Comparative effects of two AAC systems on the vocal productions of children with motor speech disorders

by

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ABSTRACT

The aims of the study were to describe and compare the vocal productions by children with motor speech disorders (MSDs) when using a communication board versus a speech-generating device (SGD) and to determine peer perceptions regarding the amount and intelligibility of the vocal productions and augmentative and alternative communication (AAC) system-based communication produced by the children with MSDs. The first aspect was addressed by analysing data that had previously been collected from four children with MSDs, between the ages of 6;11 and 11;4 (years; months). An adapted alternating treatment design was used to collect the data. The second aspect was addressed by collecting data from peers of three of the original participants using a questionnaire with visual support (Talking Mats™ framework). The peer participants were between the ages of 8;7 and 12;5. The results of the study indicate that the rate of vocal productions per minute was variable, and that the introduction of AAC intervention did not have a clearly positive effect on vocal productions. Participants all tended to display higher rates of vocal productions during the communication board intervention condition compared to the SGD intervention condition, and differences were statistically significant for three of four participants. Results of the social validation of the study indicated that peers rated the amount and comprehensibility of the vocal productions and the AAC-mediated communication very similar for both intervention conditions. They also indicated a clear preference for the SGD. A critical evaluation of the study and recommendations for future research are provided.

Key Terms

Augmentative and alternative communication, communication board, motor speech disorders (MDSs), peers, perspectives, speech-generating device (SGD), vocal productions.

OPSOMMING

Die doelwitte van die studie was om die verbale produksie van kinders met motoriese spraakgebreke (MSG) tydens die gebruik van 'n kommunikasiebord teenoor 'n spraakuitsettoestel te beskryf en te vergelyk, en om persepsies van klasmaats jeens die hoeveelheid en verstaanbaarheid van die verbale produksie en aanvullende en alternatiewe kommunikasie- (AAK) stelsel-gebaseerde kommunikasie wat deur die kinders met motoriese spraakgebreke geproduseer word, te bepaal. Die eerste aspek is hanteer deur die ontleding van data wat voorheen versamel is van vier kinders met MSG, tussen die ouderdomme van 6;11 en 11;4 (jare; maande). 'n Aangepaste afwisselende behandelingontwerp is gebruik om die data in te samel. Die tweede aspek is hanteer deur die versameling van data van klasmaats van drie van die oorspronklike deelnemers met behulp van 'n vraelys met visuele ondersteuning ('Talking Mats™ Framework'). Die klasmaatdeelnemers was tussen die ouderdomme van 8;7 en 12;5. Die resultate van die studie dui daarop dat die hoeveelheid verbale produksie per minuut gevarieër het, en dat die instelling van AAK-intervensie nie 'n duidelike positiewe uitwerking op verbale produksie gehad het nie. Al die deelnemers het geneig om 'n groter hoeveelheid verbale produksie per minuut tydens die kommunikasiebordintervensie te toon in vergelyking met die spraakuitsettoestelintervensie, en verskille was statisties beduidend vir drie van die vier deelnemers. Die resultate van die sosiale geldigheidsverklaring van die studie het aangedui dat klasmaats die hoeveelheid en verstaanbaarheid van die verbale produksie en die AAK-bemiddelde kommunikasie soortgelyk vir beide intervensiekondisies beoordeel het. Hulle het ook 'n duidelike voorkeur vir die spraakuitsettoestel aangedui. 'n Kritiese evaluering van die studie en aanbevelings vir toekomstige navorsing word voorsien.

Sleutelwoorde

Aanvullende en alternatiewe kommunikasie, kommunikasiebord, motoriese spraakgebreke (MSG), perspektief, portuurgroep, spraakuitsettoestel, verbale produksie

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1.1 Introduction

This chapter presents the problem statement and provides the rationale for the study. All relevant terms are defined, a list the abbreviations used frequently in the text is provided and an outline of the chapters is included.

1.2 Problem statement and rationale

Communication could be described as a means of "touching other people and having our lives touched by others" (Light, 1997 p. 61). This highlights the importance of communication in order for individuals to experience fulfilled lives. Without access to communication, individuals are unable to interact or influence their environments and a world without social relationships can be a lonely and frustrating one. Persons who cannot meet all their communication needs through speech alone may benefit from augmentative and alternative communication (AAC) methods.

Motor speech disorders (MSDs), such as dysarthria and childhood apraxia of speech (CAS), can be either developmental or acquired in nature. In children with disabilities it is estimated that 5% have MSDs (Communication Sciences and Disorders, 2006). MSDs are caused by neurological impairments affecting the planning, programming or execution of the movements required for speech and thus result in unintelligible or delayed speech production. Children with MSDs often experience difficulties communicating adequately with others through speech (Solomon-Rice & Soto, 2014) and may therefore benefit from AAC to aid the communication process. However, some parents are reluctant to introduce AAC, as they are concerned that AAC will inhibit their child's speech development (Romski & Sevcik, 2005).

The role of AAC is to supplement the child's current communication methods and to replace non-functional methods, such as unintelligible speech (Oomen & McCarthy, 2014). AAC and speech development should be targeted in parallel rather than as alternatives (Oomen & McCarthy, 2014) but little research has been undertaken into investigating the effect of AAC

on the vocal productions of children who have MSDs and even fewer studies exist that investigate whether there is a differential effect of speech-generating devices (SGDs) versus non-electronic systems on vocal productions. It is therefore important to conduct additional research to investigate the effect of AAC on vocal productions in children (Hart & Banda, 2010; Millar, Light, & Schlosser, 2006; Oomen & McCarthy, 2014; Schlosser & Wendt, 2008).

Another area requiring additional research is that of the subjective benefits of different AAC systems as perceived by the communication partners of the person using AAC because they are important consumers of the intervention (Schlosser, 1999). Their perceptions regarding the benefits of intervention can provide social validation of the strategies and techniques used. In the classroom environment a child's predominant communication partners are his/her peers, yet research has shown that children seldom use their AAC systems in the classroom to communicate with peers and rather use AAC to interact with adult communication partners (Lilienfeld & Alant, 2005). One reason why children do not use AAC to communicate may be a peer's perception of AAC. A peer's perception has the potential to encourage or inhibit interactions with the child using AAC and it is therefore important to determine the perspectives of peers regarding AAC (Lilienfeld & Alant, 2002).

1.3 Definition of key terms

1.3.1 Augmentative and alternative communication

Augmentative and alternative communication includes any form of communication used to supplement or replace oral speech that is not functional (ASHA, 2015).

1.3.2 Augmentative and alternative communication system

An AAC system typically consists of aided and/or unaided methods of communication and includes the strategies, techniques and devices used to communicate (Lloyd, Fuller, & Arvidson, 1997). An aided AAC system requires an aid external to the person's physical body (Tönsing, Alant, & Lloyd, 2005).

1.3.3 Communication board

A communication board is a board with orthographic or picture symbols that children

with communication difficulties can point to, gesture to or gaze at in order to communicate their thoughts (Logsdon, 2014). In the current study a communication board refers to a small laminated piece of paper with 10 picture communication symbols (PCS) printed on it. The symbols are arranged in a Fitzgerald key layout.

1.3.4 Speech-generating device

An SGD, otherwise known as a voice output communication aid (VOCA), is an electronic communication device used by people who have difficulty communicating verbally. The device is able to produce a previously recorded or synthetic spoken message (Rispoli, Franco, van der Meer, Lang, & Camargo, 2010, p. 277)

1.3.5 Motor speech disorders

This refers to a group of disorders as a result of neurological impairment affecting the movements of the muscles required for speech production (Communication Sciences and Disorders, 2006).

1.3.6 Participant

In the current study a participant is defined as a child with an MSDs who was a participant in the study previously conducted by Tönsing (2015) and whose vocal productions were measured.

1.3.7 Peer participant

In the current study a peer participant refers to a peer of one of the original participants used in the Tönsing (2015) study. Peer participants participated in the social validation aspect of the current study.

1.3.8 System for Analysing Language Transcripts software program

The System for Analysing Language Transcripts (SALT) program (Miller & Iglesias, 2012) is designed to transcribe and analyse language samples. The program provides specific transcription codes that can be used to analyse the language sample. Conventions are provided for speech approximations, vocalisations and many more aspects (see Appendix A).

1.3.9 Talking Mats™ framework

The Talking Mats™ framework is a low-technology communication system that helps people with communication difficulties to express their views (Murphy & Cameron, 2008). The framework uses pictures pertaining to topics and options to be explored, as well as a visual scale that allows people with communication difficulties to express their perspective regarding each topic.

1.3.10 Vocal productions

In the current study, the term vocal productions describes a word or sound intentionally produced by the voice for the purpose of communication. This includes the production of spoken words, word approximations and vocalisations. Vocally produced sound effects were excluded from vocal productions in this study, as were all sounds that were not primarily intentionally communicative (e.g. laughing, sneezing, coughing).

1.3.11 Spoken word

For this study, a spoken word describes a word produced with the standard phonology of South African English.

1.3.12 Word approximation

For the current study, this describes a vocal production containing a vowel and one or more consonants (or a developmentally appropriate substitute matching the consonant placement) of the target word (e.g. “tum” for “thumb”) (Brady, Thiemann-Bourque, Fleming, & Matthews, 2013) in the correct order. The target word needed to be clearly identifiable from the context (e.g. from the storyline, the child’s pointing or gaze).

1.3.13 Vocalisation

For the current study, a vocalisation is defined as a vocal production that deviates from the standard phonology of any possible target spoken word as inferred by the context in such a way that it contains fewer than one vowel and one consonant sound or a developmentally appropriate substitute matching the consonant placement that is the same as the target word.

1.4 Abbreviations

AAC	-	Augmentative and Alternative Communication
CAS	-	Childhood Apraxia of Speech
CP	-	Cerebral Palsy
MSDs	-	Motor Speech Disorders
PDD-NOS	-	Pervasive Developmental Disorder Not Otherwise Specified
PECS	-	Picture Exchange Communication System
PND	-	Percentage of Non-overlapping Data
SALT	-	Systematic Analysis of Language Transcripts
SGD	-	Speech-generating Device
VI	-	Velopharyngeal Insufficiency
VOCA	-	Voice Output Communication Aid

1.5 Outline of chapters

Chapter 1 provides an introduction to the study and a rationale for why this study was necessary.

Chapter 2 provides an introduction to speech development and its importance in communication. It highlights the communication difficulties faced by children with MSDs and discusses the importance of the use of AAC with these children. The chapter then provides an overview of the literature examining research on the effects of concomitant effects of AAC on vocal productions in children with developmental disabilities. Finally, the gap in current research is highlighted and the importance of the current study is pointed out.

Chapter 3 describes the methodology of the study. As this study targeted two aspects (vocal productions of children who were introduced to two different AAC systems as well as peer perceptions), the methodology reports on both the methods used to gather and analyse data on children's vocal productions and the methods used to gather and analyse data regarding peer perceptions.

Chapter 4 presents the results of the study. Rates of vocal productions per minute are

graphed per participant per session across baseline and intervention phases of the two conditions (communication board vs. SGD). The rate per minute for each of the vocal production types (including vocalisations, word approximations and spoken words) across the baseline and intervention phases are also provided for each condition (both per session as well as means and standard deviations for each phase for each condition).

Chapter 5 discusses the results of the study in relation to the literature and also highlights the relevant contribution to the field of AAC.

Chapter 6 provides a summary of the study, as well as the clinical implications, limitations and recommendations for future research.

1.6 Summary

This chapter highlighted the importance of the current study and provided the rationale for why it should be conducted. It also provided a definition of the key terms that will appear in the following chapters and provided the relevant abbreviations, as well as an overview of the subsequent chapters.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Communication is broadly defined as the giving or receiving of messages from one person to another (Romski & Sevcik, 2005), and speech is the most common mode used for face-to-face communication (Millar et al., 2006). For children with MSDs, spoken communication with others can be difficult as a result of neurological impairments and without adequate access to speech, individuals become limited in their participation in various aspects of life (Beukelman & Mirenda, 2005). AAC is one method that can be used to bridge the communication gap for these individuals. AAC can be used to supplement oral speech or substitute speech that is not functional (ASHA, 2015). The purpose is not to replace the child's attempts at speech production or discourage speech development, yet parents often voice concern about the possible negative influence of AAC on speech development (Romski & Sevcik, 2005), and more broadly on the development of vocal productions. This chapter will review the relevant literature on vocal productions in children and discuss the terminology used in the field. It will then provide an overview of MSDs and the consequences for speech development. It will discuss AAC and the effect of various AAC systems on the vocal productions of children with disabilities, as well as the use of social validation in research to obtain stakeholder perspectives of empirically measured effects.

2.2 Vocal productions in children

During the first year of life infants exhibit various vocal productions, which are important speech and language milestones, as they have been shown to influence later meaningful speech production (Highman, Hennessey, Sherwood, & Leitão, 2008) and language development (Morris, 2010). Reflexive phonation, cooing, expansion, canonical babbling and meaningful speech are the five stages of vocal development that all typically developing infants progress through (Kuhl & Meltzoff, 1996). Reflexive phonation includes reflexive sounds such as coughing and crying; cooing occurs when the infant produces quasi-vocalic vowel-like sounds; expansion is the production of clear vowels; canonical babbling includes consonant-vowel syllables and in meaningful speech the infant combines babbling with intelligible words. These

vocal productions change as a child matures and this change can be attributed to two things: anatomical change and vocal learning (Kuhl & Meltzoff). As children grow, their vocal tracts develop to something more closely resembling an adult's vocal tract and this change allows for increased motor skill of the articulators. The second factor playing a role in the change in vocal productions is vocal learning and imitation. Imitation is the phase when the child acquires specific sound patterns or words by hearing speech produced by others and then attempts to produce and match his/her own production to what was heard. By the age of one year, children produce single words and thereafter continue combining these words until they begin forming sentences. Although this progression is universal, the organisation of infants' phonological system is strongly influenced by their language environment (Goldstein & Schwade, 2008). Research has shown that auditory feedback from hearing language spoken by others in the environment, as well as from hearing their own vocalisations, contributes to a child's speech development (Kuhl & Meltzoff, 1996).

Currently much overlap exists in the use of various terms to describe the vocal productions of children. The term babbling is frequently used as an umbrella term to describe the vocal productions of infants (from the reflexive phonation stage to the meaningful speech stage). The term vocalisation has been used to describe the productions of both typically developing children as well as children with disabilities, and is widely used among researchers (Brady et al., 2013; Pennington, 2008; Carr & Felce, 2006). Verbalisation is another term used frequently to describe more intelligible vocal productions of children with disabilities (Charlop-Christy, Carpenter, Le, LeBlanc & Kellet, 2002). Phonetically consistent forms, speech approximations or word approximations generally describe productions that differ phonetically from the adult form, yet are recognisable (from their phonetic properties and/or the context) as attempts to produce a specific target word (e.g. Brady et al., 2013; Ganz, Simpson, & Corbin-Newsome, 2008; Tincani, Crozier, & Alazette, 2006). Lastly, speech has been described as sounds produced by the vocal tract that are recognisable words (Pennington, 2008). As the definitions tend to vary among researchers and there is no standard definition for each term, this can lead to confusion when reviewing the literature on AAC and vocal productions. For the current study, the term vocal productions will be used to encompass all the above terms. For definitions of different types of vocal productions measured in this study, please see page 4.

2.3 Motor speech disorders in children

Children with MSDs, such as dysarthria and apraxia, have impairments that affect the movement of the muscles required for speech production. The type and severity of the disorder will vary depending on which area of the nervous system is affected (ASHA, 2015). It is estimated that 5% of children with developmental disabilities have MSDs; however, definite estimates are difficult to ascertain (Communication Sciences & Disorders, 2006). MSDs are commonly associated with diagnoses such as cerebral palsy (CP) and childhood apraxia of speech (CAS) and result in unintelligible speech and delays in speech production. CP is a disorder of movement and posture as a result of a non-progressive disturbance to the brain (Blair & Watson, 2006; Bax et al., 2005). Statistics indicate that in 2004 the prevalence of CP was above two to three per 1000 live births in the USA (Prevalence of Cerebral Palsy, 2015). CAS, on the other hand, has a lower prevalence of one to two children per 1000 (ASHA, 2015) and is defined as a disorder by which the sequencing of speech sounds is severely affected (Highman et al., 2013).

As CP and CAS are developmental in nature, some of their characteristics are observable from infancy. The late onset of babbling or absence of babbling may be an early indicator of neurogenic disorders such as apraxia and dysarthria (Oller, Eilers, Neal & Cobo-Lewis, 1998). Anecdotal reports suggest that children with CAS and CP exhibit reduced babbling as well as a reduced range of vocalisation patterns (Highman et al., 2008). Children with CAS also present with co-occurring language difficulties, consequently placing them at risk of later academic difficulties. Especially the areas of reading and spelling are at risk, because children with CAS may have difficulty with speech sound analysis and synthesis skills as a result of the speech difficulties they experience (Lewis, Freebairn, Hansen, Iyengar, & Taylor, 2004). In a study investigating the speech, language and written skills of children with CAS, children were followed for two years, from preschool to primary school, and results indicated that although some improvements were seen in articulation skills, the children continued to have difficulty with language, reading and spelling skills (Lewis et al., 2004).

Furthermore, as a result of motor disturbances, children with MSDs can be restricted in their use of speech, gesture and facial expressions, consequently placing them at risk of

communication difficulties and social interaction difficulties. Communication difficulties have been observed in approximately 42% of children with CP (Parkes, cited in Pennington, Goldbart, & Marshall, 2011). Although such difficulties are so prevalent in children with CP, the exact nature of the problem has never been systematically studied or classified (Hustad, Gorton & Lee, 2010) and very little longitudinal research has been done investigating the social functioning and communication of these individuals (Voorman, Dallmeijer, Van Eck, Schuengel & Becher, 2009). Voorman et al. (2009) conducted a study that observed 110 children with CP over a three-year period. The results indicated an increase in restrictions of social functioning and communication in children as they got older and the researchers attributed these restrictions to a combination of disease characteristics, personal factors and environmental factors.

Such limited research indicates a need for additional investigations into the speech characteristics and development of children with MSDs. Since these disorders primarily affect the planning or execution of the movements required for speech production, future research should specifically examine the use of AAC and vocal productions in children with MSDs.

2.4 Augmentative and alternative communication

Communication could be described as a means of "touching other people and having our lives touched by others" (Light, 1997, p. 61). Communication is necessary in order for individuals to experience fulfilled lives. Without access to speech, many individuals become limited in their participation in various aspects of life such as family, community, education and hobbies (Beukelman & Mirenda, 2005). For children who struggle to communicate verbally with others, additional or alternative communication methods are therefore required. AAC can be used to supplement oral speech or substitute speech that is not functional (ASHA, 2015). It is important for the type of AAC system to be appropriately matched to the individual in order to optimise the communication interaction. AAC options include either aided or unaided systems. Aided AAC systems can then be further divided into non-electronic systems (e.g. communication boards) or electronic systems including electronics and computer technologies (Wilkinson & Hennig, 2007). Questions have been raised about the effect of AAC on a child's vocal productions and subsequent speech development. Since speech is seen as the most effective and

accepted mode for face-to-face interaction (Millar et al., 2006), it is important to address these questions.

2.5 The effect of AAC on vocal productions in children

When deciding about which type of AAC option to use in intervention or whether to introduce AAC at all, it is important to have empirical evidence upon which to base such decisions. Many parents are concerned about the possible negative effects on vocal productions for their child if AAC or certain types of AAC are introduced as an intervention method. They believe that children with disabilities may rely on AAC rather than being challenged to develop speech and that if children prefer to use AAC to communicate, they will not be motivated to learn to use speech (Millar et al., 2006).

In contrast, Blischak, Lombardino and Dyson (2003) propose various factors inherent in some or all AAC systems, which may provide a rationale for why AAC systems may actually enhance vocal productions. A reduction in physical demands and a reduction in pressure to speak are two of the possible factors. With AAC, individuals learn to use an alternative physical movement to communicate. This will allow the person to bypass physical and cognitive demands imposed by speech and focus on learning to communicate efficiently. Once automaticity in AAC has been achieved, reallocation of resources towards speech production may occur. Secondly, reducing the emotional pressure to speak for individuals with MSDs (by using an AAC system) may in turn reduce physical pressure on all the systems required for speech, thus indirectly benefiting natural vocal productions. Although the main goal of AAC intervention is to improve the child's communication, not specifically to improve vocal productions, its effect on vocal productions still needs to be investigated in order to gain evidence to guide the clinical decision-making process in AAC (Schlosser & Wendt, 2008).

