The PhonicStick Nursery Study

Can phonological awareness be initiated by using a speaking joystick?

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ABSTRACT

The PhonicStick is a “speaking” joystick, developed at the School of Computing, University of Dundee in Scotland. It contains speech sounds that can be blended together into words. The aim of the present study was to investigate if phonological awareness can be initiated with PhonicStick training in four-year-old children. The study also investigated if the amount of training is relevant to do this. 18 Scottish nursery children participated in the study. The two test groups had six (T1) and ten (T2) training sessions. The control group (C) had no training. Phonological awareness is defined as the ability to detect and manipulate sounds in words. When comparing pre- and post-assessments in phonological awareness no improvements were seen in the two test groups in relation to the control group. A possible reason for this might be that the PhonicStick did not train the assessed parts of phonological awareness (Phoneme isolation and Phoneme segmentation). When comparing the PhonicStick pre- and post assessments (Phoneme production and Production and identification of word) T2 was the group which increased the most. In addition, age seems to be an important factor for phonological awareness. The children who were younger than four years and four months (n=8) showed no initial ability in the phonological awareness assessment. In the post-assessment two children in this age group had improved, but since one of them was in C, this was not attributed to the PhonicStick training.

Keywords: the PhonicStick, phonological awareness, phoneme isolation, phoneme segmentation, nursery children

SAMMANFATTNING

The PhonicStick är en "talande" joystick, som är utvecklad vid School of Computing, University of Dundee i Skottland. Den innehåller språkljud som kan sättas ihop till ord. Syftet med den här studien var att undersöka om fonologisk medvetenhet kan väckas med PhonicStick-träning hos fyraåriga barn. Studien undersökte också om mängden träning är av betydelse för detta. 18 skotska förskolebarn deltog i studien. De två testgrupperna hade sex (T1) och tio (T2) träningstillfällen. Kontrollgruppen (C) fick ingen träning. Fonologisk medvetenhet definieras som förmågan att upptäcka och manipulera ljud i ord. När pre- och post-testen i fonologisk medvetenhet jämfördes, sågs inga förbättringar i de två testgrupperna i relation till kontrollgruppen. En möjlig förklaring till detta skulle kunna vara att the PhonicStick inte träner de bedömda delarna av fonologisk medvetenhet (Fonemisolering och Fonemsegmentering). När PhonicStick pre- och post-testen (Fonemproduktion och Produktion och identifiering av ord) jämfördes, sågs den största förbättringen hos T2. Dessutom verkar ålder vara en viktig faktor när det gäller fonologisk medvetenhet. Barnen som var yngre än fyra år och fyra månader (n=8) visade ingen initial förmåga i det fonologiska medvetenhetstestet. I posttesten av fonologisk medvetenhet hade två barn i denna åldersgrupp förbättrats, men eftersom en av dem var i C, berodde det inte på PhonicStick-träningen.

Nyckelord: the PhonicStick, fonologisk medvetenhet, fonemisolering, fonemsegmentering, förskolebarn
1. Introduction

The PhonicStick is a “speaking” joystick developed at the School of Computing, University of Dundee, Scotland. The original idea was to enable speech and literacy learning in children with autism, cerebral palsy and Down’s syndrome with complex communication needs (Black et al., 2008a). The present study aims to investigate if the PhonicStick can be used to initiate phonological awareness in Scottish four-year-old children and to see if the amount of training is relevant in order to do this. The PhonicStick allows children to access letter sounds called phonics (Jolly Learning, 2010). Phonics refers to a set of phonemes which are learnt together with letter names for the purpose of literacy learning. The present study deals with pre-analytic sounds of a language, phones, and sounds which affect the meaning of a word, phonemes. However, the term phone will be used in the PhonicStick contexts.

In the following chapters, the term phonological awareness will be defined and some previous research on phonological awareness will be presented. Nursery organisation and the curriculum will also be explained, as well as literacy teaching methods. Finally, the development and previous studies of the PhonicStick will be presented.

1.1. Phonological awareness

1.1.1. Definition

Phonological awareness refers to the knowledge about the sound structure of the language and is usually defined as the ability to detect and manipulate sounds in words (Catts & Kamhi, 2005). In other words, it includes the ability to segment words and identify phonemes.

Some researchers have made distinctions between the terms phonological awareness and phonemic awareness. The term phonological awareness includes the ability to detect and manipulate both smaller and larger units of spoken words, whereas the term phonemic awareness focuses only on the ability to detect smaller individual phonemes in words (Catts & Kamhi, 2005). Stanovich (1992) has also suggested the term phonological sensitivity, which can be viewed as a continuum ranging from deep to shallow sensitivity. In this thesis, the term phonological awareness will be used, while it implies a more general level of awareness than phonemic awareness.

Phonological abilities can be grouped and measured in many different ways. According to Dodd et al. (2000) tasks requiring phonological awareness include at least six different sound awareness skills: syllable segmentation, rhyme awareness, alliteration awareness, phoneme isolation, phoneme segmentation and letter knowledge. Adams (1990) divides phonological tasks into four main types: syllable and phoneme tasks, phoneme manipulation tasks, sound blending tasks and rhyming tasks. Catts and Kamhi (2005) group phonological awareness tasks into three broad categories: phoneme segmentation, phoneme synthesis and sound comparison. However, in this thesis the classification by Dodd et al. (2000) will be used. The phonological awareness assessment used in this study, is constructed according to this system.

Some research (Yopp, 1988) has indicated that the tasks may vary in the complexity of their overall cognitive requirements, and there may be some differences between analysis and synthesis tasks at certain ages (Wagner et al, 1994). Differences among these tasks in their level of difficulty seem primarily related to the extent to which they require explicit manipulation of individual phonemes (Catts & Kamhi, 2005).
1.1.2. Development of phonological awareness

Phonological awareness is not a unitary skill (Hoien et al., 1995). Rather, it develops along a continuum according to three different levels of awareness: syllabic, intra-syllabic and phonemic. Syllabic refers to the awareness of syllables in words. Intra-syllabic refers to the awareness of onset and rime within syllables. The onset consists of the initial consonant or consonant cluster and the rime the vowel and any proceeding consonants. Finally, phonemic refers to the awareness of individual sounds in words, which affects the meaning of the word. Awareness of the syllabic unit is attained early. Intra-syllabic awareness skills are the next to emerge. A strong relationship has been established between the knowledge of nursery rhymes and the development of awareness of onsets and rimes (Maclean et al., 1987). Goswami (2006) suggested a universal sequence of development from awareness of larger units (syllables, onsets, rimes) to awareness of smaller units (phonemes).

Burt et al. (1999) assessed and analysed phonological awareness and processing skills of four-year-old preschool British children. They were assessed on eight tasks: consistency of word production, phonological variability according to speech production task, non-word imitation, syllable segmentation, rhyme awareness, alliteration awareness, phoneme isolation and phoneme segmentation. The results indicated that age significantly correlated with performance on tasks targeting alliteration, non-word imitation, phonological variability, phoneme isolation and segmentation. Consequently, the older children were more phonologically aware than the younger children.

1.1.3. Phonological awareness and literacy acquisition

The present study is based on the theory that phonological awareness is important when children learn to read and write. Catts & Kamhi (2005) argued that it helps the children to understand the alphabetic principle. English is an alphabetic language which requires knowledge about the sounds in words and that the sounds are represented by letters. To be able to learn individual letter sounds, at least emergent levels of phonological awareness is needed. In addition, phonological awareness makes it easier for the children to notice the regular ways that letters represent sounds in words. The ability to be aware of the relationship between the sounds in a word and the way it is spelled, reinforces knowledge of individual sound-letter correspondences and helps in forming mental representations of words that involve a close relationship of their written and spoken forms.

Many researchers worldwide have agreed on the importance of phonological awareness in learning to read and write. However, opinions differ on how phonological awareness and literacy acquisition relate. Either it develops after reading instructions (Morais et al, 1979) or before literacy acquisition (Adams, 1990; Lundberg et al., 1980,1988; Ball & Blachman, 1991; Hoien et al, 1995; Schneider, 1997; Reading & Van Deuren, 2007). Morais et al (1986) showed that illiterate adults performed significantly lower on phonemic segmentation tasks, which therefore was assumed to require experience of reading instructions. In spite of these results, several studies have supported the second view and emphasised the positive long-term effects on reading and writing. For example, in a study by Lundberg et al. (1980) 143 Swedish kindergartners were given a number of phonological awareness tests. The results showed that these tests were important predictors of reading almost two years later. A Norwegian study found a similar pattern of results. Hoien et al. (1995) reported that
syllable, rhyme and phoneme awareness all made independent contributions to variance in reading in a large group of 15,000 children. In another study by Lundberg et al. (1988) 400 Danish preschool children participated in an intensive programme to stimulate their phonological awareness. They were followed up through four school years to evaluate their reading and spelling skills. The research team found that the trained children showed better reading and spelling skills and were better prepared to work with the alphabetic system than the children who did not participate. In other words, the early discovery of the phoneme had given the trained children an initial advantage in learning to read and spell. Ball & Blachman (1991) strengthened the studies by Lundberg et al. and showed that children who receive phonemic awareness training in kindergarten are superior in early word recognition and spelling skills than untrained children. The study of Lundberg et al. was also replicated by Schneider et al. (1997) on German preschool children. They came to the conclusion that early and intensive training of phonological awareness had positive effects on subsequent reading and writing skills and that the effects could be seen even during a short period of time. Furthermore, Reading & Van Deuren (2007) assessed literacy skills of first-grade children. One group received instruction in phonemic awareness in kindergarten, while one group did not. Results suggested that learning phonemic awareness in kindergarten supported subsequent reading and also that phonemic awareness skills occurred within a short time period.

According to Bus & Van Ijzendoorn (1999), one way to maximise the influence of training is to start early. The effects of training programs appeared strongest in preschool and kindergarten before children have begun to read. At this age, most children benefited from small group instruction that is relatively brief and that includes engaging in game-like activities. Ehri et al. (2001) stressed the importance of focusing on a limited set of skills such as blending and segmenting when teaching phonological awareness. These skills should also be taught explicitly and systematically. Besides, methods that integrated instruction in sound-letter correspondences and that directly linked newly acquired phonemic awareness to reading and spelling made the learning more effective (Bus & Van Ijzendoorn 1999; Ehri et al. 2001).

