Does dynamic learning predict reading skills?

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Master's thesis

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ABSTRACT

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This study concentrated on dynamic learning and its possibilities in predicting reading and writing skills and finding those children who are in need of special attention. The aim was to deepen the knowledge we already have on dynamic learning and especially to concentrate on those children who have difficulties in succession in the paired associated learning tasks which represented the concept of dynamic learning in this study. The study was executed in the years 2009-2010 when some Finnish first grade teachers attended an educational program to improve their skills in dealing with reading and writing deficits. The participants consisted of 116 first graders who played the LukiTuki –assessment computer game three times in one school year and whose reading and writing skills were measured. Based on the succession in the tasks the participants were split into two groups; those who succeeded well in the paired associate learning task and who did not. The main outcomes of the studies were that paired associate learning task didn't predict reading and writing skills when the norm group was concerned but it was one of the main explicators of reading and writing skills within those children who had weaker success in the paired learning tasks. Consequently, paired associate learning task would be an important assessment tool for finding the children in need of special attention concerning reading and writing skills, but the quality of the task needs to be taken to the next level.

Keywords: Reading skills, orthography, paired-associate learning, dynamic learning, Lukituki –assessment computer game

TIIVISTELMÄ

Ennustaako dynaaminen oppiminen lukemisen taitoja?

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Tämä tutkimus keskittyi dynaamiseen oppimiseen ja sen mahdollisuuksiin lukemisen ja kirjoittamisen taitojen ennustajana sekä niiden lasten löytämisessä, jotka tarvitsevat erityistä tukea. Tutkimuksen tarkoitus oli syventää tietämystä, jota meillä jo on dynaamisesta oppimisesta sekä erityisesti keskittyä niihin lapsiin, joilla on ongelmia parittais-assosiatiivisen oppimisen tehtävissä (jotka tässä tutkimuksessa edustivat dynaamisen oppimisen käsitettä). Tutkimus toteutettiin vuosina 2009–2010, jolloin joukko suomalaisia ensimmäisen luokan opettajia osallistui koulutusohjelmaan parantaakseen taitojaan toimia lasten kanssa, joilla on lukemisen ja kirjoittamisen pulmia. Tutkimuksen osallistujat muodostuivat 116 ekaluokkalaisesta, jotka pelasivat LukiTuki –arviointipeliä kolmesti yhden lukuvuoden aikana ja joiden lukemisen ja kirjoittamisen taitoja arvioitiin. Tutkittavat jaettiin kahteen ryhmään tehtävissä menestymisen perusteella; niihin, jotka menestyivät hyvin parittais-assosiatiivisen oppimisen tehtävissä ja niihin, jotka menestyivät niissä heikommin. Tärkeimmät tutkimustulokset osoittivat, että parittais-assosiatiivisen oppimisen tehtävät eivät selittäneet lukemisen ja kirjoittamisen taitoja kun koko normiryhmää tutkittiin, mutta se kuitenkin osoittautui yhdeksi tärkeimmistä lukemisen ja kirjoittamisen taitojen selittäjistä niiden lasten kohdalla, joilla oli parittais-assosiatiivisen oppimisen tehtävissä heikko menestyminen. Näin ollen, parittais-assosiatiivisen oppimisen tehtävä voisi toimia hyvänä arviointimenetelmänä niiden lasten löytämiseksi, jotka tarvitsevat erityistä tukea liittyen lukemisen ja kirjoittamisen taitoihin, mutta tehtävän laatu olisi vielä vietävä seuraavalle tasolle.

Avainsanat: Lukemisen taidot, ortografia, parittais-assosiatiivinen oppiminen, dynaaminen oppiminen, Lukituki -arviointitietokonepeli

CONTENTS

1. INTRODUCTION

The ultimate goal of reading is to understand continuous written text (Bowey, 2005). In today's Western society the ability to read is vital; it is a way of communicating, learning and being a part of a community. If reading skills delay for some reason or don't develop in a normal pace it is probable that other problems such as learning difficulties or emotional problems will follow.

The importance of reading skills has led to a huge amount of research on the field. The studies have shown that the development of reading skills are at least partly predictable and that early practice of reading skills can lead to success (Puolakanaho et al., 2008). Considering these findings it is crucial to find more effective ways of forecasting developing reading skills. One issue in the research of reading skills is that most of the studies are carried out in English speaking surroundings. However, there is a major difference between Finnish and English orthographies and therefore most of the research results aren't fully competent in a consistent orthography such as Finnish. Another factor that hasn't been under that great deal of attention in the research of reading is something called dynamic learning. The concept of dynamic learning tries to capture child's learning ability that is independent from the education and other previously learned skills. This study concentrates on the dynamic perspective of predicting reading skills in a consistent orthography.

In this study, an evaluative computer game Lukituki—that was originally modified from a literate game called Ekapeli—was being used to assess several predicting abilities of reading. Paired associate learning task represented the dynamic learning task which was assumed to reveal general learning potential. Whether paired associated learning task carried a real predictive value on reading skills was the main interest of this quantitative study. Those who performed poorly on the paired associate learning task were under special attention in this study.

1.1 Development of reading skills in Finnish

Finnish language has a consistent orthography meaning that grapheme-phoneme correspondences are regular and symmetrical in both directions (Lyytinen et al., 2005). Phonemic quantity is a feature of Finnish that makes it distinct from most other languages; almost every phoneme can have two lengths, long and short (thus words like *mato* (mato) [worm] and *matto* (mat:o) [mat] have different meanings). Almost every word in Finnish is multisyllabic and because of the grammatical qualities words tend to be relatively long. Compared to highly irregular English, Finnish is an extremely regular and purely phonemic orthography. (Lyytinen et al., 2005)

The main characteristics of reading skills acquisition of Finnish children are presented here briefly. Broadly one third of Finnish children naturally acquire reading skills before entering school (Lyytinen et al. 2005; Silven, Poskiparta, & Niemi, 2004); more closely half of the children know all the Finnish letters and one fourth reach almost perfect decoding accuracy of syllables and pseudowords when entering school (Holopainen, Ahonen, Tolvanen, & Lyytinen, 2000). That is partly because of the transparency and consistency of Finnish language and the availability of written material in the everyday environment (Lyytinen et al., 2005). Before entering school most children attend pre-school where letters and words are informally introduced (Lyytinen et al., 2005). Formal reading instruction begins at the age of 7 when children attend first grade (Lyytinen et al., 2005). While most Finnish children developed reading skills quite effortlessly during a couple first years of reading instruction, there still are some children that face problems in this process and need special attention in learning to read (Lyytinen et al., 2005); dyslexia is prevalent among Finnish children (Lyytinen, Erskine, Kujala, Ojanen, & Richardson, 2009).

