Using a matrix strategy to teach graphic symbol combinations to children with limited speech during shared storybook reading

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Soli Deo Gloria

"Let him who boasts boast in the Lord."

1 Corinthians 1: 27

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Abstract

Children with limited speech using graphic symbols for communication often express themselves predominantly through single symbols rather than symbol combinations. This study aimed to investigate the effect of an intervention strategy that was incorporated into shared storybook reading on the production of graphic symbol combinations. Three children between the ages of 7;9 (years;months) and 10;8 with limited speech and physical impairments participated in the study. A multiple probe design across behaviours (3 different types of semantic symbol combinations) was used, replicated across the 3 participants. Intervention entailed prompting the production of strategic symbol combinations (generated from a matrix) during shared storybook reading by using a prompting hierarchy. The participants' production of combinations targeted during intervention as well as their ability to generalize to nontarget combinations from the matrix was monitored using a probe test (picture description task). All 3 participants showed some gains in acquiring the combinations and generalizing to nontarget combinations, as measured by the probe test. While 1 participant showed convincing effects, the other 2 showed lower effects. Lower effects may be partly ascribed to participant characteristics as well as to the discrepancies between the intervention and probe contexts. All participants performed better within the shared storybook reading context. Results suggest that the production of symbol combinations can be facilitated during shared storybook reading and that the matrix strategy promotes generalization to untrained semantic combinations. However, participant gains may not reflect immediately in formal testing situations.

Keywords:
Aided communication, augmentative and alternative communication, children, graphic symbol combinations, language learning, limited speech, matrix strategy, multiple probe design, prompting hierarchy, shared storybook reading.

Opsomming

Kinders met beperkte spraak wat grafiese simbole vir kommunikasie gebruik, druk hulself dikwels hoofsaaklik deur die gebruik van enkel simbole uit, eerder as deur die gebruik van simboolkombinasies. Hierdie studie het gepoog om die effek van `n intervensiestrategie wat by gedeelde storieboeklees geïnkorporeer is op die produksie van grafiese simboolkombinasies te ondersoek. Drie kinders tussen die ouderdomme van 7;9 (jare;maande) en 10;8 met beperkte spraak en fisiese gestremdheid het aan die studie deelgeneem. `n Ontwerp vir veelvuldige proewe oor gedragsvorme heen (3 verskillende tipes semantiese kombinasies) en wat oor 3 deelnemers herhaal is, is gebruik. Intervensie het behels dat die produksie van strategiese simboolkombinasies (soos gegenereer vanaf `n matriks) gedurende gedeelde storieboeklees deur die gebruik van ‘n hiërargie van leidrade aangemoedig is. Die deelnemers se aanleer van die kombinasies wat gedurende intervensie geteiken is, asook hulle vermoë om te veralgemeen na nie-teiken kombinasies van die matriks, is deur die gebruik van ‘n toets (prentbeskrywingstaak) gemonitor. Al 3 deelnemers het `n mate van vordering getoon in die aanleer van kombinasies en die veralgemening na nie-teiken kombinasies, soos gemeet deur die toets. Terwyl 1 deelnemer oortuigende effekte getoon het, het die ander 2 laer effekte getoon. Laer effekte kan gedeeltelik aan eienskappe van die deelnemers asook die gebrek aan ooreenstemming tussen intervensie- en toetskontekste toegeskryf word. Alle deelnemers het in die konteks van die gedeelde storieboeklees beter presteer. Resultate dui aan dat di produksie avn simboolkombinasies gedurende gedeelde storieboeklees gefasiliteer kan word en dat die matriksstrategie die veralgemening na ongeteikende semantiese kombinasies kan bevorder. Deelnemers se wins in vaardighede mag egter nie dadelik in formele toetssituasies reflekteer nie.

Sleutelterme:
Aanleer van taal, aanvullende en alternatiewe kommunikasie, beperkte spraak, gedeelde storieboeklees, gesteunde kommunikasie, grafiese simboolkombinasies, hiërargie van leidrade, kinders, matriksstrategie, veelvuldige proef ontwerp.

CHAPTER 1
PROBLEM STATEMENT AND RATIONALE

1.1 Introduction

This chapter presents the problem statement and contextualizes the study. Furthermore, frequently used terms are defined, abbreviations and the notation used are explained and an overview is given of the chapters of the dissertation.

1.2 Problem statement and rationale

The centrality of communication to the human experience is attested to by people from all societies across the globe. There is hardly any form of human activity that does not, directly or indirectly, involve communication. Without communication, our everyday functioning would not be possible, and organized society would not exist.

One of the tasks set before the developing child is that of becoming a competent communicator. This entails the ability to exchange (understand and convey) increasingly complex meanings and intentions in an increasing number of contexts with an increasing range of partners. While the newborn infant can merely react reflexively to internal states (e.g. hunger) or external stimuli (e.g. being fed or soothed), the 5-year-old child can negotiate the roles and script of a pretend game with peers. This monumental shift in communication ability rests largely on the child's development of language. Children increasingly unravel the referential and pragmatic meanings of the spoken language of competent communicators around them and start to use spoken language to express their own referential meanings and pragmatic intentions. Language development encompasses an increase in both linguistic competence (related to the form and content of language) and sociolinguistic competence (being able to use language) and is instrumental in promoting effective communication (Light, 1989).

While early receptive milestones are harder to pinpoint (Bates, 1993), the first significant expressive milestone in language development is the production of the first meaningful word. This event attests to the child's ability to produce a specific string of

sounds (form) to convey a specific meaning (content) in order to fulfil a communicative goal (function). A second important milestone is the emergence of word combinations. While familiar partners, with the help of contextual cues, are able to attribute a variety of meanings to the child's single word productions, the utility of single words to express relations between people, objects, actions and attributes remains extremely limited. Early two-word combinations are not regarded as syntactic, yet they represent an important stepping stone in the development of the ability to combine words into sentences that can express an unlimited number of meanings, thereby providing the user with a powerful and versatile communicative tool.

When a child's ability to use spoken language remains limited, spoken language needs to be augmented or replaced by other means of communication. The goal of becoming a competent communicator now needs to be realized through a different pathway, namely through augmentative and alternative communication (AAC) (Light, 2003). Just like typically developing children, children using AAC should exchange increasingly complex meanings and intentions in an increasing number of contexts with an increasing range of partners. Light (1989, 2003) subdivided communicative competence for persons using AAC into four interrelated competencies, namely linguistic, social (sociolinguistic and sociorelational), operational and strategic competence. Linguistic competence (i.e. the ability to understand and use the form and content of the linguistic code) enables the expression of a range of meanings transcending the immediate context, and remains central to becoming a competent communicator.

Linguistic competence for children using AAC encompasses a variety of skills (Light, 2003). On the one hand, children need to learn the language used by their family and community. On the other hand, they need to learn to express meaning via their AAC symbols. Similar to the expressive language development of typically developing children, this would entail initially learning to use single symbols and then progressing to symbol combinations to express increasingly complex messages.

The use of graphic symbols as an alternative or supplement to speech to aid the expression and/or understanding of children with limited speech is a common practice, especially when children have additional physical challenges. Graphic symbols such as Picture Communication Symbols (PCS) are typically used on nonelectronic communication boards and in conjunction with speech-generating devices (SGDs). Children relying on graphic symbols for expression often struggle to acquire the production of multisymbol messages. Various authors note the high frequency of single symbol utterances—despite expressive vocabularies big enough to warrant symbol combinations (Collins, 1996; Smith, 1996; Soto & Toro-Zambrana, 1995; Sutton & Morford, 1998; Van Balkom & Welle Donker-Gimbrère, 1996; Von Tetzchner & Martinsen, 1996).

Historically, this was attributed to an underlying language deficiency in the person using graphic symbols. However, the fact that even speaking children display shorter utterances and deviant word order in the graphic modality while their spoken abilities do not display such limitations (Smith, 1996; Sutton, Trudeau, Morford, Rios, & Poirier, 2010; Trudeau, Sutton, Dagenais, De Broeck, & Morford, 2007), seems to dispute this explanation. The compensation hypothesis and the modality-specific hypothesis have been offered as two alternative explanations (Soto, 1999; Sutton, Soto, & Blockberger, 2002). The compensation hypothesis posits that graphic symbol output reflects the compensatory strategies employed to avoid cognitive, physical and linguistic limitations that are inherent in aided communication (Sutton et al., 2002; Van Balkom & Welle Donker-Gimbrère, 1996). Such constraints include greater physical effort and slower rate of message production characteristic of aided AAC. Using one symbol rather than combinations speeds up the message transmission process and reduces physical demand and might therefore be used as a compensatory technique to circumvent these constraints and facilitate communication that is more effective.

The modality-specific hypothesis, in turn, offers the constraints inherent in the visual graphic modality as an explanation for the structure of graphic symbol output (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). Graphic symbols do not have the

same linguistic status as spoken words (Smith, 2006). Many are not arbitrary, since there is often a visual relationship between the symbol and the referent. Even though some symbols can be segmented (e.g. Blissymbols), they do not consist of meaningless subunits, while spoken words are made up of sounds (which are, in themselves, meaningless). Unlike spoken words, graphic symbols are not produced by the person using them, but merely selected (Smith 2006). These factors all seem to indicate that expressing oneself with graphic symbols differs substantially from expressing oneself using spoken words.

Interpreting the meaning of single-symbol utterances places high demands on the message recipient. Without the help of background knowledge and/or contextual cues, this task may be very difficult, if not impossible. Blockberger and Sutton (2003) note that, during the stage when young children typically communicate using single words, they are mostly in the care of adults who know them intimately and spend much time with them, thus enabling these partners to interpret these messages in the light of a shared context. When single-symbol messages persist during the time when children's range of communication partners extends to persons who do not know them as well, these reduced messages can lead to frequent communication breakdowns. Such breakdowns may result in much frustration, abandonment of communicative attempts, passivity and learnt helplessness. Social networks often remain limited. Use of single-symbol messages may also create unfavourable impressions of the competence of the person using AAC. It has been shown that unfamiliar observers with and without background in AAC rated a person using AAC as less communicatively competent when he was communicating in single words than when he was using phrases to express himself (Hoag, Bedrosian, Johnson, & Molineux, 1994).

Although use of single symbols, rather than combinations of symbols, may have advantages in terms of the rate of message production and may reduce physical and cognitive demand for the person using AAC, there may be various situations in which the production of symbol combinations increases communicative competence. Facilitating the production of symbol combinations in children who rely on graphic symbols for

expression is therefore an important intervention aim that can contribute to the overall communicative competence of the child. A limited number of intervention studies have targeted the production of graphic symbol combinations. The use of aided input (adult models of word combinations using graphic symbols) within natural contexts has been shown to be effective to promote the production of imitated and spontaneous multigraphic symbol combinations in children who require AAC (Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008; Binger, Kent-Walsh, Ewing, & Taylor, 2010). Because aided input techniques attempt to simulate the natural language environment that surrounds typically developing children acquiring speech, these techniques tend to be less specific in the exact models provided by adults and the exact structures produced by the children. In the studies by Binger et al. (2008; 2010) the children's understanding of their own productions and the meaningfulness of these productions was not directly monitored.

Another intervention study targeting the production of graphic symbol combinations employed a hybrid intervention technique that combined indirect, naturalistic strategies with more direct teaching strategies. The mand-model technique combined with a matrix strategy (Nigam, Schlosser, & Lloyd, 2006) was used to target specific two-symbol combinations in structured teaching contexts. The advantage of using more structured intervention techniques is the ability to show a direct link between the specific instruction given and the specific structures learnt by the child. At the same time, such approaches tend to be conducted in formal contrived teaching situations and additional training may be necessary for skills to generalize to natural interactive situations.

The current study employed a structured intervention approach within a more naturalistic context, namely shared storybook reading, to facilitate the production of specific graphic symbol combinations. Shared storybook reading allows for conversational turn taking between a more competent and a less competent partner around a predetermined, structured topic (the storyline). It was therefore a suitable context for the current intervention, as it afforded the opportunity to target preselected symbol combinations using preselected graphic symbols. Furthermore, it allowed for

structured scaffolding (time delay, mands and aided models) to be provided to the participants in order to prompt the production of the target combinations.

1.3 Terminology

Here following are the definitions of terms frequently referred to in the study.

1.3.1 Augmentative and alternative communication (AAC)

Augmentative and Alternative Communication refers to "the supplementation or replacement of natural speech and/or writing using aided and/or unaided symbols" (Lloyd, Fuller, & Arvidson, 1997, p. 524) in order to support the communication efforts of persons whose speech is not adequate to meet all their communication needs.

1.3.2 Children with limited speech

Children with limited speech cannot adequately meet all their communication needs through speech. For the purpose of this study, limited speech was defined as speech that was less than 50% comprehensible to unfamiliar partners in the semantic context condition of the Index of Augmented Speech Comprehensibility in Children (I-ASCC) (Dowden, 1997).

1.3.3 Graphic symbols

These are two-dimensional, visual symbolic representations of a concept. Graphic symbol systems or sets are typically represented using black outlines and many are at least partially picture based.

1.3.4 Intervention strategy

The intervention strategy employed during shared storybook reading consisted of two main components, namely the use of a matrix strategy and the use of a hierarchy of prompts. The matrix strategy is specifically aimed at teaching the production of word combinations, by drawing up a "combination matrix" (Nigam et al., 2006), whereby a set number of lexical items fulfilling one specific semantic role are systematically combined with each of a set number of lexical items fulfilling another semantic role. A limited set

of strategic combinations from the matrix is then taught, while generalization to the remaining combinations is hoped to be achieved (Nelson, 1993).

A number of prompts were given in order to elicit the production of symbol combinations from participants. These prompts were given in a specific order, from least to most directive, until a correct response was elicited. The prompts were based on techniques used in naturalistic language teaching strategies. These included expectant time delay (Halle, Baer, & Spradlin, 1981), questions, mands and models (Warren, McQuarter, & Rogers-Warren, 1984) as well a physical assistance to produce the symbol combination (Angelo & Goldstein, 1990).

1.3.5 Picture Communication Symbols (PCS)

These constitute a graphic symbol library of simple clear drawings (originally black and white). Many PCS attempt to represent a concept pictorially. No grammatical rules exist for generating new symbols or combining symbols and, as such, symbols form a set rather than a generative system (Fuller, Lloyd, & Stratton, 1997, p. 55). While the classic symbol collection comprises about 4500 symbols, many additional libraries exist, making the PCS one of the largest symbol collections available (Mayer-Johnson, 2011).

1.3.6 Production of graphic symbol combinations

This term refers to the act of producing a message by pointing sequentially to at least two graphic symbols. Such a message intends to convey a specific semantic relationship (e.g. *BOY RUN*, denoting that the boy is running). The term *production* is, at times, used interchangeably with *expression*.

1.3.7 Shared storybook reading

For the purpose of this study, this refers to the process of a literate person and a child jointly engaging in an illustrated storybook. The literate person takes the lead in reading the story but creates opportunities for the child to contribute parts of the story.

1.4 Abbreviations

AAC	Augmentative and alternative communication
CELF	Clinical Evaluation of Language Fundamentals
CI	Confidence interval
I-ASCC	Index of Augmented Speech Comprehensibility in Children
IRD	Improvement rate difference
LDS	Language Development Survey
MLU	Mean length of utterance
PCS	Picture Communication Symbols
PND	Percentage nonoverlapping data
PPVT-4	Peabody Picture Vocabulary Test, Fourth Edition
PPVT-R	Peabody Picture Vocabulary Test—Revised
REEL-2	Bzoch-League Receptive Expressive Emergent Language Scale Second Edition
SERLA	Sotho Expressive Receptive Language Assessment
SGD	Speech-generating device
VERLA	Venda Expressive Receptive Language Assessment

1.5 Notation

The notation used this dissertation follows that suggested by Von Tetzchner and Basil (2011). Spoken words are thus written in italics, while the glosses of graphic symbols are written in italicized capital letters. Gestures and manual signs are represented using capitals. When speech and graphic symbols are simultaneously used for expression, they appear within waved parentheses.

1.6 Overview of the chapters

The study is presented in six chapters. Chapter 1 presents the problem statement and context of the study. Frequently used terms are defined and abbreviations are explained. The notation used in the study is explained.

Chapter 2 presents theory and research findings that relate to the acquisition of word combinations in typically developing children. Data is presented about the way in which graphic symbol output in children using AAC changes over time; research findings regarding the structure of graphic symbol output composed by speaking children are also discussed. A model (adapted from Bedrosian, 1997) of factors influencing language acquisition through AAC is presented. The possible influence of each factor on the production of graphic symbol combinations is discussed. Intervention studies targeting the production of graphic symbol combinations are summarized and reviewed. The chapter concludes by illustrating how the current study extends previous intervention research.

The methodology of the study is discussed in Chapter 3. The aims and the design are clarified. The objectives and outcomes of the pilot study are described, followed by a description of the main study. The main study is described in terms of the participants (selection criteria, recruitment and description), the materials and equipment used, as well as the procedures followed during each stage of the study. The data analysis procedures are also described, including procedures used to monitor reliability of the data and treatment integrity.

Chapter 4 contains a description of the results of the study according to the subaims identified in Chapter 3. First, the effect of the intervention on the production of graphic symbol combinations (intervention and generalization items) is described for each of the participants. Second, the results of the analyses regarding the influence of the type of semantic combination and the order in which the combinations were targeted are presented. Last, the structure of the responses classified as correct is described in terms of number and order of elements.

In Chapter 5, the results of the study (particularly those pertaining to subaims i, ii, and iv) are interpreted and integrated with the relevant literature. Possible influences on the effectiveness of the intervention in promoting the production of graphic symbol combinations are grouped and discussed according to the model presented in Chapter 2.

Similarities and differences to previous findings are highlighted. The structure of the multi-graphic symbol responses produced is also compared to previous research findings and possible influences are explored.

Finally, the most important conclusions regarding the effectiveness of the intervention are presented in Chapter 6. Clinical implications of the results are discussed and the study is evaluated in terms of its strengths and limitations. Recommendations for further research are also provided.

1.7 Summary

In this chapter, the rationale for the study was presented by highlighting the difficulties which many children communicating with graphic symbols experience in transitioning from the use of single symbols to the use of symbol combinations for expression. Previous research in this area was briefly presented and the need to extend this research was highlighted. The frequently used terms and abbreviations were explained, as was the notation used. An overview of the chapters contained in this dissertation was given.

CHAPTER 2
LEARNING TO PRODUCE GRAPHIC SYMBOL COMBINATIONS

2.1 Introduction

Human communication differs from communication amongst other species by the capacity of humans to use language. Language can be defined as a conventional, arbitrary set of symbols that can be combined productively according to specific rules to create an unlimited number of meanings (Bloom & Lahey, 1978). The representational power of language lies precisely within the unlimited number of meanings that its user is able to express. At least two characteristics of linguistic signs underlie this representational power: first, their symbolic nature and, second, their potential for productive combination. Children acquiring language need to master both these aspects. They first acquire symbolic skills as they come to understand the correspondence between words and their referents. Second, they break through into grammar when they start combining words in increasingly complex sentences that enable them to express an increasing variety of thoughts and intentions (Pinker, 1994).

The ultimate aim, when introducing AAC strategies to children who have not been able to develop sufficient speech to meet their expressive communication needs, should be allowing the child to obtain, as near as possible, the same communicative competence that a typical speaker has. The notion of "communicative autonomy" has been coined in this regard (Von Tetzchner & Grove, 2003, p. 27), describing the capacity of the person using AAC to express their communicative intentions in a way that ensures that these intentions are understood. From a linguistic point of view it seems that, first, the child's ability to connect the AAC symbol and the referent of this symbol and, second, the child's ability to productively combine these symbols would be of paramount importance to achieve increasing communicative autonomy.

Throughout this chapter, the phrase *acquisition of graphic symbol combinations* will be used to refer to the ultimate aim, this being the ability to independently and meaningfully generate graphic symbol combinations for communicative purposes. The

mere fact that children are seen or can be taught to produce graphic symbol combinations under certain controlled conditions cannot be seen as evidence that they indeed posses such flexible, generative abilities. However, as will be highlighted further on with reference to language acquisition theories, practice in producing such combinations may be a step towards the acquisition of this skill.

Intervention studies and theoretical writings in the field of AAC have explored symbol acquisition in greater depth than the acquisition of symbol combination skills. Factors that need consideration in selecting symbols have been explored, including issues such as iconicity (Luftig & Bersani, 1985; Stephenson, 2009a), vocabulary variables (Arvidson & Lloyd, 1997) and learnability (Clark, 1981; Ecklund & Reichle, 1987; Goossens, 1983; Mizuko, 1987; Stephenson, 2009c). Instructional methods of teaching symbols have been explored and compared by various researchers (Drager, et al., 2006; Hetzroni, Quist, & Lloyd, 2002; McNaughton & Warrick, 1984; Moolman & Alant, 1997; Schlosser & Lloyd, 1993; Stephenson, 2009b). Theoretical issues pertaining to symbol acquisition (such as the linguistic status of AAC symbols, their relationship to spoken words and the role of instruction [Smith, 2006]) have been explored, but many open questions do remain. The acquisition of skills for combining symbols seems to be understood even less.

The aim of this chapter is, first, to promote an understanding of the factors influencing the ability of children using graphic symbols for communication to produce symbol combinations. To this end, the acquisition of spoken word combinations in children with typical development is reviewed, including both research findings as well as theoretical aspects. Data regarding the ways in which graphic symbol output is structured and how this changes over time is presented, highlighting similarities to and differences from spoken language development. A model of the influences on language acquisition through graphic symbols is presented and each of the factors is discussed in terms of its potential influence on the production of symbol combinations. Second, the chapter presents a summary and an evaluation of intervention approaches that have

sought to promote graphic symbol combinations. Last, the current study is introduced, with reference to the way in which it builds on previous studies.

2.2 Acquisition of word combinations in children with typical development

Analysing the typical development of a particular skill can be a useful starting point from which to understand how and why development of this skill through an alternative pathway may differ. In gaining a better understanding of the emergence of spoken word combinations in the expressive language of typically developing children, both empirical data from actual studies as well as a brief review of some of the theories on the acquisition of early word combinations may be helpful.

Diary studies, some large sample studies and longitudinal language samples (Bates, Dale & Thal, 1995; Brown, 1973; Miller & Ervin, 1964) have been used to document the process of acquisition of early word combinations, as well as preceding and concomitant developmental milestones that may be correlated with the emergence of word combinations. Based (to a greater or lesser extent) on gathered data, theorists have attempted to propose explanations as to when, how and why word combinations emerge in children's speech. Some of the research findings as well as some theoretical positions regarding the acquisition of word combination skills in typical speech-language development are reviewed below.

Around their first birthday, most typically developing children utter their first word. A period of gradual acquisition of single words is usually followed by a growth spurt in vocabulary within the second year of their life (Bates et al., 1995). This growth spurt mostly precedes or coincides with the onset of word combinations, which first occur in a child's speech at around 18-25 months (Bates et al., 1995). Although some phrases may be recognized (often imprecisely articulated) in the child's expressive lexicon prior to this point, these are mostly rote imitations of adult phrases (MacWhinney, 1982). The onset of two-word combinations has been correlated with a single-word expressive vocabulary that has reached a size of between 50 and 100 words (Bates et al., 1995, p. 10; 25). This finding has lead to the theory that a threshold of lexical items is reached that

allows (or forces) children to start segmenting, analysing and productively recombining lexical items, the first evidence of which are two-word combinations (excepting formulaic phrases which the child has learnt in a rote manner) (Locke, 1997; Marchman & Bates, 1994).

Researchers have investigated whether the composition of the child's vocabulary changes within the period in which the child acquires his/her first 200 words, in order to determine possible influences on early word combinations. When analysing the expressive vocabulary of 1803 English-speaking children according to proportion of common nouns, predicates (verbs and adjectives) and closed class words (pronouns, prepositions, articles etc.)—omitting proper nouns and other words like sound imitations—Bates et al. (1995) noted a relatively stable ratio of around 7.3:1.7:1. Caselli, Casadio, and Bates (1999) found virtually identical ratios in the vocabulary of Italian children. The child's early vocabulary is thus clearly dominated by nouns, the word class which also shows the steepest growth curve within the period of acquisition of the first 200 words. Predicates (verbs and adjectives) increase very slowly and steadily in proportion over this time, while closed class words seem to remain at a stable low proportion. There does not seem to be a particular change in word class ratios before word combinations appear. However, during the period of acquiring the next 400 words (i.e. up to an expressive vocabulary of 600 words), the proportion of nouns to predicates to closed class words changes to roughly 6.5:2.1: 1.4. During this time, the proportion of nouns decreases (although they are still by far the most frequent part of speech in the expressive lexicon), while both predicates and closed class words increase—predicates steadily, and closed class words with increasing acceleration (cf. Figure 4.8 in Bates et al., 1995, p. 115). The latter has been correlated with the "take-off point" of syntax (increased utterance length and complexity and more consistent word order) beyond the stage of early word combinations.

Ingram (1989) summarized writings and research describing a period of so-called "holistic successive single-word utterances" (Bloom, as cited in Ingram, 1989) or "vertical constructions" (Scollon, as cited in Ingram, 1989) preceding the emergence of

two-word combinations. These authors indicated that, before children combine words, they seem to use single words (sometimes in successive turns, alternating with a partner) which all relate to a specific event or activity. Bloom (as cited in Ingram, 1989) gave the example of her daughter Alison's use of the words *up, neck* and *zip* in successive turns to express her desire for her mother to zip up her coat. Fónagy (as cited in Ingram, 1989) and also Branigan (1979) established criteria to differentiate between true word combinations and vertical constructions by means of intonation and duration of pause between the words, but the differentiation between these two is not always clear-cut.

Early word combinations differ significantly from adult speech—they consist of content rather than function words; bound morphemes are largely absent and word order is not always consistent, even when the adult form of the language has consistent word order. Nevertheless, the early word combinations observed in children's speech across different languages show surprising similarities in content and structure. Theorists have attempted to explain which principles govern the acquisition of word combinations. Ingram (1989) summarized several of these theories in his chapter entitled "The period of first word combinations" (pp. 234-339). Coming from a nativist perspective, McNeill (as cited in Ingram, 1989) proposed that, at the onset of language acquisition, the child has knowledge of a basic set of grammatical relations (such as predicate, subject, main verb, etc.) that exists in all languages that are available to him/her. The child gradually identifies these relations in the (spoken) language he/she is exposed to. These grammatical relations subsequently manifest in the child's productions in a predictable order. This orientation (Standard Theory) credits the child with grammatical knowledge from the outset, but acknowledges that a gradual "mapping" of this knowledge onto the child's expressive forms occurs. While the child's abilities to do so are innate, a certain amount of language exposure is necessary for the system to "kick in".

Semantic approaches, in turn, propose that early word combinations express specific semantic relations reflecting the child's cognitive developmental level. Various researchers analysed early word combinations according to semantic relations expressed (Braine, 1976; Brown 1973; Radford, 1990). Brown's (1973) classification (based on

data from children from a variety of language backgrounds) is probably one of the better-known ones. He identified 11 semantic relations occurring in children's two-word combinations, with eight types of relations accounting for about 70% of the children's two-word utterances. The most frequent relation was found to be agent-action, followed by action-object, possessor-possession and entity-location. Brown proposed that these relations represented the knowledge the child acquired about the world during the sensorimotor period of cognitive development. Brown regarded this knowledge as universal and proposed that all children developing language would show the same relations. This proposition was seemingly supported by Brown's own data, as well as that of other researchers (e.g. Braine, 1976). In general, semantic approaches do not credit the child with syntactic knowledge. Indeed, some theorists propose that the child's semantic knowledge is a necessary precedent of syntactic knowledge (semantic bootstrapping—e.g. Pinker, 1994).

Cognitive-semantic theories would seem to propose that world knowledge gained through experience with the physical environment is a prerequisite for the emergence of two-word combinations. Attempts to determine cognitive concomitants of the onset of two-word combinations in young children have led researchers to investigate aspects such the child's understanding of causality (Harding & Golinkoff, 1979), symbolic play (McCune-Nicolich, 1981) and categorization skills (Mervis & Bertrand, 1993). Studies have yielded different results. A summary of the studies reviewed by Corrigan (1979) merely seems to point to a correlation between the emergence of language and the transition from sensorimotor stage 5 to stage 6. Ingram (1989), based on analyses of spontaneous language samples, proposed that acquisition of word combinations and attainment of nonlinguistic cognitive skills are not necessarily clearly correlated. Closer correlations between language *comprehension* and cognitive skills rather than language *production* and cognitive skills have been suggested (Bates et al., 1995).

Social constructivism (Vygotsky, as cited in Renner, 2003) sees language development as the product of the child's interactions with competent language users. The influence of partner input during the stage of early word combinations has thus been

sought to be established (Retherford, Schwartz & Chapman, 1981). While mothers seem to adjust their mean length of utterance (MLU) to be on average about two to three words ahead of that of their children, there is less evidence that mothers adjusted the semantic roles and syntactic categories that they used. Rather, it seems that children eventually came to use the semantic roles and syntactic categories modelled by their mothers.

MacWhinney's computational model (1982) deserves a brief mention at this point, since it represents as attempt to differentiate different stages in the process of acquiring word combinations, relating to different processing mechanisms employed by the child. Three mechanisms are identified, the first of which is rote, whereby the child imitates two-word combinations that represent memorized (and often reduced) phrases and sentences. The child then moves on to employ analogy, whereby rote two-word combinations are broken up, and one lexical item is substituted with another. It seems that the child must have some notion of semantic roles in order to substitute words in a logical manner. The final strategy employed is combination, whereby four consecutive processes are employed to order the words within a structure. Of these processes, the first proposes that functional factors (such as the informativeness of the word) determine how children order words. The second proposes that a word's position in a sentence leads the child to abstract certain rules relating to order. The third process entails the child's awareness of semantic relations and formulating combinations based on the knowledge of these. Finally, the child acquires an understanding (even if only implicit) of grammatical categories such as subject and object, which allows him/her to progress into more adult-like grammar.

MacWhinney's approach has been classified as functionalist (Ingram, 1989) and it certainly proposes that both nature and nurture contribute to the child's acquisition of word combinations. Models which the child can imitate seem important to allow for the first processing mechanism (rote), while the ensuing processes increasingly rely on the child's ability to generate a rule system according to which word combinations are composed (cf. also Locke, 1997, p. 273). Matrix strategy interventions used to teach children who experience language learning difficulties to express word combinations

seem to simulate the analogy processing mechanism. This strategy consists of systematically combining lexical items fulfilling one specific semantic role with lexical items fulfilling another semantic role (Chae & Wendt, 2012). This strategy has been used to teach word combinations to children using speech (Ezell & Goldstein, 1989; Mineo & Goldstein, 1990), unaided AAC symbols (Karlan et al., 1982) as well as graphic symbols (Nigam et al., 2006). Returning to the explanation of the term *acquisition* referred to under Section 2.1, it would thus seem that such strategies can promote the production of word (or graphic symbol) combinations and even promote some level of generalization and flexibility (e.g. substituting lexical items fulfilling a specific semantic roles with others fulfilling the same role). At the same time it becomes clear that such skills do not yet constitute the ability to independently and meaningfully generate graphic symbol combinations for communicative purposes, and therefore cannot be regarded as constituting the acquisition of graphic symbol combination skills.

2.3 Structure of graphic symbol output in children

2.3.1 Structure of graphic symbol output in children with limited speech

One problem with investigating the expressive use of graphic symbols for communicative purposes is the question as to whether or not this is a skill can be said to "develop". Certainly many factors speak against it, such as the fact that children using graphic symbols are not part of a natural community of speakers and that formal instruction in the use of graphic symbols is usually provided. Other factors will be discussed in Section 2.4. While there are a few intervention studies aimed at increasing children's expressive use of two-word sequences using graphic symbols (reviewed under Section 2.5), the data of interest here are descriptive developmental data, rather than data on the effect of various intervention programmes. However, because most children learning to use graphic symbols are being taught to do so through regular intervention, descriptive data are necessarily influenced by intervention processes.

Table 2.1 represents a summary of three descriptive longitudinal studies that attempted to describe how the structure of graphic symbol output of children using

graphic symbols changed over time. Only studies in which participants had a mean length of utterance (MLU) of less than 2 at the first point of measurement were included. Studies were also only included if measurements captured (in some way) the changes in utterance structure over time.

From Table 2.1 it becomes clear that data are limited, and sample sizes in each of the studies were relatively small (typical of studies targeting this population). Participants differed in terms of age, receptive abilities and types of graphic symbols used. Furthermore, the number of utterances upon which the analyses are based are relatively small, and very small when compared with data available for speaking children. Nevertheless, the authors make similar deductions about the structure of graphic symbol output, these being that

- in general, output was limited (speaking children produce about 100-200 utterances per 30 minutes conversation time [Crystal, Fletcher & Garman, 1976; Miller, 1981]);
- MLU seemed disproportionately low in comparison to children's cognitive and receptive skills; and
- MLU increased at a slow rate (on average 0.16–0.6 morphemes per year, compared to 1.84 morphemes per year reported for typically developing children aged 18–60 months [Miller & Chapman, 1981]).

It is further noteworthy that MLU increase seemed slowest for children with the lowest number of symbols. However, while Udwin and Yule (1990) specifically reported how many symbols were understood by the participants, it is unclear whether the number of items on the boards reported for the other two studies also represented items that were definitely comprehended by participants.

Kaul (2003) gave a detailed breakdown of the content of symbols found on the communication boards of the five participants using aided AAC. At the beginning of the study, participants had an average of 180 words on their boards (range 95-311). The ratio of nouns to predicates to closed-class words was around 6.8:2.5:0.7. This ratio remained relatively stable over the course of the ensuing two years—in spite of an increase in the

Table 2.1

Longitudinal Studies Capturing the Development of Early Symbol Combination Skills in Children Using Graphic Symbols

Author(s), date and title	Time frame of study and number of data collection points	Participants: Diagnosis and age at onset of study	Receptive language skills	Graphic symbols used, size of aided vocabulary	Situations in which output was recorded	No. of utterances collected	Structure of graphic output
Kaul, 2003: "Patterns of language use in Hindi speaking children with cerebral palsy: natural speakers and aided communicators"	19 months 4 data collection points	5 children with cerebral palsy, mean age 8;8 (years;months) (range: 7;4–10;7)	3-4 information carrying words understood	3 participants used "pictographic representations"; 2 used word boards (Hindi) Average of 189 symbols on communication boards at 1st data collection point, average of 376 symbols on communication boards available at last data collection point	Interactions with a familiar partner at school	50 utterances per data collection point (time taken to collect these varied from 2.4 sessions initially to 1.4 sessions at final data collection point)	- MLU increased from 1.54 to 2.5 - Average MLU increase per year: 0.6 - Predominance of nouns - Reduced use of grammatical markers - Lack of complex utterances - Only one participant used word order that differed from spoken language at the beginning of the study—changed later to conform to order of spoken language
Smith & Grove, 1999: "The bimodal situation of children learning language using manual and graphic signs."	2 years 6 data collection points	Two children with cerebral palsy, aged 5;0 and 4;6 respectively	Within normal limits	PCS; 200+ symbols available on personal communication boards	Not specified	Participant 1, 1st visit: 28 Participant 1, 6th visit: 34 Participant 2: 1st visit: 2 Participant 2: 6th visit: 17	- Initially utterances consisted almost exclusively of single symbols - One participant progressed to MLU (counting PCS only) of 2.0, the other to 1.32 - Estimate of average MLU increase per year: 0.33 - Predominance of nouns in PCS-only output
Uwin & Yule, 1990: "Augmentative communication systems taught to cerebral palsied children—a longitudinal study. I. The acquisition of signs and symbols, and syntactic aspects of their use over time."	18 months 4 data collection points	20 children with cerebral palsy, mean age 6;1 (range: 3;6–9;8)	On average on 3-4 year level	Bliss; 54 items understood at 1st data collection point, 113.7 items understood at last data collection point	Semi-structured conversational exchanges with researcher (30 min each)	Mean no., 1st visit: 11.4 Mean no. , 4th visit: 21.1	- Predominantly single-symbol utterances, but gradual increase of multisymbol utterances (30% of all utterances initially, 45% at end) - MLU increased from 1.44 to 1.69 - Average MLU increase per year: 0.16 - Predominance of nouns - Lack of early syntactic structures (negatives, questions, commands) - Very few complex structures - Most (but not all) multisymbol constructions followed English word order

average number of words on the boards to 345 items. The proportions of the word classes found on the communication boards of the participants in Kaul's study appear quite comparable to those found by Bates and colleagues (1995) in the expressive lexicon of speaking children in the 200-600 word stage (6.5:2.1:1.4), although the former show a higher proportion of predicates and a lower proportion of closed class words. Comparisons between the ratios are somewhat complicated, first because common and proper nouns were not separated in the study by Kaul, which might have inflated the proportion of nouns. Second, the children in Kaul's study used Hindi as their receptive language. Third, while one would like to think of the words on the child's communication board as representative of the child's expressive vocabulary, this is not necessarily the case—the child might not use all the words on the board, and/or might want to express certain words which are not contained on the board.

Authors of the three studies remarked on the predominance of nouns in the output produced by the children. Kaul (2003) specifically compared the output produced by the five aided communicators to that of five speaking children with similar profiles (age, diagnosis, receptive language level). She noted that aided communicators used about double the amount of nouns that the natural speaker used, while only using half as many verbs (p. 340).

Various case reports and clinical examples have corroborated the findings of these three studies (Basil & Soro-Camats, 1996; Brekke & Von Tetzchner, 2003; Hjelmquist & Dahlgren Sandberg, 1996; Soto & Hartman, 2006; Soto, Yu, & Henneberry, 2007; Spiegel, Benjamin, & Spiegel, 1993). The presence of vertical constructions (which typically precede two-word combinations in speaking children) in the aided production of children has furthermore been noted in several reports. Hjelmquist and Dahlgren Sandberg (1996) described the communication of seven adolescents with physical disabilities using Blissymbols, as evidenced in video recordings of interactions between the adolescents and their parents. Various vertical constructions using successive single words were evident in the examples given, in spite of receptive skills on a higher level. The vocabularies available to the adolescents numbered 462 items or more.

Basil and Soro-Camats (1996) reported on the communication development of a girl with multiple disabilities (intellectual impairment and athetoid cerebral palsy), spanning the age of 3;6 (years;months) to 7;3. At age 3;8, the girl was introduced to PCS and, at the end of the study, she had a vocabulary of 151 graphic symbols on eye gaze frames. All examples of interactions given were single symbol utterances, while some evidenced vertical constructions.

Brekke and Von Tetzchner (2003) described the communication development of Sander from the age of 3 to 13 years. Sander had cerebral palsy and used aided symbols. His receptive language and cognitive abilities were age-appropriate. At age 3;4 he was first introduced to pictograms. Until age 5;6 he only used single pictograms. After some changes were made to his language environment (e.g. partner training), vertical constructions appeared first, before the emergence of symbol combinations.

Soto and Seligman-Wine (2003) presented the case study of the communication development of Yehonathan, a boy with athetoid cerebral palsy, from age 2;6 to age 18. His receptive language and cognitive abilities were age-appropriate (and possibly advanced). While photographs of objects and activities were used in intervention from the age of 2;6, more formalized graphic symbols were introduced at age 3;6. It is interesting to note that Yehonathan started using symbol combinations almost directly after receiving his own communication board. At age 3;7 an example of a four-symbol telegraph-like sequence was given consisting of all nouns. It seems that this immediate use of multisymbol utterances is relatively unusual.

2.3.2 Structure of graphic symbol output in typically developing children

Some studies have explored the graphic symbol output produced by typically developing (speaking) children. Smith (1996) introduced five children with typical development aged 3;5 to 4;7 to the use of a communication board containing 53 PCS. Over a period of 10 weeks, the children were taught to use the boards in various communication situations. After this period, the children were individually assessed on their communication board use. They were required to use the board to describe pictures

aimed at eliciting a variety of semantic relations. The youngest child was not able to complete this task and labelled the PCS on her board without this action being relevant to the task. The other children, in spite of intact spoken language abilities, used predominantly single symbol utterances (82.8%) to describe the pictures.

Sutton and Morford (1998) found similar results with slightly older children, where kindergarten children with typical development produced utterances in PCS consisting of a single verb 44% of the time in response to video stimuli that depicted subject-verb-object (SVO) structures. The older children in the study (groups from Grades 2, 4 and 6 were also included) tended to produce more multisymbol utterances, but the order patterns did not always follow English syntax. Still, the order patterns were not random, with a high percentage of OV patterns observed.

Sutton et al. (2010) asked preschoolers (3-4 years of age) to transpose spoken SVO sentences into graphic symbol sequences. Only 47.5% of responses included all three symbols (subject, verb and object). Of the incomplete responses, the verb was omitted 78% of the time, the subject 15% of the time and the object 7% of the time. This finding contrasts with that of Sutton and Morford (1998) where a single verb was the most common response, but task parameters between these two studies differed. Nevertheless, it appears that, compared to spoken output, symbol output is often reduced.

Trudeau et al. (2007) found that, with increasing age, persons with typical speech and language skills became more and more competent in constructing meaningful graphic symbol output. They proposed that metalinguistic skills that only develop later in life (teenage- to adulthood) are needed in the successful construction of graphic symbol output. The school-aged children taking part in this study mostly seemed to lack these metalinguistic skills.

Alant, Du Plooy, and Dada (2007) explored the graphic symbol constructions of children aged 7;6 to 8;6 in response to questions about a story that had been read to them. The order of the symbols on the screen (that was used by participants to answer) was

varied—an SVO and an SOV arrangement were given to each of two equivalent groups of children. The ordering of the constituent symbols did not predispose the children to follow that particular order in their constructions. Both conditions elicited SVO and SOV constructions (overall equal in frequency), while the SVO condition also elicited more single symbol responses than expected. Participants' spoken responses did not evidence SOV constructions.

Taken together, these results indicate that speaking children, who are able to combine spoken words, are not automatically able to transfer this skill to graphic symbols. Graphic symbol constructions often tend to be reduced compared to spoken output, while ordering of the constituents also seems to deviate at times from that of spoken constructions.

2.4 Factors influencing the production of graphic symbol combinations

From Section 2.3 it becomes apparent that the production of graphic symbol combinations is a skill that often seems to present a particular hurdle for children using graphic symbols. Three hypotheses have been advanced in an attempt to account for this phenomenon. The first of these, the linguistic deficit hypothesis, ascribes the limited multiword constructions by children using graphic symbols to an underlying language deficiency in the child. The second hypothesis (compensation hypothesis) posits that aided communication has inherent constraints related to cognitive, physical and linguistic aspects, which persons using AAC aim to minimize by changing their graphic symbol output (Sutton et al., 2002; Van Balkom & Welle Donker-Gimbrère, 1996). Third, the modality-specific hypothesis offers the constraints inherent in the visual graphic modality as an explanation for the structure of graphic symbol output (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). Seeing that the latter two hypotheses are working hypotheses, contrasts between the two have not been refined.

It is likely that, in any given situation, a variety of factors may influence the graphic symbol output produced by an individual. For this reason, the hypotheses mentioned above need not be completely mutually exclusive. A representation of factors

that, individually and together, are likely to influence the language acquisition process (and therefore also the production of graphic symbol combinations) in children using graphic symbols for expression is given in Figure 2.1. The model is based on the one proposed by Bedrosian (1997, p. 184). The influence of five parameters (mentioned in Figure 2.1) on the production of symbol combinations in children with limited speech will now be discussed. The discussion will include both potential barriers and facilitative factors.

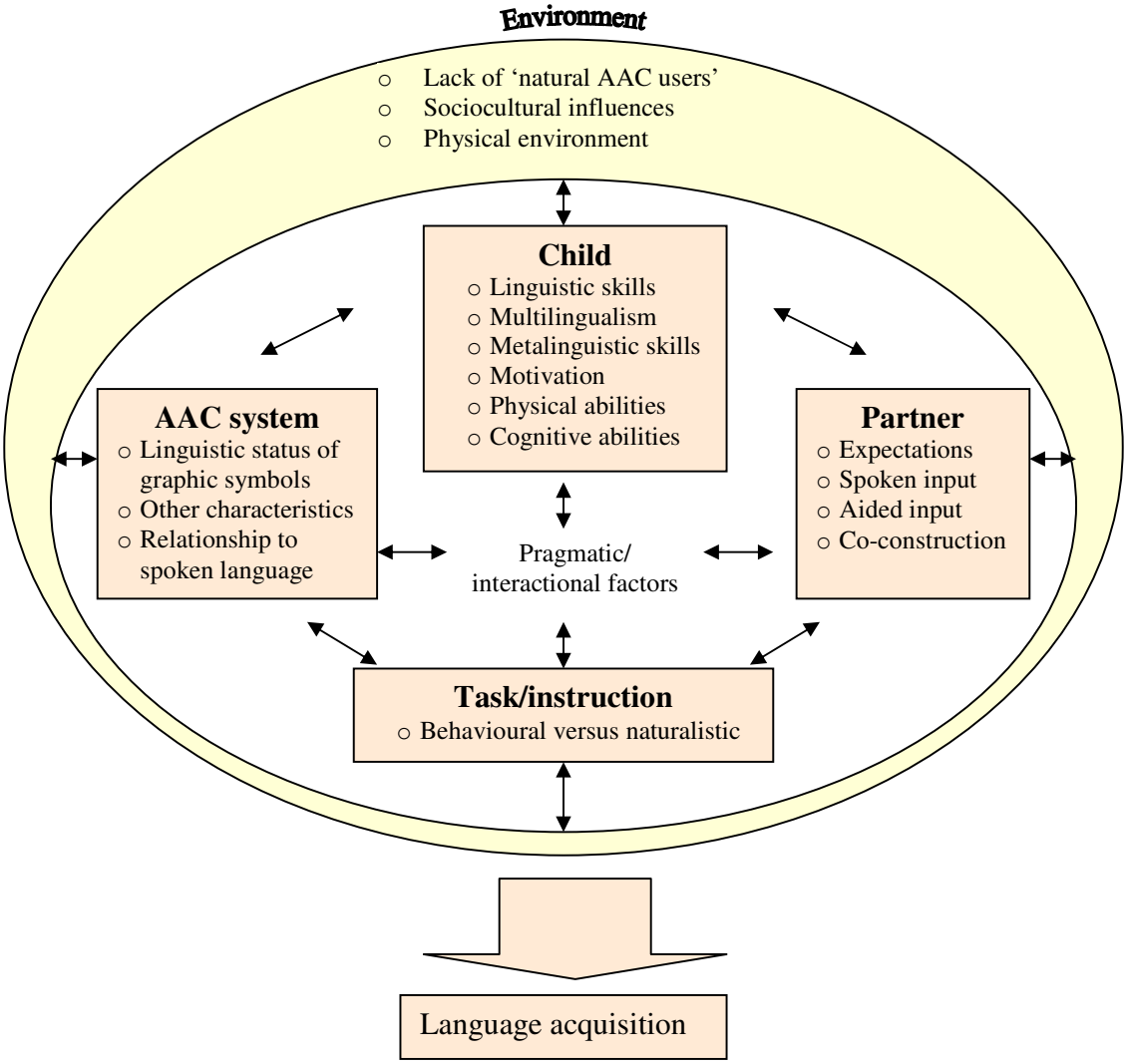

Figure 2.1. Factors influencing language development through graphic symbols (based on Bedrosian, 1997, p. 184). Arrows merely represent some potential mutual influences between factors. It is likely that all factors mutually influence each other, but the nature of these influences is not always clearly understood.

2.4.1 Child

Persons using AAC have been classified according to the function that an AAC system serves them (Von Tetzchner & Martinsen, 1992). The expressive group needs AAC mainly for expression, while comprehension of spoken language is good. In the supportive language group, AAC serves to support language development during a period where speech is not sufficient to meet expressive needs. The alternative language group consists of individuals whose spoken language comprehension and production are affected, and AAC is needed for both input and output. The groups thus differ specifically on their (spoken) receptive language abilities, with the expressive and mostly the supportive language groups consisting of individuals with language comprehension that is good (or at least substantially better) than expressive skills, while the same expressive-receptive gap does not exist for individuals in the alternative language group. The discussion will henceforth focus mainly on the first two groups, where receptive skills are typically better than expressive skills.

