The effect of augmentative and alternative communication on the receptive language skills of children with developmental disabilities: A scoping review

by

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ABSTRACT

Receptive language skills form the foundation for later expressive use and therefore play an important role in language development. The role of receptive language skills in the field of augmentative and alternative communication (AAC) has received limited attention as, historically, the function of AAC has been to enhance the expressive language skills of persons who rely on AAC. While this is an important role and the primary outcome of AAC intervention, the role of AAC intervention on receptive language skills is equally important. The ability of persons who rely on AAC to understand spoken language ranges from age equivalent comprehension to minimal comprehension. AAC interventions that improve comprehension include a variety of strategies, but a synthesis of the effects of these strategies has not occurred. The aim of this scoping review was, therefore, to map and synthesise the research evidence on the effects of AAC interventions on receptive language skills of children with developmental disabilities. A four-pronged search strategy was used to identify studies that met the inclusion criteria. Twenty-three studies were included in the scoping review. The studies were described in terms of number of publications, participant characteristics, research design, AAC interventions, intervention outcomes, intervention effects, and quality appraisal. Furthermore, the studies were described in terms of three groups of effects: (i) the effect of aided AAC interventions, (ii) the effect of unaided AAC interventions, and (iii) a comparison of two types of AAC interventions. The trends and gaps in the literature are highlighted in terms of the use of AAC interventions and the receptive language skills addressed. Directions for future research are posited. Valuable preliminary evidence regarding the effects of AAC interventions on receptive language skills of children with developmental disabilities was obtained in the scoping review.

Keywords: AAC, augmented input, developmental disabilities, effects, interventions, receptive language skills.

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LIST OF ABBREVIATIONS

AAC	Augmentative and alternative communication
ALgS	Aided Language Stimulation
ASD	Autism spectrum disorder
BD	Behavioural disorder
CA	Chronological age
CP	Cerebral palsy
DS	Down syndrome
HL	Hearing loss
ID	Intellectual disability
IOA	Inter-observer agreement
MR	Mental retardation
PDD	Pervasive developmental disorder
SAL	System for Augmenting Language
SGD	Speech-generating device
TC	Total communication
TI	Treatment integrity
VI	Visual impairment
VOCA	Voice output communication aid

1. PROBLEM STATEMENT AND LITERATURE REVIEW

Many children with developmental disabilities, for example, those with Down syndrome, autism spectrum disorders, pervasive developmental disorders, and cerebral palsy, present with a delay or deficits in language and communication skills as a core characteristic of the disability (Ganz et al., 2012; Romski & Sevcik, 1997; Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015; Sevcik, 2006; Weitz, Dexter, & Moore, 1997). Augmentative and alternative communication (AAC) offers a means of communication for persons with developmental disabilities who have limited or no functional speech (Beukelman & Mirenda, 2013). With the use of AAC, the temporary or permanent impairments, activity limitations and participation restrictions of persons with disorders of speech-language production and/or comprehension are compensated for as necessary (ASHA, 2005; Beukelman & Mirenda, 2013). AAC can therefore serve as an alternative and augmentative mode of communication that could either substitute ("alternative") or supplement ("augmentative") language in order to support communication and language development (Sevcik, 2006). Over the past 30 years, there has been an increase in the number of persons with significant communication disabilities who require AAC (Light & McNaughton, 2012). This is due to several factors, including an increase in the incidence of disorders such as autism. Additionally, with advances in medical intervention, there are now increased survival rates for pre-term babies who may develop developmental disabilities or have acquired disabilities. This has resulted in an increase in the number of children who may require AAC permanently or temporarily. The benefits of AAC have been obtained with infants and toddlers, as well as older beginning communicators (Light & McNaughton, 2012).

The acquisition of an AAC system is a complex process and poses a considerable challenge for children who rely on AAC (Dada & Alant, 2009; Light, 1997). One such challenge is that children who require AAC are exposed to spoken language input (oral modality); however, they are required to develop an expressive language system in a different modality (visual modality) (Light, 1997; Smith, 2015; Sutton, Soto & Blockberger, 2002). This results in an "input-output asymmetry" (Light, 1997; Sennott, Light, & McNaughton, 2016). In addition, the acquisition of AAC systems is further complicated by the fact that children who rely on AAC rarely observe adults modelling the use of their expressive communication system

(Blockberger & Sutton, 2003; Sennott, et al., 2016; von Tetzchner & Grove, 2003; von Tetzchner, 2015). This may be attributed to the input modality being auditory (speech) with limited modelling or use of the visual modality. Furthermore, children who rely on AAC may have limited means of testing their hypotheses regarding the meaning of words as they have difficulty producing the word (Dada & Alant, 2009; Light, 1997). Hence, the learning of aided communication occurs relatively late, with limited role models and rare interaction with persons who rely on AAC who are experts in the use of their AAC system (Smith, 2015; von Tetzchner, 2015; von Tetzchner & Grove, 2003).

Communication partners interacting with persons who rely on AAC may have difficulty ascertaining the appropriate level of language input due to difficulties in estimating the children's comprehension skills (Light, 1997). This may result in communication partners either overestimating or underestimating the comprehension skills of the child who relies on AAC. When receptive language skills are overestimated, the child may have difficulty understanding the language used around them. On the other hand, when receptive language is underestimated, the learning of a new language form and content will be restricted due to a less-than-optimal language code and model (Dada & Alant, 2009; Light, 1997; von Tetzchner & Grove, 2003).

Receptive language skills in persons that use AAC

In order to develop functional communication skills, young children who rely on AAC must be able to comprehend and express language so that they can take on the role of both listener and speaker (Romski & Sevcik, 1993; Romski et al., 2010; Sevcik, 2006). Historically, AAC intervention for children with developmental disabilities has been to provide an expressive mode of communicating in order to express basic wants and needs, to transfer information, to establish social closeness and to conform to social conventions of politeness (Beukelman & Mirenda, 2013; Light, 1997; Romski & Sevcik, 1993; Wood, Lasker, Siegel-Causey, Beukelman, & Ball, 1998). AAC interventions addressing the expressive abilities of children who rely on AAC have been addressed extensively in the literature (e.g. Binger & Light, 2007; Costantino & Bonati, 2014; Drager, Postal, Castellano, Gagliano, & Glyn 2006; Millar, Light, & Schlosser, 2006; Schlosser & Koul, 2015; Schlosser & Wendt, 2008; Still, Rehfeldt, Whelan, May, & Dymond, 2014). However, there has been a paucity

of research that has focused on AAC intervention that aimed to improve receptive language skills (Dada & Alant, 2009; Light, 1997; Romski & Sevcik, 1993; Schlosser et al., 2013; Sevcik, 2006). For children who require AAC, there are two routes to understanding a spoken message. The child may either understand through the comprehension of speech or alternatively through the comprehension of the AAC symbols (Dada & Alant, 2009; Romski & Sevcik, 1993). A third route could be comprehension of both speech and AAC symbols.

Comprehension of speech

The ability of the person who relies on AAC to use speech comprehension as a foundation for acquiring an AAC system is influenced by the ability to establish arbitrary relationships between words, objects and events (Dada & Alant, 2009; Romski & Sevcik, 1993) and by the ability to transfer such information across modes; from an auditory to a visual mode (Romski & Sevcik, 1993; Sevcik, Romski, & Wilkinson, 1991). If such relationships can be established, extant receptive language skills can function as a foundation on which the AAC symbol and referent relationship can be established (Romski & Sevcik, 1993). However, if the person who relies on AAC has poor spoken receptive language abilities, the relationship must be established almost exclusively on contextual cues in the environment (Dada & Alant, 2009; Romski & Sevcik, 1993; Romski, Sevcik & Pate, 1988).

Symbol comprehension

Some persons who rely on AAC may not comprehend speech. For these individuals, AAC symbol comprehension is a skill that can develop as part of the AAC acquisition process itself (Romski & Sevcik, 1993). A symbol is considered to be “something that stands for or represents another thing or concept” (Alant, Bornman & Lloyd, 2006, p. 145). Symbols include three-dimensional objects, pictures with a high resemblance to their referents, line drawings (coloured, and black and white), and abstract forms such as Blissymbols, lexigrams and printed words (Stephenson, 2009).

Children acquiring AAC need to determine how words and meanings of their internal lexicon relate to the external lexicon or symbols (Smith, 2015). Little is known about how children who rely on AAC come to know the vocabulary in their systems. The link between internal and external lexicons remains unclear until

literacy skills are developed. This has led to a research focus on iconicity (Smith, 2015). Iconicity is one of the factors that will influence the ability to recognise a relationship between a symbol and its referent, as it is the perceived relationship between a symbol and its referent. Using a psycholinguistic understanding of the term, iconicity refers to any type of association, not only visual, between a symbol and its referent (Dada, Huguet & Bornman, 2013; Schlosser & Sigafoos, 2002). Iconicity exists on a continuum from transparent to opaque symbols (Dada, et al., 2013; Lloyd & Blischak, 1992; Lloyd & Fuller, 1990; Stephenson, 2009). With transparent symbols, the visual aspects resemble the referent and therefore the meanings are easily guessable without the provision of additional cues (Dada, et al., 2013; Fuller & Lloyd, 1991; Mineo Mollica, 2003; Stephenson, 2009). A symbol, however, is considered opaque when it is not iconic, as there is no relationship between the referent and symbol (Dada et al., 2013; Fuller & Lloyd, 1991; Smith, 2006). Translucency describes a relationship between the symbol and referent that is not easily guessable, but once the referent is known, the relationship can be perceived. The relationship may be semantic, conceptual or linguistic (Dada et al., 2013). The iconicity hypothesis suggests that symbols which bear a greater resemblance to their referents will be easier to learn and recognise compared to more abstract symbols (Smith, 2015; Stephenson, 2007, 2009). Once a symbol and referent are realised to be related in some way, a representational insight is thought to be achieved (Mineo Mollica, 2003; Stephenson, 2007). This is evidence of a perception of relationship and does not imply the ability to use the symbol in a fully symbolic way for a range of communicative functions (Mineo Mollica, 2003; Stephenson, 2007).

Wood and her colleagues devised a framework that emphasised augmenting input for children and adults who may rely on AAC; the “AAC Input Framework” (AACIF) (Wood et al., 1998). The AACIF assists with the synthesis of input strategies for persons who rely on AAC. It includes four components: (i) augmenting the message, (ii) mapping language and symbols, (iii) augmenting retention, and (iv) developing a pool of response options, all of which concern the input that the person who relies on AAC receives in order to enhance communication (Wood et al., 1998). In order to understand or use an AAC symbol, the person who relies on AAC will need to map the symbol to its referent. Input would need to be provided to assist in the building of connections between objects, gestures or signs and their referents or

spoken words (Wood et al., 1998). It is the scaffolding strategies of those in the environment, through the use of joint activities whereby the functions of symbols are discovered, that make it possible for persons who rely on AAC, who do not acquire language through the use of spoken language, to learn language (von Tetzchner & Grove, 2003). Teaching AAC symbols to persons who rely on AAC may be done using a variety of strategies. One strategy to facilitate teaching symbols is referred to as augmented input (Dada & Alant, 2009; Light, 1997).