1.2 Predictors of reading skills

1.2.1 Phonological awareness

Phonological awareness simply means the ability to perceive and manipulate the sounds of spoken words and understanding the connections between grapheme-phoneme correspondences (Goswami & Bryant, 1990). According to the definition of Castles and Coltheart (2004), phonological awareness consists of awareness of phonemes which are the most basic speech units of language, and of larger units such as rhymes and syllables. According to Carroll, Snowling, Stevenson and Hulme (2003) phonological awareness can be divided into two different phases based on the child's chronological age; first there is an early implicit (unconscious) sensitivity to sound similarity and later there is an explicit (conscious) awareness of phonemes. In this context awareness of syllables and phonemes and their connection to learning to read is vital.

One thing that makes phonological awareness such an important factor is that in most cases it works as a significant predictor of future reading skills with both fluent and dyslexic readers. Several studies (Allor, 2002; Burges & Lonigan, 1998; Bus & IJzendoorn, 1999; Carroll et al., 2003; Kirby, Parrila, & Pfeiffer, 2003; Leppänen, Niemi, Aunola, & Nurmi, 2006; Lervåg, Bråten, & Hulme, 2009; Torppa, Poikkeus, Laakso, Eklund, & Lyytinen, 2006; Wolf, Bowers, & Biddle, 2000) showed that there is a strong connection between early phonological awareness and later reading skills.

The relation between phonological awareness and reading skills has been evaluated considering the orthography of the language. According to Wolf et al. (2000), in languages with a consistent orthography (such as Finnish) phonological awareness doesn't play as a big role in reading development than it does in languages with an inconsistent orthography (such as English). However, there is strong evidence that the structure of orthography doesn't affect the importance of phonological awareness in relation to reading skills; some studies showed that it had a high impact on reading in

both consistent and inconsistent orthographies (Caravolas et al., 2005; Muller & Brady, 2001). One perspective is that in a consistent orthography like Finnish, phonological awareness is mostly a consequence than a precursor to reading and that early mastery of words increases the awareness of sound patterns in words (Silven, Poskiparta, & Niemi, 2004), but the study of Puolakanaho (2007) gives different vision to the issue. Her study was conducted in a Finnish speaking environment and it has shown strong evidence to the connection between phonological awareness and reading skills in a consistent orthography and especially in a predicting way; phonological awareness measured at the age of 3,5 years strongly predicted reading skills later in life (Puolakanaho, 2007).

1.2.2 Rapid automatic naming (RAN)

A rapid automatic naming (more shortly RAN) task is widely used to measure continuous, serial naming-speed performance on common visual stimuli (Wolf et al., 2000). In a study of Wolf et al. (2000) the majority of children with reading disabilities faced difficulties when they were supposed to name familiar visual symbols (letters, numbers, colors, simple objects) as rapidly as possible. They suggest that naming speed is a stronger predictor of reading skills than phonological awareness in languages with consistent orthography, especially for those with severe dyslexia (Wolf et al., 2000).

Better readers have been found to be more accurate in rapid automatic naming tasks than poorer readers (Fowlert & Swainson, 2004). Slow naming speed in kindergarten predicted problems with reading for many years (Kirby et al., 2003). Especially RAN for numbers and letters have been found to be a strong predictor of reading rate, while RAN for pictures didn't have the same effect (Savage & Frederickson, 2005). In a longitudinal JLD –study half of the children who turned out to be dyslexic showed poor scores in rapid naming tasks (Lyytinen et. al., 2009) and the study of Salmi (2008) showed that slower naming skills measured at the age of 3.5 predicted worse reading skills in the second grade and faster naming skills predicted better reading skills.

1.2.3 Letter knowledge

Letter knowledge is a strong predictor of reading skills; it is obvious that knowing letter names helps children to learn to read and spell (Foulin, 2005). Despite that, the route from letter knowledge to fluent reading isn't always that straightforward. According to Foulin (2005), good letter knowledge speeds up the development of other essential literacy-related skills such as letter-sound knowledge and phonemic sensitivity skills which for their part improve reading abilities. That idea was supported by other studies proposing that letter knowledge and phonological abilities are in a reciprocal relation so that higher levels of letter knowledge lead to higher levels of phonological abilities and vise versa (Burges & Lonigan, 1998; De Jong & Olson, 2004; Leppänen et al., 2006). These findings indicate that letter knowledge has at least an indirect impact on reading abilities. Torppa et al. (2006) also showed a causal connection between slow letter name learning and high risk for dyslexia (which means that at least one of the parents had diagnosed dyslexia). In a study of Puolakanaho et. al. (2008) letter knowledge was associated not only with reading skills but also with many subskills (i.e. phonological awareness and rapid naming skills) and performance IQ.

In a Finnish longitudinal study (Lyytinen et. al., 2009) (JLD) the development of knowledge of letter names was an exceptionally predictive measure of reading problems. All children who ended up with reading problems at first grade showed substantially lower letter knowledge at the age of four, and much more consistently that with any other predictive measure; although some false positives were observed which might be because of insufficient opportunity to learn letters before entering school. (Lyytinen et. al., 2009)

1.2.4 Phonological working memory

Phonological working memory that is also known as verbal short term memory basically means the ability to store phonological information temporarily (Gathercole & Baddeley, 1993). To some extend it overlaps with the term phonological awareness (Wagner &

Torgesen, 1987; Windfuhr & Snowling, 2001) yet it carries a certain amount of predictability on reading development that is not explicable by other measures. There is some evidence that a causal connection between phonological memory and letter knowledge can be found (De Jong & Olson, 2004; Puolakanaho et. al., 2008). It can also work as a discriminator of spontaneous learners from later decoders (Holopainen, Ahonen, & Lyytinen, 2001), in others words, children who have good phonological working memory are more likely to learn to read quite effortlessly. Based on studies by Holopainen et al. (2001), good phonological working memory may be a sign of a better attentive orientation that leads to spontaneous discovery of the orthographic code.

1.3 Dynamic learning and assessment

1.3.1 Basics of dynamic learning and assessment

Cognitive abilities have traditionally been measured with conventional (also known as static or traditional) assessment methods, such as IQ tests (Grigorenko & Sternberg, 1998). These kind of conventional tests measure abilities that are developed formerly, in other words, they indicate the capacity that is latent. That kind of capacity is something that is affected not only by real learning abilities but many other variables such as amount of education and parental support (Grigorenko & Sternberg, 1998). Conventional assessment methods don't reveal the real learning potential and cognitive development of diverse children (Grigorenko, 2009) and they underestimate what person might achieve with adequate environmental support (Jitendra & Kameenui, 1993; Swanson, 1995). The concept of dynamic assessment arose when researchers wanted to design an assessment approach that would be more responsive to individual potentials (Jitendra & Kameenui, 1993).

Grigorenko and Sternberg (1998) presented that one of the most significant differences between static and dynamic testing is that static testing is primarily interested in pre-existing skills and the products of those skills, whereas dynamic testing tries to find the

psychological processes in learning and change. As Grigorenko (2009) put it, the aim of dynamic assessment is to realize the learning potential that lies in every one of us regardless of the current ability level. The main point is to try to understand the potential of a person when he/she is given adequate educational intervention (Grigorenko, 2009; Grigorenko & Sternberg, 1998). The fundamental idea of dynamic testing is that the examinee can start at the zero level of previous knowledge on the task, so that the ability being tested doesn't represent previously acquired knowledge but the capacity to master the knowledge that is present only at the dynamic testing situation (Grigorenko & Sternberg, 1998). This kind of position enables the comparison between people from different backgrounds better than conventional assessment methods do.

