A PhonicStick Study

Investigating the Effectiveness of a Phonological Awareness Intervention in Children with Down Syndrome.

Josefin Granholm
Jenny Gullberg

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Supervisors:
Margareta Jennische
Emma Ager
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ABSTRACT
Phonological awareness is a set of language manipulation skills such as blending, rhyme, alliteration production and detection. There are disagreements among researchers how phonological awareness is connected to literacy learning and also how and if children with Down syndrome acquire phonological awareness. The specific phenotype of Down syndrome shows deficits in both short term memory and language development. It is therefore of great concern to investigate how children with Down syndrome acquire phonological awareness and later on literacy. The PhonicStick is a joystick that generates speech sounds. In this study, the PhonicStick was used in phonological awareness intervention in children with Down syndrome. It was compared to intervention with Praxis cards – an already existing picture material in Swedish speech and language therapy. The aim of the study was to investigate if children with Down syndrome can improve phonological awareness during a six week period, and if this was the case, was there a difference in effectiveness between the materials. Six children with Down syndrome participated in this cross-over study. The results indicated that some children can acquire phonological awareness during a six week period. However, it was not possible to address the effectiveness to a certain material. The preference among the children to play with PhonicStick, showed that this is a material that motivates the children to participate in intervention. If the PhonicStick is adapted to this population of children with Down syndrome, this material can be used for phonological awareness intervention in children with Down syndrome.

Keywords: Down syndrome, phonological awareness, the PhonicStick, Praxis cards, phonological awareness intervention

SAMMANFATTNING

Nyckelord: Downs syndrom, fonologisk medvetenhet, PhonicStick, Praxiskort, intervention av fonologisk medvetenhet
1. Introduction

Down Syndrome (DS) is the most prevalent genetic cause for intellectual disability. Because of the chromosomal genotype that individuals with DS have, a series of malformations can be seen both on a physiological and psychological level. The specific phenotype of DS shows deficits in both short term memory and language development. It is therefore of great concern to investigate how children with DS acquire phonological awareness (PA) and later on literacy. The PhonicStick (PS) is a speech sound generating device that allows the user to “collect” sounds and thereby generate words with a maximum of three sounds. The Praxis cards are based on pictures that represent the Swedish speech sounds. The cards can be combined in order to produce different words. The aim of this study was to investigate if children with DS can benefit from PA intervention and, if this is the case, is there a difference in effectiveness between training with PS compared to training with Praxis cards.

In this master thesis, the DS genotype and phenotype is described. An overview of language development and phonological awareness is presented. Questions will be raised regarding the role of PA intervention for children with DS.

1.1. Down syndrome and language development

1.1.1. Down syndrome

DS is the most prevalent genetic cause for intellectual disability (Abbeduto et al., 2007). The prevalence in Sweden is 1.2 of 1000 born children (Annerén et al., 1996). DS is a congenital disease that is caused by a mutation of chromosome 21. There are four kinds of DS and the most prevalent form of DS (94 %) is an extra chromosome 21, trisomy 21, when the individual has three instead of two chromosomes in all cells. The second most common kind of DS, Translocation Trisomy 21 (4 %), is caused by an extra chromosome 21 that is attached to another chromosome, usually 13, 14, 15, 21, or 22. Instead of having a whole extra chromosome 21 attached to another chromosome some children have a Partial Trisomy 21, where a segment of chromosome 21 has translocated to another chromosome. This is the rarest divergence of DS. The remainder is Trisomy 21 mosaic where a blend of normal cells and chromosomal divergent cells has emerged (Annerén et al., 1996). Because of the chromosomal genotype that individuals with DS have, a series of malformations can be seen both on a physiological
and psychological level. Hypotonus, congenital cardiac defect and gastrointestinal malformation are some of the physiological abnormalities connected to DS (Bille & Olow, 1999). These children also have difficulties coordinating movements and carry out them with precision and speed. The largest difficulties are seen in fine motor ability. The deficits in fine motor abilities in hands, eyes and oral cavity prevent children with DS to develop a rather good ability to speak, read and write (Annerén et al., 1996).

There are some physiological deficits such as hearing-loss and oral motor problems that have a high impact on the cognition and language acquisition (Abbeduto et al., 2007).

1.1.2. Hearing-loss and oral-motor structure

Hearing-loss and deviances in oral motor-structure are both contributing factors that obstruct the language learning and use. Regarding the hearing, approximately 70-80 % (Annerén et al., 1996) of the population with DS has either a conductive or a sensorineural hearing-loss (Abbeduto, 2007).

According to Stoel-Gammon (2001) the period of time and the degree of hearing-loss are both variables that are associated with language learning i.e. more extended periods with a great hearing-loss causes low results on language measures.

In the area of oral-motor structure, smaller oral cavity in combination with larger muscular tongue and hypotonus in facial musculature, all have negative impacts on articulatory and phonatory abilities (Stoel-Gammon, 2001).

1.1.3. Cognitive impairments connected to Down syndrome

Down syndrome (DS) is the most common reason to mental retardation. Mental development is measured by intelligence quotient (IQ) and normal IQ is defined as IQ exceeding 70. Mild to moderate mental retardation (MMR) is defined as IQ between 50 and 70 and severe mental retardation (SMR) as IQ below 50 (Bille & Olow, 1999). The IQ seen in children with DS varies from 30 to 70, with a mean of 50 (Abbeduto et al. 2007).

Stoel-Gammon (2001) summarizes research about the nervous system in individuals with DS. Research show anatomical differences in the central and peripheral nervous system, which include reduced brain size and weight, smaller and fewer sulci, narrower superior temporal gyrus, fewer cortical neurons, decreased neuronal density, delayed neuronal myelination, abnormal dendrite structures and
altered cellular membranes. These neuronal abnormalities have high impact on the
cognition in individuals with DS (Stoe-Gammon, 2001). Research has shown that
deficits can be of auditive, visual, tactile and proprioceptive kind. These deficits can
occur separately or in interplay. Some domains of cognition are more affected than
others. Auditive perception is the most occurring deficit and is also considered to be the
largest obstacle. The child may have difficulties in maintaining and focusing the
attention, even though it has normal hearing. Memory in general, both short- and long-
term, are affected in children with DS. The characteristics of these impairments can be
difficulties in remembering the order of certain information and keeping several units
active simultaneously. Short-term memory plays an important role in all cognitive
skills, language included. The size and speed of the short term memory decides how fast
or slow the perception-process is. This skill is crucial for comparing, categorizing and
individuals with DS have some areas of strength within the visou-spatial domain, such
as visual memory, visou-motor integration and visual imitation. The abstract thinking is
often delayed (Annerén 1996) and theory of mind (the ability to understand how other
individuals feel and think (Hartelius et.al. 2008)) is another area where individuals with
DS show decreased ability. Phonological memory, with poor performance in
remembrance of auditory presented sequences, is challenged in particular (Abbeduto et
al. 2007).

1.1.4. Language development in Down syndrome

As opposed to typically developing children, who start to communicate intentionally at
approximately 9 months of age, children with DS transcend to intentional
communication at about 24 to 36 months. Babbling and phonological development in
children with DS are characterized by a delay in canonical babbling up to 2 months and
a greater inconsistency in the pattern of babble (Abbeduto et.al. 2007). Stoel-Gammon
(2001) suggests that this could reflect the general delay in motor skills and the divergent
structures in the oral cavity.

The onset of first word in children with DS varies from around the first year (as
typically developing children) to as late as 7 years of age. During the transition to
speech, the phonology of babble and speech in children with DS shares the same
characteristics as typically developing children. More specific this means, that frequent
consonants as stops, nasals and glides predominate early word production (Stoel-Gammon, 2001). However, the abnormalities in the oral-motor structure lead to a relative weakness in producing intelligible speech in general (Abbeduto et al., 2007). The syllable structure also shares the same consonant-vowel pattern as typically developing children. Thus, in spite of the normal patterns in language development, children with DS exhibit a substantial language delay and the growth of productive vocabulary is therefore exceeding slow (Stoel-Gammon, 2001). Later in childhood the individuals are more linguistically challenged in terms of deficits in auditory short-term memory, communicative skills on a social basis and intelligibility (Chapman & Hesketh, 2001). Children with DS produce sentences that are shorter and more telegraphic, i.e. they omit function words and modifiers more frequent than typically developing children (Verruci et. al, 2006). Despite these difficulties the comprehension of spoken language keeps up with the nonverbal cognition which helps the child in development of social and adaptive behavior (Chapman & Hesketh, 2001).

Altogether, the low intelligibility and the slow language development are not only due to impairments of general cognition, hearing loss and structural differences in facial area but also specific deficits in phonological short-term memory. Skills that strengthen the communication for this specific group are gestural communication and visual memory (Chapman & Hesketh, 2001). Taken these qualities in account with expressive language deficits and poor performance in phonological short-term memory, signs as Augmentative and Alternative Communication (AAC) are often taught during the early childhood to enhance the communicative experience and development (Abbeduto et al., 2007).

1.2. Phonological awareness

The phoneme is the smallest segmental unit of sound employed to form meaningful contrasts between utterances and is therefore the foundation on which all language is built upon (Bolander, 2001).

Phonological awareness (PA) – the understanding that sounds can be put together to form meaningful words and vice versa. It involves a set of language manipulation skills such as blending, rhyme, alliteration production and detection. Catts and Kamhi (2005) makes a distinction between the concepts phonological awareness and phonemic awareness. According to them phonemic awareness is a specific term that involves
understanding of the separate sounds in words as well as knowledge about the distinctive features of the phonemes. They consider phonological awareness as a general term that only involves knowledge about sound units in words such as rhyme and syllable detection and do not include knowledge about separate sounds. In this study we will use the term phonological awareness (PA) as a generic term that includes both phonemic and phonological awareness.

The development of PA is preceded by the ability to make judgments on a supraphonemic level e.g. syllable detection and rhyme. Gathercole and Baddeley (1993) makes the assumption that this phenomenon is due to the differences of acoustic energies across time and makes the assertion that the phonemic structure has no simple acoustic correlate whereas syllable structure has. There is a large complexity in the mechanisms underlying how listeners derive phonological information about the structure in the acoustic signal. These mechanisms also seem to be linked to the speech production. Since the syllabic structure seems to have a stronger characteristic for detection, it can be analyzed relatively easy in comparison to the abstract phonological structure, which appears to take children many years to learn. Explicit awareness of phonemes does emerge as late as five to six years of age. Gathercole and Baddeley (1993) offer an explanation to this and suggest that the phonological system in a child at this age is still maturing. Further they describe the maturation process deriving from a representation of words in a holistic fashion (based on vague articulatory gestures). At the end of this maturation process, the child has phonological representations of all familiar words.

1.2.1. Phonological awareness and literacy

There are four causal hypotheses of the relationship between PA and literacy: (i) According to Ehri (1999), cited by Kennedy & Flynn, s. 100 (2003), the development of literacy is dependent upon PA-skills. Studies have shown that PA-skills can predict how reading ability may proceed. A study made by Bradley and Bryant (1983) show strong evidence that PA-skills as rhyme and alliteration have a strong impact on later eventual literacy skills. (ii) Morais et al. (1979) claim that PA may develop as a consequence when the child learns to read. Further they describe this approach as follows: “Awareness of speech as a sequence of phones is thus not attained spontaneously in the course of general cognitive growth, but demands some specific training, which, for most
persons, is probably provided by learning to read in the alphabetic system” (s. 323). (iii) Gathercole and Baddeley (1993) suggest a reciprocal relationship between PA and literacy and that this relationship is the initial pacemaker in learning to read. When children start to understand the letter-sound correspondence, they have to be able to identify a words phonological structure, if they shall be able to apply a phonological recoding strategy in a successful manner. In this stage of reading development – PA and reading ability are likely to facilitate one another. (iii) There might be no direct causal link between these two skills. Liberman et.al (1977) cited in Cossu, Rossini and Marshall, s.130 (1993) suggests that both these skills are merely a manifestation of intellectual maturation of some other, unknown kind.

Children with reading difficulties often use their knowledge about the semantic features of words in the decoding process. When reading non-words, children have to rely on a correct phonological decoding strategy. Hence, they find it more difficult to process a non-word compared to a real word (Ericson, 2007).

The desirable scenario is that every child receives rich language stimulation from birth. Parents and other adults in the child’s environment should stimulate the child and adjust their language to meet the child’s level. Nevertheless there are children who do not develop language and communication as expected. Research and clinical work show that these children need extra stimulation to progress in their language and communication development (Nettelbladt & Salameh, 2007).

1.3. Phonological awareness in Down syndrome

Deficits in auditory short term memory and poor reading ability have shown correlation with poor awareness of phonemes (Gathercole & Baddeley, 1993). As mentioned earlier the specific phenotype of DS show deficits in both short term memory and language development. It is therefore of great concern to investigate how children with DS acquire PA and later on literacy.