1.1.4. Phonological awareness in different languages

Goswami (2006) discussed how phonological awareness varied in different languages and how it was associated to reading across languages. He also suggested a possible theory of reading, phonology and development: the psycholinguistic grain size theory. According to the psycholinguistic grain size theory, beginning readers are faced with three problems: availability, consistency, and granularity of symbol-to-sound mappings. Basically, he argued that the development of reading is founded in phonological processing across languages. More specifically, he meant that languages vary in their phonological structure and in the consistency. Therefore, cross-language differences in the development of certain aspects of phonological awareness and in the development of phonological recoding strategies should be expected across orthographies.

Goswami (2006) compared children learning transparent orthographies, such as Greek, and non-transparent orthographies, such as English and claimed that Greek children acquired phonological awareness relatively quickly, whereas English children were much slower. This statement was proved in a study by Seymour et al (2003) where grapheme-phoneme recoding skills were compared during the first year of schooling in 13 European orthographies. The results indicated that children from a majority of European countries became accurate and fluent in foundation level reading before the end of the first school year. There were some exceptions, notably in French, Portuguese,
Danish, and particularly in English. Once again, it was argued that fundamental linguistic differences in syllabic complexity and orthographic depth are responsible. Seymour et al (2003) also claimed that syllabic complexity affects decoding, whereas orthographic depth affects both word reading and non-word reading. The rate of development in English was more than twice as slow as in transparent orthographies. It also turned out that Scottish children scored the least in grapheme-phoneme recoding tests. To conclude, the success rates achieved by children in the different countries appeared very closely tied to the transparency and phonological structure of the different languages (Seymour et al, 2003).

2. Early education in Scotland

2.1. Nursery organisation

Since 2000 all children in Scotland aged three and four are entitled to free, part-time preschool education. In July 2004, 85 per cent of three-year-olds and 100 per cent of four-year-olds received preschool education (QCDA, 2010). There is a growing appreciation of education and care in the preschool setting being interlinked. As a result, services that have traditionally been thought of as providers of care are now recognised as also playing a role in educating young children (European Commission, 2010). This view is reflected in the Scottish curriculum for education. Preschool, primary school and secondary school all fall under the same curriculum.

2.2. The Curriculum

In August 2010 a new curriculum was implemented in the Scottish school system. The Curriculum for Excellence arose from a great national consultation, the National Debate in 2002 (The Scottish Government, 2010). Pupils, parents, teachers, employers and others gave their opinions on what they valued in the existing curriculum and what was needed to be changed. On the basis of the views from the National Debate, along with current research and international comparisons, a review group was established in 2003 in order to create a new and updated curriculum (Learning and Teaching Scotland, 2010).

2.2.1. Curriculum for Excellence

Curriculum for Excellence aims to achieve a transformation of education in Scotland by providing a coherent, more flexible and enriched curriculum. The children are given a connection throughout their education with smooth transitions, e.g. between preschool to primary school (Learning and Teaching Scotland, 2010). There are five levels of learning: the early, the first, the second, the third and fourth and the senior level.

The early level includes the preschool years and primary 1. It is designed to meet the needs of most children from three years until the end of primary 1. The core messages relate to the importance of “Active, experiential learning”, “A holistic approach to learning”, “Smooth transitions” and “Learning through play” (Learning and Teaching Scotland, 2010). The Scottish education system is therefore expected to promote the autonomy of individuals and at the same time to equip them, on the basis of interdependence, to fulfill the variety of roles which society demands (The Scottish Government, 2010). In the early level, the individual goals are described as statements, e.g.
“As I listen and talk in different situations, I am learning to take turns and am
developing my awareness of when to talk and when to listen.”

“As I listen and take part in conversations and discussions, I discover new words and
phrases which I use to help me express my ideas, thoughts and feelings.”

“I enjoy exploring and playing with the patterns and sounds of language, and can use
what I learn.”

“I explore sounds, letters and words, discovering how they work together, and I can use
what I learn to help me as I read and write.”

(Learning and Teaching Scotland, 2010)

2.2.1.1 Literacy and English

Literacy and English falls under the subject area Language. It is designed to promote the
development of critical and creative thinking as well as competence in listening and
talking, reading and writing and will give the child important personal skills and team
working skills needed in life and later on when working. Teachers are encouraged to
balance play-based learning with more systematic development and learning of skills
and techniques for reading, including phonics.

2.3 Literacy teaching methods

In 2005 the Secretary of State invited Jim Rose to undertake a Reading Review in order
to judge the best way forward regarding literacy teaching for children who are beginner
readers and writers. In the final report he claimed that The British National Curriculum
that was used 1989-1998 made very little impact on raising standards of reading. Although phonic work was a statutory component of the National Curriculum, reports
from Her Majesty’s Inspectors have shown that it was a weak feature of the teaching
(Rose, 2006) and Rose found it to treat phonic work as essential subject content instead
of a method of teaching (Rose, 2005). In 1998 the National Literacy Strategy was
introduced which engaged schools in developing a structured teaching program of
literacy. This included not only what phonic content should be taught but also how to
teach it and it was followed by a rise in standards. According to Rose, one of the main
ingredients for success in the teaching of beginner readers, are well-designed,
systematic programs of work that are implemented thoroughly. He proposed a
systematic synthetic phonics approach to be used (Rose, 2006). However, Wyse &
Goswami (2008) claimed that the report provided no reliable empirical evidence
regarding the synthetic phonics being the best method. They referred to the American
National Reading Panel report that showed no significant difference regarding the
effectiveness between an analytic- and a synthetic approach.

2.3.1 Synthetic phonics

To use a systematic phonics approach in the teaching of reading is an increasingly
recognised method in the English-speaking countries. In 2000 the American National
Reading Panel made a report on teaching children to read in English and concluded that
specific systematic phonics programs are all significantly more effective than non-
phonics programs. The core components of a phonics program are the teaching of
grapheme-phoneme correspondence and to blend sounds into words and reversely to
segment words into sounds (Wyse & Goswami, 2008). One approach to this teaching program is the synthetic phonics. It focuses on letter sounds instead of letter names. When a few letter sounds have been taught, the children are shown how the sounds can be blended into words (Johnston & Watson, 1997). This is in contrast to the predominant Scottish reading method, analytical phonics, where the children learn the phonics in the context of the whole word (Johnston & Watson, 2005). In synthetic phonics the children learn to write each letter on the same day as the sound is introduced (Synthetic Phonics, 2010). Since the children learn most of the letter sounds and digraphs during the beginning of their first school year they soon have the tools to read and understand new and unfamiliar words by themselves (Johnston & Watson, 2005).

2.3.2. Jolly phonics

In Great Britain the Jolly phonics is a common literacy teaching approach. It is based on the synthetic phonics method and teaches the letter sounds in a systematic way. The 42 phonics of English are taught in groups. There are seven groups with six phonics in each. Some sounds are written with two letters. Some of these look the same but sound differently. These letter combinations are called digraphs, e.g. \textit{th} in \textit{that} and \textit{three}. Learning the letter sounds instead of the letter names facilitates the ability to sound out each phoneme in a word and then contract them to a word, e.g. d-o-g dog (Jolly Learning, 2010).

3. The PhonicStick

3.1. Speaking phonics

The PhonicStick is a speech sound generating joystick, developed in 2005 in an ongoing project called “Speaking Phonics” at the School of Computing, University of Dundee in Scotland. The original idea was to enable speech production and literacy learning without any demands on visual ability in children with autism, cerebral palsy and Down’s syndrome with complex communication needs (CCN) (Black et al., 2008a). CCN include severe physical and communication impairments and possibly varying degrees of intellectual disability, e.g. due to cerebral palsy. Other groups, e.g. people with acquired language impairments and children with phonological difficulties would also benefit from support in phonological awareness in order to acquire literacy (R. Black, personal communication, 2010-12-09).

3.2. Speech generating devices

A speech generating device (SGD) or voice output communication aid (VOCA) is a type of augmentative and alternative communication (AAC) aid used to support literacy learning and phonological awareness in people with CCN. Most SGDs require a visual interface and represents phonics using pictures or letters. The PhonicStick does not require visual ability and enables people with CCN to generate phonics and to play with sounds. It also gives immediate auditory feedback. The PhonicStick was made as a joystick because it is a well-established method for wheelchair motor control. Another reason to use a joystick was that children with physical disabilities experienced difficulties to navigate computer interfaces (Black et al., 2008a).
The PhonicStick prototype contains the six phonics of the first learning stage in the Jolly Phonics literacy programme: /s/, /a/, /t/, /i/, /p/ and /n/. The phonics can be blended together into words and non-words with two or three phonics. To hear a phonic, the joystick is moved in one of six directions and back to the centre position. The aim is to have all 42 phonics of the English language on the joystick (Black et al., 2008b).

Figure 1. The mapping of the first stage of the PhonicStick.

Figure 2. The full mapping of all 42 phonics on the PhonicStick.

3.3. Previous studies

A pilot study was conducted within the developing of the PhonicStick to investigate if it could be used to support phonic access for children with CCN. The study included seven Scottish children aged six to fifteen. Five of the children had some degree of physical and/or learning disability and two had no disabilities. The results showed that all seven children were able to retrieve all six phonics in order to sound out words within a game after one training session of 20 minutes. Although two children experienced difficulties in accessing some of the positions of the phonics because of their physical disabilities, they were still able to demonstrate that they knew the positions of all six phonics. In addition, one of the participants with Down’s syndrome used the PhonicStick as an augmentative aid to clarify her speech (Black et al., 2008a).