Augmented input

Augmented input refers to using an aided or unaided AAC system to augment the incoming language or communication so that the visual modality augments, rather than replaces, speech (Dada & Alant, 2009). The spoken message is augmented by either aided or unaided AAC systems, with objects, pictures, photographs, gestures and/or voice output technology (Dada & Alant, 2009; Jones & Bailey-Orr, 2012; Romski & Sevcik, 1993; Romski & Sevcik, 2003). The benefits of augmented input include the communication partner modelling AAC (Sennott et al., 2016), as well as providing the person who relies on AAC exposure to a mature model of communication using their AAC system. In addition, the symmetry between language input and output for persons who rely on AAC is improved (Binger & Light, 2007; Sennott et al., 2016).

Unaided augmented input

Augmented input may be provided using unaided AAC systems. Unaided AAC systems do not require systems external to the body. The individual's own body is used as the mode of communication (Mirenda, 2003). The idea of supplementing spoken input with unaided systems has existed since the 1960s, when manual signing first began to be studied (Schlosser et al., 2013). Examples of unaided AAC systems include eye gaze, pointing, gestures, leading the communication partner's hand to an object, conventional body language, finger spelling, and manual signing (van der Meer et al., 2012).

Total communication is the simultaneous use of speech and gestures (Kennedy, 1994). Traditionally, it was used in deaf education but has also been used extensively with persons with disabilities, despite the fact that they may be capable of acquiring spoken language (Kennedy, 1994). Sign systems have been shown to

support the development of basic communicative skills and complex language functions (Bednarski, 2016; Grove, 1980). Total communication has been found to result in faster and more complete acquisition of receptive and/or expressive vocabulary than speech alone (Mirenda, 2003). The body of literature relating to total communication, in general, has limitations, such as few participants, infrequent use of controls and inconsistencies in methodology (Kennedy, 1994). In addition, results are difficult to interpret due to a lack of clear definitions of terms and incomplete descriptions of participants (Kennedy, 1994).

Makaton is a language programme that includes various modes of communication as it comprises three principles: sign, symbol and speech. It was designed to encourage functional communication and interactive behaviour in persons with communication and language difficulties (Mistry & Barnes, 2013; Walker, 1987). Key words are signed in spoken word order and accompanied by normal grammatical speech (Walker, 1987). Contrary to sign language, Makaton does not have syntax, morphology and phonology. The stripping of linguistic information could be the reason for such sign systems to be easier to acquire by individuals with intellectual disabilities. The vocabulary is believed to work as a facilitator of language rather than a language itself (Bednarski, 2016). Makaton views speech, signs and symbols to be complementary rather than alternatives to one another (Walker, 1987). From an early age, the use of gestures and non-verbal communication is evident and is clearly a natural process (Mistry & Barnes, 2013). The use of signing, which is only one element of Makaton, provides a means of communication before spoken language has developed (Mistry & Barnes, 2013). Makaton has been found to benefit communication with disabled children and adults (Bednarski, 2016). However, most of the literature focuses on the development of expressive language (Bednarski, 2016; Mistry & Barnes, 2013). Therefore, further research on the receptive language benefits of sign systems would be beneficial.

Makaton has been critiqued for a variety of reasons, including the questioning of the methodology of sign selection and usage, and that communication skill development could be impeded in some children due to the highly restricted teaching method and vocabulary structure (Sheehy & Duffy, 2009).

Comparative studies involving unaided augmented input indicate that simultaneous communication (the simultaneous use of speech and signing (Marmor

& Petitto, 1979; Remington & Clarke, 1983; Wilbur & Petersen, 1998) tends to be more efficient than signing alone in expressive signing, and that simultaneous communication yields more receptive speech gains than oral instruction alone. The effects of simultaneous communication on receptive speech may, however, vary depending on the characteristics of the child (Schlosser & Sigafoos, 2006).

Aided augmented input

Aided augmented input strategies intend to teach language to persons who use AAC in a natural way, as they are based on the way natural speakers learn to understand language (Dada & Alant, 2009). Communication partners use the AAC system as a naturalistic communication interaction; a "dynamic process between two people which is highly interactive, bi-directional and multi-modal" (Kraat, 1985, p. 21 in Sennott et al., 2016). The aided augmented input strategies share the principle of providing aided augmented input using photographs, line drawings, objects, graphic symbols and/or abstract symbols simultaneously with ongoing spoken language.

A number of aided augmented input strategies have been proposed that refer to interactive modelling of an AAC system by the communication partner (Sennott et al., 2016). These include Aided Language Stimulation (ALgS; Goosens', 1989), System for Augmenting Language (SAL; Romski & Sevcik, 1996), Natural Aided Language (Cafiero, 2001), aided language modelling (Drager et al., 2006) and aided AAC modelling (Binger & Light, 2007). Sennott et al. (2016) conducted a systematic review on the effects of interventions, including the modelling of aided AAC by communication partners on the language acquisition of individuals with complex communication needs. In their systematic review, augmented input strategies were found to produce large and clinically relevant effects on the beginning language skills of children who use AAC, including increased communication turns, the gaining of vocabulary knowledge, the communication of increased multi-symbol utterances, and the demonstration of knowledge of early morphological forms.

Aided language stimulation involves the communication partner selecting a symbol on the child's communication board with verbal stimuli, so that ongoing language stimulation is provided (Dada & Alant, 2009; Drager et al., 2006; Goosens', 1989; Harris & Reichle, 2004). The basic assumption regarding aided language stimulation is that this is an input strategy with the aim of increasing receptive

language abilities and should be provided according to certain criteria that are not based on empirical investigation but rather the author's clinical experience (Dada & Alant, 2009). This includes using more comments than questions and therefore providing more input. Output or expression from the child is not emphasised. Studies on the effect of this technique are limited, mainly because of limited studies, including case studies and single-subject designs (Binger & Light, 2007; Dada & Alant, 2009; Harris & Reichle, 2004).

The SAL is an augmented input technique that utilises a speech-generating device (SGD). According to Romski and Sevcik (1996), the SAL encompasses five components: a speech communication output device, vocabulary items, naturalistic communication exchanges, and the provision of feedback and resources. Natural situations are important as they encourage rather than require use of symbols in daily activities (Drager et al., 2006; Harris & Reichle, 2004; Romski & Sevcik, 1996). The speech output provides a link to the natural auditory world (Romski & Sevcik, 1997). The provision of speech output with visual graphic symbols has been found to result in more efficient learning with fewer errors compared to when graphic symbols are used alone, highlighting how speech technology plays a critical role in augmented receptive language learning (Brady, 2000; Romski & Sevcik, 1997; Romski et al., 2010; Schlosser, Belfiore, Nigam, Blischak, & Hetzroni, 1995). The SAL differs from aided language stimulation, firstly, due to the use of an SGD and secondly, because the techniques are simpler than the procedures used in aided language stimulation (Dada & Alant, 2009).

Natural aided language merges aided language input with naturalistic learning. In natural aided language, multiple communication boards, with vocabulary for specific activities, are placed around a room. The interventionist serves as a natural model in the child's environment, thereby using the visual language system in a reinforcing environment. This approach has resulted in improved expressive and receptive language (Dada & Alant, 2009; Drager et al., 2006).

Similarly, aided language modelling is a modelling intervention based on the commonalities of the previously mentioned strategies (Drager et al., 2006). It involves engaging the child in interactive play activities. Referents in the environment are pointed to, followed by the graphic symbol, while the referent is named (Dada & Alant, 2009; Drager et al., 2006). Aided language modelling has been found to increase comprehension with some children with autism, and has resulted in the

acquisition of new vocabulary (Drager et al., 2006).

Aided AAC modelling is a strategy that involves any models of symbols and/or combinations of symbols through AAC use, with the goal that the child produces them (Dada & Alant, 2009; Romski et al., 2010). It involves using natural speech while key graphic symbols on the AAC device are pointed to and labelled (Binger & Light, 2007).

While many studies support the use of aided augmented input, variation in terms of the reporting of the frequency of augmented input has been noted (Dada & Alant, 2009). For example, some studies have reported a positive effect with only four exposures per session (e.g. Drager et al., 2006; Harris & Reichle, 2004), while others utilised 30 exposures (e.g. Binger & Light, 2007). In addition, the measures used to determine the effect of the intervention strategy ranged from probes involving matching a line drawing to an object and a spoken label to an object (e.g. Drager et al., 2006; Harris & Reichle, 2004), to probes that involved matching line drawings and spoken labels to graphic symbols (e.g. Binger & Light, 2007). The latter could be argued as recognition of perceptual similarities or the teaching and probing of stimuli rather than comprehension of the concepts (Dada & Alant, 2009).

The systematic review by Sennott et al. (2016) which investigated the impact of aided AAC modelling-based interventions (where the communication partner models aided AAC as they speak, while engaging in naturalistic communication interaction) on language acquisition found positive and main effects for pragmatics, semantic, syntactic and morphological development for young children who are beginning communicators. When focusing on semantic development in particular, the evidence presented in the systematic review demonstrates that AAC modelling-based interventions impact vocabulary knowledge for small sets of target vocabulary words. Across the four studies which addressed semantics, vocabulary knowledge increased steadily from baseline to intervention (Sennott et al., 2016). These studies provide evidence that the provision of appropriate models of the use of AAC within naturalistic contexts, together with various interactions techniques, for children who rely on AAC, results in observable gains in both expressive and receptive language. This makes a strong argument for using AAC modelling as a foundation of AAC intervention. Limitations of the systematic review were, however, mentioned, including; a gap in the disability groups represented as the population of children with complex communication needs is diverse; and non-responders most likely not

being represented in the literature, limiting the understanding of profile of non-responders to treatment (Sennott et al., 2016).

Future research across pragmatic, semantic, syntactic and morphological domains is needed, according to Sennott et al. (2016). For example, research is needed to determine how AAC modelling-based interventions would work to affect skills in the semantic domain beyond the positive findings represented in the review describing increases in vocabulary knowledge for small sets of target vocabulary words.