Research have shown that children with DS perform poorly in tasks regarding PA compared to typically developing children matched on reading ability, mental age, other cognitive characteristics and chronological age (Lemons & Fuchs, 2009). There are conflicting findings about how and if children with DS acquire PA. van Bysterveldt et.al (2006) suggests that further investigation is necessary in order to determine the mechanisms underlying PA in DS.
According to van Bysterveldt et al. (2006), PA-training can improve reading skills, alphabetical knowledge and phonological awareness in children with DS. Even though the training period is relatively short, studies have shown that children with DS can improve phonological awareness skills (Kennedy & Flynn, 2002). In a study on PA among normally developing pre-school children, by Olofsson & Lundberg, 1983, cited in Lundberg et al., s. 266 (1988), it was shown that it is possible to increase PA in a relatively short training period (six to eight weeks). Content et al. (1982) found training effects only after four sessions. Cossu et al. (1993) claimed that PA is not a prerequisite for literacy development in children with DS. In their study they argue that “all causal hypotheses relating PA to the acquisition of reading (or vice versa) are false if the connection is taken as a necessary one” s.134. However Cupples and Iacono (2000) argue against this statement and give two major reasons for rejecting the strong argument of Cossu et al.: (i) They claim that Cossu et al. “lack the theoretical knowledge regarding the minimal level of PA that is associated with acquisition of an alphabetic reading system” s. 596. Further they mean that, since the children in the study did not score zero on the PA tasks, it is not possible to claim that they lack PA totally. (ii) They also have objections against the methodology in the study. The assessment tasks are cognitively challenging and hence the low scores may be a result of poor general cognitive ability rather than lack of PA.

1.4. The PhonicStick

1.4.1. Speech generating devices

Speech generating devices (SGD) is a group of augmentative and alternative communication devices which are extensively used to encourage children with complex communication need (CCN) to engage in communication, literacy learning and to support phonemic awareness (Black et al. 2008a, 2008b). The most prevalent SGDs are based on pictures/icon interface or retrieval of pre stored text to access novel words. This programming necessitates either a visual encoding system or literacy skills (Black et al., 2008b).

The idea behind the PhonicStick (PS), developed at the School of Computing, University of Dundee, started with the observation that children with CCN were able to control their wheelchairs with a joystick while many of the children had difficulties navigating with a joystick in a computer interface. The possible reason behind this
observation is that wheelchair navigation gives direct feedback without the need to navigate a second interface (Black et al., 2008a). PS is based on the literacy learning program Jolly Phonics. Phonemes used in the program are referred to as phonics and this thesis will refer to them in the same manner when in association with PS.

A prototype with six phonics (see Figure 1) were made to enable direct auditory feedback using a joystick connected to an already existing stylus text input system by Perlin (1998) cited in Black et al. (2008a). The PS allows the user to “collect” sounds and thereby generate words with a maximum of three sounds. To access the phonics the user moves the joystick in compass rose directions and around a circumference (Black et al., 2008a). In future mapping all 42 speech sounds used in the English language will be programmed on the joystick (Black et al., 2008b) grouped by phonemic characteristics (see Figure 2) Black, 2009 referred in Ager & Solli, s. 10 (2009).

In comparison to prior SGDs the PS enables children with CCN to play with sounds without a visual interface and thereby strengthen their PA (Black et al., 2008a).

![Figure 1 PhonicStick prototype.](image)

![Figure 2 Future mappings.](image)

1.4.2. The PhonicStick in phonological awareness intervention

In the master thesis by Lempke & Lindberg-Wesslert (2009) they investigated how children with DS handled the PS. The aim of the study was to “investigate if the PhonicStick could be used to initiate interest in language play in children with DS, in
order to stimulate their reduced phonological awareness” s. 6. The study showed that the children benefited from training with the PS even though it was in a short period of time. Lempke & Lindberg-Wesslert claim that “the PhonicStick with advantage can be used to introduce and enhance phonological awareness in children with Down syndrome” s. 4. In their study there were no contrast made between training with PS and other training materials.

1.5. Praxis

Praxis is the Swedish version of Nuffield Centre Dyspraxia Programme (NDP) that has been developed by Speech and Language Pathologists at Nuffield Hearing and Speech centre, a specialist’s ward at Royal National Throat, Nose and Ear Hospital in London. The NDP was produced in purpose to meet the need for children with dyspraxia (neurological deficits in planning and programming of speech) that did not answer to traditional treatment therapy. The main goal with NDP is to teach children all the articulatory movements that are needed in phoneme and speech production. These movements are coordinated into sequences that later on will be automated into adequate speech patterns. The method and material proved to be advantageous even for children with other language disorders (Hellquist, B. 1996).

The material is based on pictures that represent the Swedish speech sounds with a logical correspondence, e.g. /s/ is represented by a snake that “says” /sss/. The pictures can be combined in order to produce different words. In Sweden the Praxis material is primarily used in intervention with children that have dyspraxia or phonological language impairment. According to the Praxis manual, the therapy starts with basic training of voice and oral motor skills followed by production of isolated phonemes. When the child masters these skills the therapy concentrates on co-articulation of phonemes into words. This part of the therapy is subdivided in levels based on degree of difficulty of the phoneme structure in a word, from CV-structure (e.g. /PÅ/) to more complex combinations as CCV (e.g. /KLO/). The final level contains mastery of combining words into phrases and sentences (Hellquist, B. 1996).

1.5.1. Praxis pictures in phonological awareness intervention

Praxis pictures offer a persistent visual support, which is advantageous for the population with DS who has a strong visual memory. The pictures are connected to a
sound by its acoustic features and are not connected to the orthographic symbol. Therefore the Praxis pictures can be used without alphabetical knowledge. Children are able to learn that the sounds are connected to a picture on a non arbitrary level. The Praxis pictures also require the child to produce the sounds verbally.

1.6. Aim

The aim of this study was to compare the effectiveness of PS to an already existing material that can be used to improve PA.

Questions that this study aimed to answer regarded the effectiveness of the intervention materials and therefore the main question was:

- Can PA improve by intervention during a six week period?

Sub questions that this thesis aimed to answer were:

- If this is the case; is there a difference in effectiveness between training with PS compared to training with Praxis cards.
- Are there other qualities in the child that affects the outcome of the intervention?
2. Method

2.1. Recruitment

Children were recruited through Svenska Downföreningen, which is a non-profit organization whose purpose is to support individuals with DS, their families and other people in the network around them. An information letter (Appendix 1) was sent out to parents/guardians that contacted the researchers for further information and application to the study.

Children were also recruited through speech and language pathologists at the surrounding county councils in purpose to come in contact with conceivable participants. The parents/guardians then contacted the researchers for application.

The first six children who fulfilled the inclusion criterions where included in the study. The criterions for participation were that the child:

- lived in the area of Uppsala and Stockholm.
- had a diagnosis of Down syndrome without any other impairment that seriously would affect their ability to participate in the training sessions, such as Autism-spectrum disorder.
- was integrated in some kind of school-system.
- had Swedish as first language.

The age range of the children participating in the study was from 8:0 to 13:11 years, three boys and three girls. When entering the study, they were given a color code.

2.2. Materials

2.2.1. The PhonicStick

The PhonicStick is a software and must therefore be connected to a computer. The PhonicStick was made out of a computer joystick, by label Logitech, Attack™ 3 Joystick. To make it easier for the children to maneuver the joystick, a wooden ball replaced the regular stick. On the joystick there were two buttons programmed to “speak” and two buttons programmed to erase the collected phonics. The joystick must be placed in exact position in order to register a sound. In order for the joystick to generate a word, the “speak” button had to be pressed after collecting two or three
phonics. The clear button erased all collected phonics. Six phonics were programmed in the Swedish version, selected by Ager & Solli (2010). The chosen phonics were /a/, /ɔ/, /l/, /m/, /k/, /t/. Figure 3 shows the positions of the phonics. The reason that these phonics were chosen was because they generate a large amount of real Swedish words. In this study 22 real words were used, 18 consisting of three phonics and four consisting of two phonics. 24 non-words were used, 14 consisting of three phonics and ten consisting of two phonics (Appendix 2). Non-words are included because it enables the child to disregard the meaning of a word and instead put focus on the sound structure.

![Figure 3 PhonicStick, Swedish version.](image)

2.2.2. Praxis cards

The present study did not apply the methodology of the Praxis material that is to teach children the articulatory movements that are needed in phoneme and speech production. Since this study aim to develop PA and not articulation in particular, only the pictures as training material were used. Six pictures were selected that corresponded to the sounds that were programmed on the PhonicStick. The pictures were laminated and therefore referred to as Praxis cards. Below is a description of the sound-picture correspondence for each card.

/a/: represented by a crocodile that opens its mouth and says /a/.

/ɔ/: represented by a fish that is blowing bubbles with its mouth and sounds /ɔ/.

/l/: represented by a choir that sings /l/.

/m/: represented by a girl that is eating ice-cream and says /m/.

/k/: represented by a gun that fires off and says /k/.

/t/: represented by a drum that plays /t/.

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1 The vowels are in their regular form, in Swedish, short vowel.
2.2.3. Other materials

All sessions were videotaped and an external microphone was used. Plastic markers were used at the Phonological awareness level tests (described in 2.4.1). These plastic markers were used to enhance the numbers of sounds in a word.

2.3. Project design

2.3.1. Cross-Over trial

In a crossover-trial all participants take part in a series of treatments in a randomized order. The simplest lay-out consists of two treatments designed (Crossover trials, u.d.) “AB/BA” in which the participants are randomized to either A or B and then “crossover” to the other treatment (Cochrane Handbook for Systematic Reviews of Interventions, Section 16.4, u.d.). The design provides data about each treatment within each patient and hence the investigator does not need to make allowances for variation that can occur between participants – which is the case in a parallel group trial. A crucial consideration in this design is whether the participant starts the second treatment period in a similar state as in the first, therefore a base-line test is administered prior to each treatment period. If there is a difference in the state, the comparison of treatments will be incorrect and there will be a within-participant variation (Crossover trials, u.d.). With the crossover-trial it is possible to remove comparisons and any components that are related to the differences between participants in the study (Jones & Kenward, 2003).

In this study, this kind of within-group design was advantageous because of the different range of abilities that children with DS have (Annerén et al., 1996). By using this design ”subject effects” (differences in ability between each participant) are removed (Jones & Kenward, 2003). Since children with DS constitute a heterogeneous group concerning their capacities and difficulties, this study also included qualitative observations of all children. Parameters that were identified as other qualities that were considered to affect the outcome were described in an individual case report for each child.

The intervention was divided in two periods (1 and 2). Three children started period 1 with PS and the remaining three with Praxis. At the start of period 2 there was a cross-over in material i.e. the children that started period 1 with PS changed material to Praxis and vice versa. Prior to each period, a PA-level test was administered to function as baseline of PA-skill. A material test was administered in the beginning (pre-
test) and in the end (post-test) of both periods in order to investigate if the child had adapted PA on a specific basis with the different materials. An overview of the intervention is presented in Figure 4.

![Figure 4 Overview of the intervention.](image)

### 2.4. Description of phonological awareness tasks in test and training

Three different aspects of PA-skills were distributed with rising level of difficulty where segmentation was the easiest followed by blending and position analysis as the most difficult task (Tornéus et al., 1984). Next level was introduced when the participant solved the tasks in the right manner on the current level.

The training revolved around the three following skills:

- **Segmentation**: Identification of the separate sounds in a word (e.g. which sounds do you hear in the word TALL (Eng. transl. PINE)?). From word to sounds.
- **Blending**: Blend sounds into words (e.g. which word does the sounds K-A-M (Eng. transl. COMB) form?). From sound to word.
- **Position analysis**: Identification of a sound’s position in a word (e.g. which sound follow L in LAMM (Eng. transl. LAMB)?).

These skills are all assessed in both the PA-level tests and the Material tests. A further description of these tests follows below.
2.4.1. **Phonological awareness-level tests**

These tests were administered without neither Praxis nor PS. Only verbal answers were registered as correct answers. Markers were used as concretization of the speech sounds. In Appendix 3, instructions for the test procedure is described and a wordlist is attached to each test. The phonological awareness-level tests (PA-level test) consisted of ten words in each PA-skill, described earlier.

2.4.2. **Material tests – PhonicStick and Praxis**

With the material tests, the children provide the answers through the current material. In Appendix 4, instructions for the test procedure is described and a wordlist is attached to each test. Different lists were used in order to avoid systematical errors. The material test consisted of six words in each PA-skill, described earlier. The tests were named after (i) which material that was used and (ii) in which period e.g. *PhonicStick test period 1*. 

3. Procedure

Each child participated in 12 sessions during a total time of six weeks. Each session lasted for approximately 30 minutes. Below is a description of each session. Some of the sessions are carried out in the same manner but with different material, therefore they are described together.

**Session 1:** To initiate the study, an individual meeting was held with each family. The purpose of this meeting was to establish contact and to get a notion about each participant’s abilities and personality. During this meeting practical planning about the time and place for the training was determined with the parents/guardians and school personnel hence the training occurred at the school in all cases. Each child was randomized into (i) Material (PS or Praxis) for period 1 and (ii) Wordlist (A or B) for period 1. The wordlist was the basis for both the material test and training during each period. In the cross over to period 2, both material and wordlist were changed i.e. from PS to Praxis, or vice versa and from wordlist A to wordlist B, or vice versa.

**Session 2 and 7:** Administration of PA-level test 1 and 2 respectively and presentation of the material for period 1 (The PhonicStick or Praxis). Appendix 3 and 5.

**Session 3 - 6 and 8 - 11** consisted of testing and training of different aspects of PA with PS (TPS) and Praxis (TP) respectively. Real words and non-words were mixed in all tasks. The training was adapted based on each participant’s skill and pace. Specific instructions for each session are described in appendix 6 – 9 and 4.

**Session 12:** Administration of final PA-level test (Appendix 3) and observation of free play with material of participant’s choice.