In addition, three master theses have been done by six final year speech and language therapy students at the University of Uppsala to investigate different aspects of the PhonicStick. Ager & Solli (2009) evaluated the use and effect/impact of the PhonicStick for phonological awareness in 46 Swedish preschool children aged five and six. The children were randomly divided into a test group and a control group and were pre-and post-tested to analyse the possible improvement of parts of the phonological awareness. The test group had three PhonicStick training sessions, which included different games and tests. The results from the pre- and post tests of phonological awareness showed no significant differences between the test and the control group.
This was discussed as being due to the limited time between the pre- and post test, thus too few training sessions during a too short time of training with the PhonicStick. Another reason discussed was that the PhonicStick did not train the tested parts of phonological awareness. However, four out of five subtests of the PhonicStick assessments showed significant improvement between training session one and training session three. Ager & Sollf suggested more training sessions in a more intense and/or longer training period for future studies.

Lempke & Lindberg-Wesslert (2009) investigated if the PhonicStick could be used to initiate interest in language play in children with Down’s syndrome in order to stimulate their reduced phonological awareness. Six children with Down’s syndrome between five and 15 years of age took part in six training sessions. Two training sessions included pre- and post testing of phonological awareness and four training sessions were intervention training sessions with the PhonicStick. The results showed that the PhonicStick can be used to introduce and enhance phonological awareness in children with Down’s syndrome and that an increase in phonological awareness is possible even during a short time of practise. They concluded that children with Down’s syndrome benefit from practising phonological awareness through language play and that they might have future positive effects on their literacy acquisition.

Kimhag & Lindmark (2009) tested ten South African children aged five to six to see if they could learn how to use the PhonicStick and to see if their phonological awareness was improved. The PhonicStick was used for a period of three weeks. The children’s phonological awareness was tested before and after the training sessions. In addition, their ability to produce sounds and words with the PhonicStick was tested. The results indicated that their ability to produce sounds and words improved significantly from the first to the third test training session, although their phonological awareness did not improve after the training period. The results also showed that the children appeared to be interested in the PhonicStick and that they found it relatively easy to manoeuvre. Kimhag & Lindmark (2009) concluded that more time was needed to find out if training would result in improved phonological awareness skills.

Since no previous study has investigated PhonicStick training in four-year-old children, the present study will give some additional information about the fields of application of the PhonicStick. In previous studies ceiling effects were seen. By studying four-year old children ceiling effects might be avoided since their phonological awareness normally has not yet developed.
4. Aim

The aim of this study was to investigate if the PhonicStick can be used to initiate phonological awareness in Scottish four-year-old children and to see if the amount of training is relevant in order to do this.

The following research questions were asked:
   Can the PhonicStick be used to initiate phonological awareness in Scottish four-year-old children?

   How do different amounts of training affect phonological awareness in Scottish four-year-old children?

The following research questions were also investigated:
   What is expected from Scottish four-year-old children regarding phonological awareness?

   How do Scottish four-year-old children handle the PhonicStick?

   Can Scottish four-year-old children learn to find the positions of the phones on the PhonicStick?

   Can Scottish four-year-old children learn to identify and produce words with the PhonicStick?
5. Method

5.1. Participants
The study involved 18 children aged 3:11 to 4:8 years and months (3.92 to 4.67 years) who were recruited from a local nursery in Dundee, Scotland. The nursery manager was given an information letter and was asked to give her consent for the children to participate (See Appendix 1 and 3). The children’s parents also received information letters and were asked to give their consents for their child to take part (See Appendix 2 and 4). The children, whose parents had given their consent, were asked if they wanted to help with the research. The age of four was chosen because literacy learning has not yet started at that age in Scotland. The inclusion criteria were enrolment at a preschool or nursery school, sufficient physical ability to control the joystick and no obvious hearing impairment. The children were divided into three groups: Test group 1 (T1), Test group 2 (T2) and a Control group (C), and. T1 received six training sessions with the PhonicStick. T2 received ten training sessions and the C group received one training session, the Introduction of the PhonicStick. For T1 the mean age was 4.25 (years), the median age 4.25, the minimum age 4.00 and the maximum age 4.42. For T2 the mean age was 4.20, the median age 4.15, the minimum age 3.92 and the maximum age 4.67. For the C group the mean age was 4.42, the median age 4.50, the minimum age 3.92 and the maximum age 4.67. The mean age, the median age, the minimum age and the maximum age of all three groups are given in Table 1.

Table 1. Mean age, median age, minimum (min) and maximum (max) age of all three group: Test group 1 (T1), Test group 2 (T2) and the Control group (C).

<table>
<thead>
<tr>
<th></th>
<th>Mean age</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4.25</td>
<td>4.25</td>
<td>4.00</td>
<td>4.42</td>
</tr>
<tr>
<td>T2</td>
<td>4.20</td>
<td>4.15</td>
<td>3.92</td>
<td>4.67</td>
</tr>
<tr>
<td>C</td>
<td>4.42</td>
<td>4.50</td>
<td>3.92</td>
<td>4.67</td>
</tr>
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</table>

5.2. Materials

5.2.1. Assessment of phonological awareness
The Preschool and Primary Inventory of Phonological Awareness (PIPA) was used to assess the children’s phonological awareness skills (Dodd et al, 2000). PIPA is designed for children aged three to seven and consists of six subtests: syllable segmentation, rhyme awareness, alliteration awareness, phoneme isolation, phoneme segmentation and letter knowledge. Each subtest assesses different aspects of phonological awareness development.

5.2.2. The PhonicStick
The PhonicStick is made out of a computer joystick by label Logitech, Attack™ Joystick. The original stick was removed and replaced by a wooden ball in order to make the PhonicStick easier to handle for the children. There are two “speak-buttons” and two “clear-buttons” programmed on the joystick. When two or three phones have been produced, one of the “speak-buttons” has to be pressed in order to hear the word. The “clear-button” is used after an incorrect phone has been produced or in order to produce a new word. To hear a phone the joystick is moved in one of the six directions and back to the centre. For example, for /a/ the joystick is moved to the north position and back to the centre. When the joystick is pushed to a position where there is no
phone, it sounds “boink”. Additional equipment consisted of a laptop and two items of load speakers.

5.3. Procedure

The study was undertaken by two final year speech- and language therapy students as their master thesis. The study took place during five weeks over a period of seven weeks, due to a holiday when some children did not attend nursery. At the start of the study all children completed two subtests of the Preschool and Primary Inventory of Phonological Awareness (PIPA). The children who scored high on these tests were randomly distributed among the three groups. The rest of the children were placed in the groups according to which days and at what time of the day they were registered to be at the nursery. By doing this, the children in each group were more likely to be present at the nursery at the same time. There were six children in each of the three groups.

Each group was divided into two teams with three children in each. The training sessions and the PhonicStick assessments were conducted in these teams. Test group 1 (two teams) had six training sessions with the PhonicStick. Test group 2 (two teams) had 10 training sessions with the PhonicStick. The Control group (two teams) had one training session, the Introduction to the PhonicStick. All children were also individually assessed on their phonological awareness three times in order to measure any possible differences between the groups. All the groups were assessed thrice with the PhonicStick. If a child was missing, the training session or assessment was postponed to one of the following days. An overview is seen in Table 2.

Table 2. Overview of training and assessment sessions

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>T1</td>
<td>I</td>
<td>**/</td>
<td>**</td>
<td>** I</td>
</tr>
<tr>
<td>T2</td>
<td>I</td>
<td>**/</td>
<td>**</td>
<td>** I</td>
</tr>
<tr>
<td>C</td>
<td>I</td>
<td>*/</td>
<td>I</td>
<td>/</td>
</tr>
</tbody>
</table>

*=training session with PhonicStick, I= phonological awareness assessment, /= PhonicStick-assessment. T1 = Test group 1, T2 = Test group 2. C= Control group.

5.3.1. Assessment of Phonological Awareness

In this study the phoneme isolation and phoneme segmentation subtests (PIPA) were used because they are designed for children aged four or older. The whole test battery takes 25-30 minutes to complete and each subtest takes about 4-5 minutes to administer. Each test item can be repeated once in both subtests and after four consecutive errors the subtest is interrupted. Positive feedback is given irrespective of answer.

In the phoneme isolation subtest the child is shown a picture from a stimulus booklet and is asked to isolate the first sound of a target word. The examiner says: “The first sound of your name is…” and expects the child to say initial sound and provides praise. The examiner says the initial sound if the child does not respond. Then the examiner says: “Here’s a picture of a dog. “The first sound of dog is /d/”, “Tell me the first sound of apple” and provides appropriate feedback. After that, the examiner continues on to the test items but does not provide feedback. In the phoneme isolation subtest there are one demonstration, two practice items and 12 test items. The scoring is 1=correct answer, 0=incorrect answer and NR=no response.

In the phoneme segmentation subtest requires the child to segment a spoken word into individual phonemes. Plastic counters are used to symbolise each phoneme. The examiner says: “Here’s a picture of a bear. We can say bear with counters, B...EAR. The child is asked to separate each sound and to place appropriate number of counters
on the table. The examiner provides appropriate feedback and continues: “Let’s try another one- PIG. I’m going to say PIG with counters, P...I...G. This time you’re going to do it without the pictures”. The stimulus booklet was only shown during the demonstration. In the phoneme segmentation subtest there are two demonstration items, 4 practice items and 12 test items. The scoring is 1=correct answer, 0=incorrect answer and NR=no response.

5.3.2. Introduction of the PhonicStick
All teams were introduced to and assessed with the PhonicStick at the start of the study. One of the researchers introduced the PhonicStick and one child at a time was given help to find all the six phonics. The child was told to move the joystick in six different directions and to listen to what sound he/she heard. Each child was also introduced to the “speak-button” and the “clear-button” and was told that it was possible to make words consisting of two or three sounds. At the end of the training session, each child produced one or two words with some help from the researcher.

5.3.3. The PhonicStick assessments and training sessions
The researchers took turns in leading the training sessions and assessments. Each assessment and training session began with a repetition of the phone positions. Each training session lasted for about 20 minutes and each assessment took about 30 minutes to complete. The assessments and training sessions are described sequentially below (See Appendix 10).