Millar et al. (2006) conducted a review of studies published between 1975 and 2003 that investigated the effect of AAC systems on the speech production of individuals with developmental disabilities. Speech production was defined as the oral expression of language and included oral production of intelligible words or word approximations understood in context. Electronic searches, hand searches and a list of journals were used to find the 23 studies that met

the inclusion criteria. Sixty-seven participants took part in these studies. The participants were between 1 and 60 years old; 40% of them had cognitive impairment, 31% had autism, one participant had CP, five had dysarthria and/or apraxia, and the remaining participants had other disabilities or the diagnoses of participants were described for groups rather than individual children and were therefore difficult to aggregate. The majority of the studies in the review reported modest gains in speech production; however, five participants showed a decrease in speech production upon the introduction of AAC. Specifically regarding the study involving children with MSDs, two participants were reported to have increased their speech production and two participants decreased their speech production upon introduction of aided AAC without voice output, whereas four participants increased their speech production and one participant decreased speech production upon introduction of AAC with voice output (Blischak, 1999). Unfortunately this study failed to establish experimental control along with 16 other studies and the results were not analysed further. The remaining six studies were reported on in more detail although the lack of data on treatment integrity limited the internal validity of these studies. In the six studies included in the review, there were a total of 17 participants, of which four had autism and 13 had cognitive impairment, Down's syndrome or developmental delay. Five of the studies investigated the effects of unaided AAC interventions and the last study investigated the effect of aided AAC without a speech output feature on speech production. The results of this review indicated increases in speech production in 89% of cases and no decreases in the remaining 11% of cases. In 37% of the studies the percentage of non-overlapping data (PND) was at least 90, indicating that the AAC interventions were highly effective in increasing vocal productions. One study in the review reported that the participants had limited speech repertoires to begin with and their speech gains were 4-10 times greater after AAC intervention (Kouri, as cited in Millar et al., 2006).

Other reviews have been conducted after Millar et al.'s (2006) review. One systematic review, conducted by Schlosser and Wendt (2008), searched for studies published between 1975 and 2007, which aimed at determining the effects of AAC intervention on vocal productions in children with autism. The single-subject studies included 27 participants and the group designs included 98 participants. The results of the review indicated that none of the studies reported a decline in speech production as a result of AAC intervention and that most studies found a

modest increase in vocal productions for most participants. A second narrative review conducted by Schlosser and Sigafoos (2006) aimed to synthesise comparative AAC intervention studies using single-subject experimental designs; however, this review did not specifically aim to investigate the comparative effects on vocal productions. Forty-five studies were identified through the search and were discussed according to their comparison of non-electronic systems versus SGDs; picture exchange systems and SGDs versus manual signs; AAC systems versus speech-language interventions. Only two studies in this review specifically compared the effects of SGDs on vocal productions (Parsons & La Sorte, as cited in Schlosser & Sigafoos, 2006; Sigafoos, Didden & O'Reilly, 2003). The results indicated that one study found that computer-based instruction with voice output resulted in greater spontaneous speech production in participants compared to instruction without voice output (Parsons & La Sorte, as cited in Schlosser & Sigafoos, 2006). The other study found no differences in vocalisations for SGD use with or without voice output (Sigafoos, Didden & O'Reilly, 2003). A third review conducted by Gevarter et al. (2013) compared communication systems for individuals with developmental disabilities. Again, this review did not specifically investigate the effects on vocal productions. Twenty-eight studies involving 77 participants were included in this review. The studies relevant to this literature search were the 10 that compared non-electronic picture systems to SGDs and of those studies, only two indirectly measured effects on vocal productions. The results of one study (Beck et al., 2008) regarding vocal responses were inconclusive; however, another study (Boesch et al., 2011) found that SGDs improved or maintained the percentage of spontaneous intelligible speech better than the use of a picture exchange communication system (PECS). Although each of these reviews summarised important information on the effects of AAC on vocal productions, no systematic search of the literature has been conducted (since the one conducted by Millar et al., 2006) to identify studies specifically measuring the effect of aided AAC on vocal productions in children with disabilities in general. For this reason, a systematic search was done to identify such studies.

2.5.1 Search terms and strategy

A systematic search was conducted to find more recent studies (2004-2015) that documented the use of AAC and vocal productions not included in the aforementioned systematic review (Millar et al., 2006). The search terms used are provided in Figure 2.1.

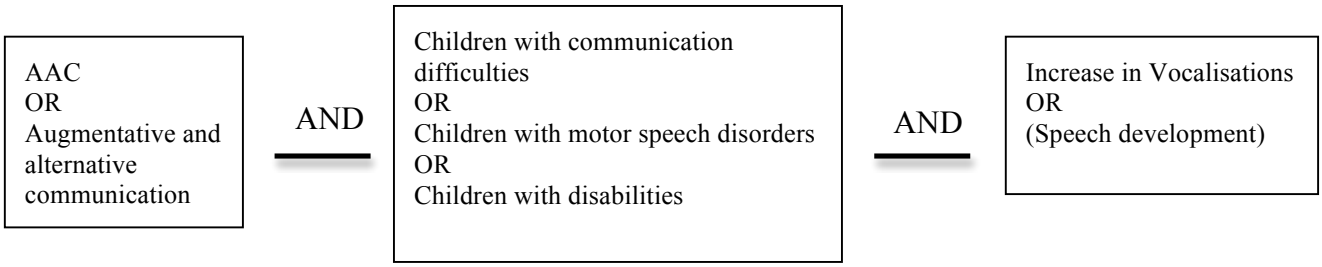

Figure 2.1. Search parameters

These search terms were entered into 10 databases (see Figure 2.2) resulting in 32 hits. An additional 22 records were identified through a hand search. Duplicated records were then removed, resulting in a total of 50 articles. One further record was omitted, since it was a PhD thesis, the results of which were reported in an article that was included in the review. The remaining records were screened for relevance according to the following criteria: a) studies including children with disabilities, b) studies conducted between 2004 and 2015, c) studies reporting original research, and d) studies reporting empirical evidence regarding the effect of aided AAC on vocal productions. Thirty-four articles did not comply with all the criteria and were therefore not analysed further. One article (Binger, Berens, Kent-Walsh & Taylor, 2008) reported data on vocalisations of participants from two separate studies. The original studies were therefore included, although the data on vocalisations was taken from Binger et al. (2008). The PRISMA diagram in Figure 2.2 (see overleaf) graphically depicts the process.

A total of 17 studies were included in the review. These studies are summarised in Tables 2.1 – 2.3. The studies are grouped into (1) those investigating the effect of non-electronic AAC systems (with or without comparisons to unaided AAC or other non-AAC interventions) on vocal productions, (2) those investigating the effect of SGDs (with or without comparisons to unaided AAC or other non-AAC interventions) on vocal productions, and (3) those comparing the effect of non-electronic-aided AAC systems versus SGDs on vocal productions or comparing the effect of an SGD with and without voice output on vocal productions. In one study (Binger et al., 2008), two participants used SGDs and another a communication board. The results for these participants were thus separated and discussed in Tables 2.1 and 2.2 respectively.

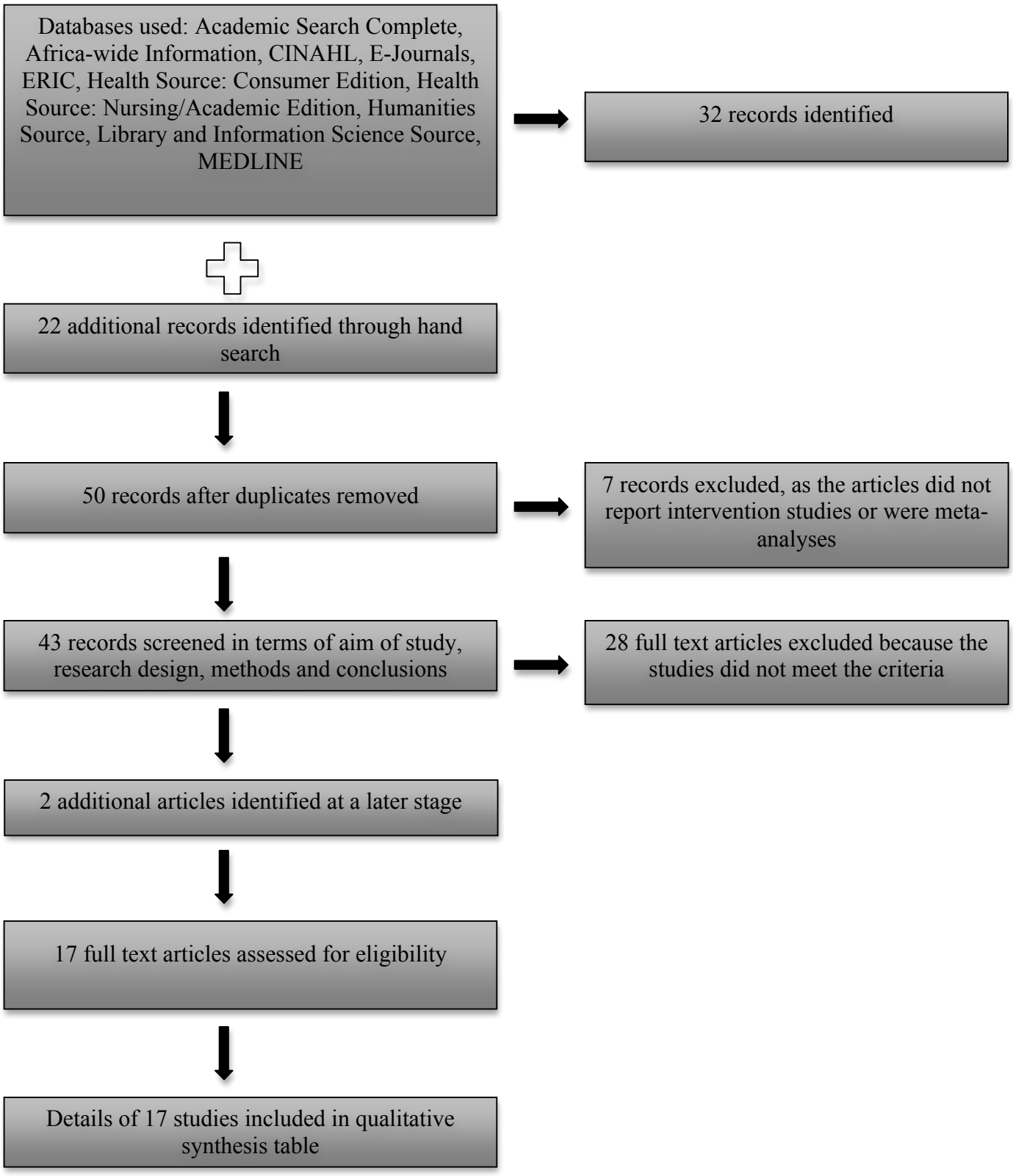

Figure 2.2. Selection process for studies included in the systematic literature search

Table 2.1

Studies investigating the effects of non-electronic AAC (with or without comparisons to unaided AAC or other on-AAC interventions) on vocal productions

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
1	Binger et al. (2008)	To determine the effects of a caregiver instructional programme on the multi-symbol utterance production of Latino children who used AAC.	Single-case multiple probe across participants	One child 3 years old with velocardiofacial syndrome, velo-pharyngeal insufficiency and suspected CAS (two further children received intervention involving SGDs – see Table 2.2)	IV: Prompting strategy during book reading to encourage communication board use DV: Multi-symbol utterances Concomitant measures on syllables vocalised were reported in Binger, Berens and Kent-Walsh (2008)	Syllables vocalised (not specified further)	There were no significant differences between number of syllables vocalised during baseline and intervention and results were regarded as evidence that AAC use did not have negative effects on speech.
2	Carr & Felce (2006)	To evaluate the effect of implementing the early stages of PECS on spoken word production.	Pretest-posttest control group design	41 children with autism 3-7 years old	IV: Early stages of PECS DV: Spoken word production	Spoken words were defined as production of a specific word to communicate. Vocalisations were defined as any discrete or non-continuous vocalisation while looking at an adult.	Children who received PECS intervention showed significant increases in the total spoken words and vocalisations compared to children in the control group.

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
3	Ganz, Heath, Rispoli, & Earles-Vollrath (2010)	To compare the effects of PECS with a verbal modelling intervention on four communicative behaviours.	Single-case multi-treatment/ multi-measure design	One boy with autism 3 years old	IV: PECS and verbal modelling intervention approaches DV: Picture requests, imitated verbalisations, picture discrimination and any related speech.	Imitated verbalisations were defined as imitation of the name of an item or a verbal approximation (at least one vowel-consonant combination from the word). Related speech was defined as any words or word approximations that were independently produced.	No change in imitated verbalisations was noted. Small increases in related speech for the PECS and verbal modelling phases.
4	Ganz & Simpson (2004)	To evaluate the utility of PECS in promoting word utterances and functional communication skills in children with ASD.	Single-case changing criteria design	One child with autism and two children with developmental delay, autism-like characteristics and specific language impairment 3-7 years old	IV: PECS phases I-IV DV: Word utterances and functional communication skills	Intelligible words (not defined further). Word vocalisation was defined as any vocalisation the observers could recognise as an intelligible word.	Results indicated that word utterances increased in mean number of words and one child showed an increase in grammar complexity of his word utterances.

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
5	Ganz et al. (2008)	To investigate the efficacy and impact of PECS on vocal communication among three pre-schoolers with ASD.	Single-case multiple baseline design across participants	Three preschool aged children diagnosed with autism.	IV: PECS phases I-IV DV: Intelligible words, word approximations and vocalisations	Intelligible words (not defined further). Word approximations were defined as any utterance that did not exactly match the words verbally modelled during the exchange but did have at minimum of one consonant and one vowel in common with the modelled word.	One participant showed a slight increase in the number of intelligible words used at the end of phase 3 and 4 of PECS training, but he used few word approximations and vocalisations during the training. Another participant began using intelligible words and word approximations but these were very few. The last participant showed no difference in expressive speech.
6	Kravits, Kamps, Kemmerer & Potucek (2002)	To examine the effect of PECS on the spontaneous communication skills of a girl with autism.	Single-case multiple baseline design across settings	One girl with autism 6 years old	IV: PECS phases I-III DV: Spontaneous communication skills (requests, comments, expansions)	Words and word approximations were not further defined.	Results indicated that vocal productions increased independently from use of picture symbols and in conjunction with the use of picture symbols in both environments.
7	Tincani (2004)	To compare the effects of PECS and sign language training on the acquisition of mands and to examine the differential effects of each modality on vocal behaviour.	Single-case alternating treatment design	Two children with autism 5-6 years old	IV: PECS phases I-III and sign language training DV: Mands and vocalisations	A word vocalization was defined as the correct production of the item's name.	PECS training and sign language training caused vocal productions to increase significantly for both participants but sign language training produced a higher percentage of word vocalisation for both participants.

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
8	Tincani et al. (2006) Study 1	To examine the effect of PECS on manding and speech development of school-aged children with autism.	Delayed multiple baseline design across PECS phases	Two boys with autism 10-11 years old	IV: PECS phases I-IV DV: Mands and vocal approximations	A word vocalisation was defined as the participant clearly producing the correct name of the item he was manding. A vocal approximation was defined as the participant emitting a vocalisation that was not clearly the name of the manded item.	Increases in vocal approximations during the last PECS phase.
9	Tincani et al. (2006) Study 2	To examine the effect of PECS on manding and speech development of school-aged children with autism.	ABAB design.	Two boys with autism 10-11 years old (the same participants as those who took part in Study 1)	IV: PECS phases I-IV DV: Mands and vocal approximations	A word vocalisation was defined as the participant clearly producing the correct name of the item he was manding. A vocal approximation was defined as the participant emitting a vocalisation that was not clearly the name of the manded item.	Significant increase in vocal approximations

Table 2.2

Studies investigating the effects of SGDs (with or without comparisons to unaided AAC or other non-AAC interventions) on vocal productions

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
10	Bellon-Harn & Harn (2008)	To extend the application of scaffolding strategies during repeated	Single-case multi-element design (adapted	One girl with developmental delay and moderate-severe cognitive	IV: Two intervention conditions 1. RSR with scaffolding and 2. RSR with scaffolding and SGD	Language and speech samples (not defined further) Speech samples were measured according to use of initial and final consonants.	Overall number of spoken utterances was greater during SGD condition. Increases in

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
		storybook reading (RSR) to intervention using AAC with a child with severe impairments.	alternating treatment design without a baseline phase)	impairment. 6 years old	DV: Language and speech samples		phonological complexity of words were noted in both contexts.
11	Binger et al. (2008)	To determine the effects of a caregiver instructional programme on the multi-symbol utterance productions of Latino children who used AAC.	Single-case multiple probe across participants	Two children 2-4 years old with diagnoses of (1) profound phonological disorder; and (2) subpalatal cleft and velopharyngeal insufficiency (VI) (one other child received intervention involving a communication board – see Table 2.1)	IV: Prompting strategy during book reading to encourage SGD use DV: Multi-symbol utterances Concomitant measures on syllables vocalised were reported in Binger, Berens and Kent-Walsh (2008)	Syllables vocalised (not specified further)	There were no significant differences between number of syllables vocalised during baseline and intervention and results were regarded as evidence that AAC use did not have negative effects on speech.
12	Binger, Kent-Walsh, Ewing & Taylor (2010)	To determine the effects of an instructional programme for educational assistants on the multi-symbol utterance productions of children who used AAC	Single-case multiple probe across participants	Three children aged 4;6 to 6;4 , with diagnoses of (1) developmental disability (DD), (2) DD and suspected CAS, and (3) CP and dysarthria	IV: Prompting strategy during book reading to encourage SGD use DV: Multi-symbol utterances Concomitant measures on syllables vocalised were reported in Binger, Berens and Kent-Walsh (2008)	Syllables vocalised (not specified further)	There were no significant differences between number of syllables vocalised during baseline and intervention and results were regarded as evidence that AAC use did not have negative effects on speech.

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
13	King, Hengst & DeThorne (2013)	To examine the effects of integrated multimodal intervention (IMI) that incorporated SGD use on increasing quality of natural speech production.	Single-case multiple probe design across participants	Three children with severe speech sound disorders 4-9 years old	IV: IMI and SGD DV: Word level productions of target speech sounds	Target words consisted of the participant's target speech sound and the participant's control speech sound.	More accurate production of treatment words. Increases in total amount of natural speech for all participants.
14	Neeley, Pulliam, Catt & McDaniel (2015)	To investigate the initial and renewed impact of SGDs on expressive communication behaviours of a child with ASD.	Retro-spective case study design	One child with autism 4-10 years old	IV: SGD communication DV: communication behaviours, including natural verbalisations	Natural verbalisations (not defined further) were categorised as either a functional word or a representational word. Functional words were defined as words pronounced with adequate accuracy to be intelligible. Representational words were defined as abbreviated natural verbalisation with enough phonological structure to be defined as representing a word.	Results indicated an increase in percentage of natural verbalisation, an increase in the number of different natural verbalisations and an increase in the production of functional verbalisation over the 6-year period.
15	Thunberg, Sandberg & Ahlsén (2009)	To focus on the use of SGDs in the home environment.	Single-case A-B design	Three children with autism 5-7½ years old	IV: Introduction of SGD into home routines DV: Child's engagement, role in turn-taking, communication mode (including vocalisations and speech) and communication effectiveness.	A vocalisation was defined as a sound or sequence of sounds not intelligible to the coder as a spoken word. Speech was defined as a sound sequence that is understood by the coder to be a word/phrase.	Results indicated an increase in speech production when the SGD was introduced and a decrease in pre-linguistic forms for two participants. One participant showed an increase in both intelligible and unintelligible

No.	Authors	Aim	Design	Participants	Dependent variable (DV) and independent variable (IV)	Vocal production definition for the study	Author's conclusions regarding vocal productions
							vocal productions when the SGD was introduced.

Table 2.3

Studies comparing the effects of non-electronic aided AAC systems with SGDs or comparing an SGD with and without voice output on vocal productions

No.	Authors	Aim	Design	Participants	Dependent Variable (DV) & Independent Variable (IV)	Vocal Production definition for the study	Author's conclusions regarding vocal productions
16	Beck, Stoner & Bock (2008)	To determine the influence of PECS and VOCAs on verbalisations	Single-case alternating treatment design	Four preschool aged children with little to no functional speech. Two children were diagnosed with autism, one child was diagnosed with PDD-NOS and one child was diagnosed with specific language impairment with symptoms of apraxia.	IV: PECS phases I-III and an SGD DV: Verbalisations	Vocalisations and verbalisations (not specified further) were recorded.	Since the study did not include a baseline phase, only the trends observed during the two intervention conditions could be reported. One participant showed a decrease in verbalisation for both conditions. One participant showed an advantage of VOCA over PECS on verbalisations. One participant showed an advantage of PECS over VOCA for the number of verbalisations but showed an advantage of VOCA over PECS for the increase in the percentage of intelligible verbalisations. His complexity of verbalisation increased more for the VOCA condition compared

No.	Authors	Aim	Design	Participants	Dependent Variable (DV) & Independent Variable (IV)	Vocal Production definition for the study	Author's conclusions regarding vocal productions
							to the PECS condition. The final participant also showed mixed effects for both conditions. Her mean utterances per session increased for the PECS condition but decreased for the VOCA condition but the mean percentage of intelligible verbalisations increased in the VOCA condition but remained the same for the PECS condition.
17	Boesch, Wendt, Subrama-nian & Hsu (2013)	To compare the effect of the PECS protocol and an SGD on social-communicative behaviour and natural speech.	Single-case, multiple baseline design with embedded alternating treatment design	Three children with severe autism 6-10 years old	IV: Modified PECS protocol and SGD DV: Social-communicative behaviour and speech production.	Speech production was defined as the participant producing verbalisation intended to transmit a meaningful communicative message.	Overall, speech emergence was lacking for all participants in all conditions.
18	Schlosser et al. (2006)	To evaluate whether children with autism learn to request more efficiently when provided with an SGD using speech output rather than an SGD without speech output and to monitor natural speech	Single-case adapted alternating treatment design	Five children with autism 8-10 years old	IV: Two SGDs - one with speech output and one without speech output feature DV: Requesting and natural speech production	A correct vocalisation was defined as a vocalisation that approximated or matched the spoken equivalent of an object.	Only one participant showed a slight increase in the elicited vocalisations during the non-speech condition and there was no change in vocalisations for the speech condition. There were no changes in elicited vocalisations for the other four participants for both conditions.