Speech output technology

Speech output technology is an additional AAC intervention route that can be used to facilitate comprehension of an AAC system (Romski & Sevcik, 1993). It is a component of AAC input using speech output, whether digital or synthetic, that can accompany AAC symbol use when an electronic device is used (Romski & Sevcik, 1993). Speech output technology can be produced by the following devices; SGDs, (also known as voice output communication aids, VOCAs), talking word processors and apps for handheld multipurpose electronic devices (e.g. iPad, iPod, computer tablets) (Schlosser & Koul, 2015). Given the mobile technology revolution in the AAC field (Light & McNaughton, 2013; Shane et al., 2012), the use of mobile technologies is becoming a trend and is reported in several recent studies (Schlosser & Koul, 2015). Studies have shown that the use of a speech output communication device may assist in the development of receptive and expressive language skills (Huntress, Lee, Creaghead, Wheeler & Braverman,1990; Romski & Sevcik, 1992; Sevcik & Romski, 1993). This may be due to the consistency of the synthetic speech output, allowing for easier segmentation of the speech stream (Romski & Sevcik, 1993). However, Reynolds and Jefferson (1999) have found the understanding of synthetic speech to be poorer than natural speech in children. They argue that the impoverished acoustic-phonetic signals adversely affected the information processing systems of both younger and older children. The younger the child is when first using an AAC device with synthetic speech, the easier the cognitive system will start efficiently processing the acoustic-phonetic structure of the speech (Reynolds & Jefferson, 1999). Interestingly, most studies and reviews focus on the use of speech output technology as a means of facilitating the AAC user's expressive language (e.g. Higginbotham, Scally, Lundy, & Kowarsky, 1995;

Schlosser & Koul, 2015).

Based on the literature reviewed, a variety of intervention techniques exist that aim to facilitate the receptive language skills of persons who rely on AAC, including unaided and aided augmented input. However, the effect of AAC interventions on receptive language has received limited attention (Romski & Sevcik, 1993; Sevcik, 2006).

Over the past two decades, there has been a growing emphasis on using the best available evidence upon which to base healthcare decisions (Evans, 2003; Schlosser & Raghavendra, 2004). Evidence-based practice requires that decisions be made based on a body of evidence rather than just a single study (Elamin & Montori, 2012). Scoping reviews are becoming a popular approach to reviewing health research studies (Levac, Colquhoun & O'Brien, 2010) in order to guide the decision-making process based on the best available evidence. The existing quantity of studies on AAC interventions should be integrated with a systematic method in order for conclusions to be made, based on research-evidence regarding the effects of AAC interventions on the receptive language skills of children with developmental disabilities. Thus, the purpose of this scoping review is to synthesise the research evidence on the effects of AAC interventions on receptive language skills in children with developmental disabilities.

2. METHODOLOGY

2.1 Aims

2.1.1 Main aim

The main aim of this scoping review is to map the research evidence to date regarding the effects of AAC interventions on the receptive language skills of children with developmental disabilities. The intent is to identify the trends and gaps in the existing literature.

2.1.2 Sub-aims

The sub-aims of the study are:

i. To describe the research trends in terms of the AAC interventions that focus on receptive language skills;
ii. To describe the effect of the AAC interventions on the receptive language skills of children with developmental disabilities;
iii. To identify gaps in the literature and posit directions for future research.

2.2 Research design and phases

A scoping review was conducted in order to address the research aims. Increasingly, scoping reviews are becoming a popular approach when reviewing evidence in health research (Daudt, van Mossel, & Scott, 2013; Levac et al., 2010). They may be particularly relevant in fields with emerging evidence, where a lack of randomised controlled trials makes it difficult to conduct a systematic review (Levac et al., 2010). Scoping reviews “aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available, and can be undertaken as stand-alone projects in their own right, especially where an area is complex or has not been reviewed comprehensively before” (Mays, Roberts, & Popay, 2001, p. 194 in Arksey & O’Malley, 2005). While scoping reviews share many characteristics with systematic reviews, there are some differences. For example, in scoping reviews, less focused research questions are used. Scoping reviews address broader topics. In addition, a quantitative synthesis or statistical aggregation of effect sizes is optional but not required (Arksey & O’Malley, 2005; Schlosser & Koul, 2015). A major goal of a scoping review is to identify research gaps so that further research directions can be stimulated. This scoping review aimed to

summarise and disseminate research findings regarding the effects of AAC intervention on receptive language skills of children with developmental disabilities. This scoping review was guided by the framework developed by Arksey and O'Malley. The research phases are summarised in Table 1. This scoping review was structured and reported on following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement, which allows for transparent and complete reporting of a review by following a reporting guideline (Hutton et al., 2015; Moher, Liberati, Tetzlaff & Altman, 2009).

Table 1

Overview of Arksey and O'Malley's methodological framework

	Framework stage (Research phase)	**Description**
1.	Identifying the research question	The research aim and sub-aims were used to guide the scope of enquiry. This indicated the concept, target population and outcomes to clarify the focus of the scoping review and to establish an effective search strategy. The rationale for why such a review should be conducted was considered.
2.	Identifying relevant studies	This included experts in the field of AAC as well as information specialists knowledgeable in search strategies.
3.	Study selection	Decisions regarding inclusion and exclusion criteria were made at the beginning of the process. Reviewers discussed these criteria at the beginning, mid-point and final stages of the title, abstract and full text review process in order to refine the criteria. Two researchers independently reviewed title and abstracts of studies, as well as the full texts of the articles for inclusion. Conflicts were resolved by discussing rationales until a consensus could be made. A third reviewer was not needed to resolve disagreements.
4.	Charting the data	A data extraction form was developed to determine which variables to extract so that the research aim could be addressed. This was an iterative process whereby the form was continually updated.
5.	Collating, summarising and reporting results	This stage included three distinct steps: 1. Analysis, including descriptive numerical summary analysis and qualitative thematic analysis 2. Reporting of the results 3. Considering the meaning of the results with regards to the aim of the study. Implications for future research were also discussed.
6.	Consultation	This may be conducted at a later stage.

2.3 Ethical issues

As scoping reviews identify, appraise and synthesise relevant studies, human participants are not directly involved. Therefore, the research ethics that are applicable to human subjects do not apply to this study. However, as per requirement of the University of Pretoria, ethical clearance for this study was

obtained from the Faculty of Humanities (Appendix A). The original proposal included a systematic review of the effects of AAC interventions on receptive language skills. This was, however, changed to a scoping review to provide breadth rather than depth on the subject, as such a review has not been conducted in the past. The following ethical issues were considered:

2.3.1 Accuracy

In order to ensure accuracy, the study strived to ensure that the methods of the scoping review were provided so that it can be replicated in order to allow others to verify the knowledgeable claims (McMillan & Schumacher, 2014). Data was not made up, modified or omitted, and immediate correction of errors was made (McMillan & Schumacher, 2014).

2.3.2 Plagiarism

Plagiarism occurs when there is failure to acknowledge the work of others. Plagiarism was avoided by giving credit to others' work. This involved the use of quotation marks for verbatim use of others' work and references to a source so that the work of others was not represented as the work of the review authors (McMillan & Schumacher, 2014).

2.4 Protocol

A protocol, in the form of a proposal, was compiled for this scoping review to outline the crucial procedures of the review. The use of a protocol increases the transparency and replicability of the review process (Schlosser, Wendt, & Sigafoos, 2007). As the proposal stated inclusion and exclusion criteria *a priori*, the bias of selection of studies was reduced (Schlesselman & Collins, 2003; Schlosser et al., 2007). The proposal was peer-reviewed by two critical reviewers.

2.5 Registration of the scoping review

The review was registered with PROSPERO, an international database of prospectively registered reviews. A permanent record of the key features of the protocol are recorded and maintained with the use of PROSPERO. By adding the scoping review to the comprehensive listing of reviews registered at inception, duplication can be avoided and the opportunity for reporting bias is reduced, as what

was planned in the protocol can be compared with the completed review (PROSPERO website www.crd.york.ac.uk). The PROSPERO registration number for the review is CRD42016050159.

2.6 Pilot search

A pilot study was conducted in order to assess the feasibility of the search terms, inclusion criteria and materials used in the study (Thabane et al., 2010). This helped to guide the planning of the search strategy. Appendices B, C, D and E illustrate the pilot searches that were conducted and show how these search terms were refined over time.

Table 2 illustrates the aims, outcomes and recommendations of the pilot search. The recommendations for the pilot search were included in the main study.

Table 2

Pilot study

Aim	Procedure	Findings	Recommendations
To determine if the search terms were appropriate.	Searches were conducted.	Many irrelevant articles were found, such as studies on late language emergence, early behavioural intervention and self-care training.	*Removed*: - "special needs, impairment, autis*, development* delay*, "pervasive developmental disorder", "down syndrome", "cerebral palsy - youth, adolescen*, teenage*, toddler*, infan* - "scene cues", "speech technology" *Added:* - symbol, "graphic symbol"
To determine whether the *Title and Abstract Screening Tool* (Appendix F) was easy to apply when screening the titles and abstracts of studies.	The *Title and Abstract Screening Relevance Tool* was used by colleagues with a special interest in AAC. The tool was used to screen the titles and abstracts of randomly selected studies that were obtained during the pilot searches.	It cannot be determined whether a study is from a peer-reviewed journal, thesis or dissertation when screening the title and abstract of a study. 'Developmental disabilities' is a broad term, a breakdown of possible disabilities would help. Quantitative data is implied in the design to be included.	Remove: "Is the citation published in a peer-reviewed journal or as a thesis or dissertation?" A list of developmental disabilities was added to the inclusion/exclusion criteria. Remove the row in the summary table of the tool that addressed the outcome of quantitative data on receptive language before and after intervention.

Aim	Procedure	Findings	Recommendations
To determine if the inclusion and exclusion criteria were applicable.	The inclusion and exclusion criteria included in the *Title and Abstract Screening Relevance Tool* were reviewed by colleagues with a special interest in AAC when completing the tool with randomly selected articles. The inclusion and exclusion criteria were continually updated as titles and abstracts of articles obtained during the article search were screened in order to ensure consistency between the two reviewers.	Inclusion and exclusion criteria that were relevant but not included were found while screening the titles, abstracts and full texts of the articles retrieved during the scoping search.	<u>Added to 'Population' exclusion criteria</u>: - Children with typical development - Children with visual impairments and no other concomitant disabilities - Children with learning disabilities/difficulties, dyslexia or developmental language delay - Children who are poor readers and/or late talkers. <u>Added to 'AAC intervention' inclusion criteria</u>: - An AAC intervention should facilitate a child's communicative competence through the use of multiple communication modalities that supplement ("augmentative") or replace ("alternative") natural speech (Light, Beukelman & Reichle, 2003; Schlosser & Wendt, 2008). <u>Added to 'AAC intervention' exclusion criteria</u>: - Interventions using audio-taped instruction (video modelling and no spoken input) - Reading of word/text - Direct teaching of symbols or interventions focused on teaching symbols (e.g. effect of iconicity) - Effects of different display designs, use of colour - Behaviour analysis training interventions - Discrimination training - Picture Exchange Communication System as outcomes are typically expressive. <u>Added to 'Design' exclusion criteria</u>: - Use of two case studies - Qualitative studies - Mixed method designs - Observational studies - Assessment using different measures - Comparisons to typical development without intervention. <u>Added to 'Outcome' exclusion criteria</u>: - Learnability, translucency, iconicity - Parents' perceptions and understanding of AAC - Intelligibility - Emotion comprehension - Studies that use gaze fixation or looking at the symbol/object/photograph as an indication of comprehension.