The linguistic deficit hypothesis suggests that restricted graphic output is attributable to an underlying linguistic deficit in children with limited speech. However, research with typically developing children who were taught to use graphic symbols indicates that children with intact expressive language skills in the spoken modality also display restricted graphic output (see Section 2.3.2). Furthermore, there have been reports of aided communicators whose graphic symbol output was restricted to one-word utterances, although spoken syntax progressed quickly to multiword utterances when speech was acquired (Kraat, 1991; Sutton and Dench, 1998). Thus, even though a child may have adequate language skills to allow for the development of spoken word combinations, these linguistic skills may not transfer automatically to allow for the development of graphic symbol combinations.

At the same time, certain language skills do seem to influence the transition to graphic symbol combinations. Sevcik (2006) noted that comprehension of spoken language seemed to play a role in whether or not participants in a longitudinal study (Romski & Sevcik, 1996) made a transition from single- to multisymbol output.

Specifically, participants with spoken language comprehension of an age equivalent to or over 24 months seemed more likely to make this transition. Increased metalinguistic skills have been suggested to facilitate more complex graphic symbol output (Smith, 2006; Trudeau, et al., 2007), possibly due to the ability to "translate" spoken output into graphic output (Smith, 2006).

The influence of multilingualism on the development of graphic symbol combinations and AAC use in general is not well understood. In South Africa, a great proportion of children with limited speech receive schooling and/or intervention in a language that is not their home language. In addition to learning to express themselves using an alternative modality, these children have to contend with two or more receptive languages. Children exposed to more than one language have been found to possess superior metalinguistic skills (Bialystok, 1988) and are typically used to the process of translation (Malakoff & Hakuta, 1991). It has been suggested that these two skills could promote the formulation of aided output that mirrors the order of spoken language (Smith, 2006, p.153). This position would suggest that bi- or multilingualism might thus benefit children using graphic symbols in the formulation of more complex graphic output. However, the extent to which skills gained from the manipulation of two spoken languages are transferable to the manipulation of different modalities remains uncertain.

Apart from linguistic skills, motivation and inner drive to communicate may also play a role. Soto and Seligman-Wine (2003) specifically noted the great motivation and active initiative of the young aided communicator whom they described in their case report as an important factor in the particularly successful development of aided communication and his relatively immediate transition to multisymbol utterances when provided with the graphic symbols needed to do so.

According to the compensation hypothesis, the structure of graphic symbol output reflects strategies employed to compensate for cognitive, physical and linguistic limitations that are inherent to aided communication (Sutton et al., 2002; Van Balkom & Welle Donker-Gimbrère, 1996). Use of graphic symbols might interact with the child's

abilities in ways that predispose the use of short, single-symbol utterances. For children with physical disabilities, producing graphic symbol utterances might be associated with great physical effort. Direct selection may be cumbersome and slow, as may be the physical navigation through various pages on a nonelectronic display. While the use of high technology devices accessed through scanning with the help of switches may reduce physical effort, this process may further slow the rate of communication and place additional cognitive demands on the child. Finding a symbol in a multilevel display per se requires visual and memory skills. For many children, the cost of producing multisymbol utterances might be too high in relation to the benefit this offers.

2.4.2 Partner

A social constructivist perspective views language acquisition as a process by which a competent partner scaffolds the productions of the child, thereby leading the child to become increasingly competent. Partners need to adjust their input to present the "just right challenge"—presenting children with structures which they cannot yet produce independently, but which they are in the process of acquiring. Implicit in this process is the partner's belief in the child's ability to progress and improve in linguistic skills.

Basil (1992) remarked on the tendency of adults to have reduced expectations of children with limited speech and particularly of those with physical disabilities. Such children are often given "free rewards", meaning that the satisfaction of the child's needs and wants by the caregiver does not depend on any action by the child. This may have serious consequences for the child's motivation to communicate, and may hinder the acquisition of linguistic skills such as expressive symbol combinations.

When partners do attempt to scaffold language development of children with limited speech, the level at which the partner's input should be pitched may be difficult to determine. Comprehension skills may frequently be underestimated, resulting in partner input that is below the child's receptive level. Partners may furthermore adjust their interaction patterns, taking on more responsibility for the interaction, potentially spending a great amount of time in clarifying the message the child intends to convey (co-

construction). The communicative passivity frequently observed in children with limited speech might be the result of a cyclical action—children have reduced means of expression, causing caregivers to take over more of the interaction in an attempt to keep the conversation going, resulting in reduced opportunities for children to contribute (Light, Collier, & Parnes, 1985). Particularly if the child's rate of communication is slow (e.g. the child might need a lot of time to select graphic symbols), the child might get little or no chance to construct more than one symbol per turn. Strategies such as increasing communication opportunities and waiting long enough to allow the child time to complete his/her response have been shown to increase the active participation of children with limited speech (Rowland & Schweigert, 1993; Sigafoos, 1999).

When graphic symbols are introduced, partners are often encouraged to provide aided input, that is, to model the use of graphic symbols to children with limited speech (Goossens, 1989; Romski & Sevcik, 1996; Wilkinson, Romski, & Sevcik, 1994). Rather than emphasizing children's ability to express themselves using the graphic symbols, focus is placed on giving multimodal input to children, since it is postulated that this process closely parallels the language acquisition of typically developing children. Through observing symbols being used communicatively in context, comprehension and eventually use of the symbols is hoped to be fostered.

The extent to which communication partners consistently provide aided input in naturally occurring situations seems to remain limited (Romski & Sevcik, 1996; Sevcik, 2006; Wilkinson et al., 1994). There might be several reasons for this. Incorporating a physical aid (e.g. communication board or SGD) into everyday activities such as dressing, feeding and other physical care routines (which tend to dominate caregiver-child time especially when children have physical disabilities [Light & Kelford-Smith, 1993]) might be cumbersome. Furthermore, when children have good or at least some understanding of spoken language, symbol input might not be needed for receptive reasons. Seeing that caregiver modifications to the input they give to children mostly seems to stem from the motivation to scaffold understanding (Cross, 1977; Ochs & Schieffelin, 1995), the natural incentive to aid spoken utterances might be absent.

Graphic symbols are not the "first language" of either caregivers or practitioners who support children with limited speech and their families. It is therefore often unclear to these individuals what a "mature form" of graphic symbol use would look like. Typically, partners would be encouraged to speak a sentence and simultaneously point to symbols. Such practices have typically led to one (and, to a lesser extent, two) graphic symbol production(s) per spoken utterance (Wilkinson et al., 1994). In typical language development, mothers have been seen to adjust their MLU to two to three units ahead of that of their children (Retherford et al., 1981). Reduced graphic symbol input by caregivers might therefore have a role to play in the reduced graphic output seen in children with limited speech.

Aided models as a means to increase the complexity of graphic output have been successfully employed in various intervention studies, either as the primary intervention technique or in combination with other strategies (Binger et al, 2008; 2010; Binger & Light, 2007; Bruno & Trembath, 2006; Goossens, 1989; Iacono & Duncum, 1995; Romski & Sevcik, 1996). A review of some of these studies is presented in Section 2.5.

2.4.3 Environment

Although the child's primary caregiver typically plays a very important role in the language socialization of the young child, the larger language community also has an influence, which usually increases in magnitude as the child becomes older and increasingly independent of primary caregivers. Children learning to communicate using graphic symbols are not surrounded by a language community of "natural users". The most obvious consequence is a lack of input in the graphic modality that the child can analyse and process to discover structural regularities. Another consequence may be the lack of communicative partners—people in the environment mostly do not use a graphic modality and they may also struggle to understand it. This may have serious consequences on the motivation of the child to use it. Involvement of peers, teachers and other partners in AAC intervention has been shown to have a positive effect on the use of

AAC systems (Cafiero, 2001; Lilienfeld & Alant, 2005; Schepis & Reid, 1995; Schepis, Reid, Behrmann, & Sutton, 1998).

The sociocultural environment may furthermore influence the way in which people within a specific community generally engage with children. In traditional African culture, for example, it is unusual for children to engage with adults in interactive activities such as play (Balton, 2009; Bornman, 2001; Geiger & Alant, 2005). Children are expected to observe and obey adults, while they would typically interact communicatively with other children. Such views would determine the way partners interact with children and may influence linguistic development. Intervention techniques and tasks initiated by service providers who are not part of the child's culture may furthermore not always be congruent with the community's sociocultural views.

Apart from the social and sociocultural environment, the physical environment may also need to be considered when seeking to optimize the development of a graphic symbol-based expressive mode. From a social constructivist perspective, access to early routines that provide language-rich exchanges between adult and child would be of pivotal importance. Play routines, mealtime, bath time and shared storybook reading are examples of contexts within which language development could be fostered. Children with physical disabilities often struggle to access environments and activities, leading to reduced participation and reduced opportunities for interaction, socialization, and language development. In addition, the simultaneous manipulation of communication aids (e.g. communication boards or SGDs) and objects needed for an activity (e.g. toys) may prove physically challenging. Environmental adaptations to ensure simultaneous access to activities and to communication aids may include correct positioning to optimize hand function, the use of stands and/or laptrays to position communication aids optimally, and the use of adapted toys. Furthermore, activities should be chosen that match the child's motor abilities.

2.4.4 AAC system: Graphic symbols

The modality-specific hypothesis posits that the visual graphic modality itself imposes certain constraints and possibilities on graphic symbol output[1] (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). In order to explore this hypothesis, the characteristics of graphic symbol systems are described, both characteristics relating to the linguistic status of graphic symbols as well as other characteristics that may be advantageous in learning graphic symbol combinations.

2.4.4.1 Linguistic status of graphic symbols

Human languages share certain characteristics that distinguish them from other forms of communication (e.g. nonverbal communication or animal communication). Some specific characteristics include:

- the presentation of information that is sequentially processed to extract meaning,
- an arbitrary relationship between the referent and the symbol used to represent it (De Saussure, 1972/1983),
- duality of patterning, with the smallest units or building blocks being meaningless (Hockett & Altmann, as cited in Zirin, 1980), and
- "producibility", that is, human language can be produced by the user (Petitto, 1993).

Smith (2006) explored the linguistic status of graphic symbols in order to illustrate their potential (or lack thereof) to be used to achieve linguistic expression. Specifically, she explored the level of arbitrariness, duality of patterning and producibility of graphic symbols. Based on her work, the next section will explore these characteristics of graphic symbols, with the addition of information processing of graphic symbols as another factor.

2.4.4.1.1 Information processing

The model of dual coding (Paivio, 1971) has been used to highlight issues in graphic symbol processing (Loncke, Campbell, England, & Haley, 2006; Loncke, Lloyd,

[1] It seems that the description 'visual graphic modality' is restricted to graphic symbols and does not include traditional orthography.

Van Balkom, & Arvidson, 1999). In this model, Paivio (1971) illustrates how mental processes are facilitated by both imagens (mental "pictures", i.e. mental representations of objects) and logogens (thought based on [spoken] language). Imagens are processed spatially, since visual perception is specialized in parallel (simultaneous or discursive) processing of information. Logogens, in turn, demand sequential processing, because auditory perceptual systems are specialized in processing sequences, such as spoken language. From these observations, some deductions can be made as to the processing of graphic symbols versus spoken words. Since many graphic symbols can be described as pictures or images, it follows that they will most likely be processed in a parallel fashion. Trying to impose sequential processing onto such visual images (e.g. by pointing to a sequence of symbols on a board) might be counter-intuitive. The receiver of such a sequence would need to use parallel processing to interpret single words, but sequential processing to string these words into a "sentence". This process may be confusing. The tendency by partners to "voice over" the graphic symbol selections made by the person using graphic symbols might be an attempt to recode the information into an auditory format to aid sequential processing.

Global representation and parallel processing seems to a be a particular characteristic of *pictures*, rather than of visual information per se. Manual signs, while also visual, do display some sequential temporal patterning, as they are dynamic rather than static. While some information is presented in parallel (e.g. the concept *very big* might be conveyed in an exaggerated movement when signing BIG) and the spatial medium is exploited for certain aspects such as pronominal reference, concepts within a sentence are mostly ordered sequentially. Traditional orthography in the form of printed material, in turn, requires sequential spatial processing (e.g. from left to right and top to bottom), in spite of being a visual static medium. It is interesting to note though, that orthography is derived from spoken languages and that children do not typically acquire it merely by exposure, but that formal instruction is needed.

In summary, the processing of graphic symbols may predispose toward global rather than sequential processing and may inhibit the development of a sequential structure (such as pointing to symbol sequences) in graphic symbol output.

2.4.4.1.2 Iconicity

Most graphic symbol systems attempt to depict at least some language concepts (typically nouns) in a way that captures the visual features of the referent (transparent symbols) (Smith, 2006). When this visual relationship between symbol and referent is recognized, the symbol becomes guessable and therefore easier to learn (Loncke et al., 2006; Luftig & Bersani, 1985; Mirenda & Locke, 1989). Words have been described as "picture producers" or "non-picture producers" (Van Tatenhove, 1999), depending on the ease with which a referent is captured in a picture. The concept picture producer is similar to Paivio's (1971) concept of "concrete" or "picturable" words, describing the ease with which a word directly evokes a mental image (although Paivio points out that, even for concrete words, the images evoked are highly individual, and influenced by world knowledge, experience and culture). Paivio further explains that words other than nouns (verbs, adjectives etc.) are relatively less concrete, since their meaning can vary depending on the context of the sentence. In order for such words to evoke an image, they need to be "concretized", by being related to an object and/or person. To depict the verb *run*, for example, we need someone who is running (i.e. an agent); to depict *dirty* we need something which is dirty (i.e. an entity). This concretization of words that are, in themselves, more abstract, is observed in graphic symbol sets such as PCS, where attributes are depicted by entities displaying such attributes (e.g. the concept *beautiful* is depicted by the face of a beautiful lady). Actions are depicted by an agent performing this action and, at times, even the object of an action (e.g. a person bringing a box to depict *bring*), or the location (e.g. a person sitting on a chair to depict *sit*). At the same time, each image is intended to only convey one concept, such as *BEAUTIFUL, BRING* and *SIT*.

Children learning to communicate using graphic symbols are presented with such concretized images and are typically expected to learn a 'one-picture-one-word'

relationship, without which sentence building and expansion of potential messages that can be created remains limited. However, by their very nature, the graphic symbols may lead the child to interpret their meanings quite differently and by pointing to one symbol, the child might intend to convey more than the single word contained in the accompanying gloss (Smith, 2006). Thus, pointing to the PCS for *SLEEP* (depicting a person's head with closed eyes lying on a pillow) might convey *person gone to bed* and pointing to the PCS for *BEAUTIFUL* might convey *a beautiful lady*. This situation can lead to single symbols being used to convey semantic relations that, when speech is used, are conveyed with word combinations. Furthermore, for a child to express a relation such as *dog sleep* using the symbol sequence *DOG SLEEP* could seem illogical, as the meaning conveyed by the sequence might be closer to *dog person lying on pillow*—possibly conveying that the dog has gone to lie on the pillow next to the person. It seems clear that, while iconicity may aid in learning the meaning of symbols, it may also interfere with expressing meaning and, in particular, semantic relations.

Another consequence of a focus on iconicity may be a tendency to represent primarily nouns versus other word classes, since nouns are generally more concrete and easier to depict. Children may therefore not have access to the word classes needed to produce combinations. Verbs followed by adjectives seem to be the next easiest word classes to represent pictorially, while function words tend to be abstract and difficult to depict. Even when communication aids go beyond nouns, the pool of function words represented is usually small or absent. While this should not necessarily by itself prevent the construction of early semantic relations (which are made up of content rather than function words), the lack of function words prevents partners from being able to present more complex aided models to the child, a factor which might have a negative influence on language growth beyond the single-word stage.

2.4.4.1.3 Duality of patterning

According to De Saussure (1972/1983), linguistic signs display duality of patterning—that is, the smallest meaningful units can be segmented since they are composed of so-called "meaningless" units. In spoken languages, morphemes and words

are made up of phonemes, which, in themselves, do not carry a specific meaning. In sign languages, so-called cheremes (meaningless hand shapes, locations and movements) combine to form meaningful signs (Stokoe, 2005). These meaningful units are in turn combined into utterances or sentences, which further clarify the relations and meanings between constituent words.

While people who are not literate seldom have explicit knowledge of the meaningless units that compose language, these units nevertheless allow for a system that, with a limited number of basic "building blocks" (e.g. around 40 phonemes in spoken English [Pinker, 1994]) allows the construction of an unlimited number of meanings. In spoken language, this is achieved by temporal patterning of meaningless units. In written language, graphemes are visually sequenced. Many graphic symbol used in AAC do not display dual patterning, since meaningful units are not made up of a limited, defined number of meaningless units. While some graphic symbols (e.g. certain Blissymbols) can be segmented and are governed by rules in terms of how elements are combined, the smallest units are nevertheless not meaningless. Others (such as PCS) cannot be segmented. As a result, they are not generative.

One consequence may be that lack of combination at the first level of patterning (meaningless units into words) makes it difficult for persons using AAC to proceed to the second level of patterning (combining words to express certain relations). Another consequence is that graphic symbol sets require the physical and tangible representation of each individual concept (word) in space (or in the virtual memory of a device) and require the person using AAC to retrieve the symbol from this location. Thus, in order to have access a 100-word vocabulary, each of these 100 items need to be portrayed in a specific location. Retrieval from this location might place a high demand on visual memory and require navigational skills to access the correct symbol. To produce a symbol combination would be even more demanding than producing a single symbol and might overtax the child's capacity (see Section 2.4.1 also)

2.4.4.1.4 Producibility

The fact that the graphic symbols are typically not produced on the spot means that they have to be preselected (typically by someone other than the child who will be expected to use them) prior to the communicative interactions which they are supposed to support. This can, in many instances, lead to a lack of context-relevant vocabulary. Unusual and unforeseen events and experiences often provide rich language learning opportunities—however, the very fact that they are unforeseen would make it likely that relevant graphic symbol-based vocabulary is not available. In addition, children's internal lexicon may bear little resemblance to the graphic symbols that are available to them as an expressive lexicon (Loncke, 2008). The fact that graphic symbols are produced by others (e.g. the developers of a specific system) and are often also preselected for the person in need of AAC by someone else leads to a situation whereby persons with intact receptive and expressive spoken language make the decisions about a graphic "language" which they themselves have never needed to use. Graphic symbols may be designed in ways that make them usable as a code for spoken language, rather than as a true graphic language, the properties and structure of which may be very different from the graphic symbol sets and systems that are available at present. In contrast to sign languages, which developed naturally amongst deaf communities, there is not yet a graphic symbol language that developed naturally[2] and the properties of such a language are thus not known.

The ability to produce linguistic signs is a prerequisite for modifying and expanding a particular system beyond the input received. The emergence of Creole, a fully grammatical language amongst children whose parents speak pidgin (a very much impoverished "language" with no fixed grammatical structure or word order) (Bickerton, 1983), illustrates that children have the ability to modify the code they hear and add linguistic structure to it. A similar situation is observed when deaf children have hearing parents who do not expose them to a sign language. Such children have been found to

[2] One might argue that many early forms of writing (e.g. early forms of Sumarian, Egyptian and Chinese writing) made use of pictograms primarily, and are thus 'natural' pictographic languages (DeFrancis, 1989; Robinson, 2011). However, these were never primary forms of language, and users would have relied primarily on an oral language for communication. It is also interesting to note that such pictographic forms of writing are not in use any more.

develop structural regularities in the gestures and gesture combinations they use that go beyond the gestural input received from their parents (Goldin-Meadow & Mylander, 1984; 1990). The ability to produce and modify symbols is crucial to this process. In many ways, children learning to use graphic symbols also find themselves in a situation whereby the input they receive in the modality that they are expected to use is minimal. However, because they cannot produce and modify the graphic output on the first level of patterning, their potential to impose linguistic structure on graphic output may be limited.

In considering the linguistic status of graphic symbols, an attempt has been made to assess their potential for linguistic expression and the likelihood of children learning to use them to recognize and use any linguistic potential. Although graphic symbols seem to fall short of truly linguistic symbols in many respects they may, at the same time, possess certain characteristics that can be manipulated to encourage the learning of graphic symbol combinations.

2.4.4.2 Other characteristics of graphic symbols

The fact that graphic symbols exist physically in space outside of the body of the person using them allows for a symbol to be assigned a permanent location on a communication board, facilitating retrieval, because the symbol merely needs to be recognized rather than retrieved from memory and produced. When targeting early semantic combinations, symbols can furthermore be grouped and colour coded according to the semantic role they fulfil (e.g. agents, actions, attributes, etc.). This might aid visual processing, and might even foster the development of an awareness of semantic roles. Various studies aimed at fostering graphic symbols combinations have made use of grouping and colour coding on the overlays or communication boards used (Binger et al., 2008; 2010; Binger & Light, 2007; Bruno & Trembath, 2006). Visual sequencing of the symbols selected (e.g. in a message window of a dynamic screen communication device or on a low-tech sentence strip) may be another way of enhancing the production of symbol combinations.

2.4.4.3 Relationship between graphic symbols and spoken words

When children with limited speech have an understanding of spoken language, asymmetry exists between input an output modes. While spoken language is usually the main input mode, output needs to be constructed in graphic symbols (and possibly other nonlinguistic modes of communication).The relationship between input and output modes for persons using speech for input and graphic symbols for output is not well understood (Smith, 2006). One hypothesis assumes that spoken language forms the underlying language base for both receptive and expressive language. However, for expressive purposes, this spoken language is recoded into another mode (graphic symbols) at the point of transmission ("recoding route"). An important corollary of this hypothesis is that graphic symbol use would conform, as far as possible, to the structure of spoken language. An alternative hypothesis posits that the underlying language base of a person exists in both spoken and graphic representation, and that ideas to be expressed are encoded in the graphic modality directly as the message is formulated (Smith, 2006). This has been termed the "reformation route" (Smith & Grove, 1999). From this hypothesis, it would follow that the graphic modality would be used in a different way to the spoken modality—namely a way that exploits the characteristics and potential of the graphic modality.

Clear evidence to support either hypothesis is still lacking, and, short of self-report or "think-out-loud" strategies (which are difficult if not impossible for the population concerned), such evidence would be hard to construct based only on observation of output structure, since there are so many other factors affecting this. Research conducted with speaking participants (Nakamura, Newell, Alm, & Waller, 1998; Smith, 1996; Sutton & Morford, 1998; Sutton, Gallagher, Morford, & Shahnaz, 2000; Trudeau, et al., 2007; Trudeau et al., 2010) seems to indicate that even speaking individuals compose graphic output that structurally deviates from spoken output. However, with increasing age there is a tendency to construct output that is closer in structure to that of the person's spoken language. This may be an indication of increasing metalinguistic awareness and a conscious "translation" from the spoken to the graphic mode. Structure of the spoken language also seems to influence structure of graphic

output, as observed in the graphic symbol output generated by English-speaking versus Japanese-speaking adults (Nakamura et al., 1998).

2.4.5 Task and instruction

Graphic symbols not only differ from spoken words in their inherent characteristics, but also in the way in which their acquisition is initiated in children. Spoken language develops within a community of proficient users—graphic symbols are typically selected and taught by professionals. Instruction in graphic symbol use is typically initiated only after the child has failed to develop speech—thus, access to an expressive mode is delayed. Especially in developing countries such as South Africa, it is not uncommon to see that the introduction of AAC occurs only during middle to late childhood (ages 5 to 10)—if at all.

Language intervention techniques (including those making use of AAC) for children with disabilities and/or delays, span the continuum from strictly behavioural approaches to naturalistic (also termed developmental or social-pragmatic) treatment approaches; hybrid approaches, combining aspects of both occur somewhere between the extremes of the continuum (Gerber, 2003; Gillum, Camarata, Nelson, & Camarata, 2003; Koul, Schlosser, & Sancibrian, 2001). Behavioural intervention techniques tend to be highly structured and directive, and usually take place in less natural contexts. Naturalistic strategies attempt to simulate the way in which caregivers foster language development of typically developing children within natural routines and tend to be child led, making use of natural reinforcers (Koul et al., 2001; Snell, Chen, & Hoover, 2006).

Naturalistic approaches tend to promote AAC use in the "real world" and to focus on participation goals (cf. the International Classification of Functioning, Disability and Health for Children and Youth [ICF-CY], WHO, 2007) rather than on discrete skills, which would fall at the level of body functions and structure (Granlund, Björck-Åkesson, Wilder, & Ylvén, 2008; Raghavendra, Bornman, Granlund, & Björck-Åkesson, 2007). Such interventions typically address not only the child, but also the partner and the environment (cf. Figure 2.1). More directive approaches are typically used to train

specific skills, with a focus on measurable behaviours of the participant within a controlled setting. Directive approaches have often been used for children with more severe disabilities (Snell et al., 2006), as well as with older children (Binger & Light, 2008).

From a social constructivist perspective, language development of young children is best fostered in meaningful adult-child interactions that occur within natural routines. A high degree of turn taking within predictable contexts allows children to practice and extend language skills with the support of an adult conversational partner. Language skills are used for creating shared meaning; their practice and use are thus not divorced from their function, as is typical of approaches that are more behavioural.

In many societies, shared storybook reading is a relatively common activity for young children to be engaged in together with parents and/or teachers (Balton, 2009; Snow, 1983; Snow & Ninio, 1986). The popularity of shared storybook reading as an intervention and teaching context among speech language therapists is congruent with an emphasis on naturalistic intervention approaches (Kaderavek & Justice, 2002). From a social constructivist view of language acquisition, shared storybook reading is an ideal context for fostering language skills, because it allows for high-quality child-adult engagement and meaningful interactions within which the child's language development can be scaffolded.

Storybook reading has been used as a context for AAC intervention to target various language skills, such as linguistic or symbolic participation (Bornman, Alant, & Meiring, 2001; Koppenhaver, Erickson, & Skotko, 2001), receptive and expressive use of graphic symbols (Stephenson, 2009b) and graphic symbol combination skills (Binger et al., 2008, 2010). Shared storybook reading provides a context in which the vocabulary for interaction can be predetermined relatively easily, since the story pictures and text define the semantic content to a large degree. This is particularly useful in communication interactions supported by graphic symbols, where appropriate vocabulary and symbols for interaction need to be determined beforehand. Furthermore, this activity naturally

involves the attention to graphic stimuli (pictures, text). Incorporating graphic symbols into this activity would thus seem congruous with the actions already taking place. Shared storybook reading also allows for turn taking typical of conversation (Bellon, Ogletree, & Harn; 2000, Ninio & Bruner, 1978), and thus offers a natural opportunity for providing aided input as well as prompting aided output. The storyline can be used as a script, and specific teaching strategies such as expectant time delay (Halle et al., 1981), questions, mands and models (Warren et al., 1984) can be incorporated into this activity at predetermined points. Furthermore, extensive manipulation of materials is typically not needed in this context and children with physical disabilities would generally not experience physical access barriers preventing them from participating in this activity.

A summary of experimental intervention studies of children with limited speech that aimed to increase graphic utterance length is provided in the next section. The specific intervention strategies and tasks chosen for these studies are further discussed in Section 2.5.4, as are the merits and challenges of each of the chosen strategies and tasks.

2.5 Intervention aimed at promoting the production of graphic symbol combinations

In order to gain an understanding of intervention approaches that have proven successful to promote the production of graphic symbol combinations in children with limited speech, a literature search was done. The following electronic databases were searched: ERIC, Medline, PsychInfo, Health Source (Consumer and Nursing/Academic Edition) and Masterfile Premier. These databases were chosen in order to cover health-related, educational and psychology-related literature. The following search terms were used: *child, augmentative and alternative communication, aided, graphic, symbol combination, multisymbol (multi-symbol*), and *semantic combination*. Each search included three terms. The term *child* was included in every search. For the remaining two terms, the terms *augmentative and alternative communication*, *aided* and *graphic* were each paired with the remaining three terms. No limitations on dates were set. The studies obtained through this search were then evaluated, and only studies complying with the following criteria were included:

- the study had to be an intervention study making use of an experimental design;

- the main aim of the intervention had to be increased graphic symbol utterance length.

Three studies were identified. A summary of these studies is presented in Table 2.2.

Language intervention for children with limited speech would typically address any one or more of the components depicted in Figure 2.1, these being the child, the AAC system, the partner, the task and instructional method, as well as the environment. The three studies summarized in Table 2.2 will now be analysed according to these components, and potential gaps in the knowledge base will be highlighted. The measurements used in each of the studies and the outcomes that were achieved will also be discussed.

2.5.1 Participants

When looking at the nine participants involved in these three studies, children with a variety of diagnoses are represented. Two participants had physical challenges (Binger et al., 2010; Nigam et al., 2006). Five participants were under the age of 6 years, with borderline to average English receptive language skills. One participant in the study by Binger et al. (2010) was over the age of 6 years, and had profound receptive delays. The participants in the study by Nigam, et al. (2006) were older (7;8–13;6) and in all likelihood had significant receptive language delays, although no formal test scores were available. All participants except for one in the study by Binger et al. (2010) seemed to have had English as home language. Participants' expressive vocabulary size in the studies by Binger et al. (2008, 2010) was at least 25 words and/or symbols, and varied from 15 to 45 words and/or symbols for the participants in the study by Nigam et al.

Two of the nine participants had no previous experience with aided communication, while one had minimal experience. The other six had extensive experience with aided communication systems.

Table 2.2

Summary of Experimental Studies Aimed at Increasing Utterance Length in Children With Limited Speech

Authors, date and title	Participants	Design	Materials	Treatment	Measurement	Results	
						Effect	**Efficiency**
Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008: "Teaching Latino parents to support the multisymbol message productions of their children who require AAC"	Three Latino children aged 2;11– 4;1 with severe congenital motor speech impairment ***Diagnoses:*** (1) profound phonological process disorder, (2) velocardiofacial syndrome and suspected childhood apraxia of speech (CAS); (3) subpalatal cleft ***Receptive language***: age-appropriate (average range) (TACL-3) ***Speech intelligibility***: I-ASCC (no context condition): 0-3% ***Expressive vocabulary***: At least 25 words/symbols (CDI) ***Motor skills***: No significant impairments reported ***Previous experience with aided AAC***: Two had none; one minimal ***Book reading***: Regular experience	Single subject, multiple probe design across three participants	Per story, 30-35 coloured PCS symbols as well as illustrations from the book representing the main characters were used on one overlay on SGDs (Mercury™ and MightyMo™) and on a communication board. Symbols were arranged according to the Fitzgerald Key and the background of each symbol was colour coded.	Caregivers were taught to use a "Read, Ask, Answer" strategy during shared storybook reading, together with the provision of two-symbol aided models on communication boards or SGDs.	Frequency of children's initiated and imitated multi-graphic symbol messages within a 10 min book reading activity.	The intervention was shown to be effective as evidenced by PND, level, level change, and trend across the three participants. Generalization to new stories, and maintenance postintervention was established. PND was 100% for each the three phases and each of the three participants. Level change was immediate for two participants, and level between intervention and baseline differed considerably.	Participants reached criterion after 3, 11 and 6 sessions respectively.
Binger, Kent-Walsh, Ewing, & Taylor, 2010: "Teaching educational assistants to facilitate the multisymbol message productions of young students who require augmentative and alternative communication"	Three children (two Latino and one Anglo) aged 4;6–6;4 with severe congenital motor speech impairment ***Diagnoses:*** (1) Developmental delay, (DD), (2) DD and CAS, (3) cerebral palsy ***Receptive language***: Profound delay, low average and average (TACL-3) ***Speech intelligibility***: I-ASCC (no context condition): 0-30% ***Expressive vocabulary***: At least 25 words/symbols (CDI) ***Motor skills***: One had hemiplegia ***Previous experience with aided AAC***: all ***Book reading***: Regular experience	Single subject, multiple probe design across three participants	Per story, 30-35 coloured PCS symbols as well as illustrations from the book representing the main characters were used on one overlay on SGDs. Symbols were arranged according to the Fitzgerald Key and the background of each symbol was colour-coded.	Educational assistants were taught to use a "Read, Ask, Answer, Prompt" strategy during shared storybook reading, together with the provision of two-symbol aided models on SGDs.	Frequency of children's initiated and imitated multi-graphic symbol messages within a 10 min book reading activity.	The intervention was shown to be effective as evidenced by PND, level, level change, and trend across the three participants. Generalization to new stories, and maintenance postintervention was established. PND was 100% for two participants and 80% for the other one. Level change was immediate for two participants, and level between intervention and baseline differed considerably.	Participants reached criterion after 3, 5 and 6 sessions respectively.

Authors, date and title	Participants	Design	Materials	Treatment	Measurement	Results	
						Effect	Efficiency
Nigam, Schlosser & Lloyd, 2006: "Concomitant use of the matrix strategy and the mand-model procedure in teaching graphic symbol combinations"	Three children with little or no functional speech (LNFS) aged 7;8 to 13;6. ***Diagnoses***: (1) autism and intellectual impairment, (2) intellectual and physical impairment, (3) autism ***Receptive language***: No formal scores, understood simple commands, yes/no questions and wh-type questions ***Speech***: Not described ***Expressive language***: According to parent report, participants frequently used 15-45 PCS symbols, one also used 5 manual signs ***Motor skills***: One participant with significant impairments (no independent mobility) ***Previous experience with aided AAC***: All	Single subject, multiple probe design across four sets of action-object combinations	Twelve black-and-white PCS on a communication board, arranged according to semantic role.	Matrix structure of 12 target items and 24 generalization items (action-object combinations) was used. The researcher manipulated objects and attempted to elicit the target structure by a mand-model procedure, using a communication board.	Target and generalization action-object combinations produced by pointing to the correct symbol sequence on the communication board.	Two of the three participants showed a clear effect of the intervention as evidenced by PND, level and trend across the four sets of combinations targeted. Immediate level change was only observed for sets three and four of the first participant. The two participants demonstrated generalization to 67 and 58% of the untrained exemplars from the matrix. There was also some evidence of generalization across trainers. One participant did not show progress, and intervention was abandoned after 13 sessions.	Participant 1: From the graph, it seems that criterion was reached after 16, 16, 9 and 9 sessions for the four sets respectively. Participant 2: From the graph, it seems that criterion was reached after 20, 16, 13 and 11 sessions for the four sets respectively.

Note. TACL-3 = Test of Auditory Comprehension of Language (3rd edition) (Carrow-Woolfolk, 1999); I-ASCC = Index of Augmented Speech Intelligibility in Children (Dowden, 1997); n/c = no context condition; CDI = MacArthur Communicative Development Inventory (Fenson et al., 1993); PCS = Picture Communication Symbols; SGD = speech-generating device; PND = percentage nonoverlapping data.

2.5.2 Partner

Researchers conducted the intervention in the study by Nigam et al. (2006), whereas parents were the interveners in the study by Binger et al. (2008). In the study by Binger et al. (2010), they were educational assistants. Allowing familiar partners to apply intervention techniques increases the external validity of the method and is more likely to ensure that intervention benefits are carried over into the child's everyday routine once the intervention study has ended. At the same time, there is some loss of control over the manner in which intervention is executed when it is done by different people. Especially when intervention methods need a high degree of control in order to preserve treatment integrity, it may be advisable for researchers to administer the intervention themselves first, before attempting to train others to do so.

2.5.3 AAC system

Five participants used an SGD, while four used a communication board. No direct comparisons were made between the effectiveness and efficiency of these two types of communication aids to foster the production of graphic symbol combinations, although the participants using SGDs seemed, on average, to learn faster to produce graphic symbol combinations. In all three studies, use was made of PCS. The boards or overlays used by Binger et al. (2008, 2010) also contained other colour pictures to represent story characters. In all three studies, symbols were grouped according to the semantic role they fulfilled, and organized in a left-to-right progression. In two studies, symbols were colour coded as well (Binger et al., 2008, 2010).

2.5.4 Task and instruction

In two studies (Binger et al., 2008, 2010) aided models were employed as the main intervention technique. These were used in relatively naturalistic settings, namely shared storybook reading (Binger et al., 2008; 2010). The storybooks used in these studies were selected based on the participants' receptive language level, cultural background and interests, in order to ensure that the task and materials were motivating and relevant to the children. The storybook reading was facilitated in the home context (Binger et al., 2008) or in a separate room at school (Binger et al., 2010).

The exact structures modelled to the children in these studies were not fixed–this flexibility allowed adult models that could take child interest and focus of attention into account, at least to some degree. It has been proposed that such indirect, naturalistic teaching techniques facilitate generalization of skills, since the target skills are acquired in context. Furthermore, the provision of aided input in context can be seen as simulating the language learning environment which typically developing children are exposed to, where adult models within a meaningful context scaffold receptive and expressive language skills. The disadvantage of more naturalistic intervention techniques is the lack of control over certain aspects of the intervention. In the studies mentioned above the exact number and nature of the aided models that were provided was not controlled and this might have led to variations in input and thus to variations in performance.

The other study targeting symbol combination skills employed a hybrid intervention technique where indirect, naturalistic strategies were combined with teaching strategies that were more direct. Nigam et al. (2006) used a matrix strategy combined with the mand-model technique to teach combinations of two graphic symbols (agent-object) to three children aged 7-13 years with little or no functional speech (LNFS). Matrix strategies entail drawing up a matrix of teaching and generalization items by systematically combining a set number of words fulfilling one semantic role (e.g. agent) with each of a set number of words fulfilling another semantic role (e.g. action). A limited set of strategic combinations from the matrix is then taught, while it is hoped that generalization to the remaining combinations will be achieved. The semantic relations taught are thus very specific and determined beforehand. In the study by Nigam et al., six actions were combined with six objects, thus producing 36 combinations. Of these, 12 were taught in four sets of three combinations each. Generalization to the other 24 items was systematically monitored. During teaching, the researcher performed actions using real objects to demonstrate the specific semantic relations that he sought to teach, and then requested children to label these actions. Mand-models were also used to elicit and teach the combinations.

The study by Nigam et al. (2006) made use of a structured training context. The semantic combinations selected for training were predetermined. Such direct intervention strategies afford the interventionist more control of the input provided, while the acquisition of the exact structures targeted can be monitored. However, critique against such approaches includes a tendency of these approaches to teach out of context, thus neglecting pragmatic aspects, and the tendency to put the child in the role of a passive respondent (Prizant & Wetherby, 1998; Gerber, 2003). The training tasks selected may not always be motivating or relevant to the participant.

2.5.5 Measurement and results

In the studies by Binger et al. (2008; 2010), imitated and spontaneous productions of multisymbol combinations were measured. Seeing that no aided models were provided during baselines, technically children could not imitate these during baseline. This may have contributed to the difference in baseline and intervention scores. Furthermore, although it is likely that children's productions were functional and meaningful, the results reported do not allow any specific deductions to be made regarding this aspect. Correspondence between the child's productions and the intended meaning of the production could not be directly determined, because any multisymbol production was measured. Results of both studies indicate that the intervention was effective as evidenced by percentage nonoverlapping data (PND), level, level change, and trend across all participants.

The study by Nigam et al. (2006) measured the production of specific combinations that were systematically taught. For each trial, there was thus a specific correct answer. Productions were only accepted as correct if the word order was maintained in the same way as it had been taught. Two of the three participants showed a clear effect of the intervention as evidenced by PND, level and trend across the four sets of combinations targeted. An immediate change in level was only observed for sets three and four of the first participant.

All three studies measured generalization. Since Binger et al. (2008, 2010) did not target specific structures, generalization of multisymbol productions to new contexts (new storybooks) was measured. Parents or educational assistants did provide aided models during the generalization phase. The aim of this phase seemed primarily to be to determine whether parents or educational assistants could transfer the strategy learnt of providing aided models to a new storybook. For the children participating in the studies, the generalization phase was, in essence, another treatment phase, since the same intervention strategies were employed as during the treatment phase.

Owing to the fact that a matrix structure of target items was used during intervention, Nigam et al. (2006) could assess whether participants could generalize their learning to the 24 untaught structures that formed part of the teaching matrix. The two participants who showed progress during intervention generalized to 67% and 58% of untrained combinations respectively—mostly to those combinations where both elements had been taught in other combinations. Generalization across trainers was also assessed, with the two participants achieving a maximum of 46% and 50% respectively of items correct during sessions administered by a second trainer.

2.6 Current study

From the summary in the previous section, it is clear that our knowledge base as to interventions that effectively promote graphic symbol combinations in children with limited speech is still limited. Only nine participants have yet taken part in experimental studies aimed at teaching or facilitating graphic symbol combinations. Only two of these participants had physical challenges, and only one had English as an additional language.

The studies employing more naturalistic intervention contexts (storybook reading) and techniques (aided models) did not target specific combinations and the children's understanding of their own productions and the meaningfulness of these productions could not be directly monitored. Imitated and spontaneous productions were measured. The study making use of structured teaching situations did not measure whether

participants could produce the combinations taught in contexts outside of the intervention, for example in response to different elicitation material.

The present study aimed to extend the research on interventions aimed at fostering expressive graphic symbol combinations. It was decided to target specific two-symbol semantic combinations in order to maintain control of the input given, and to ensure that there was correspondence between the stimulus used and the participant's production. A matrix was used to generate intervention and generalization items. However, rather than teaching these structures in a decontextualized situation, the intervention items were incorporated into a storybook. A more naturalistic context (shared storybook reading) was used in the hope of increasing the external validity of the intervention and increasing participants' motivation. At the same time, testing of the intervention and generalization items was done via a probe test (see Section 3.8.3.2), using different material than that used during intervention. In this way, it was hoped to establish whether participants could produce the combinations to accurately describe pictures, rather than just learning to produce them rote in the shared storybook reading context. The use of the probe test also facilitated testing generalization items. However, the use of the probe test meant that the participants were measured on their ability to produce the target combinations outside of the intervention context. Generalization to a different context and different eliciting material was thus required.

2.7 Conclusion

Various factors influence the process of learning to produce graphic symbol combinations in children relying on AAC for expression. In exploring these, it becomes clear that this process differs fundamentally from the acquisition of spoken word combinations. Nevertheless, various intervention approaches have increased the production of multisymbol combinations in children with limited speech. These intervention approaches have either made use of natural contexts and naturalistic intervention approaches (specifically aided models), or of specific teaching contexts and structured intervention approaches. An argument is presented as to why a combination of

such approaches, which is used in the current study, may be beneficial to facilitate the production of symbol combination skills in children with limited speech.

2.8 Summary

First, the current chapter synthesized information relevant to gaining a clearer understanding of the development of graphic symbol combination skills in children with limited speech. Although our understanding of this process is far from complete, reviews of data and theories on the development of spoken word combinations skills versus the development of graphic symbol combination skills highlight similarities and differences amongst these processes. A model (adapted from Bedrosian, 1997) of factors influencing language acquisition through AAC was presented; these factors (child, partner, environment, AAC system, as well as task and instruction) were discussed with specific reference to the production of graphic symbol combinations.

Second, an overview of intervention studies that aimed to increase multisymbol combinations was provided. These studies were analysed according to the factors mentioned above. Last, the current study wais briefly introduced and a rationale was given for its components.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter provides an overview of the methodology used in the study. The aims of the study are discussed, followed by the specification of the design. The pilot study and recommendations from it are discussed. The participants are introduced, after which the material and equipment used are described. The procedures followed during the assessment and experimental stages of the main study are set out. Lastly, the data analysis procedures are discussed.

3.2 Aims

3.2.1 Main Aim

The main aim of the study was to determine the effect of an intervention strategy employed during shared storybook reading on the production of graphic symbol combinations (representing three types of semantic relations) by children with limited speech.

3.2.2 Subaims

In order to achieve the main aim, the following subaims were identified:

i. To determine the effect of the intervention strategy on the participants' ability to express the graphic symbol combinations targeted during intervention using a communication board,
ii. To determine the effect of the intervention strategy on the participants' ability to express graphic symbol combinations that were not specifically targeted during intervention (generalized production),
iii. To determine whether the type of semantic relation or the order of presentation influenced the participants' acquisition of symbol combinations,
iv. To analyse the structure of correct responses given by participants in terms of number of elements and order of elements in more depth.

3.3 Design

A multiple probe design across behaviours replicated across participants was employed. Three different types of semantic relations (agent-action, possessor-possession, and attribute-entity) were targeted in intervention. There were 10 items per type of relation, five of which were assigned as intervention items while the other five were used to test generalization. The independent variable was the intervention strategy, comprising a prompting hierarchy used in combination with a matrix structure of target items incorporated into a shared storybook reading activity. The dependent variable was the production of 15 graphic symbol combinations (five per type of semantic relation), using a communication board in response to picture stimuli and a cueing question (probe test—see Section 3.8.3.2). In addition, generalization to 15 untaught combinations (five per type of relation) was also measured using the same procedure. The study included a baseline phase where the production of the combinations was monitored by means of the probe test for at least three sessions before intervention began. Intervention commenced on the first type of relation, while the other two remained in baseline. During the intervention phase, production of the five target combinations chosen for a particular type of relation was prompted and modelled during storybook reading. The participants' ability to produce these combinations (as well as generalization to untaught combinations) was monitored during the intervention phase using the probe test. Once either the teaching or learning criterion was reached on the particular type of relation, intervention ceased on that relation and commenced on the next relation. The order in which the three types of semantic relations were targeted was systematically varied across participants. The ability to produce the combinations was monitored postintervention for the first two types of semantic relations targeted per participant.

3.4 Stages

The study consisted of various stages. A brief overview is given in Figure 3.1.

Approval of the Research Ethics Committee of the Faculty of Humanities of the University of Pretoria was obtained first. Next, the researcher obtained consent

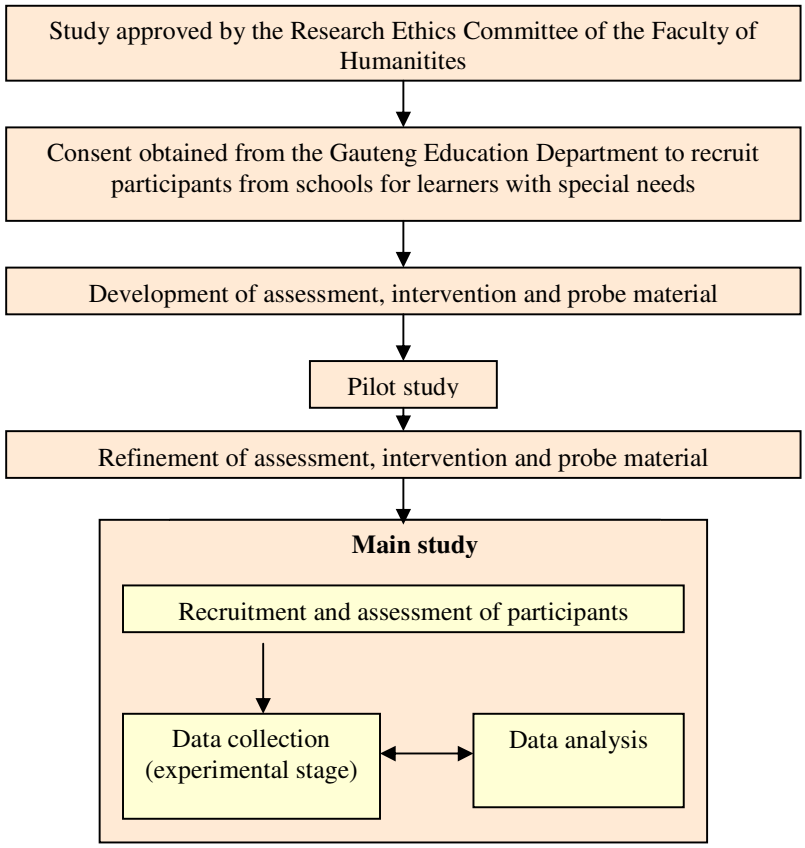

Figure 3.1. Overview of the stages of the study.

from the Gauteng Education Department to recruit learners from schools for learners with special needs in the province. Subsequently, material was developed for assessment of potential participants, as well as for the intervention procedure and the probes (measurement). The next stage was to pilot all the procedures (assessment, intervention and probes) with one participant, in order to verify the appropriateness of material and procedures. Procedures and material were consequently amended as necessary. Following this, the main study commenced. First, participants were recruited, assessed and selected. Thereafter the experimental stage commenced, during which the baseline probes were conducted with the selected participants, followed by the systematic introduction of intervention and intervention probes across the three types of symbol combinations. The data was collected over the course of two months. As data was collected, it was analysed

and graphic portrayals of participant performance were created. Once all the data was collected, further analyses pertaining to overall performance were done.

