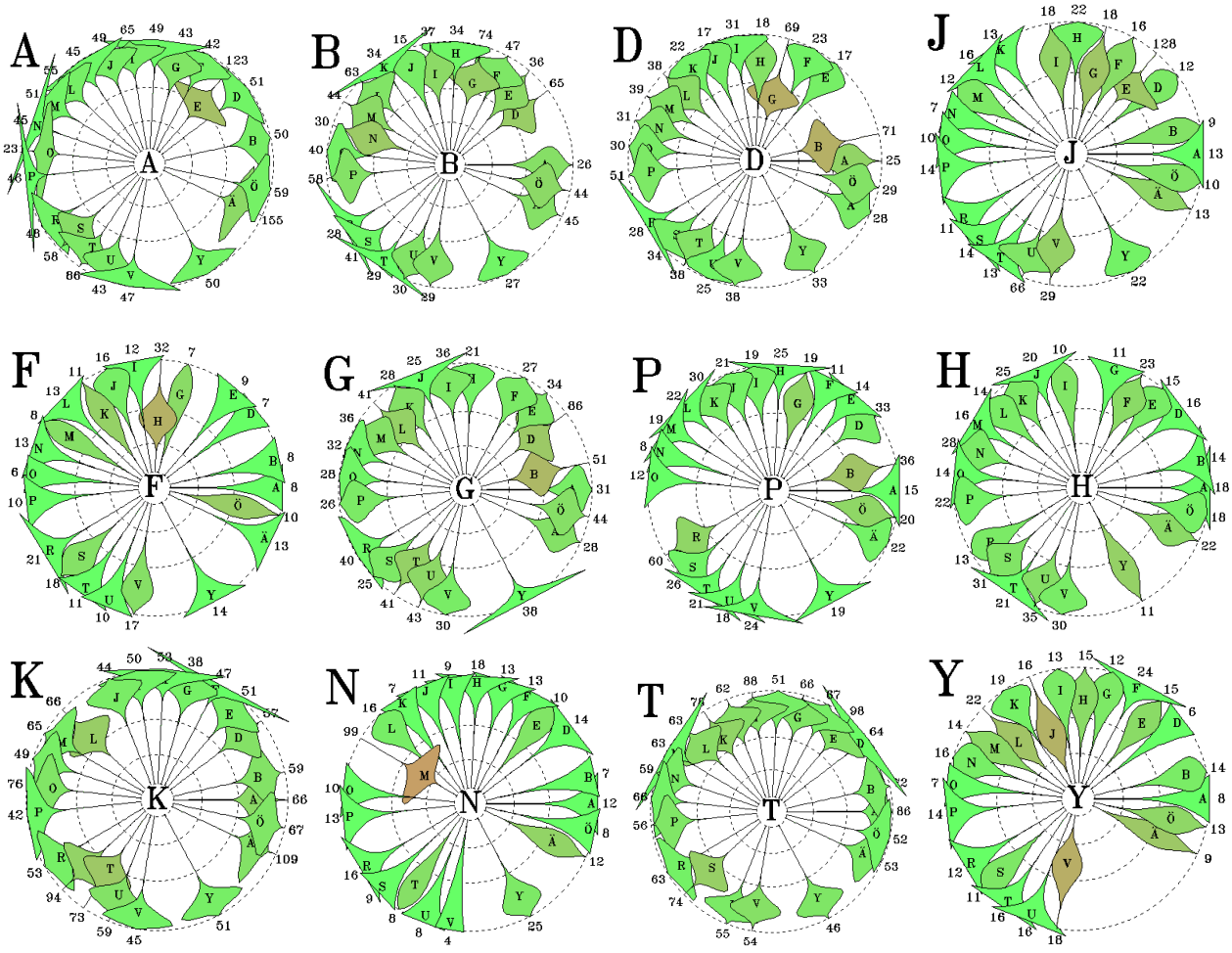
Learning process

Vera scored 2 out of 23 in the first assessment field of *Graphogame.* She only knew the letters O and S. In the second assessment field of Vera reached the score of 6 out of 23 (A, B, I, M, S and T). In the third field she managed to double the result, scoring 12 out of 23 (A, E, H, I, J, L, N, P, R, S, U and Ö). She seems to have learned the letters A, E, I and R during the first three assessment fields. According to these results, she progressed but not enough to move from the poor level to the average level.

Vera seems to have trouble especially with the letters: D, F, G, K, V, Y and Ä, which she did not get right during any of the three assessment fields. During the seven first trials of the game, she recognized these letters poorly and had trouble with the most of the other letters as well. When

playing the game, Vera managed to progress in her scores for the letters she had trouble with at the beginning of the game, except for Ä, which she first recognized 46% of the time and at the end only 29% of the time.

When looking into the graphs provided by Daisygraph, one can see the great number of times the pairs of target letters and distracters have appeared together, since Vera has played the game for 16 hours and 50 minutes and the graphs are formed of the totality of the trials of the game fields. This leads to the graphs being very reliable and probabilities of distracter effects can be calculated reliably. Vera's Daisygraphs illustrate how she is not yet capable of separating the letters, since for each target letter there are several strong distracters. For instance for letter D, the strong distracters are G and B and the target is recognized about 70% of the time when occurring with these distracters. For the letter Y the strong distracters are J and V (target recognized 63% of the time when occurring with these distracters).



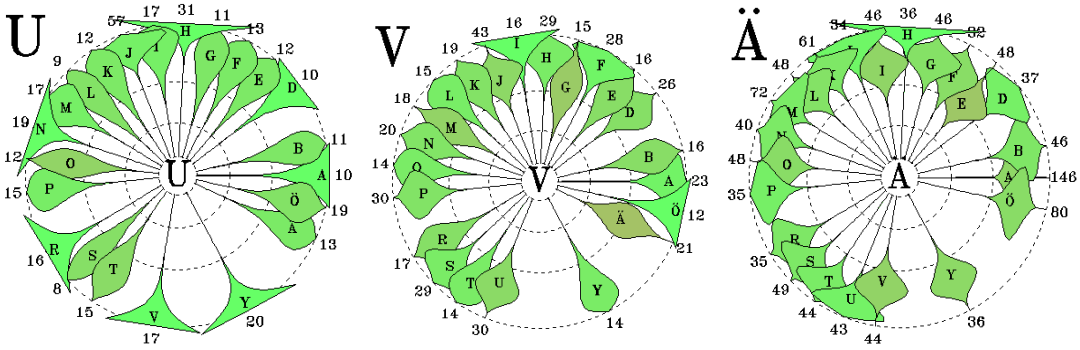


Illustration 3: Vera, Daisygraph illustrating difficulty in A, B, D, J, F, G, P, H, K, N, T, Y, U, V and Ä.

When looking more closely at Vera's playing, it can be seen that at the first training fields of *Graphogame* Vera had the most trouble with especially the letter A (that she systematically mixed up with I, E, O and Ä), but also with the letters K (which she mixed up with D, T, L, E, O and B), Ä (mixed up with K, E, M and O) and Ö (mixed up with M, K and E). This happened systematically and Vera mixed up the same letters several times despite the fact that the game indicates every time when a player gives a wrong response. Little by little Vera learned to give the right response for the letter A, but her difficulty with the letters Ä and Ö persisted until the 4th training field of *Graphogame.* When new letters were introduced in the training fields, Vera faced difficulties especially with letters F (mixed up with M and Ä), G (mixed up with Ä, B, T and D), B (mixed up with O, N, P), K (mixed up with J, M and L), T (mixed up with K, N, S and G) and D (mixed up with G, Y and M). The fact that there were several strong distracters for each letter makes it difficult to analyse the impact of Russian language on Vera's letter-sound skills in Finnish: She did not simply choose the Russian letter counterpart for letter sounds, but she was having overall difficulties in matching letter sounds with their written counterpart. Interestingly, however, Vera's difficulty with the letter Ä influenced her responses for other letters as well, for instance F, G, L and M. Vera kept on choosing the wrong response when hearing the sound Ä and she also chose the letter Ä when hearing other letter-sounds. The interesting thing about the impact of the letter Ä is that the letter-sound for Ä in Finnish can be heard at first in the letter-sounds for F, L and M ([äf], [äl], [äm]). Vera may have thus chosen the letter Ä as soon as recognizing its sound at the beginning of another letter-sound (F, L or M). Another interesting thing in Vera's playing was that when advancing in the game, Vera kept on making mistakes in different letter-names but one of her most systematically occurring difficulty concerned double vowels AA and EE. The version of *Graphogame* used in this study included several of these double vowels due to the fact that they are known to be difficult for Russian speakers. The Russian impact on Vera's responses could thus be seen in her difficulty in double vowels. In addition, the fact that Vera's most difficult letters were

the ones having different counterparts in Russian compared to Finnish also contributes to showing the impact of Russian in Vera's playing. When Vera had to give a response for one of these difficult letters, she certainly started to guess the responses instead of trying to recall the right response, which can explain the fact that there were several strong distracters for each letter.

During the playing period Vera's results stayed thus considerably poor and she kept on mixing up target and distracter letters. The trial percentages show that there has been some progress in her responses but that there has also been much attenuation. For instance, her score for syllables AI and LO has improved from 86% to 100% but her score for syllable OS has dropped from 100% to 86% and for syllable SU from 100% to 57%. Therefore, the percentages give support to the scores of the assessment fields of the game, which show that Vera's results remained considerably poor.