2.7 Search strategy

A multi-faceted search strategy was utilised in order to avoid a biased yield (Millar et al., 2006; Schlosser & Lee, 2000; White, 1994). A four-pronged search strategy was used to identify studies that potentially meet the inclusion criteria: (1) electronic databases search for peer-reviewed studies; (2) ProQuest Dissertations and Theses search; (3) hand search of the journal *Augmentative and Alternative Communication*; and (4) ancestry searches (Schlosser & Lee, 2000; White, 1994).

The following electronic databases were searched for published work using Ebscohost as the platform: Academic Search Complete, Cumulative Nursing and Allied Health Literature (CINAHL), Educational Resources Information Centre (ERIC) and PsychINFO. Linguistics and Language Behaviour Abstracts (LLBA) was searched with the use of ProQuest as the platform. MEDLINE was searched using Ovid. The searches were limited to English, peer-reviewed articles published between January 1970 and February 2017. Two information specialists at the Medical Library and Merensky Library at the University of Pretoria were consulted in the compilation of search strategies for the electronic database searches. A search within ProQuest Dissertations and Theses Global was conducted to locate unpublished theses and dissertations. See Table 3 for database-specific search strategies. The database search was completed in February 2017. The *Augmentative and Alternative Communication* journal was hand searched from Volume One (1985) to Volume 32 (2016). Hand searches allow relevant professional journals to be systematically searched (Schlosser & Lee, 2000). Ancestry searches of included articles were used as a fourth technique during the search. This involved hand searching the reference lists of included published articles (Schlosser & Lee, 2000).

Table 3

Search strategies and yields for electronic databases

Database	Search strategy	Yield	Total minus duplicates
Medline (Ovid)	Exp Intellectual Disability/ AND Autistic Disorder/ AND Communication Aids for Disabled/ AND Language Development Disorder/	11	
CINAHL (Ebscohost)	(MM “Intellectual Disability+”) AND (MM “Alternative and Augmentative Communication”) AND (MM “Language	343	340

Database	Search strategy	Yield	Total minus duplicates
	Disorders+")		
Academic Search Complete (Ebscohost)	"Disab* AND (child* OR pediatric OR paediatric) AND (Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR " "speech generating device*" OR "voice output communication aid*" OR gesture* OR "finger spell*" OR "manual sign*" OR sign* OR "simultaneous communication" OR symbol OR "graphic symbol" OR total communication) AND (Comprehension OR "receptive language" OR understand* OR interpret* OR receptive vocabulary)	2218	2164
ERIC (Ebscohost)	"Disab* AND (child* OR pediatric OR paediatric) AND (Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR " "speech generating device*" OR "voice output communication aid*" OR gesture* OR "finger spell*" OR "manual sign*" OR sign* OR "simultaneous communication" OR symbol OR "graphic symbol" OR total communication) AND (Comprehension OR "receptive language" OR understand* OR interpret* OR receptive vocabulary)	687	359
PsychINFO (Ebscohost)	"Disab* AND (child* OR pediatric OR paediatric) AND (Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR " "speech generating device*" OR "voice output communication aid*" OR gesture* OR "finger spell*" OR "manual sign*" OR sign* OR "simultaneous communication" OR symbol OR "graphic symbol" OR total communication) AND (Comprehension OR "receptive language" OR understand* OR interpret* OR receptive vocabulary)	2092	1258
LLBA (ProQuest)	Disab* AND (child* OR pediatric OR paediatric) AND (Augmentative AND alternative communication OR communication aid* OR "communication system*" OR augmented input OR "speech generating device*" OR "voice output communication aid*" OR gesture* OR "finger spell*" OR "manual sign*" OR sign* OR "simultaneous communication" OR symbol OR "graphic symbol" OR total communication) AND (Comprehension OR "receptive language" OR understand* OR interpret* OR receptive vocabulary)	31	9

2.8 Criteria for inclusion

Table 4 illustrates the inclusion and exclusion criteria used in this study in terms of the populations, types of AAC interventions, designs and outcomes of the study.

Table 4

Criteria for the inclusion and exclusion of studies

Criteria	Inclusion Criteria	Exclusion Criteria
Age of Population	Children 0 – 18 years old	All those older than 18 years
Population	Children who have a developmental disability, including but not limited to: - autism - autism spectrum disorder (ASD) - intellectual disability (ID) - related syndromes (e.g. Down syndrome (DS)) - cerebral palsy (CP).	- Children with typical development - Children diagnosed with mental health disorders - Children with a hearing impairment (with or without hearing aids and/or cochlear implants) and no other concomitant disabilities - Children with visual impairments and no other concomitant disabilities - Children with a specific language impairment, learning disabilities/difficulties, dyslexia or developmental language delay - Children who are poor readers and/or late talkers.
AAC intervention	The intervention should be classified as being within the scope of AAC; 'an area of research,clinical and educational practice. AAC involves attempts to study and when necessary compensate for temporary or permanent impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/or comprehension, including spoken and written modes of communication' (ASHA, 2005). An AAC intervention should facilitate a child's communicative competence through the use of multiple communication modalities that supplement ("augmentative") or replace ("alternative") natural speech (Light, Beukelman, & Reichle, 2003; Schlosser & Wendt, 2008). The following AAC interventions were considered to be applicable for inclusion: augmented input, Aided Language Stimulation, Natural Aided Language, aided language modelling, aided AAC modelling, SAL, symbols, graphic symbols, scene cues, SGDs, simultaneous communication, total communication,	Pseudoscientific interventions such as facilitated communication training (FCT) or Rapid Prompting Method Interventions using audio-taped instruction (video modelling and no spoken input) Reading of word/text Direct teaching of symbols or interventions focused on teaching symbols (e.g. effect of iconicity) with no AAC intervention Effects of different display designs, use of colour Behaviour analysis training interventions Discrimination training Picture Exchange Communication System, as outcomes are typically expressive

Criteria	Inclusion Criteria	Exclusion Criteria
	Makaton and interventions teaching finger spelling and manual signs	
Design	Experimental design (including true experimental, quasi-experimental and single subject experimental designs (SSED), group designs) Group designs using pre-post designs were included.	- Pre-experimental designs (e.g. AB designs, pre-post designs) - Case studies (including use of two case studies), literature reviews, systematic reviews, meta-analysis, scoping reviews - Opinion pieces, policy reviews, editorials - Qualitative studies - Mixed method designs - Observational studies - Assessment using different measures - Comparisons to typical development without intervention
Time period	Published between January 1970 and February 2017. As an independent field, AAC has been recognised since the 1970s.	All publications prior to January 1970
Outcome/ Concept of receptive language skills	- **Receptive language** is the understanding of linguistic information. - It is synonymous with language comprehension. - Aspects of receptive language include comprehension of: ○ **Vocabulary**: comprehension on a single word level. ○ **Grammatical morphology**: the internal organisation of words. A morpheme is the smallest grammatical unit. ○ **Syntax**: governs the form or structure of a sentence. These rules specify word, phrase and clause; sentence organisation; relationship between words, word classes and other sentence elements. ○ **Discourse**: understanding language on a conversational level. ○ **Literacy**: the act of reading, decoding and comprehending language (Shurr & Taber-Doughty, 2012) ○ **Symbols**: "something that stands for or represents another thing or concept" (Alant, Bornman & Lloyd, 2006, p. 145). For example, 3D objects, pictures with a high resemblance to their referents, line drawings (coloured and black and white), and abstract forms such as Blissymbols, lexigrams and printed words.	Expressive language skills - Expressive vocabulary development - Sentence production - Spelling skills - Narrative skills Interaction skills Pragmatics; including humour comprehension and facial expression comprehension Attitudes of others towards persons who rely on AAC Learnability, translucency, iconicity Parents perceptions and understanding of AAC. Intelligibility Emotion comprehension Studies that use gaze fixation or looking at the symbol/ object/photograph as an indication of comprehension

2.9 Selection of studies

The title and abstract of each study was read and compared to the inclusion

and exclusion criteria (Table 4) in order to determine if the study met inclusion criteria. Based on these criteria, the *Title and Abstract Screening Relevance Tool* (see Appendix F) was developed to assist in the screening of study titles and abstracts to determine the eligibility for inclusion.

The title and abstract review was done independently by two researchers using Covidence. Covidence is a web-based software platform that allows for efficient production of systematic reviews (Cochrane Community website: http://community.cochrane.org/tools/review-production-tools/covidence/about-covidence). In Covidence, the researcher could indicate 'Yes', 'No' or 'Can't tell' to various questions relating to inclusion and exclusion criteria, using the *Title and Abstract Screening Relevance Tool.* The questions included:

- Does the citation report on children (younger than 18)?
- Does the citation report on a developmental disability?
- Does the citation include an intervention classified as being within the scope of AAC?
- Is the citation published in English?

If the reviewer answered NO to any of the questions, the article was excluded. If the reviewer answered YES to all questions, the article was included for full text screening. If the reviewer answered CAN'T TELL to any or all of the questions, the article was included for full text screening. A table listing the AAC interventions terms that may be applicable was included in the screening tool.

All included articles were then reviewed at full text level, independently by two researchers. This was also done using Covidence, answering the same four questions as per the title and abstract review. All studies that were included in the scoping review were considered appropriate by both authors. The PRISMA diagram is shown in Figure 1 reviewing the phases used to identify articles for inclusion.