3.5 Terms

Terminology around multiple probe designs can be confusing. For example, some authors (cf. Schlosser, 2003b) seem to use the term *probe* as a noun, while others advise that it should be used as an adjective (Gast & Ledford, 2010, p. 295). In order to clarify how terms relating to the experimental stage of this study are defined, a list follows:

- ***Probe***: Measurement of the dependent variable, that is, the production of graphic symbol combinations targeted during intervention, as well as the measurement of generalization to untrained items;
- ***Probe test***: Picture description task used to measure the dependent variable as well as performance on generalization items;
- ***Baseline probe***: Measurement of the dependent variable and generalization items before intervention commenced;
- ***Intervention probe***: Measurement of the dependent variable and generalization items during the time when intervention was given;
- ***Postintervention probe***: Measurement of the dependent variable and generalization items after intervention on the type of semantic relation had ceased;
- ***Intervention***: Independent variable or treatment, consisting of a prompting hierarchy used to prompt the production of selected combinations (intervention items) from the matrix during shared storybook reading (five items per story); in accordance with the design, the independent variable was applied consecutively to three behaviours (i.e. three types of semantic relations).
- ***Shared storybook reading***: Context used during which intervention was applied;
- ***Response during shared storybook reading***: Participants' responses to the various levels of prompting given during shared storybook reading were captured from the video recordings using data recording sheets (see Appendix A). Correct responses to the first level of prompting were graphed.
- ***Baseline phase***: Period of time during which baseline probes were administered;

- ***Intervention phase***: Period of time during which intervention and intervention probes were administered;
- ***Postintervention phase***: This refers to the period of time during which postintervention probes were administered.

3.6 Pilot study

A pilot study was conducted in order to assess the appropriateness of the selection criteria, the material and the procedures proposed for the study. Procedural integrity checklists for intervention and probe test procedures were also developed and tested during the pilot study. Prior to the commencement of the pilot study, clearance from the Research Ethics Committee of the Faculty of Humanities of the University of Pretoria was obtained (see Appendix B). Consent was also obtained from the Gauteng Education Department to approach public schools for learners with special educational needs in order to recruit participants (see Appendix C).

3.6.1 Participant

One girl (aged 6;5) from a school for children with physical and/or learning disabilities took part in the pilot study. Consent was obtained from the principal, the governing body as well as from the parents (see Appendix D). The participant complied with the original set of selection criteria provided in Appendix E.

The participant was from a middle class socioeconomic background. Her home language was English. She attended an English medium Grade R[3]/Grade 1 combined classroom at a school for children with physical and/or learning disabilities. She was following a Grade R curriculum.

According to parent report, the participant developed typically until the age of 2, at which time she became ill and regressed rapidly in her motor abilities, losing the ability to walk and speak. At the time of the study, she presented with spastic

[3] Grade R describes the reception year, which would be the equivalent of the Kindergarten year in the USA. Children are typically 5-6 years of age. It is not a compulsory year of schooling.

quadriplegia. She made use of an electric wheelchair at home, which she operated independently. She was well-positioned in the wheelchair with a laptray and footrests. At school, and sometimes at home, she was positioned in a custom-made buggy, also with a footrest and a laptray. She depended on her facilitator for mobility when in her buggy. The participant wore soft splints at school separating her fingers. She was able to point accurately using either her left or right hand, although pointing was slow.

The participant had severe dysarthria, and was only able to articulate the words *yes, no, Lu* (name of a cartoon character) and *Rian* (name of her friend). She communicated mainly by answering yes/no questions, facial expression, pointing and eye-gazing to objects and people in the environment as well as using some gestures (for EAT, DRINK, PRAY, HOUSE). She also had a communication book with 360 PCS (each accompanied by a written sentence, phrase or word), 13 written words without PCS, the alphabet, numbers and eight photographs of people. The PCS were divided into 14 categories, of which 10 were specific semantic categories (e.g. weather, personal information, people etc.) and four represented specific word classes (e.g. verbs, prepositions, etc.). The frame of each cell was colour coded roughly within the categories mentioned above. The PCS and photographs were also in colour. There was a maximum of 56 cells per page. According to the participant's mother, the book was not used much at home, and the participant did not use it spontaneously. Her teacher also reported that the book was not readily available in class and was therefore not used much. According to her mother and speech language therapist, the participant communicated in single-symbol messages (gestures, spoken words, pointing to PCS, objects and people) and did not combine symbols.

Her receptive vocabulary was assessed by means of the Peabody Picture Vocabulary Test—Revised (PPVT-R) (Dunn & Dunn, 1981). The participant achieved an age equivalent score of 6;1, scoring within the 47th percentile, equivalent to a standard score of 99. Her receptive English abilities thus seemed age appropriate.

The participant had received speech and language therapy for about four years at the time of the study. Intervention aims had included oral and feeding skills, improving communication through aided strategies (PCS in a communication book) as well as literacy skills. At the time of the study, the speech language therapist at school had just introduced her to The Grid 2 (communication and access program) by Sensory Software International (Ltd.), and focused on teaching scanning with switches, because the participant struggled to use a conventional mouse. Literacy skills were also targeted in therapy. Regarding scholastic skills, the participant could do sums up to 10, and also read and spell some 3-letter words.

The participant enjoyed books and the family took out eight books a week from the local library, which were read to the participant. She remained relatively passive during storybook reading, not least because of her severe communication difficulties. Regarding play, the participant engaged in imaginative play and was able to combine play schemes, such as consecutively dressing, feeding and putting her doll to sleep.

3.6.2 Objectives, materials, results and recommendations

Table 3.1 outlines the objectives, materials, procedures, results and recommendations of the pilot study.

Table 3.1

Results of the Pilot Study

Objectives	Materials	Procedures	Results	Adjustments made
To evaluate the appropriateness of the selection criteria for participants	List of selection criteria (see Appendix E)	Three schools and two centres for children with severe disabilities were visited to identify possible participants with the help of teachers and/or therapists. Children that were identified were then briefly screened or observed in class to determine whether they complied with selection criteria.	A total of 14 children were briefly screened or observed. Only one child complied with all the selection criteria. Participants were mostly either too verbal (five were able to express more than 30 words through speech) or did not have adequate comprehension skills in English (five). One child was already combining symbols (natural gestures), one struggled to access the communication board accurately and one exhibited noncompliant behaviour, which was deemed as having the potential to interfere with intervention.	It became clear from the recruitment procedures that selection criteria are relatively strict. However, this is common in single subject designs (Bedrosian, 2003). Recruitment for the main study was decided to be done in another city where there were more English medium special schools. It was decided that the understanding of the specific relations targeted would be a descriptive rather than a selection criterion, because literature is divided on the precedence of comprehension of two-word semantic relations over production of such relations (see for example Chapman & Miller, 1975). A criterion regarding the ability of children to concentrate on a 10 min long story was added. Once recruitment started for the main study, some further adjustments were made. A summary of the adjustments is given in Table 3.2.
To evaluate the appropriateness of the test of comprehension of relations targeted	30 A4 sheets depicting each of the relations targeted with at least four foils per relation (see Section 3.8.2.7)	Three 3-year-old and three 4-year-old typically developing children underwent the procedure (see Section 3.8.2.7). The test was then also administered to the pilot participant.	The typically developing 3- and 4-year-old children were able to point out the correct pictures with 94% accuracy (range: 86.6-100%). The pilot participant correctly pointed out 93.3% of the relations targeted.	The material and procedure used to test comprehension of relations targeted seemed appropriate. As mentioned above, the ability to understand the relations targeted became a descriptive rather than a selection criterion in the main study.
To evaluate the appropriateness of the procedure and material used to test the ability to	21-item board of transparent PCS, based on the "ability to identify line drawings" test	The participant was asked to point to each of the 21 symbols on the screening overlay in response to the spoken word.	The participant pointed out all 21 symbols correctly.	The board seemed appropriate to screen the ability to recognize and point out PCS symbols on a 21-item overlay. However, seeing that a similar procedure was followed to determine the recognition of the 21

Objectives	Materials	Procedures	Results	Adjustments made
recognize and point to 21 transparent PCS	(Dada, 2004)			graphic symbols used during intervention, this screening test was found to be somewhat superfluous. It was therefore decided to omit this procedure for the main study.
To evaluate the appropriateness of the communication board used during shared storybook reading and during the probe test	Communication board with 21 symbols (17 PCS symbols and 4 hand-drawn symbols) arranged according to the Fitzgerald Key (Fitzgerald, 1959).	As an assessment measure, the participant was asked to point to each of the 21 symbols on the board in response to the spoken word. Any symbols that were not immediately recognized were taught using a paired association teaching strategy. The communication board was then also available to the participant during the probe test procedure and the shared storybook reading activity.	During assessment, the participant correctly identified 20 symbols. For *SHIRT*, she pointed to *DIRTY*. These two symbols were thus taught to her by paired association. After a 2 min teaching sessions, the participant pointed out these symbols correctly. All symbols were then retested, and the participant pointed all out correctly. The participant used the symbols appropriately during the probe test and shared storybook reading.	None
To determine the appropriateness of the eliciting material used during the probe test	30 A4 sized pictures depicting the relations targeted.	The probe test was conducted with the pilot participant during baseline, intervention and postintervention phases. This entailed requesting the participant to label each of 30 A4 pictures depicting the 15 target and 15 generalization items.	Overall, the probe test seemed to measure the production of graphic symbol combinations successfully. However, the following was noted: - After intervention commenced on the first type of semantic relation (attribute-entity), the participant described two of the five pictures illustrating a dog (for agent-action items) as *DIRTY*. It was noted that the dog was always depicted with spots, which looked similar to the pictures depicting dirty items. - The participant's performance on possessor-possession items was below that of the other two types of semantic relations.	- The pictures of the dog were changed to remove the spots. - Possessor-possession pictures were adjusted to have only two possessors on each picture, rather than three. - In order to maintain uniformity across all pictures, all pictures were coloured.
To determine the appropriateness of the procedure used to conduct the probe test and to develop a checklist for the procedural integrity of the probes	30 A4 sized pictures depicting the relations targeted, communication board, a Canon Legria FS 306 video camera mounted on a tripod, PC and software for	An initial checklist outlining the procedural steps was drawn up before the start of the first baseline probes. The probe test was then conducted with the pilot participant during baseline, intervention and postintervention phases according to these procedural guidelines. The checklist was completed by the researcher, as she rated her own performance from a video recording on the same day as the probe had been conducted. After completion of all probe test sessions, an independent observer used the procedural	The following was noted as the checklist was used: - While the checklist initially stipulated a waiting time for a response of maximally 5 s, waiting time tended to be longer than 5 s as the participant had a slow response time due to motor limitations - The checklist did not specify how many times a cueing question would be asked, which resulted in the question being repeated at times - The checklist did not specify the amount of time that the researcher needed to wait after the participant pointed to one symbol to allow the participant enough time to initiate pointing to a	The procedure for the main study was amended on the following points (which were included in the checklist used for procedural integrity): - A maximum response time of 10 s was set to accommodate participants with slower response times; - The cueing question or mand was only asked or given once; - The researcher waited 3 s after the participant pointed to one symbol to allow the participant to initiate the

Objectives	Materials	Procedures	Results	Adjustments made
	transfer and playback of recordings, procedural integrity checklist for probe test	integrity checklist to rate 3 randomly selected probe test sessions (25%).	second symbol. Consequently, the time between the participant responding and the researcher moving on to the next item varied. - The checklist did not specify when the participant would be given a break. - The checklist included one general rating on the presence of distractions, but did not provide the possibility of rating whether distractions occurred in conjunction with specific items.	process of pointing to a second symbol, unless the participant indicated that he/she had finished her turn by looking at the researcher, or trying to page to the next picture. - The participants were given a break after completing 10 items - The presence of distractions was to be rated per item.
To determine the appropriateness of the material and procedure used during shared storybook reading (intervention) and to develop a checklist for the procedural integrity of the intervention	Three stories with illustrations, communication board, a Canon Legria FS 306 video camera mounted on a tripod, PC and software for transfer and playback of recordings, procedural integrity checklist for intervention	The three storybooks developed for the intervention were piloted with six typically developing children (ranging in age from 2;5 to 3;3) (see Section 3.8.3.4). An initial checklist for procedural integrity was drawn up before the start of the intervention sessions (shared storybook reading sessions). Five intervention sessions were conducted per type of semantic relation. During each session, the relevant story was read to the participant and the prompting hierarchy was employed to prompt the production of the target graphic symbol combinations from the participant. The checklist was completed by the researcher, as she rated her own performance from a video recording on the same day as the shared storybook reading session had taken place. The checklist was then refined and completed by an independent observer based on video recordings of three randomly selected shared storybook reading (intervention) sessions (20% of total).	The storybooks were found appropriate for use with typically-developing children aged 2;5 to 3;3 (see also Section 3.8.3.4). Overall, the intervention seemed to promote the production of the symbol combinations targeted as well as the generalization of these skills to untrained combinations of the same kind (see Appendix F for a graphic portrayal of the results of the probe test measurements). While employing the prompting hierarchy, it was found that the second level of prompting did not seem to flow naturally in some instances. The expectant time delay (after every prompt) furthermore tended to be longer (max of 10 s) than initially stipulated. The prompting hierarchy also did not specify how to handle self-corrections. It was furthermore found that the last picture of the second story elicited a nontarget combination (*BOY RUN*) while the last picture of the third story seemed to elicit an incorrect combination (*BUNNY HAND* rather than *BUNNY TUMMY*). The checklist included one general rating on the presence of distractions, but did not provide the possibility of rating whether distractions occurred in conjunction with specific items.	- An expectant time delay of up to 10 s was stipulated after each prompt. - The first and second levels of prompting were combined. - The way self-corrections were to be handled was specified in the prompting hierarchy. - The last picture of the second story was adjusted so that the picture eliciting the nontarget combination could be removed. - The last picture of the third story was amended to depict the relation targeted more clearly. - The checklist was amended to reflect the changes to the prompting hierarchy and to allow rating distractions per item.
To determine whether the three behaviours targeted were independent of each other as is required in a multiple probe design across	Visual portrayal of participant's performance	The participant's results were visually portrayed and analysed to determine whether the introduction of intervention targeting a specific semantic relation caused any change in the baselines of the relation(s) not yet treated. Results are given in Appendix F.	Although there was some activity in untreated baselines after introduction of treatment (see Appendix F), there were no ascending baselines and no overlapping data between baselines and intervention. This seemed to indicate that behaviours were sufficiently independent from each other to be suitable for a multiple probe design.	None

Objectives	Materials	Procedures	Results	Adjustments made
behaviours				
To determine whether video recordings were effective to record responses during the probe test and whether these recordings allowed for the rating of the reliability of the transcription and classification of responses by an independent observer	A Canon Legria FS 306 video camera mounted on a tripod, PC and software for transfer and playback of recordings, score sheets to transcribe and rate responses .	The camera on the tripod was placed directly in front of the participant to capture her pointing to the communication board. All probe test sessions were recorded. At the end of each day's recording, the video recording was transferred to a PC using appropriate software. The researcher viewed the recording and transcribed the participant's responses onto a score sheet. Each response was classified as correct or incorrect. The number of target graphic symbols produced per response (one or two) was also noted. The structure of correct responses was furthermore classified according to number and order of elements. After completion of all probe test recordings, an independent observer viewed the recordings of three randomly selected sessions and transcribed and coded the participant's responses.	It was found that responses were mostly clearly visible on the video recording. The score sheets were found appropriate to capture the data. A point-by-point agreement of 88% was obtained as a measure of transcription reliability. The disagreement in 12% of the responses could partly be ascribed to difference in interpretation (e.g. researcher might interpret an action as a purposeful point, whereas independent observer might interpret is as an unintentional touching of a symbol). In some cases it seemed that the recording was not clear. Sometimes, the participant's other arm or fingers obscured the exact picture she was pointing to. It was also noted that on two occasions, the picture shown to the participant obscured which symbol she was pointing to. A point-by-point agreement of 99% was obtained as a measure of reliability of classifying the responses as either correct or incorrect, indicating that the classification could be executed reliably.	During the main study, the researcher adjusted the angle of the camera and removed anything that obscured the recording.
To determine whether video recordings of the probes as well as the intervention procedures allowed the rating of the procedural integrity of the intervention procedure as well as the probes by an independent observer	A Canon Legria FS 306 video camera mounted on a tripod, a Panasonic NV-GS75 video camera mounted on a tripod, PC and software for transfer and playback of recordings, procedural integrity checklists for both probe test and intervention.	The camera on the tripod was placed directly in front of the participant to capture her pointing to the communication board. All probe test sessions and all shared storybook reading (intervention) sessions were recorded. During four intervention sessions and one probe test session an additional camera on a tripod was placed either behind the participant facing the researcher or next to the participant and the researcher, in order to capture what the researcher was doing. The researcher rated the procedural integrity of every session using a preliminary version of the procedural integrity checklist. After completion of the recordings, an independent observer viewed the recordings of three randomly selected probe test sessions and three randomly selected intervention sessions. Using these recordings, the independent observer rated the procedural integrity of the probe test and intervention procedure.	From the ratings done by the researcher herself and those done by the independent observer, it became apparent that the following procedural aspects were not always clearly visible from the recordings made by the first camera: - The way the experimenter was seated; - Whether the picture or story illustration was presented in a way clearly visible to the participant; - How the specific aspect on the possessor-possession pictures was pointed out to the participant. The second camera made these aspects more visible, but made it more cumbersome for the independent rater due to having to watch two recordings.	The angle of the first camera as well as the angle at which the researcher was seated was slightly adjusted so that both the participant and his/her responses on the board as well as the picture stimuli presented were captured by one camera.

3.7 Participants

3.7.1 Selection criteria

A homogeneous sample of participants is recommendable for a single subject design, since the likelihood of consistent findings is greatly increased (Wolery & Lane, 2010). At the same time, this can lead to very stringent selection criteria, which can complicate participant recruitment, especially amongst a population such as children with limited speech (Bedrosian, 2003). After her analysis of 22 efficacy studies employing a single subject design, Bedrosian (2003) indicated that language comprehension, language production, cognitive level, intervention history, sensory status, and the preintervention levels of the dependent variable are crucial variables that should be as homogeneous as possible across participants. As far as possible, these variables were therefore taken into consideration when compiling selection criteria for the study. Furthermore, the selection criteria established by Binger and Light (2007) and Binger et al. (2008) were used as guidelines, as these two studies also targeted symbol combinations. The original selection criteria for participants are given in Appendix E. After the pilot study, adjustments were made to selection criteria. When recruitment of participants started, further adjustments were necessary for a variety of reasons. All adjustments made to the selection criteria are set out in Table 3.2. The final selection criteria are summarized in Table 3.3.

Although it would have been preferable to stipulate prior experience with using graphic symbols for expressive purposes as a selection criterion, this would have further reduced the number of potential participants, because AAC is not uniformly implemented by therapists and no mandate for its implementation exists in South Africa. Furthermore, the age range was also larger than in the studies by Binger and Light (2007) and Binger et al. (2008). During recruitment, it was generally found that the younger children often did not have sufficient English language skills to be included.

Table 3.2

Adjustments Made to Selection Criteria

Original criterion	**Adjustment**	**Reason for change**
Little or no functional speech (less than 30 intelligible spoken words)	Limited speech (less than 50 percent comprehensible to unfamiliar partners in the semantic context conditions of the I-ASCC (Dowden, 1997)	Little consensus existed amongst service providers and parents in reporting the number of intelligible spoken words, with parents generally reporting more than 30 and service providers reporting considerably less. A more objective measure was needed.
Using single graphic symbols expressively	This criterion was abolished.	It was difficult to recruit enough participants who complied with this criterion, possibly because AAC is not yet routinely implemented from an early age in South Africa. Furthermore, a previous study (Binger et al., 2008) showed that a child without prior experience with graphic symbols learnt to combine graphic symbols in intervention.
Not combining symbols for expressive communication	Not combining graphic symbols for expressive communication	Parent and service provider report did not always corroborate on the original criterion, as some participants seemed on occasion to combine vocalizations and/or gestures/signs. However, according to report, none combined graphic symbols.
Being able to comprehend at least 80% of the graphic symbols used on the communication board with a maximum of five training sessions provided if necessary	Being able to comprehend at least 75% of the graphic symbols used on the communication board with a maximum of five training sessions provided if necessary	This criterion was relaxed to include more participants.
Being able to comprehend at least 80% of the semantic relations targeted in intervention	This criterion was abolished.	Literature is divided on the precedence of comprehension of two-word semantic relations over production of such relations (see for example Chapman & Miller, 1975).
English home language	Having received English medium tuition for at least 1.5 years	It was not possible to recruit enough suitable candidates who had English as a sole home language.
No criterion on behaviour and/or attention skills included	Ability to concentrate on a 10-min long story	Inability to concentrate on the story read during intervention would interfere with the participants' ability to benefit from the intervention.

Table 3.3

Final Selection Criteria

Criterion	Motivation	Measure
Limited speech (less than 50% comprehensible to unfamiliar partners in the semantic context condition of the I-ASCC (Dowden, 1997)	Participants should not be able to meet all their communication needs using speech (i.e. they should be candidates for using AAC).	Index of Augmented Speech Comprehensibility in Children (I-ASCC) (Dowden, 1997)
Not combining graphic symbols for expressive communication	The aim of the study was to facilitate production of graphic symbol combinations.	Parent, teacher and therapist report
Able to accurately point to items on a 21-item communication board	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 out items on a 21-item communication board with graphic symbols.
Functional vision and hearing	Participants needed to be able to hear spoken instructions and the story being read out loud to them. They also needed to see the story's pictures and the graphic symbols.	Parent report. Participants were expected to point out graphic symbols out of an array of 21, in response to a verbal request. This gave an indication of functional vision and hearing.
Being able to comprehend at least 75% of the graphic symbols used on the communication board with a maximum of five training sessions provided if necessary	In order to be used for expressive communication, participants needed to know what concepts the symbols represented.	Participants were asked to point to graphic symbols on the communication board used in the study in response to spoken words.
Aged 3-10 years	The age range was delimited in order to ensure that material would be appropriate to participants.	Parent report
Having received English medium tuition for at least 1.5 years	Since the intervention was conducted in English, participants had to have had a fair amount of exposure to English in order to benefit from the intervention.	Parent report
Receptive English language skills at an age equivalent of at least 30 months	Participants had to understand the stories presented in order to benefit maximally from the intervention.	The Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4) (Dunn & Dunn, 2007) as well as the receptive subtests of the Clinical Evaluation of Language Fundamentals – Preschool UK (CELF-Preschool^{UK}) (Wiig, Secord, & Semel, 2000) were administered to determine receptive language abilities.
Able to concentrate on a 10 min story	The intervention required participants to engage in shared storybook reading for about 10 min at a time.	Parent and teacher report

3.7.2 Recruitment and assessment of participants

Consent was obtained from the Gauteng Department of Education to recruit participants from schools catering for learners with special needs in six different districts (see Appendix C). These districts were proposed due to their physical accessibility for the researcher (convenience sampling). The principals and governing bodies of five schools for learners with special educational needs were approached by letter and consented to recruit participants from amongst the learners at the school (see Appendix G). The directors of two centres for children with special needs (run as nongovernment organizations) were also approached in writing and gave consent to recruit participants from amongst the children attending the centres. Speech language therapists and/or class teachers were then asked to identify possible candidates from their classes or caseloads. Nine children from four schools and one centre were identified as possible participants. Parents of these children were approached by letter to request consent for the possible participation of their child in the study (see Appendix H). Parents of all nine children consented, two after first requesting a face-to-face meeting with the researcher and one after conducting a telephone conversation with the researcher. Since sessions were to be conducted at school, class teachers were also asked for consent to work with potential participants at school (see Appendix I). All class teachers gave consent.

Subsequently, the children were asked for their assent (see also Section 3.5) to participate in the assessment procedure (see Section 3.9.2.1). All nine children assented. Four children did not comply with the selection criteria. Three had English language skills of an age equivalent below 2;6 according to the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4) (Dunn & Dunn, 2007). One child struggled to comply during the session. The parents and class teachers of the five children who did comply with the selection criteria were contacted to arrange suitable times and dates for the data collection. In spite of parent, teacher and/or therapist reports that none of the five children had been observed to produce any graphic symbol combinations, two children spontaneously produced agent-action combinations during the initial baseline, prior to the commencement of intervention for any of the combinations. These children made use of personal communication booklets with 559 and 616 PCS symbols respectively,

predominantly representing nouns (68% and 71% respectively). Typically, only one word class was represented per page, necessitating navigation across pages to produce (most) symbol combinations. Partner interaction style may have also been of such a nature that only single symbols were expected in interaction. These factors might have prevented these two participants from displaying their symbol combination skills. When given a communication board with different word classes and presented with picture material depicting agent-action combinations, both participants started to combine symbols "spontaneously". Because they did not produce any of the other two types of semantic relations spontaneously during baseline, they still received intervention; but since there were only two opportunities to illustrate the effect of the intervention, their results were not analysed further. The graphic portrayals of their performance are provided in Appendix J.

3.7.3 Description of participants

Additional descriptive information was gathered, including the participants' ability to understand the 30 semantic relations targeted during intervention. Diagnosis, intervention history, exposure to storybook reading at home and level of play were additional descriptive variables. To supplement clinician-administered receptive language measures, items from the receptive subscale of the Bzoch-League Receptive Expressive Emergent Language Scale Second Edition (REEL-2) (Bzoch & League, 1991) for ages 24-36 months were included in the parent interview, as well as some language markers from the list of Speech and Language Milestones (Department of Education and Culture, 1996) for ages 36-72 months. An adapted version of the Language Development Survey (LDS) (Rescorla,1989) was administered as part of the parent interview to obtain information about expressive vocabulary. Information on the participants' prior exposure to graphic symbols and their ability to use graphic symbols for expression was obtained from parents, therapists and teachers. A summary of participant characteristics is given in Table 3.4.

3.7.3.1 Participant 1

Participant 1 was a boy aged 8;0 from a middle-class socioeconomic background. He lived with his parents in a townhouse. The family spoke Northern Sotho

Table 3.4

Participant Characteristics

No	Age[a], gender	Disability	Home language and proficiency[b]	PPVT-4 scores			CELF-Preschool[UK] receptive language scores	LDS	I-ASCC		Comprehension of relations targeted			Compr. of graphic symbols	Main communication modes
				Stand Score	%ile	Age eq.			No context	Sem. context	A-A	P-P	A-E		
1	8;0 M	Spastic quadriplegia following near – drowning incident at age 3	English and Northern Sotho Capabilities in Northern Sotho: 30/35 items (86%) correct[c]	73	4	5;0	Age eq.: 4;0 Raw s.: LC: 14 BC: 13 SS: 18	189 c.a.w. 139	13%	27%	10/10	10/10	10/10	100% on 2nd trial	Single spoken words, vocalizations, word approximations
2	7;9 M	Cerebral Palsy (spastic quadriplegia with more involvement on left side)	Northern Sotho 17/35 items (49%) correct[d]	26	<0.1	2;6	Age eq.: 2;11 Raw sc.: LC: 7 BC: 7 SS: 13	185 c.a.w. 79	3%	17%	6/10	8/10	7/10	76% on 2nd trial	Vocalizations and word approximations, pointing to objects and people, some Makaton gesture approximations, miming, idiosyncratic gestures
3	10;8 F	Cerebral Palsy (spastic quadriplegia)	Tshivenda 24/35 items (69%) correct[e]	31	<0.1	3;4	Age eq.: 3;2 Raw sc.: LC: 7 BC: 14 SS: 13	158 c.a.w. 14	0%	7%	8/10	9/10	10/10	95% on 2nd trial	Vocalizations, word approximations, pointing to objects and people, infrequent use of PCS boards in class

Note. LC = subtest on comprehension of linguistic concept; BC = subtest on comprehension of basic concepts; SS = subtest on comprehension of sentence structure; c.a.w. = clearly articulated words; A-A = agent-action; P-P = possessor-possession; A-E = attribute-entity.
[a]Age at beginning of the study. [b] As tested by receptive subtests of Sotho Expressive Receptive Language Assessment (Participants 1 and 2) and Venda Expressive Receptive Language Assessment (Participant 3). [c] A total raw score equivalent to 86% correct equates to Z score 1.54 and %ile 93.9 for 3.9-4.2-year-old isiZulu speaking children. [d] A total raw score equivalent to 49% correct equates to Z score -1.64 and %ile 5.1 for 3.9-4.2-year-old isiZulu speaking children. [e] A total raw score equivalent to 69% correct equates to Z score 0.10 and %ile 53.9 for 3.9-4.2-year-old isiZulu speaking children

and English at home. His father worked, while his mother was a homemaker. She particularly remarked that she had quit her job at the time of her son's near-drowning accident in order to be able to take care of him. However, she was in the process of training as a beautician at the time of the study. His father seemed to take on a decision-making role regarding the children, and asked to meet the researcher before giving permission for his son to participate in the study. His mother, however, was responsible for caregiving tasks.

Participant 1 had been attending an English medium public school for children with physical and/or learning disabilities for 1;5 years at the time of the study. He was attending Grade 1 (academic stream) at the time of the study.

Participant 1 had suffered severe asphyxia as a result of a near-drowning incident at age 3;6. He had been in a coma for 2 months following the incident, and consequently had presented with severe motor problems and no speech. At the time of the study, Participant 1's gross and fine motor skills were still severely affected. He displayed spasticity and dystonia in all four limbs. He used an electric wheelchair at home and at school, which he operated independently with his right hand. According to his therapist, his speech was limited to about 10 clearly articulated words (e.g. *yes, no, mom, dad)*, although he could produce many word approximations, which were understood by familiar partners. According to the I-ASCC (Dowden, 1997) his speech intelligibility was 13% and 27% in the *no context* and *semantic contex*" conditions respectively (unfamiliar partner). His speech was slow and effortful and characterized by poor breath control; he also tended to produce only initial syllables of words. He communicated mostly through single word approximations, as well as by answering yes/no questions. However, his parents reported that he used some sentences at home. His parents also reported about 139 clearly articulated words according to the adapted LDS (Rescorla, 1989). He had previously been provided with a communication board with PCS, mounted on his laptray. He had also been given a communication book with PCS. The book had consisted of an index page of four to five categories (e.g. *school, home, I need/want*) with corresponding vocabulary pages. He had used the board and the book previously to resolve

communication breakdowns. However, he had not been able to turn the pages of the book independently. It seemed that he did not continue using the book and board—his therapist presumed they were too limiting. At the time of the study, he had also recently received his electric wheelchair, which had not been fitted with a laptray; his board and book were therefore not always accessible. His therapist had decided to rather introduce him to The Grid 2 Windows-based communication and access program from Sensory Software International (Ltd.), and to concentrate on literacy skills in order to enable him to express any message he wanted to.

Regarding his receptive language skills, his mother reported that she thought his English skills were better than his Northern Sotho skills. Both were spoken at home. According to the language milestones given during the interview, she estimated his receptive language skills at a level of at least 6 years. His receptive Northern Sotho skills as evaluated by the Sotho Expressive Receptive Language Assessment (SERLA; Bortz, 1997) showed better proficiency in the African language than the proficiency of either of the other two participants. His receptive English language skills were also better than those of the other two participants were (see Table 3.4, Section 3.7.3). He achieved age equivalents of 5;0 and 4;0 on the PPPVT-4 (Dunn & Dunn, 2007) and the Clinical Evaluation of Language Fundamentals – Preschool UK (CELF–Preschool^{UK}) (Wiig et al., 2000) respectively. Since the latter two assessment tools are not normed for the South African population, these scores have to be interpreted with caution.

Participant 1 started attending a care centre for children with severe disabilities 6 months after the near-drowning incident, where he received a period of speech and language therapy. After 2.5 years, he started attending the school where he received regular speech and language therapy. The main aim of intervention at the time of the study was for him to learn The Grid 2 computer program and improve his literacy skills. Regarding scholastic skills, his teacher reported that he was able to spell some 3-letter words, and was reading some slightly longer words. He was learning to do addition and subtraction of numbers up to 10. His teacher reported that it usually took him long to understand and learn.

His teacher reported that stories were read in a group situation in class on most school days. Participant 1 seemed to enjoy story time and tried to answer questions posed to him. His parents also read stories to him on weekends. Regarding play, Participant 1's physical challenges limited his ability to engage in pretend play. He did seem to engage in some pretend play with, for example, toy cars.

3.7.3.2 Participant 2

Participant 2 was a boy aged 7;9 from a working-class socioeconomic background. He lived with his parents in a one-roomed apartment on top of a six-storey building, sharing ablution facilities with another family. His home language was Northern Sotho. His care fell mostly to his mother and paternal grandmother. His mother worked shifts as a floor manager at a fast food restaurant. When her shifts necessitated that she be away outside of school hours, Participant 2 either attended a local crèche or was looked after by his grandmother. Occasionally his father would also take care of him. Participant 2 spent many weekends with his grandmother. His grandmother worked as an assistant in the preschool class of a Jewish school, and it was evident that she tried to apply some of the experience and knowledge she gained through her job to set up activities (e.g. games, learning the alphabet and storybook reading) that she felt might benefit her grandson's educational and communication progress.

Participant 2 had been attending an English medium public school (with associated preschool) for children with physical and/or learning disabilities for 3 years at the time of the study. He was attending Grade R at the time of the study.

Participant 2 was born with spastic quadriplegia affecting the left side of his body more than the right side. He was ambulatory, but walked with an uneven gait. He pointed accurately and with ease using his right hand. His speech language therapist reported severe apraxia of speech. According to the report of his teacher, the speech language therapist and his mother, he used very few intelligible words (e.g. *mama, papa, no, bye).* His speech was 3% and 17% intelligible to an unfamiliar partner in the no context and

semantic context conditions of the I-ASCC (Dowden, 1997). His word approximations consisted mostly of vowels. When completing the LDS, his mother did report that he could clearly articulate 79 of the 311 words on the LDS (Rescorla, 1989)—many more than she had indicated during the interview. He also communicated using some Makaton sign approximations, as well as idiosyncratic gestures, miming and pointing to objects and people. He had been exposed to PCS for receptive vocabulary development, but not for expressive purposes. According to his mother, his teacher and the speech language therapist, Participant 2 had started to combine concepts expressively (e.g. he would sometimes mime and also use idiosyncratic gestures). However, he still communicated primarily in one-concept utterances (an estimated 90% of the time).

Regarding his receptive language skills in his home language, his mother reported these to be on an age equivalent level of about 3;6 to 4;6. When his Northern Sotho receptive skills were tested using the SERLA (Bortz, 1997), he seemed to perform below the level reported by his mother (see Table 3.3; see also Section 3.8.2.6 for further information on the SERLA). When questioned about this, his mother indicated that Participant 2 had been exposed to English, Zulu and Sotho in the crèche. His cumulative understanding of all three languages may thus have been better than the results of formal tests targeting only one language would have shown. His English receptive language skills tested at age equivalents of 2;6 and 2;11 on the PPVT-4 (Dunn & Dunn, 2007) and the CELF—Preschool UK (Wiig et al., 2000) respectively. Scores have to be interpreted with caution as these assessment tools are not standardized for the South African population.

Participant 2 had received regular speech and language therapy since entering the school. Intervention aims had included improved oral motor skills, improving speech intelligibility through structured syllable and word training (Kaufman programme; Kaufman, 2005) as well as improved receptive language skills. However, his therapist indicated that she thought he would need augmentative methods of communicating in the future. Regarding scholastic skills, Participant 2's teacher reported that the aims for him

were to start identifying some letter names as well as numbers up to 10. However, she indicated that he seemed to learn slowly.

Participant 2 was exposed to storybook reading in a group format at school, two to three times per week. His teacher reported that he seemed to enjoy story time and would try to imitate actions or sounds. He tried to answer some questions using single word approximations. He seemed to enjoy physical outdoor play as well as construction (building blocks) with some simple symbolic actions (e.g. pretending to drive a car) evident on occasion.

3.7.3.3 Participant 3

Participant 3 was a girl of 10;8 from a middle-class socioeconomic background. She lived with her parents, two sisters (aged 14 and 4 years) and an uncle in a five-bedroom house with a garden. Her home language was Tshivenda. Her fathers' position in a national government department necessitated frequent trips around the country. Her mother was a homemaker, a role she described as taxing, especially in view of having a child with a disability. For example, not all parts of the house were wheelchair accessible and she indicated that carrying her daughter around had become very cumbersome. Once again, it seemed that her father was the one who mainly took decisions regarding the children (he also asked to meet the researcher before giving permission for his daughter to participate in the study), while her mother was responsible for caregiving tasks.

Participant 3 had been attending a double medium (English and Afrikaans) public school for children with physical disabilities for 6.5 years at the time of the study. She had been attending the English medium class for the initial 3 years, and was then (on request from her parents), placed in an Afrikaans medium class for 3 years. However, she had been placed back in the English class at the beginning of the school year in which the study took place (6 months prior to study). Her mother felt that her receptive English skills were good due to watching many English programmes on television. Her receptive Tshivenda skills seemed, according to parent report, to be on about a 3;6- to 4;6 age equivalent level. These findings are corroborated by her performance in the Venda Receptive Expressive Language Test (VERLA) (Bortz, 1997), as indicated in Table 3.4

(see also Section 3.8.2.6 for further information on the VERLA). Her English receptive language skills tested at age equivalents of 3;4 and 3;2 on the PPVT-4 (Dunn & Dunn, 2007) and the CELF—Preschool UK (Wiig at al., 2000) respectively. As the latter two assessment tools are not standardized for the South African population, these scores have to be interpreted with caution.

Participant 3 was born with spastic quadriplegia. She was not ambulatory, but used a wheelchair at school (not self-propelled). At home, she did not use a wheelchair at the time of the study, since the one she had used before had become too small. She was therefore carried around by her mother. Participant 3 could point accurately, but pointing was slow and effortful due to severe spasticity in her arms and hands. According to her mother, Participant 3 used about four to five Tshivenda words at home (e.g. for *hungry* and *water*), as well as some English word approximations (e.g. for *television* and *juice*). She would communicate almost exclusively with one word at a time. Her teacher and speech language therapist reported that, at school, she sometimes tried to produce spoken words, but would produce only the vowel sounds and velar stops ([g] and [k]). Her word approximations were not understandable unless the hearer had precise contextual clues. The comprehensibility of her spoken English as judged by an unfamiliar listener was 0% in the no context condition, and 7% in the semantic context condition of the I-ASCC (Dowden, 1997). According to her mother, she could clearly articulate 14 of the 311 words on the LDS (Rescorla, 1989).

Participant 3 used two communication boards with 20 and 24 PCS respectively to communicate in class. She usually needed prompting to use the boards, and would point to one symbol at a time. Yes/no-questions were used to clarify messages. She also used an alphabet board and a board with numerals for schoolwork. She had been taught to spell some 3- and 4-letter words.

Participant 3 had received regular weekly speech and language therapy since entering the school at age 4. At the time of the study, intervention aims included improved receptive language skills and learning to use PCS to express herself. Regarding

scholastic skills, Participant 3 could identify numerals up to 10 and could also read and spell some 3- and 4-letter words.

Storybook reading took place almost every school day in a group format in the classroom. Participant 3 seemed to enjoy this, but her teacher reported that she had difficulty responding to questions. Regarding play, her mother reported that dolls were her preferred toys, and that she engaged in some simple pretend play (feeding, putting doll to sleep) with dolls. Access to and manipulation of toys was, however, difficult, and Participant 3 spent much of her free time at home watching television.

3.8 Equipment and materials

3.8.1 Equipment

A Canon Legria FS 306 video recorder was used to film the probe test and shared storybook reading sessions. A Panasonic Mini Cassette Recorder (Model no. RQ-L10) was used to record the production of words used to score speech comprehensibility according to the I-ASCC (Dowden, 1997).

3.8.2 Materials used during assessment of participants

3.8.2.1 Peabody Picture Vocabulary Test, Fourth Edition (PPVT-4)

The PPVT-4 (Dunn & Dunn, 2007) was used to obtain a standard score, percentile rank and an age equivalent score of participants' receptive vocabulary in English. As this assessment tool is not normed for the South African population, the scores obtained by participants have to be interpreted with caution.

3.8.2.2 Clinical Evaluation of Language Fundamentals – Preschool UK (CELF–Preschool^{UK})

The three receptive subtests of the CELF–Preschool^{UK} (Wiig et al., 2000) were used to determine participants' receptive English language abilities in the following areas:

- understanding of linguistic concepts,
- understanding of basic concepts,
- understanding of sentence structure.

Once again, this assessment tool is not standardized for the South African population, and therefore the scores obtained by participants have to be interpreted with caution.

3.8.2.3 Parent, teacher and therapist interviews

Interview schedules for parents, teachers and therapists of the participants were developed in order to obtain relevant background information. The parent interview schedule included items from the receptive subscale of the REEL-2 (Bzoch & League, 1991) for ages 24 to 36 months, as well as items from the list of Speech and Language Milestones for ages 36 to 72 months (Department of Education and Culture, 1996). The interview schedules are provided in Appendix K.

3.8.2.4 Language Development Survey (LDS)

In order to obtain an idea of the expressive vocabulary of the participants, an adaptation of the LDS (Rescorla, 1989) was used. This instrument was originally developed as a parent-completed screening tool of expressive vocabulary for children aged 18 to 35 months. The LDS (Rescorla, 1989) gives a list of 311 words of which typically developing children aged 2 years are expected to produce at least 50. The LDS (Rescorla, 1989) was adapted for the South African context (Gonasillan, 2011) and further adapted by the current researcher to include report of other modalities, including signs and gestures, pointing to pictures or graphic symbols, pointing to objects or persons or other (see Appendix L). Parents were further required to distinguish between words that were clearly articulated versus those that were not clearly articulated. Results from the adapted LDS have to be viewed with caution, since the South African version and additional adaptations by the researcher departed from the original instrument and are not standardized. It is unclear, for example, whether a parent's designation of a word as "clearly articulated" would mean the word is understandable to unfamiliar listeners in a situation where no context is given. Furthermore, including modalities such as pointing to objects, persons and pictures entails the risk of overestimating expressive vocabulary,

because pointing to these entities may merely serve to draw attention to them, rather than to express a concept. However, pointing to aspects within the environment is often an important way to communicate for children and adults with limited speech, especially if they do not have access to an extensive formal AAC system. The instructions requested parents to distinguish between the two intentions of pointing and report only on pointing that served to express a concept, yet this distinction may have been difficult.

On the other hand, use of an adaptation of the LDS may have underestimated participants' expressive vocabulary, since the original measure is clearly aimed at much younger children and the word list may not be comprehensive enough to capture expressive vocabulary size of older children, even those with limited expressive skills. Although parents had the opportunity to add additional words, this is in general more difficult for them to do than to work from an existing list.

3.8.2.5 Index of Augmented Speech Comprehensibility in Children (I-ASCC)

This nonstandardized clinical measure by Dowden (1997) was used to obtain a more objective indication of the comprehensibility of the participant's speech. The measure includes 30 word pools of 10 words each relating to different semantic or contextual categories. One word was chosen randomly from each of these 30 word pools. In three cases, this word was deemed unfamiliar to children in the South African context. Two of the words were changed to more familiar words designating the same concept (i.e. *mittens* was changed to *gloves*, and *store* was changed to *shop*). In one instance another word from the pool was substituted (i.e. *snow* was replaced with *stones*). In three instances the selected word was deemed difficult to depict visually and therefore another word from the pool was selected to replace it (i.e. *picture* was replaced with *radio*, *grr* was replaced by *quack* and *fruit* was substituted with *sandwich*). The word *banana* happened to have been selected twice from different word pools, and the second occurrence of the word was thus replaced with *watermelon*. The pictures, target words and eliciting phrases are provided in Appendix M.

3.8.2.6 South African Language Assessments

For various cultural-historic reasons standardized assessment materials for children in any of the African languages spoken in South Africa are extremely limited. A list can be found in Mphahlele (2006). The South African Language Assessment (Bortz, 1997) counts among the few nontranslated measures which target language skills beyond vocabulary in five African languages, including Northern Sotho and Tshivenda. It is also the only language assessment measure known to the author for Tshivenda. For these reasons, it was decided to use this measure to obtain an impression of home language proficiency of the participants. However, norms are available only for the isiZulu version, specifically for isiZulu-speaking children aged 3;9 to 4;2 (z-scores and percentile ranks based on the total raw score), although the isiZulu version was pilot tested on children ranging from 2;9 to 5;5.. The receptive subtests from the Venda Expressive Receptive Language Assessment (VERLA) and the Sotho Expressive Receptive Language Assessment (SERLA) (Bortz, 1997) could thus only be used to obtain a subjective impression of the receptive skills of the participants.

The test was administered by two mother tongue speakers of Tshivenda or Northern Sotho, who each had experience in conducting assessments with young children (an educational psychologist and a speech language therapist). Apart from the lack of norms, results may also have been affected by the influence that urbanization has had on African languages in South Africa. Due to frequent contact with members of other language groups as well as exposure to English, speakers often engage in complex patterns of code-switching and the resulting language that is used and which children are exposed to can differ in many ways from the rural variety. The rural forms tend to be regarded as the standard versions of the language by urban residents, while they describe their own varieties as “diluted”, “divided” or “skimming the top” (Slabbert & Finlayson, 2000). Although the urban mother tongue speakers conducting the assessments modified the wording where they felt that children would not understand the “rural” or “standard” version (as is explicitly required in the test instructions), children may still have been disadvantaged through underexposure to the more formal version of the African language and test results may have underestimated their receptive language skills.

3.8.2.7 Test of comprehension of relations targeted

In order to test understanding of the targeted symbol combinations, each of the combinations (intervention and generalization items) was represented in a picture. A minimum of four foils were used together with each picture. The foils were constructed in such a way that there were at least two distracters per semantic role. Thus, for agent-action combinations (e.g. *The dog runs*), there were two foils depicting the same agent as the target, but different actions (e.g. *The dog sleeps* and *The dog eats*), as well as two foils depicting the same action as the target, but different agents (e.g. *The boy runs* and *The cat runs*). The pictures used to test possessor-possession combinations were slightly different, in that three possessors were depicted on one sheet of paper, each having various items as possessions (hat, shoes, tummy, hands, nose). There were thus, theoretically, more than two foils for the possession role. Some of the pictures were taken from Blacksheep Press (2004; 2006), while others were hand-drawn. The target and foils for one combination were depicted on one sheet of A4 paper. For the agent-action and attribute-entity combinations, the five pictures were put into a 2 x 3 grid, with the position of the target being systematically varied. (See Appendix N for examples of the materials used during the test.)

The appropriateness of the material as well as the procedure was pretested by involving three 3-year-old and three 4-year-old typically developing children (age range 3;0 to 4;5). Each child was seen individually (either at school or at their home) and presented with the picture material described above. They were then verbally asked to point out the picture corresponding to the relation targeted, by a question or mand such as *Where is (relation targeted)?* or *Show me (relation targeted).* No further prompts were given and children were not given feedback on the correctness of their response. The number of correct identifications ranged from 26 to 30 for the 30 relations, with an average of 28.2 (94%) correct identifications. The procedures were thus deemed appropriate for testing comprehension of the relations.

3.8.3 Material used during data collection (experimental stage)

3.8.3.1 Matrices

Making use of the matrix strategy (Nigam et al., 2006), two words fulfilling a specific semantic role were systematically combined with five words fulfilling another semantic role for each of the three types of semantic relations targeted. This resulted in 10 combinations per type of semantic relation. The combinations are presented in Table 3.5.