These results suggest that either Vera really does not yet recognize the letters even with almost 17 hours of exercise or she has lost the motivation to play at a certain point. Nevertheless, if we only look at results gotten during the 3-week playing period, some progress can be seen in the assessment fields. However, Vera's final result (12) is still on the poor level. It would be interesting to be able to understand Vera's poor results, because the elements of her language environment are in contradiction with her game results. Her parents estimated that her oral skills in Finnish were 5 and that she speaks Finnish better than Russian, so she should not have difficulty in Finnish language. However, her parents' indication of her Finnish literacy skills is 2.5, indicating a quite poor level. It should be taken into account that these are only Vera's parents' subjective estimations. Further specific linguistic testing, more background information and more comments from her teacher would have been needed in order to further analyse Vera's case.

3.4. Vitali

Vitali was born in 2002 and arrived in Finland less than a year ago. He played *Graphogame* for a total of 3 hours 13 minutes (11598,6 seconds) in 12 playing sessions. He reached the field 7 of the game. Because of the Christmas break, his playing was divided into two periods and therefore, only the first two assessment fields are taken into account in this study. He played the game approximately every day or every second day.

Language background

Having lived less than a year in Finland, Vitali has not attended a Finnish kindergarten or preschool. He currently receives tuition of Finnish as a second language. The first language of both of his parents is Russian and only Russian is spoken at home (input in Finnish 0%).

Vitali's parents report that Vitali cannot yet speak Finnish. He speaks and understands Russian perfectly, whereas he can only speak and understand a little Finnish (*Oral skills in Finnish* 2, *Oral skills in Russian* 5). He does not have any social hobbies and has either no or one Finnish friend. Vitali reads or is read to in Russian and he uses media in both Finnish and Russian. His parents estimate that it is highly important for Vitali to learn Finnish. They estimate that Vitali has moderate reading and writing skills in Russian and poor reading and writing skills in Finnish (3 in Russian and 2 in Finnish).

Learning process

In the first assessment field of the game, Vitali reached the score 13 out of 23 (D, E, G, I, K, L, M, N, O, P, R, S, T). In the second field he reached the score 18, thus increasing his result from the level 1 to the level 2. He seems to have learned the letters A, H, J, U, Ä and Ö, but has relapsed in the letter K.

Based on the both assessment fields completed, Vitali seems to have trouble especially with the letters B, F, V and Y. The target F appeared 24 times during Vitali's playing and during the first

seven trials Vitali recognized it correctly 43% of the time. The target Y appeared 20 times and he recognized it at a 57% level of accuracy. When it comes to the targets B and V, Vitali recognized them at 86% accuracy during the seven first trials. During the game, Vitali managed to progress in his recognition percentages for F (56%) and Y (86%), however his score for B and V relapsed to 71%.

Daisygraph shows that there are several distracters that have not appeared enough times together with the target letter. This leads it to be impossible to calculate the percentage of the effect of the distracter. The red color petals for targets F (distracter S) and K (distracter T) indicate a poor level of performance when it comes to these letter pairs appearing together. The brown color indicates a moderate level, which is the case for instance for the target T occurring together with distracters K and M, or the target H occurring together with the distracter E.

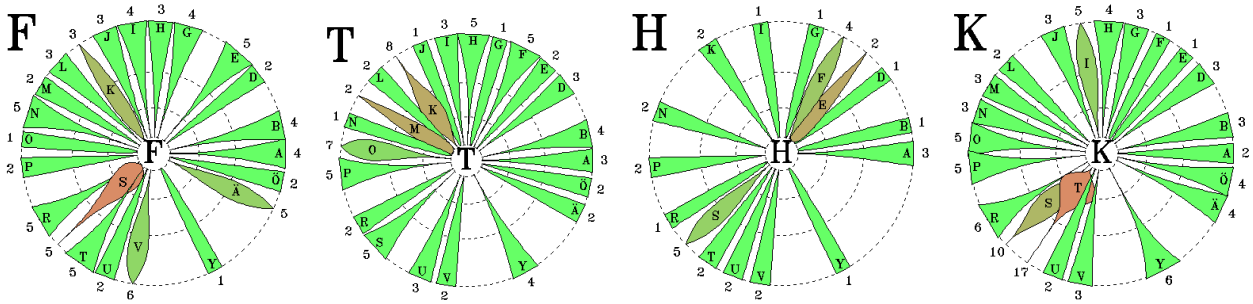


Illustration 4: Vitali, Daisygraphs illustrating the difficulty in targets F, T, H and K

Vitali's result in *Phonological awareness test* was 10 out of 20. On the whole Vitali made 1099 total selections and 226 incorrect selections in the game. He managed to progress in his results for some of the letters and syllables that he had had trouble with at the beginning of the game, such as ÖYS, which he recognized at the beginning at 29% accuracy and at the end at 71% accuracy and HYT which he first recognized 43% of the time and at the end 86% of the time. Vitali also learned to better recognize the words UU-HI, ÄÄ-NI, UU-MA and AA-SI. However, for most of the stimuli his results stayed on the same level or relapsed. For instance, there was a 14-15% decline in the following letters: B, D, L, N, O, R, V.

In Vitali's case it is important to notice that Vitali does not yet speak Finnish very well, since he has lived in Finland for less than a year. He is learning to read in both Russian and Finnish and he seems to show difficulty in acquiring literacy skills in Finnish, because of his poor language skills. His parents' estimation of his skills corresponds to his game results. The fact that Vitali mostly had trouble with letters B, D, F, H, N, R and V indicates that he is trying to transfer the reading skills from reading in Russian to reading in Finnish, which obviously does not seem to work due to the different counterparts for these letters in Finnish. However, when looking at Vitali's assessment

field scores, the results are promising: he managed to progress from the poor level to the average level having completed only two assessment fields. Therefore, playing the *Graphogame* seems to have been useful for him.

3.5. Irina

Irina was born in 2002 and has lived in Finland from 4 to 6 years. Irina played the game for a total of 2 hours 47 minutes (10042,1 seconds) in 14 sessions, reaching the field 9 of the game. During the first three weeks, she completed the first three assessment fields of the game. She played the game once approximately every three days.

Language background

The first language of Irina's parents is Russian and only Russian is spoken at home (7% of input in Finnish). Irina has attended Finnish kindergarten or preschool but has not received any Finnish as second language tuition. She does not have any social hobbies, but she has more than 8 Finnish friends and she plays with them daily. Her parents estimated that she speaks and understands Russian better than Finnish (score 5/5 for *Oral skills in Russian* and 4/5 for *Oral skills in Finnish*). Irina reads or is read to in Russian and uses the media in both of the languages. In terms of her *literacy skills,* her parents estimate her skills to be 4 in Finnish and 4.5 in Russian. She rarely has linguistic problems. Her parents estimate that it is very important for Irina to learn the Finnish language.

Learning process

In the first assessment field of *Graphogame*, Irina recognized 15 letters (D, E, H, I, J, K, N, O, P, R, T, U, V, Y, Ä). In the second assessment field Irina got a score 20 out of 23, having only G (F), L (N) and Ö (answering Ä) wrong. In the third assessment field she scored 21, getting only B and P wrong, answering P instead of B and M instead of P. Irina thus progressed in her results from the poor level to the high level. According to the assessment and game field results, Irina has trouble with following letters: A(57%), B(86%), F(57%), G(71%), L(71%) M (57%), S(86%) and Ö(57%). During the game, Irina managed to progress in her results in terms of all her difficult letters.

Daisygraph shows Irina's difficulty with the target letters. For instance, the target letter A has been recognized about 60% of the time of the distracter O (which has occurred 23 times together with A) and A has been recognized about 70% of accuracy of distracter Ä (which has occurred 36 times together with A). The target M's strong distracter is N, which has occurred 32 times together with M and Irina has recognized it in about 80% of the trials. The target P's distracters are R, which has occurred 42 times with the letter P and Irina recognized P in 80% of the trials and D, which has occurred 11 times with P and Irina recognized it in 75% of these trials.

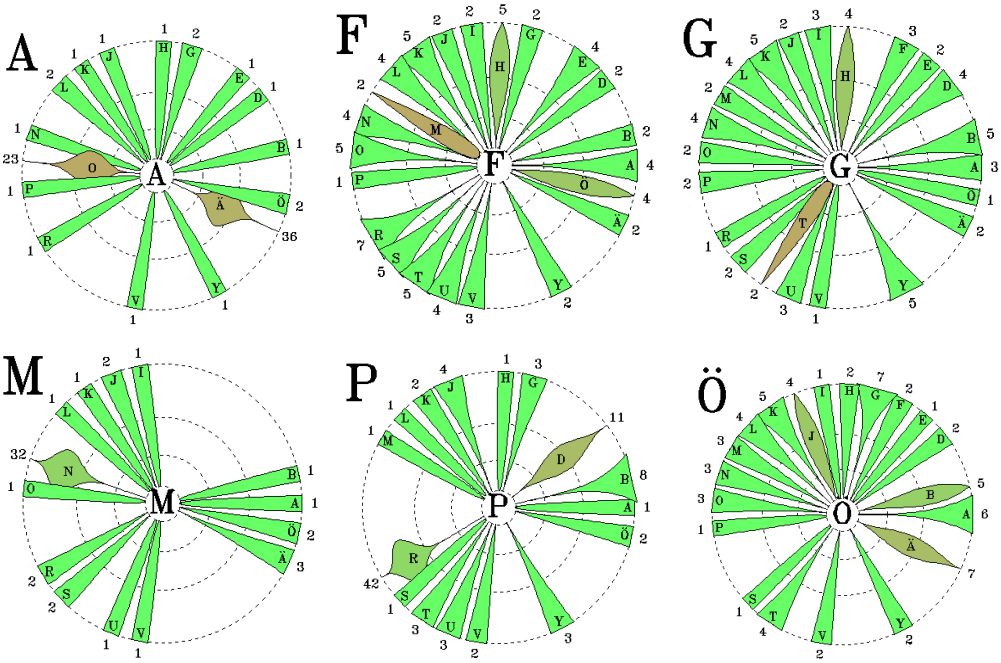


Illustration 5: Irina, Daisygraph illustrating difficulty in letters A, F, G, M, P and Ö.