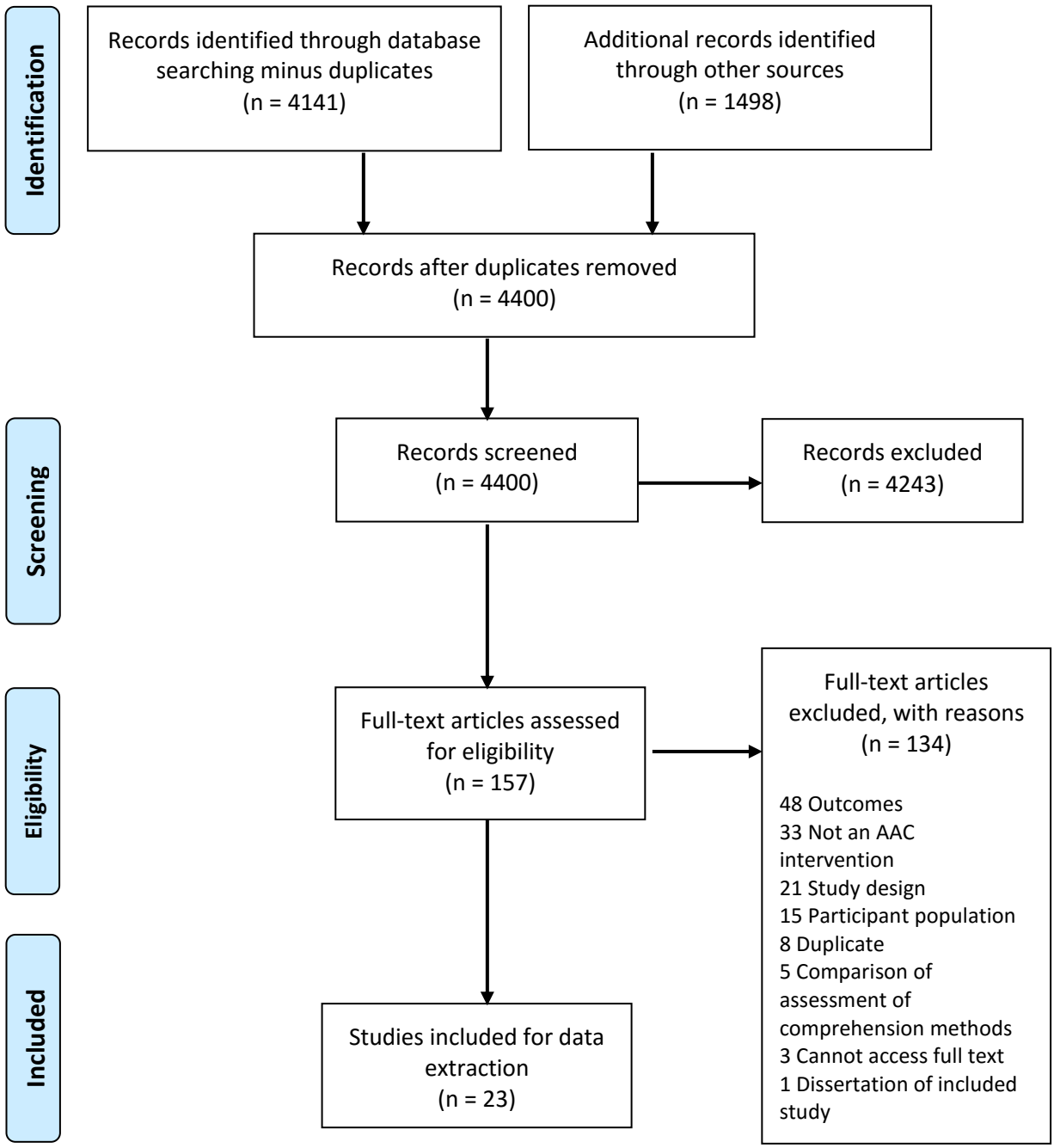


Figure 1: *PRISMA flow diagram of the selection process*

Figure 1 illustrates that 4141 studies were identified through database searches. An additional 1498 studies were identified through a search of ProQuest Dissertations and Theses, a hand search of the journal *Augmentative and Alternative Communication* and through ancestry searches of included published articles. After duplicates were removed, 4400 studies remained for title and abstract screening. Following title and abstract screening, 4243 studies were excluded. The full text of

157 studies was assessed for eligibility. Of these studies, 134 were excluded, resulting in 23 studies that were included for data extraction. Reasons for exclusion include: unrelated outcomes (*n* = 48), use of an intervention that is not considered within the scope of AAC (*n* = 33), incorrect research design (*n* = 21), wrong participant population *(n* = 15), duplicates (*n* = 8), comparisons of assessment of comprehension (*n* = 5), not being able to access the full text (*n* = 3) and a dissertation of an included study (*n* = 1).

2.10 Data extraction

A data extraction form (Appendix G) was developed from Schlosser et al. (2009) and Schlosser and Koul (2015). Data from each of the included articles was extracted in terms of (Table 5):

Table 5

Data extracted from the studies

Criteria	**Justification**
Authors and date of publication	To determine a trend in the number of publications by determining the frequency of publications per year
Purpose of the study	To allow qualitative analysis of the research aims and to facilitate the linking of aims to main findings, research limitations and future research recommendations
Participants (name/number, age, gender, diagnosis)	To determine the frequencies of the ages, genders and types of disabilities included in the research studies
Sampling method	To determine the frequencies of different sampling methods
Research design	To determine the frequencies of different types of study designs
Type of AAC intervention	To determine trends in the types of AAC interventions used when targeting receptive language skills
Outcomes	To determine trends in receptive language skills targeted in AAC interventions
Effect	To determine the effects of AAC interventions on receptive language skills
Quality appraisal	To determine the certainty of evidence provided in the studies

The authors, dates of publications, purpose of the studies, participant ages, gender and diagnosis, sampling method and research design were transcribed verbatim from each study. The type of AAC intervention was also taken directly from the study. If an intervention was not defined as falling within a specific strategy, the components of the intervention were extracted. For example, if symbols were used but were not referred to as being part of a specific input strategy, the use of symbols

was extracted as the intervention to support receptive language. Specific augmented input strategies included Aided Language Stimulation, natural aided language, aided language modelling, SAL, total communication or simultaneous communication. Data on outcomes included the receptive language skill targeted by the AAC intervention.

Meaningfulness of effect size arises from the relation to clinical judgement or an external participant improvement criterion (Parker & Brossart, 2003). The effect of the independent variable on the dependent variable was determined by using the interpretation of the effect as reported by the original authors of the studies. According to how the effects were described in each study, effect was classified as complete, partial/mixed or no effect. If a large effect of intervention was found compared to the control, the study was classified as providing complete effect. In single subject designs, the participant served as their own controls (Horner et al., 2005; Horner & Smolkowski, 2012). If effects approaching significance were reported, if there were any variations in the results between participants or a combination of positive and negative outcomes were obtained, the study was classified as providing partial or mixed effects. If there was no significant effect between intervention and control, the study was classified as having no effect. A similar method was used by Banks et al. (2016), whereby the impact of the intervention was classified according to the evidence described in each study.

In order to conduct a quality appraisal, a certainty framework was used to assess the certainty of research evidence of each included study. The certainty framework has been used in previous reviews (e.g. Millar et al., 2006; Schlosser & Koul, 2015; Schlosser & Sigafoos, 2006; Schlosser & Wendt, 2008). This framework involves coding the methodological quality of each study according to the work of Simeonsson and Bailey (1991) (Millar et al., 2006) based on (i) the design of the study, (ii) inter-observer agreement (IOA) of the dependent variable, and (iii) treatment integrity (TI). Based on these ratings in these three categories, the quality of the studies was then classified into four groupings: conclusive, preponderant, suggestive, and inconclusive. Conclusive evidence clearly shows that the outcomes are the result of the intervention. A study was rated as conclusive if the design provided experimental control, IOA was reliable and treatment integrity was solid. Preponderant evidence leads to the conclusion that the reported outcomes are more than likely a result of the intervention, but the evidence was not conclusive. A study was rated as preponderant if there were minor flaws in the design, IOA or treatment

integrity. Suggestive evidence is used when it is plausible but not certain that the outcomes were the result of the AAC intervention. A study was rated as suggestive if it featured a strong design but inadequate IOA and/or treatment integrity, or minor design flaws and inadequate IOA and/or treatment integrity. Lastly, a study was rated as inconclusive when it was impossible to determine if the outcomes were associated with the intervention because of fatal flaws in the design, regardless of IOA or treatment integrity (Millar et al., 2006; Schlosser & Koul, 2015; Schlosser & Wendt, 2008). The first author extracted data from all of the studies independently, with the second coder checking the data extraction of 100% of the included studies.

2.11 Reliability

Design validity refers to the truthfulness of the findings and conclusions or the degree to which scientific explanations match reality. Data reliability refers to the consistency of measurement or the extent to which results remain the same over different cases of data collection (McMillan & Schumacher, 2015). Data collection reliability for the scoping review was ensured by the following recommendations (Mosca, 2015):

- Using the PRISMA Statement Checklist (Moher et al., 2009) to outline the steps to be included in the review,
- Searching multiple databases,
- Selecting articles according to inclusion criteria, and
- Using two reviewers to independently screen article titles, abstracts and full texts, as well as checking the data extraction on all the articles.

IOA was calculated for title and abstract screening, full text screening and data extraction. IOA was calculated by dividing the number of agreements by the number of agreements plus disagreements multiplied by 100. IOA for title and abstract review was 93.5%. IOA for full text screening was 92%. IOA for data extraction was 96%. The disagreements that did occur were resolved by comparing and discussing rationales and establishing a consensus.

3. RESULTS AND DISCUSSION

A total of 23 studies (Tables 9, 10, 11) met the criteria for inclusion. An overview of the studies will be provided in terms of (i) number of publications, (ii) participant characteristics, (iii) research design, (iv) AAC interventions, (v) intervention outcomes, (vi) effects, and (vii) quality appraisal. Thereafter, these studies will be discussed in terms of the sub-aims of the study by examining (i) the effects of unaided AAC interventions on the receptive language skills of children with developmental disabilities (*n* = 5), (ii) the effects of aided AAC interventions on the receptive language skills of children with developmental disabilities (*n* = 15), and (iii) a comparison of two AAC interventions (*n* = 3).

3.1 Number of publications per year

The number of publications from 1970 to 2017 is illustrated in Figure 2. An increase in the number of publications per year is observed from the 1970s to 2017. No articles met the inclusion criteria in the period 1970 to 1980, despite AAC being recognised as an independent field since the 1970s (Ogletree & Harn, 2001; Romski et al., 2015; Zangari, Lloyd, & Vicker, 1994). It is evident that most of the research was done between 2006 and 2017 (end of February).