Table 3.5

Summary of Combinations Targeted for Intervention and Used to Test Generalization

Semantic relation	**Intervention items**	**Generalization items**
Agent-action	The dog cries	The dog falls
	The dog sleeps	The dog runs
	The boy falls	The dog laughs
	The boy runs	The boy cries
	The boy laughs	The boy sleeps
Possessor-possession	The girl's hat	The girl's shoe
	The girl's nose	The girl's tummy
	The girl's hand	The bunny's hat
	The bunny's shoe	The bunny's nose
	The bunny's tummy	The bunny's hand
Attribute-entity	Dirty shirt	Dirty car
	Dirty pants	Dirty aeroplane
	Dirty teddy	Broken teddy
	Broken car	Broken shirt
	Broken aeroplane	Broken pants

The following factors were taken into consideration in selecting the combinations:

- Each combination needed to be easily depicted, in order to develop picture material for probes and for use during intervention that could elicit the semantic relations expressively.
- The combinations targeted during intervention needed to be taken up in a story.

The 21 words making up the three matrices were chosen with the following criteria in mind:

- Words needed to be chosen that could function in a matrix where all words fulfilling one semantic role were combinable with all the words fulfilling the complementing semantic role.
- Words needed to be simple enough to be appropriate for children on a receptive language age equivalent of 30 months. To this end, the LDS (Rescorla, 1989) was consulted. This instrument was developed as a screening tool of expressive vocabulary for children aged 18-35 months. Of the 21 words, 17 were taken from the LDS (Rescorla, 1989).
- Words were selected that could be relatively easily represented with graphic symbols. At the same time, these graphic symbols needed to be sufficiently different from each other so as not to cause confusion.

In order to assign intervention and generalization items, each of these 10 combinations (per type of semantic relation) were divided into five pairs, based on the two words fulfilling the first semantic role (e.g. for agent-action combinations, *The boy sleeps* would be paired with *The dog sleeps*). One of each of these pairs was selected to be incorporated into a story, with care being taken that each of the two words fulfilling the first semantic role occurred at least twice (e.g. at least two combinations had to have *the dog* as an agent). Selection was furthermore based on whether the combinations could be logically incorporated into a story line. The other combination in the pair was then automatically assigned as a generalization item.

The three matrices for the three types of semantic relations are presented in Appendix O.

3.8.3.2 Probe test

The probe test was developed to measure the participants' ability to express the combinations (both those targeted during intervention and those used to test generalization) using graphic symbols, both during the baseline and intervention phases.

Similar pictures were used as those depicting the target combinations in the test of comprehension of targeted relations (see Table 3.1, Section 3.6.2 for minor changes made to the pictures). For agent-action and attribute-entity combinations, the pictures were enlarged and coloured and each picture was presented on one A4 page. For possessor-possession combinations, a girl and a bunny were depicted on an A4 sheet. It was decided that the researcher would point out the aspect of the picture being asked about using a stick (the stick was narrower and could be used to point more accurately than a finger). The probe test thus consisted of 30 A4 pictures (of which the 10 testing possessor-possession combinations were identical). (See Appendix P for examples of the pictures used during the probe test.)

3.8.3.3 Communication board

A communication board with each of the 21 graphic symbols derived from the three matrices was constructed. Of the 21 symbols, 17 were PCS and four were hand drawn. The four hand-drawn symbols represented the concepts *NOSE*, *TUMMY, DIRTY* and *BROKEN*. The PCS for the concepts *TUMMY* and *NOSE* consist of the body parts drawn in isolation, which was judged as potentially confusing. Light and Drager (2007) remark on the tendency of children to represent concepts grounded in context, without isolating parts of the whole (p. 208). The hand-drawn symbols thus had more context, for example, the symbol for *NOSE* consisted of a drawing of the whole face with the nose enlarged, while the symbol for *TUMMY* consisted of a whole body, with the tummy enlarged. The PCS for *BROKEN* is a cracked cup. This was not deemed generic enough, as the targeted relations were *broken car*, *broken aeroplane* and so on. Using the picture of a broken cup to symbolize *BROKEN* therefore seemed potentially confusing. Instead, a rectangle, snapped in two, was drawn to represent *BROKEN*. Similarly, a rectangle with black marks on it was drawn to represent *DIRTY*.

Since the aim of the intervention was for participants to express semantic relations using graphic symbols, graphic symbols were organized according to the Fitzgerald Key (Fitzgerald, 1959), and the background of each category was colour-coded. Categories, from left to right, included:

- who (agents) and whose (possessors), coded in purple,
- verbs (actions), coded in pink,
- adjectives (attributes), coded in blue,
- what (objects), coded in yellow.

This organization is not strictly according to word class, but rather according to semantic case or thematic role of the word. As the specific semantic case of each of the words was predetermined, it was possible to organize the board in this way. Often, the use of specific vocabulary items on a board is not as predictable, in which case it is easier to organize the board according to word class, because the semantic case of a word is not predetermined (e.g. the *BOY* might be an agent, a possessor, a recipient, etc.). However, the original Fitzgerald Key (Fitzgerald, 1959) uses a semantic case organization rather than an organization according to word class. A representation of the board is provided in Appendix Q.

3.8.3.4 Stories

The researcher developed three stories to incorporate each of the three sets of five intervention items. Each item was incorporated twice into the story to allow for two teaching opportunities. Thus, the first story contained each of the five agent-action combinations twice, the second each of the five possessor-possession combinations twice, and so forth. The stories were developed based on the following principles:

- Use of vocabulary that is simple to understand for children whose language comprehension is on an age equivalent level of at least 30 months
- Use of simple sentences
- Use of a story grammar pattern of one or more simple episodes (Peterson & McCabe, 1983); a simple episode consists of an initiating event which results in an overt attempt by the main character, with a direct consequence.

After the stories were developed, the percentage of vocabulary items that appear in the Language Development Survey (Rescorla, 1989) was determined. The LDS (Rescorla, 1989) provides a list of words of which typically developing children aged 2

are expected to produce at least 50. Of the vocabulary items included in the stories (not counting pronouns, articles and auxiliary verbs) 52%, 46% and 58% respectively were found in the LDS (Rescorla, 1989) for Stories 1, 2 and 3 respectively. The readability of the stories was also determined from an online readability calculator based on the Flesch-Kincaid Readability Index (Joe's Web Tools, n.d.). Grade equivalents of -1.1, 0.3 and 0.5 were obtained for Stories 1, 2 and 3 respectively. The stories thus had a readability level below the first grade suggesting that, overall, the stories consisted of simple short sentences and words with few syllables.

The suitability of the stories for children of language age 2;6 to 3 was confirmed by reading each of the stories individually to each of six typically developing children (ranging in age from 2;5 to 3;3). All sessions were video recorded. All six children were able to concentrate on the stories told. All were engaged, looking at the illustrations and making appropriate eye contact with the researcher. All responded to questions and comments by the researcher most of the time. The stories were therefore considered suitable for children of language age 30 months upwards.

The stories were illustrated by a graphic artist. (See Appendix R for the stories and examples of the illustrations). Mostly, only one target relation appeared in an illustration. Where two or more illustrations of target relations appeared in a picture, removable parts or flaps were used in order to separate the pictures of the target relations visually from each other. The illustrations were printed on A4 paper (landscape format), with text appearing below the illustration. Each page was laminated and the pages were ring bound.

The three stories were comparable in terms of number of words and number of illustrated pages. The story incorporating agent-action combinations consisted of 160 words and had 14 illustrated pages. The story that incorporated the attribute-entity combinations had 182 words and 11 illustrated pages, while the story that incorporated the possessor-possession combinations consisted of 211 words and 12 illustrated pages.

3.8.3.5 Data recording sheets for data collection

Two types of data recording sheets were developed. First, a sheet for collecting data from the probe test was developed. Before each administration of the probe test, the picture material used to elicit responses was placed in random order. A score sheet was then compiled reflecting the order of the items. Space was provided for transcription of the participant's response, as well as for classifying it as either correct (containing both target graphic symbols) or incorrect. (An example of a probe test score sheet is provided in Appendix S.)

Second, a data recording sheet was developed to capture the participants' responses to the various levels of prompting employed during shared storybook reading (see Appendix A). This information was gathered merely for descriptive purposes and for keeping record of participants' progress during the shared storybook reading activities. The target combinations were listed in the order in which they appeared in the story, providing space to transcribe the participants' responses to each level of prompting.

3.8.3.6 Checklists for procedural integrity

Checklists were developed to rate the integrity of the procedure used during the probe test (see Appendix T) as well as for the procedure used during intervention (see Appendix U). In accordance with the recommendations by Gast (2010), the score sheets endeavoured to allow scoring each procedural variable.

3.9 Procedures

3.9.1 Ethical considerations

Clearance for the study was obtained from the Research Ethics Committee of the Faculty of Humanities of the University of Pretoria before any data collection commenced, including the pilot study (see Appendix B). Prior to recruitment of participants, consent was also obtained from the Gauteng Education Department to recruit participants from schools for learners with special educational needs (see Appendix C). Once permission had been granted, principals and governing bodies of the

selected schools were approached and informed in writing of the details of the study. Written consent was obtained before potential participants' parents were approached (see Appendix D [pilot study] and Appendix G [main study]).

Any study involving human participants needs to abide by the appropriate ethical principles, summarized under autonomy, beneficence and justice in the Belmont report (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). Autonomy implies that participants' right to be informed of all aspects of the study and their freedom to choose whether they would like to participate or not needs to be respected. When participants in a study are under age (as was the case in the current study), parental permission and child assent are required in the place of informed consent (Rossi, Reynolds, & Nelson, 2003). In the current study, only children whose parents or legal guardians (and, where appropriate, teachers) gave consent participated in the study. Parents' (and, where appropriate, teachers') informed consent was obtained by providing them with a letter containing detailed written information on the study and requesting their response to indicate their consent or refusal for their child to participate in the study (see Appendix D [pilot study] and Appendices H and I [main study]). Prior to each session, each participant was requested assent for participation. All children could indicate *yes* and *no* using gestures and/or vocalizations. The content of the request was as follows: *Hello (child's name). I want to work with you today. Do you want to come and work with me today?* Sessions were only conducted if participants assented.

The principle of beneficence requires that participation in the study should have benefits for the participants and that any possible negative consequences of participation should be limited. In the current study, participation entailed intensive one-on-one training in graphic symbol combination skills over a period of at least 15 days for each participant. Seeing that participants all had limited speech, this skill would be seen as important to enhance their communication and linguistic abilities. The researcher tried to avoid possible negative consequences related to conducting the study during school hours by scheduling the sessions in such a way as not to clash with important academic activities. Furthermore, the researcher informally met potential participants before the

assessment procedure commenced, in order for them to be familiar with the researcher before any formal procedures commenced. Thus the researcher sought to minimize the risk of children feeling ill at ease with an unfamiliar person testing them.

The principle of justice requires that burden and benefit be spread evenly across the population who would ultimately benefit from the results. This intervention study aimed to facilitate a skill in a very specific group of individuals. As the training programme had not been previously evaluated, the selection criteria for the current study were strict, in order to recruit only participants for whom the likelihood of benefit from the intervention was high.

3.9.2 Settings

All procedures involving the participants directly were conducted at the schools the participants attended, as well as within the participants' home settings when this was necessitated by holidays or nonattendance. For Participant 2, sessions were also conducted at the crèche that the participant attended during the holidays. Participants 1 and 2 attended the same school (School A), while Participant 3 attended a different school (School B). Both schools were public schools. School A was an English medium school for learners with physical and/or learning disabilities. School B was a dual medium (English and Afrikaans) school for learners with physical disabilities. At each of the two schools, procedures were conducted within a therapy room, and at the crèche in an empty classroom. Within the home settings, sessions were conducted in bedrooms (Participants 1 and 2) or the family lounge (Participant 3). The latter was the only setting that did not have a door closing it off from the rest of the house. The participant and researcher were seated next to each other with a work surface in front of the participant. The researcher used this work surface to display the necessary materials. The assessment materials, the storybooks used for intervention and the probe test pictures were elevated to allow the participant to see them. The communication board was mounted on a stand at an angle of about 60° to allow for easier access.

3.9.3 Stages of main study

The main study consisted of various stages, as illustrated in Figure 3.1. The recruitment and assessment of participants has been briefly described in Section 3.7.2. Further details are provided below (Section 3.9.4). This was followed by the experimental stage, which entailed measuring the dependent variable across a baseline and an intervention phase (for all three types of semantic relations targeted), as well as during a postintervention phase (first two types of semantic relations targeted). During the intervention phase, the treatment (independent variable) was also administered. Data analysis was the last stage.

3.9.4 Assessment of participants

During this stage, the researcher determined whether the participants complied with the selection criteria and gathered additional descriptive criteria. Furthermore, the participants were given training on any graphic symbols (from the 21 graphic symbols used during intervention), which they did not recognize on first exposure. The procedures involving the participants directly were conducted over 2 to 3 days, with sessions lasting about 60 min. Breaks were given to prevent fatigue. Administration of the PPVT-4 (Dunn & Dunn, 2007), CELF–Preschool^{UK} (Wiig et al., 2000), VERLA/SERLA (Bortz, 1997) and I-ASCC (Dowden, 1997) proceeded as required by the instructions of these assessment tools. Some of the other procedures used are described below.

3.9.4.1 Parent, teacher and therapist interview and completion of LDS

The parents of the participants were interviewed to obtain relevant background information. Parent interviews were conducted at the participants' homes. Similarly, teachers and speech language therapists of the children were also interviewed to obtain a more comprehensive picture of the child's functioning. Teacher and therapist interviews were conducted at school. (The interview schedules are described in Section 3.8.2.3 and presented in Appendix K.) Interviews lasted between 10 and 20 min. The researcher also asked parents about the participants' expressive vocabulary using the adapted form of the LDS (Rescorla, 1989). The LDS was completed at the participant's home or at the

parent's workplace. (The adapted form of the LDS is described in Section 3.8.2.4 and the form is presented in Appendix L.) The completion lasted about 20 to 30 min.

3.9.4.2 Comprehension and training of graphic symbols

In order to assess receptive knowledge of the 21 graphic symbols used in the study, participants were given the communication board constructed for use during the probe test and during the shared storybook reading activity. (The board is described in Section 3.8.3.3 and presented in Appendix Q.) Participants were asked to point out each of the 21 concepts on the board. They were asked a question or given a mand such as *Show me ___(word),* or *Where is _____(word)?* Incorrect responses were immediately corrected, in anticipation of the next step (training). The 21 concepts were tested in random order, with one trial per graphic symbol. Participants who scored 100% correct on the first testing were retested on all 21 graphic symbols. If they achieved 75% or more correct on the second testing, they were included in the study. Those who did not achieve 75% or more on the second testing as well as those who did not score 100% on first testing were provided with paired-associate training of those symbols not correctly identified, with retesting and retraining of these specific symbols up to five times. If 100% accuracy on the specific symbols was not reached after five training sessions, participants were excluded. If 100% accuracy was reached within these five training sessions, all 21 symbols were retested. The cut-off for inclusion in the study was 75% or more correct on the retesting of all 21 symbols. The process is depicted diagrammatically in Figure 3.2.

3.9.4.3 Comprehension of relations targeted

Participants were presented with the pictures of the targeted relations as well as the foils (see material described under Section 3.8.2.7 and the example in Appendix N) and asked to identify the relation targeted by pointing. See Table 3.4 (p. 67) for the results.

3.9.5 Data collection/experimental stage

The experimental stage consisted of the measurement of the dependent variable by means of the probe test, as well as the administration of the independent variable (intervention aimed at fostering the production of semantic combinations through graphic symbols). The probe test will be described first, since it was administered in the baseline,

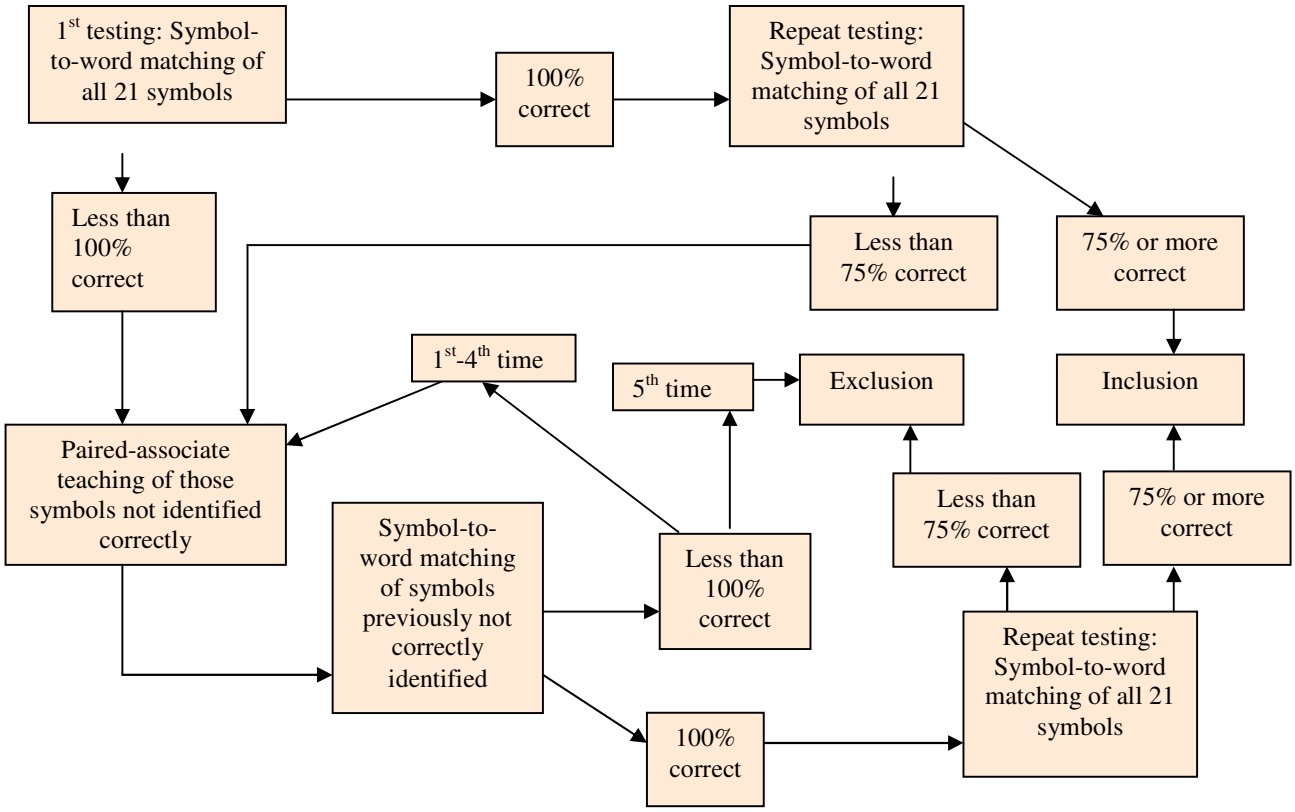

Figure 3.2. Assessment and training procedure: comprehension of graphic symbols.

intervention and postintervention phases. The probes administered by means of the probe test during baseline, intervention and postintervention phases will be described next, while the intervention strategy will be described last.

Sessions were scheduled as frequently as the school and family schedule allowed, but not more than one per day. For Participant 1, 22 sessions were conducted over a period of 52 days, which meant an average of about 3.0 sessions per week. A maximum

of 5 sessions and a minimum of 1 session per week were conducted. For Participant 2, 24 sessions were conducted over a period of 40 days, averaging to 4.2 sessions per week. A maximum of 6 sessions and a minimum of 2 sessions were conducted per week. With Participant 3, 26 sessions were conducted over a period of 47 days, which worked out to an average of 3.9 sessions per week. A maximum of 6 and a minimum of 2 session were conducted per week.

3.9.5.1 Probe Test

The probe test was employed to determine the participants' ability to express the 30 semantic combinations (15 intervention items and 15 generalization items) by means of graphic symbols throughout the experimental phases of the study. A description of the probe test material is given in Section 3.8.3.2. All administrations of the probe test were video recorded. Before the 30 items were administered, they were placed in random order. The items were administered in three groups of 10, interspersed with short breaks during which a choice of a sticker or a reinforcing nonrelated activity was given to the participant (e.g. access to a battery-operated toy). Each participant also collected a sticker on a score sheet for every 10 items completed. When 10 stickers had been collected, the participant was allowed to choose a small gift from a selection (e.g. bracelets, small toy cars, hair accessories, erasers, pencils, toy figurines). During the probe test, only one trial was given per item. Participants were seen individually. The participant had the communication board available on a table or laptray in front of him/her. The researcher presented the participant with a picture and asked an open-ended question or gave a mand for a response. Mands and questions differed slightly for each semantic relation; they are summarized in Table 3.6.

Table 3.6

Questions and Mands Used to Elicit Responses During the Probe Test

Agent-action combinations	**Attribute-entity combinations**	**Possessor-possession combinations**
What is happening on this picture? Tell me about this picture.	What is this? Tell me about this picture.	What is this? Tell me about this.

A response was scored as correct if the participant pointed to at least both target symbols (in any order). The researcher acknowledged any response in a neutral way (e.g. *I see. Oh.*). The responses were not corrected and no prompts for elaboration or direct models were given. If the participant did not respond within 10 s, it was considered as no response. If the participant started responding within the 10 s, he/she was allowed to complete the response. After a response, the researcher waited an additional 3 s before moving on to the next picture, to ensure the participant had completed his/her response. Noncontingent encouraging feedback (e.g. *You are working hard. You are pointing like a star.*) was given intermittently to encourage the participant to continue. One administration of the probe test (with two breaks) took about 10 to 20 min.

3.9.5.2 Baseline probes

During baseline, the probe test was administered to determine the participants' ability to express the semantic relations (intervention items and generalization items) by means of graphic symbols before intervention commenced. Three consecutive baseline probes were conducted before intervention commenced on the first type of semantic relation. When intervention commenced on this type of semantic relation, the other two types of semantic relations continued untreated, and were monitored with baseline probes. Baseline probes for these relations coincided with intervention probes on the semantic relation that was being treated, since all 30 items of the probe test were administered every time (some of which may have been items that had already received treatment, while others had not). Probes were conducted after the first intervention session that targeted the first type of semantic relation and, subsequently, after every second intervention session targeting that type of semantic relation. The baseline probes for the relations that had not yet been targeted were therefore conducted on days that corresponded to the first, third and fifth (and possibly seventh and ninth) day of intervention of the relation that was being targeted in intervention. Once intervention started on the second type of semantic relation, the baseline probes continued for the last semantic relation at the same intervals.

3.9.5.3 Intervention probes

On the first, third, fifth (and where needed, seventh and ninth) day of treatment, probes were conducted to monitor the ability to produce the combinations targeted in intervention as well as untrained items of the same type of semantic relation. These probes were conducted by means of the probe test. On the days when both the intervention procedure and the probes were conducted, probes were always conducted after the intervention procedure.

3.9.5.4 Postintervention probes

For the first and second type of relation targeted in intervention, probes continued after intervention had ceased. These postintervention probes were conducted on days during which intervention probes were conducted on the semantic relation treated at that stage.

3.9.5.5 Intervention

Intervention took place within a shared storybook reading context. The order in which the three types of semantic relations were targeted was counterbalanced across the five participants that commenced with the study. The order in which relations were targeted for the three participants, whose results will be discussed, is presented in Table 3.7.

Table 3.7

Order in Which the Semantic Relations were Targeted for Each Participant

Order in which semantic relations were targeted	**Participant 1**	**Participant 2**	**Participant 3**
1st semantic relation	Attribute-entity	Agent-action	Possessor-possession
2nd semantic relation	Agent-action	Possessor-possession	Agent-action
3rd semantic relation	Possessor-possession	Attribute-entity	Attribute-entity

Since the data of two participants could not be used because of unstable baselines, the order of the relations for each of the remaining three participants is not completely

counterbalanced. The agent-action combination, for example, appears in the second position twice, and the attribute-entity combination appears twice in the final position.

The intervention on the first semantic relation commenced after three consecutive baseline sessions. All procedures were video-recorded. A checklist with all the important aspects to be adhered to during intervention is provided in Appendix U. During intervention, the researcher engaged in shared storybook reading with the participant. This included reading the story, while showing the illustrations, commenting and elaborating as needed. As far as possible, any initiations by the participant were accommodated and responded to. For example, while reading Story 1 (agent-action; see Appendix R), a participant pointed to the illustration of the dog in the picture showing the boy crying and the dog licking his face (see Appendix R). The researcher then commented, *Yes, the dog is licking the boy's face*. The participant had the communication board available on a table or laptray in front of him/her. The researcher employed a prompting hierarchy before each target item to create an opportunity for the participant to express or learn to express the particular semantic combination using graphic symbols. The prompting hierarchy consisted of

- Level 1: drawing the participant's attention to the picture depicting the target semantic relation (e.g. picture showing a boy running) by pointing and verbalizing (e.g. *look, oh-oh*, etc.) and pausing for 10 s;
- Level 2: asking an open-ended question to elicit the semantic relation (e.g. *What is happening here?*) followed by a 10 s pause;
- Level 3: requesting the participant to express the semantic relation using the communication board (e.g. *Tell me with your board*) followed by a 10 s pause;
- Level 4: providing an aided model of the semantic relation, followed by a request to imitate the aided model, followed by a 10 s pause; and
- Level 5: providing physical assistance to produce the 2-symbol semantic relation using the communication board.

A correct production following any level of prompting was confirmed and reinforced by another aided model from the researcher. The complete prompting procedure and feedback provided is set out in Figure 3.3.

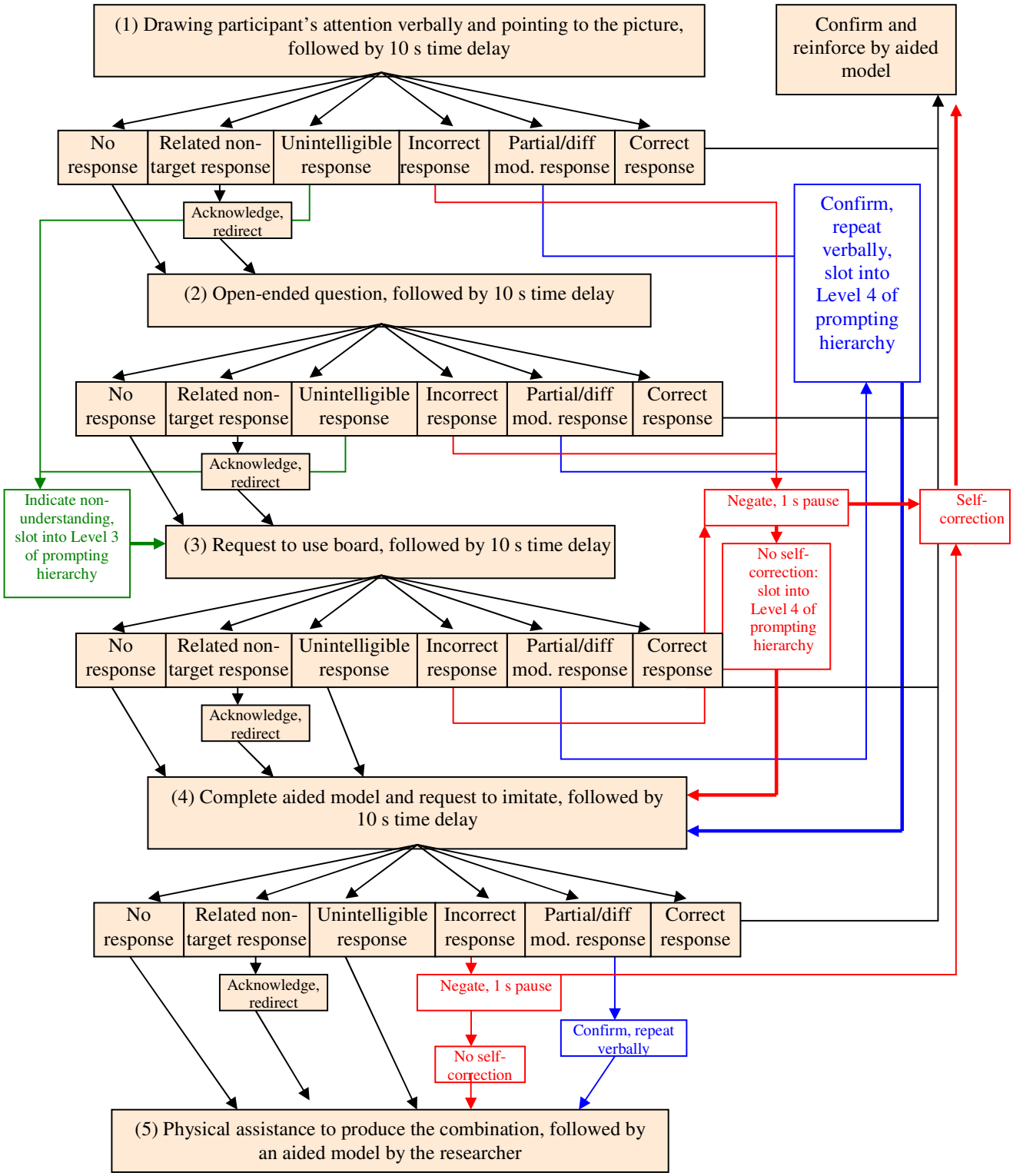

Figure 3.3. Schematic representation of prompting hierarchy employed during intervention.

A response was considered correct if the participant pointed to at least both graphic symbols (in any order) making up the target semantic relation. Any spontaneous self-corrections (corrections within 1 s) were treated like a correct response. On days during which the probe test was conducted after the intervention, the participant was encouraged (after completion of the story) to remember what he/she had learnt during the story when completing the probe test. Each shared storybook reading session lasted about 10 min.

In order to prevent participants from reacting negatively to extended repeated testing and intervention, both a teaching and a learning criterion were set. Intervention ceased on the semantic relation treated when either of the following conditions were met: once a participant's score increased by at least two correct answers (i.e. 40%) for two consecutive probes as compared to baseline average (with a minimum of three probes conducted during intervention), or after a maximum of nine teaching sessions.

3.9.5.6 Treatment boost

When participants achieved two consecutive 0% scores during intervention probes directly after treatment commenced, or when a drop in performance was seen on the intervention items during the intervention phase, a treatment boosting procedure was implemented before the following intervention probes. After the story had been read to the participant, and before the probe test was conducted, the following steps were taken:

- The participant was briefly reminded of the combinations learnt by giving him/her two aided models (e.g. *Remember what we learnt in the story. We learnt about the {GIRL girl's} {HAT hat} and the {BUNNY bunny's} {SHOE shoe}*).
- The correspondence between the probe test pictures and the story pictures was clarified, by giving two examples of corresponding pictures (e.g., while showing the probe test and story pictures, *Look, this is a bunny and this is also a bunny*.). Only single words (no word combinations) were used to clarify the correspondence.
- The participant was encouraged to remember what was learnt in the story when completing the probe test.

If participants still did not produce the appropriate combinations within the first ten items in the probe test, steps 1-3 were repeated before completing the next 10 items, and again before the last 10 items when necessary.

3.10 Data analysis

Each administration of the probe test was video recorded. Score sheets (see Appendix S) were used to transcribe the participant's response to each item on the test from the recording. The transcription was done on the same day as the recording was made. Each response was then classified as correct (i.e. containing both of the target symbols) or incorrect. Correct responses were further classified as either containing only two symbols or containing more than two symbols. Those containing two symbols were further classified as those containing the two symbols in the same order as targeted during storybook reading, or as those containing the two symbols in reverse order. The percentage of correct responses per semantic relation was calculated and depicted graphically per participant per relation. The total percentage of correct responses per phase per relation per participant was also calculated. This enabled comparisons of performance across participants as well as across types of semantic relations and the order in which the relations were presented.

The percentage of nonoverlapping data (PND) was calculated for the intervention and postintervention phases by determining the percentage of data points where the percentage of correct responses was more than the highest percentage achieved during baseline (Gast & Spriggs, 2010). The precise formula is as follows:

$$\frac{\text{No. of data points within a phase where \% correct responses is higher than highest \% achieved during baseline}}{\text{Total no. of data points for this phase}}$$

Furthermore, improvement rate difference (IRD) was calculated to determine the effect size of the treatment. According to Parker, Vannest, and Brown (2009), IRD is "the improvement rate (IR) of the treatment phase(s) minus the improvement rate of the baseline phase(s)" (p. 138). The formula for calculating IRD is thus $IR_T - IR_B = IRD$ (Parker et al., 2009, p. 138). IR for each phase is defined as the number of improved data

points divided by the total number of data points within that phase (Parker et al., 2009, p. 139), with the formula as follows:

$$\frac{\text{No. of improved data points}}{\text{Total no. of data points}}$$

Confidence intervals (CIs) (85%) were also established using the NCSS two proportions test module, to determine the certainty with which the effect size could be regarded as true. The CIs calculated were based on bootstrapping, as recommended by Parker et al. (2009). Bootstrapping allows estimations without needing to assume a normal distribution, but rather by simulating repeated observations from the actual data obtained.

For descriptive purposes, participants' responses to the various levels of prompting employed during shared storybook reading were captured from the video recordings of intervention sessions on a data recording sheet (see Appendix A). In order to obtain an impression of the progress participants made during shared storybook reading, all their correct responses (i.e. those containing at least both target symbols) to the first level of prompting were graphed as well.

3.10.1 Procedural integrity

In order to establish treatment integrity, Schlosser (2003a, p. 193) recommends that 20% to 40% of all sessions be rated for procedural integrity by an independent observer. Sessions rated should be equally distributed across all phases of the study. Checklists were therefore developed during the pilot study both for the procedure used during the probe test (see Appendix T), as well as for the procedure used during intervention (see Appendix U). For each participant, an independent observer viewed video recordings of one to two randomly selected probe test sessions from each of the phases of the study, these being

- baseline phase across all three semantic relations,
- intervention phase for first relation targeted (coinciding with baseline phases of the second and third relation),

- intervention phase for the second relation targeted (coinciding with postintervention phase for the first relation and baseline phase for the third relation), and
- intervention phase for third targeted relation (coinciding with postintervention phases for the first and second relation).

This amounted to a total of between 20% and 33% of all probe test sessions per participant per phase. The independent observer furthermore viewed video recordings of one to two randomly selected intervention sessions per relation for each participant, amounting to 20% to 33% of all intervention sessions. The independent observer rated the adherence to the procedural steps using the checklists. The percentage of adherence was calculated by the following formula:

$$\frac{\text{number of steps correctly executed}}{\text{total number of steps}} \text{ X } 100$$

3.10.2 Reliability of transcription and data collected

For each participant, an independent observer viewed video recordings of one to two randomly selected probe test sessions from each of the phases of the study, amounting to a total of between 20% and 33% of all probe test sessions, as recommended by Ayres and Gast (2010). The independent observer transcribed the participants' responses by writing down which PCS symbols the participants pointed to, using appropriate blank data collection score sheets like those used by the researcher (see Appendix S for an example). Point-by-point agreement on the transcription was calculated by the following formula:

$$\frac{\text{Number of agreements}}{\text{Number of agreements plus disagreements}} \text{ X } 100$$

The independent observer furthermore classified each response as correct or incorrect from the video recordings of the sessions viewed. Point-by-point agreement on the data was calculated by the following formula:

$$\frac{\text{Number of agreements}}{\text{Number of agreements plus disagreements}} \text{ X } 100$$

3.11 Summary

This chapter provided an overview of the methodology employed in the study. The aims and the design were stipulated. The pilot study and consequent recommendations for the main study were discussed. The participant recruitment was explained and a description of the participants was given. The equipment and materials used were described. The procedures used during the assessment and experimental stages of the main study were explained. The procedure used for the analysis of the data was briefly explained, as were the procedures used to calculate procedural integrity and reliability of the data.

CHAPTER 4
RESULTS

4.1 Introduction

This chapter presents an overview of the results of the study. In order to orientate the reader, the list of terms pertaining to the experimental stage of the study is repeated here. Because procedural integrity and reliability of data coding need to be demonstrated before any conclusions about the effectiveness of the intervention can be made (Gast, 2010, p. 93), these aspects are presented next. Following this, the results are discussed according to the subaims formulated for the study (see Section 3.2.2). First, the effect of the intervention on symbol combination skills (intervention and generalization items) is discussed for each participant, ending with a summary of results across participants (Subaims i and ii). This is followed by an analysis to detect any possible influence of the type of semantic relation or the order of presentation on the results (Subaim iii). Lastly, an analysis of the structure of all correct responses is presented (Subaim iv).

4.2 Terms

Following a list of how terms are used in this study.

- ***Probe***: Measurement of the dependent variable, that is, the production of graphic symbol combinations targeted during intervention, as well as the measurement of generalization to untrained items;
- ***Probe test***: Picture description task used to measure the dependent variable as well as performance on generalization items;
- ***Baseline probe***: Measurement of the dependent variable and generalization items before intervention commenced;
- ***Intervention probe***: Measurement of the dependent variable and generalization items during the time when intervention was given;
- ***Postintervention probe***: Measurement of the dependent variable and generalization items after intervention on the type of semantic relation had ceased;

- ***Intervention***: Independent variable or treatment, consisting of a prompting hierarchy used to prompt the production of selected combinations (intervention items) from the matrix during shared storybook reading (five items per story). In accordance with the design, the independent variable was applied consecutively to three behaviours (i.e. three types of semantic relations);
- ***Shared storybook reading***: Context used during which intervention was applied;
- ***Response during shared storybook reading***: Participants' responses to the various levels of prompting given during shared storybook reading were captured from the video recordings using data recording sheets (see Appendix A). Correct responses to the first level of prompting were graphed.
- ***Baseline phase***: Period of time during which baseline probes were administered;
- ***Intervention phase***: Period of time during which intervention and intervention probes were administered;
- ***Postintervention phase***: Period of time during which postintervention probes were administered.

4.3 Procedural integrity

The procedural integrity of a proportion of both the intervention sessions and probe test sessions was determined for each participant and each phase. An independent observer (speech language therapist) viewed between 20% and 33 % of video recordings of both the intervention procedure and the probe test for each participant across each of the phases, scoring the adherence to procedures using the score sheets (see Appendices T and U). The percentage of steps adhered to was calculated for each session. Detailed results per phase per participant are provided in Appendices V and W. A summary of the overall procedural integrity ratings of the intervention and probe test procedures is in Table 4.1.

Table 4.1

Overall Procedural Integrity of Intervention and Probe Test Across Participants

	Participant 1	**Participant 2**	**Participant 3**
Procedural integrity of intervention[a]	98.7%	98.3%	99.0%
Procedural integrity of probe test[a]	99.5%	100%	99.6%

[a] *measured by % of steps adhered to as rated by independent observer*

The procedural integrity of the intervention procedure varied from 96% to 100% across the three participants and the three intervention phases, with overall integrity ranging from 98.3% to 99%. The intervention procedure was thus reliably executed.

Procedural integrity of the probe test ranged from 99% to 100% across the three participants and the four phases (baseline phase and three intervention phases), with overall integrity of 99.5% to 100% for each participant across the different phases. Thus, the probe test was also executed reliably.

4.4 Reliability of transcription and data collected

The independent observer transcribed the participants' graphic symbol responses during the probe test for each of the video recordings observed, and classified each response as correct or incorrect. Point-by-point agreement of the transcription and the classification of responses per participant per phase was calculated. (Detailed results are provided in Appendix X). A summary of the overall point-by-point agreement of the transcription and classification per participant is presented in Table 4.2.

Table 4.2

Overall Point-by-Point Agreement of Transcription and Classification of Responses Across Participants

	Participant 1	**Participant 2**	**Participant 3**
Point-by-point agreement of transcription	88.2%	90.4%	86.5%
Point-by-point agreement of classification of responses	99.2%	100%	98.5%

Point-by-point agreement of the transcription per participant and per type of semantic relation ranged from 80% to 100% across the three participants across the phases, with overall reliability between 86.5% and 90.4%. There may have been a few reasons as to why the score was not higher. The interpretation as to whether a picture was deliberately pointed to or scanned with the forefinger in the process of finding the target was not always clear, and because no voice-over and confirmation of the intended message could be given during the probe test, the researcher was not able to confirm the

message produced by the participants. However, this only minimally affected the classification of responses. Point-by-point agreement of classification of responses as correct or incorrect per participant per phase and per type of semantic relation ranged from 93% to 100%, with an overall agreement of 99.2%. This represents overall good agreement and indicates that the classification was reliable.

4.5 Effect of intervention on the production of graphic symbol combinations

In this section, the effect of the intervention on the production of graphic symbol combinations (both intervention and generalization items) is discussed per participant according to a graphic portrayal of the results of the probes across the phases and the types of semantic relations targeted in intervention. Visual analysis of the graphs was supplemented by the calculation of the overall percentage of correct responses per phase, PND as well as IRD (comparing baseline and intervention phases). Appendix Y contains a summary of percentage correct, PND, IRD and corresponding CI per participant, per phase, for both intervention and generalization items.

Performance during the shared storybook reading activities (intervention) is also discussed to shed more light on the achievements of each participant. Results are then summarized and integrated with participant characteristics and contextual factors possibly influencing performance. The section concludes with a summary of the results across all three participants.

4.5.1 Participant 1

4.5.1.1 Performance as measured by probe test

Figure 4.1 presents an overview of Participant 1's performance on the probes administered during the baseline, intervention and postintervention phase for each target semantic relation.

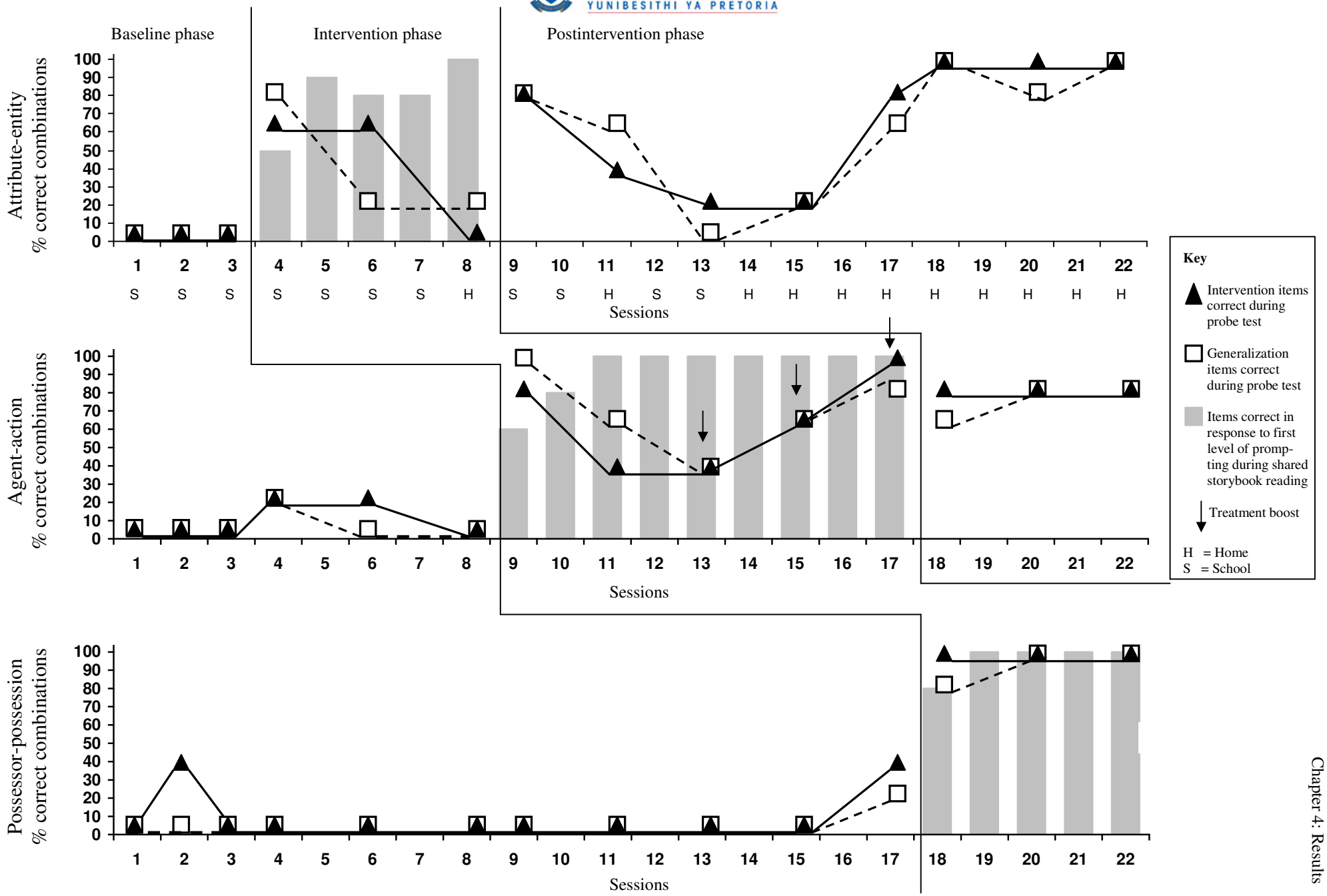

Figure 4.1. Percentage of correct symbol combinations expressed by Participant 1 across the three types of relations targeted.

Performance on both intervention items (white squares) and generalization items (black triangles) is depicted. Appendix Y gives a summary of percentage of items correct, PND and IRD with corresponding CI per phase.

4.5.1.1.1 Intervention items

A stable baseline of 0% across three sessions was obtained on the attribute-entity combination. When intervention was introduced, Participant 1's performance rose to 60% on the first intervention probe, signifying an immediate level change indicating that the intervention had an immediate effect. Participant 1 maintained this performance for the next probe, whereby the learning criterion was reached. However, another intervention probe was conducted in order to obtain three data points for the intervention phase. On the third intervention probe, his performance returned to 0%, resulting in an overall decelerating trend during the intervention phase. However, as this data point was regarded as an outlier, intervention on this type of semantic relation ceased and the next type of semantic relation was targeted. The PND when comparing the baseline and the intervention phase was 67%. Overall performance during intervention was 40% correct, as compared to 0% during baseline. Improvement rate difference (IRD) was .67, 85% CI [.33, 1.00].

On the first postintervention probe, Participant 1's performance reached 80% correct, representing an immediate change from his last performance during the intervention phase. However, as explained, this data point was regarded as an outlier. His performance of 80% correct represented an increase from the highest score obtained during the intervention phase (which was 60% correct). Over the next three probes, however, his performance declined to 40% and 20%. On the fifth postintervention probe, Participant 1's performance rose again to 80%, after which he maintained his performance of 100% over the following three probes. During the postintervention phase, an initial decelerating trend (Sessions 9-13) thus stabilized shortly at 20% (Sessions 13-15), after which a steep accelerating trend was observed (Sessions 15-18), stabilizing at maximum performance (100% correct) for three consecutive probes (Sessions 18-22). The PND of the postintervention phase as compared to baseline was 100%. Overall

performance during the postintervention phase was 68% of items correct, compared to 40% during intervention and 0% during baseline.

For the agent-action combination, the first three baseline probes remained at 0%. When intervention was introduced on the attribute-entity combination, performance rose to 20% for two probes, but returned to 0% on the last baseline probe. Thus, the intervention applied to the attribute-entity combination had little effect on the agent-action combination. Overall performance during this phase was 7% of items correct. When intervention was introduced, Participant 1's performance rose to 80% on the first intervention probe, representing an immediate level change indicating that the intervention had an immediate effect. His performance then declined to 40% on the next intervention probe. The treatment boost was therefore used for the remaining intervention sessions, whereby the correspondence between probe pictures and the story was made more salient. He scored 40% on the following probe, and his performance then increased again to 60% and 100%. After an initial decelerating trend during the intervention phase, an accelerating trend was observed over the course of the last three probes (Sessions 13-17). The PND between baseline and intervention was 100%. His overall performance during the intervention phase was 64% of items correct. IRD was 1.00, 85% CI [1.00, 1.00]. He maintained a stable performance of 80% on the three postintervention probes, giving an overall performance of 80% of items correct during this phase. The PND of the postintervention phase as compared to baseline was 100%.