On the whole, Irina made 1181 correct and 370 incorrect selections while playing the game. In the *Phonological awareness test* she received the score of 15. In terms of syllables, the most results stayed at the starting level or attenuated during the game. However, Irina managed to progress for instance in the syllable AI, which she first recognized at 29% level and at the end at level of 86% and in the syllable SI, which she first got correctly 57% of the time and at the end 100% of the time.

All in all, Irina's difficulties represent the most common difficulties for Russian speakers: The difficulties are attached to letters that have a different counterpart in Russian compared to Finnish, such as B, D, F, G, H, N, P and R. This is understandable when taking into account that Irina's parents estimated her daughter's literacy skills to be better in Russian than in Finnish. On the contrary, Irina's parents estimated Irina's literacy skills to be on the level of 4.5, which did not correspond Irina's score in the first assessment field (15), here still classified as poor. However, when playing *Graphogame,* Irina managed to reach a good level in the letters with which she had difficulties at the beginning of the game. Only in the letters M and P (71%) Irina did not reach the

level of good performance (80%). On the contrary, her difficulties with syllables persisted and even if she progressed in some syllables, she relapsed in others so that it is not really possible to say that she has progressed when it comes to syllables. This may be due to the fact that she is only starting to learn to read and she is still getting influenced by her literacy skills in Russian. All in all, playing the game helped Irina to progress remarkably in terms of her letter-sound knowledge.

3.6. Juri

Juri was born in 2002 in Finland. He had already played the version of *Graphogame of mathematics* before participating in this study, so he was familiar with the game concept. Juri played the game during a period of 5 hours 49 minutes (20959,8 seconds) in 19 playing sessions, reaching the field 13. He played the game approximately every day or every other day. During the 3-week playing period he completed four assessment fields, but only the two first ones are taken into account because of reliability issues: the playing length was not long enough for the last two fields.

Language background

Juri's father's first language is Finnish and his mother's Russian. However, only Russian is spoken at home (input in Finnish 0%). Juri has attended Finnish kindergarten or preschool and Finnish as a second language tuition. Juri has a social hobby that he participates in once a week. He has 6 to 7 Finnish friends that he plays with every other day. At home Juri is read to in Russian and he uses media in both Russian and Finnish. Interestingly, the parents estimate Juri's oral skills in Finnish as very good (*Oral skills in Finnish* and *in Russian* are 5, reported by the parents). However, he has been diagnosed with dysphasia and he also has attention problems. He sometimes also has difficulties in finding the right word, he is uncommunicative and has problems with certain phonemes. Juri's parents estimate that it is highly important for Juri to learn the Finnish language. When it comes to his *literacy skills,* his parents estimate his skills to be on the level 1 in Russian and on the level 2.5 in Finnish.

Learning process

In the first assessment field Juri reached the score 9 out of 23 (A, I, K, M, O, R, S, U, V). In the second assessment field Juri's score was 13 out of 23. He had learned the letters J, Y, T and Ö. However, his score remains on the poor level.

According to these results, Juri seems to have difficulties with B, D, E, F, G, H, L, N, P and Ä. In addition, during the seven first trials of the game, Juri recognized Y only 57% of the time and the letter Ö in 43% of its appearances. During the game, he managed to boost his score for the letters that he had difficulties with at the beginning of the game.

When looking at the Daisygraph for Juri's results, we can see that for the target letter B there are three strong distracters: M, H and G. For target letter D the strong distracters are G, B, P and T. In the case of the letter E it has been mixed up with distracter T in more than 50% of the trials (11) and it is also sometimes (20% of the 8 trials) mixed up with A. The target letter G is most often mixed up with D, then K, B and H. The letter N has been mixed up in about 40% of the 15 trials with the letter M.

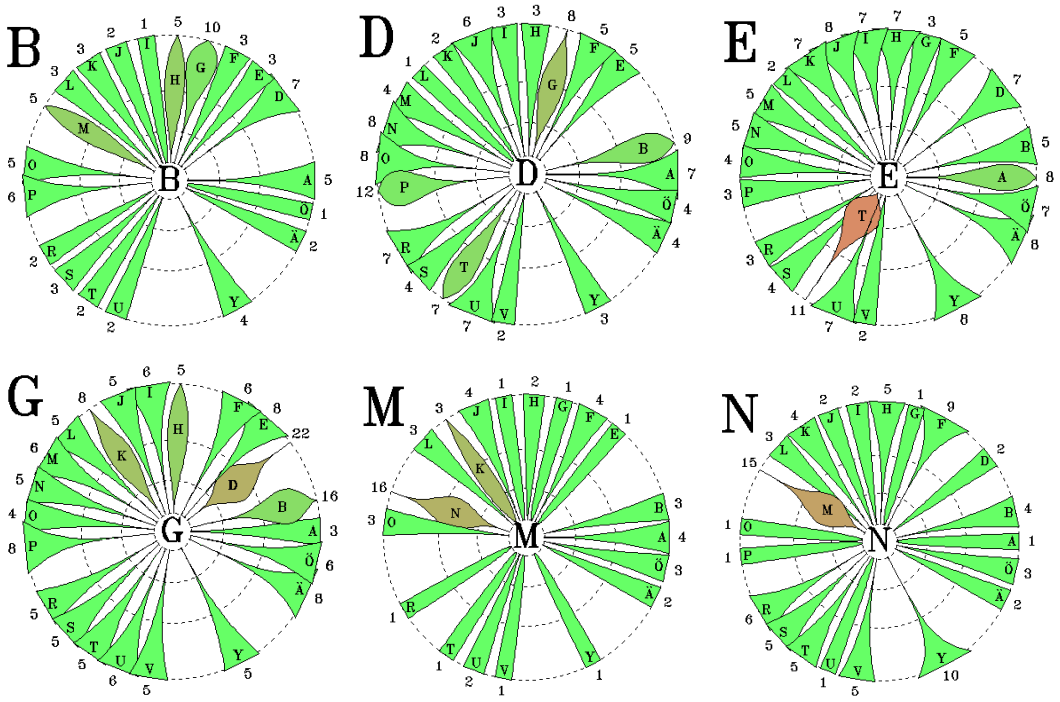


Illustration 6: Juri, Daisygraph illustrating difficulty in target letters B, D, E, G, M and N.

Juri's scores for syllables and words were moderate at the beginning of his playing time and he managed to progress with the help of *Graphogame.* For instance, he recognized the word MA-TO at first at 29% accuracy and at the end at 86% accuracy. In addition, he had scored 43% of correct answers in syllables UO and KE and in the end he got them all correctly (100%). For the most of the syllables his score in the end was between 86% and 100%. His results relapsed remarkably only in terms of the following elements: MO (from 100% to 71%), TI (from 86% to 71%), RU (from 100% to 86%), UU-NI (from 86% to 57%).

It would have been interesting to study the results of the rest of the assessment fields that Juri completed, but unfortunately they cannot be taken into account due to very short time of exposure

to these particular fields. All in all, there is a trend of progress in Juri's results that can be spotted from the percentages of his correct answers in the seven last trials of the game fields. However, due to lack of information in the assessment fields, the progress cannot be highlighted, since his results remained on the poor level.

Interestingly, Juri's parents had estimated their son's literacy skills to be better in Finnish compared to Russian, even if the letters Juri has trouble with are mostly the ones that cause the most trouble because of the Russian influence. It is also important to take into account that Juri was diagnosed with dysphasia and that he has attention problems. However, it is impossible to estimate their impact on Juri's game results. In any case, it has been generally stated that computer games may be helpful for children with attention problems, since they help them to concentrate and they consist of a proper amount of stimuli. Further information would be needed in order to further analyze this benefit for Juri.

3.7. Tamara

Tamara was born in 2003 and has lived in Finland for 4 to 6 years. She played the game both at school at home for a total of 1 hour 8 minutes (4060,6 seconds) in 7 sessions. She completed the field 4 of the game and the two first assessment fields. Her median playing density was every 5 or 6 days.

Language background

Tamara's father is Finnish and mother Russian speaking and both of the languages are spoken at home (input of Finnish 60%). She has attended Finnish kindergarten or preschool and has not received any Finnish as a second language teaching. According to the estimations of her parents, Tamara speaks only a little Russian, understands Russian very well, speaks Finnish and that she speaks and understands Finnish very well (*Oral skills in Finnish* 4, *in Russian* 3). She does not yet know how to read in either Finnish or Russian (*Literacy skills in Russian* 1 and *in Finnish* 1,5 implying that she is learning to read, the most probably due to the ongoing literacy training). At home she is read to in Finnish. She has 4 to 5 Finnish friends and she plays with them daily. Her parents report her having sometimes trouble with being uncommunicative, with pronunciation, comprehension and trouble with certain phonemes. They also estimate that it is highly important for Tamara to learn the Finnish language.

Learning process

Tamara played only the fields of *Graphogame* with letters (except for syllable TI). In the first assessment field of Tamara got 3 out of 23 correct answers. She recognized correctly only the letters B, O, S. During the seven first trials these letters were recognized at 86% accuracy level. In the second assessment field of *Graphogame* she got 9 out of 23 correct answers, staying thus on the poor level of scores. She knew the letters A, E, I, L, M, O, R, S, T and did not get the following correctly: B, D, F, G, H, J, K, N, P, U, V, Y, Ä, Ö.