- **Phonic Stick pre-assessment**
  Subtest 1 Phone identification
  The researcher produced a phone on the PhonicStick and one child at a time was asked to identify the correct picture. Six Praxis pictures were used, where each picture represented a sound, e.g. a car sounds /n/. The child received 1 score for each correct answer. There were two test items per child and the highest possible score was 2.

  Subtest 2 Phone production
  The researchers sounded out a phone and showed the corresponding picture as a support. The children were asked to produce two phones each on the joystick. The child received 1 score for each correct answer. There were two test items per child and the highest possible score was 2.

  Subtest 3 Production and identification of word
  Picture-chart 1 (See Appendix 6) was shown to the children as a stimulus. Four of the pictures could be produced and two of them could not be produced with the PhonicStick. The pictures were discussed and the children were told to blend some phones in order to make words. The children were given semantic or phonological prompting and help to move the joystick in the right direction if needed. If a child produced and identified a real word without any prompting, 2 scores were given. If a child produced a real word with phonological prompting and identified it as a real word, 1 score was given. If the child did not manage to produce a real word but was able to identify it as a non real word, 1 score was given.
Training session 2 (T1 and T2)
Each child was asked to take a word card from a pile. The researcher read the word out loud and asked each child to produce the first, middle or last sound of the word with the PhonicStick.

Training session 3 (T1 and T2)
The children played “Simon says”. In Simon says the researcher says e.g. “Simon says /t/” and the child is supposed to produce a /t/ on the PhonicStick. If the researcher does not start with “Simon says…” the child is not supposed to produce the sound.

Training session 4 (T1 and T2)
The children played Bingo with the Praxis pictures (Hellquist, 1999).

Training session 5 (T1 and T2)
The children played Bingo with the Praxis pictures.

Training session 6 (T1 and T2)
The children played Pairs (Memory) with the Praxis pictures.

- PhonicStick middle-assessment (T1, T2 and C)
  (See pre-assessment) Picture-chart 2 (See Appendix 7) was used.

Training session 7 (T2)
The children played Bingo with pictures from Picture-chart 4 (See Appendix 9).

Training session 8 (T2)
The children played Pairs (Memory) with pictures from Picture-chart 4.

Training session 9 (T2)
The children played “Simon says”.

Training session 10 (T2)
The children played Bingo with pictures from Picture-chart 4.

- PhonicStick post-assessment (T1, T2 and C)
  (See pre-assessment) Picture-chart 3 (See Appendix 8) was used.

5.4. Procedure adjustments
The original plan was to have five subtests on each PhonicStick assessment. Two of the subtests were removed in order to shorten the assessments. *Word production after dictation* was removed. The two subtests *Production of spontaneous words* and *Production of picture-based words* were changed into one and same subtest *Production and identification of word*. *Phon identification* was excluded after the initial analysis since it focused more on learning the pictures than identifying the sounds. The original games were also changed and adapted according to the children’s level of phonological awareness. Focus was on learning the separate sounds. The original plan was to have four children in each team. Four children had the Introduction of the PhonicStick together. Later, the number of children had to be changed to three children because the researchers found it difficult to concentrate on four children at the same time. Some
teams had the Introduction and PhonicStick pre-assessment on the same occasion due to the restricted time of the study. Participant 6 (T1) missed the Introduction and PhonicStick pre-assessment. Participant 7 (T2) missed training session 2 and Participant 9 (T2) missed training session 3. Participant 4 (T1) and Participant 8 (T2) had training session 4 together. Participant 1 (T1) and Participant 8 (T2) had training session 5 together.

5.5. Data analysis

For all analyses descriptive statistics are given. In tables and figures mean values are presented because the median was 0 in most cases. For each phonological awareness assessment the results per group have been calculated. In the PhonicStick assessments the sum of results on the two subtests Phone production and Production and identification of word were calculated for each group. Thereafter, the results for each separate subtest were calculated. A non-parametrical independent samples Kruskal-Wallis test was used to investigate if there were any significant differences. The test compared each subtest of the PhonicStick and phonological awareness pre-, middle- and post assessments between the groups. The effect of age was not statistically analysed.

Moreover, the results of all assessments were analysed in two different age groups, age group <4.33 and age group >=4.33. In the analysis of the age groups the results were compared in the two test groups together (T1+T2) and the control group (C) alone. In addition, an observation of the participants was done in order to describe the results and the children in a qualitative way. The assessments and the training sessions were video recorded to facilitate the analysis of the study. Notes were also taken to enable judgment between the researchers.

5.6. Ethical aspects

The parents and the nursery manager gave their informed consent of taking part in the study. Separate video release forms were also signed by parents/guardians (See Appendix 5). The study was approved by The Tayside Committee on Medical Research Ethics Service of the NHS, Scotland. There was a risk that the participants felt stressed due to not understanding and/or failing the tasks. To minimise these effects they were encouraged and given positive feedback for effort rather than correct answers. The participants could withdraw from the study at any time. Personal information, test results and video recordings have been collected and stored in a locked closet at the School of Computing, University of Dundee, Scotland.
6. Results

6.1. Assessment of phonological awareness

6.1.1. Phoneme isolation

In the phonological awareness (PA) assessment the highest possible score is 12. The mean score for T1 in the pre-assessment was 1.83. In the middle-assessment the mean score for T1 was 2.00. In the post-test the mean score for T1 was 3.00. The mean score for T2 in the pre-assessment was 3.50. The mean score for T2 in the middle-assessment was 3.50. In the post-assessment the mean score for T2 was 3.00. For the C group the mean score in the pre-assessment was 3.83. In the middle-assessment the mean score for C group was 3.83. In the post-assessment the mean score for C group was 5.33. The mean scores, the minimum scores and the maximum scores of the assessments are given in Table 3. There was no significant difference between the groups (p>0.05).

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>Min</th>
<th>Max</th>
<th>T2</th>
<th>Min</th>
<th>Max</th>
<th>C</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-assessment</td>
<td>1.83</td>
<td>0</td>
<td>10</td>
<td>3.50</td>
<td>0</td>
<td>11</td>
<td>3.83</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Middle-assessment</td>
<td>2.00</td>
<td>0</td>
<td>11</td>
<td>3.50</td>
<td>0</td>
<td>11</td>
<td>3.83</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Post-assessment</td>
<td>3.00</td>
<td>0</td>
<td>12</td>
<td>3.00</td>
<td>0</td>
<td>10</td>
<td>5.33</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

T1, which had six training sessions, showed only slight differences between the assessments. The difference between the pre-assessment and middle-assessment in T1 was 0.17. The difference between the middle-assessment and post-assessment was 1.00. The difference between the post-assessment and post-assessment was 1.17. T2, which had ten training sessions, showed no increase between the assessments. The difference from the pre-assessment to the post-assessment was -0.50. For C, which had no training sessions, there were slight differences between the assessments. The difference from the pre-assessment and post-assessment was 1.50. This implies that the children in C group were better from the beginning of the study compared to the children in the two test groups. This can have affected the results for the C group. Of the test groups, only T1 showed an improvement. This could mean that a process in PA has begun and is developing in some children in T1 and the C group. The number of children with correct answers (scores 0-12) are shown in Fig 3.
In the pre-assessment and the middle-assessment no ceiling effects were seen in the groups. However, in the post-assessment there was one girl (4:8) in T1 who scored 12. If the assessment had included more test items, she might have received a higher score.

6.1.2. Phoneme segmentation

In this subtest there were only slight differences of the results between the groups. The highest possible score was 12. The mean score for T1 was 0.00 on the PA pre-assessment and 0.17 on the PA middle- and post-assessments. The mean score on T2 was 0.00 in all three PA assessments. For the C group the mean score was 0.00 on the PA pre-assessment, 0.17 on the PA middle-assessment and 0.50 on the PA post-assessment.

The difference between the PA pre- and middle-assessments was 0.17 for T1. Between the PA middle- and post-assessments the difference was 0.00 for T1. The difference between all three assessments was 0.00 for T2. For the C group the difference between the PA pre- and middle assessments was 0.17, and between the PA middle- and post-assessments it was 0.33. The results of this subtest imply that it was too difficult and due to the low scores and the small differences it was not included in the statistic analysis.

6.2. The PhonicStick assessments

6.2.1. Sum of results

The sum of results on the two subtests Phone production and Production and identification of word were calculated for each assessment. The highest possible total score to receive in the PhonicStick assessment was 6 for each child. For T1 the mean total score on the pre-assessment was 0.80, on the middle-assessment it was 0.83 and on the post-assessment the mean total score was 1.67. For T2 the mean total score on the pre-assessment was 0.17. On the middle-assessment the mean total score was 0.83 and on the post-assessment it was 1.83. For the C group the mean total score on the pre-assessment was 0.20. The mean total score on the middle-assessment was 0.67 and on the post-assessment it was 0.83. The mean total scores for all assessments are given in
Fig 4. All three groups showed slight improvements between the pre-and post-assessments. T2 increased the most.

![Graph showing improvements over time for T1, T2, and C groups.](image)

**Figure 4.** Sum of results: the two subtests *Phone production* and *Production and identification of word*. Mean total scores for Test group 1 (T1), Test group 2 (T2) and the Control group (C) in the PhonicStick pre-, middle- and post-assessments.

In the sum of results on the subtests *Phone production* and *Production and identification of word* no ceiling effects were seen. However, on the subtest *Phone production* some children reached the ceiling and this can have affected the sum of results.

### 6.2.2. Phone production

The maximum score on the subtest *Phone production* was 2 per child. For T1 the mean score on the pre-assessment was 0.40. The mean score on the middle-assessment was 0.50. The mean score of the post-assessment was 1.00. For T2 the mean score on the pre-assessment was 0.00. The mean score on the middle-assessment was 0.33. The mean score on the post-assessment was 0.83. For the C group the mean score on the pre-assessment was 0.20. The mean score on the middle-assessment was 0.17. The mean score on the post-assessment was 0.50. The mean score of *Phone production* in all assessments are given in Fig 5. There was no significant difference between the groups ($p>0.05$). Only slight differences were seen in all three groups but T2 increased the most.
In the pre-assessment no children in the three groups reached the ceiling of 2 scores. In the middle-assessment there was one child in T1 and one child in T2 who reached the ceiling. In the post-assessment two children in T1 and two children in T2 reached the ceiling.