No.	Authors	Aim	Design	Participants	Dependent Variable (DV) & Independent Variable (IV)	Vocal Production definition for the study	Author's conclusions regarding vocal productions
		production.					

2.6 Synthesis of studies found

Of the studies listed in the table above, nine reported on the effects of non-electronic AAC on vocal productions, six reported on the effects of SGDs on vocal productions and three were comparative studies, specifically comparing the effects of non-electronic-aided AAC systems with SGDs or comparing an SGD with and without voice output. With regard to design, one study made use of a retrospective case study design, one study made use of a group design (pre-test post-test) and 15 studies made use of a single-case design. Of these single-case designs, three were multiple probe designs, three were multiple baseline designs, two studies used an alternating treatment design, one study used an adapted alternating treatment design, one study used a combined multiple baseline alternating treatment design, one study used an A-B design, one study used an ABAB design, one used a multi-treatment/multi-measure design, one study used a multi-element design and one used a changing criteria design. While a quality appraisal of the studies is beyond the scope of this literature review, it is important to note that, judging by design type alone, variations are evident in the degree of experimental control that could be achieved in each of these studies. Regarding single-case designs, multiple baseline designs can provide the strongest evidence, followed by multiple probe and adapted alternating treatment designs. Alternating treatment designs and ABAB designs rank lower. A-B designs and case studies are regarded as pre-experimental (Schlosser & Raghavendra, 2004).

There were 79 participants in the 17 studies. Of these, 66 had autism or pervasive developmental disorder not otherwise specified (PDD-NOS), five participants had developmental delay and concomitant difficulties (one of which had suspected CAS), four participants had severe speech sound or phonological disorders, two had VI associated with a cleft palate or a syndrome (one of these also had suspected CAS), one had CP and dysarthria and one participant was diagnosed with specific language impairment and exhibited symptoms of apraxia. Of all the participants in the above studies, four had an MSD or suspected MSD (Beck et al., 2008; Binger et al., 2008; Binger et al., 2010). This indicates a significant gap in the literature investigating the effect of AAC on vocal productions in children with MSDs.

From the table it is clear that a variety of vocal productions (i.e. not only speech or spoken words) were measured as independent variables. While intelligible speech is certainly the

ultimate 'good outcome', it is important to investigate other vocal productions as well, as, developmentally, they may be regarded as precursors of speech. It is therefore encouraging that authors did not concentrate only on speech. It is further evident that the results regarding the effect of AAC on vocal productions are mixed. A total of 64 participants showed increases in the number of vocal productions or in the quality of vocal productions, 14 participants showed no difference or no increases in vocal productions as a result of AAC intervention, and one participant showed a decrease in vocal productions as a result of AAC intervention. In order to understand the differential effects of non-electronic versus electronic AAC systems on vocal productions, the three groups of studies (those making use of non-electronic AAC, those using SGDs and those comparing the two) will now be discussed.

2.6.1 The effect of non-electronic AAC systems on vocal productions

Unlike SGDs, non-electronic AAC systems do not have audible voice output. However, when training a child in the use of picture symbols, augmented input strategies such as aided language stimulation (Dada & Alant, 2009; Goossens, 1989) entail speaking the word and pointing to the picture symbol at the same time. Thus the child is still exposed to a spoken word model with the added visual input. The use of such strategies (AAC and speech modelling) has been shown to facilitate speech development more than the use of speech-only intervention (Cress & Marvin, 2009). The absence of speech output from the AAC system may also encourage the person using AAC to use vocal productions in conjunction with the AAC system when communicating in order to avoid communication breakdowns, which may occur if their partner cannot see or interpret the picture symbol and/or gloss to which the person is pointing. Eight studies included in Table 2.1 used non-electronic AAC systems in their intervention approach.

There were 54 participants across all nine studies. Fifty-one participants had autism and two participants had developmental delay. One had VI and suspected CAS. Eight of the studies specifically investigated the effects of AAC on vocal productions, while one documented concomitant effects. Seven studies investigated the effects of PECS and one study investigated the effects of PECS and verbal modelling intervention approaches. One study documented concomitant effects of intervention making use of a communication board. The type of vocal

production measured varied across the studies, with four studies investigating spoken words, spontaneous speech or related speech, two studies investigating verbalisations or vocalisations, two studies investigating vocal approximations and one study investigating all three types of vocal productions. One study investigated syllables vocalised. The results (as interpreted by the authors of the studies) indicated that 48 participants showed increases in the quantity of vocal productions (including speech, vocalisations and vocal approximations), one participant showed small increases in one type of vocal production (spoken words) and no change in other forms of vocal productions (imitated verbalisation), three participants showed increases in the mean number of vocal productions per utterance, and one participant showed increases in the quality of vocal productions (increase in grammar complexity and intelligibility). Two participants showed no change in vocal productions.

In summary, non-electronic AAC systems had a positive effect on the vocal productions of 52 participants and had no effect on the vocal productions of two participants.

2.6.2 The effect of SGDs on vocal productions

The acoustic output feature specific to SGDs may promote vocal productions in a unique way. SGDs provide those using them with a consistent speech model as well as an increased number of models within a single interaction, compared to a non-electronic AAC system. This may have benefits not only for language comprehension but also for vocal productions. Furthermore, it provides stimulus association for the person using the device, unlike non-electronic AAC systems. The pairing of the auditory and visual symbols for the individual with a disability is hypothesised to strengthen the understanding and internal representation of the word, consequently promoting vocal productions (Blischak et al., 2003). Four of the studies included in Table 2.2 included SGDs in their intervention approach.

The studies that examined the effects of electronic AAC systems on the vocal productions of children included 13 participants across all six studies. Four participants had autism, one participant had a developmental delay with moderate cognitive impairment, three participants had severe speech sound disorders, one participant had a profound phonological disorder, one participant had a subpalatal cleft and VI, one participant had a developmental

disability, one participant had a developmental disability and CAS, and the third child had CP and dysarthria. Two studies investigated the effects of SGDs alone, one study compared RSR with scaffolding and RSR with scaffolding and an SGD, two studies investigated the effects of a prompting strategy during book reading to encourage SGD use, and the final study investigated the effects of integrated multimodal intervention that incorporated an SGD. The type of vocal production varied across the studies, with one study investigating specific speech sounds, one study investigating verbalisation, two studies investigating syllables vocalised (not defined further), one study investigating speech and one study investigating speech and vocalisations. The results of these studies found that three participants showed improvements in pronunciation of speech sounds, as well as an increase in vocal productions. One participant showed an increase in the number, variety and functionality of vocal productions, two participants showed increases in one type of vocal production (speech) and decreases in other types of vocal productions (pre-linguistic forms), one participant showed an increase in the quantity and quality of vocal productions, one participant showed increases in overall vocal productions, and five participants showed no change in the amount of vocal productions from the baseline phase to the post-baseline phase.

In summary, SGDs predominantly had a positive effect on vocal productions for many participants of the reviewed studies; however, there was no change in vocal productions for five participants.

2.6.3 Comparative effect of non-electronic-aided AAC system and SGDs, as well as an SGD with and without voice output on vocal productions

Of the three studies that compared the effects of electronic versus non-electronic AAC systems or the effect of an SGD with and without voice output on the vocal productions of children, there were 12 participants across all three studies. Eleven participants had autism or PDD-NOS and one participant had specific language impairment with symptoms of apraxia. Two studies compared the effects of PECS and SGDs, and one study compared two SGDs (one with voice output and one without voice output). The type of vocal productions varied across the studies, with two studies investigating speech production and one study investigating verbalisations. The results of these studies found that three participants showed no improvement

in vocal productions for either the PECS or SGD conditions. In the second study, one participant showed an increase in vocal productions during the non-speech condition of the SGD and no change in vocal productions for the speech condition of the SGD, and four participants showed no change in vocal productions for the speech and non-speech conditions of the SGDs. In the final study, one participant showed a decrease in verbalisation for both conditions, one participant showed an advantage of VOCA over PECS on verbalisation, one participant showed an advantage of PECS over VOCA for the number of verbalisations but showed an advantage of VOCA over PECS for the increase in the percentage of intelligible verbalisations. His complexity of verbalisation increased more for the VOCA condition compared to the PECS condition. The final participant (who had an MSD) also showed mixed effects for both conditions. Her mean utterances per session increased in the PECS condition but decreased in the VOCA condition; the mean percentage of intelligible verbalisations increased in the VOCA condition but remained the same in the PECS condition.

In summary, the comparative effect of PECS versus SGDs was mixed, and no clear advantage of one system over another was observed. When comparing an SGD with and without voice output, only one of the five participants showed a slight increase in vocal productions in the 'non-speech' condition. Further research is therefore needed to clarify the differential effects of systems with and without voice output and/or electronic versus non-electronic forms of AAC on vocal productions.

2.6.4 Summary

From this review, various gaps in the literature are evident. Of the studies, seven investigated the effects of AAC on speech only, excluding other forms of vocal productions. Three of the studies investigated both intelligible speech production as well as one of vocalisations, verbalisations or word approximations. Although it is encouraging that forms of vocal productions other than speech were measured, the number of studies doing so is still small. A comprehensive view of vocal productions (including intelligible and unintelligible forms) may assist in obtaining a more comprehensive view of the influence of AAC on different types of vocal productions. Children with disabilities may be following unique routes of speech development and these may become clearer if all forms of vocal productions are measured. Only

four participants across all 17 studies were diagnosed with or suspected of having an MSD. Considering the prevalence of these disorders, as mentioned previously, it is vital that more studies investigate the use of AAC in this population. Finally, only three of the 17 studies actually compared the effects of different AAC systems on vocal productions. Comparative studies provide an important evidence base in the decision-making process. Professionals and parents need to know the benefits and limitations of each type of system, as well as the potential effects on vocal productions in order to make informed decisions that will optimally suit the child requiring AAC.

2.7 Social validation

Besides the objective measurable effects of AAC on vocal productions, the subjective benefits are also important to measure. Social validation is a tool that can be used to collect subjective information about a particular topic being researched. Subjective information is necessary to supplement the objective data obtained in order to determine whether the goals, methods and outcomes of intervention are perceived as socially important and acceptable by the stakeholders in the intervention (Schlosser, 1999), as it is then more likely that the intervention outcomes will be maintained. Direct stakeholders, such as peers, are some of the most important people in determining the social validity of the intervention because they are directly affected by the intervention. As children get older, they begin spending a greater amount of time in the school environment and thus have an increasing number of opportunities to interact, learn and build friendships with their peers. However, research shows that children infrequently use their AAC systems to interact in the classroom (Chung, Carter, & Sisco, 2012). A possible reason for this may be peers' perspectives of AAC. A positive perception of AAC can facilitate successful social interaction between a child using AAC and a peer (Calculator, 1999) and can in turn contribute to an optimal learning environment (Beck, Bock, Thompson & Kosuwan, 2002). Two comparative studies investigated the attitudes to and perceptions of children of a peer using two AAC systems (one with voice output and one without voice output or a communication board). Both studies found more positive attitudes and perceptions of a peer using an electronic AAC system with voice output technology (Lilienfeld & Alant, 2002); Horn, 2014). However, despite their vital contribution to research, there are very few studies that use social validation techniques to gather information (Schlosser, 1999), thus highlighting another important area

requiring more focus in AAC research. When considering the effect of different AAC systems on vocal productions, the question arises whether any differential effects are recognisable by direct stakeholders such as peers.

2.8 Aim of the study

The first aim of this study is to extend the literature on the effect of using an SGD versus a communication board on vocal productions, with specific focus on children with MSDs. Secondly, the study will attempt to validate the effect of the intervention socially by ascertaining the perceptions of the participants' peers of the vocal productions of the participant while using each of the AAC systems.

2.9 Summary

In this chapter, the manner in which vocal productions changes as children get older was discussed. Various terms used in literature to describe various forms of vocal productions were discussed, and consistent terms used in this study were defined and justified. The incidence and characteristics of children with MSDs and the effect of MSDs on speech development were described, and the importance of AAC as another means of communication for these children was highlighted. The chapter then provided an overview of the literature on the effect of various AAC systems on the vocal productions of children with disabilities. The results indicated a slightly mixed effect, with the majority of participants (N=64) experiencing a positive effect on vocal production, while 14 participants did not evidence any changes in vocal productions and the vocal productions of one participant decreased. Finally, the use of social validation in research was discussed and its role in providing subjective evidence for the interventions used with children with disabilities was highlighted.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter describes the methodology used for the study. This study addressed two aspects, namely the vocal productions of children with MSDs during the use of a communication board versus an SGD, as well as peer perceptions about the amount and intelligibility of the vocal productions and AAC-system-based communication produced by children with MSD. The first aspect was addressed by analysing data that had previously been collected (Tönsing, 2015) for a study entitled "Supporting the production of graphic symbol combinations by children with limited speech: A comparison of two AAC systems". For ease of reading this study will be referred to as Study A. The second aspect was addressed through collecting data from peers using a questionnaire with visual support (Talking Mats™ framework) and this study will be referred to as Study B. In this chapter, the main aim and sub-aims of the overall study are first explained. Section 3.3 explains the methodology of Study A that was used to compare the vocal productions of children using two AAC systems. Reference is made to the research design, participants, materials and equipment and data collection procedures used by Tönsing (2015). The data analysis procedures relevant to Study A are then discussed. Section 3.4 explains the research design, participants, materials and equipment, data collection and data analysis procedures used in Study B, aimed at gathering and analysing data related to peer perceptions. Finally, validity and reliability issues and ethical considerations are described for both studies.

3.2 Aims of the study

3.2.1. Main aim

To describe and compare the vocal productions by children with MSD when using a communication board versus an SGD and to determine peer perceptions regarding the amount and intelligibility of the vocal productions and AAC-system-based communication produced by the children with MSD.

3.2.2 Sub-aims

1. To describe the effect of introducing AAC intervention using a communication board (non-electronic system) during a storybook reading activity on the vocal productions of children with MSD;
2. To describe the effect of introducing AAC intervention using an SGD (electronic system) during a storybook reading activity on the vocal productions of children with MSD;
3. To compare the vocal productions of children with MSD when using a non-electronic system versus an electronic system.
4. To determine peer perceptions of the amount and intelligibility of the vocal productions and AAC-system-based communication produced by children with MSD during baseline and intervention.

3.3 Methodology of Study A: Comparing the vocal productions of children using two AAC systems

As indicated, the data used for comparing vocal productions was drawn from a previous study (Tönsing, 2015). The design, participants, materials and equipment, and data collection procedures of this study will therefore be described briefly. The data analysis procedures unique to the current study (Study B) will also be described.

3.3.1 Research design

A quantitative, single-subject, adapted alternating treatment design was used, including a baseline phase and an intervention phase with at least five sessions per condition (communication board versus SGD). The study also contained a preference and a maintenance phase; however, data from these phases will not be reported here.

3.3.2 Participants

3.3.2.1 Selection criteria

The data was collected from four participants who were recruited from schools for learners with special needs in Gauteng. Selection criteria for the participants of this study are provided in Table 3.1.

Table 3.1

Selection criteria for participants in original study

No.	Criteria	Justification	Measure
1	Little or no functional speech	To ensure that the intervention provided was appropriate.	Index of Augmented Speech Comprehensibility in Children (I-ASCC; Dowden, 1997)
2	Adequate motor function and control	Able to access symbols on the AAC devices accurately and directly.	Screening
3	Functional vision and hearing	Required to hear the story and see the symbols on the AAC devices.	Teacher report
4	Able to comprehend at least 90% of the graphic symbols used in intervention	The aim of the study was to get children to combine symbols expressively, therefore an understanding of these symbols was required.	Screening task and paired associate teaching when necessary
5	Not combining graphic symbols	The aim of the study was to facilitate production of graphic symbol combinations.	Parent, teacher and therapist report
6	Able to accurately direct-select graphic symbols on a communication board and iPad	Participants needed to be able to direct-select so that they could make use of the communication board without too much motor effort.	Participants were asked to point to items on a 10-item communication board and iPad.
7	Aged 11;11 years or below	For the storybook reading activity used for intervention to be appropriate	Biographical information sheet
8	Comprehension of English language at a 36-month-old level	Vocabulary used in the story was at that age equivalent	Peabody Picture Vocabulary Test Fourth Edition (PPVT-4; Dunn & Dunn, 2007)
9	English as one of the languages spoken in the home or at least 3 years of English medium education	Since the intervention was conducted in English, participants required exposure to English to benefit from intervention.	Parent and teacher report
10	Able to concentrate on a 10-min story	Length of story that will be used	Teacher report

3.3.2.2 Descriptive criteria

Participant 1 was a male aged 11;3, diagnosed with CP (spastic hemiplegia) and severe dysarthria. His home language was Southern Soto. His comprehension of the English language according to his score on the PPVT-4 placed him at an age equivalent of 3;7. Within the no semantic context-unfamiliar listener condition of the I-ASCC, he scored 0% on the comprehensibility of his speech. He was previously provided with a communication book containing PCS symbols, although he did not use this very much. His main method of communication included use of vocalisations, pointing, gestures and facial expressions.

Participant 2 was a male aged 11;4, diagnosed with perisylvian syndrome and severe dysarthria. His home language was Setswana. His comprehension of the English language according to his score on the PPVT-4 placed him at an age equivalent of 2;10. Within the no semantic context-unfamiliar listener condition of the I-ASCC, he scored 3% on the comprehensibility of his speech. He was previously provided with a communication board and book containing PCS symbols; however, he did not use these very much either. His main method of communication included use of vocalisations, word approximations, pointing, gestures and facial expressions.

Participant 3 was a female aged 8;0, diagnosed with CP (spastic quadriplegia) and severe apraxia of speech. Her home languages were Setswana, English and isiZulu. Her comprehension of the English language according to her score on the PPVT-4 placed her at an age equivalent of 3;6. Within the no semantic context-unfamiliar listener condition of the I-ASCC, she scored 8% on the comprehensibility of her speech. She had previously been exposed to communication boards and the GoTalk application on the iPad; however, she did not use any type of AAC system. Her main method of communication included use of vocalisations, word approximations, pointing, gestures and facial expressions.

Participant 4 was a male aged 6;11, diagnosed with CP (athetoid quadriplegia) and severe dysarthria. His home language was Setswana. His comprehension of the English language according to his score on the PPVT-4 placed him at an age equivalent of 3;9. Within the no semantic context-unfamiliar listener condition of the I-ASCC, he scored 0% on the

comprehensibility of his speech. He infrequently used a communication book containing PCS symbols to communicate in the classroom. His main method of communication included use of vocalisations, word approximations, pointing, gestures and facial expressions.

3.3.3 Materials and equipment

3.3.3.1 Standardised tests

Tönsing (2015) used the PPVT-4 (Dunn & Dunn, 2007) and the Elaborated Phrases and Sentences subtest of the Test for Auditory Comprehension of Language (TACL; Carrow-Woolfolk, 1998) to measure the receptive English language skills of the participants. The scores were interpreted with caution, as the tests are not normed on the South African population and because the participants' first language was not English. The South African Language Assessment (SALA; Bortz, 1997) was used to measure the receptive language skills of the children's home language. The I-ASCC (Dowden, 1997), a non-standardised test, was used to obtain information about the intelligibility of the participants' speech. The Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2004) was administered to get an impression of the participants' non-verbal abilities. This test has been used with persons from various language and cultural backgrounds. For information on test results, please refer to Tönsing (2015, p.6).

3.3.3.2 Semantic relations and storybooks

As the aim of the original study was to teach graphic symbol combinations, three sets of semantic relations were developed (Tönsing, 2015). Each set consisted of 10 words: two agents, three actions, two attributes and three entities. These semantic relations can be found in Table 3.2 below. Three stories comparable in length and story grammar structure were used during the SGD and communication board conditions respectively. For reference the stories are presented in Appendix B. Each story contained six target semantic combinations: three agent-action and three attribute-entity combinations (e.g. 'the girl eats' and 'yellow shoe'). The stories were illustrated and contained some movable parts and flaps. The three stories (A, B and C) were allocated in a systematically counterbalanced fashion to the SGD and the communication board condition, as well as a choice condition (implemented during baseline and the preference phase)

to all the participants (see Table 3 in Tönsing, 2015, p. 8). The data from the choice condition will not be reported on here.