However, when studying the table 3 (page 45), we can see that among the letters Tamara got correctly in the second assessment field, there were ones in which she performed poorly during the 7 first trials of the game: E (43%), T (43%), I (57%) and L (57%). In addition, the target letter Ä she recognized in 71% of the trials. According to these results she seems to have problems with E, D, F, G, H, I, J, K, L, N, T, P, U, V, Y, Ä and Ö. She made 450 correct selections and 150 incorrect selections. Therefore, 25% of her selections were incorrect. During the seven last trials of the game, Tamara managed to improve her results for all the letters in spite of B (dropped from 86% to 71%) and Ä (relapsing from 71% to 57%). However, Tamara only reached the perfect score (100%) in the following letters: I, L, O, S and T. In addition, she reached the level of good performance (86%) in letters A and M. When it comes to the remaining letters, her results remained moderate.

When studying the Daisygraphs, we can see that there are several strong distracters for almost all the letters. For instance, the target E has gotten the most often mixed up with B, Y, Ö, A and Ä but sometimes also with U, P, O, M, L, K, J and H. The letter Ä has been mixed up with especially with A and G but also sometimes with D, E, H, I, K, M, S and T.

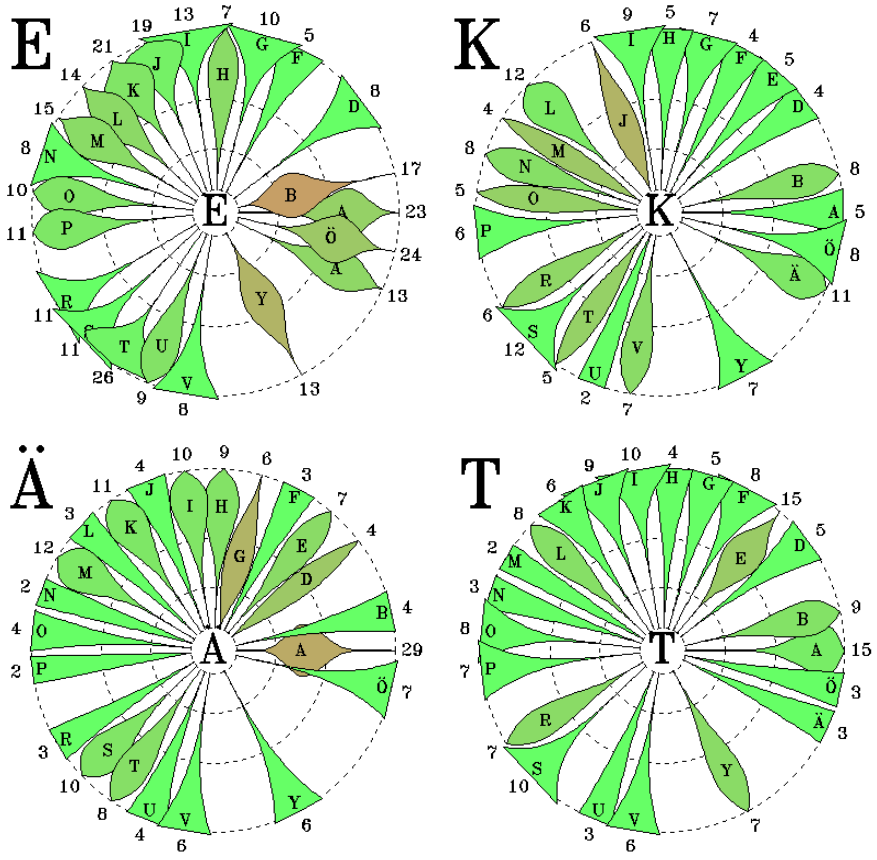


Illustration 7: Tamara, Daisygraph illustrating difficulty in E, K, Ä, T.

Target letter	Number of Trials	The seven first trials' performance level	The seven last trials' performance level	All trials' perfomance level
A	99	71%	86%	79% ↑
B	43	86%	71%	81% ↓
D	11	57%	71%	64% ↑
E	99	43%	57%	65% ↑
G	13	43%	71%	54% ↑
I	36	57%	100%	67% ↑
J	18	43%	71%	61% ↑
K	40	57%	71%	68% ↑
L	15	57%	100%	73% ↑
M	22	71%	86%	77% ↑
O	45	86%	100%	96% ↑
P	8	43%	43%	38% –
S	23	86%	100%	96% ↑
T	39	43%	100%	77% ↑
TI	7	71%	71%	71% –
Ä	60	71%	57%	63% ↓
Ö	29	57%	57%	66% –

Table 2: Tamara, Table illustrating Tamara's performance during the seven first and the seven last game trials and her progress in the game.

Tamara's results correspond with the estimation of her parents, who estimated her literacy skills to be in the level of 1.5, indicating a very poor level. This may be due to the fact that she is only learning to recognize the letters and in both of her languages at the same time. It is also possible that the short playing time and weak playing density affect the reliability of the results. For instance, it could be seen from the Daisygraphs that there were several thin petals for distracters, implying that the number of times the target letter and the distracter had occurred together was not big enough for calculating the mixing effect of the distracter. In this case the distracter's influence was not illustrated on the graph at all. When looking at the assessment field scores, Tamara shows some progress, even if she did not manage to reach the average level. Due to the short playing time, she only completed the first two assessment fields. Based on her game results we can presume that playing the game further would have been beneficial for her letter-sound knowledge.

3.8. Pavel

Pavel was born in 2002 and has spent less than a year in Finland. Pavel played *Graphogame* both at school and at home about every day for a total of 4 hours 42 minutes (16900,4 seconds) in 19 sessions, reaching the 16th field of the game. He completed the first six assessment fields of *Graphogame* out of which the first four were completed during the 3-week playing time and are thus the ones included in the study.

Language background

The first language of both of Pavel's parents is Russian and only Russian is spoken at home (input in Finnish 20%). Pavel has attended Finnish kindergarten or preschool and receives Finnish as a second language teaching. Pavel is read to and he uses media in both Finnish and Russian. He takes part in a social hobby every other day, has two to three Finnish friends and plays with them daily. His parents estimate that he understands Russian better than Finnish (5/5 for Russian, 4/5 for Finnish) and that he speaks both of the languages fluently. According to the estimations of his parents, he also has moderate reading and writing skills in both of the languages (*Literacy skills* in both of the languages 3). He has language related difficulties every now and then. His parents estimate that it is very important for Pavel to learn the Finnish language.

Learning process

In the first assessment field of *Graphogame,* at the beginning of the game, Pavel's score was 21 out of 23. He knew the letters: A, B, C, D, E, F, G, H, I, K, L, M, N, P, R, S, T, U, V, Y, Ä and Ö. He only chose an incorrect answer for J (S) and O (no answer). In the second assessment field, Pavel got the score 22, getting only an incorrect answer (O) for L. In the third and the fourth assessment fields his score remained 22, but in these fields he gave an incorrect answer (V) for the target letter F. His scores remained thus on a good level. In *Phonological awareness test* his score was 19 out of 20.

When looking at Pavel's results more closely, we can see that during the seven first trials of the game, Pavel had some difficulty in recognizing N (71%), F, G, J, L and O (86%). During the game, Pavel has managed to boost his results for letters J, L, N, which he knew during the seven last trials perfectly (100%). His results for F and O remained the same and for G they relapsed to 71%.

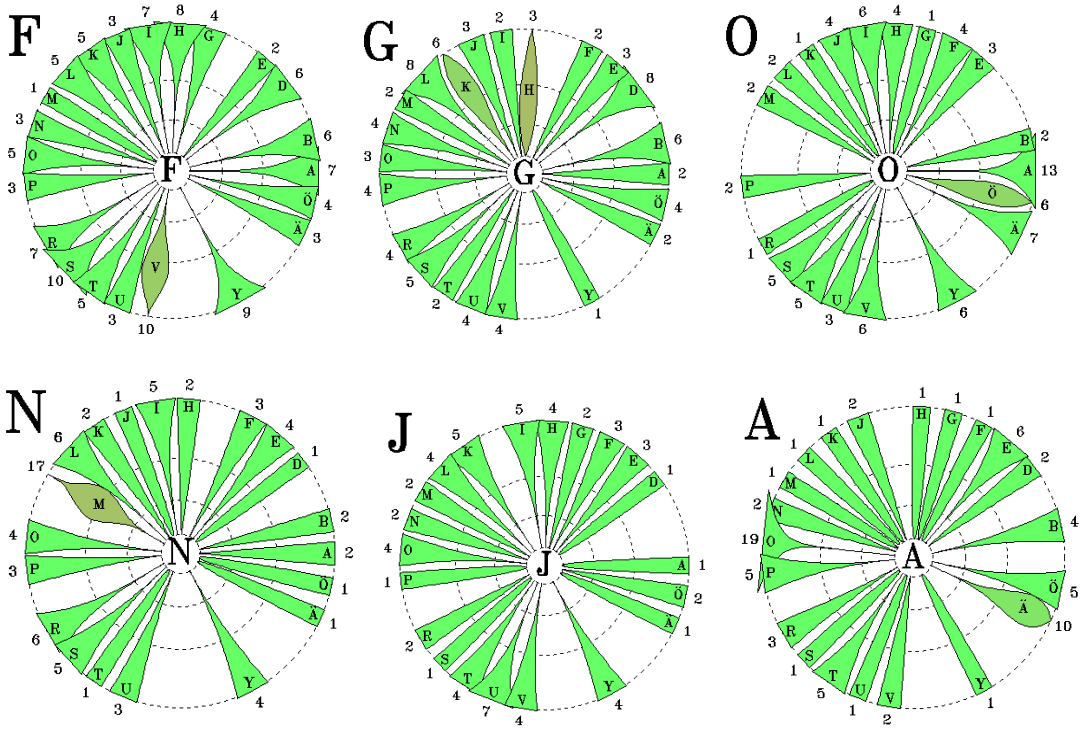


Illustration 8: Pavel, Daisygraph illustrating the performance in the target letters F, G, O, N, J and A.