Grigorenko (2009) summarized the basic ideas of dynamic assessment in the field of research and found that there are three types of practical implementations of the method. Those implementations are highly trained clinicians, highly scripted protocols and computer-based models. An example of a highly trained clinician is a psychologist who has expert-level skills on dynamic testing including high levels of understanding the psychological theories and processes relevant to testing. Highly scripted protocols mean prepackaged or manualized protocols that can be used in a standard way despite the person who executed the assessment. In the present study, computer-based models are being used. The paired associate learning task stands for the dynamic aspect of learning to read.

1.3.2 Paired associate learning (PAL)

Paired associate learning task measures the ability to maintain two temporary representations, a visual and a verbal one, and to form a new association between the representations in the long-term memory. Actually, visual-verbal associate learning can be seen as a basic factor of orthographic learning which requires association between printed words (graphemic features) and their phonological forms (Hulme, 1981). Furthermore, paired associate learning requires letter-sound and letter-name knowledge,

which both are strong predictors of reading skills (Muter, Hulme, Snowling, & Taylor, 1997). That supports the assumption that paired associated learning is an important factor in learning the reading and writing of Finnish language that has a highly consistent orthography.

Studies executed in English speaking environments support the idea that PAL tasks carry a predictive value of reading skills. In a study of Windfuhr and Snowling (2001) PAL task consisted of pairing four abstract visual shapes with four spoken pseudowords (two of one-syllable, *stosp* and *taith*, and two of three-syllable, *meferal* and *balio*). Participants were asked to repeat the pseudoword while carefully looking at each abstract shape. This procedure was done twice and the correct pronunciation of each nonword was made sure. After the shape-pseudoword pairs were shown to the children twice, the children were instructed to try to recall the name of each of the shapes. PAL operated as a strong predictor of reading skills amongst normal readers both independently and together with phonological awareness and verbal memory.

Another study that concentrated on paired associate learning in English speaking surroundings (Hulme, Goetz, Gooch, Adams, & Snowling, 2007) also found strong evidence on behalf of the effect of PAL on reading abilities. The study specified that it is particularly visual–verbal PAL that strongly correlates with reading skills; not verbal–verbal or visual–visual PAL. In other words, tasks where the examinee is supposed to connect a visual image to a verbal sound carry the strongest predictive value of reading skills. The study also showed that PAL draws on partially separate cognitive abilities from phonological awareness. In that study the visual–verbal task contained five visual shapes and five pseudowords which were supposed to be associated in pairs. First the examiner made sure that the child was able to articulate clearly each pseudoword. The examiner then presented one shape at a time, stating the nonwords with which it was associated twice. After presenting all five shape-word pairs the examiner showed each card in turn asking the child for the right pseudoword.

Paired associate learning seems to be a predictor of reading skills amongst normal readers in an inconsistent orthography, but it also seems to correlate with dyslexia; dyslexic readers had difficulties associating verbal and visual stimuli in studies of English speaking children (Castles & Holmes, 1996; Vellutino, Scanlon, & Spearing, 1995).

These findings can't be generalized without a question to Finnish and other languages with consistent orthographies. Lervåg et al. (2009) carried out a study that among other things concentrated on visual–verbal PAL as a predictor of reading skills in a relatively consistent Norwegian language. In the PAL task the child was supposed to pair three pictures with three nonwords. In *PAL children* task the child had to associate CCVCV pseudowords with photographs of unfamiliar children, in *PAL animals* task the association had to be made between CVCV pseudowords and drawings of fantasy animals and in *PAL signs* task the child had to associate CCVC pseudowords with unfamiliar letters (Greek, Hebrew and Arabic). In each of these tests, the three pictures were presented in a fixed quasirandom sequence. The examiner presented the pictures and named them, and the child was asked to repeat the names. After this, the names for the object were being asked. Surprisingly, they found out that PAL did not play a significant role in predicting reading abilities within normal readers.

However, a study executed in German language (a consistent orthography) showed that dyslexic readers had more difficulties in learning to associate visual stimulus with nonsense names than normal readers did when the task was to pair three invented animals with three imaginary names (pseudoword) (Wimmer, Mayringer, & Landerl, 1998). First, the pictures of the animals were presented, and then each animal was presented with its name (*filo*, *kogan* and *spurk)*. After repeating the names once more, the test trials consisted of asking the children for the names of the animals in the original order.

This quite narrow and contradictory evidence leaves the questions unsolved; does paired associate learning task predict reading skills in a consistent orthography, and if so, does it have the effect with both normal and poor readers? The special attention in this study is on those children who have difficulties in the paired associated learning task (the

examinees were split into two groups; slow learners and fast learners). This new approach gives different view to the meaning of dynamic learning and its ability to find those who are in need of special attention concerning reading and writing skills.

1.4 Research questions

The purpose of the present study was to examine if a paired associate learning task give extra predictive value on reading skills. Paired associate learning in this study represent the idea of dynamic assessment. Several studies have shown that phonological awareness (e.g. Leppänen et al., 2006; Lervåg et al., 2009; Torppa et al., 2006), rapid automatized naming (e.g. Kirby et al., 2003), letter knowledge (e.g. Foulin 2005; Torppa et al., 2006), and phonological working memory (e.g. De Jong & Olson, 2004; Holopainen et al., 2001) are strong predictors of reading skills, but the predictive value of paired associate learning task has been more or less controversial (e.g. Lervåg et al., 2009; Wimmer et al., 1998). The studies executed in languages with inconsistent orthographies such as English (e.g. Windfuhr and Snowling, 2001) give witness to the view that paired associate learning tasks have a strong predictive value of reading skills, but studies on more consistent orthographies have shown different outcomes (Lervåg et al., 2009). The aim of this study is to deepen the knowledge that we already have on paired associate learning tasks and dynamic assessment on reading in consistent orthographies. Special interest is in those children who have weaker success in paired associate learning tasks.

There were two main research questions in this study:

1) Did paired associate learning task improve the predictability of reading and writing skills in first grade compared to traditional cognitive measures?

2) How did those who had weaker performance on the paired associate learning task differ from those who had better performance on paired associate learning task concerning reading and writing skills in first grade?
   a) Which variables explain the reading and writing skills in different times of measurements in the slow learners and fast learners groups?
   b) Did reading deficits occur with children who were weaker in the associate learning task more likely than in children who succeeded in the task?

2. METHODS

This study was a sub-study of an educational program called "Lukitietoa ja –taitoa verkosta". The program was organized together with the LukiMat project and the main operators were Niilo Mäki Institute and the Jyväskylä University. The program was realized in years 2009-2010. The aim of the "Lukitietoa ja –taitoa verkosta" program was to educate teachers to be able to evaluate and support pupils with reading and writing deficits using a network environment, and also to provide teachers with up-to-date information on how to react on reading and writing deficits in school environment. (For more information see http://www.lukimat.fi/tiedotteet/uutisarkisto/lukitietoa-ja-taitoa-verkosta-verkkokoulutus.) This particular study concentrates on first grade pupils who have been assessed with several tasks during the year 2009-2010. The main purpose of this study was to find out if paired-associate learning task had a predictive value on reading and writing skills in first grade having special attention on those who had weak success in the dynamic learning tasks.