Table 3.2

Semantic Combinations Targeted in the Original Study

	Agents	**Actions**	**Attributes**	**Entities**
Set 1	Ben, dog	Run, laugh, fall	Red, dirty	Ball, shirt, pants
Set 2	Girl, rabbit	Sit, eat, drink	Yellow, clean	Plate, glass, shoe
Set 3	Sam, cat	Sleep, walk, cry	Blue, broken	Hat, car, aeroplane

3.3.3.3 Recording device

A Cannon Legria FS 306 video recorder was used to film the baseline and intervention sessions.

3.3.3.4 AAC devices

The Apple iPad 4 with the Go Talk now application was used for the SGD condition and a communication board was used for the communication board condition (Tönsing, 2015). PCSwere used on both the board and SGD pages. One board and overlay was developed for each set of target semantic relations. A Fitzgerald key layout was used for the symbol overlays of the SGD and communication board. The layout, size of cells and colour coding were identical for both communication aids (see Appendix C). A US English child synthetic voice was used on the SGD because no South African English child synthetic voice was available.

3.3.3.5 SALT program

The SALT program (SALT; Miller & Igleisias, 2008) has specifically been designed to transcribe and analyse language samples. The program provides general transcription rules and codes that can be used to analyse the language sample. Specific codes and transcription rules applicable to this study were also developed (see Appendix A).

3.3.4 Data collection procedures

The data collection procedures followed by Tönsing (2015) consisted of a baseline phase, intervention phase, preference phase and maintenance phase. The preference and maintenance phases are not analysed and are not discussed further in this study. The procedures used for each phase are summarised below. A more detailed account of the research phases can be found in Tönsing (2015).

Baseline

Tönsing (2015) reports that nine sessions were conducted during this phase over the course of three days. On each day one session for the communication board condition and one session for the SGD condition were conducted. A third session was conducted for a choice condition, but data from this phase will not be considered further in this study. During each baseline session, the researcher read the story allocated to the specific condition to the participant with the relevant AAC system (SGD or communication board) available on a table in front of the participant. Before the target combinations appeared in the story, the researcher would draw the participant's attention to the relevant story illustration depicting the target combination (e.g. "Oh look here") followed by an expectant pause. The researcher acknowledged any responses made by the participant in a neutral way and then proceeded to verbalise the target combination. The researcher did not draw any attention to the AAC system. A correct response by the participant consisted of pointing (in the correct order) to both symbols that made up the target combination on the communication board or activating the appropriate cells (in the correct order) on the SGD. The conditions were counterbalanced for each participant.

Intervention

According to Tönsing (2015), one intervention session for each condition was conducted per day. During a session, the relevant story allocated to the condition was read and a five-level prompting hierarchy (least to most) was used to elicit the target graphic symbol combinations. The order of sessions was alternated across days and participants. The five prompts consisted of (1) drawing attention to the story illustration of the target combination, (2) an open-ended question to elicit the target combination, (3) a request for the child to express the combination using the AAC device, (4) an aided model of the combination with a request for the child to

imitate the model, and (5) hand-over-hand assistance to help the child point at or press the relevant target symbols. As many prompts in the hierarchy as needed were given until a correct response was elicited. A correct response by the participant consisted of pointing (in the correct order) to both symbols that made up the target combination on the communication board or activating the appropriate cells (in the correct order) on the SGD.

3.3.5 Data analysis

Permission was obtained from the researcher of the original study (Tönsing, 2015), as well as the parents of the original study participants, to reanalyse the data.

The original video recordings of the participants' performance across the baseline and intervention phases were observed. The recordings were transcribed using the SALT program, according to the transcription rules developed (see Appendix A). Codes were inserted to mark the spoken words, word approximations and vocalisations produced by each participant at each phase. The start and end times of the interactions were noted from the recordings. The rate per minute of overall vocal productions per participant was determined for baseline and intervention sessions, plotted on a line graph and analysed visually to determine changes between the baseline and intervention phases and also between intervention conditions. The PND (Parker &Vannest, 2009) was calculated, as it is considered a strong and useful effect size for single-subject designs and can be flexibly applied to designs with multiple phases, such as an adapted alternating treatment design, which was used to gather this data. The rates per minute of the three different types of vocal productions (vocalisations, word approximations and spoken words) were also calculated per participant, as were the average rate and accompanying standard deviation during the baseline and intervention session for overall vocal productions and each subtype for each participant. The Wilcoxon ranked pairs test (Wilcoxon, 1945) was used to determine whether there were significant differences in the rates of vocal productions by participants across the two intervention conditions.

3.4 Methodology of Study B: Social validation

3.4.1 Research design

A quantitative comparative survey design was used to determine the perceptions of peers regarding the amount and intelligibility of vocal productions and AAC-system-based communication produced by the children with MSD.

3.4.2 Participants

3.4.2.1 Sampling and recruitment

Non-probability, purposive sampling was used to recruit peers of three participants (Participants 1, 2, and 4). The class teachers of these three participants were provided with details of the study and asked to identify two to three suitable candidates. Participant 3 attends a Setswana-medium school for learners with severe intellectual disability and would be unable to understand the questions in the rating scale. Information letters were sent to the parents of nine potential peer participants and eight parents replied, giving consent.

3.4.2.2 Selection Criteria

The selection criteria used to recruit the peer participants can be found in Table 3.2.

Table 3.3

Selection Criteria for peer participants

Criterion	Justification	Measure
Peers of participants used in Tönsing (2015) study	Perceptions of peers can influence the classroom interactions of children using AAC (Calculator, 1999).	Class lists
Able to use the Talking Mats™ procedure	The Talking Mats™ framework provides a means of expressing views more easily using visual support (Brewster, 2004; Murphy & Cameron, 2008).	Screening procedure
Functional vision and hearing	The child needs to hear the questions, which will be read out by the researcher and he/she will need to see the graphic symbols for the Talking Mats™ procedure.	Teacher questionnaire Screening procedure
English language comprehension at a 4-year-old level	Children of this age can understand 'when' and 'how' questions and answer questions about hypothetical events (Sax & Weston, 2007)	PPVT-4 (Dunn & Dunn, 2007)
Able to concentrate for 15 minutes (video watching and questioning)	Required for participation in the rating scale procedure	Teacher will be asked to identify suitable candidates

Of the eight potential peer participants, one did not pass the Talking Mats™ screening test and was therefore excluded from the study. One peer participant was chosen to take part in the pilot study. Therefore, six peer participants took part in the main study.

3.4.2.3 Descriptive criteria

The PPVT-4 was used to gather an age-equivalent score of the participants' receptive vocabulary skills. All participants scored within the range of 4;6- 5;3 (years; months) for this test. The Preschool Language Scale Fourth Edition (PLS-4; Zimmerman, Steiner & Pond, 2002) was used to gather additional information on the peers' language skills and all participants

achieved above 4;0 (years; months) for this test. The Kaufman Brief Intelligence Test, Second Edition (KBIT-2; Kaufman & Kaufman, 2004) was administered to get an impression of non-verbal abilities. Each of these participants scored within the range of 5;2- 7;3 (years; months) for this test. Table 3.3 provides the description criteria of the peer participants who took part in the main study.

Table 3.4

Table of descriptive criteria of peer participants

Peer participant	C.A.	Gender	Communication mode	PPVT age equivalent	KBIT-2 age equivalent	Peer of original participant no …
1	8;7	F	Verbal	4;7	5;2	4
2	8;11	F	Verbal	4;6	5;6	4
3	12;1	F	Verbal	5;3	6;3	2
4	11;3	M	Verbal	5;1	5;6	2
5	12;2	M	Verbal	5;3	5;2	1
6	12;5	M	Verbal	4;11	5;6	1

3.4.3 Pilot study

A pilot study was conducted in order to refine the rating scale questions and data collection procedures for the study. The child who took part in the pilot study passed all the screening procedures. She was a girl aged 8;4 who achieved an age equivalent of 4;3 on the PPVT and 6;0 on the KBIT. Table 3.2 gives a detailed description of the aims, procedures, results and recommendations of the pilot study.

Table 3.5
Description of aims, procedures, results and recommendations of pilot study

Aims	**Procedures**	**Results**	**Recommendations for main study**
To determine whether the selection criteria for participants and methods of determining these were appropriate.	The researcher observed whether the peer participant was able to perform the various tasks.	The participant was able to complete each of the screening tasks easily and also the rating task.	It was recommended that the same selection criteria be used for the participants in the main study.
To establish whether the instructions provided to participants were clear and understandable.	Instructions were provided at the beginning of the session to ensure that the participant was aware of the procedures to follow.	The participant was able to understand and follow the instructions provided during the data collection procedures easily.	It was recommended that the same instructions be given to participants for the main study.
To determine the comprehensibility of the rating scale questions	The researcher observed the ease with which the participant understood the questions asked by the researcher.	The participant was able to understand the questions asked by the researcher easily.	It was recommended that the same wording be used for the rating scale questions for the main study.
To establish the effectiveness of the Talking Mats™ framework to answer the rating scale questions and to determine the time needed to do so.	The researcher observed how effective the Talking Mats™ framework was for the child to answer the questions after each video.	The participant was able to answer the rating scale questions easily and effectively using the Talking Mats™ framework.	It was recommended that the same Talking Mats™ framework be used when answering the rating scale questions for the main study.

3.4.4 Materials and equipment

3.4.4.1 Standardised tests

Three standardised tests were used to gather information on the peer participant's language abilities. The PPVT was used to gather information on the peer participants' receptive vocabulary skills and the PLS-4 was used to gather additional information on the peer participants' language skills. The KBIT-2 was administered to get an impression of non-verbal abilities. It must be noted that the scores for these tests must be interpreted with caution, as these tests are not standardised for the South African population.

3.4.4.2 Talking Mats™ framework

An adapted version of The Talking Mats™ framework was used to administer the questionnaire to the peer participants and gather their responses. The Talking Mats™ framework makes use of various pictures pertaining to "topics" and "perspectives" to help people with communication difficulties to express their views (Murphy & Cameron, 2008). In the current study a piece of carpet (sized 40-60 cm) was used as the canvas upon which picture symbols could be placed, representing the topics to be covered, each of the questions administered and the rating scale that the participants could use to answer the questions (see Appendix D).

3.4.4.3 Questions

Five questions that were to be answered using a four-point rating scale were developed to obtain information regarding the perceptions of the peer participants (see Appendix E). Four of the questions were aimed at eliciting information about peer perceptions regarding the amount and intelligibility of the vocal productions and AAC-system-based communication produced by the children with MSDs during the use of two AAC systems. A fifth question was aimed at the peers' perception about the desirability of using either of the AAC systems to communicate. One preference question was also asked, which was answered without a scale.

3.4.4.4 Rating Scale

The rating scale was visually depicted using a four-point scale. Each point on the scale was represented by a coloured picture of a basket (one empty basket and three containing different numbers of apples – see Appendix F). These pictures were affixed with Velcro to a

piece of carpet (sized 40 X 60 cm). Picture symbols pertaining to each question were presented to the peer participant as each of the questions was administered (see Appendix E for the questions and picture symbols). The peer participant was required to place the picture symbol below the picture of the basket corresponding to the chosen point on the scale in response to that question in order to communicate his/her answer visually.

3.4.4.5 Material for screening of Talking Mats™ procedure

A picture of a young girl and four pictures (a slab of chocolate, a bicycle, a broccoli stick, and an injection syringe) pertaining to each of the questions in the screening procedure were used to represent the various items this little girl liked "a lot, quite a bit, not that much and not at all" respectively (see Appendix G). A piece of carpet (sized 40 X 60 cm) acted as the canvas upon which each of the pictures was affixed as the relevant question in the screening procedure was asked. The four-point rating scale symbols were also affixed to the top of the piece of carpet so that the participants could place the relevant picture symbol below the appropriate point on the rating scale.

3.4.4.6 Recording device

A Samsung video recorder was used to film the rating scale procedure with the peer participants.

3.4.4.7 Video clips

Two video clips were shown to the peer participants. One video from the intervention phase of the communication board condition and one video from the intervention phase of the SGD condition were selected. The videos that were chosen were the ones in which the child (original study participants) exhibited most vocal productions and the section of video that was shown was 2½ minutes in length, starting at 1 minute into the video.

3.4.4.8 Laptop to view videos

An Apple Mac Book Air was used to show the video clips to the peer participants.

3.4.5 General procedures

Permission for conducting the study was obtained from the Ethics Board of the Faculty of Humanities, University of Pretoria (See Appendix H) as well as from the Gauteng Department of Education (see Appendix I). An information letter and consent form were given to the school principal, requesting permission to conduct this study at the school and permission was obtained from the school principal (See Appendix J). Consent was obtained from the parents of the children with MSDs to show recordings made during the data collection of the original study (Tönsing, 2015) to their child's peers. (See Appendix K for an example of these letters.) Teachers were asked to identify suitable peers whom they thought would meet the selection criteria. Information letters and consent forms were sent to the parents of these potential peer participants, informing them of all aspects of the study and requesting permission for their child to participate. All except one parent replied, giving consent. (See Appendix L for an example of the letters of consent.) Verbal assent from all potential peer participants was obtained prior to commencing any procedures, including screening. (See Appendix M for the script used to obtain participant assent.)

3.4.5.1 Screening procedure

Once parental consent and assent from the child had been obtained, screening commenced to ensure that the potential participants met all selection criteria. The PPVT-4 was administered to all the potential peer participants to ensure that their receptive language skills were on the level of a four-year-old child in order for them to be able to understand the instructions and questions during the rating scale procedure. A section of the PLS-4 was administered to gather additional information about their receptive language skills. The KBIT-2 was also administered to get an impression of non-verbal abilities. The peers who met the receptive language criterion as determined by the PPVT age equivalent scores then underwent screening of the Talking Mats™ framework to ensure their understanding of the procedure. A screening procedure (see Appendix G) was developed whereby participants were introduced to a character and told about various things that she liked to eat and do. The question was asked how much she would like a certain item if it were given to her. Two training questions were provided so that the researcher could model how to use the scale to answer the questions. For the remaining screening questions the peers indicated their understanding of the visual scale by

placing the graphic symbol below the relevant item on the visual scale. In order to pass the screening, peer participants had to answer all four questions correctly using the Talking Mats™ framework. The answers to the screening questions were as follows: the little girl likes chocolate a lot, she likes riding her bike a little, she does not like broccoli that much and she does not like injections at all.

3.4.5.2 Data collection

Data on the peers' perceptions was collected individually, using the Talking Mats™ framework. The peer participant watched 2.5 minute sections of two videos of the original study participant participating in the storybook reading activity. One video was of the child using the communication board (from the intervention phase), and one video was of the child using the SGD (once again, from the intervention phase). The videos that were chosen were the ones in which the child exhibited most vocal productions and the section of video that was shown was 2½ minutes in length, starting at 1 minute into the video. After watching each video, the child was reminded of how to use the Talking Mats™ procedure to answer the questions and then the rating scale questions were asked (see Appendix E). A graphic symbol was given to the child to represent the question being asked visually and the child was required to place the graphic symbol below the picture of the apple basket that represented his/her chosen point on the scale. To minimise order effects, the presentation of videos was counterbalanced across participants (e.g. if Peer Participant 1 was shown the SGD video first and the communication board video second then, the opposite was done for Peer Participant 2). A procedural guideline was developed to ensure that the researcher adhered to all steps required during the rating scale procedure (see Appendix N). The peer participant and the researcher were video-recorded during this procedure. The camera was positioned to the side of the peer participant in order to ensure that he/she was not distracted by the presence of the camera.

3.4.6 Data analysis

The data obtained from the rating scale was analysed by determining the mean scores and standard deviations of ratings assigned to both the communication board and the SGD conditions. A comparison of these scores was made to determine whether peers perceived

differences when comparing the use of the two AAC systems. Because of the small sample size only descriptive statistics were used.

3.5 Validity and reliability

3.5.1 Data reliability

Two speech-language pathologists with training in the SALT programme acted as second observers to ensure the reliability of the data on vocal productions. Each video-recorded session was viewed by either of the observers, as they followed along on the transcripts generated by the first transcriber (author) in the SALT program. The second observer marked any disagreements with the existing transcripts regarding the vocal productions of the participants, as well as the start and end time of the videos. Disagreements regarding vocal productions included omissions, additions, or disagreements with the classification of the vocal production (i.e. intelligible words, word approximations or vocalisations). Disagreements regarding start and end times of the interactions were observed when the second observer changed the start and end times according to the recordings. Because the rate of vocal productions was measured in this study, the start and end times of transcriptions were very important. Point-by-point agreement was calculated on the transcriptions using the formula suggested by Cucchiarini (1995):

$$\frac{\text{number of agreements}}{\text{number of agreements + number of disagreements}} \times \frac{100}{1}$$

An overall score of 93% inter-rater reliability for the vocal productions was achieved, and an overall score of 89% was achieved for the start and end times of interactions.

All disagreements were reviewed by the first transcriber, who then made a final decision on the transcription coding and start and end times, based on once more viewing relevant sections of the video recording.

3.5.2 Procedural reliability: Study A

The procedural reliability of the story reading interventions had already been determined. A speech-language pathologist with postgraduate training in AAC acted as the independent

observer. She viewed 20% of the video-recorded sessions that were randomly selected. She rated the adherence to procedures and an overall integrity of 99.7% was achieved.

3.5.3 Procedural reliability: Study B

An independent observer watched a randomly selected 20% of the video-recorded questionnaire sessions and rated the researcher's adherence to procedures according to the procedural protocol (see Appendix N). Overall integrity of 100% was achieved.

3.6 Ethical considerations

When working with human participants, the ethical principles that should be upheld include (1) that the participants should not come to harm; (2) that voluntary, informed consent be obtained before participants are included in the study; and (3) that participants' privacy be protected at all times (Leedy & Ormrod, 2005). In this study, these aspects will be addressed in the following manner:

3.6.1 Study A

The original study (Tönsing, 2015) was approved by the Ethics Board of the Faculty of Humanities, University of Pretoria and the Gauteng Department of Education. At that time, permission was obtained for further data analysis on condition that the parents of the participants consented. Permission was therefore obtained from the parents of the original participants to reanalyse the video data to determine the amount of vocalisations during baseline and the two intervention conditions (see Appendix K).

3.6.2 Study B

Regarding the social validation by peers, permission from the Faculty of Humanities Board of Ethics and the Gauteng Department of Education was obtained prior to conducting the study (see Appendices H and I). The procedures used in this study did not pose any direct physical risk to the original or peer participants. In order to ensure that the parents of the original participants did not perceive the viewing of videos of the child by peers as harmful to their child or themselves, their consent was obtained for showing the videos to peers (see Appendix K). Furthermore, the original participants were also informed of the intention to show videos to their

peers, and their assent was obtained before this was done (see Appendix O). An appropriate introduction was given to peer participants before viewing the video to ensure that they understood that the purpose was not to criticise the child in the video in any way.

Voluntary, informed assent from peer participants and voluntary informed consent from the principal and caregivers were obtained before screening of participants commenced (Leedy & Ormrod, 2005). An information letter with a request for consent was sent to the school principal, requesting permission to conduct another study at the school (see Appendix J). Written consent was obtained from parents of the participants who took part in the study by Tönsing (2015) to reanalyse the existing data and to show the video recordings to their child's peers. The original participants were informed of the intention to show video footage to their peers, using appropriate language and visual support, and their assent was requested (see Appendix O). They were given the opportunity to indicate whether or not they agreed, using a communication mode of which they were capable (e.g. head shake/nod, pointing to pictures for 'yes' or 'no'). Information letters explaining the aims, procedures and materials of the study were sent to the parents of the peers so that they were fully informed about the study and their written consent was requested (see Appendix L). The peer participants were informed of all aspects of the study. Visual aids were used to supplement information given verbally. Their assent was requested prior to collecting data from them (including screening). The assent procedure is described in Appendix M. Parents and peer participants were informed about their right to withdraw from the study at any stage. Participants were provided with a printed stop sign so that they could indicate that they wanted to discontinue.

Information letters were provided to the teachers of the participants to allow children in their class to participate in the study. Teachers were consulted about appropriate times to conduct the peer rating, to ensure that the peer participants did not miss out on important class work.

Participants' privacy was protected by providing each participant with a respondent number and only the researcher knew which participant corresponded with which respondent number. Only the researcher, her supervisors and the independent rater viewed the video footage of the peers. The data will be archived at the Centre for AAC for 15 years. A summary of the

research results devoid of any identifying information will be made available to interested staff or parents.

3.7 Summary

This methodology chapter gives an overview of the methodologies relevant to both Study A (aimed at determining the effect of two AAC systems on the vocal productions of children with MSDs) and Study B (aimed at obtaining peer perceptions on vocal and AAC-mediated communication as a method of socially validating intervention effects). Since the video recordings from which data on vocal productions was gleaned for Study A were made as part of a previous study (Tönsing, 2015), the design, participants, materials and data collection procedures employed in that study were described. The transcription and data analysis procedures used to gather data on vocal productions for the current study were then given. The research design, participants, materials and equipment used in Study B were then explained, as were the pilot study, data collection procedures and data analysis procedures for this study. Finally, validity and reliability issues and ethical considerations pertaining to both studies were described.

CHAPTER 4
RESULTS

4.1 Introduction

The results of the study are presented according to the rate per minute of total vocal productions for each session in the baseline phase and the intervention phase for each participant. The rate of each type of vocal production per session is also presented, and averages and standard deviations per participant per phase are given. Finally the results for the social validation are presented. Ratings from each peer participant per question are reported, as are means and standard deviations.