However, in Daisygraphs we cannot see difficulty for all of Pavel's difficult letters (N, F, G, J, L, O), because the distracter petals are too thin, implying that they have not occurred together with the target letter enough times in order to calculate the performance percentage. This can be seen for instance when looking at the Daisygraphs of J and O. In addition, Daisygraphs reveal some mistakes that could not be seen in the game results, for instance that the target letter N has been mixed up in 25% of the 17 trials with the letter M. In addition, the target letter A has sometimes been mixed up with distracter Ä.

All in all, Pavel made 2125 correct selections and only 157 incorrect selections when playing the game, which implies a very good level of skills. Therefore, he also got good results in terms of syllables and words. Interestingly, Pavel did not show any remarkable difficulty even in words with double vowels which can be especially difficult for Russian speakers. For instance, at the beginning of the game, he got a perfect score for words UU-NI, AAL-TO, AAR-RE, UUR-NA, AA-SIIN, AAL-TOON, KOON-NIN and TUU-LEEN. He also managed to progress during the game in terms of syllables and words. For instance the syllable TE he recognized at first at 71% accuracy level and

perfectly (100%) at the end. He recognized he word KÄYN-TI correctly in 43% of the seven first trials and in 71% of the seven last trials. However, his scores for some words relapsed, for instance for AA-MUUN, ÄÄN-TÖ and AAL-TO. All in all, his game results stayed very good throughout the playing time, despite of some relapses.

Pavel's results are impressive when his language background is taken into account. He has lived for less than a year in Finland and only Russian is spoken at home and his parents estimate that Russian is Pavel's stronger language. In addition, they estimate Pavel to have only moderate literacy skills in both languages. However, Pavel's game results are very good even if he sometimes mixed up the target letter with the distracter (for instance F with V and N with M). It is possible that the parents were not able to correctly estimate Pavel's literacy skills in Finnish, due to the fact that they do not speak Finnish and they probably cannot help Pavel with his Finnish homework either. In Pavel's case there are probably several factors that have contributed to the good results. The fact that Pavel played *Graphogame* in March implies that he has already participated in reading tuition during the seven first months of the first school year, during which the majority of Finnish children acquire reading skills. In addition, the fact that Pavel has participated in Finnish kindergarten or pre-school and receives Finnish as second language teaching must have helped him in catching up with Finnish children in acquiring literacy skills in Finnish. The social hobby that he takes part in every other day can also have helped him in boosting his language skills. It would have been interesting to know if Pavel receives any reading tuition in Russian. If he does attend reading tuition in Russian, he manages to block the transfer from Russian very well.

3.9. Summary of the results

According to the results of the pilot study (Rantanen et al., 2008), the most difficult letters for Russian speakers were the ones that have a different phonemic counterpart in Russian compared to Finnish (B, D, F, G, H, N, P and R). These letters were also the ones that were represented the most often as the most difficult letters in all the case stories. In addition, in the case stories the letters Ä and Ö were also among the difficult letters, which can stem from the fact that they do not exist in Russian.

Name of the player	**Difficult letters**
Jelena	A, B, D, F, G, L, N, P, V, Ö
Mihail	D, E, H, I, L, Ö
Vera	D, F, G, K, V, Y, Ä
Vitali	B, F, V, Y, T, H, K
Irina	A, B, F, G, L, M, S, Ö
Juri	B, D, E, F, G, H, L, N, P, Ä
Tamara	E, D, F, G, H, I, J, K, L, N, T, P, U, Y, Ä, Ö
Pavel	N, F, G, J, L, O

Table 3: Difficult letters in each case story

The results of these eight case stories are promising: all the children managed to progress in the game despite of their different language skills and starting levels. The players acquired better and better results in the assessment fields, in spite of some relapses (Jelena, Mihail, Irina). There was progress even if the player started from a very poor level, for instance in Tamara's and Vera's case. However, when looking into the percentage of correct answers during the seven last trials played, the results are less convergent, especially when it comes to syllables and words. In the results of several players there was both progress and deterioration. However, it must be taken into account

that the percentage of correct answers per the seven last trials is less reliable as an instrument compared to the results of assessment fields of *Graphogame*. Nevertheless, the percentage can give supplementary information, especially in terms of difficult letters, syllables and words. All in all, the percentage of correct answers during the seven last trials demonstrates that *Graphogame* is more beneficial for learning letters in comparison with syllables or words. For instance, Mihail, who already knew the letters well when starting to play the game, did not show any remarkable progress in syllables or words represented by the percentage of the seven last trials. The percentage of the seven last trials also demonstrates less relapse in letters compared to syllables or words. For instance in Vera's, Vitali's and Irina's case, the results for syllables or words remained the same or deteriorated more than ameliorated according to the percentages of the seven first and the seven last trials. Only in Juri's and Pavel's case were the results for syllables and words clearly better during the seven last trials in comparison with the seven first trials of the game.

When it comes to the connection between the language background information and the game results, there were several surprising issues. The only correlation was that in general the parents' estimations of the child's literacy skills were convergent with the initial skills (measured in the first assessment field), except for Irina's and Pavel's case. On the contrary, the oral language skills in Finnish, estimated by the parents did not correlate with the game results. For instance in Tamara's case, her parents had estimated her oral skills to be good, whereas her results in the game were poor. However, it is important to take into account that investigating the children's skills only with the help of a questionnaire does not give a realistic image and more objective assessment methods would have been needed. The time lived in Finland should have been an important factor influencing the language skills of the child. However, different case stories were chosen, representing different lengths of time lived in Finland and occurring with different game results. Therefore, there were cases in which the player was born in Finland, had good oral language skills in Finnish and still had poor game results (Vera and Juri). In addition, there was the case of Pavel who had lived in Finland for less than a year and had very good results in the assessment fields. In Pavel's case there were several supporting factors in his language background that could have helped him in catching up with Finnish children. The different case stories demonstrate how immigrant children have unique language backgrounds which affect their learning paths in reading acquisition in Finnish in different ways.

It would have been interesting to get more background information on the players, such as whether or not they attend Russian literacy tuition. It would have also been interesting to hear the players' opinion of the game and to get more information about the intervention circumstances, such as the headphones used, the length of each playing session etc, because there were some

results that had to be excluded due to a short exposure time implying the lack of concentration of the player. In addition, even if the game results showed some progress in the players' skills, the results were expected to be even better than they turned out to be. The reliability of the results would have also been better if the playing time of the players had been more similar. The mean playing time in this group was 304.5 minutes (5 hours), which is sufficient, but is strongly distorted by Vera's long playing time (16 hours and 50 minutes). When Vera's playing time is left out, the mean playing time of this group is 210 minutes (3 hours and 30 minutes). In addition, it would have been interesting to run a post-test in order to find out the efficacy of the intervention. There were cognitive-linguistic tests designed to be a part of this study, which were to be conducted at the beginning, in the middle and at the end of the playing period. However, these tests were finally completed by only the minority of the players, and therefore they were not included in this study.

3.10. The teachers' feedback on the intervention

Six teachers completed a questionnaire after the intervention and their responses covered the information concerning 23 players and four out of the eight case stories. The number of pupils per teacher was between 1 and 7 and therefore the results are calculated based on the percentages of the 23 pupils provided by the six teachers. The questionnaire completed by the teachers gave promising results. In general, the playing sessions could be organized well without any major problems. The teachers of 78% of these 23 children felt that the game served its purpose either well or very well. In addition, concerning 78% of these children, the teachers also estimated that the children found the game either pleasant or very pleasant. Out of the 23 players, the game's difficulty level was estimated to be good for 61% of the players. In addition, the teachers estimated that the game made the players' skills progress in 61% of the cases. On the contrary, only small progress was reported by teachers of 22% of the players. When it comes to the questionnaires completed by the teachers of the four case stories, the questionnaires include only positive comments on the game and the intervention. These teachers reported the game to be motivating for the children. In addition, they estimated that using the headphones helped the pupils to concentrate on playing.

All in all, the teachers gave positive feedback on the game in general and estimated that the game helped the pupils in acquiring the basic skills of reading acquisition. However, it is important to take into account that only 6 questionnaires were returned and thus, there is a lot of information missing. It is impossible to try to estimate the value of this missing information. Interestingly,

however, in terms of the six returned questionnaires, the teachers' comments on the effectiveness of the game were somewhat convergent with their pupils' progress in the game. In other words, the teachers were more likely to report having noticed progress in the pupil's skills when there had been clear progress in the pupil's game results. The teachers' subjective estimation that the *Graphogame* is a useful tool in learning the basic skills of reading acquisition is not, however, a sufficient element to prove the effectiveness of the intervention period. A supplementary post-test would have been needed in order to show the constancy of the learned skills. Nevertheless, the teachers' positive experiences of the game, together with the pupils' progressive game results give support to the assumption that playing the game is useful.