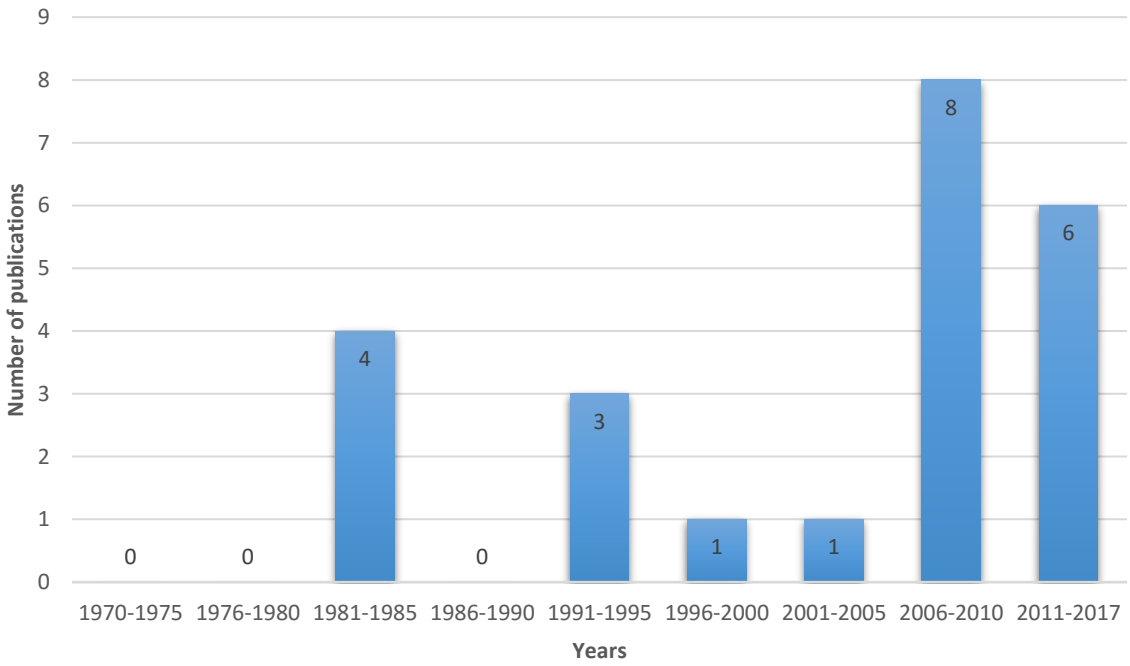


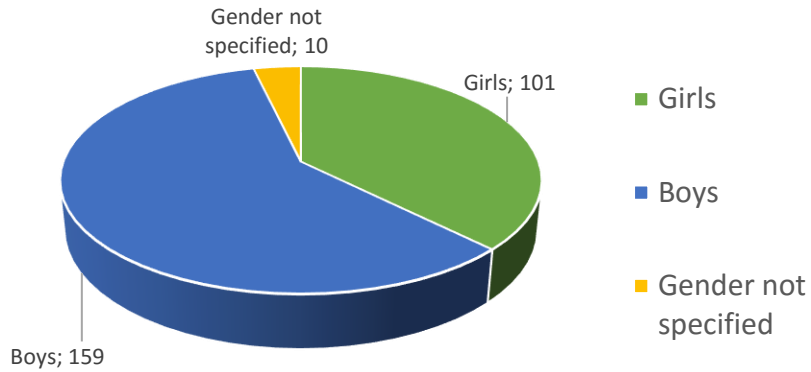
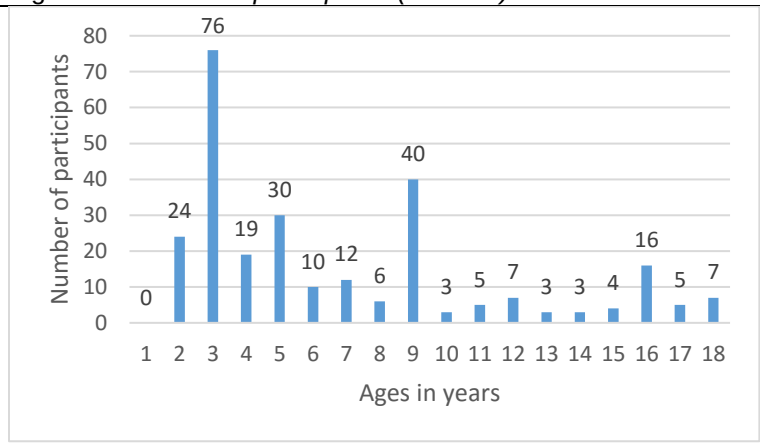
Figure 2. *Number of publications*

3.2 Participants

Table 6 describes the participant characteristics. The gender, age and diagnosis of the participants are described.

Table 6

Participant characteristics

Description	Result
Gender of participants A total of 270 participated in the 23 included studies. The majority of the participants were male (*n* = 159) and the remainder were female (*n* = 101) (Figure 3). The gender of ten of the participants was not specified.	 Figure 3. *Number of participants (N = 270)*
Age of participants The ages of children with developmental disabilities ranged from two to 18 years of age (Figure 4). Some studies reported average age for groups rather than individual children (Studies 4, 13, 17, 19).	 Figure 4. *Ages of participants*

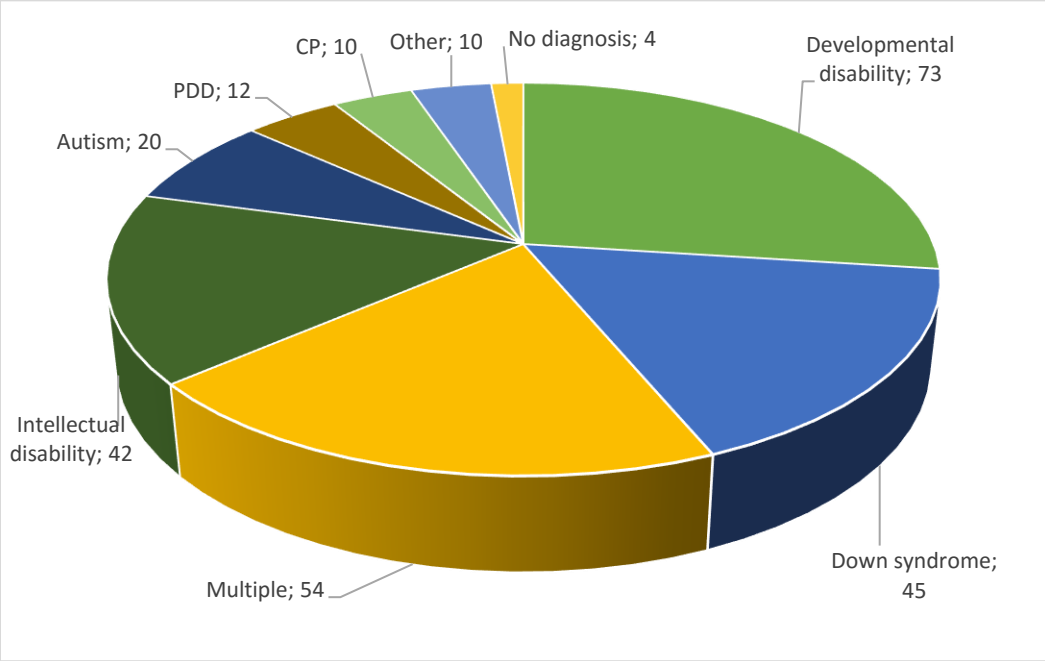
Description	Result
Participant Diagnosis The different diagnoses of the participants included (Figure 5): Developmental disability (*n* = 73), Down syndrome (DS) (*n* = 45), multiple disabilities (*n* = 54), intellectual disability (*n* = 42), autism (*n* = 20), pervasive developmental disorder (PDD) (*n* = 12), cerebral palsy (*n* = 10), and other (*n* = 10). Four participants had no or unknown diagnosis.	 Figure 5. *Participant diagnosis*

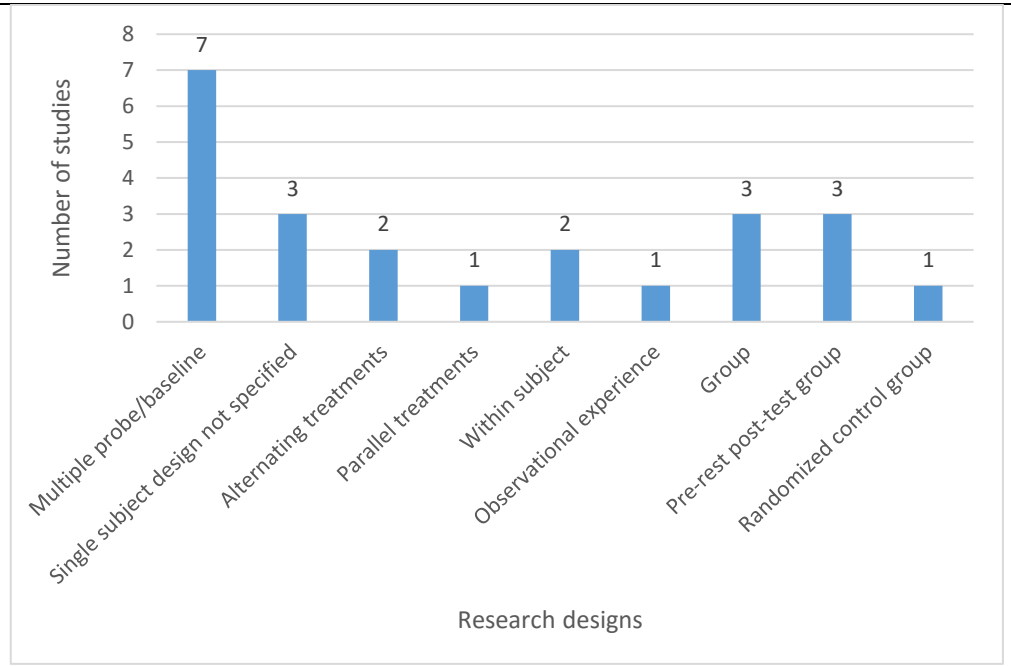
Table 6 illustrates that the majority of the participants were male. This is consistent with the systematic review conducted by Sennott et al. (2016), which also found that the majority of the participants were male. Furthermore, the vast number of studies focus on young children (0 to 4 years) (*n* = 119 participants). This is congruent with the literature, as early intervention for children with communication impairments is important for the successful developmental outcomes for the child (ASHA, 2008; Romski et al., 2010). Table 6 highlights that there is a paucity of research with adolescents, those aged ten to 19 years of age (WHO, 2017). Different contexts and communication demands arise from the use of AAC at different ages (Light & McNaughton, 2012; Schlosser & Koul, 2015), hence, further research with adolescents is needed to address this gap. Developmental disability (unspecified) was the diagnosis used with the majority of participants (*n* = 73). There is a paucity in research on the effects of AAC interventions on receptive language skills in children with CP and PDD, despite an increase in the incidence of disorders such as autism (Light & McNaughton, 2012).