6.2.3. Production and identification of word

The maximum score on the subtest Production and identification of word was 4 per child. For T1 the mean score on the pre-assessment was 0.40. The mean score on the middle-assessment was 0.33. The mean score of the post-assessment was 0.67. For T2 the mean score on the pre-assessment was 0.17. The mean score on the middle-assessment was 0.50. The mean score on the post-assessment was 1.00. For the C group the mean score on the pre-assessment was 0.00. The mean score on the middle-assessment was 0.50. The mean score on the post-assessment was 0.33. The mean scores of all three assessments are given in Fig 6. There was no significant difference between the groups ($p>0.05$).

T1 and the C group showed only slight improvements from the pre- to the post-assessment. T2 was the group which increased the most.
The results of the subtest *Production and identification of word* show that more training, i.e. ten training sessions lead to higher results than six and/or no training sessions.

### 6.2.4. Statistical analysis

A non-parametrical Kruskal-Wallis test did not show any significant differences in any aspects between the three groups in the PA and PhonicStick pre-, middle- and post-assessments.

### 6.3. Age groups

The results of the assessments were compared according to two different age groups. T1 and T2 were seen as one test group in this analysis (T1+T2). T1+T2 and the C group were divided into the age group <4.33 years and the age group >=4.33 years. The age limit 4.33 years was chosen because this was the median age of all 18 children. This was also the age where the youngest child received scores on the PA pre-assessment. In the age group <4.33 in T1+T2 there were seven children. In the age group >=4.33 in T1+T2 there were five children. In the age group <4.33 years in the C group there was one child. In the age group >=4.33 in C there were five children.

#### Table 4. Number of children in Test group 1 (T1), Test group 2 (T2) and the Control group (C) according to the two age groups, <4.33 and >=4.33.

<table>
<thead>
<tr>
<th></th>
<th>&lt;4.33</th>
<th>&gt;=4.33</th>
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<tbody>
<tr>
<td>T1 (n=6)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>T2 (n=6)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>C (n=6)</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

#### 6.3.1. PA assessment (Phoneme isolation)

In the pre-assessment of PA, phoneme isolation in T1+T2 all seven children scored 0 in the age group <4.33. In the age group >=4.33 one child scored 0, one child scored 1, two children scored 10 and one child scored 11. One child in the C group scored 0 in the
age group <4.33. In the age group >=4.33 two children scored 0, one child scored 2, one child scored 10 and one child scored 11.

The pre-assessment of PA (Fig 7 and 8) show that no children in the age group <4.33 either in T1+T2 or in the C group received any scores and that the majority of children (seven of eight) in the age group <4.33 are in T1+T2. The children who received high scores in the age group >=4.33 are evenly distributed between T1+T2 and the C group.

In the post-assessment of PA (Fig 9 and 10), phoneme isolation in T1+T2 six children scored 0 and 1 child scored 4 in the age group <4.33. In the age group >=4.33 one child scored 0, one child scored 2, one child scored 8, one child scored 10 and one child scored 12. One child in the C group scored 7 in the age group <4.33. In the age group >=4.33 two children scored 0, two children scored 8 and one child scored 9.

The results indicate that a process in PA has started to develop in one child in T1+T2 (n=7) and one child in the C group (n=1) in the age group <4.33. A similar effect is seen in the age group >=4.33 where one child in T1+T2 and one child in the C group improved from the pre-assessment to the post-assessment. Since the same improvements are seen in T1+T2 and C, the possible initiation of PA cannot be proved to be due to the PhonicStick-training.

The results also show that age seems to be an important factor in the initiation of PA. There is an essentially greater number of children who scored 0 in the age group <4.33.

**T1+T2**

![Graph](image)

**Figure 7.** Pre-assessment (Phoneme isolation, PA). Number of children in Test group 1(T1) + Test group 2 (T2) according to the two age groups <4.33 (n=7) and >=4.33 (n=5).
**Figure 8.** Pre-assessment (Phoneme isolation, PA). Number of children in the Control group (C) according to the two age groups <4.33 (n=1) and >=4.33 (n=5).

**Figure 9.** Post-assessment (Phoneme isolation, PA). Number of children in the Test group (T1) + Test group 2 (T2) according to the two age groups <4.33 (n=7) and >=4.33 (n=5).
6.3.2. The PhonicStick assessments

6.3.2.1 Phone production

In the PhonicStick post-assessment on subtest Phone production four children scored 0, one child scored 1 and two children scored 2 in T1+T2 in the age group <4.33. In the age group >=4.33 in T1+T2 one child scored 0, two children scored 1 and two children scored 2. One child scored 0 in the age group <4.33 in the C group. In the age group >=4.33 in C two children scored 0 and three children scored 1. The PhonicStick post-assessment (Fig 11) shows that there is a greater number of children in the age group <4.33 who have difficulties to find the phones on the joystick.

Figure 10. Pre-assessment (Phoneme isolation, PA). Number of children in the Control group (C) according to the two age groups <4.33 (n=1) and >=4.33 (n=5).
6.3.2.2 Production and identification of word

In the PhonicStick post-assessment on subtest *Production and identification of word* (Fig 12) five children scored 0, one child scored 1 and one child scored 2 in T1+T2 in the age group <4.33. In the age group >=4.33 in T1+T2 two children scored 0, one child scored 1, one child scored 2 and one child scored 3. In the C group in the age group <4.33 one child scored 0. In the age group >=4.33 three children scored 0 and two children scored 1 in the C group.

The results indicate that there is a greater number of children in the age group <4.33 who have difficulties to produce and identify words compared to the age group >=4.33. As mentioned before, age seems to be an important factor in the initiation of PA. This is a possible explanation for the low results among the youngest children (age group <4.33).
Figure 12. Phonic-Stick post-assessment, subtest *Production and identification of word*. Number of children in Test group 1 (T1) + Test group 2 (T2) according to the two age groups <4.33 (n=7) and >=4.33 (n=5).
7. Discussion

The aim of the present study was to investigate if interest in phonological awareness can be initiated after different amounts of training with the PhonicStick in Scottish four-year-old children. The results of the phonological awareness assessments indicate that training with the PhonicStick does not initiate phonological awareness. Further on, the PhonicStick pre- and post-assessments do not show that more training (ten training sessions) leads to a higher increase of results than less (six training sessions) or no training. However, the most prominent result was seen when comparing the younger (<4.33) with the older (>=4.33) children. High results in all assessments seem to be related to higher age (>=4.33).

7.1. Result discussion

7.1.1. Phonological awareness

This study does not support that training with the PhonicStick can initiate phonological awareness in Scottish four-year-old children. No significant differences were seen between the phonological awareness pre- and post assessments. The previous PhonicStick studies by Ager & Solli (2009) and Kimhag & Lindmark (2009) showed similar results. One possible explanation to the non-significant results in the present study might be that the assessments only measured phoneme isolation and phoneme segmentation. These are only two aspects of phonological awareness which includes several different awareness skills such as rhyme awareness and syllable awareness (Adams, 1990; Hoien et al. 1995; Yopp, 1988). The study does not investigate whether the children have developed other abilities of phonological awareness. Another explanation might be that the PhonicStick training did not train the specific parts of the phonological awareness assessed.

This study does not support that more training with the PhonicStick leads to a higher improvement of phonological awareness. T2, which had most training, i.e. ten training sessions, received higher results in the PhonicStick post-assessment than T1 and the C group, which had six and no training sessions at all. This suggests that more training is needed in order to learn how to use the joystick concerning four-year-old children. In previous studies the children were older and they only had three training sessions. They improved their results although the training only included three training sessions. It is possible that the older the children are, the less training is needed.

There seems to be a difference between younger and older four-year-old Scottish children regarding phonological awareness. The results seen when comparing the younger (<4.33) with the older (>=4.33) children indicate that a certain age is crucial for the ability to isolate phonemes. The children in the age group <4.33 seem to be too young for this. Burt et al. (1999), who also assessed phonological awareness skills of four-year-old children, concluded that age correlated with performance on e.g. phoneme isolation. This research supports our finding that age is an important factor when developing phonological awareness. In addition, the standardization of PIPA shows that four-year-old children who score 0 in the subtests used are within the normal range (Dodd et al. 2000).

In the previous PhonicStick study by Ager & Solli (2009) five and six year-old children reached the ceiling in the PA-assessments. To avoid ceiling effects the present study looked at four-year-old children and what is expected regarding phonological awareness in that age.
Ager & Solli (2009) argued that parts of the phonological awareness was not affected and improved because of the limited number of training sessions in their study. The results of the present study indicate that more training sessions do not lead to an improvement between the phonological awareness pre- and post-assessment. However, it is difficult to conclude if the amount of training matters since the groups were not completely homogenous. The group division lead to an uneven age distribution among the three groups. There was a greater number of older (≥4.33) children in the C group than in T1 and T2.

7.1.2. The PhonicStick

In the present study the children learnt how to handle the PhonicStick. However, there were a few exceptions of children who needed more help. A possible reason to this is that these children at times had a lack of motivation and concentration. Another reason might be that the children have different motor skills.

In the PhonicStick assessments slight improvements were seen between the pre- and post assessments in all three groups. However, the improvements were not significant within the separate subtests. In spite of this, it is worth mentioning that T2 increased the most on both subtests. In the sum of results (total score) of the subtests Phone production and Production and identification of word in the post-assessment, T2 received the highest mean total score (1.83). This was not high in relation to the highest possible score 6.

In the subtest Phone production all three groups improved slightly when comparing pre- and post-assessments. Ceiling effects were seen in four children in T1 and T2, which might have affected the results. If there had been more test items in this subtest, the children might have received higher mean scores. As described in the Observations, /p/ and /i/ seemed to be more difficult to produce than the other phones. This is supported by the results, where the children who received these test items, often received no scores. These children might have scored higher if they had received other phones.