2.1 Participants

The participants consisted of Finnish first grade pupils who were raffled by the first grade teachers who attended the "Lukitietoa ja –taitoa verkosta" education program in years 2009-2010. The teachers selected three pupils based on the alphabetical order of their last names, so that every first, fifth and tenth pupil of the class were selected to the norm group. Four of the teachers used the assessment tool for the whole class and in these cases the whole class was selected to the norm group. The norm data consisted of 116 primary school children who started the first grade at the beginning of the autumn 2009. 61 of the participants were females (52.6 %) and 55 were males (47.4 %). According to the questionnaires sent to the parents, two participants had Russian as their first language. Six of the children had started school in 2008, and the rest in 2009. Two children had diagnosed dyslexia and fifteen children were assessed as having the possibility to have

dyslexia. Eight participants had other kind of diagnosed problems with development or learning (such as dyscalculia, motoric deficits and ADD).

2.2 Design and procedure

The children were tested altogether three times during one school year. The first measurement (Time 1) took place during September and October in 2009 when the children played the assessment computer game (Lukituki) and their reading and writing skills were measured. The second measurement (Time 2) took place before and after Christmas 2009 when the children played some sections of the Lukituki game, their reading and writing skills were measured and they played a literate game called Ekapeli I. The third and final measurement (Time 3) took place in the spring of 2010, when the methods were same as in the second measurement, but some reading tests were added. The parents were also asked to fill an inquiry during the data gathering about the possibility of familial risk of dyslexia.

2.3 The Assessment Methods

2.3.1 Lukituki – the assessment game

The Lukituki –assessment computer game was developed for teachers as a tool of assessing reading skills of children in first grade. The game based on a Finnish Literate game called Ekapeli which is a computer-based game that helps children to improve their pre-reading skills such as phonological awareness.

Cognitive and language skills consisted of six tests: phonological awareness, rapid automatic naming, letter knowledge, phonological working memory, visual-motoric skills and vocabulary. These skills and the paired associate learning task were measured using the Lukituki –assessment game during the three measurements in the first school year. Table 1 shows the execution times of the tasks used in the study.

TABLE 1. Assessment test executed at different times of measurement

Measures	Time 1	Time 2	Time 3
Language and cognitive skills			
1. Phonological awareness	X		
2. Rapid automatic naming (objects)	X	X	
3. Rapid automatic naming (letters)			X
4. Letter knowledge	X	X	
5. Phonological working memory	X		
6. Visual-morotic skills	X		
7. Vocabulary		X	
Paired associate learning tasks			
8. PAL A	X	X	
9. PAL B		X	X
Reading and writing skills			
10. Allu TL2	X	X	X
11. Pseudowords	X	X	X

Note: PAL A is paired associate learning task with Finnish phones and PAL B is paired associate learning task with unfamiliar phones

Phonological awareness. In this task the player was first familiarized with the three pictures in the screen ("here are a car, a train and a boat"). After that the child heard a sound (one phone, syllable or word) and had to find a target where the recent sound belonged to (for example syllable "*ta*" goes to a picture presenting a fence, "*aita*"). The player practiced the task for three times which was followed by 20 trials (maximum score being 20). The section was cut off if the player got 4 or less correct answers within the 10 first trials.

Rapid automatic naming (RAN). In the RAN –tasks the child was asked to name, as rapidly as possible, a series of five visual-object or letter stimuli. The child was first familiarized with the stimuli.

Ran of objects. The objects were “train” (”*juna*”), “fence” (”*aita*”), ”button” (”*nappi*”), ”hand” (”*käsi*”) and ”worm” (”*mato*”). Total matrix (30 items; 5 stimuli randomly presented 6 times) completion time (in seconds) was used as the measure.

Ran of letters. Ran of letters was similar to ran of objects but letters were the stimuli. Letters used in this section were “O”, “A”, “S”, “T” and “P”.

Letter knowledge. In the letter knowledge task, the child heard a phone and then had to find the corresponding letter from the screen. The amount of correct answers was measured (minimun: 1, maximum: 23).

Phonological working memory. In this task the player saw different colors in the screen (black, white, red, green, blue and yellow) and then heard the names of the colors in different orders (with increasing amount). After that the player was supposed to click the colors on the screen at the same order he/she heard them to be said. There were 10 sections in the task but the section was cut off if the player made errors in three tasks in a row. The score varied from 0 to 10 based on the correct trials.

Visual-motoric skills. In this section the player was supposed to follow a line of pictures by pointing the green spot with a mouse as quickly as possible. The measurement was time (in seconds) used in the task.

Vocabulary. In this task the player was asked to choose the picture he/she heard from the earphones. In the beginning there were three pictures which familiarized the child with the task. Those were followed by 30 series of pictures having 5 pictures in each series. The series was presented two times so that all together 60 words were asked. The results could vary from 0 to 60.

Paired associate learning (PAL). Paired associate learning which was called “Learn the signs” (“*Opi merkit*”) in the Lukituki game was measured in three points of time. In the first measurement (PAL A) the player had to associate three unfamiliar Braille –signs with three different Finnish phones (“a”, “i” and “u”). Each phone represented one sign

and the player had to find the right combination by trying different possibilities. The task went on as long as the player was able to find all three combinations and to choose them correctly three times in a row. If the player made a wrong option the right sign was presented.

In the second measurement besides the previous task (PAL A2) there also was a new version (PAL B), in which the phones were replaced with unfamiliar consonants from a foreign language (Tonga). In both sections (PAL A2 and PAL B) the trials were limited in the second measurement; after 100 failed trials the task was interrupted.

In the third measurement the second version of the task was being used (PAL B2) so that the child had to connect unfamiliar consonants (Tonga) with Braille –signs. In every PAL –tasks the amount of trials was used as a measure.

2.3.2 Reading and writing skills

The reading skills were assessed using the following tests. The reading and writing skills were measured individually three times during the first grade (Time 1, Time 2 and Time 3).

Allu TL2. Allu TL2 belongs to the group of Allu –tests (Lindeman, 2000). The task measured the technical reading ability and it included four training sections and 80 testing sections. Each section contained four almost similar words and one picture. The child was supposed to choose the word that fits the picture by its meaning and to connect the word with the picture by drawing a line between them. Children worked with the task independently with their own speed for five minutes. The amount of correct answers could vary between 0 and 80.

Pseudowords. Pseudowords task measured the ability to write unfamiliar words according to teacher's verbal instructions. Every child participated in short syllables task which consisted of nine different pseudo syllables. If the child got only three or less

correct the task could have been cut off at this point. Others continued to short pseudowords task which consisted of nine words. If the child got more than three correct answers he/she continued to long pseudowords task which included nine complex words. The amount of correct answers was calculated so that each section varied from 0 to 9 and the whole task varied from 0 to 27 points.