3.3 Research designs, AAC interventions and intervention outcomes

Table 7 illustrates the studies in terms of the overall designs, AAC interventions and intervention outcomes.

Table 7

Designs, types of AAC interventions and outcomes of the studies

Description	Result
Designs Seven studies used a group design. Of these seven studies, three used a pre-test post-test group design and one used a randomised control group. Three of the group studies were not classified further. The majority of the studies used a single-subject design (*n* = 13). A multiple-baseline design together with its variant, a multi-probe design (*n* = 7), was used most frequently in the studies investigating the effects of AAC interventions. Other single-subject designs include alternating treatments (*n* = 2) and parallel treatments (*n* = 1). A within subject design was used in two studies. An observational experience design with an intervention was also included in the scoping review (Figure 6).	 Figure 6. *Research designs*

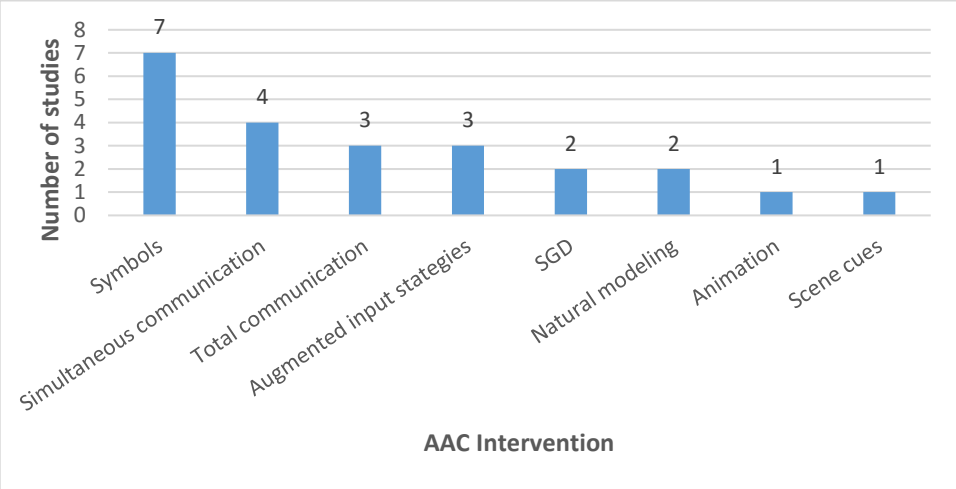
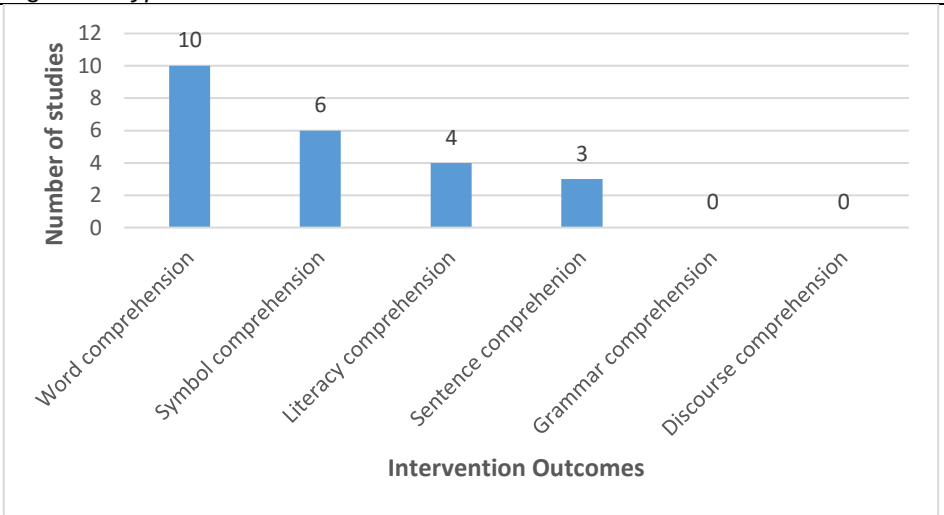
Description	Result
Types of AAC interventions Unaided augmented input strategies (N = 7) included simultaneous communication (*n* = 4) and total communication (*n* = 3). Augmented input strategies (*N* = 3) included the following specific strategies; Aided Language Stimulation (*n* = 2) and Aided Language Modelling (*n* = 1). Furthermore, there were studies that did not refer to a specific input strategy (*N* = 11). These studies paired the visual and auditory modalities in the intervention using symbols (*n* = 7), SGD (*n* = 2), animation (*n* = 1) or scene cues (*n* = 1). Additionally, two studies used natural modelling of AAC in the learning environment as the intervention. In the studies that used symbols as the augmented input, graphic symbols (*n* = 5) were used more frequently than tangible symbols (*n* = 2).	 Figure 7. *Types of AAC interventions*
Intervention Outcomes The outcomes targeted in the included studies were word comprehension (*n* = 10), symbol comprehension (*n* = 6), literacy comprehension (*n* = 4) and sentence comprehension (*n* = 3). Grammar and discourse comprehension were not included in any of the studies.	 Figure 8. *Intervention outcomes*

Table 7 illustrates that the majority of the studies used single-subject designs. This is congruent with the literature, as persons who rely on AAC represent a diverse and heterogeneous population, making it difficult, if not impossible, to form large experimental and control groups (Higginbotham & Bedrosian, 1995; Ho, 2000). Due to the experimental benefits of single-subject designs with diverse populations such as persons who rely on AAC, single-subject design studies provide some of the most relevant evidence (Schlosser, 2003; Sennott et al., 2016). A multiple baseline design and its variant (multiple probe design) were the preferred design strategy. These designs included multiple baselines across activities (*n* = 3), across participants (*n* = 3) and across materials (*n* = 1).

When comparing the efficacy of two or more interventions, certain single-subject designs may be more appropriate for drawing valid conclusions regarding the relative efficacy of the interventions. The parallel treatments design allows intra-subject replications across equated sets, and is therefore ranked the highest (Schlosser & Sigafoos, 2006). This design was only used in one study, which is in line with the literature, which states that despite the appeal of a parallel treatments design, it has only been used in a few studies (Schlosser & Sigafoos, 2006). An alternating treatment design was used with two studies that compared the effects of two AAC interventions. The use of an alternating treatment design can be problematic due to an insufficient number of demonstrations of experimental control that is necessary to meet evidence standards for single-subject designs (Horner et al., 2005; Schlosser & Koul, 2015). As the same sets are used for each treatment, carry-over effects become a concern (Schlosser & Sigafoos, 2006).

A group design was used in seven of the included studies. Due to the heterogeneity of participants, the use of group designs involving persons who rely on AAC has been criticised (Higginbotham & Bedrosian, 1995). Furthermore, studies using a group design are rare in the field of AAC (Sennott et al., 2016). Of the seven studies included in this scoping review that used a group design, only one study used a randomised control group. With randomised trials, participants are randomly assigned to either the intervention or control group (Elamin & Montori, 2012). If well conducted, randomised trials rank highest on the hierarchy of treatment designs for controlling internal validity and making causal inferences. However, when randomised control studies are rare, the inclusion of other designs may be necessary (Schlosser et al., 2007). Three studies used a pre-experimental design

(pre-test post-test group design) (Lee, Jeong, & Kim, 2013; Trief, Cascella, & Bruce, 2013; Weller & Mahoney, 1983), therefore they may not be capable of providing a rigorously convincing demonstration of effect (Roche et al., 2014).

Table 7 highlights that in terms of the AAC intervention strategies, there is a focus on aided augmented input (*N* = 16). Symbols were used most frequently (*n* = 7), followed by augmented input strategies (*n* = 3), natural modelling (*n* = 2), use of an SGD (*n* = 2), animation (*n* = 1) and scene cues *(n* = 1). There were therefore studies that paired the visual and auditory modalities but were not referred to as using a specific augmented input strategy. This highlights a need to better clarify the various intervention approaches as there are a number of similar intervention packages which refer to the interactive modelling of an AAC system by a communication partner (Sennott et al., 2016). Study procedures may also need to be clearer in order to be able to classify an intervention in terms of a specific augmented input strategy. Similar trends of unclear procedures were highlighted in the systematic review by Sennott et al. (2016), where three of the ten included studies only provided general descriptions of activities instead of explicitly stating the specific intervention package components.

In the studies that utilised symbols (*n* = 7), a preference for the use of graphic symbols (*n* = 5) was observed, highlighting the need to focus on the effect of objects and other symbols on receptive language skills of children with developmental disabilities. This is congruent with the literature, as Roche et al. (2014) concluded that additional research into the merits of tangible symbols is warranted, based on their systematic review.

In terms of the outcomes targeted in the studies, Table 7 illustrates a trend of studies that focus on word comprehension (*n* = 10) (Acosta, 1981; Dada & Alant, 2009; Kennedy, 1994; Lee et al., 2013; Poulton, 1981; Remington & Clarke, 1993 a & b; Romski et al., 2010; van der Schuit, Segers, van Balkom, Stoep, & Verhoeven, 2010; Weller & Mahoney, 1983) followed by studies on symbol comprehension (*n* = 6) (Barton, Sevcik & Romski, 2006; Drager et al., 2006; Fujisawa, Inoue, Yamana & Hayashi, 2011; Harris & Reichle, 2004; Ho, 2000; Trief et al., 2013), sentence comprehension (*n* = 3) (Preis, 2006; Romski & Ruder, 1984; Schlosser et al., 2013) and comprehension of literacy (*n* = 4) (Bailey, Angell & Stoner, 2011; Browder, Ahlgrim-Delzell, Courtade, Gibbs & Flowers, 2008; Mims, Browder, Baker & Lee, 2009; Shurr & Taber-Doughty, 2012).

The studies that focused on word comprehension measured the understanding of vocabulary on a word level. Word comprehension was measured using tasks that involved pointing to or matching a spoken and/or signed label to an object (Acosta, 1981; Dada & Alant, 2009; Drager et al., 2006; Poulton, 1981), graphic symbol (Lee et al., 2013; Remington & Clarke, 1993a&b; van der Schuit et al., 2010) or video (Kennedy, 1994), or using spontaneous augmented and/or spoken word use (Fujisawa et al., 2011; Romski et al., 2010; Weller & Mahoney, 1983) during the intervention in response to a question in order to demonstrate their understanding. Symbol comprehension looked at the understanding of symbols, whether graphic or tangible. This was measured using a task that involved matching graphic or tangible symbols to photographs (Barton et al., 2006), objects or spoken word (Harris & Reichle, 2004; Ho, 2000; Trief et al., 2013). Sentence comprehension involved the completion or implementation of a directive or instruction presented with augmented input (Preis, 2006; Romski & Ruder, 1984; Schlosser et al., 2013). Literacy comprehension refers to the understanding of stories or text. Story comprehension was measured by pointing to symbols in response to a spoken word (Bailey et al., 2011; Browder et al., 2008; Mims et al., 2009; Shurr & Taber-Doughty, 2012).