4.2 Rate of vocal productions

4.2.1 Participant 1

The rate of vocal productions by Participant 1 during baseline and intervention for both the SGD and the communication board conditions is given in Figure 4.1.

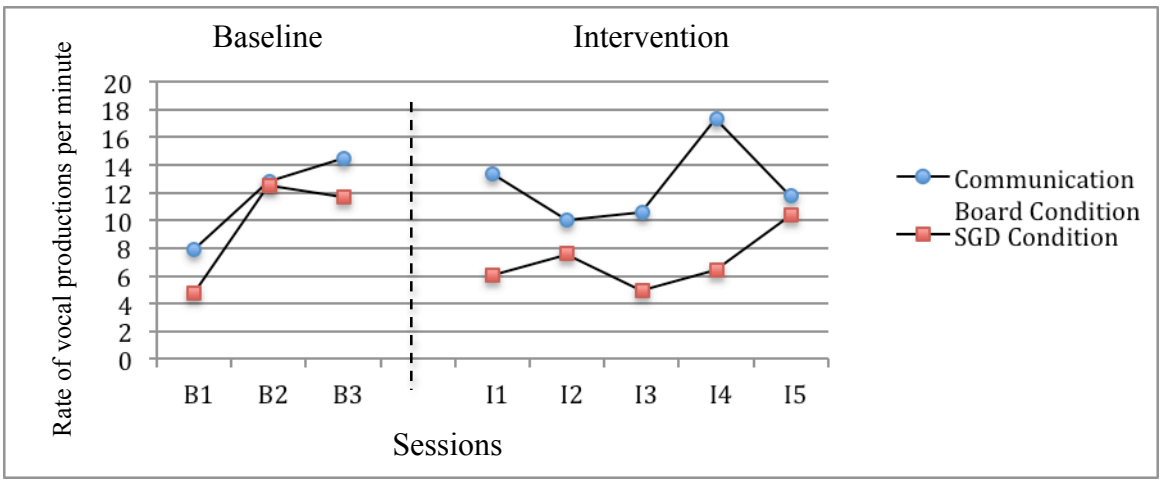

Figure 4.1. Rate of vocal productions by Participant 1 in the SGD and communication board conditions

4.2.1.1 Communication board condition

Participant 1 showed an accelerating trend in the rate of vocal productions per minute during the baseline phase for the communication board condition. The vocal production rate per minute increased from 7.8 to 14.4 from the first to the third baseline session. When intervention

was introduced, the vocal production rate decreased slightly to 13.3 and decreased further in the next intervention session to 10.0. Thereafter, it increased over the next two intervention sessions to 17.3 in session I4, only to decrease again to 11.7 in session I5. Performance during intervention was therefore variable without a clear trend. An increase from 11.7 to 12.4 in the mean rate of vocalisations was observed from the baseline phase to the intervention phase and the PND for this condition was 20%, indicating weak treatment effects.

4.2.1.2 SGD condition

In the SGD condition, a steep increase in production rate was seen from the first to the second baseline session, with a slight decrease again in the last baseline session. The vocal production rate decreased from 11.7 during the last baseline session to 6.0 during the first intervention session. Overall, an upward trend in the rate of vocal productions was seen during the remaining intervention sessions, although a decrease was again noted from Session I2 to I3. Rates remained below those observed in the last two baseline sessions. The mean rate of vocal productions per minute decreased from 9.6 during baseline to 7.1 during intervention. The PND was 0%, indicating no effect of the treatment on vocal productions.

The Wilcoxon ranked pair test revealed a significant difference in the rate of Participant 1's vocal productions between the two intervention conditions ($z= 2.02$ $p = 0.04$).

Table 4.1 summarises the rates of production of vocalisations, word approximations and spoken words per session for both conditions, and also gives the mean and standard deviations for each phase of each condition. From the table it is evident that Participant 1 produced predominantly vocalisations rather than more intelligible forms of vocal productions. The mean rate of vocalisations increased slightly from 11.7 during baseline to 12.4 during intervention for the communication board condition; and from 9.5 to 7.0 during the SGD condition. Furthermore, Participant 1 began producing spoken words during the last two intervention sessions, which he had not done during the baseline phases for the communication board condition. The mean rate of spoken words during the SGD condition remained the same from the baseline phase to the intervention phase.

Table 4.1

Participant 1's rate of production of vocalisations, word approximations and spoken words per minute

			VOC/min	WA/min	SW/min	Total Vocal Productions/min
Communication Board Condition	**Baseline**	B1	7.8	0	0	7.8
		B2	12.8	0	0	12.8
		B3	14.4	0	0	14.4
		M	**11.7**	**0**	**0**	**11.7**
		SD	**3.4**	**0**	**0**	**3.4**
	Intervention	I1	13.3	0	0	13.3
		I2	10.0	0	0	10.0
		I3	10.5	0	0	10.5
		I4	16.9	0	0.4	17.3
		I5	11.1	0	0.7	11.7
		M	**12.4**	**0**	**0.2**	**12.6**
		SD	**2.8**	**0**	**0.3**	**2.9**
SGD condition	**Baseline**	B1	4.7	0	0	4.7
		B2	12.5	0	0	12.5
		B3	11.4	0	0.3	11.7
		M	**9.5**	**0**	**0.1**	**9.6**
		SD	**4.2**	**0**	**0.2**	**4.3**
	Intervention	I1	6.0	0	0	6.0
		I2	7.6	0	0	7.6
		I3	4.7	0	0.2	4.9
		I4	6.1	0	0.3	6.4
		I5	10.4	0	0	10.4
		M	**7.0**	**0**	**0.1**	**7.1**
		SD	**2.2**	**0**	**0.1**	**2.1**

4.2.2 Participant 2

The rate of vocal productions by Participant 2 during baseline and intervention for both the SGD and the communication board conditions is given in Figure 4.2.

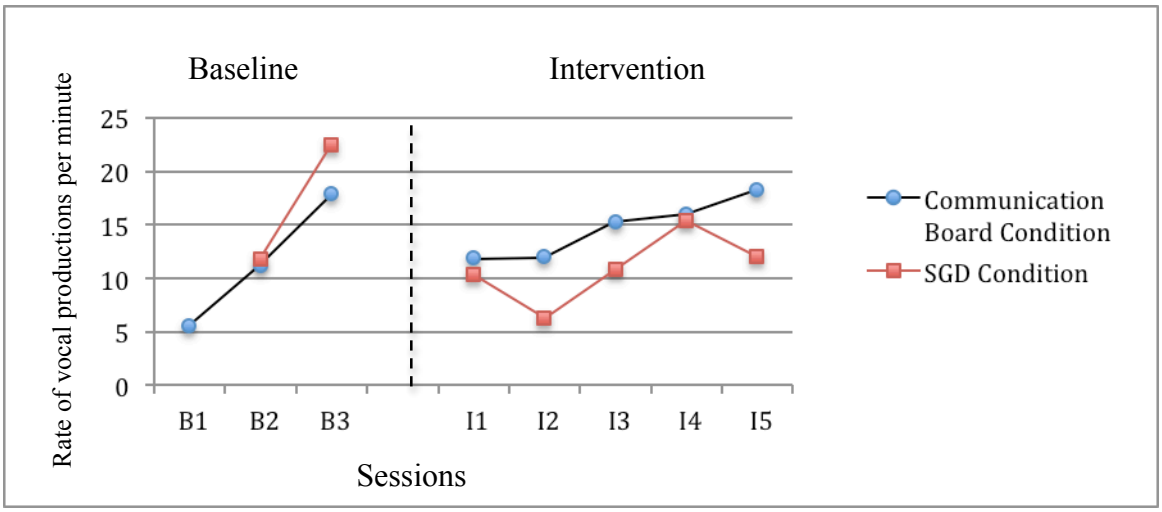

Figure 4.2. Rate of vocal productions by Participant 2 in the SGD and communication board conditions.

4.2.2.1 Communication board condition

Participant 2 showed an accelerating trend in rate of vocal productions during the baseline sessions, increasing from 5.6 to 17.9. A decrease to 11.8 in the rate of vocal productions was observed in the first intervention session, compared to the last baseline session. Thereafter a steadily accelerating trend can be observed with the last intervention session ending on a rate of 18.3 vocal productions per minute. The mean rate of vocal productions per minute increased from 11.5 during baseline to 14.7 during intervention and the PND was 20%, indicating weak treatment effects.

4.2.2.2 SGD condition

For the SGD condition, there is missing information for the first baseline session owing to malfunctioning video equipment, but thereafter the rate of vocal production increased from 11.8 to 22.4 from session B2 to B3. Again, there was a decrease in the rate of vocal productions when intervention was initially introduced and a further decrease was seen in Session I2. The rate of vocal productions then increased from 6.2 to 15.3 over the course of two intervention sessions, but then decreased again to 12 during session I5. Performance during intervention was therefore variable without a clear trend. The mean rate of vocal productions per minute decreased from 17.1 during baseline to 10.9 during intervention and the PND was 0%, indicating no treatment effect.

The Wilcoxon ranked pair test revealed a significant difference for Participant 2's performance between the two intervention conditions ($z= 2.02$ $p = 0.04$).

Table 4.2 summarises the rates of production of vocalisations, word approximations and spoken words per session for both conditions, and also gives the mean and standard deviations for each phase of each condition. From the table it is evident that Participant 2's mean rate of vocalisations per minute decreased from 5.5 to 4.1, but the mean rates of word approximations and spoken words per minute increased from 2.6 to 5.5 and 3.5 to 5.1 respectively, from the baseline to the intervention phase in the communication board condition. For the SGD condition, there was a decrease in mean rate of vocalisations from 9.2 to 4.8. For word approximations there was also a slight decrease in the mean rate from 3.7 to 3.6, and for spoken words a decrease from 4.2 to 2.4 was evident from the baseline to the intervention phases.

Table 4.2

Participant 2's rate of production of vocalisations, word approximations and spoken words per minute

			VOC/min	WA/min	SW/min	Total Vocal Productions/min
Communication Board Condition	**Baseline**	B1	2.4	0.8	2.4	5.6
		B2	7.1	2.5	1.6	11.2
		B3	7.0	4.5	6.4	17.9
		M	**5.5**	**2.6**	**3.5**	**11.5**
		SD	**2.7**	**1.8**	**2.6**	**6.1**
	Intervention	I1	4.7	4.2	3.0	11.8
		I2	2.6	5.7	3.7	12.0
		I3	4.1	6.4	4.8	15.2
		I4	4.1	5.1	6.8	16.0
		I5	4.9	5.9	7.5	18.3
		M	**4.1**	**5.5**	**5.1**	**14.7**
		SD	**0.9**	**0.8**	**1.9**	**2.8**
SGD condition	**Baseline**	B1	Missing data	Missing data	Missing data	Missing data
		B2	5.3	2.6	3.9	11.8
		B3	13.0	4.9	4.6	22.4
		M	**9.2**	**3.7**	**4.2**	**17.1**
		SD	**5.4**	**1.6**	**0.4**	**7.5**
	Intervention	I1	4.6	3.8	2.0	10.3
		I2	1.0	3.3	1.9	6.2
		I3	7.0	2.5	1.2	10.8
		I4	6.2	4.9	4.3	15.3
		I5	5.4	3.8	2.8	12.0
		M	**4.8**	**3.6**	**2.4**	**10.9**
		SD	**2.3**	**0.9**	**1.2**	**3.3**

4.2.3 Participant 3

The rate of vocal productions by Participant 3 during baseline and intervention for both the SGD and the communication board conditions is given in Figure 4.3.

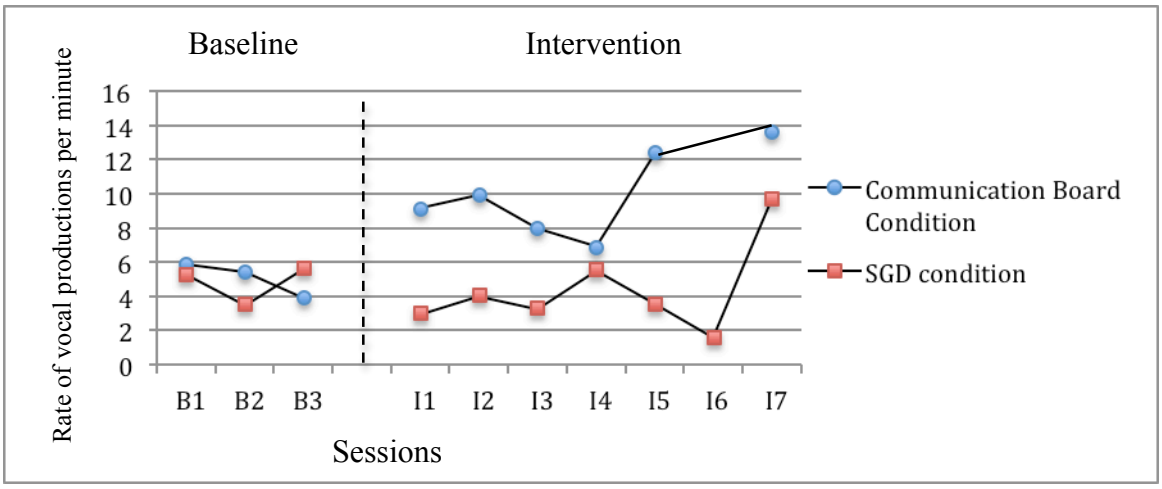

Figure 4.3. Rate of vocal productions by Participant 3 in the SGD and communication board conditions.

4.2.3.1 Communication board condition

Participant 3 showed a slight decrease of 5.9 to 3.9 in the rate of vocal productions during the three baseline sessions for the communication board condition and then showed a steep increase to 9.1 in the first intervention session. There was an accelerating trend in the rates of vocal productions from session I1 to I2 and I4 to I7, but a decelerating trend from sessions I2 to I4. This could be due to the fact that the participant seemed to have a cold on those days of intervention. Session I6 was not conducted because the criterion on the original dependent variable (production of graphic symbol combinations) had been reached in this condition at this point. Overall, all rates of vocal productions during the intervention sessions were higher than those observed during the baseline sessions. The mean rate of vocal productions per minute increased from 5.0 during baseline to 10.0 during intervention and the PND score was 100%, indicating strong treatment effects.

4.2.3.2 SGD condition

A slightly more varied performance can be observed during the SGD condition across both the baseline and intervention phases. During the baseline sessions, the rate of vocal productions decreased from 5.3 to 3.5, but then increased to 5.6 in the last baseline session. The rate of vocal productions then decreased significantly to 3.0 during the first intervention session and continued to fluctuate for the remaining intervention sessions, but peaked at 9.7 for the last

intervention session. No clear trend could be observed during this condition. The mean rate of vocal productions per minute decreased slightly from 4.8 during baseline to 4.4 during intervention and the PND score was 14.3%, indicating weak treatment effects.

The Wilcoxon ranked pair test revealed a significant difference in the rate of vocal productions of Participant 3 between the two intervention conditions ($z= 2.2$, $p = 0.02$).

Table 4.3 summarises the rates of production of vocalisations, word approximations and spoken words per session for both conditions, and also gives the mean and standard deviations for each phase of each condition. From the table it is evident that the mean rate for vocalisations, word approximations and spoken words increased (2.1 to 3.3, 1.8 to 4.6 and 1.2 to 2.1 respectively) from the baseline to the intervention phase for the communication board condition. For the SGD condition, the mean rate of word approximations and spoken words increased (from 1.2 to 1.4 and 1.1 to 1.2 respectively) but the mean rate of vocalisations decreased from 2.4 to 1.6.

Table 4.3

Participant 3's rate of production of vocalisations, word approximations and spoken words per minute

			VOC/min	WA/min	SW/min	Total Vocal Productions/min
Communication Board Condition	**Baseline**	B1	2.2	2.0	1.6	5.9
		B2	3.1	1.6	0.7	5.4
		B3	0.8	1.8	1.2	3.9
		M	**2.1**	**1.8**	**1.2**	**5.0**
		SD	**1.2**	**0.2**	**0.5**	**1.0**
	Intervention	I1	3.5	4.1	1.5	9.1
		I2	2.5	5.6	1.8	9.9
		I3	2.3	4.3	1.3	8.0
		I4	2.3	3.8	0.7	6.9
		I5	4.8	3.5	4.1	12.4
		I7	4.5	6.1	3.1	13.6
		M	**3.3**	**4.6**	**2.1**	**10.0**
		SD	**1.1**	**1.0**	**1.2**	**2.6**
SGD condition	**Baseline**	B1	3.5	0.5	1.4	5.3
		B2	2.1	1.2	0.2	3.5
		B3	1.7	2.0	1.9	5.6
		M	**2.4**	**1.2**	**1.1**	**4.8**
		SD	**0.9**	**0.8**	**0.9**	**1.1**
	Intervention	I1	1.4	0.1	0.6	3.0
		I2	2.6	0.9	0.6	4.1
		I3	1.2	0.6	1.6	3.3
		I4	1.6	1.6	2.3	5.6
		I5	0.9	1.0	1.7	3.6
		I6	0.5	0.3	0.8	1.6
		I7	3.5	5.4	0.8	9.7
		M	**1.6**	**1.4**	**1.2**	**4.4**
		SD	**1.0**	**1.8**	**0.7**	**2.6**

4.2.4 Participant 4

The rate of vocal productions by Participant 4 during baseline and intervention for both the SGD and the communication board conditions is given in Figure 4.4.

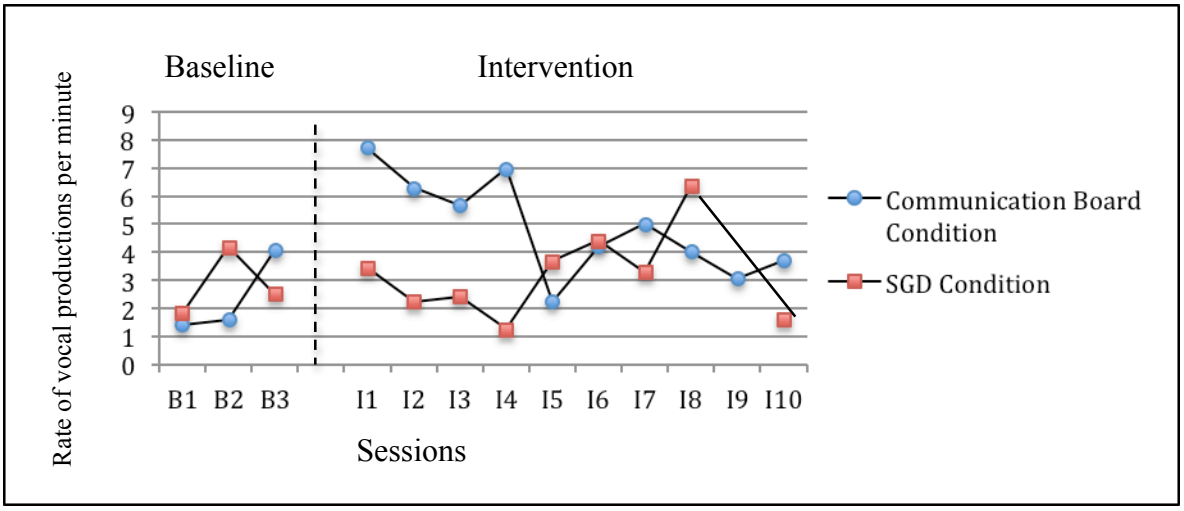

Figure 4.4. Rate of vocal productions by Participant 4 in the SGD and communication board conditions.

4.2.4.1 Communication board condition

Participant 4 showed an increase in the rate of vocal productions during the baseline phase for the communication board condition, with rates increasing from 1.4 to 4.1. The rate of vocal productions continued to increase to 7.7 when intervention was initially introduced, but then a generally decelerating trend was observed until session I5, with mild fluctuation observed at session I4. Over the next two intervention sessions, rates increased to 5.0, but then decreased to 3.0 by session I9, finally increasing slightly to 3.7 during session I10. Overall, a variable trend was observable across the intervention phase. The PND score was 70%, indicating moderate treatment effects, and the mean rate of vocal productions per minute increased from 2.4 during baseline to 4.9 during intervention.

4.2.4.2 SGD condition

A similar pattern is observable for the SGD condition, with the rate of vocal productions increasing during the baseline phase from 1.8 to 4.2 from session B1 to B2 and decreasing again to 2.5 in the final baseline session. A slight increase to 3.4 could be observed when intervention was first introduced, followed by a variable pattern of increases and decreases across the remaining intervention sessions. Performance during intervention was therefore variable without a clear trend. Session I9 was not conducted because the participant sustained an injury during a playground accident. The PND score was 22.2%, indicating weak treatment effects, and the

mean rate of vocal productions per minute decreased from 2.8 during baseline to 3.2 during intervention.

The Wilcoxon ranked pair test revealed that the difference in Participant 4's vocal productions between the two intervention conditions was not significant ($z= 1.72$; $p=0.8$).