The last type of semantic relation that was targeted was the possessor-possession combination. Of the 11 baseline probes that were conducted, Participant 1 scored 0% for 9 of them. He achieved a score of 40% for the second baseline probe (before intervention had been introduced to any of the combinations) and for the last baseline probe as well. His improved performance did not coincide with the introduction of intervention to either of the other two types of semantic relations, and it could therefore not be attributed to a response generalization. Overall, the baseline was regarded as stable, since 82% of the data points fell at 0%. The overall performance during this phase was 7% of items correct. After the introduction of intervention, Participant 1's score was 100% of

responses correct on the first intervention probe, a performance that was maintained during the second and third probe. His overall performance was thus 100% of items correct during intervention. An immediate level change after introducing intervention attests to the effect of the intervention. The PND between baseline and intervention was 100%. IRD was 1.00, 85% CI [1.00, 1.00].

The overall performance for the intervention phases was 67% of items correct and overall PND was 91%. Omnibus IRD (calculated by contrasting the overall improvement during all three intervention phases with the overall improvement during all three baseline phases) was .91, 85% CI [.82, 1.00]. These values suggest that intervention was very effective in promoting the production of graphic symbol combination skills (Scruggs & Mastropieri, 1998). For the postintervention phases (for the attribute-entity and agent-action combinations), overall performance was 71% of items correct. PND was 100%, indicating that intervention was very effective in promoting maintenance. It should be kept in mind, however, that both IRD and PND calculations are based on the degree of overlap between phases and therefore do not capture the magnitude of the change from baseline to intervention phases, nor the trend or stability of performance within a phase.

4.5.1.1.2 Generalization items

From a stable baseline of 0% across three sessions, Participant 1's performance on the generalization items of the attribute-entity combinations increased to 80% on the first probe conducted during the intervention phase and dropped to 20% on the next two probes conducted during intervention. Similar to his performance on the intervention items, the immediate level change after introducing intervention attests to its immediate effect on generalization items. However, a similar decreasing trend as for the intervention items was observed during this phase. Overall performance on generalization items during this phase was 40% of items correct. PND was 100% when comparing baseline and intervention. IRD was 1.00, 85% CI [1.00, 1.00].

During the postintervention phase, performance rose again to 80% during the first probe conducted, once again indicating a level change once intervention ceased. His

performance then decreased to 60% and 0% on the next two probes, returning to 20% on the fourth probe conducted during this phase. Thereafter, his performance rose to 60% and 100% on the next two sessions. He performed at 80% and 100% during the last two postintervention sessions. This performance mirrors the performance on intervention items, with an initial decelerating trend giving way to an accelerating trend over the probes conducted during Sessions 15-18, roughly stabilizing between 80% and 100% over the last three probes. Overall performance during this period was 63% of items correct. PND when comparing postintervention and baseline phases was 88%.

For the agent-action combinations, Participant 1's performance remained at 0% for the first three probes during the baseline phase and increased to 20% when intervention commenced on the attribute-entity combinations. Performance on generalization items returned to 0% during the fifth and sixth probe during the baseline phase. Overall performance during this phase was 3% of items correct. Once intervention commenced, Participant 1's performance on generalization items peaked at 100% on the first probe, indicating an immediate level change from minimum to maximum performance. His performance decreased to 60% and 40% during the next two probes of the intervention phase, and then increased again to 60% and 80% on the next two probes. This pattern of performance parallels the performance observed for intervention items of the agent-action combination, as well as that observed for the attribute-entity items during these sessions. Overall performance during this phase was 68% of items correct. PND as compared to baseline was 100%. IRD was 1.00, with a 85% CI [1.00, 1.00].

During the postintervention phase, he achieved 60% of items correct on the first probe and 80% on the following two probes conducted during this phase, representing a relatively stable performance over these three probes. His overall performance was 73% of items correct during this phase, and PND as compared to baseline was 100%.

Participant 1's performance on the generalization items of the possessor-possession combinations showed a stable baseline of 0% for 10 consecutive probes, with a performance of 20% on the last probe conducted during the baseline phase. Overall

performance during baseline was 2% of items correct. After intervention was introduced to this type of semantic relation, performance on generalization items increased to 80% on the first probe, representing an immediate level change. His performance rose to 100% on the next two probes. PND was 100%. IRD was 1.00, 85% CI [1.00, 1.00].

Overall performance was 67% and 65% of generalization items correct for the intervention and postintervention phases respectively, as compared to an overall performance of 2% of items correct for the baseline phases. Overall PND was 100% for the intervention phases, and 91% for the postintervention phases, indicating that the intervention was very effective to promote generalization to novel combinations, a skill that was maintained postintervention for the two behaviours on which postintervention data was collected (Scruggs & Mastropieri, 1998). Omnibus IRD was 1.00, 85% CI [1.00, 1.00], once again underlining that the intervention effectively promoted generalization to untrained exemplars.

4.5.1.2 Response during shared storybook reading sessions

Figure 4.1 also presents an overview of Participant 1's correct responses to the first level of prompting during the shared storybook reading sessions (grey bar graph). The first level of prompting consisted of drawing attention verbally and pointing to the picture, followed by an expectant time delay. The percentage of correct responses is captured in a bar graph (maximum number correct was 10, as each intervention item appeared twice). It should be noted that the absence of bars during baseline and postintervention sessions does not indicate a 0% performance, but rather that there was no measurement of performance since the shared storybook reading was only conducted during the intervention phase. A complete summary of the participant's responses to various levels of prompting is provided in Appendix Z.

From the bar graphs in Figure 4.1 it is clear that the percentage of correct items in response to the first level of prompting (verbally drawing participant's attention and pointing to the picture, followed by 10 s time delay) was generally high. An overall value of 80%, 93% and 96% respectively was attained for the first, second and third type of

semantic relation. The first intervention session for each of the three targeted relations showed the lowest percentage (50%, 60% and 80% respectively for the first, second and third relation that was targeted). Within a phase, the general trend was an increasing percentage of items correct in response to the first level of prompting with a maximum of 100% being reached after five, three and two intervention sessions respectively for the first, second and third relation. In case of the second and third relation, this performance (maximum number of items correct) was maintained for all ensuing sessions. Thus, it seems that Participant 1 produced the combinations after minimal intervention during the storybook reading sessions, responding correctly to the first level of prompting in at least half of the 10 opportunities provided. He also seemed to learn to produce the combinations increasingly quickly with each new type of semantic relation presented, indicating that the production of each type of relation seemed to be enhanced by the learning that had taken place during the intervention targeting a previous relation.

When comparing Participant 1's performance during shared storybook reading (limited here to percentage of items correct in response to the first level of prompting) with his performance during the intervention probes, he displayed a 10-20% better performance in the probes on the first intervention session of every type of relation. This indicates that, during the probe test, he was immediately able to produce the combinations targeted during intervention . The average difference across these three sessions was 17% increased performance in the probes as compared to the performance during shared storybook reading. During five sessions, Participant 1's performance was worse during the probes when compared to his performance during shared storybook reading, with differences in percentage correct ranging from 20%-100% and an average difference of 56%. Performance was identical (at 100%) during three sessions. On average, performance during shared storybook reading was 30% better than performance on the probes. While his performance seems comparable (20% or less difference in terms of percentage correct) for seven of the 11 sessions during which both the shared storybook reading and the probes were conducted, four sessions show a difference of 40%-100% in terms of percentage % correct, these being Sessions 8 (attribute-entity combination), 11, 13 and 15 (agent-action combination). There seemed to be factors

affecting Participant 1's performance during the probes conducted in these sessions. However, his performance during shared storybook reading was not affected.

4.5.1.3 Summary

Overall, IRD, PND, level change and overall performance on the probes indicate that the intervention was effective in encouraging Participant 1 to combine symbols to produce three types of semantic combinations. Furthermore, the intervention was very effective to promote generalization of this skill to untrained exemplars. The CIs obtained for the IRD values are generally very encouraging, with a zero interval being obtained for most IRD values obtained. The CI for the IRD obtained for the intervention items of the first type of relation that was targeted (attribute-entity) is relatively large, which may be attributable to the lower IRD obtained as well as the small number of data points obtained for baseline and intervention phases (Parker et al., 2009).

The postintervention data collected on two of the three types of relations furthermore suggests that ability to combine both trained and untrained exemplars was very effectively maintained postintervention. The overall performance was better during the postintervention phase than during the intervention phase for these two types of relations.

The slope change was a little less clear on the first two types of semantic relations. On the agent-action combinations, his performance decreased on the third probe during intervention and a decrease in performance on the second type of relation (attribute-entity) was seen during the second and third intervention probes as well. The decreased performance during Session 8 may have been influenced by the fact that this was the first session conducted at Participant 1's home in the afternoon, rather than at school in the morning. The novelty of the situation may have had a negative influence on performance. Subsequent sessions conducted at home (many also during the afternoon) did not seem to have the same negative effect on his performance. During Sessions 11, 12 and 13 Participant 1 was battling with a cold, which may have negatively affected his performance. It took Participant 1 much physical effort to access the pictures and he often

took a long time before he could accurately rest a finger on a symbol. He might have responded using single symbols rather than combinations in an effort to reduce fatigue. The fact that his performance on the agent-action combinations (postintervention) and the attribute-entity combinations (during intervention) mirror each other during these sessions seems to confirm that some external factors were influencing his performance. The treatment boost was thus used during Session 13, to make the correspondence between probes and intervention more salient. This seemed to have had a positive effect on performance on both types of relations, since in consequent probes, performance increased to maximum correct responses. For the attribute-entity combinations, this occurred during the postintervention phase, while performance on the agent-action combinations reached a maximum on the last intervention probe. Although his initial performance showed more variability (specifically Sessions 8, 11, and 13), his performance subsequently improved and stabilized at a high level, with very high performances across all types of relations (between 80% and 100%) observed from Session 18 onwards.

It is interesting to note that Participant 1's reduced performance on the probes during Sessions 8, 11, 13 and 15 was not mirrored in his performance during shared storybook reading (see Figures 4.2 and 4.3). It seems that performance during the probes was more vulnerable to outside influences. One reason may be that the shared storybook reading activity was more enjoyable and motivating. Contingent feedback given during this activity (as part of the intervention procedure) may also have helped to motivate participants to give correct responses. Probes were also always conducted after the shared storybook reading, thus making it more likely for fatigue to affect performance during the probes rather than during the shared storybook reading.

Participant 1 had a number of characteristics that may have contributed to his good performance (see Table 3.4, p. 67). Of the three participants, he had the best receptive English language scores; he also scored best in the receptive language subtests of the SERLA (Bortz, 1997). The fact that his speech and language development had progressed typically up until age 3 (when he had suffered a near-drowning incident) may

have given him a language base which children with congenital disabilities do not have. His speech was the most intelligible of all three participants, and he attained the highest scores for comprehension of the target relations and graphic symbols used in the study.

4.5.2 Participant 2

4.5.2.1 Performance as measured by the probe test

Participant 2's performance across baseline, intervention and postintervention phases on the intervention and generalization items of the three types of semantic relations is illustrated in Figure 4.2. A summary of percentage of items correct, PND and IRD with corresponding CI per phase is given in Appendix Y.

4.5.2.1.1 Intervention items

The first type of semantic relation that was targeted in intervention was agent-action. Participant 2's baseline performance was consistently 0% on all agent-action items. This remained unchanged during the first two intervention probes, representing no change in level—indicating that the intervention did not have an immediate effect. The treatment boost was applied implemented during the following sessions during which intervention probes were conducted. However, Participant 2's performance still remained at 0% for the next two probes, rising to 40% on the fifth intervention probe, at which time the teaching criterion was met and intervention ceased on this type of semantic relation. Change was thus only observed during the very last intervention probe. Overall performance during this phase was only 8% of items correct, and PND was only 20% as compared to baseline. IRD was .20, 85% CI [.00, .40], indicting that it was not possible to rule out the null hypothesis (IRD = 0) at an 85% level of certainty.

Performance during postintervention probes returned to 0% on the first two probes, but rose to 20% on the third postintervention probe. This probe coincided with the treatment boost employed for the second type of relation. The treatment boost might have had a carry-over effect, boosting not only performance on the type of relation receiving intervention, but also boosting performance on the type of relation that was

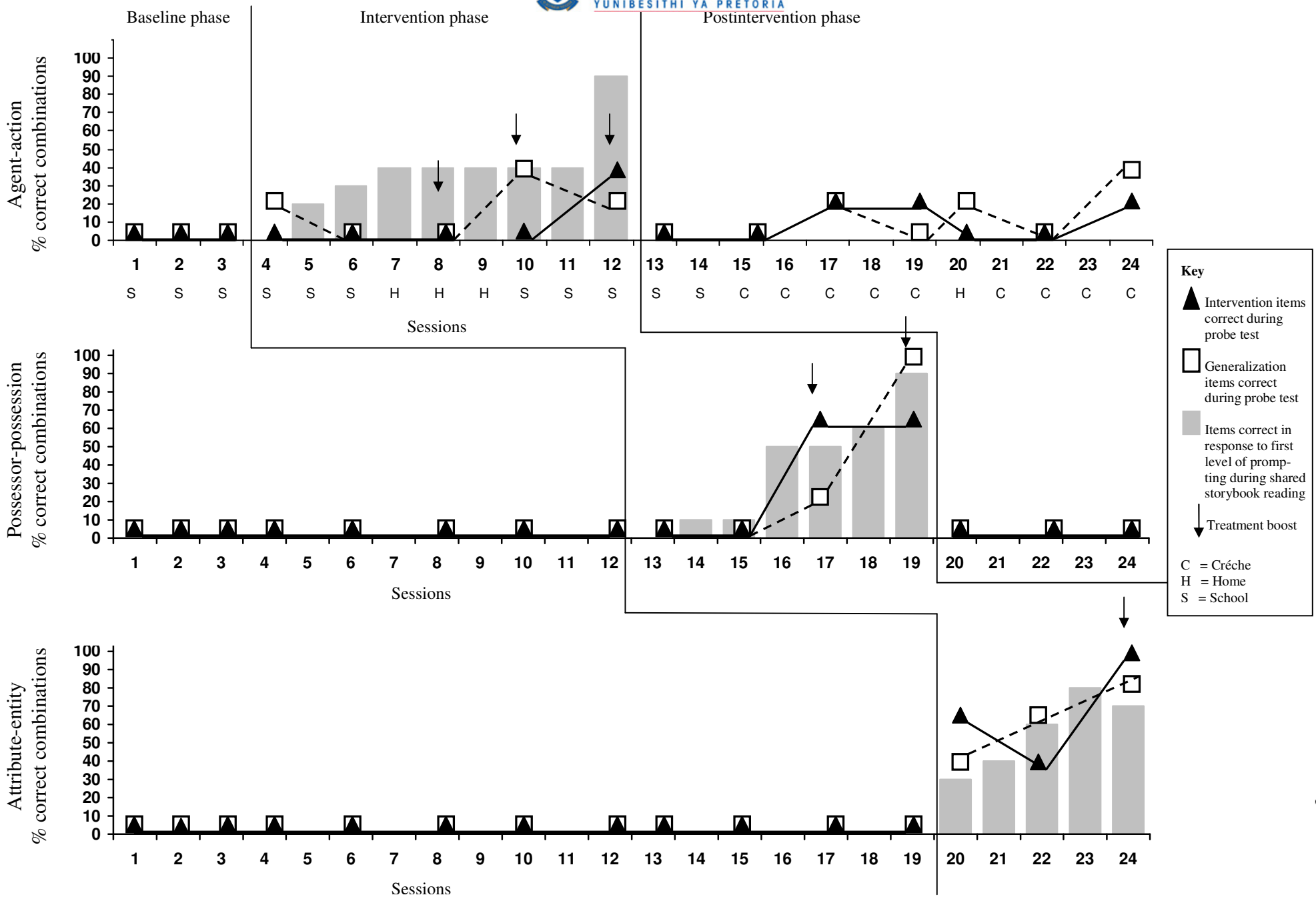

Figure 4.2. Percentage of correct symbol combinations expressed by Participant 2 across the three types of relations targeted.

targeted previously. His performance remained at 20% for the next probe, and then returned again to 0% for the next two probes, rising to 20% on the last postintervention probe. His overall performance was 9% of items correct during this phase and PND was 43%. Visual inspection of the graph shows very little effect for the intervention and postintervention phases.

On the possessor-possession combinations, Participant 2's baseline performance was once again stable at 0% across all eight sessions. Performance remained unchanged during the first two intervention probes, indicating no level change and no immediate effect of the intervention. The treatment boost was used during the next two probes. During the third probe, performance rose to 60%, and remained at 60% for the following probe. Thus, an accelerating trend was observed and overall performance was 30% of items correct. PND as compared to baseline was 50%. IRD was .50, 85% CI [.25, .75]. On the first postintervention probe, performance dropped to 0%, representing a level change of 60% in a negative direction. Performance remained at 0% for the next two probes—a return to baseline performance.

On the attribute-entity combinations, Participant 2 had a stable baseline of 0% across all 12 sessions. Once intervention commenced, performance rose to 60% on the first probe, representing an immediate change in level. Performance declined slightly to 40% on the next intervention probe. The treatment boost was thus used during the last intervention probe. Performance rose to 100% on the last probe. As only three data points were obtained, it is hard to identify a definite trend, although it is encouraging that his last performance was his best overall. Overall performance was 67% of items correct during this phase, and PND was 100%. IRD was 1.00, 85% CI [1.00, 1.00].

Overall performance during intervention phases was 30% of items correct, compared to 0% during baseline and 6% during postintervention. Overall PND during the intervention phases was 50%, indicating that the measurements obtained suggest an overall low effect of the intervention (Scruggs & Mastropieri, 1998). However, the effect clearly increased with each new type of relation being targeted. Omnibus IRD was .50,

85% CI [.33, .67]. Post-intervention PND for the first two types of relations was only 30%, indicating that the effect of the intervention was not maintained.

4.5.2.1.2 Generalization items

In general, Participant 2 performed similarly on the generalization items as on the intervention items, indicating a close link between these items. For the first type of relation (agent-action), Participant 2's performance on generalization items was 0% during baseline. After intervention commenced, his performance on generalization items rose to 20% during the first probe, indicating an absolute level change of 20%. However, his performance returned to 0% for the second and third probe occurring during the intervention phase. During the fourth probe, performance rose to 40%, and dropped to 20% during the last probe, which fell within the intervention phase. Performance thus remained variable, and no clear trend could be established. Overall performance was 16% of items correct, and PND was 60%. IRD was .60, 85% CI [.22, 1.00]. During the postintervention phase, performance dropped back to 0% on the first probe, representing a negative absolute level change of 20%. For the next five probes performance alternated between 0% and 20%, rising to 40% on the last postintervention probe. Performance thus remained poor and no clear trend could be established. Overall performance was 11% of items correct, and PND was 43% as compared to baseline.

Participant 2's performance on the generalization items of the possessor-possession combinations also showed a stable baseline of 0% across all eight sessions. His performance remained unchanged for the first two probes after intervention was introduced. No absolute level change was observed, indicating that intervention did not have an immediate effect. After introduction of the treatment boost, Participant 2's performance on generalization items rose to 20% and to 100% on the following two probes, indicating an accelerating trend. Overall performance during this phase was 30% of items correct, and PND was 50% as compared to baseline. IRD was .50, 85% CI [.25, .75].

His performance returned to 0% on the first postintervention probe, indicating a maximum negative level change (100%). Performance remained at 0% during the next two probes, indicating a return to baseline after intervention for the possessor-possession combinations ceased.

From a stable baseline of 0% across all 12 sessions on the generalization items of the attribute-entity combinations, Participant 2's performance rose to 40% on the first probe following the introduction of intervention targeting this type of relation. An absolute level change of 40% was thus observed. Performance further increased to 60% and 80% for the following two probes, resulting in an accelerating trend over this phase. Overall performance on generalization items was 60% of items correct, PND was 100% and IRD was 1.00, 85% CI [1.00, 1.00].

The overall performance during intervention phases was 32% of generalization items correct, as compared to 0% during baseline phases and 8% during postintervention phases. The overall PND during the intervention phase was 67% of items correct on generalization items across all three types of relations, indicating that intervention effect was low or questionable in terms of its success in promoting generalization to untrained items (Scruggs & Mastropieri, 1998). Omnibus IRD was .67, 85% CI [.50, .83]. Overall PND during the postintervention phases for items of the first two types of relations was 22%, indicating that the intervention was not effective in encouraging maintenance of a generalization effect observed during the intervention phase.

There were only minor differences between Participant 2's performance on generalization and intervention items with slightly better performance on the generalization items of the agent-action combinations; performance on intervention items of the attribute-entity combinations was slightly better. Once again, it seems that the matrix structure allowed any effect on intervention items to generalize to untrained exemplars from the matrix.

4.5.2.2 Response during shared storybook reading

Figures 4.2 also provides an overview of Participant 2's responses to the first level of prompting (drawing attention verbally and pointing to the picture, followed by an expectant time delay) presented during the sessions of shared storybook reading. These responses are captured in the grey bar graph. The maximum number correct was 10, as each intervention item appeared twice. As indicated for Participant 1, the absence of bars during baseline and postintervention sessions does not indicate a 0% performance, but rather that there was no measurement of performance as shared storybook reading was only conducted during the intervention phase. For a complete summary of the participant's responses to various levels of prompting please refer to Appendix Z.

Overall, Participant 2 did not respond correctly to the first level of prompting as often as the other two participants, with an overall performance of 38%, 39% and 56% correct respectively for the first, second and third type of relation. Like Participant 1, overall performance improved for each new type of relation that was targeted. The highest percentage correct that was reached was 90% during the last intervention sessions, targeting the agent-action and possessor-possession combinations respectively. Increasingly better performance across the sessions within a phase is evident, with the exception of a 10% decrease in performance from Session 23 to Session 24 for the attribute-entity combinations.

When comparing Participant 2's responses to the first level of prompting during shared storybook reading to his performance during the probes, the percentage of correct items was lower on the probes for seven of 12 sessions, with differences ranging from 10% to 70%. The average difference in performance for these seven sessions was 34%. Performance during the probes was better than that observed during shared storybook reading on three occasions (Sessions 17, 20 and 24). Notably, during Sessions 20 and 24, when intervention targeted the attribute-entity combinations, percentage correct on these combinations as tested by the probe test was 30% above the percentage correct in response to the first level of prompting during shared storybook reading. The average difference in percentage correct across all 12 sessions was 26% (with better performance

during shared storybook reading than during probes), representing the smallest average difference amongst the three participants.

In general, the trends in percentage correct on the probes across sessions mirrored the trends observed during shared storybook reading. On the agent-action combinations, the only increase in probe performance was observed from Session 10 to Session 12. Percentage correct in response to the first level of prompting during shared storybook reading similarly showed the most dramatic increase from Session 11 to Session 12. On the attribute-entity combinations the trends in performance during shared storybook reading versus probes was a little less congruent and showed a decrease in performance on the probes in Session 20 to Session 22, followed by an increase from Sessions 22 to 24. Performance during shared storybook reading increased from Session 20 to 23, followed by a slight decrease from Session 23 to 24. The overall increase is, however, observed in both the percentage correct achieved during shared storybook reading and during probes.

4.5.2.3 Summary

Level change, IRD, PND and percentage of items correct during the probes all attest to the fact that Participant 2 had initial difficulties acquiring the symbol combinations. However, his performance improved with each new type of relation. The treatment boost seems to have aided his performance, especially on the second type of relation, where an immediate change in performance was seen when the treatment boost was introduced. PND and percentage of items correct for the intervention phase increased from 20% and 8% on the intervention items of the first type of relation to 100% and 67% on the intervention items of the last type of relation respectively, and an immediate level change was only observed on the last type of relation. CIs (at 85% level of confidence) obtained for the IRDs for each of the three relations are increasingly more positive for each new relation that was targeted (increasingly narrower range). The 85% CI for the omnibus IRD of .5 is still relatively large [.33, .67].

Performance on generalization items showed a similar pattern of increasingly better performance across the types of relations, although an immediate level change (albeit slight) was observed upon the introduction of intervention on the first type of relation. PND on the first type of relation was relatively high (60%), but this score needs to be interpreted with caution in view of a low percentage correct score (16%) for generalization items during the intervention phase on the first type of relation.

IRD with accompanying CIs obtained for the first two types of relations indicate a lower effect and less confidence in the results at an 85% level (CIs are large) for generalization items. IRD values and CIs obtained for the last type of relation as well as overall are somewhat more encouraging, although the CI for the omnibus IRD is still wide, indicating reduced confidence in the results. The limited number of data points obtained as well as Participant 2's weak performance would have been partially responsible for large CIs.

Postintervention data gathered on the first two types of relations show little if any evidence of maintenance. On the agent-action combinations, a very limited number of correct responses (on intervention and generalization items) was observed postintervention, similar to the limited correct responses observed during intervention. On the possessor-possession combinations, postintervention data represent a return to baseline. The reason why Participant 2 did not maintain his performance on the possessor-possession combinations may be ascribed to the fact that fewer intervention sessions were conducted on this combination than on the agent-action combination.

Participant 2's performance during intervention seemed largely congruous with his performance during the probes in terms of trend. On the first type of relation (agent-action), the percentage of correct responses to the first level of prompting was generally higher than the percentage of correct responses given during the probes. He seemed to have some difficulty in producing the combinations targeted during intervention in the probe test. However, during intervention on the second type of relation (possessor-possession), his performance in response to the first level of prompting during

intervention mirrored his performance on the probes more closely. On the last type of relation (attribute-entity), he correctly responded to a greater percentage of items during the probe than he did during intervention (in response to the first level of prompting) on two of the three occasions on which the probes were conducted. Thus it seems that it became increasingly easy for him to produce the target and generalization items during the probe test.

Participant 2 had the lowest receptive English language score (as determined by the CELF–Preschool ^{UK} and PPVT-4) and was also the youngest participant. He also achieved the lowest score regarding the recognition of the PCS on the communication board (76% on the second trial). (For a summary of characteristics please see Table 3.4., p. 67) Additionally, the other two participants had had some experience (albeit limited) in using personalized communication boards and/or books with PCS for expressive purposes, whilst Participant 2 did not. The learning curve was thus understandably steep for him. On the initial three baseline probes, he responded mostly using mime, vocalizations and some word approximations. He only pointed to the PCS on the board on three occasions and only one of the PCS he pointed to was related to the picture shown. On the first probe after intervention commenced on the first type of relation, he responded by pointing to at least one correct PCS in response to 12 of the 30 pictures presented—once by pointing to the correct symbol combination, and 11 times by pointing to one PCS that was related to the picture shown. These graphic symbol utterances occurred in response to five agent-action pictures, five attribute-entity pictures and two possessor-possession pictures. Thus, Participant 2 learnt relatively quickly to point to single symbols, and slowly gained skills in combining symbols. The fact that he learnt to produce the combinations increasingly faster on each new type of relation that was targeted in intervention does seem to indicate that his understanding of the potential for PCS to be used to aid expression, increased. Furthermore, the matrix structure seemed conducive in helping him generalize his symbol combination skills to some combinations that had not been directly targeted in intervention. However, his lack of maintenance seems to indicate that his skills in the production of symbol combinations did not stabilize over the limited time during which the intervention was conducted.

4.5.3 Participant 3

4.5.3.1 Performance as measured by probe test

Figure 4.3 presents a graphic representation of Participant 3's performance across baseline, intervention and postintervention phases, for each of the three types of relations. Performance on both intervention and generalization items is depicted. Appendix Y gives a summary of percentage of items correct, PND and IRD with corresponding CI per phase.

4.5.3.1.1 Intervention items

From Figure 4.3 it is evident that Participant 3's performance during baseline was 0% on the first type of relation (possessor-possession) for all three probes conducted. Her performance remained at 0% during the first two intervention probes, indicating that the intervention did not have an immediate effect. The treatment boost was therefore used during the next probe, whereupon her performance increased to 20% on the next probe, and to 100% on the following probe. However, she returned to her baseline performance of 0% on the next probe, in spite of the treatment boost. During the next probe, the treatment boost was once again used, and her performance increased to 20%.

While a stable pattern of performance was observed during baseline, Participant 3's performance was erratic and variable during intervention, with no clear pattern being observed. While the intervention did seem to have an effect, no consistent trends could be discerned. Her overall performance during the intervention phase was 23% of items correct as compared to 0% during baseline. However, PND was only 50%. IRD was .50, 85% CI [.17, .83]. During the postintervention phase, an initial performance of 40% on the first probe returned to 0% for six of the remaining seven probes, only rising briefly to 20% on the sixth probe during this phase. Performance thus essentially dropped back to baseline, with overall performance at 8% of items correct, and PND at only 25% as compared to baseline.

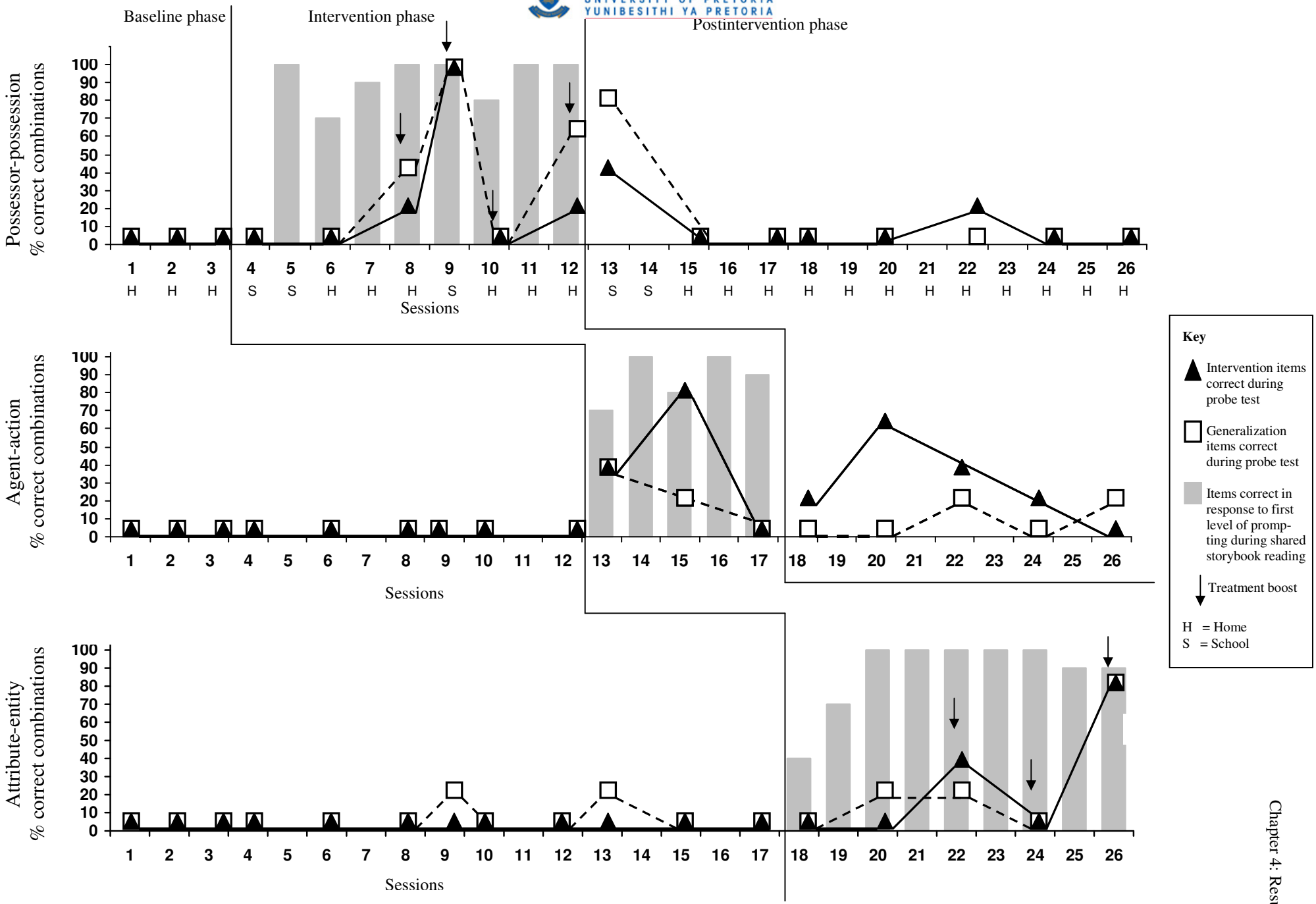

Figure 4.3. Percentage of correct symbol combinations expressed by Participant 3 across the three types of relations targeted.

On the second type of relation (agent-action), Participant 3's baseline performance was stable at 0% for all nine sessions. It increased to 40% on the first intervention probe, indicating an absolute level change of 40%. Her performance further increased to 80% on the second probe conducted during this phase, only to return to 0% on the third intervention probe. As she had technically reached the learning criterion (at least 40% above baseline average for two consecutive probes) during the second probe, intervention ceased on the second type of relation and commenced on the third. Her performance thus increased and decreased again over the three probes, but because only three data points were obtained, it is hard to identify a definite trend in intervention performance for this type of relation. Overall performance during intervention was 40% of items correct, and PND was 67%. IRD was .67, 85% CI [.33, 1.00]. On the postintervention probes, Participant 3's performance increased from 0% on the last intervention probe to 20% on the first postintervention probe, indicating an unexpected slight level change of 20%. She achieved 60% correct during the next probe, with performance declining thereafter to 40%; 20% and 0% on the next three probes. Once again, her performance was varied, with an initial accelerating trend giving way to a decelerating trend over the last few probes. Her overall performance during this phase was 28% of items correct, and PND was 80%.

Participant 3's baseline for the last type of relation (attribute-entity) was also consistently at 0% during all 12 baseline probes. Following the introduction of intervention, her performance remained at 0% during the first two intervention probes, indicating that there was no immediate effect of the intervention. The treatment boost was therefore implemented. Her performance increased to 40% during the next probe, only to return to 0% during the fourth probe. On the last intervention probe, her performance rose to 80%. Once again, performance showed great variability and no definite trends could be established. Her overall performance during intervention on this relation was 24% of items correct, and PND was only 40%. IRD was .40, 85% CI [.00, 0.80], the latter value indicating that it cannot be ruled out with 85% certainty that the true IRD is different from zero.

The overall performance during the three intervention phases was 27% of items correct, as compared to 0% during baseline and 15% during postintervention phases. The overall PND was 50% for the intervention phase and 46% for the postintervention phase, indicating that the

effectiveness of the intervention in promoting production of expressive graphic symbol combinations and the maintenance of this skill was low or questionable (Scruggs & Mastropieri, 1998). Omnibus IRD was .50, 85% CI [.29, .71].

4.5.3.1.2 Generalization items

In general, Participant 3's performance on generalization items mirrored her performance on intervention items closely. For the first type of relation (possessor-possession), a baseline performance of 0% was maintained for the first two probes conducted after intervention commenced. Once the treatment boost was implemented, she responded correctly to 40% of generalization items on the next probe and 100% on the fourth probe. Her performance dropped to 0% on the next probe, and rose again to 60% on the last intervention probe. Her performance thus varied in the same way as her performance on the intervention items for this type of relation did. Her overall performance on generalization items was 33% of items correct during this phase. PND was also 50%. IRD was .50, 85% CI [.17, .83]. On the first probe postintervention, Participant 3 responded correctly to 80% generalization item, after which her performance dropped to 0%, thus returning to baseline. Her overall postintervention performance was 10% of items correct, and PND was only 13%.

On the agent-action combinations, Participant 3's baseline performance was stable at 0% during all nine probes. Once intervention commenced, her performance increased to 40% on the first probe, indicating an absolute level change of 40%. Her performance declined again to 20% and 0% on the next two intervention probes, thus displaying a decelerating trend. Overall performance during this phase was 20% of items correct. PND was 67%. IRD was .67, 85% CI [.33, 1.00]. Participant 3's performance remained at 0% on the first two postintervention probes, increasing to 20% and returning to 0% on the following two postintervention probes. On the last probe of the postintervention phase, her performance was once again 20%. Performance was thus similar to baseline, with an overall performance of 8% of items correct, and PND of 40% as compared to baseline.

Participant 3's performance on the generalization items of the attribute-entity combination remained at 0% for 10 of 12 baseline probes, rising to 20% on the seventh and the

10th probe conducted during this phase (Sessions 9 and 13). The 10th probe coincided with the introduction of intervention on the agent-action combination. However, her performance returned to 0% on the remaining baseline probes. This can be regarded as a stable performance, since 83% of the data points fall at 0%. The overall performance on generalization items for this type of relation was at 3% of items correct during baseline. Upon introduction of intervention, her performance remained at 0% for the first probe, representing no level change. Performance increased to 20% for two probes, only to return to 0% on the fourth probe. On the last probe, she achieved 80% correct. Thus, the erratic pattern of performance on intervention items was mirrored once again on generalization items, with no clearly discernible trend. Overall performance was at 24% of items correct, with PND as compared to baseline being only 20%. IRD was .43, 85% CI [.12, .80].

Her overall performance during the intervention phases was 27% of items correct, as compared to 2% during baseline phases and 9% during postintervention phases. Overall PND was 43% for the intervention phases, and 23% for the postintervention phases, indicating that the intervention was not effective in promoting generalization to novel combinations (Scruggs & Mastropieri,1998). Omnibus IRD was .49, 85% C [.27, .70].

There was no remarkable difference in her performance on intervention versus generalization items on the possessor-possession combinations (although performance on generalization items was slightly better overall) and the attribute-entity combinations (where overall performance was identical). The difference was more marked on the agent-action combinations, where overall performance on intervention items was 20% better during both the intervention and the post intervention phases. The effect of the intervention on intervention and generalization items was thus very similar.

4.5.3.2 Response during shared storybook reading

Figure 4.3 also presents an overview of Participant 3's response during the shared storybook reading sessions. Specifically, the percentage of correct graphic symbol combinations in response to the first level of prompting (drawing attention verbally and pointing to the picture, followed by an expectant time delay) is shown in a bar graph (maximum number correct was 10,

as each intervention item appeared twice). Once again, the absence of bars during baseline and postintervention sessions does not indicate a 0% performance, but rather that there was no measurement of performance because the shared storybook reading was only conducted during the intervention phase. Appendix Z provides a complete summary of the participant's responses to various levels of prompting.

Like Participant 1, Participant 3 responded correctly to the first level of prompting (drawing participant's attention verbally and pointing to the picture, followed by 10 s time delay) during most opportunities created during shared storybook reading, with an overall percentage correct responses of 82%, 88% and 88% respectively for the first, second and third type of relation. Like Participant 1, the first intervention session for each of the three types of relations showed the lowest percentage correct (0%, 70% and 40% respectively for the first, second and third type of relation). Although the trend within a phase generally indicated increased performance with progressing sessions, there was some variation within Participant 3's performance, with a drop in performance here and there. During the intervention on the possessor-possession combinations, a 30% drop in performance was seen from Session 5 to Session 6 and a 20% drop from Session 9 to Session 10. A 20% drop was seen from Session 14 to Session 15 (agent-action combinations) and a 10% drop from Session 24 to Session 25. Between all other sessions, stable or increasing performance was observed.

While Participant 3's performance during shared storybook reading (as measured by percentage correct in responses to the first level of prompting) and the probes was identical during Sessions 4 and 9 (0% and 100% respectively), she consistently performed worse during the probes on all the other sessions. Differences in percentage correct ranged from 30%-100%. The average difference between shared storybook reading and probe performance was 53%. Some correspondence (albeit limited) in trend between performance on probes versus performance during shared storybook reading could be observed. For example, during the intervention phase that targeted the possessor-possession combinations, an overall increase in performance during both shared storybook reading and probes could be observed over Sessions 4 to 9, with a decrease from Sessions 9 to Session 10, followed by another increase from Session 10 to Session 12. Correspondence in trend was less clear for the intervention phases for the

agent-action and attribute-entity combinations. For the agent-action combinations, there was a general increasing trend in performance during shared storybook reading across Sessions 13 to 17, while performance on the probes increased from Session 13 to Session 15, but decreased from Session 15 to Session 17. Similarly, performance during shared storybook reading on the attribute-entity combinations increased from Sessions 18 to 20, stabilized at a maximum and decreased again slightly (from 100 to 90%) from Sessions 24 to 25, remaining at 90% for Session 26. Performance on the probes remained at 0% for Sessions 18 and 20, increased during Session 22, decrease again during Session 24 and increased steeply on Session 26.

It is clear that Participant 3's performance on the probes was generally much worse than her performance during shared storybook reading. In spite of some correspondence in trend, performance during shared storybook reading did not seem to be clearly related to performance during the corresponding probe.

4.5.3.3 Summary

From the results obtained it seems that the intervention did have some effect on Participant 3's production of target and generalization items, as can be seen by the increased performance on some of the intervention probes. However, the effect was neither consistent nor maintained. The most frequent response to the probe test items during both baseline and intervention was pointing to one rather than two target symbols. Participant 3 predominantly pointed to the symbols depicting agents, entities and possessions. The treatment boost seemed to have some effect in aiding her performance, as can be seen by change in levels in the first and third type of relation upon introduction of the boost. However, even with the treatment boost, performance remained variable with returns to 0% correct during Sessions 10 and 24. IRD values across intervention and generalization items for the different relations as well as omnibus IRD values range from .40 to .67 , and all accompanying CIs are wide, extending from .19 to .33 points below and above the obtained IRD values. The confidence in the results at a 85% level is thus limited. The limited number of data points as well as the small IRD values would have been responsible for wide CIs.

During intervention (storybook reading), however, Participant 3 responded correctly to at least 70% of all items upon the first level of prompting (drawing attention and expectant pause) during all sessions except for the first intervention sessions targeting possessor-possession and attribute-entity combinations respectively. It thus seems that, during the shared storybook reading situation, she quite readily combined the symbols to produce symbol combinations. However, it seemed difficult for her to transfer this skill to the probe test.

Various factors could have influenced Participant 3's performance. Most sessions were conducted at home in the afternoon, because Participant 3 was often kept out of school, remaining in bed for most of the morning. Her parents indicated that, during winter, with the cold weather conditions, it was difficult to get her ready for the school transport, which came to fetch her at 05h50 in the morning. When sessions were conducted at home, Participant 3 seemed to be somewhat less focused than when sessions were conducted at school. Sessions had to be conducted in the family lounge and, on occasion, family members would pass in the adjacent passage, although they endeavoured to keep this at a minimum. The repetitiveness of the probe test together with lack of specific feedback on the correctness of a response may also have influenced performance negatively. During a testing situation, only noncontingent encouragement can be given, to avoid the test itself becoming a learning situation. However, giving rewards (or encouragement) independent of performance may disadvantage the learning process (Basil, 1992).

While Participant 3 had better English receptive language skills than Participant 2, her motor abilities were significantly lower. She was also the only one of the candidates who did not have independent mobility. Her lack of mobility may have contributed to her being, in general, a more passive child than the other two participants were. Especially the seemingly sudden returns to 0% on intervention and generalizations items that occurred during intervention phases of all three types of relations (see Sessions 10, 17 and 24 on Figure 4.3) seemed to be linked to a lack of motivation to point to more than one symbol per response. Although she did always respond, she did not seem motivated to respond correctly, since pointing to two symbols took double the physical effort. Seeing that no negative feedback was given nor corrections were expected (unlike during shared storybook reading), there was no external motivation to respond correctly.

4.5.4 Summary of results across participants

Results as measured by the probe test differed considerably across the three participants. A clear overall effect of the intervention on symbol combination skills could only be shown for Participant 1, while the overall effect was low for Participants 2 and 3. On closer inspection of the visual portrayal of results, it seems that Participant 2, while struggling to produce the target combinations initially, learnt increasingly quicker and more with each new type of relation. Participant 3, however, showed erratic performance characterized by sharp increases and decreases in performance levels between sessions. While Participants 1 and 2 showed congruence between performance during intervention and performance during the probes, Participant 3 showed much less congruence, with overall performance during probes much lower than performance during intervention.

None of the participants showed much discrepancy between their performances on intervention items, versus their performances on generalization items on the probe test. This seems to suggest that, when the intervention had an effect on items that were specifically targeted, the effect readily generalized to other items in the matrix, which were not directly targeted. Postintervention data was only gathered on two types of relations per participant, limiting the conclusions that can be drawn from the data. Maintenance of skills postintervention was only demonstrated for Participant 1, while no or little such maintenance was shown for Participants 2 and 3.

While specific participant characteristics and contextual factors that may have influenced results have already been highlighted, these factors are further explored in the following chapter.

4.6 Influence of type of semantic relation and order of presentation

In order to gauge whether performance may have been influenced by the type of semantic relation and/or the order in which the semantic relations were targeted, the participants' performance was summarized according to both the order in which semantic relations were targeted (Table 4.3) and the type of relation (Table 4.4).

Table 4.3

Percentage of Correct Responses During Baseline (B), Intervention (I) and Post-intervention(PI) Phases According to the Order in which Semantic Relations Were Targeted

Type of relations		Participant 1			Participant 2			Participant 3			Average		
		B	I	PI	B	I	PI	B	I	PI	B	I	PI
1st type of relation	**Intervention**	0	40%	68%	0	8%	9%	0	23%	8%	0	24%	28%
	Generalization	0	40%	63%	0	16%	11%	0	33%	10%	0	30%	28%
2nd type of relation	**Intervention**	7%	64%	80%	0	30%	0%	0	40%	28%	2%	45%	36%
	Generalization	3%	68%	73%	0	30%	0%	0	20%	8%	1%	39%	27%
3rd type of relation	**Intervention**	7%	100%	-	0	67%	-	0	24%	_	2%	64%	-
	Generalization	2%	93%	-	0	60%	-	3%	24%	_	2%	59%	-
Total	**Intervention**	6%	67%	71%	0	30%	6%	0	27%	15%	2%	41%	31%
	Generalization	2%	67%	65%	0	32%	8%	2%	27%	9%	1%	42%	27%

Table 4.4

Percentage of Correct Responses During Baseline (B) and Intervention (I) Phases According to the Type of Semantic Relation

Semantic relations		Participant 1		Participant 2		Participant 3		Average	
		B	I	B	I	B	I	B	I
Agent-action	**Intervention**	7%	64%	0	8%	0	40%	2%	37%
	Generalization	3%	68%	0	16%	0	20%	1%	35%
Attribute-entity	**Intervention**	0	40%	0	67%	0	24%	0	44%
	Generalization	0	40%	0	60%	3%	24%	1%	41%
Possessor-possession	**Intervention**	7%	100%	0	30%	0	23%	2%	51%
	Generalization	2%	93%	0	30%	0	33%	1%	52%
Total	**Intervention**	6%	67%	0	30%	0	27%	2%	41%
	Generalization	2%	67%	0	32%	2%	27%	1%	42%

It appears that, overall, performance for both intervention and generalization items was best on the relations targeted last, and weakest on the first relation targeted. On closer inspection, this holds true for both Participants 1 and 2, whereas Participant 3 had a more even profile. For her, performance on intervention items was best on the second relation and worst on the first, with performance on generalization items being the best on the first relation and worst on the second. While Participants 1 and 2 thus seemed to achieve a consistent pattern of increasingly better performance, no clear pattern could be observed for Participant 3.

Analysis of the effect that the type of semantic relation had on the performance of participants does not show repeated patterns across any of the participants (cf. Table 4.4). The overall performance across participants does not differ substantially and in view of the lack of a uniform pattern across participants, the totals are not that meaningful. It seems that performance was not clearly influenced by the type of semantic relation and that the semantic relations (behaviours) were therefore equal in learnability, as required by a multiple baseline design across behaviours.

4.7 Further analysis of correct responses

All responses given during the probe test that were classified as correct were further analysed to determine to which extent they conformed to the word order and number of elements modelled during intervention. Results are presented in Table 4.5.