Table 1. Below is a schematic table over the testing and cross-over design for each participant. TPS: Training with PS. TP: Training with Praxis.
All sessions were video recorded in order to analyze data and to evaluate the participant’s interest and enthusiasm. Rhyme or other kinds of intuitive skills from the participant were registered afterwards during analysis of the video. The time for all sessions was also registered in order to calculate total time for intervention and specific training time with each material.
4. Treatment of data

All data were handled in three levels (i) a general overview in a table, (ii) case reports for each child and (iii) a session table for all participants (Appendix 10). All parameters of data were registered during the video analysis.

In the general overview, following parameters were handled:

- Raw scores for PA-level tests. Only totally correct answers were registered.
- Raw scores for material tests (Pre-tests and Post-tests). Only totally correct answers were registered.
- Numbers of sessions that it took for the child to learn:
  - Picture-sound correspondence: Ability to connect the right sound to the right Praxis card.
  - Position-sound correspondence: Where the sounds are positioned on the joystick.
- Time (measured in minutes): All video sessions were measured in time, in two ways (i) total time of all sessions and (ii) total time with each material. This was measured to compare the time of training with the test results in order to investigate if the time spent on the material gave effect on the material test results.
- Preference of material. Which material did the child prefer to play with when asked?

In the case report, following parameters were handled:

- Motivation: Did the child seem enjoy the material? Was the child willing to play with it?
- Mood: Which mood did the material and the tasks provoke in the child.
- Concentration: Dis the child lose concentration and was the child dependent upon the researcher in order to resume to the task?
- Comprehension and completion of instructions: How often was the child in need of repeated instructions from the researcher? Did the child need guidance in order to complete tasks?
- Handling of the material: Did the child’s motor skills limit the handling of the material?
In the session table (Appendix 10) all sessions for all children is described. Valuable observations, indications of adopted knowledge and specific skills are described here. In this table it was noted which material and which wordlist each child started with.
5. Ethical aspects

An information letter (Appendix 1) was sent out to parents/guardians of possible participants. Parents/guardians were informed about the extent and purpose of the study. It was clearly stated in the letter that all participation was voluntary and could be aborted without giving any reason. A consent form attached with the information letter functioned as application.

All personal data was treated confidentially. Responsible person of the data was Margareta Jennische, Department of Neuroscience, Program for Speech and Language Pathology, Uppsala university. Since the purpose of this study was to enhance PA in children with DS this was clearly expressed in the information letter and would therefore prevent possible participants to be offended by being asked to participate in the study. Every child that participated in the study got equal treatment.
6. Results

6.1. General overview

Table 2 present demographic data about age and gender and test results regarding general PA-level and specific results of the material tests. Data concerning different aspects of handling the material is also presented.

Table 2. Phonological awareness (PA) training with PhonicStick (PS) and Praxis cards (P). The results of six children with Down syndrome. Descriptive data in raw score. Picture-sound correspondence and position sound correspondence are specified in numbers of session. Test results are specified as correct answers per total numbers of carried out tasks. Total numbers of tasks in PA-level tests and material tests are 30 and 18 respectively. Further explanation of parameters, see 4. Treatment of data.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Blue</th>
<th>Purple</th>
<th>White</th>
<th>Red</th>
<th>Green</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>13:11</td>
<td>10:11</td>
<td>8:10</td>
<td>8:0</td>
<td>13:3</td>
<td>11:11</td>
</tr>
<tr>
<td>Gender</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>PA-level test 1</td>
<td>0/5</td>
<td>0/6</td>
<td>20/26</td>
<td>0/5</td>
<td>19/25</td>
<td>0/4</td>
</tr>
<tr>
<td>PA-level test 2</td>
<td>0/10</td>
<td>0/12</td>
<td>22/30</td>
<td>0/7</td>
<td>24/30</td>
<td>0/19</td>
</tr>
<tr>
<td>PA-level test 3</td>
<td>0/3</td>
<td>2/16</td>
<td>28/30</td>
<td>0/5</td>
<td>21/30</td>
<td>9/29</td>
</tr>
<tr>
<td>Material test:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 1</td>
<td>Pre-test PS: 0/0</td>
<td>Pre-test PS: 15/18</td>
<td>Pre-test P: 0/4</td>
<td>Pre-test P: 11/18</td>
<td>Pre-test P: 1/12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-test PS: 0/3</td>
<td>Post-test PS: 16/18</td>
<td>Post-test P: 0/9</td>
<td>Post-test P: 17/18</td>
<td>Post-test P: 0/12</td>
<td></td>
</tr>
<tr>
<td>Material test:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Period 2</td>
<td>Pre-test P: 0/3</td>
<td>Pre-test P: 12/18</td>
<td>Pre-test PS: 0/2</td>
<td>Pre-test PS: 15/18</td>
<td>Pre-test PS: 0/13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-test P: 0/11</td>
<td>Post-test P: 15/18</td>
<td>Post-test PS: 0/7</td>
<td>Post-test PS: 11/18</td>
<td>Post-test PS: 3/18</td>
<td></td>
</tr>
<tr>
<td>Picture-sound correspondence</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Position-sound correspondence</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Total time</td>
<td>106,7</td>
<td>99</td>
<td>114,5</td>
<td>86,45</td>
<td>101,8</td>
<td>92,7</td>
</tr>
<tr>
<td>Praxis (min)</td>
<td>84,25</td>
<td>81,2</td>
<td>109,8</td>
<td>73,3</td>
<td>106,8</td>
<td>70,2</td>
</tr>
<tr>
<td>Preference</td>
<td>Praxis</td>
<td>PhonicStick</td>
<td>PhonicStick</td>
<td>PhonicStick</td>
<td>PhonicStick</td>
<td>PhonicStick</td>
</tr>
</tbody>
</table>
From the extracted data in the general overview, a preference towards playing with PS can be seen. Further, the children seemed to learn the picture-sound correspondence during a fewer numbers of sessions than the position-sound correspondence. The children that started with a low number of completed tasks on the tests were able to carry out a larger number of tasks as the intervention progressed. Three children (White, Green and Yellow) showed signs of acquired PA from PA-level test 1 to PA-level test 3. There is a wide spread in time spent on each material. For some children this is due to interest in the material and task, but for others it is due to the opposite, the child often lost concentration and needed more time to carry out the sessions.

6.2. Individual case report

Due to the differences in both intervention and outcome of each child, an individual case report is presented below. References to specific observed skills during sessions, are presented in Appendix 10.

6.2.1. Child Blue

**Motivation:** With the PhonicStick, Blue is willing to engage in the activities but remains quite passive. During all sessions, she starts to show unwillingness after approximately 4-5 tasks. Encouragement from researcher works to some extent. With the Praxis cards she is unwilling to engage in any activities with the Praxis pictures. There is a major breakthrough when she is engaged in more active plays e.g. hiding pictures (session 8) and jumping on pictures and saying the corresponding sound (session 10).

**Mood:** During PS period, she shifts in mood. She is happy and laughs when she generates sounds of own choice. When she is asked to produce a sound or word of researchers choice, she pretends to cry and shows unwillingness by turning away from researcher and PS. She gets quiet and refuses to repeat sounds and words. When crossing over to the Praxis cards (at session 7 and in the beginning of session 8), she is angry and makes it very clear that she do not want to participate in any games. Once she starts with more active plays her mood changes. She is happy, interested and laughs.

**Concentration:** Blue is mostly concentrated and even though she sometimes looks away and stops playing with the PS, she is still attentive to what the researcher says. It is difficult to interpret whether the unwillingness is due to loss of concentration
or motivation. With the Praxis cards, she can remain concentrated for longer periods of time from later half of session 8 and forward. She listens to instructions and keeps focus for a long time.

**Comprehension and completion of instructions:** Blue learns quickly how the joystick works but is in need of guidance and repeated instructions to finish the tasks. It is uncertain if she understands the meaning of the instructions or if she merely does what she is told. Follows through when the instructions are concrete and on single sentence basis e.g. “Can you find /a/ with the joystick”. She does not seem to comprehend instructions or questions on a slight more abstract basis e.g. “Can you find a sound with the joystick”. When the researcher explains how sounds are blended into words, she turns away and does not want to listen. With the Praxis cards she continues to follow instructions when they are concrete and on single sentence basis. She seems to understand to some extent which cards to use in order to create a certain word, but can not understand which sounds (without the cards) to use in the same manner.

**Handling of material:** Blue can handle the joystick correctly but she has some trouble generating /k/. With Praxis, she manages to connect each sound to right picture at session 9. She has no difficulty using the cards.

**PA-development:** It is uncertain if this girl has made any advances regarding PA during this intervention. However, she shows signs of being able to hear when two words shares the same sound structure e.g. when researcher says /kal/, Blue says /kalle/. She also identifies the final sound /k/ in /tack/ (session 11).

### 6.2.2. Child Purple

**Motivation:** Purple has high level of motivation during period 1 with PS. He is attentive to the researcher and interested in the material. There is some lack of motivation during period 2 with Praxis. Purple says “No!” at some occasions but still continues to engage in the task.

**Mood:** He laughs and claps his hands when he has accomplished to create a word – both with PS and Praxis. He sometimes says “No” but never gets angry.

**Concentration:** Purple has high level of concentration. The researcher need to give him repeated instructions but he always seems to listen. At session six, he looses focus on the task and just wants to play with the joystick.
**Comprehension and completion of instructions:** Purple is in need of repeated instruction and guidance in order to understand what he is supposed to do with the joystick. The researcher need to place Purple’s hand on the joystick and then tell him to generate a sound with it. He needs both instructions and physical guidance from the researcher during session 2 and 3. With the Praxis cards he names and signs the motive on the pictures instead of the sounds. Purple needs to be asked how the card sounds, in order to say the corresponding sound. He is able to identify some sounds in words but not all. Hence, he has grasped the process of segmentation to some extent.

**Handling of material:** Purple has difficulties finding the exact sound positions on the joystick. He often moves the joystick in the right direction but not exact. The joystick can not register a sound unless it is placed in the exact position. When introducing the Praxis cards, he begins to name the motive on the card and not the corresponding sound (session 7). When he understands the principle of the cards, he learns them quickly. He has some trouble putting them in right order.

**PA-development:** It is uncertain if this boy has made any advances regarding PA during this intervention. He is able to blend /k/-/a/-/t/ into /katt/ (eng. transl: cat) and /t/-/a/-/k/ into /tack/ (eng. transl: thank you), both words are highly frequent in his speech. Segments /lam/ with the Praxis cards, but places the cards in wrong order (session 12). He seems to show bigger understanding about blending tasks than segmentation tasks.

6.2.3. **Child White**

**Motivation:** White is eager to play and participate in tasks with PS. She shows enthusiasm and laughs in every session. She asks the researcher if she can get more tasks. During the period with Praxis she also shows enthusiasm and is eager to participate in tasks. White tries to explain her thoughts during the tasks and comments her own performance (e.g. easy, difficult) in accordance to her achievement.

**Mood:** White shows happiness and is eager during the whole intervention. She gets thoughtful and somewhat frustrated when she has trouble performing a specific task.

**Concentration:** She has the same level of focus during the period with PS as during the period with Praxis. She gets carried away easily in speculations and ideas in how to play with the different materials. The researcher often has to help her direct attention back to the specific tasks.
Comprehension and completion and instructions: White follows instructions and learns the principle of the tasks very quickly during the whole intervention. She is helped by reflecting on the word by “tasting” the words (saying the word aloud) during the period with PS. She needs repetition of specific tasks during both periods to complete the tasks. She needs more repetitions in non-word tasks, compared to real word tasks.

Handling of material: White has some trouble to maneuver the joystick in the exact positions. She has to be reminded to bring the joystick back to the middle in order to register the next sound. She is helped by pointing out the sound positions on the joystick. She has no trouble handling the Praxis cards.

PA-development: Initially she has some difficulty blending words with a vowel in initial position and segments and blends the sound in the wrong order. She also has some trouble identifying sounds that are prior to another. In PA-level test 2, there is an improvement in how she handles the blending tasks. She no longer has trouble identifying sounds that are prior to another sound. During period 2 with Praxis, she has some trouble placing the cards in right order and need guidance to place them from left to right to produce a word. Even tough she places the cards in wrong order she says them in right order to blend a given word. She chooses the right sound in the blending tasks but places them sometimes in wrong order. She manages to identify sounds in all positions in the beginning of period 2. By the end of the period, she corrects herself when placing the cards in wrong order.

6.2.4. Child Red

Motivation: During the Praxis period Red often starts with excitement and a high level of motivation. After approximately two or three tasks he looses his motivation and he is more motivated to play games to learn the picture-sound correspondence rather than the PA-tasks. When using the PS he tends to keep his motivation in a longer period of time during the sessions and shows higher excitement. During the whole intervention he sometimes express that he is tired, the tasks “are difficult” and he seems to give up. He is often unwilling to complete the tasks.

Mood: Red laughs and has a positive approach to the Praxis cards. When crossing over to PS, Red shows the same positive approach. During the whole intervention he jokes around and tries to engage the researcher in other activities.
Concentration: During the whole intervention Red often initiates the sessions with focus on the material and current task. After approximately five minutes he loses his concentration and the researcher needs to encourage him to continue. During the Praxis period he often finds something else to talk about or starts to play with other things in the room. With the PS he lacks concentration in the tasks but continues to play with the different buttons on the PS.