Table 4.4 summarises the rates of production of vocalisations, word approximations and spoken words per session for both conditions, and also gives the mean and standard deviations for each phase of each condition. From the table it is evident that Participant 4's mean rate of vocalisations increased from 2.3 to 3.7 from baseline to intervention for the communication board condition. Participant 4 also began producing word approximations during the intervention phase of the communication board condition, bringing the mean rate up from 0 to 0.3. The mean rate of spoken words remained constant for the communication board condition. For the SGD condition, an increase from 2.0 to 2.9 in the mean rate of vocalisations could be observed from the baseline to the intervention phase, but a decrease in the mean rate was observed for both word approximations and spoken words (from 0.5 to 0.1 and 0.3 to 0.2 respectively).

Table 4.4

Participant 4's rate of production of vocalisations, word approximations and spoken words per minute

			VOC/min	WA/min	SW/min	Total Vocal Productions/min
Communication Board Condition	**Baseline**	B1	1.2	0	0.2	1.4
		B2	1.6	0	0	1.6
		B3	4.1	0	0	4.1
		M	**2.3**	**0**	**0**	**2.4**
		SD	**1.5**	**0**	**0.1**	**1.5**
	Intervention	I1	7.7	0	0	7.7
		I2	5.9	0.3	0	6.3
		I3	5.3	0.4	0	5.7
		I4	5.2	1.4	0	7.0
		I5	1.7	0.5	0	2.2
		I6	4.2	0	0	4.2
		I7	4.3	0.5	0.2	5.0
		I8	3.8	0.2	0	4.0
		I9	2.8	0.2	0	3.0
		I10	3.5	0	0.2	3.7
		M	**3.7**	**0.3**	**0**	**4.9**
		SD	**1.7**	**0.4**	**0.1**	**1.8**
SGD condition	**Baseline**	B1	1.6	0.2	0	1.8
		B2	2.5	0.8	0.8	4.2
		B3	1.9	0.4	0.2	2.5
		M	**2.0**	**0.5**	**0.3**	**2.8**
		SD	**0.4**	**0.3**	**0.4**	**1.2**
	Intervention	I1	3.0	0.1	0.3	3.4
		I2	2.2	0	0	2.2
		I3	2.3	0	0.1	2.4
		I4	1.2	0	0	1.2
		I5	3.5	0.2	0	3.7
		I6	3.8	0.2	0.4	4.4
		I7	3.0	0.3	0	3.3
		I8	5.3	0.2	0.8	6.3
		I10	1.6	0	0	1.6
		M	**2.9**	**0.1**	**0.2**	**3.2**
		SD	**1.2**	**0.1**	**0.3**	**1.6**

4.3 Summary of results regarding the effect of AAC systems on vocal productions

Overall, the results did not show a clear positive effect of intervention on vocal productions. In the communication board condition, a clear positive effect was only visible for Participant 3. The accelerating baseline trends for the three others made interpretation somewhat difficult. Participants 1 and 2 showed a negative level change in rate of vocal productions upon introduction of the communication board intervention. While Participant 2 showed an accelerating trend during intervention (though at a slower rate than during baseline) Participant 1 showed a variable trend. This was also the case for Participant 4, who, although displaying a positive level change upon the introduction of intervention, displayed large fluctuations in rate of vocal productions across sessions. The mean rate of vocal production was higher during intervention than during baseline for all four participants. When analysing the types of vocal productions produced during baseline and intervention, it is evident that Participants 1 and 4 produced, on average, a higher rate of vocalisations than word approximations or spoken words, both during baseline and intervention. Participants 2 and 3 also produced a higher mean rate of vocalisations during baseline, but produced a higher mean rate of word approximations compared to vocalisations and spoken words during intervention, suggesting that their vocal productions were phonetically closer to those of the standard form.

During the SGD condition, Participants 1, 3 and 4 showed variable trends during baseline, while no trend for Participant 2 could be determined owing to missing data for one session. Variable trends in the rate of vocal productions were also seen during the intervention phase for all four participants, although Participant 1 at least showed an increase in rate over the last three intervention sessions. Negative level changes were observed for Participants 1-3 upon introduction of intervention, while Participant 4 showed a positive level change. The mean rate of vocal productions was lower during intervention than during baseline for all but Participant 4. Regarding types of vocal productions, all participants produced predominantly vocalisations rather than word approximations or spoken words during both the baseline and intervention phases.

When comparing the effect of the two conditions on vocal productions, there were significant differences in rates of vocal productions for three of the four participants according to the Wilcoxon ranked pair test. These participants produced significantly higher rates of vocal productions during the communication board condition compared to the SGD condition. The rate of vocalisations increased for three participants and decreased for one participant from the baseline to the intervention phase during the communication board condition. Contrastingly, vocalisations decreased for three participants and increased for one participant from the baseline to the intervention phase during the SGD condition. Word approximations and spoken words increased for two participants and remained the same for one participant from the baseline to the intervention condition during the communication board condition. However, word approximations and spoken words decreased for two participants and increased for one participant from the baseline to the intervention phase during the SGD condition.

4.4 Social validation

Table 4.5 presents the scores of all six peer participants regarding their perceptions of vocal productions during the communication board and SGD conditions, perceptions of AAC use by the original participant during the communication board and SGD conditions, and desirability of the AAC systems.

Table 4.5

Peer perceptions of vocal productions and AAC use of original participant and perceptions of desirability of AAC systems used

Original study participant	Peer participant	Peer perceptions of vocal productions by original study participant				Peer perceptions of AAC use by original study participant				Evaluation of desirability of AAC system (4= very desirable, 1 = not desirable at all)	
		Amount (4= a lot, 1= not at all)		Amount comprehensible to peer (4= a lot, 1= not at all)		Amount (4= a lot, 1= not at all)		Amount comprehensible to peer (4= a lot, 1= not at all)			
		Comm. board	SGD	Comm. board	SGD	Comm. board	SGD	Comm. board	SGD	Comm. board	SGD
4	1	4	4	3	2	2	3	4	1	4	4
4	2	4	4	2	2	4	4	4	4	4	4
2	3	2	3	4	4	3	4	4	4	4	4
2	4	4	4	4	4	4	4	4	4	4	4
1	5	2	2	3	3	3	1	4	4	4	3
1	6	4	3	3	4	2	2	1	4	4	4
	M	3.3	3.3	3.2	3.2	3.0	3.0	3.5	3.5	4.0	3.8
	SD	1.0	0.8	0.8	1.0	0.9	1.3	1.2	1.2	0.0	0.4

From the table it is evident that the majority of peer participants perceived their peers to have produced quite a lot of vocal productions during both the communication board condition and the SGD condition (M=3.3 for both). These vocal productions were also generally rated as relatively comprehensible in both conditions (M=3.2). Regarding use of the two AAC systems, peers also generally thought that participants used both quite a bit (M=3.3 for both conditions). For the final question, both systems were rated high in desirability although the communication board was rated slightly higher - all six participants indicated that they would like to use a communication board a lot if they were required to use an AAC device to communicate, whereas only five participants gave this high rating to the SGD.

However, when asked to choose between the communication board and the SGD as the preferred AAC system of use, all six participants indicated the SGD as their system of preference to use.

When looking at ratings given by individual peers, it is clear that some perceived differences between the two conditions on some of the parameters rated. Peer Participants 2 and 5, for example, rated the comprehensibility of the two AAC systems very differently. Other peers (particularly Peer Participants 4 and 6) rated all aspects of the two conditions in an identical fashion.

4.5 Summary

This chapter reported the rate per minute values for each of the vocal productions measured for each participant, as well as the rate per minute for the total number of vocal productions for each participant. It provided visual representation of these values in the form of graphs and tables, with means and standard deviations included in the tables. Overall, results regarding vocal productions were variable, and the introduction of AAC intervention did not have a clear positive effect on vocal productions. Participants all tended to display higher rates of vocal productions during the communication board intervention condition compared to the SGD intervention condition, and differences were statistically significant for three of four participants. This chapter also reported on peer perceptions of each of the AAC systems. Results indicated that peers rated the amount and comprehensibility of vocal productions and the AAC-mediated communication acts very similarly for both intervention conditions. They also indicated a clear preference for the SGD as the system of choice for themselves, should they ever want or need to use an AAC.

CHAPTER 5
DISCUSSION

5.1 Introduction

The following chapter will discuss the results in terms of the four sub-aims of the study. The chapter will commence with a short section that aims to contextualise the results for the reader in order not to over- or under-interpret the significance of the results. The results pertaining to the effect of the communication board intervention on vocal productions will be discussed first, followed by those pertaining to the effect of the SGD intervention on vocal productions. Next, the results obtained by comparing the effect of each of these conditions on vocal productions will be discussed. In each case, results will be interpreted in the light of previous findings, highlighting similarities and differences and proposing possible reasons. Lastly, the social validation aspect of the study will be discussed in terms of the perceptions of peer participants of vocal production, AAC use and preference for a device.

5.2 Effect of interventions employing different AAC systems on vocal productions

Before commencing with the discussion of the results, it is helpful to view these in the context of the original study. Firstly, the aim of the intervention employed in the initial study was not to improve vocal productions, but to teach symbol combinations (Tönsing, 2015). The effect on vocal productions was a secondary consideration, thus the intervention was not planned with this in mind. Consequently, there was no monitoring of this aspect during the baseline and intervention phases, and phase change decisions were not made on the basis of changes in vocal productions. Therefore, a stable baseline for this variable was not necessarily established before intervention commenced. While this may have implications for interpreting the results and identifying the intervention effect, the results still provide valuable information on the changes in vocal production rates observed upon introducing AAC. The results will be discussed in the following four sections.

5.2.1 Vocal productions during the communication board condition

The first aim of this study was to describe the effect of introducing AAC intervention using a communication board (non-electronic system) during a storybook reading activity on the

vocal productions of children with MSDs. While a clear positive effect was observed for Participant 3, mixed and possible initially negative effects were noted for three others. When looking at the production of word approximations and spoken words only, the results look similar, with increases in these more intelligible forms of vocal productions clearly evident only for Participant 3, although Participant 2 also showed an accelerating trend after an initially negative level change upon introduction of intervention. These results are in contrast with much of the current literature, which generally found positive effects on vocal productions (Carr & Felce, 2006; Ganz & Simpson, 2004; Ganz et al., 2010; Tincani, 2004; Tincani et al., 2006; Kravits et al., 2002). However, some previous studies also found no clear effects of non-electronic AAC systems on vocal productions. Ganz et al. (2008) found no change in the production of intelligible words and word approximations in one participant with autism who was introduced to PECS, yet positive effects were observed for the other three participants. Binger et al. (2008) found no change in number of syllables vocalised in one participant with an MSDs who used a communication board during intervention. Another study involving children with MSDs found equally mixed results for the effect of an aided AAC system without voice output on natural speech production: two participants' natural speech increased and two participant's natural speech decreased (Blischak, 1999). It does seem that overall, results for children with MSDs may not be as positive as those found in children with autism, although it is hard to make direct comparisons between studies owing to differences in designs and intervention methods. The nature of speech difficulties in children with autism may be different to that of children experiencing MSDs. While children with autism may present with some speech impairments, they predominantly have difficulty with the pragmatic elements of language, social interaction, and they present with limited spontaneous communication (Matson, Kozlowski & Matson, 2012). Contrastingly, MSDs are characterised by disruptions in the physical movement of the muscles involved in speech production, primarily affecting articulation of sounds (Communication Sciences & Disorders, 2006). Children with MSDs often present with slow and laboured (CP) or disorganised speech (CAS). However, it has to be noted that not all studies involving children with autism showed positive results (e.g. Ganz et al., 2008).

All of the studies reviewed in Tables 2.1-2.3 examined the changes in quantity and quality of vocal productions, whereas the current study examined the changes in rate of vocal

productions per minute. While it was beyond the scope of the literature review to investigate the exact differences in baseline and intervention procedures of all studies included in Tables 2.1-2.3, intervention sessions typically involve additional procedures and may therefore extend over a longer period of time than baseline sessions. Counting the total number of vocal productions may therefore inflate results, whereas rate may be a more conservative measure.

One difficulty in interpreting the results for the communication board condition was the accelerating baseline trend observed in three of the participants. One possible reason for the increase in vocal productions during the baseline phase may be the participants' increased familiarity with the storybook reading procedure, which resulted in them engaging more vocally with the researcher. A reason for the initial decrease in vocal productions for Participants 1 and 2 when intervention was introduced could be the short-term effects of re-allocation of resources that occurs when children with disabilities are required to learn to use AAC (Blischak et al., 2003). Although all of the participants were familiar with AAC, the intervention involved the use of two-symbol combinations, which was a new way of communicating with the AAC systems. It should also be noted that the greatest percentage of vocal productions by participants, both during baseline and intervention consisted of vocalisations that, by definition, differed substantially in phonological structure from any possible spoken target word. These vocalisations were quite possibly not particularly intelligible and therefore may not have been as successful in relaying a specific message in communication exchanges as use of the communication board was. In addition, in view of their diagnoses, the children may have found vocal productions quite demanding to execute. This may have motivated participants to choose communication board use as a more effective and less effortful method of communication.

5.2.2 Vocal productions during the SGD condition

The second aim of this study was to describe the effect of introducing AAC intervention using an SGD (electronic system) during a storybook reading activity on the vocal productions of children with MSD. In general, similar trends were seen as in the communication board condition. None of the participants showed clear improvements upon introduction of intervention and all participants except one showed an initial decrease in vocal productions upon introduction of the SGD. Furthermore, the mean rates of vocal productions were higher during the baseline

phase compared to the intervention phase for all participants except one. When looking at rates of word approximations and spoken words over sessions, results were very similar, with no clear increases. This is again in contrast with the current literature examining the effects of SGDs on vocal productions. Most of the studies found positive effects of SGDs with voice output on vocal productions (Bellon-Harn & Harn 2008; Blischak, 1999; King et al., 2013; Neeley et al, 2015; Thunberg et al., 2009;; Parsons & LaSorte, 1993, as cited in Schlosser & Sigafoos, 2006). Only two studies reviewed in Table 2.2 found that introduction of an SGD had no effect on the number of syllables vocalised (Binger et al., 2008; Binger et al., 2010). Two of the participants included in the study by Binger et al (2010) had MSDs. Of the participants (of the studies included in Table 2.2) who showed an improvement in vocal productions upon the introduction of an SGD, none had a diagnosis of MSDs. This once again seems to agree with the results of the current study, but the small number of participants with MSDs makes any conclusions tentative. It should also be noted that Blischak (1999) found that natural speech production of four children with MSDs increased upon the introduction of an SGD with synthetic speech, whereas one child with MSDs showed a decrease in natural speech production.

5.2.3 Comparative results of communication board versus SGD

The third aim of this study was to compare the vocal productions of children with MSDs while using a communication board versus an SGD. Statistically significant differences between rates of vocal productions were found for three participants when comparing the two intervention conditions, with significantly higher rates during the communication board condition for all participants except Participant 4. These differences are also visible upon visual analysis of the graphs for the participants.

One possible reason for lower rates of vocal productions during the SGD condition in the current study could be the effect of voice output technology on participants' requirement to vocalise. Participants may have felt less of a requirement to vocalise while activating the cell with the AAC symbol on the SGD, as it provided a simultaneous audible speech output of the symbol pressed. Participants may have wanted to listen to the SGD output and therefore may have limited their vocal productions. Participants may have felt that they needed to vocalise when using the communication board in order to restore the symmetry in modality use between

themselves and their speaking partner, as they may have been aware that use of the communication board alone meant using a different modality (visual) to that used by their partners (auditory). Another possible reason why the vocal productions were higher during the communication board condition may be the possible carryover effects from hearing the SGD voice output during that condition. Participants may have felt that because no speech output occurred during the communication board condition, they needed to vocalise instead.

These results are in contrast to current literature, which indicates no significant difference between systems with and without speech output (Beck et al., 2008; Boesch et al., 2013; Schlosser et al., 2006) or a more positive effect of systems with speech output on vocal productions (Blischak, 1999). The study by Beck et al. (2008) involved one participant with an MSD, who showed similar numbers of vocalisations during the use of PECS and the use of an SGD. A study involving children with autism and autistic-like behaviour also found no differences in vocalisations for SGD use with or without voice output (Sigafoos et al., 2003). The study by Blischak (1999) also involved participants with MSDs and the results suggest that the use of an SGD with voice output resulted in increased natural speech production for four of five participants, whereas the use of graphic symbols without voice output resulted in decreases in speech production for three of four participants. The author suggested that auditory feedback from the speech output of the SGD not only provided additional auditory input and modelling for the user of the device, but also reduced physical pressure on all the systems required for speech, thus indirectly benefiting natural vocal productions (Blischak et al., 2003). It has to be noted that Blischak (1999) used a pretest-posttest design with two groups of children (N=4 and N=5 respectively), each receiving a different type of intervention (paper-based graphic symbols versus an SGD). Comparisons of the communication board and SGD conditions were based on pre- and post-instruction measures. Post-instruction measurement occurred after 18 sessions of rhyme instruction. Participants were thus exposed to AAC system use over a longer period of time than in the current study, and comparisons were made across groups rather than by comparing performance across two conditions within each participant. These differences may partly account for differences in results.

5.2.4 Social validation

Participants did not perceive the amount or comprehensibility of vocal productions or AAC communication to differ, and rated these aspects relatively highly in both conditions. These results are encouraging, as they indicate that peers perceived both AAC systems to support communication effectively and also perceived the children's vocal productions as numerous and generally comprehensible. This latter finding is interesting, as most vocal productions by the participants consisted of vocalisations and only a small number of spoken words and word approximations were measured. Possible reasons for the ease of comprehensibility of vocal productions may be attributed to the context in which the vocal productions occurred. Use of storybooks may have provided adequate graphics to help the peer participant interpret what his/her peer was communicating. Secondly, the peer participants were all familiar with the participants in the original study, which may have aided their understanding of the seemingly unintelligible vocal productions. All peer participants indicated that they would want to have an AAC system, preferably an SGD, to communicate if they required the use of an AAC system, indicating a positive perception of AAC among peers who do not require an AAC system. These results are important, as they suggest that peer perceptions of AAC are positive and conducive to introducing AAC into schools for learners with different disabilities. These findings correlate with current literature indicating that peers perceive SGDs positively (Horn, 2014; Lilienfeld and Alant, 2002).

5.3 Summary

This chapter discussed the results of the study in terms of the effects of a communication board and an SGD on the vocal productions of the participants, as well as drawing a comparison of the effects of each AAC system. It discussed the results in comparison to current literature and provided possible reasons for similarities and differences in these results.

CHAPTER 6
LIMITATIONS AND
RECOMMENDATIONS FOR FUTURE RESEARCH

6.1. Introduction

The following chapter will provide a summary of the results obtained from the study. It will then discuss the clinical implications and limitations of the study and make recommendations for future research.

6.2 Summary

The aims of this study were to investigate the effects of introducing two AAC systems into the vocal productions of children with MSDs and to compare the effects of each system. The final aim was to investigate the perspectives of children towards peers using each of the AAC systems. Overall, results regarding vocal productions were variable, and the introduction of AAC intervention did not have a clear positive effect on vocal productions over the period measured. These results are in contrast with the current literature examining both non-electronic AAC systems as well as SGDs (Bellon-Harn & Harn 2008; Carr & Felce, 2006; Ganz & Simpson, 2004; King et al., 2013; Kravitz et al., 2002; Neeley et al, 2015; Thunberg et al., 2009; Tincani, 2004; Tincani et al., 2006). Possible reasons could include the differing diagnoses of participants used in the majority of current literature and that of participants used in the current study. Participants with MSDs tend to display slightly less positive results than children with autism (Binger et al., 2008; Blischak, 1999). A second reason may be that most of the majority of current literature examined changes in quality and quantity of vocal productions, whereas this study examined changes in rate per minute. Participants all tended to display higher rates of vocal productions during the communication board intervention condition compared to the SGD intervention condition, and differences were statistically significant for three of four participants. This may indicate that participants felt less of a requirement to vocalise when speech output was provided by the AAC system, as in the case of the SGD condition. Possible carryover effects from hearing the SGD speech output during that condition may also have resulted in more vocalisations during the communication board condition. Results of the social validation aspect of the study indicated that peers rated the amount and comprehensibility of vocal productions and the AAC-mediated communication acts very similarly for both intervention conditions.

They also indicated a clear preference for the SGD as the system of choice for themselves, should they ever want or need to use an AAC system. These results are congruent with those of other studies (Horn, 2014; Lilienfeld & Alant, 2002).

6.3 Clinical implications

The current study shows that an initial decrease in vocal productions upon the introduction of AAC may occur. Although this may seem undesirable, the results should not be interpreted as a counter-indication for introducing AAC. Firstly, only short-term changes in vocal productions were measured, and predictions about long-term changes cannot be made. Secondly, in addition to measuring the effect of AAC on vocal productions, the effect of AAC on overall communication competence as judged by factors such as intelligibility and rate should be considered as well. While increases in vocal productions are certainly desirable, overall communication competence may be a more important factor to consider as an overall outcome measure (Light, 1997). Nevertheless, short-term decreases in vocal productions may be expected when introducing AAC and clinicians may need to prepare partners for such a change.