4. DISCUSSION

The main purpose of this study was to investigate if children from Russian speaking families benefit from playing *Graphogame* in terms of learning the letter-sound correspondences in Finnish. The results from the eight case stories showed that there was progress in the scores of the assessment fields regardless of the starting level. Further, we hypothesized that the children's language environment would affect their game results. This was shown to be the case especially in terms of the influence of Russian phonology on children's responses during the game. In addition, we had anticipated that the amount of Finnish input would affect the game results making the children who are more exposed to Finnish in their language environment to be ahead of their peers who hear and speak only Russian outside of school. In general, when looking only at the languages spoken at home, the results did not support this hypothesis: for instance Vitali, who had spent less than a year in Finland and was not exposed to Finnish at home (0%), reached a better score in the first assessment field (score 13) compared to Vera (score 2), who was born in Finland and was exposed to Finnish the majority of the time at home (85%). The same was true when comparing the results of Juri (born in Finland, 0% of Finnish input at home, score 9) and Tamara (4 to 6 years in Finland, 60% of input in Finnish at home, score 3). Therefore, the extent of the children's exposure to Finnish did not directly affect the game results. When comparing different children's language backgrounds with their game results, there could not be distinguished any general outcomes for certain language backgrounds. However, children's immersion in social activities with Finnish children seemed to have contributed to their language skills in Finnish. On the contrary, the transfer influence of Russian language on the children's letter-sound knowledge in Finnish was distinct and affected the children's game scores regardless of their language background. Therefore, the most concrete implication of the research was the influence of Russian on the game results.

4.1. The effect of language environment on immigrant children's reading acquisition in Finnish

The main aspect of this study concerned Russian immigrant children acquiring literacy related skills in their second language, Finnish. Earlier studies suggest that the two interrelated factors affecting second language reading acquisition are the individual's language proficiency in the given language

and their phonological awareness skills (Leikin, Share & Schwartz, 2005). Out of these two, language proficiency is largely influenced by experience: in other words, the individual's language environment. Elements contributing to immigrants' second language proficiency are thus the early exposure to the language (Hoff, 2006; Pearson, 2007), daily participation in the activities of local institutions and interaction with people from the broader community. This study assessed these language environment related factors with the help of a questionnaire completed by the children's parents. The questionnaire involved questions about the extent of the children's exposure to Finnish, about the number of their Finnish friends and Finnish activities and about their linguistic skills (estimations of the parents). The second factor affecting second language reading acquisition, the phonological awareness, for one, is a result of one's linguistic experience as well (Hoff, 2006; Kuhl et al., 1992; Bosch & Sebastián-Gallés, 2001) but it can be also trained with the help of literacy teaching and supplementary training (Bus & van Ijzendoorn, 1999; Wimmer & Goswami, 1994;Foy & Mann, 2006). This study illustrated that *Graphogame for immigrants* was an effective supplementary training method for immigrant children who are learning to read in Finnish.

Learning to read in Finnish is a demanding task for Russian speaking immigrant children due to the differences between the two languages and sometimes also due to the lack of experience in Finnish language, which was the case for Vitali for instance. When it comes to bilingual reading acquisition, Bialystok et al. (2005) claimed that the decoding skill develops separately for each language based on proficiency and instruction of the language and does not transfer to another language. Bialystok (2006) claimed this to be the case especially in terms of bilingual children learning to read in two different scripts. According to these results we can conclude that Russians do not profit from transfer of skill between the Russian and the Finnish language because Russian uses a different script. Therefore, the Russian immigrant children need to use their phonological skills in order to acquire reading skills in Finnish. In addition, a child's poor language skills in Finnish – which may be due to a lack of experience – may lead them to use the reading pattern of Russian when learning to read in Finnish, which leads to mistakes in letter-sound correspondences.

4.1.1. The early exposure to Finnish

Studies done by Hoff (2006) and Pearson (2007) indicate that the age of exposure to a certain language is a strong predictor of the level achieved in that language. In addition, according to Pearson (2007), the number of acquired words correlates with the estimates of input in the particular

language. When looking at the matter from the opposite point of view, Hoff (2006) claimed that less than 25% of input in a particular language is not sufficient in order to learn the language. Interestingly, however, when looking at the case stories, several children were raised in a fully Russian environment (according to their parents) or had recently moved to Finland and still had a very good starting level in the game (Mihail, Pavel). In addition, there were children who were born in Finland or were more exposed to Finnish at home compared to Russian and still had a poor starting level (Vera, Tamara). Therefore, in terms of the eight case stories, no direct connection could be distinguished between the early exposure to Finnish and the score of the first assessment field of the game. This is understandable, however, when taking into account that *Graphogame* does not directly measure the second language skills (that Pearson and Hoff refer to) of the player but their phonological skills and more specifically the skill of recognizing letter-sound correspondences. The good level of second language acquisition, however, contributes to the phonological skills in a language. In addition, it must be taken into account that in this study, the input of Finnish was estimated with the help of the subjective estimations of the parents. Another aspect to take into account is that the children had been in contact with the Finnish speaking community, since they attend Finnish schooling. Therefore, we cannot presume that when the children were not exposed to Finnish at home (asked in the questionnaire) they would not have the chance to learn the language anywhere else. Furthermore, the fact that the children attended Finnish reading instruction also contributes to their phonological skills in Finnish. The impact of the instruction can probably be seen for instance in the results of Pavel, who played *Graphogame* in March after having participated in literacy teaching during 7 months. There are also other factors to take into account in order to explain why the link between the extent of exposure to Finnish and the starting level of the children's letter-sound knowledge skills was so weak. One of these factors is the strong influence of Russian language on learning to read in Finnish.

4.1.2. The influence of Russian

When looking more profoundly at the game results, it could be seen that in general the children showed the most difficulty with graphemes that had two different phonemic counterparts in their two languages: All of the children had trouble with letters which were somewhat the same. In general, the letters that presented the most trouble for all the study subjects were B, D, F, G, H, N, P and R, which gives support to the earlier findings of Rantanen et al. (2008). The children of the

eight case stories showed the most difficulty with the letter F, which was difficult for seven children and the letter G, which caused difficulties for six children. For instance, at the beginning of the game Jelena only recognized the letter G at the accuracy level of 43% and similarly Vitali recognized the letter F at 43% level. When it comes to the remaining letters, the study gave the following result: the letter B was difficult for four children, five children had trouble with the letter D, six children had trouble with the letter H, four children had trouble with the letter N and three children had trouble with the letter P. In addition, three children found the letter Ä difficult and four children were having difficulties with the letter Ö, probably due to the fact that these letters do not exist in Russian. There are a couple of good examples of the difficulty with these letters: Juri recognized the letter Ö at the accuracy level of only 43% at the beginning of the game and as for Vera, her score for recognizing the letter Ä relapsed from 46% to 29% during the game trials. On the whole, another interesting thing to notice was that even if the same letters were difficult for all the study subjects, different distracter letters were present in each case story. In other words, even if the children all made wrong selections in terms of the same letters, there were considerable differences in the children's daisygraphs. For instance Vera repeatedly confused F and H whereas Pavel confused F and V. This was true in terms of all the target letter and distracter letter pairs, except for the letters M and N, which were mixed up together by Jelena, Vera, Irina, Juri and Pavel. Therefore, we can conclude that the Russian influence was seen by the fact that the subjects often gave a wrong response to the certain letters, without there being any particular (Russian) distracter letter to be chosen instead of the Finnish one. Another interesting finding was that of the double vowels. For instance Vera's one of the most systematically occurring difficulty concerned the double vowels AA and EE. Mihail faced the same difficulty in terms of syllables and words containing vowel clusters, such as TEIN, LOUR, UU-NI, EUK-KO and KÄÄN-TÖ. Interestingly, however, Pavel did not show any remarkable difficulty in words with double vowels. These clusters and double vowels are known to be generally difficult for Russian speakers, due to the fact that in Russian there are only 6 vowel phonemes which is little compared to the Finnish 8 short and 8 long vowel phonemes (de Silva & Ullakonoja, 2009).

The strong Russian influence on the game results can be easily understood when looking at the research done by Kuhl et al. (1992), who concluded that exposure to a specific language during the first 6 months of life alters an infant's phonemic perception. During the first year of life, the infant's neurological system changes and phonemic perception gets tuned to distinctions that are relevant (Bosch & Sebastián-Gallés, 2003). That is why early exposure is important in terms of acquiring phonological skills and a native level in a certain language.

All in all, we can conclude that the importance of early exposure, even if it could not be seen in terms of the amount of Finnish input in relation to acquired phonemic skills in Finnish, it could be seen in terms of Russian: the influence of early exposure to Russian could be seen by the fact that when the children heard phonemes that have a different counterpart in Russian, it left them confused. Interestingly, this was the case for also those children who had Finnish fathers and were more exposed to Finnish at home compared to Russian (Vera 85%, Jelena 50%, Tamara 60%). This can probably be explained by the fact that the mother is Russian and thus the majority of the early input has been Russian. It is also important to take into account that Finnish and Russian differ a lot in terms of their phonemic structure and this can lead the children to be confused between the two languages. In Russian, the phonemic counterpart of a syllable can be decided based on the adjoining letters or their positions (Kerek & Niemi, 2009), whereas in Finnish the phonemic representations of letters are almost fully consistent. According to Hoff (2006) and Werker et al. (2006), children exposed to two languages either develop two phonetic categories or process both languages through a single phonological system. In addition, if only one phonological system is used, this can indicate one language being more dominant than the other. It is impossible to say, only by looking at the game results, whether these children are using one or two processing systems. However, Kuhl et al. (1992) suggest that the native-language focus explains the difficulty of second language learners in processing speech sounds. If the child has learned to process language according to the Russian language model, it will not work when trying to recognize letter-sound correspondences in Finnish. In addition, it must be taken into account that acquiring letter-sound decoding skills is more difficult for languages with complex phonology (Seymour et al. 2003; Aro, 2004; Wimmer & Goswami, 1994). Therefore, if the child is already learning to read in Russian (complex phonology language), one can assume that it can slow down the child's reading acquisition in Finnish.

4.1.3. The importance of the broader community

One of the interesting issues revealed by the study was that many of the children coming from Russian speaking homes (N=24) still had very good game results to start with. Probably this can be explained by the fact that the children participated in activities with Finnish speaking children in addition to the fact that the children had already had some literacy skill tuition.