In the subtest Production and identification of word slight improvements were seen in all three groups. The ability to segment sounds into words requires some degree of phonological awareness. Since T2 increased more than T1 and the C group, it suggests that more PhonicStick training still leads to a greater awareness of sounds, although not shown in the phonological awareness assessment.

There are a few factors that might have affected the results. As mentioned before, motivation, concentration and age seem to play an important role for the results. Besides, the conditions of the study environment were limited and the study took place in a small nursery with little space. There was only one big main room and one small room for quiet times. The small room was almost never quiet enough to concentrate on the games since it was a lot of passing through. After a short while the room became very warm which also seems to have affected their concentration. Consequently, the study environment might have affected the children’s performances overall.

In addition, some technical problems with the PhonicStick appeared which might have affected the results. After blending sounds into a word and the “speak-button” had been pressed, the “clear-button” had to be pressed in order to make a new sound. If it was not “cleared”, a “boink”-sound was heard. Sometimes this also happened even though the “clear-button” had been pressed, and the child moved the joystick in one of the six directions. It is difficult to say why this happened and in a few cases the researchers restarted the program on the computer to make it work again.
7.2. Method discussion

The limited sample makes generalisations difficult and gives the study a low power. Furthermore, the study does not include information about the children’s language development. It would have been interesting to compare children with a language and/or speech disorder with children with typical language development.

No pilot study was conducted before the real study started. This would have facilitated the number, the degree of difficulty and the time duration in the PhonicStick assessments and training sessions.

This was the first study where the PhonicStick training was conducted in groups. This made it possible to meet more children during a limited period of time. There were both advantages and disadvantages of group training. One advantage was that the children were used to having other nursery activities in groups which meant that they could quickly adjust to the research teams. The children wore team name badges and were told that they were important researchers, which made the work more interesting for them. Since the three children could play together, the researchers had time to conduct the games, keep score and note any qualitative observations. Another advantage of having group training was that the children helped each other (see Observations).

A disadvantage of having groups was that all three children in one team had to be present at the same time. When a child was not present the whole group session had to be postponed. If the training had been individual, the children who were present could have started even though one child was absent. Another disadvantage of working in groups was that some children focused more on the other team mates than on the games at times. In addition, the other two children sometimes had to wait when one child needed extra time to find a phone. If the researchers would have trained the children individually, it might have been easier for the children to concentrate on the training. Besides, it would have facilitated for the researchers to focus on each child’s individual needs.

Using different group games is a good way to practise with the PhonicStick. The children enjoyed playing and competing with each other. The games Bingo and Pairs were the most appreciated. In the subtest Production and identification of word in the PhonicStick assessments, there were two pictures of words that could not be produced with the joystick. The reason for this was to see if the children understood that some sounds could not be produced. This seemed too difficult for the children to understand. Some children seemed disappointed when they chose a picture that could not be made. It had facilitated if all pictures could have been produced.

7.3. Observations

7.3.1. Using the PhonicStick

The children varied in the handling of the PhonicStick. On the one hand, a few children had special difficulties to move the joystick. For example, one boy in T1 (4:0) and one boy in T2 (4:0) were quite forceful with the joystick and moved it in many directions. On the other hand, there were a few children who were more gentle and precise with their movements, e.g. one boy in T1 (4:2) and one girl in T2 (4:8).

In the beginning of the study the children needed a lot of motor help where the researcher helped moving the joystick to the right direction. However, only a few children in all three groups still needed some motor help at the end of the study.

Some phones seemed harder to produce than others, such as /p/ and /i/. A possible reason why /p/ was difficult might be that the joystick needs to be pushed in two steps (Fig 1). In order to find /i/ the joystick is pushed in a north-west direction but the
children sometimes confused the directions and pushed it towards north-east instead. The phones that are placed straight up, down or to one of the sides (north, south, east or west) were the easiest to find. There was a tendency to move the joystick in one of these four directions when they did not know where to find the target phone.

Two children learnt how to use the “clear-button” and “speak-button” in an appropriate way, e.g. when one boy in T1 (4:6) tried to make a word but no sound came out, he said “I need to clear it first”. However, most of the children did not learn to use them correctly and either only pressed the buttons when asked to, or pressed them repeatedly.

Some of the children who became confident in finding the phones helped the other team mates during the training sessions. For example, one girl in T2 (4:8) said “It’s to this side” when her team mate could not find /i/. Another example is when one girl in T1 (4:4) tried to help her team mate, who was handling the PhonicStick forcefully, by saying “It’s because you’re too fast”.

After listening to the blended sounds, the child was asked whether it was a word or not. This often led to a good discussion and they suggested what word the blended sounds could be. For example, when the word “pas” was produced one boy (4:1) and one girl (4:5) in T1 suggested that it meant “purse” and “puzzle”. This implies that they are using their phonological awareness. Another example of this ability was seen in one boy in T1 (4:6), who produced “snt”, and thought it sounded like “Saint (Andrews)”.

This example also shows that he was good at thinking abstractly.

7.3.1.1 Motivation
The use of the PhonicStick was affected by the motivation of the child. Most of the children seemed to enjoy working with the PhonicStick and four of the children wanted to practice more than scheduled. Two of them were in T1 and two of them in the C group. In these situations they played e.g. Bingo, but without the PhonicStick and any sounds. Once in the beginning three children did not want to participate but during the rest of the study they wanted to take part. Furthermore, the children seemed to like the fact that they belonged to a team and that they played games together.

When the child could not find the right direction for a sound a “boink”-sound was heard. Some children seemed disappointed when this happened, as if they were doing something wrong. On the contrary, some seemed to think it was fun, laughed and repeated the sound.

7.3.1.2 Concentration
The children seemed to become tired and distracted after about 15 minutes. Two boys (3:11 and 4:0) and one girl (4:3) in T2 had difficulties to concentrate during the whole study. Their concentration probably affected the fact that they received no scores in the PA post-assessment. Interestingly, these children were all in the age group <4.33.

7.4 Conclusions
The results of the phonological awareness assessments indicate that training with the PhonicStick does not initiate phonological awareness, measured with phonological awareness assessments, in Scottish four-year-old children. No improvements in phonological awareness could be seen in the two test groups in relation to the control group when comparing pre- and post-assessments. Thus, the use of the PhonicStick has not affected the parts of phonological awareness assessed in this study. Slight improvements were seen when comparing the PhonicStick pre- and post-assessment in all three groups, and the results indicate that more training is preferable. However, no
significant improvements were seen within the separate subtests from the PhonicStick pre- and post assessments. There are two possible reasons for this. Either the children are too young to learn how to handle the PhonicStick, or the PhonicStick training demands a certain amount of phonological awareness that has not yet been initiated.

A division of the T1+T2 and C into age groups indicated that age is a relevant factor regarding phonological awareness. It became apparent that the children <4.33 did not have any initial ability of phonological awareness.

7.5. Suggestions for future studies

The researchers of the present study would recommend using larger study groups over a longer period of time than seven weeks for future PhonicStick studies. It would be preferable to conduct a longitudinal study with even more training sessions. The possible effect of training on parts of the phonological awareness on literacy could then be evaluated. Another study could focus on training children with a language and/or speech disorder. Do they benefit more from PhonicStick training than children with a typical language development? If they do, it might be useful clinically in speech- and language therapy. Another study, suggested before (Kimhag & Lindmark, 2009), could be performed where teachers could be trained, to see how they would work with the PhonicStick at school. It might be useful in school activities for early literacy training. Moreover, it could be interesting to see if people with expressive and/or motor aphasia could benefit from training with the PhonicStick and if they could use it as a communication aid. Finally, can the PhonicStick be used to help people with dysarthria to clarify their speech?
References


8. Appendix

1. Information sheet to manager
2. Information sheet to parents
3. Study permission form
4. Consent form
5. Release form
6. Picture-chart 1
7. Picture-chart 2
8. Picture-chart 3
9. Picture-chart 4
10. PhonicStick protocols
The PhonicStick Nursery Study

We would like to invite your pupils to take part in our research study. This information sheet explains the nature of the study. If you have any questions please ask the researchers (contact details at the end).

What is the PhonicStick Nursery Study?

The PhonicStick Nursery study is a part of an ongoing project called “Speaking Phonics” at the School of Computing, University of Dundee. The “Speaking Phonics” project is investigating ways in which children can use technology to play with sounds and words.

We know that phonological awareness (the ability to hear the different sounds in words) is an important factor in learning to read and write. We also know that word games, such as rhyming games, support the development of phonological awareness.

The Speaking Phonics team has built a talking joystick, called the PhonicStick, to help children to play with sounds. By moving the joystick in different directions, the user can collect sounds and blend them into spoken words. For example, collecting /c/, /a/, /t/ would generate the spoken word, “cat”.

Although the PhonicStick only has six phonics (the first stage of the Jolly Phonics literacy programme), several studies have shown that children with and without disabilities can use the PhonicStick to produce these sounds accurately. They can also generate short spoken words. Because the device uses phonics, users do not have to be literate in order to produce spoken words, but can play with sounds and hear what words these sounds make.

What is the aim of this PhonicStick Nursery Study?

This study is being undertaken by two final year speech and language therapy students, Ms Irmeli Peronius and Ms Nina Lindström, as their final year project. (Our contact details, and those of our supervisor, are at the end of this information sheet.)

We want to see whether pre-school children can use the PhonicStick to create spoken words. Although the study will not yet be able to prove whether the PhonicStick will help in literacy learning, we need to know if younger children can use the device to ‘play’ with words. This will help the engineers to develop the device further. We also want to see whether there might be a change in children’s phonological awareness, even over a short period.
Why have the children been invited to take part in the study?

The study is to take place in the University Nursery during the second semester of 2010. We would like to invite children who are in their last year of nursery to take part in the study. Even if the children’s first language is not English, we would like to include them in the study.

Do the children have to take part in the study?

It is up to the parents/guardians to decide to join the study. We will answer any questions about the information sheet they might have. If they agree that their children can take part, we will then ask them to sign a consent form. They will be given copies of these forms to keep.