2.4 Analysis strategies

2.4.1 Defining the slow learners and fast learners groups

As the main interest of the study was directed to those children who didn't succeed in the paired associated learning tasks, the norm group was cut into two separate groups for the analyses. Groups consisted of those who were slow learners and those who were fast learners according to the paired associate learning tasks. First the limit value was set into 70 % cut point so that 30 % of children in each paired associate learning task (PAL A, PAL A2, PAL B, PAL B2) were placed below the defining limit and 70 % above it. If the child was above the limit in three or four cases out of four, he/she was placed into the "fast learners" group. If the child was above the limit less than three times he/she was placed into the "slow learners" group. This grouping worked as a base for the analyses in the second research question. This procedure ensured minimal number of false negatives; those who ended up to the fast learners group succeeded in the paired associate learning tasks systematically.

2.4.2 Methods used in the analysis

Sum variables were formed to represent the reading and writing skills in different times of measurement. The results of Allu TL2 and three different pseudoword tasks ("Pseudowords SUM") that correlated with each other were used to calculate the sum variable called "Reading and writing skills SUM". This variable was used as a measure

of reading and writing skills in the correlations and analyses. Cronbach's alpha values were used as measures of reliability (Time 1 = .84; Time 2 = .67; Time 3 = .37).

Descriptive statistics and correlations were used to define the quality of the paired associate learning task as an indicator of learning. To find out if paired associate learning tasks gave any extra predictive value on reading and writing skills in the norm group hierarchical regression analysis was used. To find out any major differences between the two groups concerning reading and writing measures linear regression analysis was used. Descriptive statistics and correlations were used to define the two different groups. Independent samples t-test was executed to see if the slow learners and fast learners groups differed significantly concerning the reading and writing measures.

3. RESULTS

Ceiling and floor effects were present for some of the variables (Ran for objects in Times 1 and 2, Pseudowords SUM in Time 3, Ran for letters in Time 3, PAL A and PAL B) and the outliers were deleted systematically or relocated to the tails of the distributions before the analyses. Method listwise was used in the analyses. There were some missing data; all the examinees didn't conduct every task. Descriptive statistics for all the cognitive and reading variables measured at Times 1, 2 and 3 are shown in Table 2.

TABLE 2. Descriptive Statistics of Cognitive and Language skills and Reading and Writing Measures in the Norm Group

Measures	N	Minumum	Maximum	*M*	*SD*	Skewness	Kurtosis
Language and cognitive skills							
Time 1							
1. Phonological awareness	113	2	20	15.44	4.20	-0.96	0.13
2. Rapid automatic naming (objects)	104	9.53	89	42.17	11.74	0.95	3.47
3. Letter knowledge	110	2	23	14.44	5.44	-0.50	-0.65
4. Phonological working memory	108	1	7	4.44	1.39	-0.35	-0.49
5. Visual-morotic skills	110	21.15	82.19	43.83	15.71	0.61	-0.60
6. Paired associate learning (PAL A)	109	9	122	27.45	24.84	2.56	6.38
Time 2							
7. Rapid automatic naming (objects)	91	18.97	79.00	38.63	9.58	1.48	4.26
8. Letter knowledge	100	2	23	17.78	4.03	-1.29	1.93
9. Vocabulary	100	22	60	46.46	6.83	-1.18	1.91
10. Paired associate learning (PAL A2)	100	9	44	14.80	7.18	2.50	6.54
11. Paired associate learning (PAL B)	98	11	107	36.06	22.50	1.39	1.72
Time 3							
12. Rapid automatic naming (letters)	88	14.19	48.17	23.64	7.31	1.31	1.44
13. Paired associate learning (PAL B2)	92	9	95	26.77	18.80	1.86	3.26
Reading and writing skills							
Time 1							
14. Allu TL2	59	1	72	15.93	14.20	2.08	5.18
15. Pseudowords SUM	62	0	27	10.50	9.98	0.34	-1.59
16. Reading and writing skills SUM	59	1	99	26.97	22.75	1.11	1.05
Time 2							
17. Allu TL2	69	1	80	25.35	18.94	1.41	0.57
18. Pseudowords SUM	69	0	27	16.17	8.58	-0.39	-1.28
19. Reading and writing skills SUM	59	4	106	41.52	25.45	0.62	-.52
Time 3							
20. Allu TL2	57	9	80	36.60	18.77	0.89	0.00
21. Pseudowords SUM	57	8	27	23.67	4.18	-2.28	5.82
22. Reading and writing skills SUM	57	17	106	60.26	21.29	0.52	-.12

Note: Pseudowords SUM -variables are sums of different pseudoword tasks (syllables, words, complex words) in different times of measurement. Reading and writing skills SUM -variables are sums of AlluTL2 and Pseudoword tasks in different times of measurement

3.1 Predictability of reading skills

The first research question was: ”Did paired associate learning task improve the predictability of reading and writing skills in first grade compared to traditional cognitive measures?”. For descriptive information the data was first explored by correlations of the norm group between all the different variables (Table 3). Correlation matrix shows that every paired associate learning task don’t correlate significantly to each other nor to reading and writing measures in the norm group.

To answer the first research question hierarchical regression analysis (method: enter) was used (Table 4). Traditional language and cognitive skills explained 59-78 % of the variance of reading and writing skills measured in different times in the first grade. From separate variables phonological awareness had significant explanatory value on reading and writing skills in Time 2 (β = .33, p < .05). Paired associate learning tasks didn’t significantly improve the explanatory values on reading and writing skills.