The importance of Finnish friends could be seen in the game results. For instance, Jelena had more than eight Finnish friends and played with them daily: her game results were on the average

level (16, 21, 20, Phonological awareness test 20/20). On the contrary, Vitali, who had arrived in Finland less than a year ago and had either none or one Finnish friend was reported to not to speak Finnish by his parents (his game results were 13 and 18). The most remarkable game results of Pavel (21, 22, 22), who had spent less than a year in Finland was undoubtedly affected by the fact that he was reported playing with his two to three Finnish friends daily and that he attended a social hobby every other day. All in all, the game results give support to the hypothesis that making friends with Finnish speaking peers helps the immigrants in adjusting to the Finnish speaking community.

Nevertheless, a child's personality plays an important role in the extent to which the child is social and thus benefits from the social contacts in terms of their language acquisition. For instance Tamara (scores 3, 9) and Juri (9, 13) were reported by their parents to be sometimes uncommunicative and that can undoubtedly affect their relationships with their peers. However, it is impossible to find out the effect of the children's personality on their game results or on their relationships with peers based on the current test results.

According to the study of De Houwer (2007), the dominant language is easier to learn, compared to the minority language, for children living in a bilingual setting. This is because the dominant language is spoken at school and by peers and by the majority of the community. Therefore, when it comes to the Russian immigrants learning the Finnish language, this is a promising result: The fact that Finnish is the dominant language of the broader community motivates the immigrant children to learn the language even if the neurological processes influenced by early exposure build an advantage for Russian phonology. Furthermore, provided that the child already has some fundamental language skills in Finnish, the fact that Finnish is a very alphabetical language with simple phonemic structure helps in acquiring reading skills in Finnish. Therefore, the basis for Russian immigrants to learn the Finnish language is fortunate and they also clearly benefit from additional support, provided by *Graphogame,* in terms of acquiring the letter-sound correspondences in Finnish.

4.2. The utility of *Graphogame*

As mentioned before, the level of individual's phonological awareness plays an important role in terms of their second language literacy acquisition. Therefore, it is important to give second language users some additional support in boosting their phonological skills. According to the study

of Ylinen et al. (2009) phonetic training was shown to be useful for second language users in order for them to learn to weight phonetic cues in a more native-like manner. Similarly, the phonetic training provided by *Graphogame* can contribute to second language users' acquisition of letter-sound correspondences.

Earlier studies indicate that *Graphogame* provides support for children facing difficulties with letter-sound correspondences (Lyytinen et al. 2005, Lyytinen et al. 2007, Lyytinen 2008, Lyytinen et al. 2009, Hintikka et al. 2005). The current study showed that this applies to Russian immigrant children as well: Russian immigrant children profited from playing *Graphogame*. This could be seen from the game results of the eight case stories: the assessment field results got better when the children progressed in the game, with an exception of Mihail, whose result dropped from 23 to 21 and Jelena, whose score dropped from 21 to 20 in the third assessment field. In spite of the minor drop, both Mihail and Jelena stayed on their initial level of performance. The most progress can be spotted in Irina's results since she managed to progress from the poor to the high level of performance. Interestingly, even the players with poor game results, Vera, Tamara and Juri, progressed in the game, despite the fact that their results remained on the poor level. In addition, the teachers generally (61%) estimated that the intervention contributed to the basic skills of reading acquisition of the children. This finding gives support to Wimmer's and Goswami's (1994) suggestion that giving phonemic instruction and teaching grapheme-phoneme conversions to children is important. The teachers of 78% of the children also reported that children found playing *Graphogame* either pleasant or very pleasant. These comments underline the utility of *Graphogame* in the classroom setting.

Interestingly, the intervention also helped Vitali, who was reported having attention problems. He managed to progress from the poor level to the average level having completed only two assessment fields (scores 13 and 18). This result gives support to findings of Hintikka et al. (2005), whose study showed that one of the groups getting the most benefit from playing *Graphogame,* compared to attending ordinary reading instruction, were children with attention problems who had poor phoneme awareness. On the contrary, the case story results did not indicate a clear benefit from syllable training, which, according to the findings of Huemer et al. (2010) helps to recognize the syllables practiced when reading and thus the training should promote cipher reading. In Mihail's case the syllables appeared difficult to learn even with the help of extensive training offered by *Graphogame*. Mihail already mastered the letter-sound connections when starting to play the game (score 23) but he could not learn the syllables with the *Graphogame* method. This could be seen when comparing the recognition percentages at the beginning and at the end of Mihail's playing: his results did not progress for syllables or words. On the contrary, he was able to break

words into pieces, which could be seen by his *Phonological awareness test* result: 18 out of 20. His inability to learn to recognize syllables and words can be affected by the fact that he only had moderate oral language skills in Finnish and that he had not attended Finnish as second language tuition. This underlines the importance of second language proficiency in terms of second language reading acquisition. In addition, the fact that his playing density was every 7 days has probably affected the results as well: a better playing density would have been needed in order to fully benefit from the practice provided by *Graphogame.* In addition, the lack of proper follow-up studies prevents us from seeing the real effect of the intervention. It is possible that playing the game helped Mihail even if it could not be seen in his results. After all, the assessment fields were the strongest instrument to measure the skills and the syllables were not present in the assessment fields.

4.3. Critical analysis

The study was conducted in schools where pupils played the *Graphogame* under the supervision of their teachers, provided that they had written approval from the parents. The number of playing sessions organized was thus dependent on the timetable of the class, on the access to computers and on the initiative of the teachers. In the most cases it took time for the teachers to start the intervention and thus we were in contact with them several times in order to answer their questions and to find out if they were going to participate in the study. Some teachers faced technical problems, some had a very tight schedule and also in some cases children were ill (period of A1H1) and thus were absent. This led to the study sample being considerably small, which led us to choose the case stories as an analysis method for this study. It is impossible to try to estimate the impact of the missing information and the missing study subjects, because we could not contact the parents in order to find out why they did not approve of their child participating in the study. Due to the demanding task of finding study subjects, many of the children participating in the study came from the same class or the same school. However, the case stories were chosen based on several variables in order for the sample to be as informative and representative as possible. Moreover, the teachers did not report any specific details about the successfulness of the intervention, which leads us to not having any information about the intervention circumstances, such as headphones used, about the motivation level of the children and so on which might have affected the game results. All in all, the

research frame was demanding and there were considerable differences for instance in the lengths of playing or the playing density of the participants.

As a result, it could have been preferable that the children played the game at home. Playing *Graphogame* at home could have permitted the playing lengths to be longer and the playing densities to be better. Playing at home would not have interfered with the school schedule. On the other hand, it could have been problematic in terms of technical requirements: only the children whose families possess a computer could have been able to participate in the study. In addition, when taking into account that the most of the families were fully Russian speaking, it could have been perplexing for the children to practice Finnish letter-sound connections at home. According to the study of Oller and Eilers (2002), bilinguals' language knowledge is distributed between their two languages according to the situations. In other words, bilinguals create associations in order to match the circumstances, environments and people with one of their languages. Therefore, when taking into consideration that Russian immigrants practice reading acquisition related skills in Finnish generally at school, the school class can be a more natural environment for them to practice these skills via *Graphogame* as well, in comparison to their Russian speaking home. Moreover, the teachers reported the children being enthusiastic about playing the *Graphogame* during the school day, whereas it could have been questionable to see such enthusiasm for playing at home after a long day of studying at school.

In terms of the reliability issues of the intervention, it is questionable if the game serves its purpose if the child already knows how to read. In this case, the child can get very high scores to start with and they can also easily lose motivation while playing, which can lead to relapses in their game results. However, only a small minority of teachers reported the game having been too easy for children. More specific observation methods would have been needed in order to further analyze motivation-related issues. Moreover, due to the lack of pre-tests, we do not have any information about the child's reading skills in addition to the subjective estimations of their parents. In terms of the eight case stories, Mihail, for instance, already knew the letter-sound connections very well when starting to play the game, getting the highest score 23 in the two first assessment fields but his score relapsed to 21 in the third assessment field. It is impossible to estimate whether the relapse was due to losing motivation or due to a pure mistake. In any case, the game offered Mihail a chance to practice syllables which he did not yet master.

When it comes to the study instruments, the *Graphogame* gives very accurate measures with its different calculation methods and assessment fields. Therefore it is a very reliable instrument. However, the lack of post-tests and a follow-up study in this research prevents us from making any conclusions about the long-term benefit of the intervention. It must be taken into account that there

were supposed to be post-test but less than a half of the students completed them and therefore they could not be taken into account. In addition to *Graphogame*, two different questionnaires were completed by parents and by teachers. However, the results of language background given by the questionnaire completed by the parents did not correlate with any of the game results. As a result, there are several questions to be asked about the questionnaire. First, it is questionable that the Russian speaking parents manage to correctly estimate the level of their child's oral, literal and comprehension skills in Finnish, when taking into account that they do not necessarily communicate with their child in Finnish at all. Second, the subjective character of the estimations should be taken into account. Parents tend to give a positive estimation on the skills of their child. Third, it is clear that more objective assessment methods for measuring the children's language skills and reading skills should have been included in the study in order to get more reliable information about the children's skills. However, the parents' estimations of their child's literacy skills in Finnish correlated in general with their child's *Graphogame*'s starting field result. It is possible that their estimations are based on the feedback they have gotten from the teacher of their child. On the other hand, there were some contradictions in the questionnaire results. For instance, in some cases parents reported only Russian to be spoken at home but at the same time they estimated that for instance 20% of their child's home language input was in Finnish (Pavel). The parents may have included television or media in their estimations. The questionnaire should have thus been more precise, in order for it to be understood in an equal way by all the respondents. In addition, when looking into the relation between the questionnaire results and the game results, there were several questions that were left unanswered due to the fact that the questionnaire did not cover the matter. For instance, it would have been interesting to know, if the child attends Russian literacy tuition, if they currently attend a preparative class or a normal first grade etc. There were thus clearly some faults in the questionnaire.