The significant differences evident between the communication board condition and SGD condition regarding effects on vocal productions should also be considered when making clinical decisions on the type of AAC system that is to be introduced. Although results may seem to suggest that a communication board enhances vocal productions more than the use of an SGD, it has to be kept in mind that, in the current study, the higher rate of vocal productions during the communication board condition may have been a function of the alternation between this condition and the SGD condition. The voice output by the SGD may have primed the participants to vocalise during the communication board condition where voice output was lacking. Since voice output has various advantages (such as communication over a distance, increased symmetry between input and output), the current results should not discredit its use for children with MSDs. At the same time, electronic options should always be supplemented by non-electronic back-up systems. The results of the current study can alert clinicians and families to the possible interactions between each of these systems and vocal productions.

The positive perceptions held by peers towards AAC in general and especially SGDs is an encouraging finding. Since partner perceptions about AAC systems can influence use of the system, service providers such as speech-language pathologists working with children requiring AAC should take these findings into consideration when selecting and introducing an AAC system to a child.

6.4 Critical evaluation

The study was evaluated in terms of its strengths and limitations.

6.4.1 Strengths

- The single-case alternating treatment design was a strength of this study, as it allowed for the changes per session over time to be followed, providing an overall picture of the data gathered.
- The measure of rate of vocal productions was a unique one, as it examined the rate of production of vocalisations, word approximations and spoken words. It is important when researching children with MSDs to include all types of vocal productions, as their speech development does not follow typical patterns and less intelligible forms, such as vocalisations, may be present regardless of age.
- The study had good data and procedural reliability, which improves its rigour.
- Analysis of the data in terms of rate per minute of vocal productions provided a more accurate measure of vocal productions, as it accounted for variance in the length of baseline versus intervention sessions.
- The social validation aspect of the study provided valuable subjective information regarding the efficacy of the AAC intervention that could supplement the objective results obtained.

6.4.2 Limitations

One limitation of this study that is important to consider is that the results regarding vocal productions are short-term and are not representative of the long-term effects or maintenance of the intervention implemented using the AAC systems. The results of the current study may represent the reallocation of resources to learning to produce new symbol combinations using the

AAC systems. Research shows that time and additional opportunities for practice are required in order to develop an automatic skill, which subsequently enables the individual to use his/her cognitive resources in other areas, such as speech production (Blischak et al., 2003; Millar et al., 2006). Studies conducted over longer periods are required to measure the long-term effects of implementing AAC on vocal productions more accurately. A second limitation of the current study is that the data pertaining to vocal productions was gathered as a concomitant measurement. The dependent variable targeted in the original study was the production of graphic symbol combinations. As a result, changes in phase were not made based on the rate of vocal productions. A third limitation of this study is that the peers of only three of the original study participants were used for the social validation aspect of the current study. This limitation is to some degree linked to the previous point, as participants in the original study (Tönsing, 2015) were not chosen with relevant peers in mind. However, this limitation does not allow for a comprehensive picture of the peers' perspectives, as no data was obtained from the peers of Participant 3, who had unique results for her rate of vocal productions. In addition, only six peers overall were involved in this aspect of the study, which precludes any generalisations regarding peer perceptions because of the small sample size. Finally, social desirability effects may have led peer participants to provide positive answers that do not fully reflect their true perceptions.

6.5 Recommendations for future research

This study highlighted the importance of conducting additional research on the effects of different AAC systems on vocal productions in children presenting with MSDs, as there is an acute lack of research in this area. Future studies making use of single-case experimental designs with a baseline phase should monitor the vocal productions during baseline closely to ensure stability before the AAC system is introduced, so that its effect can be better understood. Future studies should continue to investigate all the different types of vocal productions, such as vocalisations, word approximations and natural speech, as children with disabilities generally produce a mixture of these types, as is evident from the results of the current study. Studies may also monitor changes in vocal productions over a longer time period in order to gain a broader perspective of the long-term effects of implementing AAC on vocal productions. Such research is required in order to gather empirical evidence to share with parents who have fears about their

child using AAC systems to communicate and to guide the decision-making process when first introducing AAC intervention. Lastly, more comprehensive analyses of video transcripts that detail not only vocal productions, but also AAC system use and other unaided forms of communication, such as gestures and pointing, may shed more light on the way in which children co-ordinate different modalities and how this changes over time when AAC is introduced. Such analyses should also include ratings of communication competence as an important outcome of measure (Light, 1997).

6.6 Summary

This chapter provided an overall summary of the study, followed by a discussion of positive implications. A critical evaluation of the study was also given in terms of strengths and limitations. Possible further avenues to explore in future studies in order to build and expand on the current results were also suggested.

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Appendix A
Transcription rules and SALT conventions

Transcription rules and SALT conventions

1. The transcription conventions as given in Appendix M of the SALT manual (Miller, Andriacchi, & Nockerts, 2011, pp. 287-290) will be followed unless stated otherwise below.
2. The main aim of the transcription is to determine the rate and number of the children's vocal productions, including vocalisations, word approximations and intelligible words. These are defined as follows:

   Vocalisation: A vocal production of any length that is not recognisable as a word or word approximation (see definitions below) because of poor articulation or background noise.

   Word approximation: Vocal productions that are attempts to articulate a particular word, as evident from the context, but these productions deviate from the standard pronunciation. Word approximations need to share at least one vowel and one consonant (in the correct order) with the target word. The consonant may be a developmentally appropriate substitute matching the consonant placement (e.g., if the child said "chi" for "sit").

   Words: Vocal productions that are clearly identifiable as words. These include filler pauses, and words for agreement and disagreement such as uhuh, mm, etc.

3. For the sake of consistency, no sound effects were included in the counts of vocal productions, as they were not regarded as essential to the meaning of the utterance. For this reason, all sound effects were transcribed but placed in curly brackets, which precluded them from being counted in the analysis.
4. **Utterance boundaries:** An utterance is complete when a thought is completed and/or when there is a definite pause (about 0.5 s or more).

<u>Conventions specific to this study</u>

.

{} Nonverbal utterances of communicative intent – can be part of a verbal utterance (on same line) or a purely nonverbal utterance. For this study gestures, mimes, sound effects and pointing were transcribed. Manipulation of material was not regarded as an 'utterance'.

XX[VOC] Vocalisation, as defined by a vocal production of any length that is not recognisable as a word or word approximation (see definitions below) because of poor articulation or background noise

Codes specific to this study

[VOC] Vocalisation (see definition above) – this code should follow every entry of XX (i.e. XX[VOC])

[WA] Any word approximation is transcribed as the target word followed by the code. The child's pronunciation is transcribed as best possible in curly brackets at the end of the utterance. For example: If the child said 'chi' for 'sit, it would be transcribed as:

C sit[WA] {child said chit}.

Spelling conventions specific to this study

Words for agreement:
Mm
Mhm
Aha (can also sound like uhu, but was transcribed as aha)
Yeah
Uh

Words for disagreement
Uhuh
Hmhm
Huhuh

Other
Oh
Ohoh (indicating that something is amiss)
Huh (an inhalation that indicates surprise, expectation or shock)
Sho
Ah
Mm
Aw (regret or compassion – like saying ‘shame’)

Sound effects
%zzz
%www
%sh
%swoosh
%brgh (crashing noise)
%pah
%qwa

Appendix B
Stories used in original study (Tönsing, 2015)

Story A

This is a dog. This is Ben. Ben has a **red ball**. He wants to play. Come and play, dog! Ben and the dog go outside. Ben throws the **red ball**. **The dog runs**. He brings back the ball. **Ben laughs**. He likes playing with the dog. Ben throws the ball again. **The dog runs**. Where is the ball? It is not in the grass! Oh no. It's in the tree! Ben climbs up the tree. Oh no. **Ben falls**! Ben climbs up the tree again. Boom! He hits the ball out of the tree. Oh no! **Ben falls**! He falls into the mud. Oh no. **Dirty shirt**! And look! **Dirty pants**! Ben and the dog run to mommy. Ben gives her the **dirty pants**. He gives her the **dirty shirt**. Mommy puts them all in the washing machine. She washes the pants and the shirt. She hangs them up. Ah, look, here the shirt and the pants are clean again. **Ben laughs**. He is happy. The dog is happy too. They go outside again. They play with the ball again.

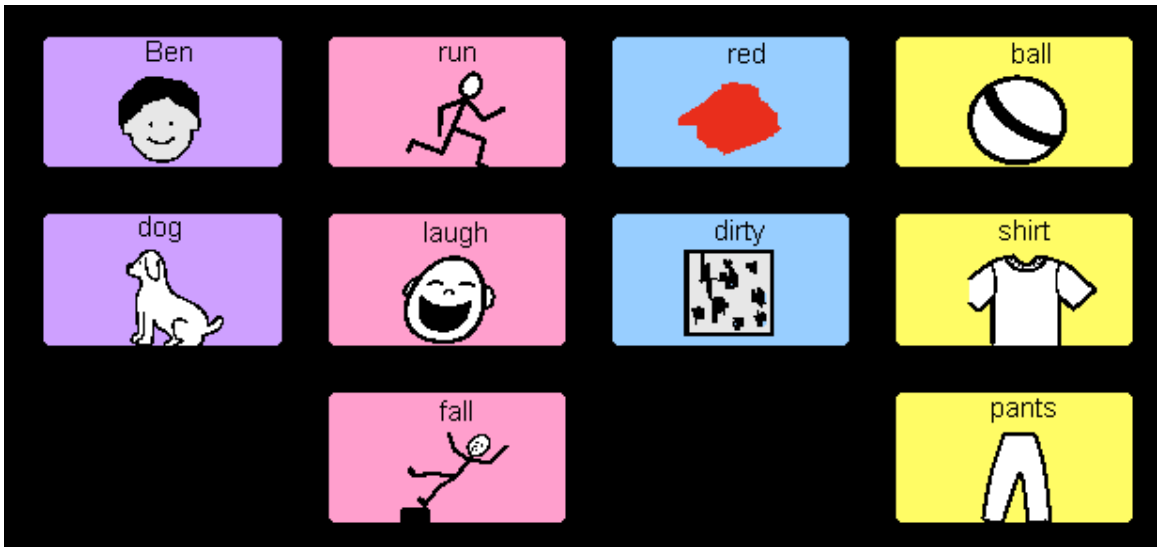
Story B

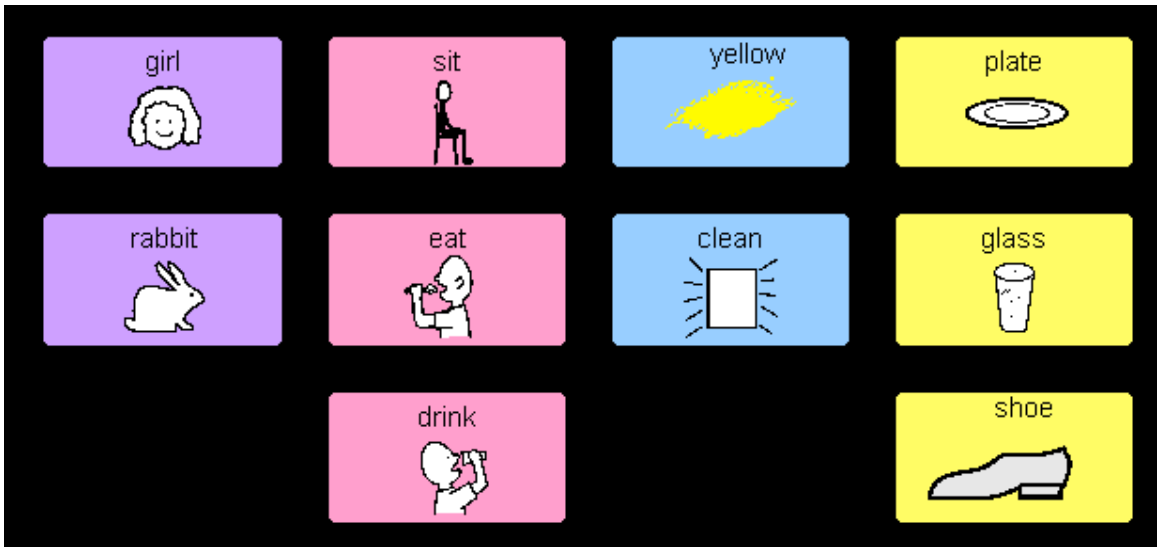
This is a cat. **The cat sleeps**. Here comes Sam. Sam has a **blue hat**. Sam wants to play. Wake up cat! Come and play. Sam puts on his **blue hat**. Sam takes his car. He also takes his plane. Sam and the cat go outside. **The cat walks**. She walks up the hill. Sam pushes the car and the aeroplane up too. The cat sits in the car. Swoosh! Down they go! What fun! **The cat walks**. She walks up the hill again. Sam pushes the car and the aeroplane up again. The cat sits in the car again. Swoosh! Here they go! Oh no. There is a stone! The cat jumps out. Crash! Sam runs down the hill. He finds the **broken car.** He finds the **broken aeroplane. Sam cries**. He is so sad that his toys are broken. Here comes Daddy. He sees that **Sam cries**. Sam gives Daddy the **broken car**. He gives Daddy his **broken aeroplane.** Daddy mends the toys. Look, they are all fixed! Yay! Sam plays with his aeroplane. The cat lies down in the grass. Sshhh! **The cat sleeps**.

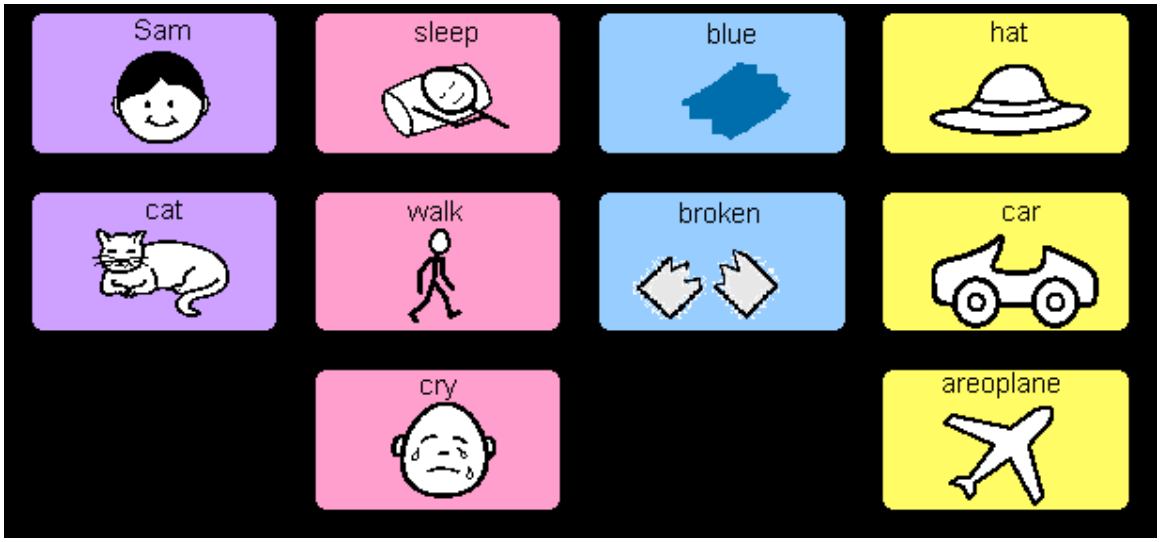
Story C

This is a rabbit. The rabbit sits. Here is a yellow shoe. Here comes the girl. She wants to go outside. She wants to play with the rabbit. She takes the yellow shoe. She puts it on the rabbit. She takes a clean glass. She takes a clean plate. She puts them in the pram. The girl and the rabbit go outside. The rabbit sits. The girl takes out the clean plate. She takes out the clean glass. She takes out some cookies and some cooldrink. The girl eats. The rabbit drinks. Oh no, here comes a bee! It sits on the rabbit's tummy! Go away, bee! The girl hits it with a cloth. The girl eats. The rabbit drinks. Oh no, here comes the bee again! She sits on the girls hand. Sting! Ouch! The bee has stung the girl! The girl screams. It hurts! She runs to mommy. Mommy puts a plaster on her hand. That feels much better. Rabbit also wants a plaster. Mommy puts one on his tummy. Now the girl and the rabbit are happy.

Appendix C
Overlays used in original study (Tönsing, 2015)







Appendix D
Talking Mats™ carpet with rating scale and answer

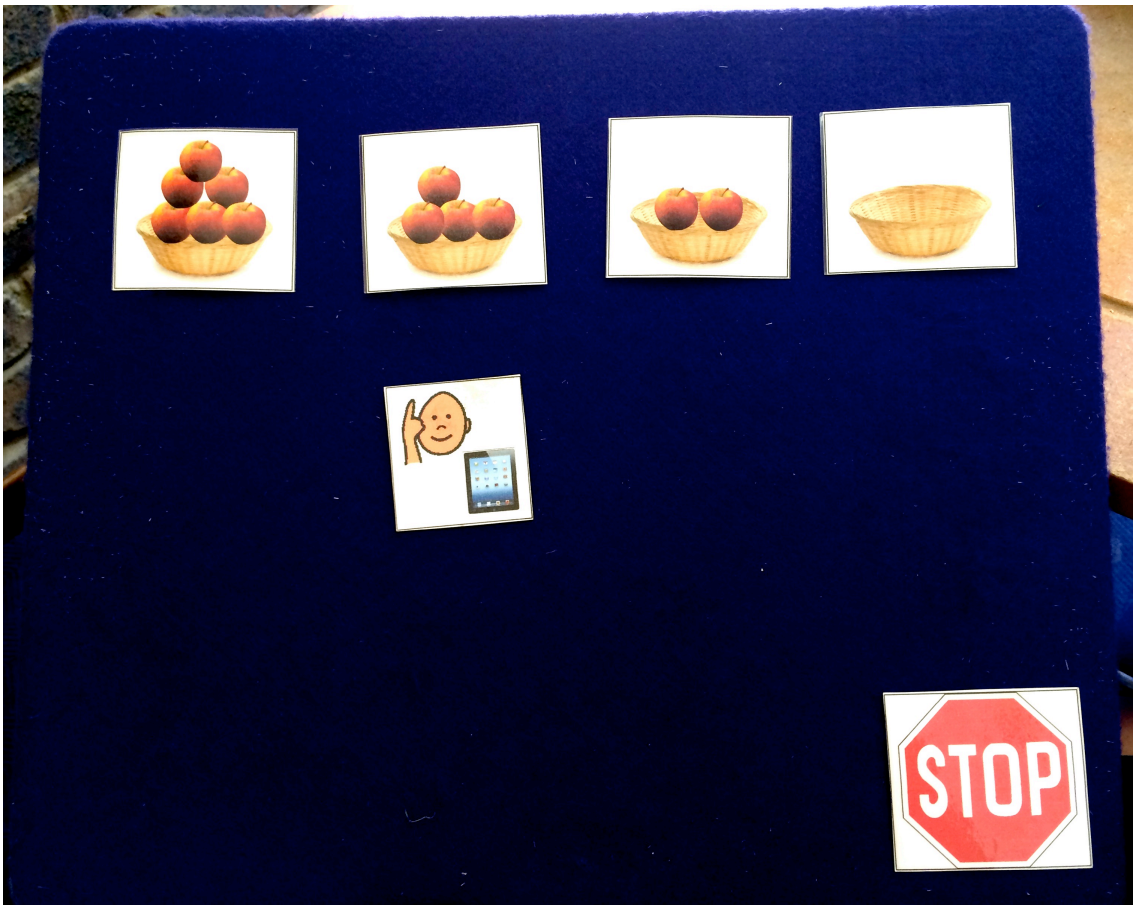


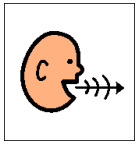
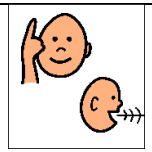
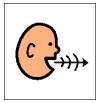
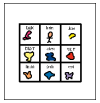
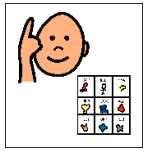
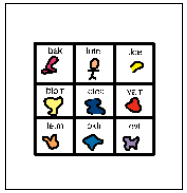
Figure A.1. Talking Mats™ rating scale represented by pictures of baskets of apples placed on a piece of carpet, with picture representing question 2.2 (see Appendix E) placed under 'quite a bit' on the rating scale

Appendix E
Rating scale questions

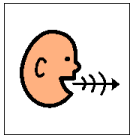
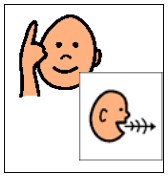
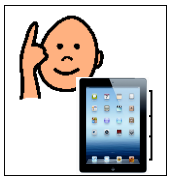
"Do you remember Thobile? Let's see if you can remember the things she liked and didn't like."

No.	Question	Picture Symbol	A lot	Quite a bit	Not that much	Not at all
a)	Thobile likes chocolate a lot. If I gave Thobile a chocolate now, how much would she like it?					
b)	Thobile doesn't like injections at all. If I gave Thobile an injection now, how much would she like it?					

Perceptions of treatment efficacy for communication board use

No.	Question	Picture Symbol	A lot	Quite a bit	Not that much	Not at all
1.1	How much did ... talk (with his/her mouth)?					
1.2	How much of what ... said (with his/her mouth) did you understand?					
1.3	How much did …. use the board with pictures to talk?	 				
1.4	How much of what … said (with the pictures) did you understand?					
1.5	If you couldn't speak, would you like to use the communication board to talk to your friends?					