Comprehension and completion of instructions: During the whole intervention he does not seem to understand the concepts “word” and “sound”, which makes it difficult for him to understand the instructions. He understands instruction on a concrete and single sentence basis. It is however difficult to determine if it is because of unwillingness or incomprehension that he does not complete the tasks. Red seems to understand that every Praxis card is connected to a speech sound. He does not seem to understand that different cards create different words. With the PS, Red quickly understands how the joystick works but needs guidance to find the positions of the sounds.

Handling of the material: Red has no difficulty using the Praxis cards. He does not learn the picture-sound correspondence fully. He can to some extent maneuver the PS but is constrained to produce some sounds because of the precise movements that are needed.

PA-development: It is uncertain if this boy has made any advances regarding PA during this intervention. There are some indications that he is able to understand when there is a similar sound structure in two words. He also manages to segment single sounds in some words (session 6).

6.2.5. Child Green

Motivation: Green is highly motivated throughout the whole intervention. He is somewhat discouraged during period 2 when he has trouble finding the sound positions with PS. He chooses not to use PS during blending tasks at session 8.

Mood: Green is happy and playful during period 1 with Praxis. He laughs and replaces one sound in a word with another (session 4) and then laughs and makes the sign for “busig" (Eng.transl: rowdy). He is confident both during training and testing sessions. When crossing over to PS, he becomes more discouraged and needs more
encouragement from researcher in order to maintain a happy mood. This lack of confidence is highly due to trouble with the joystick.

**Concentration:** Green can maintain focus during whole sessions. He sometimes begins to talk about what he is going to do after sessions, but never loses concentration completely. He always resumes to task when he is asked to continue.

**Comprehension and completion of instructions:** During period 1 with Praxis, he is thoughtful and listens to and follows instructions. He needs some guidance to understand how position analysis works. Green needs to be guided in order to detect a sound prior to another (session 6 and 7). During period 2 with PS, he is in need of repeated reminders of which word to do or which sound to collect, in order to complete the tasks.

**Handling of material:** Green learns to connect the right sound to each Praxis card during one session. He puts them in right order and handles them with great confidence. He jokes around with researcher by putting the cards in wrong order and then laughs. He places them in right order when the researcher asks him if he is joking around. He has some trouble finding the sound positions with PS. He does not show the same kind of confidence with PS, need to be assured that he is heading in the right direction before producing a sound (session 8 to 10). He also has trouble finding exact positions in order for a sound to be registered. At a numerous occasions he pushing the joystick in the right direction but it is not exact enough for the joystick to register the sound. This may have influenced his results on the material test with PS.

**PA-development:** This boy already shows some PA-skills when entering this study. He scores 19 out of 25 tasks at PA-level test 1 (see General overview). He rhymes spontaneously during session 3. There is enhancement in PA regarding position analysis from PA-level test 1 to PA-level 2, he learns to identify sounds in position analysis that are against reading direction (before a certain sound). There are also some advanced in how quickly he handles non-words, both in blending tasks and in position analysis.

6.2.6. **Child Yellow**

**Motivation:** During the Praxis period it is difficult to motivate Yellow to participate in the tasks. She is more motivated to generate own words than the words that researcher presents. When crossing over to PS she shows greater enthusiasm to
participate in the tasks. She looses however the motivation after a couple tasks. She is motivated to produce own words with PS.

**Mood:** At the beginning of the period with Praxis, Yellow is a bit shy and reserved. She does not speak spontaneously, answers only to questions, sighs and yawns. She is excited to play with PS, awaits produced words with anticipation and shows disappointment when the researcher disrupt her own play with PS.

**Concentration:** Yellow has the same level of focus during the whole intervention. She needs encouragement and guidance from the researcher to regain focus throughout the session. During the period with PS she has some difficulties waiting on instructions and is eager to press the speak-button but does what the researcher asks her to do.

**Comprehension and completion of instructions:** Yellow listens to and follows instruction on a moderate basis during the whole intervention.

**Handling of material:** She has no trouble handling the Praxis cards. She has some difficulty to find exact positions on the PS and understanding the principle to “collect” more than one sound to produce a whole word. Yellow understands the principle to produce /k/ on the joystick.

**PA-development:** During the period with Praxis she learns to segment two of three sounds in a word. In some cases she segments all the sounds in a word but puts the cards in wrong order. Sometimes she manages to segment a word correctly. Yellow manages to blend whole words but blends two out of three sounds more frequently. She identifies a sounds position but is dependent on having the whole word placed in front of her. It does not seem be a difference in how she handles real words and non-words. During the period with PS she is able to segment all sounds in words but frequently produce the sounds in wrong order. She often says the sounds verbally before producing them with PS. During the tasks with blending she often pushes the speak-button before she gives an answer. In the tasks with position analysis she can identify sounds in the initial position. She often produces the sounds verbally before producing them with PS.
7. Discussion

This study aimed to investigate if children with DS can profit from PA-intervention during a six week period. If this was the case, was there a difference in effectiveness between training with PS and training with Praxis cards? Six children with DS participated in the study. During the intervention, the children’s PA was trained and tested with both materials and on general PA-level. This study suggests that, in order for children with DS to profit from PA-training, the layout of the intervention must take the following aspects in regard: (i) how the child participates in an educational setting, e.g. is the child able to listen to and embrace instructions? (ii) Is the methodology adapted to each individual’s skill and pace? These questions will be discussed further in this section.

The outcome of this study showed varied results regarding advances in PA among the participating children. Despite the short period of time, some children showed progress in PA during this study. These results support the works of Kennedy & Flynn (2002), that children with DS can improve PA during a relatively short training period. The differences both between each individual and their scores on material tests, makes it impossible to draw any conclusions about differences in effectiveness between the materials. Further, there seems to be an overwhelming preference in playing with PS as opposed to the Praxis cards, regardless of performance during the training period with PS. Five out of the six participating children chose to play with PS at session 12 (Appendix 10).

7.1. General phonological awareness development

Regarding the main aim of this study, if PA can improve during a six week period, the answer is both yes and no. Some participants showed progress, while others did not. These results may be dependent upon several factors. Research has shown that children with DS can profit from PA-interventions (van Bysterveldt et al., 2006), but some children may need intervention during a longer period of time and with another approach, in order to profit from PA-intervention. It is therefore important to adjust intervention layout to each individual’s skill and pace. In this study, some children did not benefit from the educational setting where the intervention took place. These children may benefit from a more playful intervention layout. Differences in
phonological memory (Abbeduto et al., 2007) and the capacity of abstract thinking (Annerén et al., 1996) may also contribute to differences in performance among the children. Some of the children that showed progress in PA during the intervention had some concepts of PA when entering the study. The other participating children did not show PA at the beginning but had the ability to focus, listen to and follow instructions. Child Greens way of using the Praxis cards to joke with the researcher may imply that this child has such a high level of PA, that he is able to know how to do “wrong”. Child Yellow increased her PA-scoring from zero to nine points from PA-level test 2 to PA-level test 3, this is an implication of acquired PA. If this is due to interest in PS or total intervention time and training, remains unclear.

Yellow also showed the same level of skill in processing real words and non-word. This speaks against the theory that children with reading difficulties find it harder to process non-words than real words (Ericson, 2007). In Yellows case, maybe her processing skill is only on a phonological basis and the semantic value in a word is detached from the process. Yellow also shows a high interest in elaborating with sounds and often creates her own non-words. She does not seem to be interested in creating real word with a specific meaning.

7.2. Discussion of other aspects contributing to the outcome

The children that participated in the study all had different background concerning their ability to adapt and engage in the intervention. As discussed in the introduction the genotype and phenotype can vary among children with DS, and therefore, there are large differences in abilities in this population.

According to Fidler (2005), children with DS are visually strong and this is in accordance with the findings concerning ability to learn picture-sound correspondence. The children seemed to learn the picture-sound correspondence during a fewer numbers of sessions than the position-sound correspondence. For example, child Green learned the picture-sound correspondence during one session and never achieved position-sound correspondence fully. Child Purple learned the picture-sound correspondence during two sessions and did not, like child Green, achieve position-sound correspondence fully.

Since children with DS have deficits in both long- and short-term memory (Annerén et al., 1996), retrieval of the sounds positions seems to burden the short-term memory for some children. In child Green’s case there was a major change in both
confidence and performance when crossing over to PS. The process to find the sound positions on PS seemed to burden his short-term memory to such an extent that he was not able to elaborate with the sounds and words at the same level as he did with the Praxis cards.

The time that each child spent on the different materials was varying. For some children this was due to interest in the material and task, but for others it was due to the opposite. Some children lost concentration and needed more time in order to carry out the sessions. Children with DS often have difficulties maintaining and focus the attention (Annerén et al., 1996). This was notable in child Red’s case, he enjoyed playing with PS to a larger extent than with the Praxis cards and where with PS, able to engage more actively in the tasks. However, the total time spent with Praxis was longer because of his inability to focus on the task.

Another aspect on maintaining and focusing the attention is that the children that started with a low number of completed tasks on the tests were able to carry out a larger number of tasks as the intervention progressed. This can be interpreted as acquired ability to maintain and focus the attention when they become more familiar with the material and related tasks.

For child Blue, an increase in focus and engagement was seen when tasks became more physically active, at session 8. It is unclear if her change in mood was due to the ability to engage in more concrete activities enabled by the Praxis cards, or if she merely found the active plays more amusing.

The capacity to exert abstract thinking (Annerén et al., 1996) was probably variegated among the children in the study. This ability can be involved in many aspects of the intervention, both regarding the ability to understand the instructions and when handling the material. Some children were helped by receiving instructions on a single sentence basis. Child Purple did not initially seem to understand what he was supposed to do with the PS. He needed instructions and physical guidance from the researcher. If the concreteness in the Praxis cards were the factor that enabled PA-progress, this is an indication that some children with DS need a concrete material in order to acquire PA. Further, if this is the case, there is a difference in effectiveness between the materials.

Child White could mentally solve the tasks without the materials, but when she was asked to do the tasks with the Praxis cards she had a somewhat higher level of incorrect answers. This may imply that the Praxis cards seem to obstruct her PA. Maybe
she had automated her PA but had difficulties to abstract her awareness to the Praxis cards to a total extent.

To maneuver PS, the child needed to have a high level of fine motor skill. According to Annerén (1996), children with DS have deficits in motor abilities, especially in fine motor abilities. This fact was notably seen in child Green’s trouble to physically handling the PS. Many of the children in this study would probably be able to produce a higher level of correct answers if they were not prevented by their fine motor abilities.

7.3. Suggestions to improve the PhonicStick

In order to improve the development of the PhonicStick and its usage in the population of children with DS, there are some major issues that need to be addressed. Firstly, many of the children in this study had difficulties to produce the exact movement that was needed in order for the joystick to register a sound. The software must be able to register movements that are non-exact, but in the right direction. The children seemed to be helped by physically pointing out in which direction to move the joystick. Therefore we suggest that it would be helpful for children with DS if there were visual markers on the joystick, in order for them to navigate with higher level of precision. This is also advantageous because of their strengths in the visuo-spatial domain (Fidler, 2005).

Secondly, some children found it very amusing to press the buttons on the joystick and did because of this loose concentration. To redress this situation, it would be preferable to narrow down the numbers of buttons on the joystick as much as possible.

Finally, when the child produced one wrong sound in a word – the deleting function erases the whole word. This extra procedure, to start over with the whole word, made it harder for the child to understand which sound that was wrongly produced. It would be preferable if there was a “backspace”-function, which only erased the wrong sound instead of the whole word.

7.4. Limitations

The primary limitation in this study is the low number of participants. In order to extract valuable data, the sample must be significantly larger. Due to the limited possibilities to recruit participants, selection in this study was not optimal. Further, if the intervention would have been carried out during a longer period of time, some additional progress
might have been possible. In order to make the intervention and methodology as effective as possible, an initial thorough investigation concerning the child’s hearing status, personality and cognitive aspects (e.g. auditory short-term memory) would be preferable.

Regarding the methodology, a larger number of sounds would make the tasks more dynamic, and generate additional words. This would also enable the researcher to customize the wordlists according to the child’s interests and conceptualizations of the world. In the situations when the child did not seem to understand the instructions, it would have been helpful to clarify the instructions with visual aids and/or signs.

7.5. Conclusion

This study has shown that some children with DS can acquire PA during a six week period. However, it is not possible to address the effectiveness to a certain material due to the widely distributed results and each child’s different ability. The preference among the children to play with PS, shows that this is a material that motivates the children to participate in intervention. If the PS is adapted to this population with visual support and lower sensitivity in registration of sounds, together with an individual design of the intervention – this material can be used for PA intervention in children with DS.

7.6. Suggestions for future research

In excess of larger groups in intervention, the results of this study indicate that children are helped by visual support when using PS. Therefore, a study concerning intervention with PS and Praxis combined, would be desirable.

PS is still unexplored in this population and the field for future research is therefore open for different kinds approaches, both regarding the development of software but also implementation of methodology on this device.
8. Acknowledgements

Thanks to:
All children participating in this study, and their parents for their consent and interest in the study.

School staff for their cooperativeness and lending of their classrooms.

Margareta Jennische for support and invaluable guidance.

Emma Ager for advice, comments and precious help with the PhonicStick.

Lena A. Nilsson, for her help finding participants.

Svenska Downföreningen, for advertisement and help finding participants.

www.tyda.se for being an invaluable resource, when our mental lexicon was insufficient.
9. References


Ager, E. & Solli, E. (2009). The PhonicStick: A Swedish study – How do children age 5 and 6 handle the PhonicStick and will the use of it affect their phonological awareness? Department of Neuroscience, Program for Speech and Language Pathology, Uppsala university.