As a result, due to the fact that the relation between the language background issues and the game results was left somewhat unclear, it was difficult to find prototypes of the children. It would be interesting to know, if the lack of correlations between the language background factors and the game results was due to the weakness of the questionnaire as a study instrument or simply because the children from Russian speaking families have an equal chance of learning to read in Finnish. Further analysis methods, such as interviews and proper pre- and post-tests would have been needed in order to analyze the cases more profoundly.

4.4. Theoretical and practical benefit of the research

Despite the fact that the study frame imposed certain limitations on the extent of generalizations we can make, we can claim, based on the results that *Graphogame* offers immigrant children a chance to practice and to establish basic skills of reading acquisition regardless of their starting level. One of the most interesting findings of the current study was that the children could get relatively good game results despite the fact that their home environment was fully Russian (Mihail, Pavel, Irina). Therefore, in a way the fact that the connection between the language environment and the game results was not obvious is also promising: children from different bilingual environments can have good letter-sound connection skills, even if the home environment is almost fully Russian. In addition, social immersion was shown to play an important role in acquiring the language of the broader community: playing with Finnish friends, attending Finnish pre-school and school clearly had helped the children in acquiring some basic language skills in Finnish. By contrast, another important finding of the study revealed that the same phonemes were difficult for all the children coming from Russian speaking families, regardless of their level in Finnish. This was the case even if the parents estimated Finnish to be their child's strongest language (Vera, Tamara). This highlights the important role of the transfer from Russian affecting the children's choices in terms of letter-sound connections. As a result, we can conclude that the language environment influences different children in different ways but that the Russian influence is strong regardless of the amount of Finnish input at home. Therefore, it would be important to find ways to support the Russian speaking children in blocking the transfer from Russian when learning to read in Finnish.

The fact that the children were also learning to read in Russian might have confused them in terms of learning to read in Finnish, because of the lack of "hints" in reading in Finnish. In Russian children are first taught to find a vowel in a word in order to determine the quality of its adjoining consonant (Kerek & Niemi, 2009). In Finnish, by contrast, reading acquisition is based on learning the individual phonemic counterparts for each letter, without the help of other letters. In addition, in Finnish the focus is more on vowels compared to consonants, which is the opposite in Russian. However, the fact that Russian uses a different script should help the immigrant pupils to not to associate the Russian rules with reading acquisition in Finnish. Nevertheless, it should also be taken into account that learning to read in Russian takes a lot of effort for beginners (Kerek & Niemi, 2009), which can thus reduce the effort left for reading acquisition in Finnish or in any case, confuse the children. Thus, it would be interesting for further studies to investigate the effect of the complicated Russian orthography on reading acquisition in Finnish. It would be interesting to find

out if, in general, learning to read in Russian at the same time as acquiring reading skills in Finnish slows down the reading acquisition process in at least one of these two languages.

As a result of the strong Russian influence on acquiring Finnish literacy skills for Russian immigrants, we can conclude that it is indispensable to create personalized teaching methods for different language groups, especially for Russian speakers since they are the strongest language minority in Finland. *Graphogame* was shown to serve this purpose very well with its different features specially adapted to Russian speakers. Creating more of such supporting methods would also contribute to the National Board of Education's (Opetushallitus, 2009) objective concerning immigrants' schooling: integrating immigrants into the Finnish school system while taking into account their cultural and linguistic background. When looking at the matter from the opposite point of view, without any supportive teaching methods the Russian speaking immigrant children have to cope with two different language environments all by themselves. In comparison to Finnish children, it can be highly demanding for them to learn to read in Finnish without the help of their parents, who do not necessarily have the needed competency in Finnish in order to help their child. Therefore, it would be only fair to provide the needed support for the growing population of Russian speaking immigrant children.

The results of this study into the impact of the language environment raise several new questions to be studied. For instance, it would be interesting to study further the impact of the personality of immigrant children in their socialization, and in their language skills. It would also be interesting to study further the special features of the language environments that were now left uncovered. This could be done by interviewing the parents of the children with the help of an interpreter. In addition, as mentioned before, the language and literacy skills of children should be measured by more adequate assessment instruments. It would be important to add pre- and post-test and a follow-up study to the current study frame in order to investigate the long-term benefit of the intervention in terms of literacy skills. One of the new interesting questions would also be to compare the immigrants' game results to those of their Finnish peers in order to find out if there is a difference between their phonological skills and their progress in the game. This would be an interesting study question because of the fact that some of the most difficult phonemes for Russian speakers were shown to be F, G, B, which are quite rare in Finnish language due to the fact that they are foreign origin phonemes. It could be that these same phonemes would be difficult for Finnish children as well. If this was found to be the case, the fact that these phonemes are rare in Finnish would help to explain the phenomenon of them being among the most difficult ones for the Russian speakers, who may lack language competencies in Finnish. In that case, it would probably be also more convincing to focus on examining children's scores in more regularly occurring Finnish letters that

present difficulties for Russian speakers – P, R, S, T, Ä, Ö – in order to determine the impact of transfer from Russian.

All in all, the current study was important because it covered a matter that has not yet been studied enough. The individual learning paths of immigrant children should be better taken into account when adjusting the teaching methods to their skill levels. Especially the remarkable impact of the Russian influence on the Finnish letter-sound correspondences should be taken into account in literacy teaching and therefore, supportive teaching methods for Russian speakers should be created. *Graphogame* serves this purpose very well and thus it could be implemented in Finnish as a second language teaching for Russian speaking immigrant children. The supportive teaching methods together with social immersion can help the immigrant children in becoming members of the broader community. The bilingual language environment should not be seen as an obstacle for immigrant children to acquire a good level of literacy skills, which, for one, are a basis for the success of further schooling.

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Appendix 1: Questionnaire for parents

Questionnaire about the child's language background

1. **Mother's first language: _____**
2. **Father's first language: _____**
3. **Language/languages spoken at home: _____**
4. **Estimation of the percentage of the child's exposure to Finnish at home: _____**
5. **The child has lived in Finland _____ years.**
6. **Has the child participated in Finnish kindergarten or preschool?** 1) yes 2) no
7. **Does the child have any social hobbies? If they do, how often?**

   0) no hobbies
   1) once a month
   2) once in two weeks
   3) once a week
   4) 2-4 times a week
   5) daily

   (Supplementary information): _____
8. **How many Finnish speaking friends does the child have?**

   1) 0-1 2) 2-3 3) 4-5 4)6-7 5) 8 <
9. **How often does the child play with their Finnish speaking friends?**

   1) once in a 2 weeks time or more rarely
   2) once a week
   3) a couple of times a week
   4) every other day
   5) daily
10. **The child reads/is read to at home:**

    1) in Finnish
    2) in Russian
    3) both in Russian and in Finnish
    4) no reading at home
11. **In which language does the child use the media (tv, magazines, games etc.)?**

    _____

    _____

The child's language proficiency

12. **Does the child participate in Finnish as a second language teaching?** 1) yes 2) no

13. How important is it for the child to learn Finnish?

1) not at all important
2) a little bit important
3) somewhat important
4) very important
5) extremely important

14. The child speaks Russian:

1) not at all
2) a little
3) to some extent
4) a lot
5) always

15. The child understands Russian:

1) not at all
2) understands a little
3) averige skills
4) understands well
5) understands fully

16. The child writes Russian:

1) not at all
2) a little
3) averige skills
4) well
5) competent writer

17. The child reads Russian:

1) not at all
2) a little
3) with some trouble
4) well
5) competent reader

18. The child speaks Finnish:

1) not at all
2) a little
3) to some extent

4) a lot

5) always

19. The child understands Finnish:

1) not at all

2) understands a little

3) averige skills

4) understands well

5) understands fully

20. The child writes Finnish:

1) not at all

2) a little

3) averige skills

4) well

5) competent writer

21. The child reads Finnish:

1) not at all

2) a little

3) with some trouble

4) well

5) competent reader

22. Does the child have difficulties with language?

1) never

2) rarely

3) every now and then

4) often

5) all the time

23. How do these difficulties occur?

0) no difficulties

1) difficulty in finding words

2) coyness, uncommunicativeness

3) pronounciation difficulties

4) certain phonemes are difficult

5) over generalization of grammatic rules

6) difficulties in comprehension

7) other

difficulties:_____

Supplementary information:

_____

_____

Appendix 2: Questionnaire for teachers

Questionnaire for teachers: Graphogame for immigrants 2009

1. **Teacher who supervised the playing sessions: _____**
2. **Child/children who played Graphogame: _____**
3. **Organizing the playing sessions worked out:**
   1) fine
   2) ok
   3) not very easily
   4) I do not know
4. **Were there any technical problems when organizing the playing sessions?** 1) yes 2) no
   What kind of problems: _____
5. **The game served its purpose:**
   1) very well
   2) well
   3) middlingly
   4) somewhat badly
   5) very badly
6. **The game's difficulty level matched the children's skill level:**
   1) well
   2) the game was too difficult
   3) the game was too easy
7. **I would estimate that the pupils found playing the game:**
   1) very pleasant
   2) pleasant
   3) indifferent
   4) somewhat unpleasant
   5) unpleasant
8. **According to my estimations, there was progress in the players' basic literacy skills due to the playing:**
   1) not at all
   2) a little
   3) not much nor little
   4) much
   5) very much
9. **Which features can have affected the level up to which the children benefited from the playing:**

   _____

   _____

Other remarks:

_____

_____

_____