TABLE 3. Pearson Correlations Between Cognitive and Language skills and Reading and Writing Measures in the Norm Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Language and cognitive skills																						
Time 1																						
1. Phonological awareness	-																					
2. Rapid automatic naming (objects)	-.23*	-																				
3. Letter knowledge	.53**	-.14	-																			
4. Phonological working memory	.44**	-.15	.42**	-																		
5. Visual-morotic skills	-.13	-.03	-.13	-.23*	-																	
6. Paired associate learning (PAL A)	.05	-.13	-.28**	-.03	.09	-																
Time 2																						
7. Rapid automatic naming (objects)	-.15	.45**	-.18	-.16	-.05	.02	-															
8. Letter knowledge	.32**	-.03	.68**	.31**	-.08	-.14	-.26*	-														
9. Vocabulary	.38**	-.15	.35**	.19	.04	.07	-.37**	.34**	-													
10. Paired associate learning (PAL A2)	.06	.02	-.08	-.02	.09	.37**	.08	-.08	-.06	-												
11. Paired associate learning (PAL B)	-.12	-.04	-.10	-.18	.13	.05	.35**	-.23*	-.25*	.30**	-											
Time 3																						
12. Rapid automatic naming (letters)	-.26*	.36**	-.24*	-.33**	.10	.12	.47**	-.14	-.26*	.08	.15	-										
13. Paired associate learning (PAL B2)	.07	-.16	.10	.10	.11	.08	-.06	.04	.11	.34**	.26*	.02	-									
Reading and writing skills																						
Time 1																						
14. Allu TL2	.50**	-.37**	.56**	.30*	.05	.08	-.19	.43**	.34*	.21	-.03	-.21	.13	-								
15. Pseudowords SUM	.68**	-.23	.70**	.37**	.18	-.08	-.20	.51**	.36**	.18	.02	-.29*	.14	.77**	-							
16. Reading and writing skills SUM	.61**	-.36**	.66**	.36**	.09	.03	-.21	.50**	.36**	.21	-.02	-.28*	.13	.96**	.92**	-						
Time 2																						
17. Allu TL2	.57**	-.40**	.66**	.39**	.01	-.09	-.42**	.44**	.38**	.08	-.02	-.38**	.18	.87**	.85**	.91**	-					
18. Pseudowords SUM	.54**	-.20	.64**	.37**	.11	-.10	-.23	.51**	.24	-.01	.07	-.31*	.10	.59**	.83**	.73**	.66**	-				
19. Reading and writing skills SUM	.61**	-.37**	.70**	.41**	.05	-.10	-.38**	.50**	.36**	.06	.01	-.38**	.17	.84**	.90**	.92**	.97**	.83**	-			
Time 3																						
20. Allu TL2	.51**	-.41**	.64**	.47**	-.05	-.03	-.38**	.44**	.46**	.07	.03	-.46**	.26	.79**	.76**	.83**	.85**	.59**	.82**	-		
21. Pseudowords SUM	.54**	-.20	.50**	.55**	-.02	-.22	-.17	.34*	.14	-.07	.03	-.69**	.13	.33*	.48**	.43**	.48**	.60**	.56**	.53**	-	
22. Reading and writing skills SUM	.56**	-.40**	.66**	.53**	-.05	-.07	-.37*	.46**	.43**	.05	.03	-.54**	.25	.76**	.76**	.82**	.85**	.63**	.83**	.99**	.67**	-

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Pseudowords SUM -variables are sums of different pseudoword tasks (syllables, words, complex words) in different times of measurement. Reading and writing skills SUM -variables are sums of AlluTL2 and Pseudoword tasks in different times of measurement.

TABLE 4. The explanatory values of language and cognitive skills and paired associate learning tasks on reading and writing skills measured in three times (1, 2 and 3). Analysis was made with hierarchical regression analysis (method: enter).

	Time 1			Time 2			Time 3		
Variables	*β*	ΔR^2	R^2	*β*	ΔR^2	R^2	*β*	ΔR^2	R^2
Step 1: Language and cognitive skills		.59***	.59***		.64***	.64***		.78***	.78***
1. Phonological awareness	.15			.33*			.27		
2. Rapid automatic naming (objects, Time 1)	-.15			-.11			-.16		
3. Letter knowledge (Time 1)	.37			.25			.24		
4. Phonological working memory	-.01			.12			.20		
5. Visual-morotic skills	-.03			.04			.00		
6. Rapid automatic naming (objects, Time 2)	-.11			-.13			-.15		
7. Letter knowledge (Time 2)	.15			.14			.00		
8. Vocabulary	.14			.07			.22		
9. Rapid automatic naming (letters, Time 3)	-.13			-.11			-.16		
Step 2: Paired associate learning tasks		.04	.62**		.04	.68***		.02	.80***
10. PAL A	.10			-.11			-.09		
11. PAL A2	.18			.05			-.07		
12. PAL B	.15			.20			.16		
13. PAL B2	-.16			.03			.07		

β = standardized regression coefficient from the last step when all the variables are included, $\Delta R^2 = R^2$ change when all the variables are included.
*** $p < .001$, ** $p < .01$, $p < .05$

3.2 Differences between the slow learners and fast learners groups

The aim of the second research question was to find out differences between the slow learners and fast learners groups in reading and writing skills in first grade. Descriptive statistics and Cohen's *d* values for all the cognitive and reading variables measured at Times 1, 2 and 3 for the slow learners and fast learners groups are shown in Table 7. The correlations between the variables in the slow learners and fast learners groups are shown in Table 8.

Linear regression analyses were executed concerning the explicators for reading and writing skills in both groups; slow learners and fast learners. The results for the slow learners group are presented in Table 5 and for the fast learners group in Table 6.

TABLE 5. Linear regression models (method: stepwise) for predicting reading and writing skills in three times of measurement in the first grade in the slow learners group

Time of measurement	R^2	Variables	B	SE	Observed *p*
Time 1	.66	Letter knowledge (Time 1)	2.28	.54	.001
		PAL A2	1.54	.43	.003
Time 2	.82	Letter knowledge (Time 1)	2.88	.38	.000
		PAL A2	.34	.09	.003
		PAL B	1.04	.34	.007
Time 3	.45	Letter knowledge (Time 1)	2.39	.68	.004

Note: PAL A2 = paired associated learning task with finnish phones in the second measurement.
PAL B = paired associate learning task with unfamiliar phones in the second measurement.

TABLE 6. Linear regression models (method: stepwise) for predicting reading and writing skills in three times of measurement in the first grade in the fast learners group

Time of measurement	R^2	Variables	B	SE	Observed *p*
Time 1	.65	Phonological awareness	3.34	.76	.000
		Vocabulary	1.94	.56	.002
Time 2	.50	Phonological awareness	4.97	.97	.000
Time 3	.80	Letter knowledge (Time 1)	1.31	.52	.020
		RAN for objects (Time 2)	-1.37	.32	.000
		Phonological memory	4.04	1.79	.035
		PAL B2	.85	.40	.046

Note: PAL B2 = paired associated learning task with unfamiliar phones in the third measurement.

These outcomes tell us that different variables seem to explain the variations of reading and writing skills of slow learners and fast learners. In the slow learners group the main explanatory variables were letter knowledge and paired associate learning, whereas in the fast learners group the most important variable was phonological awareness.

Independent samples t-test was executed to see if the slow learners and fast learners groups differed significantly concerning the reading and writing measures. Slow learners did not significantly differ from fast learners in any reading or writing measure.

TABLE 7. Descriptive Statistics of Cognitive and Language skills and Reading and Writing Measures in the Fast Learners and Slow Learners Group