Lempke, E. & Lindberg-Wesslert, S. (2009). *The PhonicStick and language play – Can the PhonicStick be used for the purpose of enabling language play and thereby promote phonological awareness for children with Down’s syndrome?* Department of Neuroscience, Program for Speech and Language Pathology, Uppsala university.


**Other resources**


APPENDIX

1. Information letter
2. Wordlists
3. PA-level tests
4. Material tests
5. Session 2 and 7 Finding sounds
6. Session 3 and 8 Segmentation of speech sounds
7. Session 4 and 9 Blending
8. Session 5 and 10 Position analysis
9. Session 6 and 11 Repetition of all skills
10. Session table
Informationsbrev om studie rörande träning av fonologisk medvetenhet hos barn med Downs syndrom

Ett steg i alla barns språkutveckling är att bli medveten om de olika språkljud som ingår i det talade språket och hur de kan användas för att skapa ord och betydelse. Denna förmåga kallas fonologisk medvetenhet och är även en viktig byggsten för läs- och skrivutvecklingen. Studier har visat att barn med Downs syndrom har nedsatt fonologisk medvetenhet och riskerar därmed att utveckla läs- och skrivsvårigheter.

Studiens syfte
I denna studie vill vi jämföra effekten av två träningsmaterial som avser att träna fonologisk medvetenhet.

The PhonicStick
I denna studie kommer vi att använda ett nytt redskap kallat The PhonicStick, utvecklad vid University of Dundee i Skottland. The PhonicStick är en joystick som är programmerad med sex svenska språkljud som kan kombineras till riktiga ord (t.ex. båt, sol) och nonsensord (t.ex. lib, nåp).

Praxis

Deltagare
För deltagande söker vi barn med Downs syndrom som:
- är mellan 8 och 15 år.
- bor i Uppsala-/Stockholmsområdet
- är diagnosticerad med Downs syndrom utan annan typ av funktionsnedsättning som allvarligt påverkar förmågan att delta i träningsstunden.
- deltar i någon form av skolverksamhet.
- har svenska som modersmål.

Varför ditt barn har blivit tillfrågat att delta i denna studie
Studier har visat att barn med Downs syndrom kan ha fördel av att träna fonologisk medvetenhet för att underlätta läs- och skrivinlärningen. Med denna studie vill vi jämföra två träningsmaterial som används för att utveckla den fonologiska medvetenheten hos barn med Downs syndrom. Vår förhoppning är att studien skall ge oss kunskap kring vilken metod som passar bäst och är mest effektiv för denna grupp av barn med speciella behov. Även om ditt barn är på väg att lära sig läsa och skriva kan...
Vad innebär deltagande i denna studie?

<table>
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Personuppgifter

Intresseanmälan
Medföljande intresseanmälan ifylles och skickas till Institutionen för neurovetenskap om ni är intresserad av att delta i studien. Intresseanmälan går även bra att skicka via e-mail till oss. Adresserna hittar ni nedan på denna sida.
Vi kommer sedan att kontakta er för vidare information om studien och för att komma fram till en tidpunkt att träffas.

Det här projektet genomförs under hösten 2010 som ett examensarbete på logopedutbildningen vid Institutionen för neurovetenskap, Enheten för logopedi, Uppsala universitet. Handledare för projektet är Margareta Jennische, logoped och Dr.med.vet. margareta.jennische@neuro.uu.se.

Med vänliga hälsningar

Jenny Gullberg 076-2610301 jenny.gullberg.7648@student.uu.se
Josefin Granholm 076-2500033 josefin.granholm.4610@student.uu.se

Intresseanmälan skickas till:
Margareta Jennische margareta.jennische@neuro.uu.se
Uppsala universitet, Institutionen för neurovetenskap
Enheten för logopedi, BMC, Box 593, 751 24 Uppsala
Deltagande i studie

Jag ger härmed mitt samtycke till mitt barns deltagande i studien om träning av fonologisk medvetenhet hos barn med Downs syndrom. Jag är medveten om att deltagandet är frivilligt och att jag eller Mitt barn när som helst kan avbryta studien utan att ange skäl.
Jag samtycker även till att mitt barn videofilmas under test och träningstillfällen.

Datum:___________________________________________
Underskrift:_______________________________________
Namnförtydligande:_______________________________
Barnets namn:_____________________________________
Barnets födelsedatum:_______________________________

Kontaktuppgifter:
Telefonnummer:____________________________________
E-mailadress:______________________________________

Vi föredrar att bli kontaktade via:   □ Telefon       □ E-mail
## WORDLISTS

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</table>
PA-level test 1 (Administered at session 2)  Name:……………………

The test administrator (TA)

Segmentation: (circle the segments that the child says)
Example words: KATT and TAMM.
TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to divide it into little pieces – to sounds. Let me show you how it works!
Let us start with the word /katt/ - Say KATT. Now I will divide it into sounds: /K/-/A/-/T/
Did you hear that it was three sounds in the word? /K/-/A/-/T/.
(Mark every sound with the plastic markers.)

Let us try another word: /tamm/. Say TAMM.
Now I will divide it into sounds: /T/-/A/-/M/.
Did you hear that it was three sounds in the word? /T/-/A/-/M/.
(Mark every sound with the plastic markers.)

Beginning of test:
Now it is your turn to try!
Say _ (From wordlist)
Which sounds to you hear?? (Mark every sound with the plastic markers.)

Blending: (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.
Example words: AMMA and OCKA.
TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds. Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds. (mark every sound with the plastic marker).

Let me show you how it works!
I say /A/-/M/-/A/. Listen again and try to hear which word I am saying. (repeat the word and point at the marker) Did you hear that I said /amma/?

Let us try another!
I say /O/-/K/-/A/. Listen again and try to hear which word I am saying.
Did you hear that I said /ocka/?

Beginning of test:
Now it is your turn to try!
I say _ (from wordlist)? (TA says the sounds and marks every sound with a plastic marker)
Did you hear which word it was?

Position analysis: (Note the child’s answer)
Example words: LAMM and TOCK.
TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.

I say /lamm/, can you repeat that?
Good! Listen carefully!
Which sound do you hear after /l/ in /lamm/? It is /a/, right?

Let us try again.
I say /tocc/, can you repeat that?
Which sound do you hear before /o/ in tock? It is /t/, right?
Beginning of test

Now it is your turn to try!

I say _ (from wordlist). Can you repeat that?

Which sound do you hear before/after _ in _?

<table>
<thead>
<tr>
<th>Segmentation /katt/ /tamm/</th>
<th>Blending /amma/ /ocka/</th>
<th>Position analysis /lamm/ /tock/</th>
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<td>A-K</td>
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<tr>
<td>lall</td>
<td>l a ll</td>
<td>T-O-L</td>
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</tbody>
</table>
PA-level test 2 (Administered at session 7)  Name:………………

The test administrator (TA)

Segmentation: (circle the segments that the child says)
Example words: LOTT and KO.

TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to divide it into little pieces – to sounds. Let me show you how it works!

Let us start with the word /lott/ - Say LOTT. Now I will divide it into sounds: /L/-/O/-/T/ Did you hear that it was three sounds in the word? /L/-/O/-/T/.

(Mark every sound with the plastic markers.)

Let us try another word: /KO/. Say KO.
Now I will divide it into sounds: /K/-/O/.
Did you hear that it was two sounds in the word? /K/-/O/.

(Mark every sound with the plastic markers.)

Beginning of test:
Now it is your turn to try!
Say _ (From wordlist)
Which sounds to you hear?? (Mark every sound with the plastic markers.)

Blending: (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.

Example words: KALL and TATT.

TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds.
Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds.

(mark every sound with the plastic marker).
Let me show you how it works!

I say /K/-/A/-/L/. Listen again and try to hear which word I am saying. (repeat the word and point at the marker) Did you hear that I said /kall/?

Let us try another!
I say /T/-/A/-/T/. Listen again and try to hear which word I am saying.
Did you hear that I said /tatt/?

Beginning of test:
Now it is your turn to try!
I say _ (from wordlist)? (TA says the sounds and marks every sound with a plastic marker)
Did you hear which word it was?

Position analysis: (Note the child’s answer)
Example words: TOM and OLL.

TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.

I say /tom/, can you repeat that?
Good! Listen carefully!
Which sound do you hear after /t/ in /tom/? It is /o/, right?

Let us try again.
I say /oll/, can you repeat that?
Which sound do you hear before /l/ in oll? It is /o/, right?
Beginning of test

Now it is your turn to try!

I say _ (from wordlist). Can you repeat that?

Which sound do you hear before/after _ in _?

<table>
<thead>
<tr>
<th>Segmentation /lott/ /ko/</th>
<th>Blending /kall/ /tatt/</th>
<th>Position analysis /tom/ /oll/</th>
</tr>
</thead>
<tbody>
<tr>
<td>tom</td>
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<td>lock</td>
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<td>to</td>
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<td>ka</td>
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</table>
PA-level test 3 (Administered at session 12)       Name:……………

The test administrator (TA)

Segmentation: (circle the segments that the child says)
Example words: TALL and LA.
TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to divide it into little pieces – to sounds. Let me show you how it works!
Let us start with the word /tall/ - Say TALL. Now I will divide it into sounds: /T/-/A/-/L/.
Did you hear that it was three sounds in the word? /T/-/A/-/L/.
(Mark every sound with the plastic markers.)

Let us try another word: /la/. Say LA.
Now I will divide it into sounds: /L/-/A/.
Did you hear that it was two sounds in the word? /L/-/A/.
(Mark every sound with the plastic markers.)

Beginning of test:
Now it is your turn to try!
Say _ (From wordlist)
Which sounds to you hear?? (Mark every sound with the plastic markers.)

Blending: (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.
Example words: OM and TAMM.
TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds.
Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds.
(mark every sound with the plastic marker).

Let me show you how it works!
I say /O/-/M/. Listen again and try to hear which word I am saying. (repeat the word and point at the marker) Did you hear that I said /om/?

Let us try another!
I say /T/-/A/-/M/. Listen again and try to hear which word I am saying.
Did you hear that I said /tamm/?

Beginning of test:
Now it is your turn to try!
I say _ (from wordlist)? (TA says the sounds and marks every sound with a plastic marker)
Did you hear which word it was?

Position analysis: (Note the child’s answer)
Example words: KAM and KO.
TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.

I say /kam/, can you repeat that?
Good! Listen carefully!
Which sound do you hear after /k/ in /kam/? It is /a/, right?

Let us try again.
I say /ko/, can you repeat that?
Which sound do you hear before /o/ in tock? It is /k/, right?
Beginning of test

Now it is your turn to try!

I say (from wordlist). Can you repeat that?

Which sound do you hear before/after _ in _?

<table>
<thead>
<tr>
<th>Segmentation /tall//la/</th>
<th>Blending/om//tamm/</th>
<th>Position analysis /kam//ko/</th>
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<td>tom (before m)</td>
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<td>ack</td>
<td>a k</td>
<td>all (after a)</td>
</tr>
<tr>
<td>koll</td>
<td>k o l</td>
<td>lamm (before a)</td>
</tr>
<tr>
<td>lott</td>
<td>l o t</td>
<td>kall (before a)</td>
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<td>lo</td>
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<td>m o</td>
<td>tock</td>
</tr>
<tr>
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<td>t a t</td>
<td>mock (after m)</td>
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<td>o k a</td>
<td>allo</td>
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<tr>
<td>ammo</td>
<td>a m o</td>
<td>oll (before l)</td>
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</table>
PhonicStick test for period 1 (administered at session 3 and 6)
Name:………………..

The test administrator (TA)
Segmentation: (Circle the segments that the child says)
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to do the word that you hear with the joystick. Let me show you how it works!

Let us start with the word (A)/och/, (B)/koll/ - Say OCH / KOLL. Can you do the word with the joystick: O-K, K-O-L. (Guide the child to collect the right sounds. Press the speak-button on the joystick.)
Did you hear that it was two/three sounds in the word?

Let us try another word: (A)/momm/, (B)/lall/ - Say MOMM / LALL. Can you do the word with the joystick: M-O-M, L-A-L. (Guide the child to collect the right sounds. Press the speak-button on the joystick.)
Did you hear that it was three sounds in the word?

Beginning of test:
Now it is your turn to try!
Can you do _ with the joystick? (From wordlist)

Blending: (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds. Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds. Let me show you how it works!
I say (A)O-K, (B)K-O-L (TA collects the sounds with the joystick). Listen again and try to hear which word I am doing (TA collects the sounds again and presses the speak-button).
Did you hear that it was (A)/och/, (B)koll?

Let us try again!
I say (A)M-O-M, (B)L-A-L (TA collects the sounds with the joystick). Listen again and try to hear which word I am doing (TA collects the sounds again and presses the speak-button).
Did you hear that it was (A)/momm/, (B)lall?

Beginning of test:
Now it is your turn to try!
TA: Says the sound in the word and ask the child:
Collect the sounds that you hear! Which word did you do? (Wait for a verbal answer, then press the speak-button on the joystick).

Position analysis: (Note the child’s answer)
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.
I say (A)/och/, (B)/koll/ can you repeat that?
Good! Listen carefully!
Which sound do you hear after (A):/o/ in /och/, (B):/k/ in /koll/? Can you do the sound with the joystick?