Perceptions of treatment efficacy for SGD use

No.	Question	Picture Symbol	A lot	Quite a bit	Not that much	Not at all
2.1	How much did ... talk (with his/her mouth)?					
2.2	How much of what ... said (with his/her mouth) did you understand?					
2.3	How much did …. use the iPad to talk?					
2.4	How much of what … said (with the iPad) did you understand?					
2.5	If you couldn't speak, would you like to use the iPad to talk to your friends?					

Appendix F
Rating Scale

A lot	Quite a Bit	Not that much	Not at all
			

Appendix G
Screening procedure

Procedure/ Questions	Picture Symbol	A lot	Quite a bit	Not that much	Not at all
This is Thobile. Say hello to Thobile.					
Thobile really likes chocolate a lot. If I gave Thobile a chocolate now, how much would she like it?					
Thobile likes riding her bike quite a bit. If Thobile could ride her bike now, how much would she like it?					
Thobile doesn't like eating broccoli that much. If I gave Thobile broccoli to eat now, how much would she like it?					
Thobile doesn't like injections at all. If I gave Thobile an injection now, how much would she like it?					

Appendix H
Permission letter from the Ethics Board of the Faculty of Humanities, University of Pretoria

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

18 June 2015

Dear Dr Dada

Project:	**Comparing the vocalizations of children with limited speech when using a communication board versus an SGD during a joint story reading activity**
Researcher:	**KC Brewis**
Supervisor:	**Dr KM Tönsing**
Department:	**Centre for Augmentative and Alternative Communication**
Reference numbers:	**14080151 (GW20150415HS)**

Thank you for your response to the Committee's correspondence of 11 May 2015.

The **Research Ethics Committee** notes that the outstanding permissions from the *Department of Education and the LSEN school* were submitted as requested and has therefore given **final approval** for the above application at an *ad hoc* meeting on 18 June 2015. Data collection may therefore commence.

Please note that this approval is based on the assumption that the research will be carried out along the lines laid out in the proposal. Should the actual research depart significantly from the proposed research, it will be necessary to apply for a new research approval and ethical clearance.

The Committee requests you to convey this approval to the researcher.

We wish you success with the project.

Sincerely

Prof Karen Harris
Acting Chair: Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:Karen.harris@up.ac.za

Kindly note that your original signed approval certificate will be sent to your supervisor via the Head of Department. Please liaise with your supervisor.

Appendix I
Permission letter from Department of Education

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no: D2016 / 053

GDE RESEARCH APPROVAL LETTER

Date:	30 April 2015
Validity of Research Approval:	30 April 2015 to 2 October 2015
Name of Researcher:	Brewis K.
Address of Researcher:	22 Kings Creek; Kingswood Crescent; Riverclub; Sandton; 2196
Telephone / Fax Number/s:	083 799 7329
Email address:	kimbrewis@gmail.com
Research Topic:	Comparing the vocalizations of children with limited speech when using board versus a speech generating device (SGD) during a joint story reading activity
Number and type of schools:	TWO LSEN Schools
District/s/HO	Tshwane North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter;

2015/05/04

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

2. A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB);
3. A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned;
4. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, SGBs, teachers and learners involved. Participation is voluntary and additional remuneration will not be paid;
5. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage;
6. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year;
7. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
8. It is the researcher's responsibility to obtain written parental consent and learner;
9. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources;
10. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations;
11. On completion of the study the researcher must supply the Director: Education Research and Knowledge Management with one Hard Cover, an electronic copy and a Research Summary of the completed Research Report;
12. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned; and
13. Should the researcher have been involved with research at a school and/or a district/head office level, the Director and school concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Dr David Makhado

Director: Education Research and Knowledge Management

DATE: 2015/05/04

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix J
Example of letter of consent given to school principal

Dear Sir/Madam

Re: Participation in research study

My name is Kim Brewis, I am a student at the University of Pretoria and I am currently enrolled for a Master's degree in Augmentative and Alternative Communication (AAC) at the Centre for AAC at the University of Pretoria.

The title of my study is: "Comparing the vocalizations of children with limited speech when using a communication board versus an SGD during a joint story reading activity." One of the aims of the study is to determine the perceptions of peers regarding the influence of the use of a communication board versus a speech generating device (SGD) on vocalizations of children with limited speech.

Rationale for the study
Social validation is a process that determines whether the goals, methods and outcomes of intervention are perceived as socially important and acceptable by the stakeholders of the intervention (Schlosser, 1999), as it is then more likely that the intervention outcomes will be maintained. Peers in particular play an important role in promoting classroom participation for children who use AAC. A study that looked at the effect of implementing a training program for peers of a child who used AAC, revealed a significant increase in the number of messages communicated after the peers were trained to more effectively communicate with the child using the AAC system (Lilienfeld & Alant, 2005).

What will be expected of the school?
I will require the help of teachers to identify children who could potentially participate in the study. The children will be required to view four 5 minute videos of one of their class peers using two different AAC systems during a storybook reading activity. The children will then be asked 5 simple questions after each video. The teachers will be consulted about an appropriate time to remove the children from the class to ensure that they don't lose out on valuable class time. I will require a room on your school premises, as well as a table and two chairs to conduct the survey with the children.

What will be expected of children participating in the study?

- To meet me, possibly during break time at school
- To undergo an individual screening procedure to determine their abilities in the following areas:
  - understanding of the English language
  - adequate vision and hearing
  - concentrate for 10 minutes at a time
  - understand the procedures to be used during the study.
- This screening procedure will take a total of about 30 minutes per child.

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Sentrum vir Aanvullende en Alternatiewe Kommunikasie (SAAK)
Communication Pathology Building
University of Pretoria, Lynnwood Road
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Republic of South Africa

Fax/Faks: + 27 86 510 0841
Tel: + 27 12 420 2001

juan.bornman@up.ac.za
www.caac.up.ac.za

- If the screening procedures are passed, each child will be required to view four 5-minute videos of one of his/her class peers using two AAC devices during a storybook reading activity. The child will then be asked five simple questions about the two videos. This would take about 30 minutes pre child.
- These sessions will be video-recorded.

The following ethical principles will be upheld within this study:

- Permission was obtained from the Gauteng Department of Education (DOE).
- Written consent from all the participant's parents and verbal assent from all the participants themselves will be obtained prior to conducting the study.
- All participants will be made aware of their right to withdraw from the study at any point in time.

Who will have access to the results of the study?

The research will be stored as both hard copy and in electronic format at the University of Pretoria in the AAC center for 15 years. The data obtained from the research will be used for teaching, research and writing a scientific paper. All results will be made available for any interested staff or parents.

What are the risks and benefits?

At no time during the participation in the research will the students be at risk of any harm. The teachers will be consulted about an appropriate time to remove the children from the class to ensure that they don't lose out on valuable class time. Potential benefits of this study may include extending research within the field of AAC and providing empirical evidence to help advocated for funding of the relevant AAC systems.

I would appreciate your consideration of my request and should you like to help me with this study, please sign the attached reply slip. For any further information, please contact me on the contact details supplied below.

Kind regards

_____ _____

Kim Brewis Date

kimbrewis@gmail.com

_____ _____

Dr. Kerstin Tönsing (Supervisor) Date

Centre for Augmentative and Alternative Communication (CAAC)
Sentrum vir Aanvullende en Alternatiewe Kommunikasie (SAAK)
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UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Humanities

Office use

Principal Informed Consent: Consent Reply Slip

Name of Principal: _____

Name of School: _____

Project title: Comparing the vocalizations of children with limited speech when using a communication board versus an SGD during a joint story reading activity

Researcher: Kim-Caleigh Brewis
Master's Student
Centre for AAC

Supervisor: Dr Kerstin Tönsing

I, _____
Name and surname

☐ consent for Ms Brewis to undertake her study at the abovementioned school. This consent is voluntary and I understand that I may withdraw the consent for Ms Brewis to conduct her study at the school at any time. I understand that the data will stored for 15 years at the CAAC and that all data will be treated confidentially. I understand that the data maybe re-used for analysis. I understand that the sessions will be video-taped for data collection purposes and may be used for training and conferences. I understand that all information used and obtained in this study will be treated as confidential.

OR

☐ do not give consent for for Ms Brewis to undertake her study at the abovementioned school.

_____ _____
Principal Signature Date

School stamp

Centre for Augmentative and Alternative Communication (CAAC)
Sentrum vir Aanvullende en Alternatiewe Kommunikasie (SAAK)
Communication Pathology Building
University of Pretoria, Lynnwood Road
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Appendix K
Example of letter of consent given to parents of original study participants

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities

November 2014

To the parent/legal guardian of _____, enrolled at Pretoria School for Cerebral Palsied, Physically and Learning Disabled Learners

Dear Sir/Madam

Re: Request for permission to reuse video material collected during the research project entitled "Supporting multi-symbol utterances in children with limited speech: A comparison of two augmentative and alternative communication systems".

Thank you very much for previously allowing me to involve your child, _____, in the research study mentioned above conducted at Pretoria School for Cerebral Palsied Learners in June 2014. During this study, video material was collected of your child taking part in story reading sessions using both a communication board as well as a speech generating device.

A student who is currently enrolled for her Master's degree in Augmentative and Alternative Communication, Kim-Caileigh Brewis, would like to expand on this study by making use of the video material collected of your child. She would like to:

1. analyze the video material collected during this project to determine if there are differences in the types and amount of vocal productions (spoken words and vocalizations) that the children produced when using a communication board as opposed to a speech generating device, and
2. obtain the perceptions of five of your child's peers about the two different communication systems that your child used and the way these help your child to speak.

I would therefore like to ask your permission to use the video material collected of your child for this purpose.

Should you give permission, this would entail the following:

1. The student, Kim-Caileigh Brewis, as well as two research assistants would watch and analyse the video material collected to determine the types and amount of vocal productions that your child produced in each of the story reading sessions. They would keep any information confidential and would not share the video material with anyone else, not disseminate information that would identify your child with a third party.
2. The student would show five of your child's peers from his class two 5-min video clips of your child as he uses each of the systems, and would then ask them questions about their perceptions of the way the two different systems used help your child to speak.

The results of this analysis are intended to be published as a Master's dissertation as well as a journal article, and may also be presented at professional conferences. All data will be treated as

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confidential, and results will be reported anonymously, without linking identifying information to specific results.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. However, should you decide to withdraw your child's participation, any data pertaining to your child will be immediately destroyed.

Should you need any further information on the study, please do not hesitate to contact me on 082 661 6007 or email me at kerstin.tonsing@up.ac.za.

Kind regards

_____ _____

Kerstin Tönsing
Lecturer and Speech and Language Therapist
Centre for Augmentative and Alternative Communication
BCommunication Pathology, MA (AAC), PhD (AAC)
Cell: 082 661 6007

Date

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities

Reply slip: Reanalysis of video material collected during the study entitled "Supporting multi-symbol utterances in children with limited speech: A comparison of two augmentative and alternative communication systems" and use of this video material to obtain peer perceptions

I, _____, parent/legal guardian of
(parent/legal guardian's name)

_____, hereby do / do not (please circle appropriate)
(child's name)

grant permission for the reanalysis of video material of my child and the use of this video material to obtain peer perceptions as described in the letter attached.

_____ _____
(Signature of parent/legal guardian) (Date)

Centre for Augmentative and Alternative Communication (CAAC)
Sentrum vir Aanvullende en Alternatiewe Kommunikasie (SAAK)
Communication Pathology Building
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Appendix L
Example of letter of consent given to parents of peer participants

Dear Sir/Madam

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities

Re: Participation in research study

My name is Kim Brewis, I am a student at the University of Pretoria and I am currently enrolled for a Master's degree in Augmentative and Alternative Communication (AAC) at the Centre for AAC at the University of Pretoria.

The title of my study is: "Comparing the vocalizations of children with limited speech when using a communication board versus an SGD during a joint story reading activity". One of the aims of the study is to determine the perceptions of peers regarding the influence of the use of a communication board versus a speech generating device (SGD) on vocalizations of children with limited speech.

What is expected of my child?
Should you give consent for your child to participate in the study, and should your child be willing to participate in the study, the following will be expected of him/her:

- To meet me, possibly during break time at school
- To undergo a screening procedure to determine his/her abilities in the following areas:
  - understanding of the English language
  - adequate vision and hearing
  - concentrate for 10 minutes at a time
  - understand the procedures to be used during the study.
- This screening procedure will take a total of about 30 minutes.
- If the screening procedures are passed, your child will be required to view four 5-minute videos of one of their class peers using two AAC devices during a storybook reading activity. Your child will then be asked five simple questions about the two videos. This would take about 30 minutes.
- These sessions will be video-recorded.

What are my child's rights?
Participation in the research is voluntary. You may withdraw your child or your child may withdraw from the study at any point in time and all data pertaining to your child will be immediately destroyed.

All data pertaining to your child will be kept strictly confidential. The video recordings of the survey will only be watched by myself, my supervisors, and one independent rater.

Who will have access to the results of the study?
The research will be stored as both hard copy and in electronic format at the University of Pretoria in the AAC center for 15 years. The data obtained from the research will be used for teaching, research and writing a scientific paper. All results will be made available for any interested staff or parents.

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What are the risks and benefits?
At no time during the participation in the research will your child be at risk of any harm. Teachers will be consulted about an appropriate time to remove your child from the class to ensure that they don't lose out on valuable class time. Potential benefits of this study may include extending research within the field of AAC and providing empirical evidence to help advocated for funding of the relevant AAC systems.

I would appreciate your consideration of my request and should you like to help me with this study, please sign the attached reply slip. For any further information, please contact me on the contact details supplied below.

Kind regards

_____ _____
Kim Brewis Date
kimbrewis@gmail.com

_____ _____
Dr. Kerstin Tönsing (Supervisor) Date

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Faculty of Humanities

Office use

Parental Informed Consent: Consent Reply Slip

Name of Child: _____

Name of Parent/Caregiver: _____

Project title: Comparing the vocalizations of children with limited speech when using a communication board versus an SGD during a joint story reading activity

Researcher: Kim-Caleigh Brewis
Master's Student
Centre for AAC

Supervisor: Dr Kerstin Tönsing

I, _____
Name and surname

☐ I consent for my child to participate in this study. My consent is voluntary and I understand that I may withdraw my child's participation from the study at any time. I understand that the data will stored for 15 years at the CAAC and that all data will be treated confidentially. I understand that the data maybe re-used for analysis. I understand that the sessions will be video-taped for data collection purposes and may be used for training and conferences. I understand that all information used and obtained in this study will be treated as confidential.

OR

☐ I do not give consent for my child to participate in this study.

_____ _____
Parent/Caregiver Signature Date

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Appendix M
Script for obtaining peer participant assent

Hello, my name is Kim and I am working on a project with Kerstin. Last year Kerstin came to work with *(child's name)*.
I want to ask you whether you will work with me today. If you say yes, this is what we will do:

First, I will show you some pictures and ask you to point at some of them.

Then, I will tell you a little story about Thobile and ask you a few questions about her. You will have a chance to show me your answer by putting some pictures on a mat (*show actual mat*).

After that, I would like to show you four of the videos of *(child's name)*. After each video, I want to ask you five questions. We will be using some pictures that you can place on the same mat to answer the questions.

I will videotape you as you use the pictures to answer the questions.

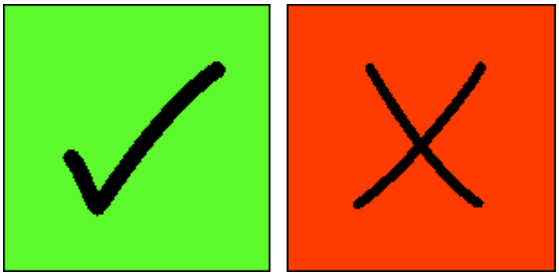
If you want to stop at any time, I want you to please tell me or point at this picture of the stop sign and I will take you back to class.

Child Assent Form

	**Do you understand everything I explained to you?** **YES** **NO**
	**Do you understand that it is your choice to help me today?** **YES** **NO**
	**Do you understand that you can stop any time you want to?** **YES** **NO**
	**Do you understand that I will be using a video camera today?** **YES** **NO**
	**Do you have any questions?** **YES** **NO**
	**Are you happy to help me today?** **YES** **NO**

Picture symbols which the potential participant can use to answer

Yes No



Appendix N
Procedural guideline

No.	Script	✓/×
1	Greetings.	
2	Remind children of their right to stop: "Remember the stop sign that is here for you. If you want to stop and go back to class at any time just let me know or you can point at the sign."	
3	Explain procedures to follow to the child: "Today we're going to watch two videos of … and then answer some questions after each video." Is that ok? Are you happy to do that with me?	
4	Wait for child's response.	
5	Show first video (e.g. iPad video).	
6	Ensure that the child pays attention to the video	
7	Remind participant how to use Talking Mats procedure: "Do you remember how to use the apple baskets? Let's go over it quickly just to make sure."	
8	Present first screening question. "Do you remember Thobile? Thobile really likes chocolate, so if I gave her a chocolate now, how much would she like it?	
9	Wait for child's response and help her/him if necessary.	
10	Confirm the child's answer.	
11	Present second screening question. "Thobile really doesn't like getting injections so if I gave her an injection now, how much would she like it?"	
12	Wait for child's response and help her/him if necessary.	
13	Confirm the child's answer.	
14	Present first topic picture and explain the topic of the question: "We will now talk about how much … talked with his mouth."	
15	Present the first survey question to the participant and name response options. "How much did … talk with his mouth? Did he talk a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
16	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
17	Confirm answer (e.g. "So you are saying he talked quite a bit with his mouth?")	
18	Present the second survey question to the participant and name response options. "How much did you understand when … spoke with his mouth? Did you understand a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
19	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
20	Confirm answer (e.g. "So you are saying you understood quite a bit of what … said with his mouth?")	
21	Present the second topic picture and explain the topic of the question: "We will now talk about how much … talked with the iPad."	
22	Present the third survey question to the participant and name response options. "How much did … talk with the iPad? Did he talk a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
23	Allow the participant up to 10s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
24	Confirm answer (e.g. "So you are saying he talked quite a bit with his mouth?")	
25	Present the fourth survey question to the participant and name response options. "How much of what … said with the iPad did you understand? Did you understand a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are	

	named.)	
26	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
27	Confirm answer (e.g. "So you are saying you understood quite a bit of what … said with the iPad?")	
28	Present the fifth survey question to the participant: "If you couldn't speak with your mouth, how much would you like to use the iPad to talk?").	
29	Show second video (e.g. Communication board video).	
30	Ensure child pays attention to video.	
31	Present relevant topic picture and explain the topic of the question: "We will now talk about how much … talked with his mouth."	
32	Present the first survey question to the participant and name response options: "How much did … talk with his mouth? Did he talk a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
33	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
34	Confirm answer (e.g. "So you are saying he talked quite a bit with his mouth?")	
35	Present the second survey question to the participant and name response options. "How much of what … said with his mouth did you understand? Did you understand a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
36	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
37	Confirm answer (e.g. "So you are saying you understood quite a bit of what … said with his mouth?")	
38	Present the second topic picture and explain the topic of the question: "We will now talk about how much … talked with the pictures".	
39	Present the third survey question to the participant and name response options. "How much did … talk with the pictures? Did he talk a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
40	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
41	Confirm answer (e.g. "So you are saying he talked quite a bit with the pictures?").	
42	Present the fourth survey question to the participant and name response options. "How much of what … said with the pictures did you understand? Did you understand a lot, quite a bit, not that much or not at all?" (Point at relevant apple basket pictures as options are named.)	
43	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
44	Confirm answer (e.g. "So you are saying you understood quite a bit of what … said with the pictures?").	
45	Present the fifth survey question to the participant and name response options. "If you couldn't speak with your mouth, how much would you like to use the pictures to talk?" (Point at relevant apple basket pictures as options are named.)	
46	Allow the participant up to 10s to respond by pointing to the relevant option or placing the picture under the relevant option on the mat.	
47	Confirm answer (e.g. "So you are saying you would like to use it quite a bit?").	
48	Present the preference question to the participant while presenting both the iPad and communication board symbols to him/her. "If you couldn't use your mouth to speak, which one would you like to use to speak?	

49	Allow the participant up to 10 s to respond by pointing at the relevant option or placing the picture under the relevant option on the mat.	
50	Confirm answer (e.g. “So you are saying you would like to use the iPad?”).	
51	Give child a sticker and thank him/her for participating.	

Appendix O
Script for obtaining assent from original study participants

Hello, my name is Kim and I am working on a project with Kerstin. Do you remember Kerstin?

She read stories with you last year and used the video recorder to record her story time with you.

I would like to know if I might please watch the videos that you made with Kerstin last year?

I would also like to show some of those videos to two of your friends in your class and ask them some questions about the videos. If you say yes, it will help me very much. Is it ok if I watch some of your videos? (Wait for answer). Is it ok to show them to some of your friends in your class? (Wait for answer).

Picture symbols which the potential participant can use to answer

Yes No