			Slow Learners (n=38)				Fast Learners (n=47)				
Measures	Minumum	Maximum	*M*	*SD*	Skewness	Kurtosis	*M*	*SD*	Skewness	Kurtosis	Cohen's *d*
Language and cognitive skills											
Time 1											
1. Phonological awareness	2	20	15.41	3.84	-1.26	1.20	14.77	4.77	-0.68	-0.53	0.15
2. Rapid automatic naming	9.53	89.00	42.29	9.66	-0.05	0.92	42.10	14.17	1.12	3.28	0.02
3. Letter knowledge	2	23	13.69	5.97	-0.53	-0.78	14.89	5.14	-0.27	-0.88	-0.22
4. Phonological working memory	1	7	4.39	1.36	-0.33	-0.11	4.36	1.38	-0.41	-0.44	0.02
5. Visual-morotic skills	21.15	82.19	46.92	16.34	0.47	-0.63	44.22	16.93	0.50	-1.03	0.16
6. Paired associate learning (PAL A)	9	122	37.42	29.69	1.81	2.69	21.57	20.07	3.680	14.98	0.63
Time 2											
7. Rapid automatic naming	18.97	79.00	41.67	11.39	1.71	3.77	37.03	8.42	0.53	0.68	0.46
8. Letter knowledge	2	23	17.08	4.75	-1.30	1.67	18.38	3.34	-0.96	0.59	-0.32
9. Vocabulary	22	60	46.34	7.37	-1.37	2.15	46.49	6.37	-0.98	2.47	-0.02
10. Paired associate learning (PAL A2)	9	44	19.29	9.56	1.50	1.27	11.91	2.67	2.42	8.75	1.05
11. Paired associate learning (PAL B)	11	107	50.41	25.18	0.65	-0.03	27.72	16.44	2.24	7.30	1.07
Time 3											
12. Rapid automatic naming	14.19	48.17	24.65	7.40	1.12	0.71	23.42	7.89	1.21	1.45	0.16
13. Paired associate learning (PAL B2)	9	95	37.57	22.40	1.11	0.59	19.70	11.98	3.08	12.75	0.99
Reading and writing skills											
Time 1											
14. Allu TL2	1	72	14.50	11.76	2.19	6.99	18.86	16.76	1.79	3.47	-0.30
15. Pseudowords SUM	0	27	12.15	9.69	-0.00	-1.66	10.38	10.57	0.41	-1.69	0.17
16. Reading and writing skills SUM	1	99	26.65	20.19	0.89	1.08	30.31	25.87	1.01	0.56	-0.16
Time 2											
17. Allu TL2	1	80	21.87	16.56	1.30	1.55	28.70	20.76	0.85	-0.50	-0.36
18. Pseudowords SUM	0	27	14.96	9.21	-0.29	-1.60	17.07	8.88	-0.46	-1.35	-0.23
19. Reading and writing skills SUM	4	106	36.83	24.15	0.60	-0.21	62.86	23.40	0.22	-0.68	-1.09
Time 3											
20. Allu TL2	9	80	37.16	19.20	1.04	0.44	39.32	20.59	0.54	-0.72	-0.36
21. Pseudowords SUM	8	27	23.84	4.72	-2.48	6.83	23.54	4.39	-2.23	5.46	0.07
22. Reading and writing skills SUM	17	106	61.00	22.01	0.52	0.41	62.86	23.40	0.22	-0.68	-0.08

Note: Those who belong to the Slow Learners group are in the weakest 30 % of children at least in two PAL tasks.
Pseudowords SUM -variables are sums of different pseudoword tasks (syllables, words, complex words) in different times of measurement.
Reading and writing skills SUM -variables are sums of AlluTL2 and Pseudoword tasks in different times of measurement.

TABLE 8. Pearson Correlations Between Cognitive and Language skills and Reading and Writing Measures in the Fast Learners and Slow Learners Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Language and cognitive skills																						
Time 1																						
1. Phonological awareness		-.01	.52**	.45**	-.17	.02	.11	.29	.30	.07	-.08	-.27	.04	.37	.55*	.48*	.45*	.50*	.50*	.45	.54*	.51*
2. Rapid automatic naming	-.36*		.01	-.04	-.28	.16	.24	.12	.12	-.11	.03	.39*	-.35*	-.21	-.18	-.21	-.42*	-.16	-.35	-.41	-.07	-.37
3. Letter knowledge	.56**	-.21		.36*	.01	-.30	.10	.69**	.27	-.07	.10	-.15	.31	.58**	.78**	.71**	.67**	.79**	.76**	.59**	.56*	.64**
4. Phonological working memory	.38*	-.12	.52**		-.18	-.12	-.04	.05	.17	-.02	-.11	-.46**	.23	.11	.30	.21	.38	.53*	.16*	.43	.61**	.51*
5. Visual-morotic skills	-.08	.06	-.27	-.28		.07	-.29	.19	.13	-.01	.26	-.11	.10	.12	.35	.24	.07	.09	.18	-.10	-.29	-.15
6. Paired associate learning (PAL A)	.11	-.43**	-.10	.11	.02		-.10	-.00	.09	.42**	-.16	.30	-.10	.06	-.12	-.02	-.07	-.11	-.09	-.22	-.49*	-.30
Time 2																						
7. Rapid automatic naming	-.43**	.56**	-.45**	-.28	.14	-.07		-.21	-.36*	-.14	.26	.30	-.34	-.08	-.09	-.09	-.06	.07	-.01	.01	.19	.06
8. Letter knowledge	.32*	-.13	.69**	.51**	-.40**	-.16	-.26		.40*	.06	-.16	-.01	.17	.49*	.68**	.61**	.52*	.61**	.59**	.42	.29	.43
9. Vocabulary	.40**	-.31*	.42**	.08	-.08	.10	-.38**	.17		-.05	.39*	-.19	.16	.07	.16	.12	.16	.02	.12	.33	.16	.32
10. Paired associate learning (PAL A2)	.11	.14	.01	.06	.18	-.01	.17	-.33*	.10		.04	-.02	.16	.61*	.14	.43	.50*	.08	.37	.23	-.25	.15
11. Paired associate learning (PAL B)	-.26	.19	-.07	-.35*	.12	-.03	.35*	-.15	-.10	.24		.07	.03	.13	.07	.11	.41	.37	.42*	.40	.20	.40
Time 3																						
12. Rapid automatic naming	-.30*	-.35*	-.35*	-.24	.21	-.06	.65**	-.26	-.33*	.19	.16		-.27	-.17	-.28	-.23	-.35	-.30	-.35	-.40	-.83**	-.54*
13. Paired associate learning (PAL B2)	.10	-.09	.00	.05	.11	.02	.11	.00	.03	.17	.08	.27		.34	.14	.26	.55**	.28	.49*	.50*	.18	.47*
Reading and writing skills																						
Time 1																						
14. Allu TL2	.61**	-.48**	.59**	.50**	-.04	.28	-.32	.47*	.63**	.15	-.07	-.29	.16		.77**	.95**	.91**	.59*	.86**	.78**	.27	.77**
15. Pseudowords SUM	.61**	-.34	.68**	.46**	.06	-.05	-.55**	-39*	.61**	.13	-.09	-.40*	.10	.79**		.93**	.81**	.78**	.86**	.60*	.47	.64*
16. Reading and writing skills SUM	.764**	-.50**	.66**	.55**	-.03	.23	-.44*	.46*	.65**	.19	-.09	-.38	.16	.97**	.92**		.92**	.71**	.91**	.75**	.38	.76*
Time 2																						
17. Allu TL2	.66**	-.38*	.63**	.42*	.01	.01	-.59**	.35	.51**	.09	-.18	-.42*	.04	.86**	.92**	.94**		.734**	.97**	.88**	.46	.89**
18. Pseudowords SUM	.68**	-.20	.59**	.26	.16	-.10	-.47*	.33	.34	.12	-.01	-.36	.07	.64**	.86**	.77**	.78**		.89**	.52*	.74**	.59*
19. Reading and writing skills SUM	.70**	-.34	.65**	.39*	.06	-.02	-.58**	.36*	.48**	.10	-.14	-.42*	.05	.84**	.94**	.93**	.98**	.89**		.82**	.59*	.85**
Time 3																						
20. Allu TL2	.69**	-.42*	.76**	.62**	-.11	.03	-.66**	.50**	.56**	-.04	-.21	-.53**	.37	.80**	.85**	.88**	.88**	.63**	.85**		.52*	.98**
21. Pseudowords SUM	.68**	-.27	.52**	.60**	.04	-.08	-.52**	.42*	.08	.18	-.13	-.60**	.18	.40	.48*	.48*	.56**	.47*	.56**	.58**		.67**
22. Reading and writing skills SUM	.73**	-.42*	.77**	.65**	-.09	.01	-.67**	.52**	.51**	.00	-.21	-.58**	.36	.77**	.83**	.86**	.88**	.64**	.85**	.99**	.70**	