Let us try again!
I say (A)/momm/, (B)/lall/, can you repeat that?
Which sound do you hear before (A):/o/ in /momm/, (B):/a/ in /lall/? Can you do the sound with the joystick?

Beginning of test:
Now it is your turn to try!
_Can you say _? (From wordlist)_
Which sound do you hear before/after _ in _?
_Can you make the sound with the joystick?_

### A. Example words: och, momm

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### B. Example words: Koll, lall

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PhonicStick test for period 2 (Administered at session 8 and 11)

Name:……………………

The test administrator (TA)

Segmentation: (circle the segments that the child says)
Example words: From list A: ALLT and TATT. From list B: KAM and MA.

TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to do the word that you hear with the joystick. Let me show you how it works!

Let us start with the word (A)/allt/, (B)/kam/ - Say ALLT / KAM. Now I will do the word with the joystick: A-L-T / M-A. (Press the speak-button on the joystick.)
Did you hear that it was three sounds in the word?

Let us try another word: (A)/tatt/, (B)/ma/ - Say TATT / MA.
Now I will do the word with the joystick: M-O-M, L-A-L. (Listen to the word with the joystick.)
Did you hear that it was two/three sounds in the word?

Beginning of test:
Now it is your turn to try!
Can you do _ with the joystick? (From wordlist)

Blending: (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.
Example words: From list A: ALLT and TATT. From list B: KAM and MA.

TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds. Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds. Let me show you how it works!
I say (A)A-L-T, (B)K-A-M (TA collects the sounds with the joystick). Listen again and try to hear which word I am doing (TA collects the sounds again and presses the speak-button).
Did you hear that it was (A)/allt/, (B)kam?

Let us try again!
I say (A)T-A-T, (B)M-A (TA collects the sounds with the joystick). Listen again and try to hear which word I am doing (TA collects the sounds again and presses the speak-button).
Did you hear that it was (A)/tatt/, (B)ma?

Beginning of test:
Now it is your turn to try!
TA: Says the sound in the word and the asks the child:
Collect the sounds that you hear! Which word did you do? (Wait for a verbal answer, then press the speak-button on the joystick).

Position analysis: (Note the child’s answer)
Example words: From list A: ALLT and TATT. From list B: KAM and MA.

TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.
I say (A)/allt/, (B)/kam/ can you repeat that?
Good! Listen carefully!
Which sound do you hear after (A):/a/ in /allt/, (B):/k/ in /kam/? Can you do the sound with the joystick?

Let us try again!
I say (A)/tatt/, (B)/ma/, can you repeat that?
Which sound do you hear before (A):/a/ in /tatt/, (B):/a/ in /ma/? Can you do the sound with the joystick?

Beginning of test:
Now it is your turn to try!
Can you say _?(From wordlist)
Which sound do you hear before/after _ in _?
Can you make the sound with the joystick?

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<td>A-K-O</td>
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A. Example word: all, tatt.

B. Example word: kam, ma.
**Praxis test for period 1 (administered at session 3 and 6)**

**Name:…………………**

The test administrator (TA)

**Segmentation:** (circle the segments that the child says)
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and I want you to do the word that you hear with the pictures. Let me show you how it works!

Let us start with the word (A)/och/, (B)/koll/ - Say OCH / KOLL. Can you do the word with the cards: O-K, K-O-L. (Guide the child to collect the right cards.)
Did you hear that is was two/three sounds in the word?

Let us try another word: (A)/momm/, (B)/lall/ - Say MOMM / LALL.
Can you do the word with the cards: M-O-M, L-A-L. (Guide the child to collect the right cards.)
Did you hear that is was three sounds in the word?

Beginning of test:
Now it is your turn to try!
Can you do _ with the cards? (From wordlist)

**Blending:** (Transcribe the child’s answer as exact as possible. Note monotonous answers)
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds.
Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds. Let me show you how it works!
I say (A)O-K, (B)K-O-L (TA places the cards in front of the child). Listen again and try to hear which word I am doing (TA points at the cards and says the sounds again – then says the word). Did you hear that it was (A)/och/, (B)/koll/?

Let us try again!
I say (A)M-O-M, (B)L-A-L (TA places the cards in front of the child). Listen again and try to hear which word I am doing (TA points at the cards and says the sounds again – then says the word). Did you hear that it was (A)/momm/, (B)/lall/?

Beginning of test:
Now it is your turn to try!
TA: Says the sound in the word and then ask the child:
*Collect the sounds that you hear! Which word did you do?* (Let the child “read” the word by using the cards.)

**Position analysis:** (Note the child’s answer)
To meet the difficulty level of PhonicStick, all cards shall be in front of the child at every task.
Example words: From list A: OCH and MOMM. From list B: KOLL and LALL.

TA says: Now we are going to listen to words and sounds. Listen carefully!
I will say a word and I want you to repeat the word.
I say (A)/och/, (B)/koll/ can you repeat that?
Good! Listen carefully!
Which sound do you hear after (A):/o/ in /och/, (B):/k/ in /koll/? Point at the card.

Let us try again!
I say (A)/momm/, (B)/lall/, can you repeat that?
Which sound do you hear before (A):/o/ in /momm/, (B):/a/ in /lall/? Point at the card.

Beginning of test:
Now it is your turn to try!
*Can you say _? (From wordlist)*
*Which sound do you hear before/after _ in _?*
*Point at the card.*

### A. Example word: och, momm

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### B. Example word: Koll, lall

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<td>L-O ma (after m)</td>
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Praxis test for period 2 (administered at session 8 and 11)
Name:  

The test administrator (TA)  
**Segmentation:** (circle the segments that the child says)  
Example words: From list A: ALLT and TATT. From list B: KAM and MA.  

TA says: Now, we are going to play with and listen to words and sounds. I will say a word to you and want you to do the word that you hear with the cards. Let me show you how it works!  

Let us start with the word (A)/allt/, (B)/kam/ - Say ALLT / KAM. Can you do the word with the cards: A-L-T, K-A-M. (Guide the child to collect the right cards.)  
Did you hear that is was three sounds in the word?  

Let us try another word: (A)/tatt/, (B)/ma/- Say TATT / MA. Can you do the word with the cards: T-A-T, M-A. (Guide the child to collect the right cards.)  
Did you hear that is was three sounds in the word?  

Beginning of test:  
Now it is your turn to try!  
Can you do _ with the cards? (From wordlist)  

**Blending:** (Transcribe the child’s answer as exact as possible. Note monotonous answers)  
There shall be a two-second gap between each sound. The pronunciation shall be monotonous.  
Example words: From list A: ALLT and TATT. From list B: KAM and MA.  

TA says: Now, we are going to play with and listen to sounds and words! I will say a word to you, but I will say it in an odd way. I will say it in small pieces – in sounds. Listen carefully and try to hear which word I am saying. Look at my lips when I say the sounds. Let me show you how it works!  
I say (A)A-L-T, (B)K-A-T (TA places the cards in front of the child). Listen again and try to hear which word I am doing (TA points at the cards and says the sounds again – then says the word).  
Did you hear that it was (A)/allt/, (B)/kam/?  

Let us try again!  
I say (A)T-A-T, (B)M-A. (TA places the cards in front of the child). Listen again and try to hear which word I am doing (TA points at the cards and says the sounds again – then says the word).  
Did you hear that it was (A)/tatt/, (B)/ma/?  

Beginning of test:  
Now it is your turn to try!  
TA: Says the sound in the word and ask the child:  
*Collect the sounds that you hear! Which word did you do?* (Let the child “read” the word by using the cards.)  

**Position analysis:** (Note the child’s answer)  
To meet the difficulty level of PhonicStick, all cards shall be in front of the child at every task. Example words: From list A: ALLT and TATT. From list B: KAM and MA.  

TA says: Now we are going to listen to words and sounds. Listen carefully! I will say a word and I want you to repeat the word. I say (A)/allt/, (B)/kam/ can you repeat that? Good! Listen carefully!
Which sound do you hear after (A):/a/ in /allt/, (B):/k/ in /kam/? Point at the card.

Let us try again!
I say (A)/tatt/, (B)/ma/, can you repeat that?
Which sound do you hear before (A):/a/ in /tatt/, (B):/a/ in /ma/? Point at the card.

Beginning of test:
Now it is your turn to try!
Can you say _? (From wordlist)
Which sound do you hear before/after _ in _?
Point at the card.

A. Example word: allt, tatt.

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B. Example word: kam, ma.

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<td>a m</td>
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Appendix 4
Session 2 and 7 Finding sounds.

PhonicStick

1. Administration of PA-level test 1

2. Introduction of PhonicStick:
   Goal: To master position-sound correspondence.
   - Say: This is a PhonicStick. With this, you can make different sounds. Try to pull it towards you, what do you hear?
     o Confirm the child and ask him/her to do the same thing again.
   - Try to pull it to the side, what do you hear?
     o Confirm the child and ask him/her to do the same thing again.
   - Try to pull it to the other side, what do you hear?
     o Confirm the child and ask him/her to do the same thing again.
   - Try to pull it towards me, what do you hear?
     o Confirm the child and ask him/her to do the same thing again.
   - Try to pull it towards me and a little bit to the side (in the child’s northwestern direction), what do you hear now?
     o Confirm the child and ask him/her to do the same thing again.
   - Try to pull it towards you and then this way (to the child’s right), what do you hear now?
     o Confirm the child and ask him/her to do the same thing again.
   - Now, try to pull it towards me and then this way (to the child’s right), what do you hear?
     o That sound (“boink”) means that there is no sound at that position. Try it again!

3. Do-the-same game
   TL makes a sound and the child is asked to collect it with the joystick.
   Repeat verbally together after the child has found the right sound.

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</table>

Guide the child if he/she does not find the right sound. The play continues until the child has reached satisfying results.

Praxis

1. Administration of PA-level test 1.

2. Introduction to Praxis
   Goal: To master picture-sound correspondence.
   - Say: These are sound pictures (show the cards). Each picture has it’s own sound.
   - This is a picture of a girl eating ice-cream and she says /m/ - What do you hear?
     o Confirm the child and ask him/her to repeat the sound.
   - This crocodile opens his mouth and says /a/ (short vowel) – What do you hear?
     o Confirm the child and ask him/her to repeat the sound.
   - These children they say /l/ - what do you hear?
     o Confirm the child and ask him/her to repeat the sound.
   - This is a revolver and when it goes off it sounds /k/ - What do you hear?
     o Confirm the child and ask him/her to repeat the sound.
   - This is a little fish that blows bubbles and says /o/ (short vowel) - What do you hear?
     o Confirm the child and ask him/her to repeat the sound.
   - This is a drum and when you tap it, it sounds /t/ - What do you hear?
     o Confirm the child and ask him/her to repeat the sound.
3. **Do-the-same game.**
TL says sound and the child is asked to point at the corresponding card. Repeat verbally together when the child has pointed at the right card.

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Guide the child if he/she does not find the right card. The play continues until the child has reached satisfying results.
Session 3 and 8 Segmentation of speech sounds.
Goal: Learn to identify the sounds in a given word (segmentation).

PhonicStick:
1. Do-the-same game
TL makes a sound and the child is asked to collect it with the joystick.
Repeat verbally together after the child has found the right sound.

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<tr>
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2. PhonicStick test. Administered at session 3 during period 1 and at session 8 during period 2.

3. Divide-the-word game (Segmentation)
Use words from wordlist A or B.
- In the word (A)/tom/ or (B)/alla/ there are three different sounds: /t/, /o/, /m/ or /a/, /l/, /a/. Can you make the word /tom/- /alla/ with the joystick?
- If you press on the speak-button, you can hear which word you did.
- If it is the wrong word, you can press the clear-button and start over.
- Guide the child by asking which word that is first, second and so on.
Guide the child when necessary. Note level of guidance:
- One sound at a time – sound repetition.
- Repetition of word.
- No extra guidance.
- Shall we try a new word?
- There are some words that are make believe, (A)/lomm/ or (B)/omma/ is such a word. Can you do it with the joystick. (Same guidance as earlier.)
- Shall we try a new word?

4. Free play
Let the child generate his/her own words. Prompt when necessary.

Praxis:
1. Do-the-same game.
TL says sound and the child is asked to point at the corresponding card.
Repeat verbally together when the child has pointed at the right card.

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2. Praxis test. Administered at session 3 during period 1 and at session 8 during period 2.

3. Divide-the-word game (Segmentation)
Use words from wordlist A or B.
- In the word (A)/tom/ or (B)/alla/ there are three different sounds: /t/, /o/, /m/ or /a/, /l/, /a/. Can you do the word /tom/ or /alla/ with the cards?
- Guide the child by asking which word that is first, second and so on.
Guide the child when necessary. Note level of guidance:
- One sound at a time – sound repetition.
- Repetition of word.
- No extra guidance.
- Shall we try a new word?
- There are some words that are make believe, (A)/lomm/ or (B)/omma/ is such a word. Can you do it with the cards. (Same guidance as earlier.)
- Shall we try a new word?

4. Free play
Let the child generate his/her own words. Prompt when necessary.
Session 4 and 9 Blending
Goal: Blend sounds into words.

PhonicStick:
1. **Repetition**: Do you remember where the sounds are?