Table 4.5

Order and Number of Elements in Correct Responses across Participants

		Participant 1	**Participant 2**	**Participant 3**	***Total***
2 symbols	**Conforming order**	94 (60%)	25 (57%)	8 (14%)	127 (49%)
	Reverse order	31 (20%)	11 (25%)	26 (46%)	68 (26%)
More than 2 symbols		32 (20%)	8 (18%)	22(39%)	62 (24%)
Total		157 (100%)	44 (100%)	56 (100%)	257 (100%)

For Participants 1 and 2, the majority of responses that were classified as correct (i.e. containing both target symbols) contained only the two target symbols in the same order as modelled during storybook reading (60% and 57% respectively). The remaining responses were roughly equally divided amongst those containing the two target symbols in the reverse order (i.e. entity-attribute, action-agent or possession-possessor) and those containing more than two symbols. For Participant 3, the majority of responses contained the two target symbols in reverse order (46%), with nearly as many responses containing more than two symbols (39%). Only 14% of responses classified as correct contained the two target symbols in the same order as modelled during storybook reading.

An overview of the order and number of elements of the correct responses according to the type of semantic relation is given in Appendix AA. Each participant performed differently on the different types of relations and the type of relation did not clearly predispose a specific element order. Participant 1 performed similarly across all three relations, with the highest percentage of responses conforming to the order for the possessor-possession combinations. Participant 2 also had the highest percentage of conforming word order responses for this type of relation, clearly above the percentage of such responses for the other two types of relations. The agent-action relation elicited a high percentage of reverse order responses from him, while the other two types of relations elicited a minimal percentage or no reverse order responses. For Participant 3, the agent-action relation elicited the highest percentage of conforming word order responses, while the possessor-possession relation elicited a particularly high percentage of reverse word order responses.

4.8 Summary

The results of the study were presented in this chapter. Good procedural integrity was demonstrated by an independent observer. The data collection and analysis was shown to be reliable, judged by good interobserver agreement. The effect of the intervention on symbol combination skills (intervention and generalization items) was discussed per participant, ending with a summary of results across participants. Although participants performed relatively well during the storybook reading activities, their performance on the probes varied. An analysis to detect any possible influence of the type of relation or the order of presentation on the results indicated that two participants seemed to have learnt to produce the combinations more effectively with each new type of relation that was targeted. The type of relation did not seem to influence results. An analysis of the structure of all correct responses indicated that all participants used conforming and nonconforming word orders in their responses and responded with utterances that contained more than the two symbols that were modelled.

CHAPTER 5
DISCUSSION

5.1 Introduction

The results obtained in the study are discussed in this chapter. Possible reasons for and influences on the performance of the participants are explored with reference to relevant literature. Results are compared to other intervention studies that targeted graphic symbol combinations. Possible reasons for differences and similarities are explored.

5.2 Effect of the intervention on symbol combination skills

Based on the results from the probe test, a clear effect of the intervention on symbol combination skills (repeated across all three behaviours targeted) could only be shown for Participant 1. The overall effect for Participants 2 and 3 was low or questionable. At the same time, Participant 2 performed increasingly better on each type of relation, while Participant 3's performance was inconsistent. Performance on the generalization items was generally very similar to that observed for intervention items, suggesting that participants applied whatever skills they gained from the intervention to the untrained exemplars from the matrix. All three participants seemed to perform better during shared storybook reading than during the probe test. The gap in performance was especially marked for Participant 3, suggesting that the probes did not tap the participant's ability fully.

Three other interventions targeting graphic symbol combinations have shown clearer and less ambiguous effects (Binger et al., 2008, 2010; Nigam et al., 2006). There are various possible reasons for the differences observed, including differences in selection criteria resulting in different participant characteristics, as well as differences in intervention procedures, design and measurement criteria. (For an overview, please see the table summarizing the most important aspects of these three studies as well as those of the current study that is provided in Appendix AB.) In the following sections, factors that may have influenced the results of the current study are explored. These factors are grouped under child-related factors, task- and instruction-related factors, AAC system-related factors as well as partner- and environment-related factors (cf. Figure 2.1, Section 2.4.1). Where appropriate, factors are compared to other studies that targeted graphic symbol combinations.

5.2.1 Child-related factors

5.2.1.1 Selection criteria

While homogeneity of participants in single subject studies increases the likelihood of consistent findings and is therefore highly desirable, it is difficult to achieve, especially amongst participants in need of AAC, where heterogeneity is the rule rather than the exception (Bedrosian, 2003). Additionally, in South Africa, there is great cultural and linguistic heterogeneity amongst the general population (as illustrated by the fact that 11 official languages are recognized in the country). Furthermore, intervention histories of children with disability also often vary considerably, because early intervention services are not always readily available, known about, or considered important by caregivers. A lack of official policies mandating services and regulating the type of services rendered to children with disabilities (e.g. provision of AAC to children with limited speech) further contributes to a lack of standardized services.

In conceptualizing the study, the literature was consulted to ensure that the criteria for selection would be set in such a way that participants who would benefit maximally by the intervention would be selected. Furthermore, homogeneity amongst participants was hoped to be achieved regarding crucial variables such as language comprehension, language and speech production, sensory status and preintervention levels of the dependent variable (see Section 3.7.1). However, some criteria (e.g. prior experience in the use of graphic symbols for expression, English home language) set in previous studies (Binger et al., 2008; Binger & Light, 2007) could not be applied in this study, in view of the fact that, in South Africa, the landscape of children in need of AAC looks differ from that in developed countries (cf. also Dada & Alant, 2009).

The variation in performance observed amongst the three participants may therefore in part be attributed to differences in participant characteristics, which the selection criteria failed to rule out. None of the participants had English as a home language. Additionally Participant 2 understood less than 80% of the target combinations (he understood only 70%), and had the lowest comprehension score (76%) of the graphic symbols used in the study. His language capabilities in both English and in his home language also tested lowest amongst the three

participants. He was also the only participant who did not have experience in using graphic symbols for expressive purposes. These characteristics may explain his initial struggle to produce graphic symbol combininations.

At the same time, Participant 3 performed worst overall on the intervention probes, although having tested superior to Participant 2 in English and home language skills, comprehension of target combinations and comprehension of graphic symbols used in the study. However, she clearly performed better during shared storybook reading. Thus, it seems that factors other than the capabilities that were tested affected performance on the intervention probes, particularly for Participant 3. These may include other inherent characteristics in interaction with the particular nature of the probes conducted, as well as possible outside influences.

5.2.1.2 Comprehension and expressive use of graphic symbols

In the current study, Participants 1 and 3 had experience in the use of graphic symbols for expressive purposes. Their understanding of the graphic symbols used in the study was also considerably better (100% and 95% respectively) than that of Participant 2 (76%). Both these participants responded relatively quickly with correct symbol combinations to the first level of prompting during shared storybook reading. Participant 2, in turn, who did not have experience with using graphic symbols expressively (although he had some receptive experience), took longer to learn to produce the symbol combinations during shared storybook reading. Experience in the use of graphic symbols for expression did not seem directly related to probe test performance in the case of Participant 3; however, other factors seemed to have influenced her performance (see Section 5.2.2).

In the study by Binger et al. (2008), participants also had minimal or no prior exposure to aided AAC. However, the participants could (or were taught to) recognize at least 90% of the graphic symbols used in the study prior to the commencement of intervention. Participants in the study conducted by Binger et al. (2010) all had prior experience in using aided AAC, although the exact symbols used were not indicated. This may have benefited their learning. The participants' understanding of the graphic symbols used in the study was not reported.

Participants in the study conducted by Nigam et al. (2006) had experience with the expressive use of graphic symbols. They could (or were taught to) recognize and use the graphic symbols used in the study, albeit only to a criterion of two correct responses across four trials per symbol. Prior exposure to aided symbols and/or training to comprehend the symbols used in the studies may have contributed to the production of graphic symbol combinations evidenced in these studies. It is interesting to note that the participant who did not learn the combinations in the study conducted by Nigam et al. (2006) had the smallest lexicon of graphic symbols on his board and reportedly used the smallest number of symbols. He furthermore needed training to recognize and use three symbols (the other two participants needed training on none or one symbol respectively) and he needed between 12 and 20 training sessions to do so. The authors hypothesized that his limited graphic symbol vocabulary may have contributed to his lack of learning.

In spoken language development, the ability to utter single words typically precedes the ability to produce word combinations; and word combinations also tend to appear only once the expressive vocabulary has reached a size of 50-100 words (Bates et al., 1995). Whether children using AAC follow similar or alternative routes in language development is still a matter of debate (Gerber & Kraat, 1992; Nigam et al., 2006; Von Tetzchner & Grove, 2003). Extrapolations from typical language development are further complicated by the fact that children whose speech is severely limited often use a variety of modalities to express themselves, such as vocalizations, word-approximations, gestures and signs as well as pointing to objects, people and graphic symbols. It still seems unclear whether expression through single graphic symbols specifically (rather than expressive use of symbols per se, regardless of modality) typically precedes use of graphic symbol combinations. In the study by Trudeau et al. (2010), the duration of using a graphic symbol-based AAC system did not predict the ability of children and adults to adopt syntactic strategies when producing graphic symbol utterances. However, all participants in the study had been using their systems for at least 6 months, and had at least 30 graphic symbols on their systems. Clearly, all had some experience with expressing themselves with graphic symbols.

Research on graphic symbol use in typically developing children does seem to suggest that expressive skills in one modality (e.g. speech) do not automatically transfer to another modality (e.g. graphic symbols) (Smith, 1996; Sutton & Morford, 1998; Sutton, et al., 2010; Trudeau et al., 2007). Modality-specific expressive experience thus seems to pose a learning advantage, promoting advances in linguistic skills in that specific modality. The randomized comparison group study by Romski et al. (2010) suggested that, for toddlers with significant risk for speech-language delays, prompting aided output facilitated expressive language development to a greater extent than providing aided input did. Specifically, expressive vocabulary growth and type/token ratio increases were greater for the augmented output group.

The current results seem to corroborate previous findings in that experience with using single graphic symbols expressively seemed to enhance the ability to learn to produce symbol combinations.

5.2.1.3 Receptive language skills

Although the receptive language measures (measuring understanding of spoken language) that were used in the study were not standardized for the targeted population, the scores obtained nevertheless enabled some level of comparison to be made between participants, particularly regarding their English skills. Receptively, Participant 2 received the lowest overall raw scores, age equivalents and/or standard scores on all measures of English and home language proficiency, which may have been linked to his slow progress both during shared storybook reading and as measured during intervention probes. Participant 1, in turn, scored highest overall on English and home language receptive abilities and progressed the fastest and the most of the three participants. He was furthermore the only participant who retained the symbol combination skills after intervention ceased. Participant 3 achieved higher receptive language scores than Participant 2, but her scores were considerably lower than those of Participant 1. Her overall performance during shared storybook reading was slightly lower than that of Participant 1 (86% of responses correct on first level of prompting, as compared to 91% for Participant 1) but considerably higher than that of Participant 2 (42%), whereas her performance on the intervention probes was erratic and overall weakest of all three participants.

Higher spoken receptive language skills have been associated with ability to produce more complex graphic symbol output in school-aged children using AAC (Sevcik, 2006). This finding was corroborated in the study by Trudeau et al. (2010), where higher receptive language skills (but not bigger receptive vocabularies) in children and adults using graphic symbol-based AAC systems were associated with the ability to adopt syntactic strategies when producing graphic symbol utterances. Similarly, in persons with typical language skills, increased age is associated with increasing skill in constructing complex graphic symbol output, possibly due to increasing linguistic and metalinguistic skills (Smith, 1996; Sutton & Morford, 1998; Sutton et al., 2010). Results of the current study generally seem to affirm the association between receptive language skills and the ability to produce more complex graphic symbol output, although Participant 3's performance on the probes seems worse than predicted by her receptive language skills.

The ability to move to graphic symbol combinations was specifically associated with a receptive language age equivalent of at least 24 months in the results reported by Sevcik (2006). In typical spoken language development, word combinations often already occur in the child's speech at a younger receptive language age (from 18 months) [Ingram, 1989]), underlining the position that receptive and expressive skills relate differently to one another within modalities compared to across modalities. In the current study, all participants tested at a receptive (spoken) language age equivalent above 2 years (lowest 2;6; PPVT-4 [Dunn & Dunn, 2007]). However, the participant with the lowest score clearly still had greater difficulty in acquiring the combinations during shared storybook reading; gains as measured by means of the probe test were modest.

It is interesting to note that Participant 2 and 3 both achieved the same raw score on the understanding of sentence structure (subtest of the CELF–Preschool^{UK} [Wiig et al., 2000]), which was clearly lower than that of Participant 1. Similarly, these two participants scored lower on the comprehension of the spoken form of the target combinations, with Participant 2 scoring lowest. In their study involving children and adults using graphic symbol based AAC systems, Trudeau et al. (2010) found that receptive syntax rather than receptive vocabulary correlated with the ability to produce stable response patterns in constructing graphic symbol sequences. Poorer

receptive syntactic skills may thus have contributed to the poorer performance of Participants 2 and 3.

In the study by Binger et al. (2008), participants had English receptive language age equivalents comparable to the participants in the current study; however, scores of the participants in the former study were age appropriate, indicating that children had typical receptive language development. In the current study, the test results showed borderline (Participant 1) to profound delays (Participants 2 and 3) in receptive language skills. When considering chronological age, the participants in the former study may have had greater language potential, as evidenced by the absence of receptive language delays. The participants in the study by Binger et al. (2010) had higher receptive language age equivalents than two of the participants in the current study (Participants 2 and 3)—the latter being the two participants that did not show convincing effects of the intervention. No formal test results regarding receptive language skills are available for the participants described by Nigam et al. (2006), making any comparisons difficult.

In addition, most participants from the three studies (Binger et al., 2008; 2010; Nigam et al., 2006) had English as their first language. These factors may have contributed to their better performance, although their exact contribution remains unclear. One participant (Binger et al., 2010) had English as a second language, yet still performed well on the intervention. However, he had significantly better speech comprehensibility according to the I-ASCC (Dowden, 1997) (30% in the no context condition), which may have influenced his superior performance.

In the current study, second language factors may have influenced participants' performance. According to the recoding route hypothesis (Smith & Grove, 1999; see also Section 2.4.4.3), metalinguistic skills and specifically translation skills may enhance the formulation of aided output that conforms to the structure of spoken language (Smith, 2006). Multilingual environments, in turn, seem to enhance metalinguistic and translation skills in children (Bialystok, 1988; Malakoff & Hakuta, 1991). It follows that bi- or multilingualism may equip children to compose more complete and complex graphic output. However, whether multilingual skills are indeed the same or at least similar to multimodal skills remains a matter of

speculation. Furthermore, while the participants in this study were receptively bilingual, their limited expressive skills may have offset any metalinguistic gains that expressive bi- or multilingual children may have.

Contrary to popular belief, early exposure to a second language does not mean higher levels of achievement in the language or that learning it is more effortless than later in life (Marinova-Todd, Marshall, & Snow, 2000). Children who receive their early education in a second language only have actually been found to struggle more, academically, than those who switch to a second language as the educational medium later in their school career (Heugh, 2000; Thomas & Collier, 2002). Although language policy in the South African education system acknowledges the superiority of home language education in the early grades, practice does not follow suit for a variety of reasons. These include the better standard of education in historically advantaged (English and Afrikaans medium) schools resulting in parents choosing these above home language medium schools, as well as the multilingual nature of the urban environment (Heugh, 2000). In special education, lack of home language medium schools and services furthermore aggravates this situation, resulting in a great proportion of learners learning through a second language from an early age. Of the three participants, only Participant 1 was exposed to English at home. Yet, all participants were immersed in an educational situation where English was the medium of instruction. Participant 3 had also been exposed to Afrikaans as an educational medium, this being a third language for her. Additional to the demands of learning to use expressive modalities to replace or supplement speech, the participants were also contending with a receptive second language as instructional medium. This may have resulted in a number of language and communication-related stressors, which may have limited their ability to fully meet the demands of yet another one (graphic symbol combinations) within the limited time of the current study.

5.2.1.4 Expressive abilities

Expressive abilities of children who require AAC are difficult to determine, since measures need to make provision for modes other than speech alone (Gerber & Kraat, 1992). Use has been made of parent report (e.g. MacArthur Communicative Development Inventory [Fenson et al., 1993]) and of nonstandardized measures of intelligibility (e.g. I-ASCC [Dowden,

1997]). In this study, the adapted LDS (Rescorla, 1989) and the I-ASCC (Dowden, 1997) were used as measures of expressive vocabulary as well as speech intelligibility. Of the three participants, Participant 1 had the largest expressive vocabulary (189 words, thus marginally bigger than Participant 2) as well as the largest clearly articulated spoken expressive vocabulary (139 words) as determined by the LDS (Rescorla, 1989). He also had the most intelligible speech (13% and 27% as judged by an unfamiliar partner in the no context and semantic context conditions respectively) according to the I-ASCC (Dowden, 1997). Participant 2 followed with a marginally smaller expressive vocabulary (185 words), but a substantially smaller clearly articulated spoken vocabulary (79 words), as well as 10% less speech intelligibility in both conditions. Participant 3 had the smallest expressive vocabulary (158 words) and a very small clearly articulated spoken vocabulary (14 words), as well as the least intelligible speech. She was also the only participant who was reported to never having been observed to combine concepts expressively in any modality. It is interesting to note that Participant 3 had the lowest percentage of responses that conformed to the structure of the models given during shared storybook reading (see Table 4.8). Her lack of speech coupled with her lack of combination experience may have had an influence (see also Section 5.3).

In typical language development, word combinations generally begin to emerge once the child's single word expressive vocabulary has reached a size of 50-100 words (Bates et al., 1995). Although the data gathered via the adapted LDS suggests that all participants exceeded the 100 word threshold in their expressive vocabularies, these findings need to be interpreted with caution (see also Section 3.8.2.4), because the inclusion of less linguistic modes of expression (such as pointing to objects and persons) might have inflated scores. As research on graphic symbol production with speaking participants furthermore indicates, linguistic skills are not automatically transferred between modalities (Smith, 1996; Sutton & Morford, 1998; Sutton et al., 2010). The fact remains that both Participants 2 and 3 showed relatively poor performance during the intervention probes, with Participant 2 also performing the poorest of all three participants during shared storybook reading. Reduced expressive skills and reduced speech intelligibility may have contributed to their overall poorer performance.

On average, participants in the study by Binger et al. (2008) had less intelligible speech than the participants in the current study, as determined by the I-ASCC (Dowden, 1997); even so they learnt to produce graphic symbol combinations. Reduced speech intelligibility alone is therefore unlikely to account for a lack of learning graphic symbol combinations. Speech intelligibility measures for the participants in the study by Binger et al. (2010) were significantly better than for the participants in the current study. Measures for the participants in the study by Nigam et al. (2006) were not reported. Due to lack of specific data regarding expressive vocabulary size for the participants in the studies reported by Binger et al. (2008; 2010), as well as Nigam et al. (2006), direct comparisons to the participants in the current study could not be made.

5.2.1.5 Physical abilities and experiences

Children with physical disabilities tend to have reduced patterns of participation (Imms, Reilly, Carlin, & Dodd, 2008; Law et al., 2006), which are exacerbated by lack of functional speech (Thirumanickam, Raghavendra, & Olsson, 2011). Higher care demands taking up time and energy of caregivers, inaccessible environments and negative attitudes have been found to be underlying reasons (King et al., 2003; Mihaylov, Javis, Colver, & Beresford, 2004). Reduced participation in children with severe physical disabilities often leads to decreased opportunities for socialization, smaller social networks and increased passivity (Basil, 1992). Reduced participation patterns are specifically seen in children who are unable to walk. Assistive devices to allow independent mobility (e.g. powered wheelchairs) have been suggested as methods to increase participation (Mihaylov et al., 2004).

From a social constructivist perspective, decreased participation and lack of opportunities for socialization have direct consequences for language development and language skills. Increased passivity associated with severe physical disability may, furthermore, lead to reduced motivation to engage in any goal-directed behaviour, including communication (Basil, 1992) and would further hamper the development of language and communication.

Participants in the current study all had physical disabilities. However, only Participant 3 did not have independent mobility (Participant 1 had an electric wheelchair and Participant 2 was

ambulatory). Her severe physical involvement coupled with the lack of independent mobility may have been associated with a lack of opportunities to participate, leading to general passivity and learnt helplessness, which could possibly have had an influence on her responses during the probe test (see also Section 5.2.2).

Participants in the other three studies that targeted graphic symbol combinations all seemed to have been mobile, with the exception of one participant in the study by Nigam et al. (2006). Lack of independent mobility did not seem to affect her performance negatively. However, as will be discussed in Section 5.2.2.1, there was considerably more congruence between the intervention and measurement in that study and intervention was conducted with smaller sets of target items over a longer time, which may have offset any effects of a passive interaction style.

5.2.2 Task- and instruction-related factors

5.2.2.1 Probe test

The internal validity of multiple probe designs can be threatened by repeated measurement. Inhibitive effects may result from lack of contingent feedback as well as fatigue and/or boredom due to repeated and lengthy testing sessions (Gast & Ledford, 2010, p. 294; Schlosser, 2003c, p. 33). In this particular study, measurement probes consisted of requesting participants to label 30 pictures. The format of the measurement may not have been very motivating for participants. Although measures were taken to prevent fatigue (breaks after every 10 items administered) and increase motivation (provision of reinforcements such as access to toys, providing stickers and collection of tokens which could be exchanged for small toys), the reinforcements given were additional to the activity itself; the activity itself did not provide its own reinforcement. In contrast, the storybook reading activity used during intervention provided its own reinforcement. Furthermore, during the administration of the probe test, no contingent feedback was given to prevent learning taking place from the test itself. Participants therefore did not know whether their responses were correct or not. Rather, noncontingent encouragement was given to encourage participants to continue the procedure. However, giving rewards (or encouragement) independent of performance can disadvantage learning (Basil, 1992).

Measurement and intervention were conducted in two different contexts, using different picture material for elicitation. While intervention took place within a storybook reading situation, measurement was conducted using a picture description format. The reason for choosing a different format for the measurement than for the intervention was, first to avoid reactivity to repeated readings of the same story affecting the measurement. In order to collect a minimum of three data points per phase, each story would have had to be read at least nine times.

Second, the format of the probe test facilitated the evaluation of generalization across the matrix. If this had been attempted within the storybook reading situation, additional stories and picture material would have been needed. Third, combinations across the three different types of semantic relations could be tested in random order during probes (rather than, for example, testing all attribute-entity combinations first, then all possessor-possession combinations followed by all agent-action combinations, as would have been needed had all three types of relations been tested within stories). This procedure thus prevented order effects from affecting the performance during probes. Fourth, use of the probe test enabled the testing of symbol combinations out of the context within which these combinations were acquired, thereby assessing decontextualized learning. This eliminated the possibility that participants' responses were just phrases that were learnt by rote and produced without comprehension.

While there were compelling reasons for choosing the probe test format as a way of measuring the effect of the intervention, using the storybook reading situation to gather baseline and intervention performance measures could possibly have had the advantage of increasing the participants' awareness of response requirements, as contingent feedback was given during intervention. This may have made participants aware of the desired response, thus increasing chances of producing it. The actual structure of the probes necessitated participants to generalize the production of the combinations learnt during storybook reading to a picture description situation where different materials were used to elicit the combinations. The lack of congruence between the two situations coupled with the lack of contingent feedback during picture description may have made it more difficult for participants to produce the combinations learnt during storybook reading in the picture description task used for measuring their progress.

The use of the treatment boost was intended to make the correspondence between intervention and probes more salient to the participants. It seemed to have some effect in boosting the performance of participants, as can be seen by level changes upon its introduction (e.g. Participant 2, Session 17; Participant 3, Sessions 8 and 17). However, it may not have been sufficient in bridging the gap between shared storybook reading and probe contexts.

In other studies targeting the production of graphic symbol combination skills (Binger et al., 2008, 2010; Nigam et al., 2006), more congruence was evident between intervention and measurement procedures. Binger et al. (2008) measured production of multisymbol messages within storytelling situations, with (intervention) and without (baseline) the caregivers using the Read, Ask and Answer strategy during reading. The intervention which Binger et al. (2010) made use of differed from this study only in that an additional step (Prompt) was added to the strategy, and that educational assistants were taught to implement the intervention. Nigam et al. (2006) demonstrated an action and required participants to describe it, both during baseline and intervention. Additional prompts and models were provided during intervention. Thus, there was congruence between intervention and measurement in these studies.

The type of behaviour targeted in each of the studies was aligned closely with the intervention method of choice. Binger et al. (2008; 2010) did not target specific types of symbol combinations, but measured any multisymbol production. The intervention was naturalistic, taking place within a natural context, and followed the child's lead. Nigam et al. (2006) targeted specific combinations and thus made use of a structured teaching situation. The current study attempted to target specific combinations but did so via a more naturalistic situation, namely a storybook reading context. In order to still measure specifically though, the probe test was devised. This resulted in lack of congruence between the intervention and the measurement contexts, which may have negatively affected results.

In the current study, performance during shared storybook reading in response to the first level of prompting (verbally and visually drawing attention to the aspect of the story illustration showing the target combination) was, on most occasions, superior to performance during the

intervention probes. This seems to underline the fact that the nature of the probes probably dampened participants' performance to some extent. Participant 3, especially, seemed to perform considerably worse on the intervention probes than during shared storybook reading, although there were isolated occasions of very good performance (e.g. Session 9 for the attribute-entity combinations, and Session 26 for the possessor-possession combinations). It seems that she performed inconsistently in a situation where no contingent feedback was provided. Basil (1992) commented on the fact that children with severe motor impairments are often given free rewards as a result of reduced expectations from adults. Such free rewards may increase passivity and reduce learning.

Informal observation and information obtained through interaction with family members and service providers seemed to suggest that the adults had little expectation of Participant 3 to progress and to become more independent, while there were higher expectations of Participants 1 and 2 (see Section 5.2.4). It seems possible that Participant 3 received more rewards that were noncontingent. The probe test might have represented yet another situation during which noncontingent rewards were given, producing inconsistent responses that did not reflect the skills gained during shared storybook reading.

During Sessions 8, 11, 13 and 15 Participant 1 also evidenced a lack of correspondence between performance during intervention probes and performance during shared storybook reading. As indicated in Section 4.4.1.3, Session 8 was the first session conducted at home, and during Sessions 11- 5 Participant 1 was battling a cold. These external factors seemed to have influenced probe performance negatively, although performance during shared storybook reading remained high. The fact that probes were conducted in a test format without contingent feedback may have made them appear more challenging and less motivating than the storybook reading activity, resulting in reduced performance.

Overall, the results suggest that behavioural measurements of a more formal nature may not fully tap the child's abilities evidenced in a more naturalistic environment. Furthermore, repeated formal testing may be prone to elicit reactivity from the child (boredom, fatigue), negatively affecting performance. In the current study, all three participants evidenced sudden

decreases in performance on intervention probes (i.e. Sessions 8 and 11 for Participant 1, Session 22 for Participant 2, and Sessions 10, 17 and 24 for Participant 3). Performance during shared storybook reading seemed more consistent overall. Repeated exposure to naturalistic activities may thus not be as prone to reactivity. Measurements that can take place within natural environments may therefore be more appropriate for designs that require repeated measurements. This also prevents the challenge of researchers spending much of the contact time with participants testing them rather than intervening. In the current study, a roughly equal amount of time was spent intervening (story reading) as was spent testing (probes). When intervention and measurement can be done within the same context, more time can potentially be spent on intervention.

5.2.2.2 Intervention

Setting a teaching criterion in addition to a learning criterion can help to prevent participants reacting negatively to extended repeated testing and intervention sessions (Gast & Ledford, 2010, p. 294; Schlosser, 2003b, p. 131). In the current study, a learning criterion was set, namely achievement of a score of at least 40% above the baseline average for two consecutive probes. A teaching criterion of nine sessions was set. Intervention ceased whenever one of these criteria was met.

Because of the teaching criterion of nine sessions, the number of intervention sessions conducted in the current study may have been too little in certain instances to enable stabilization of the targeted skills. Intervention may have ended prematurely in some instances—before a clear effect was evident and/or before the skill was established to the extent that it could be maintained after intervention ceased. Upon close inspection of Figure 4.2, it is clear that Participant 2's performance during shared storybook reading (grey bar graph) on the first type of relation only "took off" at Session 9, followed by the only increase in performance above baseline on the target items during the intervention probe. Although setting a teaching criterion can prevent the unnecessary continuation of an ineffective intervention (Schlosser, 2003b), it is typically not recommended (Gast & Ledford, 2010; Schlosser, 2003b), since less clear evidence of effectiveness and no evidence of efficacy is obtained. None of the other studies that

investigated graphic symbol combinations made use of a teaching criterion. This may have led to better effectiveness and better evidence of effectiveness.

Similarly, the learning criterion set in this study (a score of at least two correct answers above baseline average for two consecutive probes) may have been low, causing intervention to cease prematurely (e.g. on the second type of relation targeted for Participant 2, for which he did not show any maintenance postintervention). Furthermore, when intervention was introduced to a second or third tier, intervention on the previous tier ceased. Specifically in light of the fact that Participant 2 increased his performance over the consecutive types of relations that were targeted, extending intervention on the first and second type of relation may have had benefits for his performance.

Although Participant 3 clearly did not perform well on the intervention probes, extending the intervention may not have increased her performance. When inspecting Figure 4.3, it is evident that her performance during shared storybook reading was typically at maximum levels already during the second or third intervention session conducted per relation and was maintained relatively well throughout the following intervention sessions. Her performance on the probe test, however, remained variable, without any clear trends being evident. The incongruence between her performances during shared storybook reading and during the intervention probes is unlikely to have been resolved by an increased number of intervention sessions.

Other aspects of the intervention may have had an influence on the comparative effectiveness. Only the study by Nigam et al. (2006) also targeted the production of specific graphic symbol combinations during intervention. In that study, only three intervention items were targeted per set, whereas five were targeted at a time in the current study. In addition, each item was targeted three times during intervention in the study by Nigam et al., whereas in the current study items were only targeted twice during an intervention session. An average of 14 intervention sessions were conducted per set per participant in the study by Nigam et al., whereas an average of only seven sessions were conducted per type of relation per participant in the current study. In addition, only one type of relation (action-object) was targeted in the study by

Nigam et al. At the same time, the criterion for a correct response was stricter in the study by Nigam et al., since the combination had to be produced in the correct order, whereas any sequence was considered acceptable in the current study.

In the studies by Binger et al. (2008; 2010), parents or educational assistants provided a minimum of 12 models per intervention session and likely more. The average number of intervention sessions was seven and five per participant in the respective studies. However, because no specific types of relations were targeted, comparisons to the current study are complicated.

5.2.3 AAC system

The communication board used in the study by Nigam et al. (2006) consisted of 12 items arranged in two groups (actions and objects), whereas the board used in the current study consisted of 21 items arranged in four groups (agents and possessors, actions, attributes, as well as entities and possessions). This aspect may have contributed to better performance during the study by Nigam et al.

The communication boards or overlays used in the studies by Binger et al. (2008, 2010) consisted of 30-35 symbols. However, because the combinations that were modelled to the children and measured in children's productions were not specified, it is unclear whether all symbols were in fact used by parents and children.

In the study by Binger et al. (2008), it is interesting to note that participants making use of SGDs with graphic symbol overlays produced the combinations quicker than the one using nonelectronic communication boards. This finding was also observed in the study by Binger and Light (2007), where aided models provided during play scenarios were used to increase utterance length (in any modality) for children with severe congenital speech disorders. The additional auditory feedback from their selections may have reinforced learning and increased motivation. The use of multiple modalities may encourage the production of longer utterances (Loncke, 2008). All participants in the study by Binger et al. (2010) made use of an SGD, which might have advantaged their learning. In contrast, none of the participants in the current study had

access to an SGD, but made use of a communication board. This may have negatively influenced their learning.

5.2.4 Partner- and environment-related factors

Variables concerning the home environment, the family and the sociocultural context, may have influenced children's performance in the study directly or indirectly. These variables were not formally tested, but informal observations lead to some hypotheses regarding the possible influences of these factors. For all participants, intervention sessions were not only conducted in the school context, but also at home, necessitated by nonattendance (Participant 3) as well as school holidays (all participants). Participant 2 was also seen at the crèche where he often went during school holidays on days when his mother was working. For Participant 1, 11 sessions were conducted at school and an equal number were conducted at home. For Participant 2, 11 sessions were conducted at school, 4 at his grandmother's place of residence (she rented a room in a big residence, where she shared ablution and kitchen facilities with a few other families and individuals), and 9 at the crèche. For Participant 3, only 5 sessions were conducted at school, whereas 21 sessions were conducted at home. The influence of the home environment versus the school environment may have been different for each participant because the proportion of sessions conducted in different contexts varied.

Expectations by caregivers of children's performance (within the home context and in general) and interactions styles between caregivers and children may have been influenced by the family's cultural values and beliefs, family circumstances (e.g. socioeconomic variables and availability of formal and informal support), as well as child characteristics (e.g. skill levels, type and onset of disability). Some of these factors are summarized in Section 3.7.3 and in Table 3.4. The participants in this study all came from an African background, two from a Northern Sotho background and one from a Tshivenda background. However, with multiple cultures and a young democracy, individuals and families in South Africa often differ considerably in the extent to which they preserve their traditional cultural views or adapt according to influences such as a rapidly changing world and the influence of values and beliefs from other cultures. As a result, it is hard to generalize when speaking about typical cultural norms of different population groups.

Traditional African culture tends to regard learning as a process that takes place through observation, rather than through active engagement. Children are expected to learn by observing adults, rather than through engaging with adults or through adult-mediated interactive activities such as play (Bornman, 2001; Geiger & Alant, 2005; Sawadogo, 1995). Children typically also engage with other children, rather than with adults. Although all three participants were exposed to interactive storybook reading in group format during school, only Participant 1's parents read to him at home. However, Participant 2's grandmother, whom he often spent time with, read stories to him and told him traditional stories. Participant 3 was not read to at home but was mostly engaged in watching television. Her parents seemed to regard her mainly as a person in need of care and seemed to try to structure her life in such a way as to keep her content. During the cold winter months, for example, she was mostly kept at home so that she did not have to get up early for school. Of course, the role of strain on caregivers in having to care for a child with severe physical disabilities who did not have independent mobility in a home environment that was not wheelchair accessible as well as having two other children to care for should not be underestimated.

Because the majority of sessions were conducted at home, placing demands on Participant 3 within the home context may have been incongruent with the typical home routines. While this did not seem to affect the performance during shared storybook reading, it may have had an effect on the performance during the probe test. It is notable that the two sessions during which she performed best overall on the probe test (11/30 and 10/30 during Sessions 9 and 13 respectively) were conducted at school.

Beliefs of parents' about the permanence and course of their children's disabilities could affect their expectations of and involvement in intervention and it may be influenced by the onset and severity of the disability. Participant 1 had developed typically up until age 3, when he had suffered a near-drowning incident. His parents expressed the hope on numerous occasions that he would regain more of his skills, such as more intelligible speech and motor skills. This may have been occasioned by their experience of him as a typically developing child prior to the accident, as well as by his recovery from a comatose child to one that was alert, independently mobile with his electric wheelchair and attending the academic stream at a special school. Furthermore, his

speech was more intelligible than that of the other two participants, which may have also fuelled their hope of progress. Participant 2's grandmother also expressed her hope of improved speech for her grandson. Both his speech intelligibility and mobility skills were better than those of Participant 3, whose mother did not express hopes for improvement for her daughter. The severity of her daughter's impairment may have had an influence on her expectations. Parents of Participants 1 and 2 seemed more intent on seeing their children progress, as evidenced by their active interest in schoolwork and therapy, and their requests for ideas on educational activities and games that they could perform with their children at home.

Higher parental expectations have been linked to better school achievement of children (Barnard, 2004; Fan, 2001). It seems plausible that parental expectations may foster perseverance and motivation in their children, resulting in achievements that matched potential to a larger degree. It has been suggested that lack of expectations, in turn, could be linked to increased passivity in children with physical disabilities (Basil, 1992). This may result in achievements that are lower than the child's potential.

5.3 Structure of the combinations produced

From Table 4.5 it is evident that only a proportion of the participants' multisymbol productions conformed to the word order that was modelled during shared storybook reading. Participant 1 produced the highest percentage (60%) while Participant 3 produced the lowest percentage (14%). These differences amongst participants may have been influenced by the speech abilities of the participants—Participant 1 had the most intelligible speech and, according to parent report, produced the most clearly articulated words, while Participant 3's speech was least intelligible and she produced the smallest number of clearly articulated words. Experience with spoken words as an expressive mode may have predisposed Participant 1 (and Participant 2 to an extent) to produce the graphic symbol combinations in the same order as they were modelled during the stories, conforming to spoken output.

Home language may also have had a role to play. In Northern Sotho and Tshivenda, agent-action combinations have the same word order as in English. However, possessor-possession and attribute-entity combinations have the reverse order (e.g. *katse ya Thandi,*

directly translated from Northern Sotho as *the cat of Thandi,* thus *Thandi's cat; gebisi ntswu,* directly translated from Tshivenda as *cap black*, thus *the black cap*). The extent to which characteristics of the first language can negatively interfere with learning of a second language is debated in the literature. Some authors propose that common expressive errors observed in second language learners are similar to those observed in first language learners and do not result from interference from the first language (e.g. Dulay & Burt, 1974), while others propose that negative transfer from the first language can cause word order problems in the second language (e.g. Håkasson & Nettelbladt, 1996). An analysis of expressive syntactic errors made by second language English learners aged 2;9 to 6;2 who had an African language as their first language, revealed that word order errors occurred relatively seldom when compared to other syntactic and morphological errors (Preston, 1992). In the current study, Participant 3 clearly showed a greater percentage of reverse order responses for the attribute-entity and possessor-possession combinations, with a greater percentage of conforming word order responses for the agent-action combinations. The influence of home language on the ordering of the elements within the graphic symbol constructions can thus not be ruled out. The other two participants, however, did not show such a pattern, suggesting that home language structure did not necessarily influence their graphic symbol constructions.

Although reversal of elements in early two-word semantic combinations does occur in children with typical speech development, such reversals are relatively rare (Brown, 1973). However, deviations from spoken word order has been found more frequently than expected in the graphic symbol productions of children with limited speech as well as in young typically developing children (preschoolers) (Kaul, 2003; Smith, 1996; Sutton & Morford, 1998; Sutton et al., 2010; Udwin & Yule, 1990). Such deviations have also been found amongst hearing children using manual signs for expression (Grove, Dockrell, & Woll, 1996; Udwin & Yule, 1990). The percentages of conforming output, as opposed to reversing spoken word order found in the current study (49% and 26%), seem to correlate reasonably well with findings by Iacono, Mirenda, and Beukelman (1993). These authors found that 52% of word combinations produced by their participants (two children with intellectual impairments aged 3;6 and 4;6) in sign and/or graphic symbol output using an SGD, conformed to the order of spoken output, while elements were reversed in 43% of responses.

Researchers have suggested that inherent characteristics of the graphic modality play a role in the lack of conformity of the structure of graphic symbol output compared to that of spoken output (Smith, 1996; Sutton & Morford, 1998, Sutton et al., 2010). It was suggested in Section 2.4.4.1.1 that graphic symbols may predispose toward global rather than sequential processing. This may contribute to conforming and nonconforming order patterns being used interchangeably. On the communication board used, constructing two-symbol combinations conforming to the order of spoken language was accomplished by selecting symbols in a left-to-right progression (e.g. *DOG* appeared to the left of *RUN*). Ordering symbols on a communication board according to word classes in a fashion that promotes left-to-right sentence production has been suggested as a method to simplify the task of producing output structured according to spoken language. However, in a study by Alant et al. (2007) ordering of elements on a display did not influence the order in which symbols were selected to construct symbol sequences aimed at expressing SVO constructions. The current study corroborates these findings. Participants in the current study may not have had extensive exposure to literacy activities where a visual left-to-right progression is reinforced. Participants in the study by Alant et al. were typically developing and aged from 7;5 to 8;5 and presumably had at least a fair amount of exposure. Sequencing letters in a left-to-right fashion may still be quite different from selecting symbols in a left-to-right fashion from a board. In the current study, participants also did not see their sequenced productions, since the symbols were only pointed to rather than selected and placed on a sentence strip, which is used, for example, in the Picture Exchange Communication System (PECS) (Bondy & Frost, 1994) or in a message window, as is used in various dynamic display SGDs.

In the current study, reversing the elements within a particular target item did not inherently change the meaning of the item (e.g. *RUN DOG* essentially conveys the same idea as *DOG RUN*). Thus, participants may not have deemed it necessary to preserve the order within which the items were modelled. Research by Trudeau et al. (2007) suggested that speaking individuals may modify the sequence of complex graphic symbol output (in this case even in a way that output differs from the sequence of spoken output) to avoid ambiguity. Adults and teens

tend to do this more than school-aged children do; however, increased demands for clarity can induce children to use such sequencing strategies more.

In summary, the sequencing patterns of graphic output produced by the participants in this study confirm the patterns observed in previous investigations. These results once again underline that output in spoken and graphic modalities is not necessarily constructed according to the same patterns.

5.4 Summary

The results of the study were discussed in this chapter. Possible influences on the differential performance on the production of symbol combinations by each of the three participants were discussed with reference to relevant literature. Possible influences on the structure of graphic symbol combinations were also discussed. The results were compared to other relevant intervention and descriptive studies.

CHAPTER 6
CONCLUSION

6.1 Introduction

The main aim of the study was to determine the effect of a prompting hierarchy used together with a matrix strategy incorporated into shared storybook reading on the production of graphic symbol combinations (representing three types of semantic relations) by children with limited speech. The effect of the intervention was measured using the probe test.

In this chapter, the most important conclusions regarding the effectiveness of the intervention are presented. Furthermore, clinical implications of the results are discussed. The strengths and limitations of the study are summarized and recommendations for further research are provided.

6.2 Summary of findings

Based on the results from the probe test, a clear effect of the intervention on the production of targeted symbol combinations and generalization to untrained exemplars could only be shown for Participant 1. The probes only showed a low overall effect for Participants 2 and 3. An analysis of performance during shared storybook reading seems to suggest that all participants performed better in this context. The nature of the probe test may have masked the abilities that seemed to be evident during shared storybook reading. Participant 1 seemed to derive enough benefit from the intervention to make this effect measurable by the probe test. His higher receptive language skills may have contributed to his good performance (c.f. also the pilot participant). For Participant 2, probe test results show more effective and efficient learning with each new type of relation. Participant 2 had the lowest receptive language skills and no experience in the expressive use of graphic symbols. The intervention may not have continued long enough in order for a clear overall gain in skills to be demonstrated by him. Participant 3 showed a particular discrepancy between performance during shared storybook reading versus performance during the intervention probes, suggesting that she was unable and/or not motivated to transfer her skills to the probe test situation. Specific factors related to her skills and characteristics were suggested as possible reasons that exacerbated the limited congruence

between performance during intervention and during measurement (probes). Overall, the results suggest that formal testing of specific skills may mask participant ability. Measurements conducted within natural environments may be less prone to inhibit participants' performance.

6.3 Clinical implications

Incorporating specific graphic symbol combinations generated from a matrix into a storybook reading activity can be a successful way of prompting children using AAC to produce specific symbol combinations and may promote generalization to untrained exemplars, as evidenced by the results of Participant 1. However, the effectiveness and efficiency of this method may be influenced by child characteristics. Children with no previous experience in graphic symbol use for expression and/or those with receptive language skills below 3 years may take longer to learn. Furthermore, the gains made in expressing symbol combinations during storybook reading may not automatically reflect in more formalized test situations. All formalized language assessments run the risk of reduced validity, because a skill is tested outside of the natural context within which it is typically used. Lack of authenticity may lead to reduced motivation to perform (Coombe, 2007). The goal of communicating during shared storybook reading is to jointly tell and enjoy a narrative. However, in a testing situation, the child's contributions (i.e. answering questions posed by an examiner who already knows the answers) serve no true communicative goal, but are rather used to evaluate the child's skills. Children with lower motivation and those who are generally more passive may respond particularly poorly in such situations where there is little reward intrinsic to the activity.

Clinical situations generally differ from research situations in that methods are more flexible and testing is not conducted as regularly. The risk of reactivity to repeated testing is thus considerably reduced. Clinically, the use of storybook reading as a context for prompting specific combinations may be very useful. The research by Binger et al. (2008; 2010) showed that parents and educational assistants can be taught to engage in interactive reading that can promote graphic symbol combination skills in general, without targeting specific combinations.

The fact that no behavioural covariation occurred in untreated baselines when intervention was introduced to a specific tier, suggests that combination skills may not readily

generalize across different types of semantic combinations. At the same time, generalization to some of the untrained exemplars within a matrix did occur. There may therefore be a need to target specific types of semantic relations in intervention. The use of a matrix approach can furthermore promote productive new combinations, ensuring that productions are not merely learnt by rote imitation and produced as unanalysed chunks.

The three matrices used in the current study did not contain the same number of items per semantic category (e.g. same number of agents as actions). While this reduced the number of items available to test generalization, it made the incorporation of the items into a story relatively easy. Any storybook with a simple storyline involving two similar characters who do or have the same things or have similar characteristics could potentially be used to create similar matrices of agent-action, possessor-possession and attribute-entity combinations.

Performance during shared storybook reading corroborates the findings of Binger et al. (2008, 2010) that shared storybook reading is a context within which graphic symbol combinations can be relatively easily fostered. The usefulness of this context for targeting specific AAC skills was thus once again demonstrated.

6.4 Evaluation of the study

6.4.1 Strengths

This study was the first targeting specific graphic symbol combinations (agent-action, attribute-entity and possessor-possession combinations) within a shared storybook reading context, thereby attempting to retain a high level of control over the intervention while using a naturalistic context. The prompting hierarchy allowed some flexibility to respond at a level appropriate to the participant's response, and yet followed a closely scripted procedure. The performance of the participants during the storybook reading activity seems to suggest that this was a motivating and enjoyable activity for them. The fact that the applicability of the stories to young children was determined beforehand can also be regarded as a strength of the study. The equivalence of the three stories was also ensured in terms of story grammar, number of words and number of illustrations.

Furthermore, although only a small number of participants took part in the study, the multiple probe design across behaviours (three types of semantic relations) allowed for replicating the intervention three times per participant. No response generalization across types of relations occurred, thus indicating that the behaviours were indeed independent of each other as is required by this type of design.

The matrix strategy allowed for targeting five combinations per type of relation, while generalization to five untrained combinations (the elements of which had been targeted in other combinations) could be tested. Generalization could be monitored continuously throughout all the phases of the study (baseline, intervention and postintervention). According to Schlosser (2003b), the only way of adequately measuring generalization to untrained exemplars is by measuring target and nontarget responses with the same frequency (p. 114). Generalization was observed in all three participants, although the degree to which this occurred differed.

Use of the probe test to measure the effect of the intervention had the advantage that participants' abilities were tested beyond rote, context-bound skills. Participants needed to produce symbol combinations they acquired in response to a different task (picture description) and different material. Furthermore, use of the probe test allowed testing of all 30 items (generalization and intervention items) in random order across all three types of relations. Items from the baseline, and/or intervention and/or postintervention phases could thus be tested using one test procedure. In this way, generalization items could be easily monitored, with the same frequency as intervention items across all three phases of the study (baseline, intervention and postintervention). This is preferable to monitoring generalization in the baseline phase and in a separate generalization phase after the completion of intervention only, as has been done in some previous studies targeting graphic symbol combinations (e.g. Binger et al., 2008; 2010; Binger & Light, 2007; Iacono et al.; 1993).

A further strength is the high level of procedural integrity obtained for both the procedure employed during the shared storybook reading activities as well as the probe test. Good interrater

reliability for the transcription and data collected (percentage correct responses) was also obtained.

The use of IRD calculations to supplement visual analysis can be regarded as a further strength of the study. Relying on visual analysis only has limitations, since no universal decision rules exist and the interpretation of the graphs remains subjective (Campbell & Herzinger, 2010). IRD can provide an indication of effect size, which allows for a standardized method of expressing the amount of behaviour change between phases (Parker et al., 2009).