Note: Correlations above the diagonal are for the slow learners group (n=38) and those below the diagonal are for the fast learners group (n=47). Pseudowords SUM -variables are sums of different pseudoword tasks (syllables, words, complex words) in different times of measurement. Reading and writing skills SUM -variables are sums of AlluTL2 and Pseudoword tasks in different times of measurement.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4. DISCUSSION

The aim of the study was to examine dynamic learning, its predictive value on reading and writing skills, and especially to find differences between those who succeeded in the paired associate learning tasks and who did not. One aim was to deepen the knowledge that we already had on paired associate learning tasks and dynamic assessment on reading especially in consistent orthographies.

When the norm group was concerned paired associate learning tasks didn't give any extra predictive value on reading and writing skills in first grade according to more traditional language and cognitive skills (phonological awareness, rapid naming, vocabulary, visual-motoric skills, phonological short-term memory and vocabulary). Those skills and especially phonological awareness explained the variation of reading and writing skills so highly that paired associate learning tasks didn't improve the values significantly.

What was interesting was that different variables stood up to explain the reading and writing skills in the two groups studied; slow learners and fast learners in the paired associate learning tasks. In the slow learners group the main explicator of reading and writing skills at every time of measurement (the beginning, the midway and the end of first school year) was letter knowledge assessed in the first measurement. It makes sense; knowing the names of the letters is a basic skill in learning to read. At the first and the second measurement surprisingly paired associate learning tasks arose to explain the variation of reading and writing skills; task with familiar Finnish phones assessed at the second measurement explained reading and writing skills at the first and the second measurement, and task with unfamiliar phones assessed at the second measurement also explained the variation of the reading and writing skills at the midway of the school year.

In the fast learners group, in other words among those who succeeded well in the paired associate learning tasks, phonological awareness was the main explanatory variable of reading and writing skills in the beginning and in the midway of the first school year.

Also vocabulary skills added the prediction of reading and writing skills in the beginning of the school year. The explicators of reading and writing skills at the end of the school year were letter knowledge (assessed in the first measurement), RAN for objects, phonological memory and paired associate learning task with unfamiliar sounds assessed in the final measurement at the end of the school year.

To sum up, paired associate learning task i.e. dynamic learning task wasn't significant predictor of reading and writing skills in first grade when data representing the whole population was considered. But, interestingly, when those who succeeded weakly in the paired associate learning tasks were explored, dynamic learning arose to be one of the main explicators of reading and writing skills in the first grade.

These results give quite strong witness to the fact that paired associate learning tasks have the potential and ability to find the children in need of special attention concerning reading and writing skills. The actualization of the task should be taken to the next level so that it could be used effectively in real life surroundings.

Most of the few studies concerning dynamic learning and development of reading skills found strong connections between the two (Castles & Holmes, 1996; Hulme, Goetz, Gooch, Adams & Snowling, 2007; Vellutino, Scanlon, & Spearing, 1995; Windfuhr and Snowling, 2001). All these studies were executed in English speaking surroundings i.e. in a language with an extremely inconsistent orthography. The findings of this study support the findings of Lervåg (2009) saying that paired associate learning tasks don't predict reading abilities in consistent languages such as Norwegian or Finnish when the whole population is concerned.

What is different in this study compared to other studies that are referred to is the actualization of the paired associate learning task that may impinge the comparing of results. In the previously mentioned studies about dynamic learning the paired associate learning task utilized mainly pseudowords whereas in this study singular phones were being used. In other studies the examinees were well familiarized with the pseudowords

before the actual task; in this study the familiarization process wasn't carried out. The reason for the latter difference is that in this research project the aim was to see how well the assessment tasks can be executed in computer based environment only with the help of a teacher.

Although based on the results the teachers were able to carry out the assessment process relatively well there may be some variation in the measurement that cannot be controlled by the researchers. The large amount of different teachers fulfilling the assessment, the alternating environmental factors (i.e. noise and other disturbing factors), the attitude of the child towards the testing situation and the possible personal guidance to the child by teachers might have been affecting the results into some direction.

What needs to be considered is what kind of task is the best to measure dynamic and associative learning. If the child is very deeply familiarized with the stimuli of the task before the actual measurement there is a possibility that actually memory skills are being tested and not the ability to learn new connections between visual and verbal stimuli. On the other hand the quality of the task used in this research may actually measure the phonemic segmentation skills more than dynamic learning. Especially in the form of the paired associate learning task where unfamiliar phones were being used the ability to separate the phones from one another improved the success in the task. Based on this and comparative studies the best material for assessing dynamic learning skills could be pseudowords that are easily separable but not too thoroughly familiarized with the child so that the child needs to get the idea of the task and connect independently the correct visual stimulus to verbal stimulus.

After this research the paired associate learning tasks need to be improved so that the results can be regarded as more reliable and sensitive to differences between children. In this research it can be for quite high certainty to be said that the tasks better sorted out the "fast learners" i.e. those who succeeded well in the tasks. If the child was placed to the "slow learners" group the only reason probably wasn't the child had a weak ability for dynamic learning but it also could have been a result of multiple reasons why the paired

associate learning task didn’t go well (for example frustration to the task if the instructions weren’t understood well enough). The paired associate learning task in this study was cut off if the child was able to choose the right stimulus three times in a row. If the child was lucky enough to find the right combinations with the first try the results might seem to be even too positive.

The challenge for the future is to find such auditory material that would place children into an equal position to connect the material to new visual signs. After this improvement the benefits of dynamic testing can be fully used without problems of reliability and sensitivity. Dynamic learning and paired associate learning tasks when used properly do measure the basic learning skills that are essential in reading; connecting a phone with a visual stimulus. There were at least three processes in the PAL –task: learning the visual representations for each nonsense form (stimulus learning), learning the phonological representation for each of the phones (response learning), and learning the associations between the nonsense forms and their paired phones (stimulus–response association formation). As this study has proved, paired associated learning tasks have the ability to find those children who are in need of special attention concerning the development of reading and writing skills which eventually is the most crucial thing in developing these assessment methods. The challenge is to improve the task so that it can be used easily and reliably, and that it would be motivational for children.

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