<table>
<thead>
<tr>
<th>/o/</th>
<th>/m/</th>
<th>/l/</th>
<th>/k/</th>
<th>/a/</th>
<th>/t/</th>
</tr>
</thead>
</table>

2. **Build-a-word game.**
   Use words from wordlist A or B.
   Use the terms *first, in the middle and last* when talking about positions. Use phrases such as: *What sound comes first... what sound is last.*
   - Do you remember that we divided a word into sounds last time we met? Now we are going to build a word by putting together sounds.
   - If I say the sounds /k/, /a/, /t/ - /k/, /o/, /k/ which word do they make? Try collecting the sounds with the joystick! Press the speak-button.
   - What do you hear?
   - Shall we try some other sounds?

3. **Repetition of Divide-the-word game.**
   - Now we shall try to divide the word into sounds, like we did last time we met (use words from wordlist A or B).

Praxis
1. **Repetition**: Do you remember what the cards sound like?

<table>
<thead>
<tr>
<th>/o/</th>
<th>/m/</th>
<th>/l/</th>
<th>/k/</th>
<th>/a/</th>
<th>/t/</th>
</tr>
</thead>
</table>

2. **Build-a-word game.**
   Use words from wordlist A or B.
   Use the terms *first, in the middle and last* when talking about positions. Use phrases such as: *What sound comes first... what sound is last.*
   - Do you remember that we divided a word into sounds last time we met? Now we are going to build a word by putting together sounds.
   - If I say the sounds /k/, /a/, /t/ - /k/, /o/, /k/ which word do they make? Put down the sounds you hear with the cards.
   - What do you hear?
   - Shall we try some other sounds?

3. **Repetition of Divide-the-word game.**
   - Now we shall try to divide the word into sounds, like we did last time we met (use words from wordlist A or B).
Session 5 and 10 Position analysis
Goal: To identify a sounds position in a word.

PhonicStick
1. **Repetition**: Do you remember where the sounds are?

| /o/ | /m/ | /l/ | /k/ | /a/ | /t/ |

2. **Where-is-the-sound game.**
   - Use words from wordlist A or B.
   - Use the plastic markers to plot each sound.
   - Start by asking after sounds in reading direction i.e. which sound that comes after another sound.
   - Adjust the level of difficulty to the child capacity.
     - Now, we are going to find one sound in a word.
     - Can you say /lamm/ - /kall/?
     - Which sound do you hear after /a/ in /lamm/ - /kall/?
     - Can you make the sound with the joystick?

3. **Repetition of build-a-word game.**
   - Now we shall try to build a word with sounds, like we did last time we met! (use words from wordlist A or B).

Praxis
1. **Repetition**: Do you remember what the cards sound like?

| /o/ | /m/ | /l/ | /k/ | /a/ | /t/ |

2. **Where-are-the-sound game.**
   - Use words from wordlist A or B.
   - Use the plastic markers to plot each sound.
   - Start by asking after sounds in reading direction i.e. which sound that comes after another sound.
   - Adjust the level of difficulty to the child capacity.
     - Now, we are going to find one sound in a word.
     - Can you say /lamm/ - /kall/?
     - Which sound do you hear after /a/ in /lamm/ - /kall/?
     - Can you show me which card that sounds like that?

3. **Repetition of build-a-word game.**
   - Now we shall try to build a word with sounds, like we did last time we met! (use words from wordlist A or B).
Session 6 and 11
Goal: Repetition of all skills i.e. Segmentation, Blending and Position analysis. Final material test (Praxis or PhonicStick).

PhonicStick
1. Divide-the-word game (Segmentation)
   Use words from wordlist A or B.
   - In the word (A)/tom/ or (B)/alla/ there are three different sounds: /t/, /o/, /m/ or /a/, /l/, /a/. Can you make the word /tom/ - /alla/ with the joystick?
   - IF you press on the speak-button, you can hear which word you did.
   - IF it is the wrong word, you can press the clear-button and start over.
   - Guide the child by asking which word that is first, second and so on.
   Guide the child when necessary. Note level of guidance:
     - One sound at a time – sound repetition.
     - Repetition of word.
     - No extra guidance.
   - Shall we try a new word?
   - There are some words that are make believe, (A)/lomm/ or (B)/omma/ is such a word. Can you do it with the joystick. (Same guidance as earlier.)
   - Shall we try a new word?

2. Build-a-word game.
   Use words from wordlist A or B.
   Use the terms first, in the middle and last when talking about positions. Use phrases such as: What sound comes first....what sound is last.
   - Do you remember that we divided a word into sounds last time we met? Now we are going to build a word by putting together sounds.
   - -If I say the sounds /k/, /a/, /t/ - /k/, /o/, /k/ which word do they make? Try collecting the sounds with the joystick! Press the speak-button.
   - -What do you hear?
   - Shall we try some other sounds?

3. Where-is-the-sound game.
   Use words from wordlist A or B.
   Use the plastic markers to plot each sound.
   Start by asking after sounds in reading direction i.e. which sound that comes after another sound.
   Adjust the level of difficulty to the child capacity.
   - Now, we are going to find one sound in a word.
   - Can you say /lam/ - /kall/?
   - Which sound do you hear after /a/ in /lamm/ - /kall/?
   - Can you make the sound with the joystick?

4. PhonicStick test. Administered at session 6 during period 1 and at session 11 during period 2.

Praxis
1. Divide-the-word game (Segmentation)
   Use words from wordlist A or B.
   - In the word (A)/tom/ or (B)/alla/ there are three different sounds: /t/, /o/, /m/ or /a/, /l/, /a/. Can you do the word /tom/ or /alla/ with the cards?
   - Guide the child by asking which word that is first, second and so on.
   Guide the child when further necessary. Note level of guidance:
     o One sound at a time – sound repetition.
     o Repetition of word.
- Shall we try a new word?
- There are some words that are makebelieve, (A)/lomm/ or (B)/omma/ is such a word. Can you do it with the cards? (Same guidance as earlier.)
- Shall we try a new word?

2. **Build-a-word game.**

Use words from wordlist A or B.

Use the terms *first, in the middle and last* when talking about positions. Use phrases such as: *What sound comes first....what sound is last.*

- Do you remember that we divided a word into sounds last time we met? Now we are going to build a word by putting together sounds.
- If I say the sounds /k/, /a/, /t/ - /k/, /o/, /k/ which word do the build? Put down the sounds you hear with the cards.
- What do you hear?
- Shall we try some other sounds?

3. **Where-is-the-sound game.**

Use words from wordlist A or B.

Use the plastic markers to plot each sound.

Start by asking after sounds in reading direction i.e. which sound that comes after another sound.

Adjust the level of difficulty to the child capacity.

- Now, we are going to find one sound in a word.
- Can you say /lamm/ /kall/?
- Which sound do you hear after /a/ in /lamm/ /kall/?
- Can you show me which card that sounds like that?

4. **Praxis test.** Administered at session 6 during period 1 and at session 11 during period 2.
<table>
<thead>
<tr>
<th>Session 1</th>
<th>Blue</th>
<th>Purple</th>
<th>White</th>
<th>Red</th>
<th>Green</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet during the meeting. Shows interest for both the PhonicsStick and Praxis. Mother says that she sometimes do not like to participate in activities.</td>
<td>Signs and names the motive on the Praxis pictures and is happy during this session. Speaks with low intelligibility. Is interested in the PhonicsStick.</td>
<td>Plays with both Praxis and the PhonicsStick. Shows great interest in both materials. Speaks spontaneously with high intelligibility and asks questions.</td>
<td>Unfocused but shows interest in both materials. High level of physical activity. Speaks spontaneously but with low intelligibility.</td>
<td>Calm and happy. Speaks very much with moderate intelligibility. Plays with both materials and shows great interest in learning the sounds and positions. Reacts with laughter when he produces a word with the PhonicsStick.</td>
<td>Is shy and quiet. Looks at the materials but does not participate. Asks if she is allowed to go and play outside instead. Father says that she does not like to participate in situations where she is being tested.</td>
<td></td>
</tr>
</tbody>
</table>

| Session 2 | Interested and repeats what the researcher says during PA-level test 1. Speaks with low intelligibility. Does not repeat words when asked. Looks at the signed sounds. Plays with PS – do not want to find phonics when asked. Is interested when the researcher collects sounds. Generates her own words after a while. | PA-level test 1: Does not seem to understand the tasks. Uses a large amount of supported signs. Signs all six sounds and meaning of generated word. Repeats /l/ and /k/ over and over again. Repeats what the researcher says. Is interested and happy. Claps his hands. Has trouble doing exact movements with the joystick. | PA-level test 1: Is motivated but easily distracted. Scores 10/10 on the segmentation tasks. Initial vowel in the blending tasks is difficult. Blends sometimes 2/3 sounds. Identifies initial sounds easily during position analysis. Sounds prior to another are more difficult. Is helped by repeating the word aloud. | PA-level test 1: Repeats the words that the researcher says. Cannot carry out tasks in segmentation or blending. Signs the sounds. Is interested in the different Praxis-cards. Participates actively in naming the cards with correct sound. Names some cards with the letter name. | PA-level test 1: Thoughtful and need guidance with first sound in one word. Segments the remaining words. Need help dividing all sounds, blends initial and second sound e.g. /tʌ/ /l/. Notes that the non-words sound funny, laughs at /æk / l. Has some difficulties with blending non-words. Does only need instruction in the beginning of each task. | PA-level test 1: A little bit shy but participates in all presented tasks. Repeats sounds and words. Answers most tasks with “Don’t know”. Shows interest in the Praxis cards, learns the picture-sound correspondence quickly. Names some cards with the letter name: /l/, /k/, /m/. Wants to produce own words. |

| PA-level test 1: | Does not seem to understand the tasks. Uses a large amount of supported signs. Signs all six sounds and meaning of generated word. Repeats /l/ and /k/ over and over again. Repeats what the researcher says. Is interested and happy. Claps his hands. Has trouble doing exact movements with the joystick. | PA-level test 1: Is motivated but easily distracted. Scores 10/10 on the segmentation tasks. Initial vowel in the blending tasks is difficult. Blends sometimes 2/3 sounds. Identifies initial sounds easily during position analysis. Sounds prior to another are more difficult. Is helped by repeating the word aloud. | PA-level test 1: Repeats the words that the researcher says. Cannot carry out tasks in segmentation or blending. Signs the sounds. Is interested in the different Praxis-cards. Participates actively in naming the cards with correct sound. Names some cards with the letter name. | PA-level test 1: Thoughtful and need guidance with first sound in one word. Segments the remaining words. Need help dividing all sounds, blends initial and second sound e.g. /tʌ/ /l/. Notes that the non-words sound funny, laughs at /æk / l. Has some difficulties with blending non-words. Does only need instruction in the beginning of each task. | PA-level test 1: A little bit shy but participates in all presented tasks. Repeats sounds and words. Answers most tasks with “Don’t know”. Shows interest in the Praxis cards, learns the picture-sound correspondence quickly. Names some cards with the letter name: /l/, /k/, /m/. Wants to produce own words. |
### Session 3

**Starts with PhonicStick and wordlist A.**

- PhonicStick test for period 1: Starts playing with PS. Does not find specific phonics without the researchers help. Moves around the joystick randomly. Is not willing to repeat words when asked but repeats the joystick after she presses the speak-button.
- Pronounces /m/ as /l/ and /m ɔ m/ as /m ɔ ln/.

**Starts with PhonicStick and wordlist B.**

- Seems uncertain what to do with the joystick. The researcher puts Purples hands on the joystick. Need guidance to find the right sound. The researcher helps searing the joystick.
- Repeats words when the speak-button is pressed.

### Session 4

**Starts with PhonicStick and wordlist A.**

- Segments the words successfully. Confuses sometimes between /a/ and /ɔ/. Notes when she produces the wrong sounds and corrects herself. Manages to blend words but is distracted when she by mistake produces the wrong sound and has to reproduce the whole word. Has difficulties with position analysis.

**Starts with PhonicStick and wordlist B.**

- Segments the words successfully. Confuses sometimes between /a/ and /ɔ/. Notes when she produces the wrong sounds and corrects herself. Manages to blend words but is distracted when she by mistake produces the wrong sound and has to reproduce the whole word. Has difficulties with position analysis.

**Starts with Praxis and wordlist A.**

- Praxis test for period 1: Has a positive approach to the material. Manages to segment the initial sound and blend two of three sounds in some words. Repeats sounds and words. Needs concrete instructions and supported signs. Difficulty focusing on the tasks.

**Starts with Praxis and wordlist B.**

- Names all the cards. Segment two of three sounds in 4 words, e.g. /l/ and /k/ in /lɔ k/ and /k/ and /m/ in /kam/. Does not manage to blend any word. Can identify initial sounds at some occasions but need much guidance.

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**Appendix 10**

**Session 3**

- Starts with PhonicStick and wordlist A.
  - PhonicStick test for period 1: Starts playing with PS. Does not find specific phonics without the researchers help. Moves around the joystick randomly. Is not willing to repeat words when asked but repeats the joystick after she presses the speak-button.
  - Pronounces /m/ as /l/ and /m ɔ m/ as /m ɔ ln/.

**Session 4**

- Repeats what the researcher says. When showing PS, she says “don’t want to”.
  - Moves around the joystick and repeats the sounds that she hears.
  - Finds /a/, /l/, /ɔ/ in “do-the-same game”.
  - Blending: Laughs when she presses the speak-button.
  - Says /l/ with effort.

- Investigator repeats all sound positions. Continues with “do-the-same game” does not seem to hear when he finds the correct sound. Deeply concentrated.
  - Collects sounds to create words with help from the researcher. At end of session he can find some sound positions by himself.