Lastly, the children participating in the study all had physical challenges and all came from multilingual backgrounds. The study thus involved children with a profile that differed from that of children participating in previous studies targeting symbol combination skills.

6.4.2 Limitations

Two participants from whom data was collected already combined symbols to produce the agent-action combinations before intervention commenced. A different type of relation may have been used to substitute the agent-action combinations in order to allow three opportunities to demonstrate the effect of the intervention. As it is, the effect of the intervention could only be clearly measured twice for each of these participants. A combination of purposive and convenience sampling was used to select participants, because participants were recruited who had a specific profile and who were accessible to the researcher for daily sessions. Together with the fact that the data of only three participants was analysed, this limits the external validity of the study.

Results of the study are complicated by the fact that only a weak effect could be detected for two of the three participants according to the probe test measures. Although responses during the shared storybook reading suggest that participants acquired the relations within that context, lack of baseline data regarding the performance during this context prevents drawing any definite conclusions. It seems, though, that the performance during the probe test did not reflect the gain in skills that took place during shared storybook reading fully. The fact that the context within which intervention took place differed from the context within which the measurements were

taken may have played a significant role. The validity of the measurements may well have been affected by reactivity from the participants, since the repeated probes may have had an inhibitive effect due to lack of contingent reinforcement and lack of clarity of task requirements (Gast & Ledford, 2010; p. 294). In the current study, roughly as much time was spent on intervention as was spent on testing. Although regular and repeated testing is needed for a multiple probe design, testing that can be incorporated into the intervention procedure may allow more active intervention time to be spent with participants.

Setting a teaching criterion of nine sessions may have prematurely ended the intervention sessions before participants benefited adequately from the intervention. This may have contributed to the fact that only one participant showed good maintenance of the skills postintervention.

The CIs calculated for the majority of IRD values obtained were wide. This may in part be attributed to the limited number of data points from which the IRD values were calculated. The limited number of data points obtained per phase also precluded the use of other statistics, such as mean difference effect size methods and regression-based effect size measures, because these methods require correction of serial dependency through the calculation of autocorrelation. Autocorrelation can only be calculated reliably when sufficient data points are available (Wolery, Busick, Reichow, & Barton, 2010).

Only one instructor (the author) provided the intervention to all participants. Although physical location varied, intervention was only conducted within the shared storybook reading context. This limits the external validity of the intervention.

6.5 Recommendations for further research

Recommendations for future research emanating from this study are as follows:

- A replication of the study may be considered using a different format of measurement. Limited evidence of effectiveness of the intervention in the current study may have been partly attributable to testing. In future studies, instead of measuring by a test in a context that differs from the intervention, measurements could be taken within the storybook reading

context. Higher levels of congruence between the intervention and measurement contexts may help to reflect the participants' learning more genuinely. Use of different yet equivalent material during baseline and intervention may be useful to help prevent threats of repeated testing (which may have a facilitative or inhibitive effect) due to repeated exposure to the same story during baseline.

- With reference to factors influencing aided language development (see Figure 2.1), it is clear that many issues around the acquisition of graphic symbol combinations are still unexplored. Future studies may systematically attempt to determine the influence of these factors. These may include:
  - ***Child factors***:
    - Studies may aim to determine the contributions of specific skills (such as expressive vocabulary, expressive graphic symbol vocabulary, receptive language skills, motor skills and motivation) towards the acquisition of symbol combinations. Intervention procedures could be replicated while systematically varying child characteristics in order to gain a better understanding of prerequisite skills, if indeed they do exist. At the same time, cognizance needs to be taken of the challenges of such studies in populations that are typically small and highly diverse.
    - The influence of multilingualism on the acquisition of graphic symbol combinations and alternative modalities as such has not yet been adequately explored. In general, few intervention studies in the field of AAC have specifically involved participants with limited speech from multilingual backgrounds. So far, only one intervention study involving South African children from multilingual backgrounds is known of (Dada & Alant, 2009), focusing on the use of aided language stimulation to teach receptive vocabulary. In view of the significant influence of cultural issues on communication in general, and specifically on graphic symbol understanding and use (Alant, 2005a; Alant, 2005b), more intervention studies with participants from multicultural and multilingual backgrounds are needed.

- ***Partner, environment and task:*** In the current study, the researcher implemented the intervention, making use of a matrix of target and intervention items within a shared storybook reading context. The extent to which the matrix strategy can be used in different contexts (e.g. daily routines) and/or be implemented by the child's natural communication partners (e.g. caregivers, assistants, teachers) may be worthwhile to determine, as the use of natural contexts and partners may enhance the external validity of the intervention.

- ***AAC system***: Future studies may attempt to determine the influence of the use of an SGD versus a communication board on the acquisition of graphic symbol combinations. Although it has been suggested that the presence of voice output may facilitate learning graphic symbol combinations, this has not been investigated. Other factors, such as visual feedback of the sequence composed (e.g. in a message window of the device) and the visual lay-out of the symbols on a communication board, page or overlay and overall vocabulary organization of a communication aid may also be systematically varied in future studies to determine their influence on this process. The influence of the total amount of vocabulary items available to the child might also be investigated. Furthermore, the extent to which the specific symbol system or set used and/or the vocabulary items chosen influence acquisition of early symbol combinations is a question that is not yet answered. What, for example, would be the influence of the use of a less iconic, but more linguistic symbol system like Bliss versus the use of a more iconic, less linguistic set like PCS on the acquisition of symbol combinations? How are symbol combinations learnt when the child is provided with activity-specific overlays or boards versus core vocabulary boards? What is an ideal weighting of different parts of speech (e.g. nouns, verbs, adjectives and closed-class words) to foster the transition to graphic symbol combinations?

- Longitudinal descriptive studies documenting the development of expressive language through graphic symbols could shed more light on the transition from single to multisymbol utterances, and place this skill in the context of the overall trajectory of aided language development. When searching for evidence-based intervention strategies, interventionists and

researchers need to keep perspective of long-term goals. Early symbol combinations skills are typically a stepping-stone towards the development of linguistic competence. The influence of intervention strategies aimed at fostering early graphic symbol combinations skills on later aided language development need to be more fully researched, since relatively few studies exist that targeted syntactic and morphological skills beyond early symbol combinations (Binger & Light, 2008; Binger, Maguire-Marshall, & Kent-Walsh, 2011; Blockberger & Johnston, 2003; Lund & Light, 2003). Factors that can facilitate the development of these skills have yet to be adequately researched. In order to plan for the language development of a child using graphic symbols to communicate, interventionists need to be aware of the facilitators and inhibitors for each phase of the process. In the same way as certain strategies that prove helpful in acquiring symbolization skills (e.g. higher degree of iconicity of the graphic symbols) may actually prove inhibitive in progressing to symbol combination skills, factors that facilitate the latter process may not necessarily be helpful for the development of more complex syntactic production. Decisions regarding choice of AAC systems and intervention strategies, as well as regarding when to phase out or change these, need to be informed by a long-term perspective of language development through aided means.

6.6 Summary

The current chapter presented conclusions regarding the results of the study. The influence of testing on the validity of the results was specifically highlighted. Clinical implications of the results were also discussed, with reference to skills that may indicate readiness for learning graphic symbol combinations, as well as the usefulness of shared storybook reading as an intervention context. The strengths and limitations of the study were presented in an effort to evaluate all aspects of the study. Lastly, recommendations were made as to how future studies could further expand our knowledge on the acquisition of graphic symbol combinations skills, while also placing this skill within the developmental progression of children learning to communicate through graphic symbols.

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Appendices

Appendix A

Data Recording Sheets to Capture Participants' Responses during Shared Storybook Reading

Attribute-entity **Participant** _____ **Session:**_____ **Date:** _____

	Exp pause, drawing attention	Question/mand	Request to use board	Model and req. to imitate	Hand-over-hand
Dirty pants					
Dirty shirt					
Broken aeroplane					
Broken car					
Dirty teddy					
Dirty pants					
Dirty shirt					
Dirty teddy					
Broken aeroplane					
Broken car					

Agent-Action **Participant** _____ **Session:**_____ **Date:** _____

	Exp pause, drawing attention	Question/mand	Request to use board	Model and req. to imitate	Hand-over-hand
Dog sleep					
Dog run					
Boy laugh					
Dog run					
Boy fall					
Boy fall					
Boy cry					
Boy cry					
Boy laugh					
Dog sleep					

Possessor-possession **Participant _____** **Session:_____** **Date: _____**

	Exp pause, drawing attention	Question/mand	Request to use board	Model and req. to imitate	Hand-over-hand
Bunny's shoe					
Girl's hat					
Girl's nose					
Girl's hat					
Bunny's shoe					
Girl's nose					
Bunny's tummy					
Girl's hand					
Girl's hand					
Bunny's tummy					

Appendix B
Clearance Obtained From the Research Ethics Committee of the Faculty of Humanities of the University of Pretoria

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Humanities
Research Proposal and Ethics Committee

2 September 2008

Dear Prof. Alant

Project:	**The effect of the use of communication boards versus a digital speech generating device on the learning of vocabulary and graphic symbols by children who have little or no functional speech**
Researcher:	**KM Tönsing**
Supervisor:	**Prof. E Alant**
Department:	**Centre for Augmentative and Alternative Communication**
Reference number:	**95036131**

Thank you for the application you resubmitted to the Research Proposal and Ethics Committee, Faculty of Humanities.

I have pleasure in informing you that the Research Proposal and Ethics Committee formally **approved** the above study on 28 August 2008. The approval is subject to the candidate abiding by the principles and parameters set out in her application and research proposal in the actual execution of the research.

The Committee requests you to convey this approval to Ms Tönsing.

We wish you success with the project.

Sincerely

Brenda Louw

Prof. Brenda Louw
Chair: Research Proposal and Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: brenda.louw@up.ac.za

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

2012-05-25

Dear Prof Bornman

Project:	Using a matrix strategy to teach graphic symbol combinations to children with limited speech during shared storybook reading
Researcher:	K Tönsing
Supervisor:	Dr S Dada
Reference numbers:	9503613

The change of focus of the study has been noted, and I confirm that it will not be necessary to re-submit the proposal to the Ethical Research Committee. Data collection may therefore continue.

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

We wish you success with the project.

Sincerely

Prof John Sharp
Chair: Postgraduate Committee &
Research Ethics Committee
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail: john.sharp@up.ac.za

Appendix C

Permission from Gauteng Department of Education

GAUTENG PROVINCIAL GOVERNMENT

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	**20 May 2010**
Name of Researcher:	**Tönsing Kerstin Monika**
Address of Researcher:	**25 B Lavender Lane**
	1087 Cura Ave
	Equestria, Pretoria
Telephone Number:	**0128074637/0826616007**
Fax Number:	**0124204389**
Research Topic:	**Joint Storybook Reading with Support of Augmentative and Alternative Communication (AAC): Effect on the Expression of Two-Symbol Semantic Combinations by Children with Little or No Functional Speech (LNFS)**
Number and type of schools:	**4 LSEN Schools**
District/s/HO	**Tshwane South and 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 to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. ***The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.***
2. ***The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.***
3. ***A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.***

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *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, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *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.*
8. *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.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *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.*
11. *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.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *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.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director 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

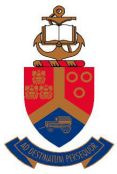
24-05-2010

Martha Mashego
ACTING DIRECTOR: KNOWLEDGE MANAGEMENT & RESEARCH

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	
Date:	

Appendix D

Consent Letters by Governing Body, Principal, Teacher and Parent for Pilot Participant



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Head
(School's name)

Re: Request for permission to conduct a pilot study at *(name of school)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission to recruit participants for a pilot study from *(name of school)*.

The title of my study is "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. The aim of the pilot study is to test the proposed procedures and material on one participant. Three stories will be read to the participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt the participant to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

Should you grant permission for me to conduct the study at your school, I would kindly ask the help of teachers and/or therapists to identify a learner who would be a suitable participant.

The following would then be required of learner taking part in the study:

1) To meet me, possibly during break time at school
2) To undergo a screening procedure to determine their abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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

This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- The parent(s)/legal guardian(s) of the learner will be approached to request consent for their child to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their child's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, the participant will be formally asked for his/her assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If the participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If the participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to conduct the study under the auspices of your school can be withdrawn at any time without negative consequences to your school.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff and/or the child's parent(s)/legal guardian(s).

Potential harm to the participant in this study might entail him/her being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participant beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give the participant the opportunity to refuse participation. Should it become evident that participant is unwilling to continue a task during a session, the task will be discontinued and the participant will be escorted back to class.

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The participant might miss out on learning time spent in his/her classes when participating in the study. Great care will be taken to schedule the study in a way that the participant misses minimal active learning time and that the school routine will be minimally affected. I would liaise with yourself, teachers and parents regarding this. The proposed time frame for data collection is May to July 2010. Care will be taken that the proposed schedule will not interfere with the parents' or the school's time plans.

Potential benefits for the participant include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of the participant decide to withdraw their child's participation, any data pertaining to the participant will be immediately destroyed. The results of the study are intended to serve as guidelines for the main study. The main study is intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of the participant.

I would appreciate it if you, as the Head of *(name of school)*, would consider this request favourably. Should you grant permission, I would kindly ask you to sign below to acknowledge your permission.

Should you need any further information on the study, please do not hesitate to contact me on (*cell number*) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
(cell no)

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal) Date
The Head: *(name of school)*

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Appendix D

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

To the parent/legal guardian of _____, enrolled at *(school's name)*

Dear Sir/Madam

Re: Request for permission for your child to participate in a pilot study at *(school's name)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission for your child to participate in a pilot study.

The title of my study is: "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. The aim of the pilot study is to test the proposed procedures and material on one participant. Three stories will be read to the participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt the participant to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

The following would be required of your child should you give permission for him/her to take part in the study:

1. To meet me, possibly during break time at school
2. To undergo a screening procedure to determine his/her abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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(This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days. Depending on the findings of the screening procedure, a brief interview might be scheduled with yourself as parent. I may then request you to complete a screening checklist regarding your child's expressive communication.)

3. If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4. If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5. To then take part in an individual daily story reading activity over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect your child's interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- Permission was obtained from the school principal (see signature on this letter).
- Your child will only participate if you have given consent. Once you have given consent, you still have the right to withdraw your child's participation at any point in the study without any negative consequences to your child or yourself. You are welcome to contact me at any point in time to obtain clarification on any aspect of the study (see contact details below).
- Prior to each session, your child will be formally asked whether they would like to participate in the session. I will make sure that this will be done in a way that your child can understand and respond. If you child is not willing to participate, the session will not be conducted, without any negative consequences for your child. If your child should become unwilling to continue participation once a session is in progress, the session will be discontinued and he/she will be escorted back to class. A small reward will be given to your child upon completion of a session. The type of reward given to your child will be selected based on your input.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- Should you so wish, formal written feedback will be given to you as parent/legal guardian concerning the performance of your child.

Potential harm to your child when participating in this study might entail him/her being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participants beforehand, this potential is hoped to be minimized. Request for participation at the beginning of each session will also give him/her the opportunity to refuse participation. Should it become evident that your child is unwilling to continue a task during a session, the task will be discontinued and your child will be escorted back to class.

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Your child might miss out on learning time by being absent from class when participating in the study. Great care will be taken to schedule the study in such a way that your child misses minimal active learning time and that the school routine will be minimally affected. As far as possible, sessions will be scheduled outside of important lessons. I would liaise with yourself, teachers and the head of the school regarding this. The proposed time frame for data collection is May to July 2010. Care will be taken that the proposed schedule will not interfere with your or the school's time plans.

Potential benefits for participants include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

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. The results of the study are intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of all participants

I would appreciate it if you would consider this request favourably. May I kindly request that you fill in the reply slip attached to indicate whether you grant permission for your child to participate in this study or not.

Should you need any further information on the study, please do not hesitate to contact me on (*cell number*) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001. Should you grant permission, I will contact you to make an appointment with you to discuss further details.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
(cell number)

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal) Date
The Head: *(name of school)*
(Telephone number of school)

Centre for Augmentative and Alternative Communication (CAAC),
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Appendix D

Reply slip: Research study at (name of school)

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

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

appropriate) grant permission for him/her to participate in the pilot study conduced at *(name of school).*

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

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Appendix D

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Chairperson
Governing Body: *(name of school)*

Re: Request for permission to conduct a pilot study at *(name of school)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission to recruit participants for a pilot study from *(name of school).*

The title of my study is "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. The aim of the pilot study is to test the proposed procedures and material on one participant. Three stories will be read to the participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt the participant to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

Should you grant permission for me to conduct the study at your school, I would kindly ask the help of teachers and/or therapists to identify a learner who would be a suitable participant.

The following would then be required of learner taking part in the study:

1) To meet me, possibly during break time at school
2) To undergo a screening procedure to determine their abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity. over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- The parent(s)/legal guardian(s) of the learner will be approached to request consent for their child to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their child's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, the participant will be formally asked for his/her assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If the participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If the participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to conduct the study under the auspices of your school can be withdrawn at any time without negative consequences to your school.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff and/or the child's parent(s)/legal guardian(s).

Potential harm to the participant in this study might entail him/her being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participant beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give the participant the opportunity to refuse participation. Should it become evident that participant is unwilling to continue a task during a session, the task will be discontinued and the participant will be escorted back to class.

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The participant might miss out on learning time spent in his/her classes when participating in the study. Great care will be taken to schedule the study in a way that the participant misses minimal active learning time and that the school routine will be minimally affected. I would liaise with yourself, teachers and parents regarding this. The proposed time frame for data collection is May to July 2010. Care will be taken that the proposed schedule will not interfere with the parents' or the school's time plans.

Potential benefits for the participant include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of the participant decide to withdraw their child's participation, any data pertaining to the participant will be immediately destroyed. The results of the study are intended to serve as guidelines for the main study. The main study is intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of the participant.

I would appreciate it if you, as the governing body of *(name of school)*, would consider this request favourably. Should you grant permission, I would kindly ask you to sign below to acknowledge your permission. Should you need any further information on the study, please do not hesitate to contact me on *(cell number)* or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____
Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP), *(cell number)*

_____ _____
Dr Shakila Dada Date
Senior Lecturer
University of Pretoria, tel. 012 420 2001

_____ _____
(name of principal) Date
The Head: *(name of school)(Telephone number of school)*

_____ _____
Chairperson of the Governing Body: Date
(name of school) (Telephone number of chairperson)

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Appendix D

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Teacher
(School's name)

Re: Request for permission for learners from your class to participate in a pilot study at *(school's name)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission to recruit participants for a pilot study from *(name of school)*.

The title of my study is "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. The aim of the pilot study is to test the proposed procedures and material on one participant. Three stories will be read to the participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt the participant to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

Should you grant permission for me to conduct the study at your school, I would kindly ask the help of teachers and/or therapists to identify a learner who would be a suitable participant.

The following would then be required of learner taking part in the study:

1) To meet me, possibly during break time at school
2) To undergo a screening procedure to determine their abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity. over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- The parent(s)/legal guardian(s) of the learner will be approached to request consent for their child to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their child's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, the participant will be formally asked for his/her assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If the participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If the participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to conduct the study under the auspices of your school can be withdrawn at any time without negative consequences to your school.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff and/or the child's parent(s)/legal guardian(s).

Potential harm to the participant in this study might entail him/her being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participant beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give the participant the opportunity to refuse participation. Should it become evident that participant is unwilling to continue a task during a session, the task will be discontinued and the participant will be escorted back to class.

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The participant might miss out on learning time spent in his/her classes when participating in the study. Great care will be taken to schedule the study in a way that the participant misses minimal active learning time and that the school routine will be minimally affected. I would liaise with yourself, teachers and parents regarding this. The proposed time frame for data collection is May to July 2010. Care will be taken that the proposed schedule will not interfere with the parents' or the school's time plans.

Potential benefits for the participant include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of the participant decide to withdraw their child's participation, any data pertaining to the participant will be immediately destroyed. The results of the study are intended to serve as guidelines for the main study. The main study is intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of the participant.

I would appreciate it if you would consider this request favourably. May I kindly request that you fill in the reply slip attached to indicate whether you grant permission for learners from your class to participate in this study or not. 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. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
082 661 6007

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal Date
The Head: *(name of school)*

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Reply slip: Research study at (school's name)

I, _____, hereby do / do not (please circle
(teacher's name)

appropriate) grant permission for _____ from my class to
(learner's name)

participate in the study conducted at *(name of school):*

_____ _____
(Signature of teacher) (Date)

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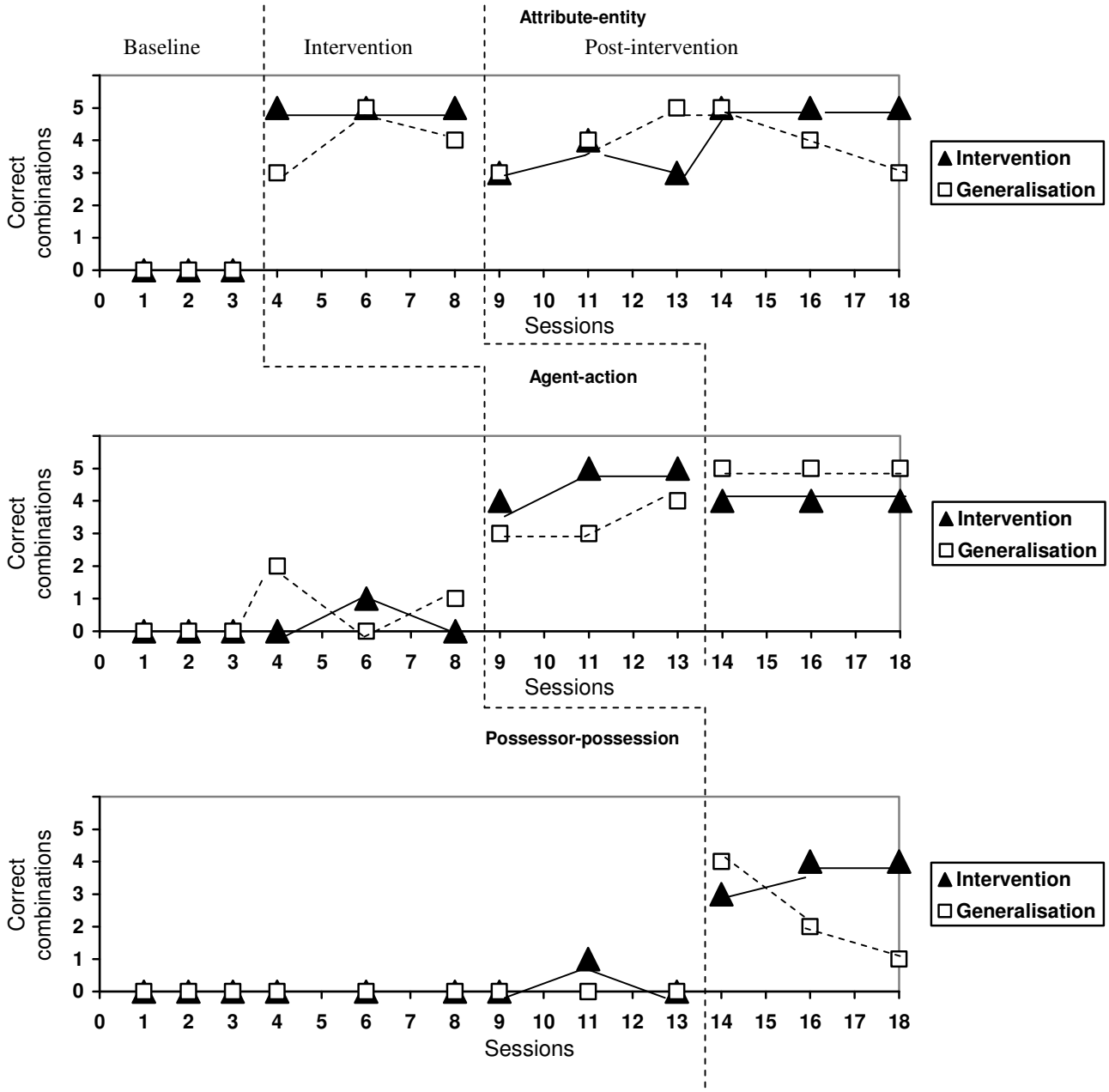
Appendix E

Original Selection Criteria

Criterion	Motivation	Measure
Little or no functional speech (less than 30 intelligible spoken words)	There must be motivation to use AAC.	Parent, teacher and therapist report – Language Development Scale (LDS) (Rescorla, 1989) with adaptations to the South African context (Gonasillan, 2011) and to accommodate different expressive modalities (see Appendix J)
Using single graphic symbols expressively	As use of single spoken words typically precedes the use of word combinations, use of single graphic symbols may precede the use of symbol combinations.	Parent, teacher and therapist report.
Not combining symbols for expressive communication	The aim of the study was to teach two graphic symbol semantic combinations.	Parent report
Able to accurately point to items on a 21-item communication board	Participants need to be able to direct-select to make use of the communication board without too much motor effort.	Participants were asked to point out items on a 21-item communication board with graphic symbols.
Functional vision and hearing	Participants need to be able to hear spoken instructions and the story being read out loud to them as well as see the story's pictures and the graphic symbols.	Parent report/medical records. Participants were also asked to point out graphic symbols out of an array of 21, as an indication of functional vision.
Being able to comprehend at least 80% of the graphic symbols used on the communication board with a maximum of 5 training sessions provided if necessary.	In order to be used for expressive communication, participants needed to know what concepts the symbols represented.	Participants were asked to point to graphic symbols on the communication board used for intervention in response to spoken words.
Being able to comprehend at least 80% of the semantic relations targeted in intervention	Children's linguistic ability in comprehension has been suggested to precedes their ability in production (Smolensky, 1996).	Participants were asked to match a spoken 2-word combination to a picture (presented with four foils).
Aged 3-10 years	The age range is delimited in order to ensure that material is appropriate to participants.	Parent report
English home language	Since the intervention was to be conducted in English, second language factors might reduce participants' ability to benefit from the intervention.	Parent report
Receptive language skills on at least 30 month level	Participants would need to understand the stories presented in order to benefit maximally from the intervention.	The Peabody Picture Vocabulary Test - Revised (Dunn & Dunn, 1981) as well as the receptive subtests of the Clinical Evaluation of Language Function-Preschool UK (CELF-Preschool UK) were administered to determine receptive language abilities.

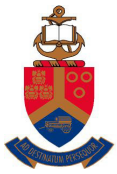
Appendix F

Data Collected From Pilot Participant: Number of Correct Two-Symbol Combinations Across the Three Semantic Relations Targeted



Appendix G

Letters to Principals and Governing Bodies of Schools to Request Consent for Recruitment of Participants for Main Study



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Head
(School's name)

Re: Request for permission to conduct a research project at *(name of school)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission to recruit participants for my proposed study from *(name of school).*

The title of my study is "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. Three stories will be read to each participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt participants to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

Should you grant permission for me to conduct the study at your school, I would kindly ask the help of teachers and/or therapists to identify learners who would be suitable participants (four to six children).

The following would then be required of learners taking part in the study:

1) To meet me, possibly during break time at school
2) To undergo a screening procedure to determine their abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity. over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- The parents/legal guardians of the learners will be approached to request consent for their children to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their children's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, each participant will be formally asked for their assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If a participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If a participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to conduct the study under the auspices of your school can be withdrawn at any time without negative consequences to your school.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff or parents/legal guardians.

Potential harm to participants in this study might entail them being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participants beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give participants the opportunity to refuse participation. Should it become evident that participants are unwilling to continue a task during a session, the task will be discontinued and participants will be escorted back to their class.

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Participants might miss out on learning time spent in their classes when participating in the study. Great care will be taken to schedule the study in a way that participants miss minimal active learning time and that the school routine will be minimally affected. I would liaise with yourself, teachers and parents regarding this. The proposed time frame for data collection is May to July 2011. Care will be taken that the proposed schedule will not interfere with the parents' or the school's time plans.

Potential benefits for participants include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of participants decide to withdraw their children's participation, any data pertaining to these participants will be immediately destroyed. The results of the study are intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of participants

I would appreciate it if you, as the Head of *(name of school)*, would consider this request favourably. Should you grant permission, I would kindly ask you to sign below to acknowledge your permission.

Should you need any further information on the study, please do not hesitate to contact me on (cell number) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
(cell number)

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal) Date
The Head: *(name of school)*

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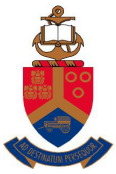
Appendix G



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Chairperson
Governing Body: *(name of school)*

Re: Request for permission to conduct a research project at *(name of school)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission to recruit participants for my proposed study from *(name of school)*.

The title of my study is "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. Three stories will be read to each participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt participants to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

Should you grant permission for me to conduct the study at the school, I would kindly ask the help of teachers and/or therapists to identify learners who would be suitable participants (four to six children).

The following would then be required of learners taking part in the study:

1) To meet me, possibly during break time at school
2) To undergo a screening procedure to determine their abilities in the following areas:
   - Functional vision and hearing
   - Understanding of all the sentence types targeted
   - Comprehension of the graphic symbols used during intervention
   - Receptive language skills

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This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity. over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- Permission was obtained from the school principal (see signature on this letter).
- The parents/legal guardians of the learners will be approached to request consent for their children to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their children's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, each participant will be formally asked for their assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If a participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If a participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to conduct the study under the auspices of the school can be withdrawn at any time without negative consequences to the school.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff or parents/legal guardians.

Potential harm to participants in this study might entail them being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participants beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give participants the opportunity to refuse participation. Should it become evident that participants are unwilling to continue a task during a session, the task will be discontinued and participants will be escorted back to their class.

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Participants might miss out on learning time spent in their classes when participating in the study. Great care will be taken to schedule the study in a way that participants miss minimal active learning time and that the school routine will be minimally affected. I would liaise with the principal, teachers and parents regarding this. The proposed time frame for data collection is May to July 2011. Care will be taken that the proposed schedule will not interfere with the parents' or the school's time plans.

Potential benefits for participants include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of participants decide to withdraw their children's participation, any data pertaining to these participants will be immediately destroyed. The results of the study are intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of participants

I would appreciate it if you, as the governing body of *(name of school)*, would consider this request favourably. Should you grant permission, I would kindly ask you to sign below to acknowledge your permission.

Should you need any further information on the study, please do not hesitate to contact me on (cell number) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____
Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP), tel. (cell number)

_____ _____
Dr Shakila Dada Date
Senior Lecturer
University of Pretoria, tel. 012 420 2001

_____ _____
(name of principal) Date
The Head: *(name of school)(Telephone number of school)*

_____ _____
Chairperson of the Governing Body: Date
(name of school) (Telephone number of chairperson)

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Appendix H

Letters to Parents of Possible Participants to Request Consent for Their Child to Participate in the Main Study

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

To the parent/legal guardian of _____, enrolled at *(school's name)*

Dear Sir/Madam

Re: Request for permission for your child to participate in a research project at *(school's name)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request your permission for your child to participate in my proposed study.

The title of my study is: "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. Three stories will be read to each participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a communication board that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt participants to point to symbol sequences. Each story will be read a number of times. The participant's learning will be monitored with a picture description task.

The following would be required of your child should you give permission for him/her to take part in the study:

1. To meet me, possibly during break time at school
2. To undergo a screening procedure to determine his/her abilities in the following areas:
    - Functional vision and hearing
    - Understanding of all the sentence types targeted
    - Comprehension of the graphic symbols used during intervention
    - Receptive language skills

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(This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days. Depending on the findings of the screening procedure, a brief interview might be scheduled with yourself as parent. I may then request you to complete a screening checklist regarding your child's expressive communication.)

3. If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4. If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5. To then take part in an individual daily story reading activity over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect your child's interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- Permission was obtained from the school principal (see signature on this letter).
- Your child will only participate if you have given consent. Once you have given consent, you still have the right to withdraw your child's participation at any point in the study without any negative consequences to your child or yourself. You are welcome to contact me at any point in time to obtain clarification on any aspect of the study (see contact details below).
- Prior to each session, your child will be formally asked whether they would like to participate in the session. I will make sure that this will be done in a way that your child can understand and respond. If you child is not willing to participate, the session will not be conducted, without any negative consequences for your child. If your child should become unwilling to continue participation once a session is in progress, the session will be discontinued and he/she will be escorted back to class. A small reward will be given to your child upon completion of a session. The type of reward given to your child will be selected based on your input.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- Should you so wish, formal written feedback will be given to you as parent/legal guardian concerning the performance of your child.

Potential harm to your child when participating in this study might entail him/her being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participants beforehand, this potential is hoped to be minimized. Request for participation at the beginning of each session will also give him/her the opportunity to refuse participation. Should it become evident that your child is unwilling to continue a task during a session, the task will be discontinued and your child will be escorted back to class.

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Your child might miss out on learning time by being absent from class when participating in the study. Great care will be taken to schedule the study in such a way that your child misses minimal active learning time and that the school routine will be minimally affected. As far as possible, sessions will be scheduled outside of important lessons. I would liaise with yourself, teachers and the head of the school regarding this. The proposed time frame for data collection is May to July 2011. Care will be taken that the proposed schedule will not interfere with your or the school's time plans.

Potential benefits for participants include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

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. The results of the study are intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of all participants

I would appreciate it if you would consider this request favourably. May I kindly request that you fill in the reply slip attached to indicate whether you grant permission for your child to participate in this study or not. Should you need any further information on the study, please do not hesitate to contact me on (cell number) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001. Should you grant permission, I will contact you to make an appointment with you to discuss further details.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
(cell number)

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal) Date
The Head: *(name of school)*
(Telephone number of school)

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Appendix H

Reply slip: Research study at (name of school)

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

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

appropriate) grant permission for him/her to participate in the study conduced at *(name of school).*

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

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Appendix I

Letter to Teachers to Request Consent for Learner(s) From Their Class to Participate in Main Study

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

(Date)

The Teacher
(School's name)

Re: Request for permission for learners from your class to participate in a research study at *(school's name)*

My name is Kerstin Tönsing. I am a speech therapist currently enrolled for a PhD in Augmentative and Alternative Communication, at the University of Pretoria, under the supervision of Dr Shakila Dada. I would like to request you permission to recruit participants for my proposed study from your class.

The title of my study is: "Joint storybook reading with the support of augmentative and alternative communication (AAC): Effect on the expression of two-symbol semantic combinations by children with little or no functional speech (LNFS)". The aim of this research project is to determine if children who use graphic symbols to communicate, can be taught to combine symbols during a story-reading activity. Three stories will be read to each participant, and specific symbol combinations will be taught during each story. While reading the story, I will model the combinations on a voice output communication device that has Picture Communication Symbols (PCS) and hand-drawn graphic symbols on it, and also prompt participants to press the correct combinations. Each story will be read a number of times, while record will be kept on the learning that the participant shows.

The following would be required of learners taking part in the study:
1) To meet me, possibly during break time at school;
2) To undergo a screening procedure to determine their abilities in the following areas:
    - Functional vision and hearing
    - Understanding of all the sentence types targeted
    - Comprehension of the graphic symbols used during intervention
    - Receptive language skills

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This screening procedure will take a total of about 2-3 hours and will be conducted over a period of 2-3 days.

3) If necessary, to undergo training of specific graphic symbols used in intervention (max. of 5 sessions of about 5 min each)
4) If the screening procedures are passed, to engage in a picture description task (about 10 min in duration) for three consecutive days.
5) To then take part in an individual daily story reading activity. over the course of about 3 weeks. One story will be read per day. This activity will take about 10 min. Fifteen sessions are planned (three stories, with 5 sessions per story). Ideally, 5 consecutive weekdays would be allocated to each story. On every second day of storytelling, a picture description task (about 10 min in duration) will also be given.

In accordance with the University's ethical procedure requirements, and in order to protect the learners' interests, the following steps have been/will be taken:

- Permission was obtained from the Gauteng Department of Education (please see information attached).
- Permission was obtained from the school principal (see signature on this letter).
- The parents/legal guardians of the learners will be approached to request consent for their children to participate in the study. They will be informed of every aspect of the study, and also made explicitly aware of their right to withdraw their children's participation at any point in the study without any negative consequences to their child or themselves. They will be given information (telephone number, email) in order to contact me at any point in time to obtain clarification on any aspect of the study.
- Prior to each session, each participant will be formally asked for their assent for participation in a modality that they are able to understand and use (e.g. graphic symbols, manual signs, spoken). If a participant does not give assent, the session will not be carried out at that point in time, without any negative consequences to the participant. If a participant becomes unwilling to participate during a session, the session will be discontinued and the participant will be escorted back to his/her class. A small token will be given to the participant upon completion of the session. The type of token will be selected based on parent and teacher input.
- Your permission to involve participants from your class during school time can be withdrawn at any time without negative consequences to yourself or the learners.
- All data will be treated as confidential, and results will be reported anonymously, without linking identifying information to specific results.
- A summary of the research results will be available to any interested staff or parents/legal guardians.

Potential harm to participants in this study might entail them being uncomfortable or reluctant to engage with an unfamiliar adult (myself) during the activities. By meeting the participants beforehand, this potential is hoped to be minimized. Request for assent at the beginning of each session will also give participants the opportunity to refuse participation. Should it become evident

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that participants are unwilling to continue a task during a session, the task will be discontinued and participants will be escorted back to their class.

Participants might miss out on learning time spent in their classes when participating in the study. Great care will be taken to schedule the study in a way that participants miss minimal
active learning time and that the school routine will be minimally affected. I would liaise with yourself, parents and the head of the school regarding this.

Potential benefits for participants include increased stimulation to foster the use of symbol combinations in a one-on-one learning situation. The results of the screening assessment as well as the way the participant responds during intervention can furthermore serve as a guideline for teaching and further intervention.

Data pertaining to this study will be stored for 15 years for the purpose of archiving. Should parents/legal guardians of participants decide to withdraw their children's participation, any data pertaining to these participants will be immediately destroyed. The results of the study are intended to be published in the form of a dissertation as well as a research article. As indicated, no identifying information will be included to ensure anonymity of participants

I would appreciate it if you would consider this request favourably. May I kindly request that you fill in the reply slip attached to indicate whether you grant permission for learners from your class to participate in this study or not. Should you need any further information on the study, please do not hesitate to contact me on (cell number) or email me at kerstin.tonsing@up.ac.za. You are also welcome to contact my supervisor, Dr Shakila Dada, at 012 420 2001.

Kind regards

_____ _____

Kerstin Tönsing Date
Speech and Language Therapist
BCommunication Pathology (UP), MAAC (UP)
(cell number)

_____ _____

Dr Shakila Dada Date
Lecturer
University of Pretoria
012 420 2001

_____ _____

(name of principal Date
The Head: *(name of school)*

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Appendix I

Reply slip: Research study at (school's name)

I, _____, hereby do / do not (please circle
(teacher's name)

appropriate) grant permission for the following learners from my class to participate in the study conducted at *(name of school):*

_____,
(learner's name)

_____,
(learner's name)

_____,
(learner's name)

_____,
(learner's name)

_____,
(learner's name)

_____.
(learner's name)

_____ _____
(Signature of teacher) (Date)

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Appendix J: Results of Participants 4 and 5

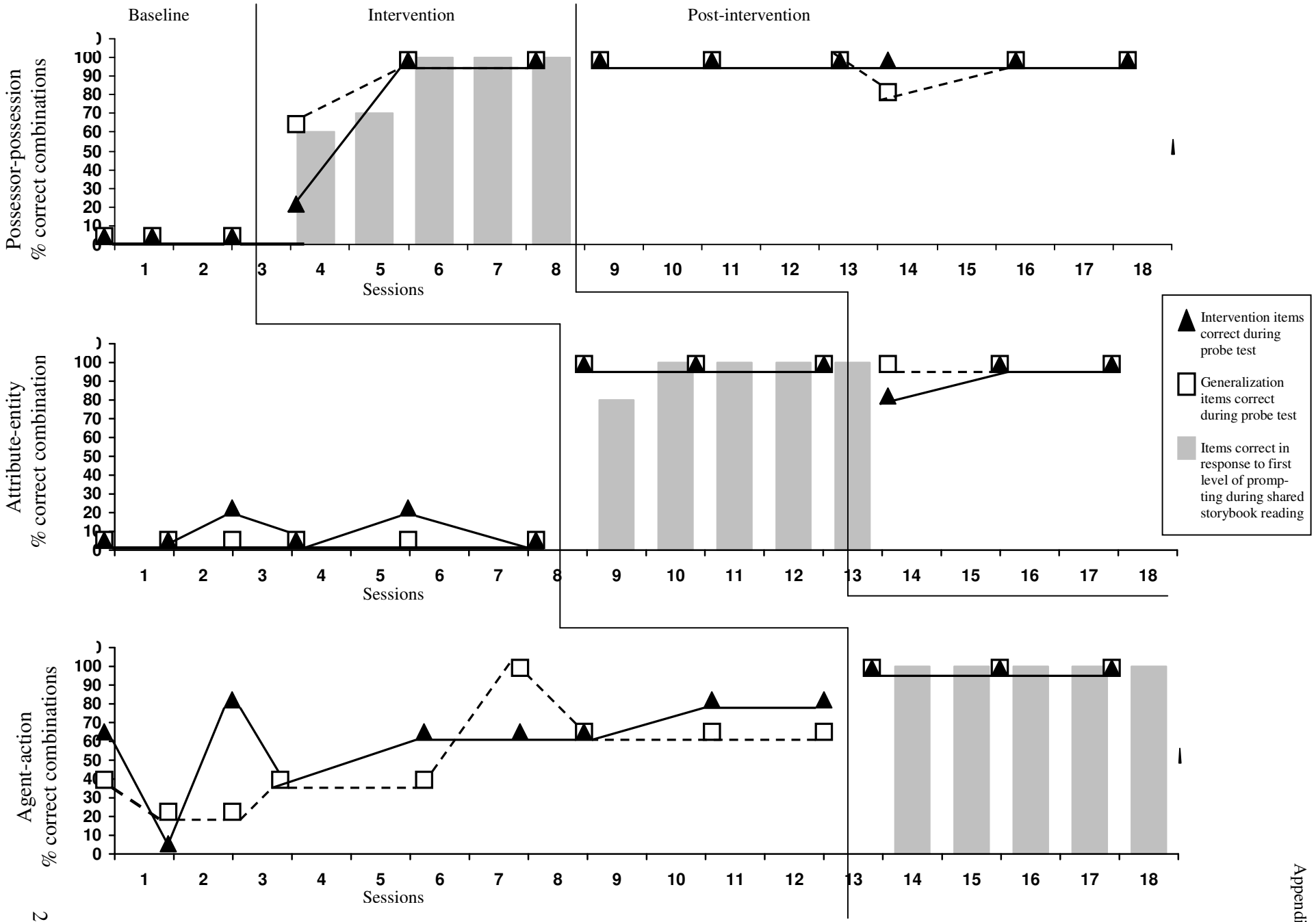


Figure 1A. Percentage of correct two-symbol combinations expressed by Participant 4 across the three semantic relations targeted.

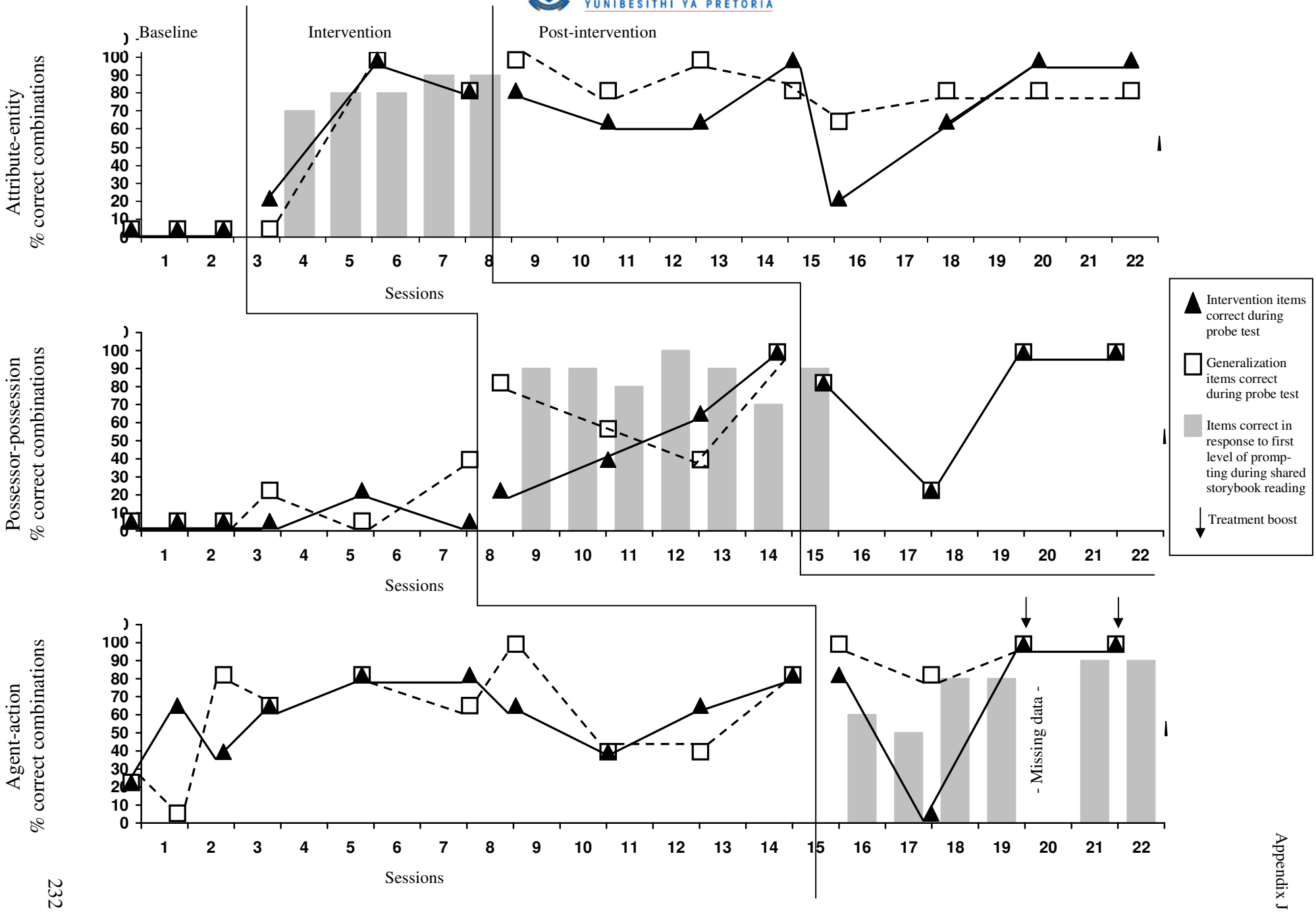


Figure 2A. Percentage of correct two-symbol combinations expressed by Participant 5 across the three semantic relations targeted.

Appendix K

Interview Schedules

AAC supported storybook reading: Parent interview schedule (background information)

Participant number_____

1. What is your child's date of birth? _____
2. Where does your child stay during term time? _____
3. Does your child have siblings? _____
4. What diagnosis was given to your child (if any)? _____
5. Does your child have any visual problems? Y/N

   If yes, please describe: _____

   _____

   _____
6. Does your child have any hearing problems? Y/N

   If yes, please describe: _____

   _____

   _____
7. Please list the words which your child can say (speak) in such a way that outsiders can understand him/her:

   _____

   _____

   _____
8. How does your child mainly communicate:

   Using one word/gesture/picture at a time_____

Using two words/gestures/pictures at a time_____

Using more than two words/gestures/pictures at a time: _____

9. If your child uses more than one word in a sentence, please give some examples:

_____

_____

10. Does your child ever point to picture symbols to communicate? Y/N

If yes, please describe: _____

_____

11. Do you read stories to your child at home? Y/N

If yes, how often? _____

12. (If participant answered 'yes' to question 11) Does your child enjoy being read to? Y/N
Comments:_____

_____

13. (If participant answered 'yes' to question 9) Does your child interact with you while you read stories to him/her? Y/N

If yes, please describe: _____

_____

_____

14. Has your child had intervention to improve his/her communication skills? Y/N

If yes, please describe how often/for how long and what the goals of the intervention were.