What happens if parents/guardians wish to withdraw their children from the study?

Parents/guardians are free to withdraw their children at any time, without giving a reason. The child is also free to withdraw at any time without giving a reason. If the child does not want to take part, we will discuss this with parents/guardians and nursery staff. Withdrawal from the study would not affect the standard of education the child receives.

What does the child have to do?

All children will be introduced to the PhonicStick at the start of the study. The children will also complete a short Phonological Awareness test. Each child will be allocated to one of three groups. Two groups will play with the PhonicStick in a structured session twice a week for 20 minutes, while the third group, the control group, will only play with the PhonicStick at the beginning and at the end of the study. The Phonological Awareness test will be repeated during the study to monitor the effect of using, or not using, the PhonicStick.

The study will extend over five weeks. If a session is missed it will be postponed to one of the following days if possible.

All sessions will be video-taped to allow the researchers to analyse the data afterwards. The aim of this research is not to ‘test’ the child but to help us to see whether there is potential for the PhonicStick to support phonological awareness for children.
What are the possible disadvantages and risks of taking part?

Because the children may have difficulty in phonological awareness, they may feel stressed during sessions. To minimise these risks we will ensure that both testing and other sessions are as playful as possible with a focus on giving positive feedback for effort rather than correct answers. Should the children become tired or unsettled, the session will be stopped. The timing and location of sessions will be discussed in consultation with the nursery staff to avoid any negative impact on the children’s nursery experience. We do not envisage any other physical or psychological risks in this study.

What are the possible benefits of taking part?

In our experience, children enjoy using new technology. They also feel empowered by taking part in research when they realize that they are helping to develop new technology. We cannot promise that the study will help individual children, but the child’s involvement will help us to understand how the PhonicStick can be used to support phonological awareness.

What happens at the end of the study?

The analysis of the data will be completed by January 2011. The results of this study will be published in academic journals and presented at academic conferences and will contribute to the ongoing research project to develop the PhonicStick. Parents/guardians and teachers will be given a report on the study and will be told of any strategies that seemed to work with individual children, as this information may be helpful in their ongoing education.

What if there is a problem?

If you have a concern about any aspect of this study, you should ask to speak to the academic supervisor, Dr Annalu Waller, who will do her best to answer your questions [ph. 01382 388223]. If you remain unhappy, you speak to the nursery’s supervisor, Karen Henderson, DUSA Building, Balfour Street, Dundee DD1 4HN [ph. 01382 385188].

Will the child’s information be kept confidential?

Yes. We will follow ethical and legal practice and all information about each child will be handled in confidence. To ensure anonymity, personal records will only be available to the research team for the duration of the study and will not be kept together with the results and video recordings or be presented in the report. If the child’s data is used for publications or presentations, no reference to her/his identity will be made. If any video data is suitable for presentation or teaching purposes, we will discuss this with parents/guardians and ask them to sign separate video release forms. Parents/guardians will be given the option of anonymising the participants’ faces.
Who has reviewed this study?

All research in the University of Dundee is looked at by an ethics committee. This study has been reviewed and given favourable opinion by the School of Computing’s Ethics Committee, a sub-committee of the University of Dundee’s Non-Clinical Research Ethics Committee.

Who can I contact in connection with this research?

The researchers undertaking the study are:

Ms Irmeli Peronius – email: Irmeli.Peronius.0770@student.uu.se
and
Ms Nina Lindström – email: Nina.Lindstrom.0358@student.uu.se

If you would like to know more about this research and/ or you have questions that cannot be answered by the researchers, please feel free to contact their Academic Supervisor:

Dr. Annalu Waller
Senior Lecturer
School of Computing
University of Dundee
Dundee DD1 4HN.
Phone: (01382) 388223
Email: awaller@computing.dundee.ac.uk.
The PhonicStick Nursery Study

We would like to invite your child to take part in our research study. Before you decide, we would like you to understand why the research is being done and what it would involve for your child. Your child’s nursery teacher, or one of our team, will answer any questions you have about the information sheet.

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Does my child have to take part in the study?

It is up to you to decide to join the study. We will answer any questions about the information sheet. If you agree that your child can take part, you sign the consent form and bring it to the nursery. You will be given copies of these forms to keep. We will also ask your child to agree to take part in the study.

What happens if I wish to withdraw my child from the study?

You are free to withdraw your child at any time, without giving a reason. Your child is also free to withdraw at any time without giving a reason. If your child does not want to take part, we will discuss this with you and your child’s teacher. Withdrawal from the study would not affect the standard of education your child receives.

What will my child have to do?

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What are the possible disadvantages and risks of taking part?

Because your child may have difficulty in phonological awareness, she/he may feel stressed during sessions. To minimise these risks we will ensure that both testing and other sessions are as playful as possible with a focus on giving positive feedback for effort rather than correct answers. Should your
child become tired or unsettled, the session will be stopped. The timing and location of sessions will be discussed in consultation with the nursery staff to avoid any negative impact on the children’s nursery experience. We do not envisage any other physical or psychological risks in this study.

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and
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If you would like to know more about this research and/ or you have questions that cannot be answered by the researchers, please feel free to contact their Academic Supervisor:

Dr. Annalu Waller
Senior Lecturer
School of Computing
University of Dundee
Dundee DD1 4HN.
Phone: (01382) 388223
Email: awaller@computing.dundee.ac.uk.
STUDY PERMISSION FORM

The PhonicStick Nursery Study

I confirm that I understand the nature of The PhonicStick Nursery Study. I confirm that Ms Irmeli Peronius and Ms Nina Lindström have permission to conduct interviews/experiments at The University of Dundee Nursery on the understanding that these visits will be undertaken according to the ethical approval obtained for this study.

Name of Person giving Permission

Position in Nursery

Signature

Date

Name of Researcher taking consent

Signature

Date

When completed: 1 for school; 1 for researcher site file.
CONSENT FORM

The PhonicStick Nursery Study

1. I confirm that I have read and understand the information sheet dated 22/08/10 (version 1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

2. I understand that my child’s participation is voluntary and that I am free to withdraw my child from the study at any time without giving any reason, without my child’s education or legal rights being affected.

3. I understand that relevant sections of my child’s data collected during the study may be looked at by individuals from the research team, from regulatory authorities or from the University, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.

4. I agree to take part in the above study.

______________________________  _____________________________
Name of Child  Name of Parent/Guardian

______________________________  _____________________________
Relationship to Child  Signature   Date

______________________________  _____________________________
Name of Person taking Consent  Signature   Date

When completed: 1 for participant; 1 for researcher site file.
The PhonicStick Nursery Study

Please initial appropriate boxes

1. I confirm that I have discussed the release of video material of my child for the purpose of teaching and presentation with a project researcher. [ ]

2. I am happy to release the video material as long as my child’s face is obscured. [ ] OR [ ]

3. I am happy to release the video material without my child’s face being obscured. [ ] OR [ ]

4. I do not want the video material of my child being used for the purpose of teaching and presentation. I understand that all such material will be destroyed after analysis for research purposes. [ ]

Name of Child________________________________________ Name of Parent/Guardian__________________________

Relationship to Child_________________________ Signature_________________________ Date_________________________

Name of Person taking Consent_________________________ Signature_________________________ Date_________________________

When completed: 1 for participant; 1 for researcher site file.
Protocols

Training session 1

<table>
<thead>
<tr>
<th>Group name</th>
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<tbody>
<tr>
<td>Child</td>
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<td>Child</td>
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<td>Child</td>
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Approximate duration of the training session: 20 minutes.

Material
The PhonicStick, computer with software, loud speakers and video camera.

Introduction
The children are shown the placements of the six phonics, the clear button and the speak button. The children are told to move the PhonicStick in different directions and to listen which sounds are made.

“This is a PhonicStick. With the PhonicStick you can make different sounds”.

When the right sound is achieved, the children are asked to repeat it. The researcher proceeds to the next sound when it has been repeated two times. The researcher helps the children at any time by guiding them the movements of the PhonicStick.

“Try to pull the joystick towards you. What do you hear?”
“Now try to pull the joystick to the side.”
“Try to pull the joystick to the other side?”
“Try to pull the joystick up, what do you hear?”
“Now, try to pull the joystick up left, what do you hear?”
“Try to pull the joystick towards you and then to the right side, what do you hear?”

The children are told to make words containing two or three sounds.
After that, the children and the researcher produce some words together.
Pre-assessment (T1, T2, C)

Approximate duration of the assessment is 30 minutes.

Material
The PhonicStick, computer with software, loud speakers, video camera, six Praxis-pictures and Picture-chart 1.

Repetition
The children are asked to remember the sounds from the introduction. The researcher makes the phones verbally and one child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child</th>
<th>Child</th>
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</thead>
<tbody>
<tr>
<td>Where’s /s/?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Where’s /i/?</td>
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<td>Where’s /t/?</td>
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<td>Where’s /p/?</td>
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<td>Where’s /n/?</td>
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<td>Where’s /a/?</td>
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</table>

1. Phone identification

Six Praxis pictures are shown to the children. We talk about the pictures.

“Here are six pictures.”
“Each picture has a sound.”
“This picture of a snake sounds like /s/.”

When the researcher makes a sound with the joystick, the children point to the corresponding picture. Each child will get two sound tasks. All six phones will be used.

<table>
<thead>
<tr>
<th>Child</th>
<th>Phonics</th>
<th>+</th>
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<tbody>
<tr>
<td>/s/ /i/</td>
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<tr>
<td>/p/ /i/</td>
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<tr>
<td>/a/ /n/</td>
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2. Phone production
The researcher makes one of the six sounds verbally together with the corresponding picture and the children make the sound with the joystick.

<table>
<thead>
<tr>
<th>Child</th>
<th>Phonics</th>
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<tbody>
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<td>/a/ /i/</td>
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<tr>
<td>/i/ /s/</td>
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<td>/n/ /p/</td>
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</tbody>
</table>
3. Production and identification of word

Picture-chart 1 is used. Four of the six pictures can be made with the PhonicStick (sun, pat, ant and tin). Two of them cannot be made with the PhonicStick (cat and bat). We talk about all pictures and the children are told to make words with the PhonicStick. If needed the children are given semantic or phonological prompting and help to move the joystick in the right direction.