- Eager to work and asks for more tasks when she is finished. Looses concentration and starts playing with other things.
  - Blends the right sounds but in wrong order e.g. /l/, /ɔ/, /m/ into /m/ mt/.
  - Needs often repetitions to carry out the tasks.
  - Reflects over the fact that she has the sounds /l/ and /s/ in her name.

- Motivated to play games to learn picture-sound correspondence.
  - Confuses the cards for /l/ and /k/, /l/ and /a/. Is happy when he manages to blend the word /k ɔ k/. Does not listen to instructions.
  - Perseverations from previous tasks. Difficulty maintaining focus.

- Eager to work and works hard. Does not need to be reminded of which word he is building. Puts two cards in wrong order, swaps the cards when the researcher asks what is wrong, and then signs “busig” (eng.transl. rowdy). Continues to joke around with the researcher but engages in the tasks.

- Confuses /a/ and /ɔ/. Blends the words /lak/ and /lal/. Is not prohibited by non-words. Segments /a/ and /k/ in /kal/ but in the wrong order. Is not motivated to do the tasks, wants to do own words. Answers with “Don’t know” but knows the correct answer if asked again. Sighs and yawns.
### Session 5

<table>
<thead>
<tr>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Is asked to find /a/</strong>. Moves around the joystick until she finds /a/ and then looks at the researcher for reactions. Finds /ɔ/, /m/ and /l/ directly. Need guidance to find /k/. Blending: Unwilling to generate a certain word. Says NO! when the researcher explains which sounds there are in the word /tall/. Looks downs and sobs.</td>
</tr>
<tr>
<td><strong>Repetition of positions.</strong> Finds /l/, /a/, /ɔ/ and /m/ with some guidance to the exact position. Claps his hand when he finds the right sound. Need guidance with one sound at a time in order to generate a word. Laughs and claps his hands when he presses the speak-button.</td>
</tr>
<tr>
<td><strong>During the tasks with position analysis White is helped by the markers for each sound. Can identify initial sounds easily. Produces often the sounds verbally before she collects them with PS. Has difficulty with sounds that is prior to another sound e.g. “which sound comes before /k/ in /ɔka/?”. Is helped by pointing out the sounds positions on PS</strong></td>
</tr>
<tr>
<td><strong>Does not want to participate.</strong> Has difficulty to find right card to right sound. Need much guidance from the researcher. Does not answer questions. Repeats some sounds that the researcher says. Says: “I am so tired”.</td>
</tr>
<tr>
<td><strong>Is joking and laughing today.</strong> Can replace single sounds without guidance e.g. puts /lal/ when he is asked to put /lam/, corrects himself when the researcher asks “what word did I say?”. Elaborates with the sounds - makes own words.</td>
</tr>
<tr>
<td><strong>Motivated to produce own words.</strong> Identifies sounds in all positions if the cards are lying in the right order. Participates in all tasks but does not show enthusiasm. Seem to understand instructions of the tasks but is in need of repetitions of the specific words and sounds in the tasks.</td>
</tr>
</tbody>
</table>

### Session 6

<table>
<thead>
<tr>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td><strong>PhonicStick test for period 1:</strong> Is concentrated but need guidance. Repeats words that the researcher says. Generates two sounds when she is encouraged by the researcher. Collects sounds but can not say which word they generate. Does not want to repeat the word. <strong>PhonicStick test for period 1:</strong> Finds all sounds at first try and is eager to continue playing. Need guidance to generate words. Need repeated instructions and the researcher need to ask Purple at numerous occasions if he is listening. Hears /k/ in /kam/ and /m/ in /mam/. Can not segment a whole word. Protests at end of session. <strong>PhonicStick test for period 1:</strong> Eager to start with the tasks. Completes all segmentation tasks besides one successfully. Blends the words without PS. Manages to identify sounds prior to another in the position analysis tasks. Produces the wrong sounds sometimes but corrects herself. <strong>Praxis test for period 1:</strong> Need encouragement from the researcher to carry out the tasks. Manages to segment /ɔ/ in /ɔka/, /a/ and /l/ in /tal/, /a/ and /m/ in /lam/. Difficulties placing the cards in right order. Says that /lɔt/ sounds like LOTTA. Difficulties focusing on the tasks. <strong>Praxis test for period 1:</strong> No video record. Need some help to complete all segmentation tasks. Blends words without using the cards - makes a remark that /ɔ k/ only contains two sounds. Can identify position of sounds when they are in reading direction. Need guidance to complete the tasks. <strong>Praxis test for period 1:</strong> Unfocused during whole session, does not want to participate. Segments one or two sounds in the tasks. In some words all three correct sounds but in the wrong order e.g. /kma/ instead of /kam/. Blends /m/, /a/, /l/ into /aml/. Need repeated instructions to carry out the tasks. Finishes 12 tasks. <strong>Praxis test for period 1:</strong> Need some help to complete all segmentation tasks. Blends words without using the cards - makes a remark that /ɔ k/ only contains two sounds. Can identify position of sounds when they are in reading direction. Need guidance to complete the tasks. <strong>Praxis test for period 1:</strong> Unfocused during whole session, does not want to participate. Segments one or two sounds in the tasks. In some words all three correct sounds but in the wrong order e.g. /kma/ instead of /kam/. Blends /m/, /a/, /l/ into /aml/. Need repeated instructions to carry out the tasks. Finishes 12 tasks.</td>
</tr>
</tbody>
</table>

### Praxis test for period 1:

- Need some help to complete all segmentation tasks.
- Blends words without using the cards - makes a remark that /ɔ k/ only contains two sounds. Can identify position of sounds when they are in reading direction. Need guidance to complete the tasks.
- Unfocused during whole session, does not want to participate. Segments one or two sounds in the tasks. In some words all three correct sounds but in the wrong order e.g. /kma/ instead of /kam/. Blends /m/, /a/, /l/ into /aml/. Need repeated instructions to carry out the tasks. Finishes 12 tasks.

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*Appendix 10*
### Session 7

**PA-level test 2:**
Concentrated and listens attentively to example tasks. Can not say which sounds there are in a given word. Repeats the sounds that the researcher says. Unwilling to continue by third word. Sobs and turns away when she is asked to answer. Does not want to look at the Praxis pictures. Looks at them as they are placed on the table.

**PA-level test 2:**
Repeats words and sounds. Listen with moderate attention to the instructions. Can sometimes identify initial sound when he is asked “which sound is first?” Says and signs the motive on the picture, not the sound. Need guidance to say the sound. Is attentive and concentrated.

**PA-level test 2:**
Plots each sound with the markers and segments all words by herself. Manages to blend 5/10 tasks. Blends the right sounds but in wrong order e.g. /k/ /ɔ/ /l/ into /ɔlk/. Performs 6/10 tasks in position analysis correctly, still has difficulty with sounds prior to another. Need repetitions some times.

**PA-level test 2:**
Repeats the sounds that the investigator says. Need instructions on a single sentence basis. Manages to segment /ɔ/ in /ɔml/. Preservations occur.

**Play with PS:**
Show great enthusiasm and concentration.

**PA-level test 2:**
Easily distracted and very tired. Segments one sound in a few tasks. Blends /l/, /ɔ/, /k/ into /ɔlk/ and /l/, /ɔ/, /ml/ into /ɔml/. Unclear if the tiredness contributes to the results. Learns quickly how to maneuver the joystick, listens to instructions. Produces sounds randomly.

### Session 8

**Crosses over to Praxis and wordlist B.**
Praxis test for period 2: Refuses to say which sounds there are in a given word. Does not want to participate. Hides her face in her hands and sobs “no”. Is asked to find the hidden pictures in the room. Searches with great enthusiasm and says “again” after the first round. Can say how all pictures sound after two rounds.

**Crosses over to Praxis and wordlist A.**
Repetition of praxis cards. Master sound-picture correspondence after one round. Praxis test for period 2: Identifies /l/ in /all/ and /k/ in /kɔ /m/. Can segment initial and following sound in some words. Lefts out final sound.

**Crosses over to Praxis and wordlist B.**
Praxis test for period 2: Begins to place the cards from right to left sometimes. Completes all segmentation tasks correctly. Blends the right sounds but places them in wrong order e.g. /lɔ k/ instead of /kɔ l/. Produces 3/6 tasks correctly. Manages to identify sounds in all positions.

**Crosses over to PhonicStick and wordlist B.**
PhonicStick test for period 2: Has difficulty to maneuver PS and remember the positions of the sounds. Moves around the joystick randomly. Manages to find the positions when the researcher gives guidance. Shows interest in producing words.

**Crosses over to PhonicStick and wordlist A.**
PhonicStick test for period 2: Segments right sounds but in wrong order. Says the sounds before she produces them with PS. Blends /l/, /ɔ/, /ml/ into /ɔm/ and /al/, /l/, /ml/ into /al/. Likes to push the “speak” button. Waits for the produced words with excitement.
### Session 9

| Concentrated. Connects all sound to the right picture. Wants to do the hiding game. Laughs and says the corresponding sound when she finds a picture. Pronounces /m/ as /n/ and /t/ as /l/. Resumes to blending task and she is able to sound two and three sounds together but can not say which word they create. Is happy during whole session. |
| Alert. Wants to decide which sounds to do. Says “No /l/, No /al/”. Repeats words and sounds that the researcher says. Places cards randomly – as he is guessing. Hears initial sounds but does not seem to grasp the whole principle of segmentation and blending. |
| Is now certain of in which direction to place the cards. Completes all blending tasks correctly. |
| Exited to play with PS. Does not listen to instructions but is motivated to produce words. Cannot produce the sounds that the researcher says, with PS. Does not find the sounds positions. Does not repeat the sounds or the words. Cannot say if a word that the researcher produces is the same as PS says. |
| Is happy and willing to start. Need guidance to find all sounds. Asks the researcher in which directions a certain sound is. Laughs and repeats the words that is generated by PS. |

### Session 10

<p>| Start with hiding the pictures. Says /l/ to the picture of the drum. A new game is presented: Jump on the pictures and say the sounds. Says two sounds together but can not blend them into a word. Unwilling to continue when she is asked to blend the sounds into a word. |
| Is focused and serious today. Can identify initial sounds at some occasions but need guidance to complete the whole word. It seems like /t/ and /k/ are easier to identify than other sounds. Segments /katt/ by himself but places the cards in wrong order. Claps his hands and laughs. |
| Identifies sounds in all positions. Manages to produce a few tasks where the sound is prior to another sound. Has some difficulty to segment non-words. |
| Does not find the sounds positions. Plays with PS but does not listen to instructions. Manages in some cases to produce correct sound with the PS. Is motivated to produce the word /tak/ in the end of the session. Shows enthusiasm when producing words. |
| Seems tired today. Is apprehensive to generate sounds. Wants to be guaranteed that he places the joystick in the right position before moving the joystick. Asks the researcher if he is heading in the right direction. Finds all sounds. |
| Happy and motivated to produce words. Needs guidance to produce words with the sounds in right order. Manages to identify sounds in initial and medial positions after repetitions. Manages to produce the word /kat/ on her own. |</p>
<table>
<thead>
<tr>
<th>Session 11</th>
<th>Praxis test for period 2: The researcher says that she is going to jump /lo/ but jumps /tu/. Blue says “no, /lu/”: the researcher asks which pictures she shall take to create /tack/? Blue finds /tu/ and /tu/ with guidance, finds /k/ by her self. Finds /a/ when she is being asked which pictures there are in /kall/. Says /kalle/. Unwilling to continue.</th>
<th>Confuses /o/ and /a/. Praxis test for period 2: Eager to start. Corrects herself when she places sounds in wrong order in the segmentation tasks. Complete 6/6 tasks correctly. Completes 6/6 tasks correctly in position analysis. Need repetition of the tasks sometimes.</th>
<th>Need to reproduce several words because some sounds are not registered by joystick. Produces sounds randomly. Is motivated and laughs. Collects sounds but can not segment the words. Cannot say if a word the researcher produce is the same as PS says. Is unwilling to carry out the tasks.</th>
<th>PhonicStick test for period 2: Segments three words with two sounds on her own (/ol/, /ok/, /ma/). Shows happiness over successfully produced words. Blends words with the right sounds but in wrong order e.g. /k/ /o/ into /ot/. Needs much repetitions of instructions.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Session 12</strong></td>
<td><strong>PA-level test 3:</strong> Segments /a/ and /l/ in the word /tall/. Repeats all words and sounds that the researcher says. The researcher says which sounds there are in a given word and then asks Blue if she can say the sounds. She says “no!”. Completes three tasks. Refuses then to continue. Chooses the Praxis cards to play with.</td>
<td><strong>PA-level test 3:</strong> Does not want to participate. Says “NO”. Listens to the researcher and says the sounds to the signs that the researcher does. Blends /tack/ and /kat/ correctly and signs the meaning of both words. Chooses PS to play with.</td>
<td><strong>PA-level test 3:</strong> Highly focused. Completes all segmentation tasks correctly. During the blending tasks she gives quick answers and completes 8/10 correctly. Needs repetition on some position analysis tasks, completes all tasks correctly. Chooses PS to play with.</td>
<td><strong>PA-level test 3:</strong> Express difficulties with the tasks. Unfocused, unwilling to carry out the tasks. Chooses actively between two sounds that are presented to produce a word. Cannot blend sounds into words. Chooses PS to play with.</td>
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