_____

_____

15. What are your child's favourite toys?_____

16. Please describe how he/she plays with them._____

17. What are your child's favouite games? _____

18. Please describe how your child engages in these games. _____

19. In order to determine the level of your child's understanding of language, please indicate whether the following statements apply to your child:

60-72 mths

- knows all opposites
- Can identify beginning and end sounds
- Knows right and left on self
- Understands the question "What will happen if…"

(*If two or less are typical of the child, proceed to the next set of items):*

48-60 mths

- Understands time concepts like last week
- Understands day/night; evening/afternoon/morning
- Understands jokes
- Knows seasons
- Understands concepts first/last
- Knows words like his, ours, theirs
- Understands words like 'most', 'prettiest', better.

(*If three or less are typical of the child, proceed to the next set of items):*

30-48 mths

- Knows name and surname
- Knows age
- Knows categories, e.g. furniture, animals etc.
- Knows basic colours
- Listens attentively and with interest to stories
- Has favourite story
- Understands concept 'because'
- Understands opposites such as long/short, little/a lot, light/heavy

(*If three or less are typical of the child, proceed to the next set of items):*

33-36 mths

- Shows interest in explanations of 'why' things are and 'how' things happen
- Can carry out up to three ore more verbal commands given in one long utterance
- Demonstrates an understanding of several prepositions

(*If less than two are typical of the child, proceed to the next set of items):*

30-33 mths

- Demonstrates an understanding of most common verbs
- Understands and responds meaningfully to most very long and complex sentence requests or commands
- Demonstrates an understanding of most common adjectives

(*If less than two are typical of the child, proceed to the next set of items):*

27-30 mths

- Demonstrates an understanding of word category associations through functional identifications (correctly answers such questions as "What do you eat with?" "What do you wear" etc.)
- Understands size difference adjectives (correctly selects "the little doll", "the small book", "the large bowl" etc.)
- Recognizes and can point to pictures of any common object

(*If less than two are typical of the child, proceed to the next set of items):*

24-27 mths

- Demonstrates an understanding of several action words (verb forms) by selecting appropriate pictures (for example, correctly chooses which picture shows eating, swinging, throwing, etc.)
- When asked, now points to 3 or more smaller parts of the body (such as chin, elbow, eyebrow, ankle, etc.)
- Recognizes some extended family name categories (such as uncle, grandma, cousin, etc.).

Appendix K

AAC supported storybook reading: Teacher interview schedule (background information)

Participant number_____

1. How does the learner communicate in class? *(Communication functions, modes and type of sentences used)*

   _____

   _____

   _____

   _____

2. Does the learner ever point to picture symbols to communicate? Y/N

   If yes, please describe: _____

   _____

3. Does the learner seem to have any hearing problems? Y/N

   If yes, please describe: _____

   _____

   _____

4. Does the learner seem to have any visual problems? Y/N

   If yes, please describe: _____

   _____

   _____

5. Please list the words which the learner can say (speak) in such a way that you can understand him/her:

   _____

_____

_____

_____

6. What are the main outcomes you are working towards for this learner this year?

_____

_____

_____

7. Do you read stories to this learner? Y/N

   If yes, please describe (how often, format, e.g. group, individual): _____

_____

_____

8. (If answer to 7 was yes) Does the learner enjoy being read to? Y/N

   Comments: _____

_____

9. Please comment on the learner's way of playing (toys and games he/she likes, how he engages with those): _____

_____

_____

Appendix K

AAC supported storybook reading: Therapist interview schedule (background information)

Participant number_____

1. How long have you been seeing this learner for intervention? _____
2. How often do you see this learner for intervention?_____
3. What format does intervention take (group/individual)? _____
4. What are your main goals for intervention? _____

   _____

   _____

5. How does the learner communicate with you? *(Researcher to probe for communication functions, modes and type of sentences used)*

   _____

   _____

   _____

   _____

6. Does the learner ever point to picture symbols to communicate? Y/N

   If yes, please describe: _____

   _____

7. Does the learner seem to have any hearing problems? Y/N

   If yes, please describe: _____

   _____

   _____

8. Does the learner seem to have any visual problems? Y/N

If yes, please describe: _____

_____

9. Please list the words which the learner can say (speak) in such a way that you can understand him/her:

_____

_____

_____

10. Do you read stories to this learner? Y/N

If yes, please describe (how often, format, e.g. group, individual): _____

_____

11. (If answer to 10 was yes) Does the learner enjoy being read to? Y/N

Comments: _____

_____

12. Please comment on the learner's way of playing (toys and games he/she likes, how he engages with those): _____

_____

_____

Appendix L

Language Development Survey (Rescorla, 1989) Amended to the South African Context (Gonasillan, 2011) and With Modifications for Different Expressive Modalities

Language Development Survey
By Leslie Rescorla

PLEASE COMPLETE THE VOCABULARY CHECKLIST

Please indicate each word that your child expresses by ticking the appropriate block after the word. Do not include words that your child repeats after you but does not express spontaneously. Also, if your child communicates by pointing to objects or people, these should be spontaneous actions, not pointing in response to questions such as 'Where is Daddy' or 'Show me the cup.'

Does your child express the following words:

FOOD	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
apple							
banana							
biscuit							
bread							
bubblegum							
butter							
cake							
cereal							
cheese							
chips							
coffee							
coke							
cookie							
drink							
egg							
food							
grapes							
hamburger							
hot dog							
ice cream							
juice							
meat							
milk							
orange							
pizza							
Raisins							
Soup							
spaghetti							
sweets							
Tea							
Toast							
Water							

CLOTHES							
Belt							
Boots							
Coat							
Dress							
Gloves							
Hat							
Jacket							
jersey							
Nappy							
Pants							
pyjamas							
Shirt							
Shoes							
slippers							
Socks							
Takkies							

PLACES							
Church							
Home							
Hospital							
Library							
McDonalds							
Park							
School							
Store							
Zoo							

ANIMALS	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
bear							
bee							
bird							
bug							
bunny							
cat							
chicken							
cow							
dog							
duck							
elephant							
fish							
frog							
horse							
monkey							
pig							
puppy							
snake							
tiger							
turkey							
Tortoise							

TOYS							
Ball							
Balloon							
Blocks							
Book							
Bubbles							
Crayons							
Doll							
Picture							
Present							
Slide							
Swing							
Teddy bear							

VEHICLES							
Bike							
Boat							
Bus							
Car							
Motorbike							
Plane							
Pram							
Train							
Trolley							
Truck							

OUTDOORS							
Flower							
House							
Moon							
Rain							
Pavement							
Sky							
Snow							
Star							
Street							
Sun							
Tree							

ACTIONS	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
bath							
breakfast							
Bring							
Catch							
Clap							
Close							
Come							
Cough							
Cut							
Dance							
Dinner							
Doodoo							
Eat							
Feed							
Finish							
Fix							
Get							
Give							
Go							
Have							
Help							
Hit							
Hug							
Jump							
kick							
Kiss							
Knock							
look							
Love							
Lunch							
Make							
Nap							
Outside							
pattycake							
Peekaboo							
Push							
Read							
Ride							
Run							
See							
Show							
Sing							
Sit							
Sleep							
Stop							
Take							
throw							
Tickle							
Walk							
Want							
Wash							
Weewee							

PERSONAL							
Brush							
comb							
Glasses							
Key							
Money							
paper							
Pen							
Pencil							
Pocketbook							
Tissue							
Toothbrush							
Umbrella							
watch							

MODIFYERS	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
All gone							
All right							
Bad							
Big							
Black							
Blue							
Broken							
Clean							
Cold							
Dark							
Dirty							
Down							
dry							
Good							
Happy							
Heavy							
Hot							
Hungry							
Little							
Mine							
More							
nice							
Open							
Pretty							
Red							
Shut							
Stinky							
That							
This							
Tired							
Up							
Wet							
White							
Yellow							
Yucky							

HOUSEHOLD							
Bath							
bed							
Blanket							
Bottle							
Bowl							
Chair							
Clock							
Cot							
Cup							
Door							
Floor							
Fork							
Glass							
Knife							
Light							
Mirror							
Pillow							
Plate							
Potty							
Radio							
Room							
Rubbish							
Sink							
Soap							
Sofa							
Spoon							
Stairs							
Table							
Telephone							
Towel							
TV							
Window							

PEOPLE	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
Aunty							
Baby							
Boy							
Daddy							
Doctor							
Girl							
Grandma							
Grandpa							
Lady							
man							
mommy							
own name							
pet name							
uncle							
TV character							

BODY PARTS							
Arm							
Bum							
Chin							
Ear							
Elbow							
Eye							
Face							
Finger							
Foot							
Hair							
Hand							
Knee							
Leg							
Mouth							
Neck							
Nose							
Teeth							
Thumb							
Toe							
tummy							

OTHERS	*No*	*Yes, by speaking (clear articulation)*	*Yes, by speaking (unclear articulation*	*Yes, by a gesture/sign*	*Yes, by pointing to object/person*	*Yes, by pointing to a picture*	*Yes, by other means (please explain)*
A,B, C etc.							
Away							
Booboo							
Byebye							
Excuse me							
Here							
Hi/hello							
In							
Me							
Meow							
My							
Myself							
Nightnight							
No							
Off							
On							
Out							
Please							
Shut up							
Takalani							
(TV program)							
Thank you							
There							
Under							
Welcome							
What							
Where							
Why							
Woof							
Yes							
You							
Yumyum							
1, 2, 3 etc							

Please list any additional words your child uses:

_____

_____

_____

Does your child combine two or more words in a 'sentence'? Yes ☐ No ☐

If yes, please provide examples:

_____

_____

_____

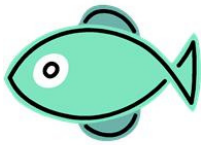
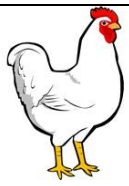
THANK YOU FOR YOUR TIME.

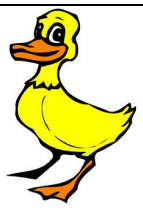
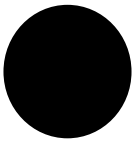
Appendix M

Eliciting Pictures, Target Words and Eliciting Phrases Selected to Administer the I-ASCC

Picture	Target word	Eliciting phrase
	Banana	What is this?
	Glue	What is this?
	Sandwich	What is this?
	Boots	What are these?
	Ball	What is this?
	Sharing	These people are drinking from one glass. They don't each have a drink – they are _____ a drink.

Picture	Target word	Eliciting phrase
	Boat	What is this?
	Blocks	What are these?
	Gloves	What are these?
	Swing	What is this?
	Helicopter	What is this?
	Shop	This lady is buying some things. She is buying things at the _____.

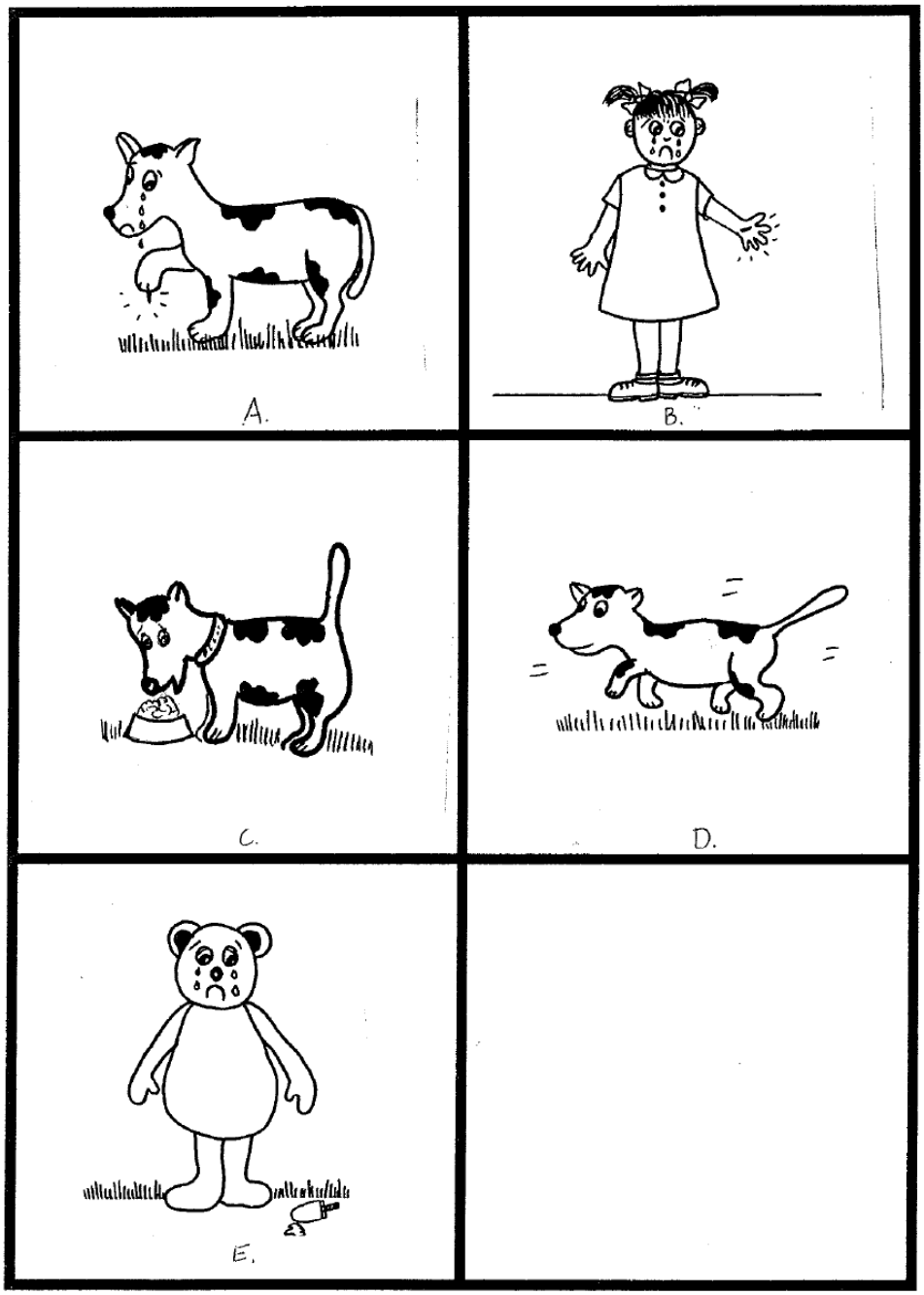
Picture	Target word	Eliciting phrase
	Apple	What is this?
	Fish	What is this?
	Doctor	This man is a _____
	Bread	What is this?
	Knee	This man has hurt his____ (Alternative – show own knee and say 'What is this?')
	Dad	This is a boy. This is his mom, and this is his _____
	Chicken	What is this?

Picture	Target word	Eliciting phrase
	Quack	This is a duck. What noise does she make?
	Underpants	What are these?
	Bird	What is this?
	Lightning	What is this?
	Watermelon	What is this?
	Black	What colour is this?
	Carrots	What are these?

Picture	Target word	Eliciting phrase
	Radio	What is this?
	Kick	What is this girl going to do with the ball? She will _____ the ball.
	Stones	What are these?
	Spilling	What happened to the milk? Someone has been _____ the milk.

Appendix N

Example of Material From the Test Used to Assess Comprehension of Target Semantic Relations



Appendix O

Matrices of the Three Semantic Relations

Agent-action

Vocabulary	**fall**	**laugh**	**cry**	**sleep**	**run**
the boy	The boy falls	The boy laughs	The boy cries	The boy sleeps	The boy runs
the dog	The dog falls	The dog laughs	The dog cries	The dog sleeps	The dog runs

Attribute-entity

Vocabulary	**shirt**	**pants**	**teddy**	**aeroplane**	**Car**
dirty	Dirty shirt	Dirty pants	Dirty teddy	Dirty aeroplane	Dirty car
broken	Broken shirt	Broken pants	Broken teddy	Broken aeroplane	Broken car

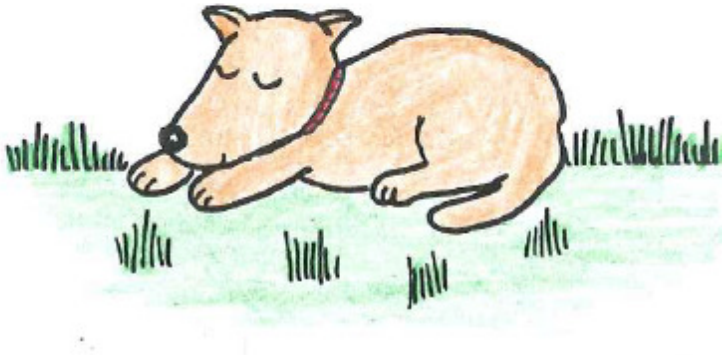
Possessor-possession

Vocabulary	**hand**	**hat**	**nose**	**tummy**	**shoe**
the girl	The girl's hand	The girl's hat	The girl's nose	The girl's tummy	The girl's shoe
the bunny	The bunny's hand	The bunny's hat	The bunny's nose	The bunny's tummy	The bunny's shoe

Note: Shaded cells indicate combinations targeted in intervention, and white cells combinations used to test generalization.

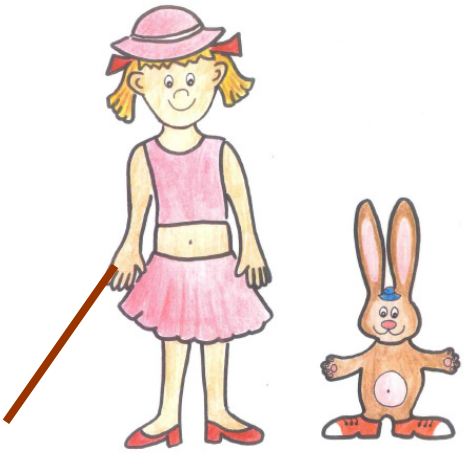
Appendix P

Examples of Picture Material Used to Conduct the Probe Test



Target combination: The dog sleeps

Target structure: Dirty car



Target structure: The girl's hand (the target aspect was pointed out using a stick)

Appendix Q

Communication Board

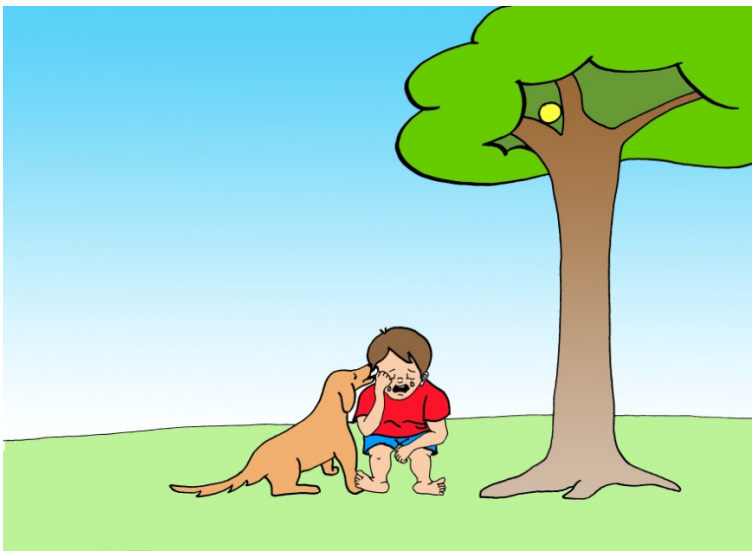
Appendix R

Stories

(Text in **bold** denotes intervention items.)

Story 1: Agent-action

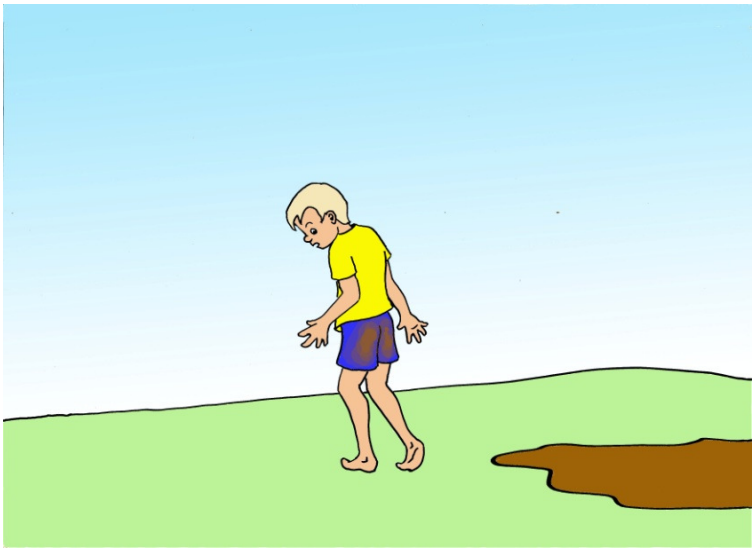
This is a dog. The **dog sleeps**. Here comes a boy. The boy has a ball. He wants to play. Come and play, dog. The boy throws the ball. **The dog runs**. He brings back the ball. The **boy laughs**. He likes playing with the dog. The boy throws the ball again. **The dog runs**. Oh no! The ball is stuck in the tree! The boy climbs up the tree. Oh no! The **boy falls**. He climbs up the tree again. Oh no! **The boy falls** again! Oh-oh! **The boy cries.** He can't get the ball! Here comes Daddy. Daddy sees that the **boy cries**. Sorry! Daddy is tall. He takes the ball down from the tree. Hooray! **The boy laughs**. He is so happy. The boy and the dog play in the garden for a long time. Then they are very tired. The boy goes inside the house. The dog lies down in the grass. Shshsh! **The dog sleeps**.



Example of an illustration

Story 2: Attribute-entity

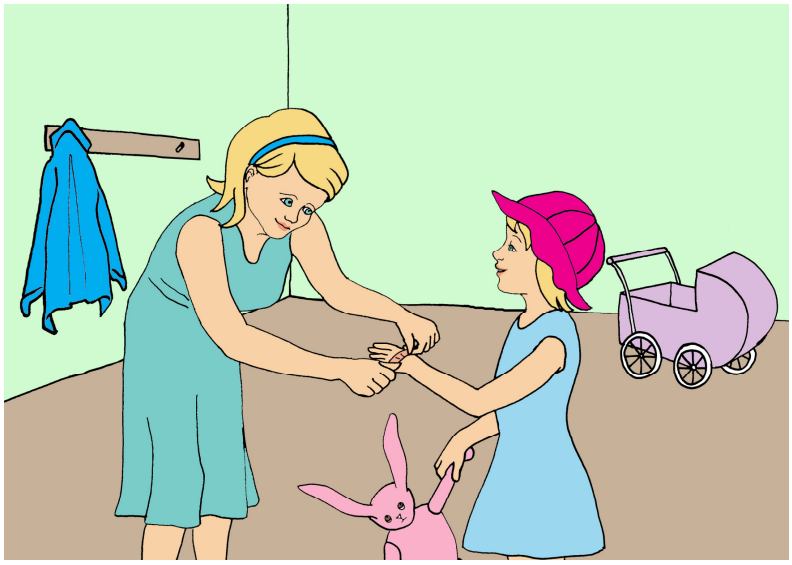
This is Bob. Bob is a boy. Bob is going to play. He takes his aeroplane and his car. He also takes his teddy. He goes outside. He jumps in a puddle. Oh-oh! **Dirty pants**! He jumps in the puddle again. **Dirty shirt**! Bob plays with his aeroplane and his car. He pushes them down the hill. Oh-oh! Crash! Boom! Where is the aeroplane? Where is the car? Bob runs down the hill. He finds the **broken aeroplane**. And there is the **broken car**. Where is teddy? He fell in the mud! Oh dear, **dirty teddy**! Bob is sad. He runs to mommy. Oh dear, says Mommy. We must get you and teddy clean. Bob gives mommy his **dirty shirt**. He gives her his **dirty pants** and he gives her the **dirty teddy**. Mommy puts them all in the washing machine. Here comes daddy. He takes the **broken car**. He takes the **broken aeroplane**. He mends them with glue. Oh, look, they are all fixed! And look, the shirt and the pants and the teddy are clean again. Bob is very happy.



Example of an illustration

Story 3: Possessor-possession

This is a girl. The girl has a bunny. There is t**he bunny's shoe**. The girl puts it on. There is t**he girl's hat**! The girl puts it on her head. She wants to go outside. Mommy puts suntan lotion on the **girl's nose**. The girl pushes the bunny in the pram. They are going into the garden. ZZZZZ! What's that? A big black fly comes buzzing. It lands on t**he girl's hat**. Go away fly! ZZZZ! The fly buzzes around. It lands on… **The bunny's shoe!** Go away! ZZZZZ. Oh-oh, where is the fly sitting now? On… t**he girl's nose**! Oh no! Go away, fly! The fly flies away. The girl and the bunny are eating ice cream. Oh dear, look, here comes a big nasty bee! She sits on… **the bunny's tummy**! The girl hits her with a blanket. Go away! ZZZZ… the bee buzzes around… Oh no, now the bee is sitting on… the **girl's hand**. Sting! The nasty bee has stung the girl! The girl screams. Ouch, that is so sore! Here comes mommy. She puts a plaster on **the girl's hand**. That feels a lot better! Bunny also wants a plaster. Mommy puts a plaster on **bunny's tummy**. Now the girl and the bunny are happy.



Example of an illustration

Appendix S

Score Sheet for Data Collection During the Probe Test

Probe test score sheet

Name: _____ **Date**: 3 June 2011

Session: _____

No	Semantic relation	Transcription	Response correct/incorrect
1	The dog laughs		
2	The boy laughs		
3	Broken aeroplane		
4	The bunny's tummy		
5	The bunny's hand		
6	Dirty shirt		
7	Dirty aeroplane		
8	The boy cries		
9	The dog runs		
10	The girl's hand		
11	Broken shirt		
12	Dirty pants		
13	The bunny's shoe		
14	The boy sleeps		
15	The girl's nose		
16	Broken pants		
17	The girl's hat		
18	The dog cries		
19	Dirty car		
20	The dog falls		
21	The bunny's hat		
22	Dirty teddy		
23	The boy runs		
24	The dog sleeps		
25	The bunny's nose		
26	The boy falls		
27	The girl's shoe		
28	Broken car		
29	Broken teddy		
30	The girl's tummy		

Appendix T

Procedural Integrity Checklist for the Probe Test

		One picture presented within view of the participant.	Experimenter ensures that the child's attention is focused on the picture.	Experimenter cues child with one general question/mand.	For possessor-possession pictures, experimenter points to the aspect of the picture that is being asked about using a stick.	The experimenter gives a time delay of 10 s after asking the question/giving the mand.	If the child attempts to point to a symbol within 10 s, the experimenter permits the child to complete the response.	If the child points to one symbol, the experimenter gives an additional 3 s to see if the child attempts to point to another symbol.	Response acknowledged in neutral way (e.g. *aha, mmm, I see, alright*) but no feedback on correctness of the response.	No correcting the child's response, providing a prompt or model.	Non-contingent encouraging feedback given after completion of item ('You're doing a good job.' 'You're working so hard.').	No physical, visual or auditory distractions.
1	The girl's shoe											
2	The bunny's hand											
3	Dirty teddy											
4	Dirty aeroplane											
5	The bunny's nose											
6	The boy laughs											
7	Broken shirt											
8	Dirty car											
9	The boy runs											
10	The dog cries											
11	The girl's hat											
12	Broken pants											
13	The dog runs											
14	The bunny's tummy											
15	The girl's nose											
16	Broken car											
17	The dog falls											
18	The bunny's shoe											
19	Dirty shirt											
20	The boy sleeps											
21	The girl's hand											
22	The boy cries											
23	The dog laughs											
24	Broken aeroplane											
25	Dirty pants											
26	The bunny's hat											
27	The dog sleeps											
28	The boy falls											
29	The girl's tummy											
30	Broken teddy											

General:

1. Experimenter seated at an angle in front of the participant and the communication board is on the table/laptray facing the participant:_____
2. Pictures are presented in random order: _____
3. Break provided after every 10 pictures: _____

Appendix U

Procedural Integrity Checklist for Intervention Procedures for Stories 1, 2 and 3

Procedural integrity: Story 1 (agent-action)

	Yes	No	Comments
Experimenter seated at an angle in front of the participant and the communication board is on the table/laptray facing the participant.			
Experimenter presents the story one picture at a time by positioning the picture within view of the participant			
Experimenter ensures that the participant's attention is focused on the story			
The experimenter reads the story, commenting and elaborating as needed.			

	No physical, auditory or visual distractions.	*Prompt 1: Experimenter draws attention to picture representing target combination (includes strategies such as verbal mand 'look!' and pointing to picture) followed by a pause up to 10 s.*	*Prompt 2: If no response, experimenter asks a general question or poses a general mand, followed by another up to 10 s pause.*	*Prompt 3: If no response, experimenter verbally requests participant to answer by using the communication board followed by another up to 10 s pause.*	*Prompt 4: If a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response to Prompts 1-4 is given, OR no response to Prompt 3, the experimenter models the correct sequence on the board while verbalizing, followed by a request to imitate, followed by another up to 10 s pause .*	*A partial or intelligible different modality response to Prompts 1-4 is affirmed before further steps are taken.*	*An incorrect response to Prompts 1-4 is negated and a 1 s pause time is given.*	*Prompt 5: If no response, a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response is given to Prompt 4, physical assistance is provided to help the participant point to the correct sequence of graphic symbols.*	*A correct response (including a self-corrected response) to Prompts 1-5 is affirmed and reinforced by an aided model (experimenter points to correct sequence on the board while verbalizing).*	*The experimenter provides a voice-over whenever the participant points to a symbol on the board.*
The dog sleeps										
The dog runs										
The boy laughs										
The dog runs										
The boy falls										
The boy falls										
The boy cries										
The boy cries										
The boy laughs										
The dog sleeps										

Procedural integrity: Story 2 (attribute-entity)

	Yes	No	Comments
Experimenter seated at an angle in front of the participant and the communication board is on the table/laptray facing the participant.			
Experimenter presents the story one picture at a time by positioning the picture within view of the participant			
Experimenter ensures that the participant's attention is focused on the story			
The experimenter reads the story, commenting and elaborating as needed..			

	No physical, auditory or visual distractions.	*Prompt 1: Experimenter draws attention to picture representing target combination (includes strategies such as verbal mand 'look!' and pointing to picture) followed by a pause up to 10 s.*	*Prompt 2: If no response, experimenter asks a general question or poses a general mand, followed by another up to 10 s pause.*	*Prompt 3: If no response, experimenter verbally requests participant to answer by using the communication board followed by another up to 10 s pause.*	*Prompt 4: If a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response to Prompts 1-4 is given, OR no response to Prompt 3, the experimenter models the correct sequence on the board while verbalizing, followed by a request to imitate, followed by another up to 10 s pause .*	*A partial or intelligible different modality response to Prompts 1-4 is affirmed before further steps are taken.*	*An incorrect response to Prompts 1-4 is negated and a 1 s pause time is given.*	*Prompt 5: If no response, a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response is given to Prompt 4, physical assistance is provided to help the participant point to the correct sequence of graphic symbols.*	*A correct response (including a self-corrected response) to Prompts 1-5 is affirmed and reinforced by an aided model (experimenter points to correct sequence on the board while verbalizing).*	*The experimenter provides a voice-over whenever the participant points to a symbol on the board.*
The bunny's shoe										
The girl's hat										
The girl's nose										
The girl's hat										
The bunny's shoe										
The girl's nose										
The bunny's tummy										
The girl's hand										
The girl's hand										
The bunny's tummy										

Procedural integrity: Story 3 (possessor-possession)

	Yes	No	Comments
Experimenter seated at an angle in front of the participant and the communication board is on the table/laptray facing the participant.			
Experimenter presents the story one picture at a time by positioning the picture within view of the participant			
Experimenter ensures that the participant's attention is focused on the story			
The experimenter reads the story, commenting and elaborating as needed.			

	No physical, auditory or visual distractions.	*Prompt 1: Experimenter draws attention to picture representing target combination (includes strategies such as verbal mand 'look!' and pointing to picture) followed by a pause up to 10 s.*	*Prompt 2: If no response, experimenter asks a general question or poses a general mand, followed by another up to 10 s pause.*	*Prompt 3: If no response, experimenter verbally requests participant to answer by using the communication board followed by another up to 10 s pause.*	*Prompt 4: If a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response to Prompts 1-4 is given, OR no response to Prompt 3, the experimenter models the correct sequence on the board while verbalizing, followed by a request to imitate, followed by another up to 10 s pause .*	*A partial or intelligible different modality response to Prompts 1-4 is affirmed before further steps are taken.*	*An incorrect response to Prompts 1-4 is negated and a 1 s pause time is given.*	*Prompt 5: If no response, a different modality/ unintelligible/partial/ incorrect (and not self-corrected) response is given to Prompt 4, physical assistance is provided to help the participant point to the correct sequence of graphic symbols.*	*A correct response (including a self-corrected response) to Prompts 1-5 is affirmed and reinforced by an aided model (experimenter points to correct sequence on the board while verbalizing).*	*The experimenter provides a voice-over whenever the participant points to a symbol on the board.*
Dirty pants										
Dirty shirt										
Broken aeroplane										
Broken car										
Dirty teddy										
Dirty shirt										
Dirty pants										
Dirty teddy										
Broken aeroplane										
Broken car										

Appendix V

Procedural Integrity of the Intervention

Participant	Phase	Number of sessions scored	% of sessions scored	% of steps adhered to as rated by independent observer
Participant 1	Intervention: A-E[1]	1	20%	98%
	Intervention: A-A[2]	2	22%	98%
	Intervention: P-P[3]	1	20%	100%
Participant 2	Intervention: A-A[2]	2	22%	100%
	Intervention: P-P[3]	2	29%	96%
	Intervention: A-E[1]	1	20%	100%
Participant 3	Intervention: P-P[3]	2	22%	98%
	Intervention: A-A[2]	1	20%	100%
	Intervention A-E[1]	2	22%	100%

[1]*Attribute-entity combination*
[2]*Agent-action combination*
[3] *Possessor-possession combination*

Appendix W

Procedural Integrity of the Probe Test

Participant	Phase	Number of sessions scored	% of sessions scored	% of steps adhered to as rated by independent observer
Participant 1	Baseline	1	33%	99%
	Intervention: A-E[1]	1	33%	100%
	Intervention: A-A[2]	1	20%	99%
	Intervention: P-P[3]	1	33%	100%
Participant 2	Baseline	1	33%	100%
	Intervention: A-A[2]	1	20%	100%
	Intervention: P-P[3]	1	25%	100%
	Intervention: A-E[1]	1	33%	100%
Participant 3	Baseline	1	33%	99%
	Intervention: P-P[3]	2	33%	100%
	Intervention: A-A[2]	1	20%	100%
	Intervention A-E[1]	1	20%	100%

[1] *Attribute-entity combination*
[2] *Agent-action combination*
[3] *Possessor-possession combination*

Appendix X

Reliability of Transcription and Data Collected Using the Probe Test

Participant	Phase	Number of sessions scored	% of sessions scored	Point-by-point agreement of transcription	Point-by-point agreement of coding
Participant 1	Baseline	1	33%	96%	100%
	Intervention: A-E[1]	1	33%	95%	100%
	Intervention: A-A[2]	1	20%	89%	100%
	Intervention: P-P[3]	1	33%	83%	97%
Participant 2	Baseline	1	33%	100%	100%
	Intervention: A-A[2]	1	20%	86%	100%
	Intervention: P-P[3]	1	25%	91%	100%
	Intervention: A-E[1]	1	33%	94%	100%
Participant 3	Baseline	1	33%	94%	100%
	Intervention: P-P[3]	2	33%	80%	100%
	Intervention: A-A[2]	1	20%	97%	100%
	Intervention A-E[1]	1	20%	83%	93%
Average		1	28%	91%	99%

[1] *Attribute-entity combination*
[2] *Agent-action combination*
[3] *Possessor-possession combination*

Appendix Y

Probe Test: Percentage of Items Correct, PND and IRD with Corresponding CI per Participant, per Phase

	Semantic relation (given in order in which intervention was applied to the semantic relation)		Percentage of items correct			PND		IRD (Baseline-intervention)	85% CI (Bootstrap).
			Baseline	Intervention	Post-intervention	Baseline-intervention	Baseline-post-intervention		
Participant 1	Intervention	AE	0	40%	68%	67%	100%	.67	[.33, 1.00]
		AA	7%	64%	80%	100%	100%	1.00	[1.00, 1.00]
		PP	7%	100%	-	100%	-	1.00	[1.00, 1.00]
		Overall	**6%**	**67%**	**71%**	**91%**	**100%**	**.91**	**[.82, 1.00]**
	Generalization	AE	0	40%	63%	100%	88%	1.00	[1.00, 1.00]
		AA	3%	68%	73%	100%	100%	1.00	[1.00, 1.00]
		PP	2%	93%	-	100%	-	1.00	[1.00, 1.00]
		Overall	**2%**	**67%**	**65%**	**100%**	**91%**	**1.00**	**[1.00, 1.00]**
Participant 2	Intervention	AA	0	8%	9%	20%	29%	.20	[.00, .40]
		PP	0	30%	0%	50%	0%	.50	[.25, .75]
		AE	0	67%	-	100%	-	1.00	[1.00, 1.00]
		Overall	**0**	**30%**	**6%**	**50%**	**30%**	**.50**	**[.33, .67]**
	Generalization	AA	0	16%	11%	60%	43%	.60	[.22, 1.00]
		PP	0	30%	0%	50%	0%	.50	[.25, .75]
		AE	0	60%	-	100%	-	1.00	[1.00, 1.00]
		Overall	**0**	**32%**	**8%**	**67%**	**30%**	**.67**	**[.50, .83]**
Participant 3	Intervention	PP	0	23%	8%	50%	25%	.50	[.17, .83]
		AA	0	40%	28%	67%	80%	.67	[.33, 1.00]
		AE	0	24%	_	40%	-	.40	[.00, .80]
		Overall	**0**	**27%**	**15%**	**50%**	**46%**	**.50**	**[.29, .71]**
	Generalization	PP	0	33%	10%	50%	13%	.50	[.17, .83]
		AA	0	20%	8%	67%	40%	.67	[.33, 1.00]
		AE	3%	24%	_	20%	-	.43	[.12, .80]
		Overall	**2%**	**27%**	**9%**	**43%**	**23%**	**.49**	**[.27, .70]**

Appendix Z

Percentage of Correct Responses per Level of Prompting During the Shared Storybook Reading Activity

		Levels of prompting				
Participant	**Semantic relation**	**Level 1: Drawing participant's attention verbally and pointing to the picture, followed by 10 s time delay**	**Level 2: Open-ended question, followed by 10 s time delay**	**Level 3: Request to use board, followed by 10 s time delay**	**Level 4: Complete aided model and invitation to imitate, followed by 10 s time delay**	**Level 5: Physical assistance to produce the combination, followed by an aided model by the researcher**
Participant 1	Attribute-entity	80.0%	0%	6.0%	12.0%	2.0%
	Agent-action	93.3%	1.1%	0%	5.6%	0%
	Possessor-possession	96.0%	0%	0%	4.0%	0%
	Overall	**90.5%**	**0.5%**	**1.6%**	**6.8%**	**0.5%**
Participant 2	Agent-action	37.8%	2.2%	3.3%	48.9%	7.8%
	Possessor-possession	38.6	0%	25.7	34.3%	1.4%
	Attribute-entity	56.0%	4.0%	0%	40.0%	0%
	Overall	**42.4**	**1.9%**	**10.0%**	**41.9**	**3.8%**
Participant 3	Possessor-possession	82.2%	2.2%	0%	15.5%	0%
	Agent-action	88.0%	4.0%	0%	8.0%	0%
	Attribute-entity	87.8%	1.1%	1.1%	7.8%	2.2%
	Overall	**85.7%**	**2.2%**	**0.4%**	**10.9%**	**0.9%**

Appendix AA

Analysis of Correct Responses Across Participants and Structures

			Attribute-entity	Agent-action	Possessor-possession	*Total*
Participant 1	**2 symbols**	**Same order**	37 (58%)	35 (59%)	22 (65%)	*94 (60%)*
		Reverse order	14 (22%)	10 (17%)	7 (21%)	*31 (20%)*
	More than 2 symbols		13 (20%)	14 (24%)	5 (15%)	*32 (20%)*
	Total		64 (100%)	59 (100%)	34 (100%)	157 (100%)
Participant 2	**2 symbols**	**Same order**	8 (42%)	7 (57%)	10 (83%)	*25 (57%)*
		Reverse order	10 (53%)	1 (8%)	0	*11 (25%)*
	More than 2 symbols		1 (5%)	5 (38%)	2 (17%)	*8 (18%)*
	Total		19 (100%)	13 (100%)	12 (100%)	44 (100%)
Participant 3	**2 symbols**	**Same order**	1 (7%)	5 (28%)	2 (8%)	*8 (14%)*
		Reverse order	5 (36%)	1 (6%)	20 (83%)	*26 (46%)*
	More than 2 symbols		8 (57%)	12 (66%)	2 (8%)	*22(39%)*
	Total		14 (100%)	18 (100%)	24 (100%)	56 (100%)

Appendix AB

Experimental Studies (Including the Current Study) Aimed at Increasing Utterance Length in Children with Limited Speech

Authors and date	Participants: Age and diagnosis	Design	Materials	Treatment	Measurement	Results	
						Effect	Efficiency
Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008: "Teaching Latino parents to support the multi-symbol message productions of their children who require AAC"	Three Latino children aged 2;11– 4;1 with severe congenital motor speech impairment ***Diagnoses:*** (1) profound phonological process disorder, (2) velocardiofacial syndrome and suspected childhood apraxia of speech (CAS); (3) subpalatal cleft ***Receptive language***: age-appropriate (average range) (TACL-3) ***Speech intelligibility***: IASCC (no context condition): 0-3% ***Expressive vocabulary***: At least 25 words/symbols (CDI) ***Motor skills***: No significant impairments reported ***Previous experience with aided AAC***: Two had none; one minimal ***Bookreading***: Regular experience	Single subject, multiple probe design across three participants	Per story, 30-35 coloured PCS symbols as well as illustrations from the book representing the main characters were used on one overlay on speech output devices (Mercury™ and MightyMo™) and on a communication board. Symbols were arranged according to the Fitzgerald key and the background of each symbol was colour-coded.	Caregivers were taught to use a 'Read, Ask, Answer' strategy during shared storybook reading, together with the provision of 2-symbol aided models on communication boards/SGD's.	Frequency of children's initiated and imitated multi-graphic symbol messages within a 10 min book reading activity.	The intervention was shown to be effective as evidenced by PND, level, level change, and trend across the three participants. Generalization to new stories, and maintenance post-intervention was established. PND was 100% for each the three phases and each of the three participants. Level change was immediate for two participants, and level between intervention and baseline differed considerably.	Participants reached criterion after 3, 11 and 6 sessions respectively.
Binger, Kent-Walsh, Ewing, & Taylor, 2010: "Teaching educational assistants to facilitate the multisymbol message productions of young students who require	Three children (two Latino and one Anglo) aged 4;6 – 6;4 with severe congenital motor speech impairment ***Diagnoses:*** (1) Developmental delay, (DD), (2) DD and CAS, (3) cerebral palsy ***Receptive language***: Profound delay, low average and average (TACL-3) ***Speech intelligibility***: IASCC (no context condition): 0-30% ***Expressive vocabulary***: At least 25 words/symbols (CDI)	Single subject, multiple probe design across three participants	Per story, 30-35 coloured PCS symbols as well as illustrations from the book representing the main characters were used on one overlay on speech output devices. Symbols were arranged according to the Fitzgerald key	Educational assistants were taught to use a 'Read, Ask, Answer, Prompt' strategy during shared storybook reading, together with the provision of 2-symbol aided	Frequency of children's initiated and imitated multi-graphic symbol messages within a 10 min book reading activity.	The intervention was shown to be effective as evidenced by PND, level, level change, and trend across the three participants. Generalization to new stories, and maintenance post-intervention was established. PND was 100% for two participants and 80% for the other one.	Participants reached criterion after 3, 5 and 6 sessions respectively.

Authors and date	Participants: Age and diagnosis	Design	Materials	Treatment	Measurement	Results	
						Effect	Efficiency
augmentative and alternative communication ”	***Motor skills***: One had hemiplegia ***Previous experience with aided AAC***: all ***Bookreading***: Regular experience		and the background of each symbol was colour-coded.	models on communication boards.		Level change was immediate for two participants, and level between intervention and baseline differed considerably.	
Nigam, Schlosser & Lloyd, 2006: “Concomitant use of the matrix strategy and the mand-model procedure in teaching graphic symbol combinations”	Three children with LNFS aged 7;8 to 13;6. ***Diagnoses***: (1) autism and intellectual impairment, (2) intellectual and physical impairment, (3) autism ***Receptive language***: No formal scores, understood simple commands, yes/no questions and wh-type questions ***Speech intelligibility***: Not described ***Expressive language***: According to parent report, participants frequently used 15-45 PCS symbols, one also used 5 manual signs ***Motor skills***: One participant with significant impairments (no independent mobility) ***Previous experience with aided AAC***: All	Multiple probe design across four sets of action-object combinations	Twelve black-and-white PCS on a communication board, arranged according to semantic role.	Matrix structure of 12 target items and 24 generalization items (action-object combinations) was used. The researcher manipulated objects and attempted to elicit the target combination by a mand-model procedure. A communication board with 12 items was used.	Target and generalization action-object combinations produced by pointing to the correct symbol sequence on the communication board	Two of the three participants showed a clear effect of the intervention as evidenced by PND, level and trend across the four sets of combinations targeted. Immediate level change was only observed for sets three and four of the first participant. The two participants demonstrated generalization to 67 and 58% of the untrained exemplars from the matrix. One participant did not show progress, and intervention was abandoned after 13 sessions.	Participant 1: From the graph, it seems that criterion was reached after 16, 16, 9 and 9 sessions for the four sets respectively. Participant 2: From the graph, it seems that criterion was reached after 20, 16, 13 and 11 sessions for the four sets respectively.
Current study	Three children with limited speech and physical impairments aged 7;9 – 10;8 ***Diagnoses***: Cerebral palsy (spastic quadriplegia), spastic quadriplegia following near-drowning ***Receptive language (ESL)***: age equivalent 2;11-4;0 (CELF); 2;6-5;0	Multiple probe design across three different types of semantic combinations	21 PCS and hand-drawn symbols on a communication board. Symbols were arranged according to the Fitzgerald key and the background of each symbol was	Matrix structure of 15 target items and 15 generalization items was used (5 of each for each type of combination)	Target and generalization items produced by pointing to at least both target graphic symbols in any order on the	Intervention effect shown for one participant, with two participants displaying low or questionable effect based on IRD, PND, trend, level and level change. Generalization occurred in	Due to setting a teaching criterion of 9 sessions, this is difficult to determine. Learning criterion reached by Participant 1 after

Authors and date	Participants: Age and diagnosis	Design	Materials	Treatment	Measurement	Results	
						Effect	Efficiency
	(PPVT) , borderline to profound delay ***Speech intelligibility***: I-ASCC(no context condition): 0-13% ***Expressive language***: 158-189 concepts (adapted LDS) ***Motor skills***: Two with significant impairments (wheelchair-bound), one of which without independent mobility. One with moderate impairment ***Previous experience with aided AAC***: Two with limited exposure, one with no exposure.		colour-coded.	was used. Researcher taught the target combinations during the joint reading of three stories. Communication board with 21 items was used.	communication board provided in response to a picture and question/mand.	correspondence to the intervention effect. Post-intervention maintenance was measured on two of the three semantic relations targeted and demonstrated for the participant who also showed a clear effect of the intervention.	3, 9, and 3 sessions; by Participant 2 after 7 and 3 sessions (not reached on the first semantic relation); by Participant 3 after 3 sessions (not reached on first and last semantic relation).

Note. TACL-3 = Test of Auditory Comprehension of Language (3rd edition); CDI = MacArthur Communicative Development Inventory