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<th>Child:</th>
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</table>

Training session 2  (T1 & T2)

Approximate duration of the training session is 20 minutes.

The children are asked to pick one card. The researcher says the word and tells the child to produce the first, middle or the last sound with the PhonicStick. The words do not need to be words that can be made with PhonicStick.

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<th>Child:</th>
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Appendix 10
Training session 3  (T1 & T2)

Approximate duration of the training session is 20 minutes.

Material
The PhonicStick, computer with software, loud speakers and video camera.

Repetition
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child</th>
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<tbody>
<tr>
<td>Where’s /s/?</td>
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<tr>
<td>Where’s /i/?</td>
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<td>Where’s /t/?</td>
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<tr>
<td>Where’s /p/?</td>
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<td></td>
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<tr>
<td>Where’s /n/?</td>
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<td></td>
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<tr>
<td>Where’s /a/?</td>
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</tbody>
</table>

Simon says.
When the researcher says “Simon says /t/”, the child makes /t/ on the PhonicStick. When the researcher does not say “Simon says” before the phone the child does not make the sound.

<table>
<thead>
<tr>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonic</td>
<td>+</td>
<td>Phonic</td>
</tr>
<tr>
<td>/t/</td>
<td>/i/</td>
<td>/p/</td>
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<tr>
<td>/i/</td>
<td>/t/</td>
<td>/i/*</td>
</tr>
<tr>
<td>/n/</td>
<td>/n/</td>
<td>/a/*</td>
</tr>
<tr>
<td>/p/</td>
<td>/s/*</td>
<td>/t/</td>
</tr>
</tbody>
</table>

Appendix 10
Training session 4  (T1 & T2)

Approximate duration of the training session is 20 minutes.

**Material**
The PhonicStick, computer with software, loud speakers, video camera and Praxis pictures /s/, /a/ and /t/.

**Repetition**
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where’s /s/?</td>
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<tr>
<td>Where’s /i/?</td>
<td></td>
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<td>Where’s /t/?</td>
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<td>Where’s /p/?</td>
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<td>Where’s /n/?</td>
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<tr>
<td>Where’s /a/?</td>
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</table>

**Bingo**
The children play bingo together. They collect phonics on a board, and the child who is the first one with a full board wins. Each board contains four pictures of one phonic. The children pick a picture from a pile and make the matched sound on the PhonicStick. The child who has the board with the matched pictures gets the picture.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child</th>
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</table>
**Training session 5**  
(T1 & T2)

Approximate duration of the training session is 20 minutes.

**Material**
The PhonicStick, computer with software, loud speakers, video camera and Praxis pictures /n/, /i/ and /p/.

**Repetition**
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
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</thead>
<tbody>
<tr>
<td>Where’s /s/?</td>
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<td>Where’s /i/?</td>
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<tr>
<td>Where’s /a/?</td>
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</table>

**Bingo**

The children play bingo together. They collect phonics on a board, and the child who is the first one with a full board wins. Each board contains four pictures of one phonic. The children pick a picture from a pile and make the matched sound on the PhonicStick. The child who has the board with the matched pictures gets the picture.

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</table>
**Training session 6** (T1 & T2)

Approximate duration of the training session is 20 minutes.

**Material**
The PhonicStick, computer with software, loud speakers and Praxis pictures (/s/,/n/,/a/,/i/,/t/,/p/).

**Repetition**
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PS.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Where’s /s/?</th>
<th>Where’s /i/?</th>
<th>Where’s /t/?</th>
<th>Where’s /p/?</th>
<th>Where’s /n/?</th>
<th>Where’s /a/?</th>
</tr>
</thead>
</table>

**Pairs (Memory)**
One child at a time turns two pictures up in order to find a pair. When a card is picked the child makes the sounds on the PS.

<table>
<thead>
<tr>
<th>Phonics</th>
<th>Child:</th>
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<th>Child:</th>
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</table>
**Middle-assessment**  (T1, T2, C)

Approximate duration of the training session is 30 minutes.

**Material**
The PhonicStick, computer with software, loud speakers, video camera and Picture-chart 2.

**Repetition**
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PS.

<table>
<thead>
<tr>
<th>Phonics</th>
<th>Where’s /s/?</th>
<th>Where’s /i/?</th>
<th>Where’s /u/?</th>
<th>Where’s /p/?</th>
<th>Where’s /n/?</th>
<th>Where’s /a/?</th>
</tr>
</thead>
</table>

1. **Phone identification**
The children are shown the six Praxis pictures. When the researcher makes a sound with the joystick, the children point to the corresponding picture. Each child will get two sound tasks. All six phones will be used.

<table>
<thead>
<tr>
<th>Child</th>
<th>Phonics</th>
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<th>-</th>
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</thead>
<tbody>
<tr>
<td>/n/ /p/</td>
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<tr>
<td>/s/ /a/</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>/i/ /u/</td>
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</tbody>
</table>

2. **Phone production**
The researcher makes one of the six sounds verbally together with the matched picture and the child makes the sound with the joystick.

<table>
<thead>
<tr>
<th>Names</th>
<th>Phonics</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>/t/ /s/</td>
<td></td>
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<tr>
<td>/i/ /p/</td>
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<tr>
<td>/n/ /a/</td>
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</tbody>
</table>
3. Production and identification of word
Picture chart 2 is used. Four of the six pictures can be made with the PhonicStick (Ann, tap, pie and pan). Two of them cannot be made with the PhonicStick (rat and car). We talk about all pictures and the children are told to make words with the PhonicStick. If needed the children are given semantic or phonological prompting and help to move the joystick in the right direction.

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<th>Child:</th>
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</table>

Appendix 10
Training session 7 (T2)

Approximate duration of the training session is 20 minutes.

Material
The PhonicStick, computer with software, loud speakers, video camera and Picture-chart 4 (/s/, /a/, /t/).

Repetition
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PS.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
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</thead>
<tbody>
<tr>
<td>Where’s /s/?</td>
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<td>Where’s /a/?</td>
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</table>

Bingo
The children play bingo together. They collect phonics on a board and the child who is the first one with a full board wins. Each board contains six pictures of one phonic. The children pick a picture from a pile and make the matched sound on the PS. The child who has the board with the matched pictures gets the card.

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</table>
Training session 8  (T2)

Approximate duration of the training session is 20 minutes.

Material
The PhonicStick, computer with software, loud speakers, video camera and Picture-chart 4 (/a/, /i/, /t/, /n/).

Repetition
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
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</thead>
<tbody>
<tr>
<td>Where’s /s/?</td>
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<td>Where’s /i/?</td>
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<td>Where’s /t/?</td>
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<td>Where’s /p/?</td>
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<td>Where’s /n/?</td>
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<tr>
<td>Where’s /a/?</td>
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</tbody>
</table>

Pairs (Memory)
One child at a time turns two pictures up in order to find a pair. When a card is picked the child makes the sounds on the PhonicStick.

Phonics

Appendix 10
Training session 9  (T2)

Approximate duration of the training session is 20 minutes.

Material
The PhonicStick, computer with software, loud speakers and video camera.

Repetition
The children are asked to remember the sounds from the previous training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
<thead>
<tr>
<th>Phonic</th>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
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<tbody>
<tr>
<td>Where’s /s/?</td>
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<td>Where’s /i/?</td>
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<tr>
<td>Where’s /a/?</td>
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</tbody>
</table>

Simon says
“Do you remember the game Simon says?”
It goes like this: When I say Simon says /t/, I want you to make a /t/ on the PhonicStick. If I say Simon says /a/ you make an /a/ on the PhonicStick. Can you do that?”
“Here comes the tricky part. If I don’t start with Simon says, you don’t make the sound. Have you got any questions? Let’s try it.”

<table>
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<tr>
<th>Child:</th>
<th>Child:</th>
<th>Child:</th>
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</thead>
<tbody>
<tr>
<td>Phonic</td>
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</table>
Training session 10  (T2)

Approximate duration of the training session: 20 minutes.

Material
The PhonicStick, computer with software, loud speakers, video camera and Picture-chart 4 (p/, /i/, /n/).

Repetition
The children are asked to remember the sounds from the previous training training sessions. The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

<table>
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<tr>
<th>Phonic</th>
<th>Child:</th>
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<td>Where’s /a/?</td>
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Bingo
The children play bingo together. They collect phonics on a board and the child who is the first one with a full board wins. Each board contains four pictures of one phonic. The children pick a picture from a pile and make the matched sound on the PhonicStick. The child who has the board with the matched pictures gets the picture.

<table>
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<th>Phonic</th>
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**Post-assessment**  
(T1, T2, C)

Approximate duration of the training session is 30 minutes.

**Material**  
The PhonicStick, computer with software, loud speakers, video camera, Praxis pictures and Picture-chart 3.

**Repetition**  
The children are asked to remember the sounds from the previous training sessions.  
The researcher makes the phones verbally together with the matched picture. One child at a time is asked to make the sounds on the PhonicStick.

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<thead>
<tr>
<th>Phonic</th>
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<tbody>
<tr>
<td>Where’s /s/?</td>
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**1. Phone identification**  
The children are shown the six Praxis pictures.  
When the researcher makes a sound with the joystick, the children point to the corresponding picture. Each child will get two sound tasks. All six phones will be used. Two of the phones will appear twice.

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<th>Names</th>
<th>Phonics</th>
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**2. Phone production**  
The researcher makes one of the six sounds verbally together with the corresponding picture and the child makes the sound with the joystick.

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3. **Production and identification of word**

Picture chart 3 is used. Four of them can be made with the PhonicStick (knit, *sit*, *nap* and *tip*). Two of them cannot be made with the PhonicStick (pig and cup). We talk about all pictures and the children are told to make words with PhonicStick. If needed the children are given semantic or phonological prompting and help to move the joystick in the right direction.

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