3.4 Effects and quality appraisal

In order to draw conclusions on a body of intervention research, effectiveness and quality appraisal need to be considered together (Schlosser & Raghavendra, 2004). A measure of quality of evidence represents the certainty that the intervention described in the study caused the change in the dependent variable (Therrien, Light, & Pope, 2016). A summary of the effects of the various AAC interventions on the intervention outcomes is presented in Table 8. The majority of the studies resulted in complete effects (*n* = 12). Nine studies resulted in partial or mixed effects, and two studies resulted in no effects on the dependent variables.

Figure 9 illustrates the effects of the various AAC interventions. The use of symbols resulted in two studies with complete effects, four with partial effects, and one study demonstrating no effects on the dependent variable. Studies using simultaneous communication as the intervention demonstrated partial effects. Total communication resulted in one study demonstrating complete effects and two with partial effects. Augmented input strategies resulted in complete effects *(n* = 3) as did

the use of an SGD (*n* = 2) and scene cues (*n* = 1). Natural modelling resulted in one study showing complete effects and another study showing no effects. The use of animation resulted in partial effects (*n* = 1). Augmented input strategies demonstrated the most complete effects. This is in line with the literature where AAC modelling-based intervention packages have produced large and clinically relevant effects on beginning language skills of individuals with complex communication needs (Sennott et al., 2016).

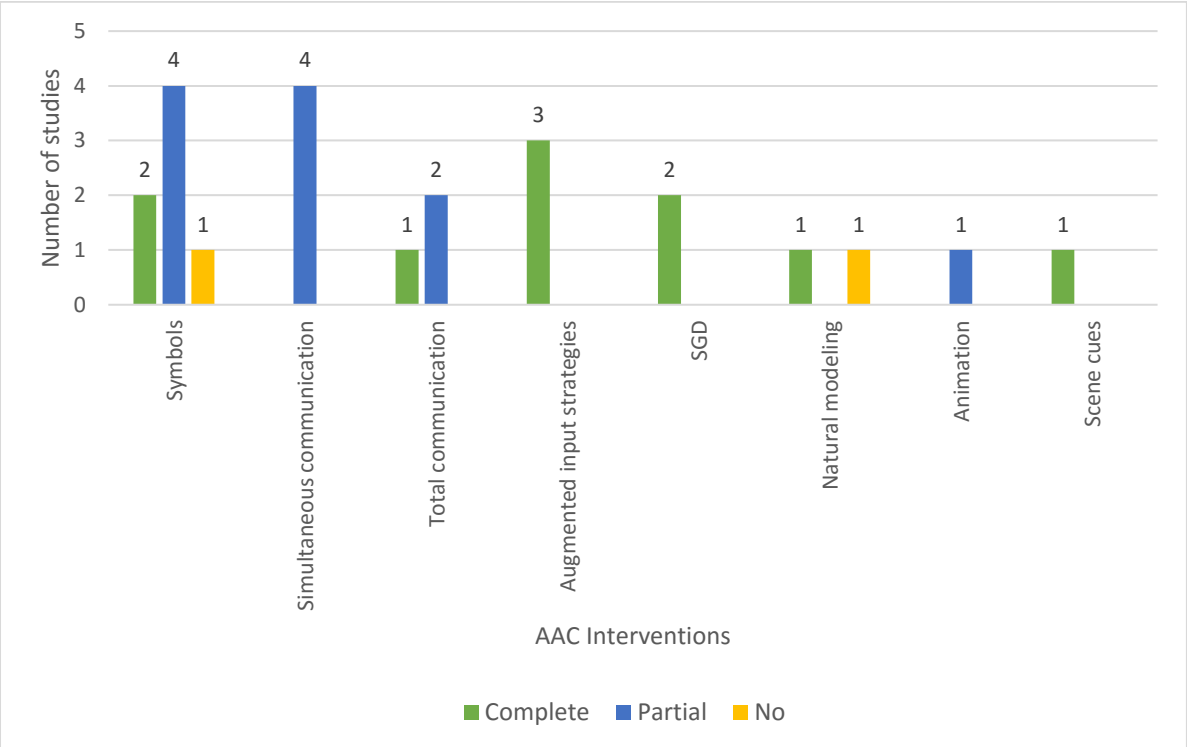
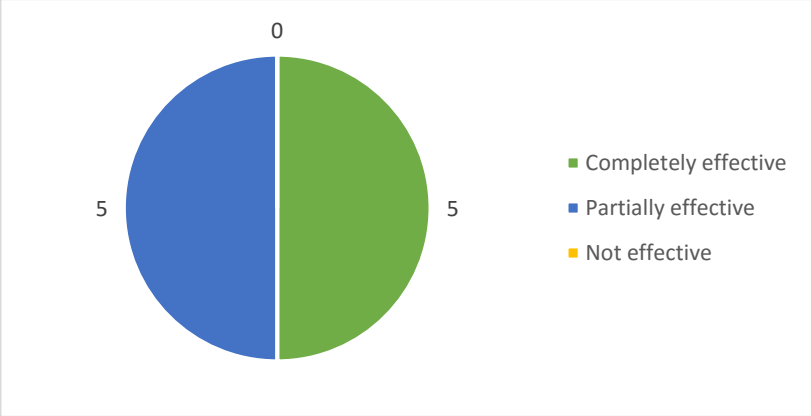
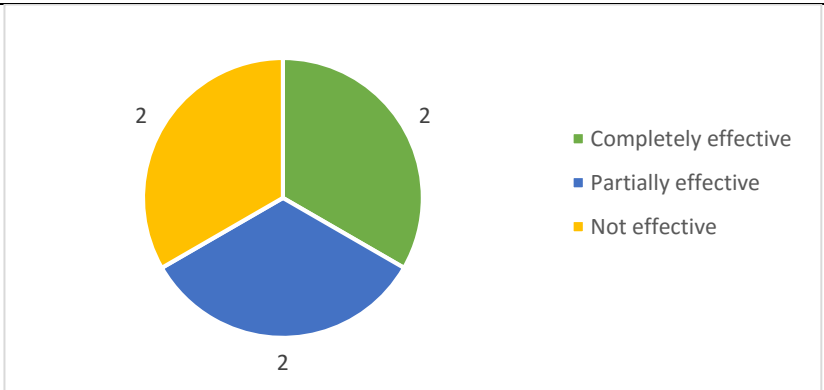
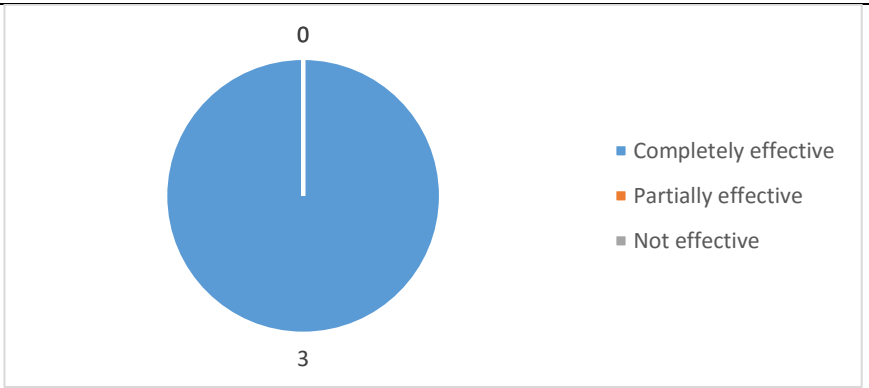
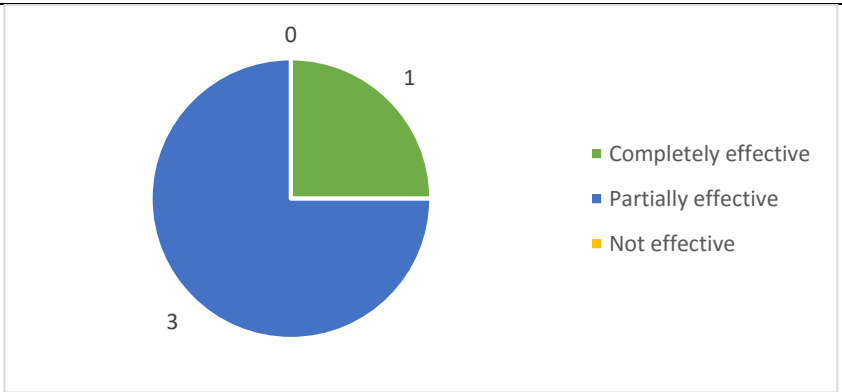


Figure 9. *Effects of AAC interventions*

Table 8

Effects of interventions on the dependent variables

Description	Result
Word comprehension Of the ten studies involving word comprehension as a dependent variable, intervention led to complete effects in five of the studies (Acosta, 1981; Dada & Alant, 2009; Lee et al., 2013; Romski et al., 2010; Van der Schuit et al., 2010). Intervention led to partial effects in the remaining five studies (Kennedy, 1994; Poulton, 1981; Remington & Clarke, 1993 a & b; Weller & Mahoney, 1983) (Figure 10).	 Figure 10. *Effects of intervention on word comprehension*
Symbol comprehension As seen in Figure 11, in the six studies with symbol comprehension as the dependent variable, intervention lead to complete effects in two of the studies (Drager et al., 2006; Harris & Reichle, 2004), partial or mixed effects in two studies (Barton et al., 2006; Fujisawa et al., 2011) and no effects in two studies (Ho, 2000; Trief et al, 2013).	 Figure 11. *Effects of intervention on symbol comprehension*

Description	Result
Sentence comprehension All three of the interventions used in the studies focusing on sentence comprehension resulted in complete effects (Preis, 2006; Romski & Ruder, 1984; Schlosser et al., 2013) (Figure 12).	 Figure 12. *Effects of intervention on sentence comprehension*
Literacy comprehension As seen in Figure 13, one study resulted in complete effects on literacy comprehension (Browder et al., 2008). Three studies resulted in partial or mixed effects on literacy comprehension (Bailey et al., 2011; Mims et al., 2009; Shurr & Taber-Doughty, 2012).	 Figure 13. *Effects of intervention on literacy comprehension*

Quality of evidence obtained from the different AAC interventions is presented in Figure 14. Eleven studies were rated as conclusive, three were rated as preponderant and seven were rated as suggestive. Two studies were rated as inconclusive. The use of augmented input strategies and symbols resulted in the most conclusive evidence.

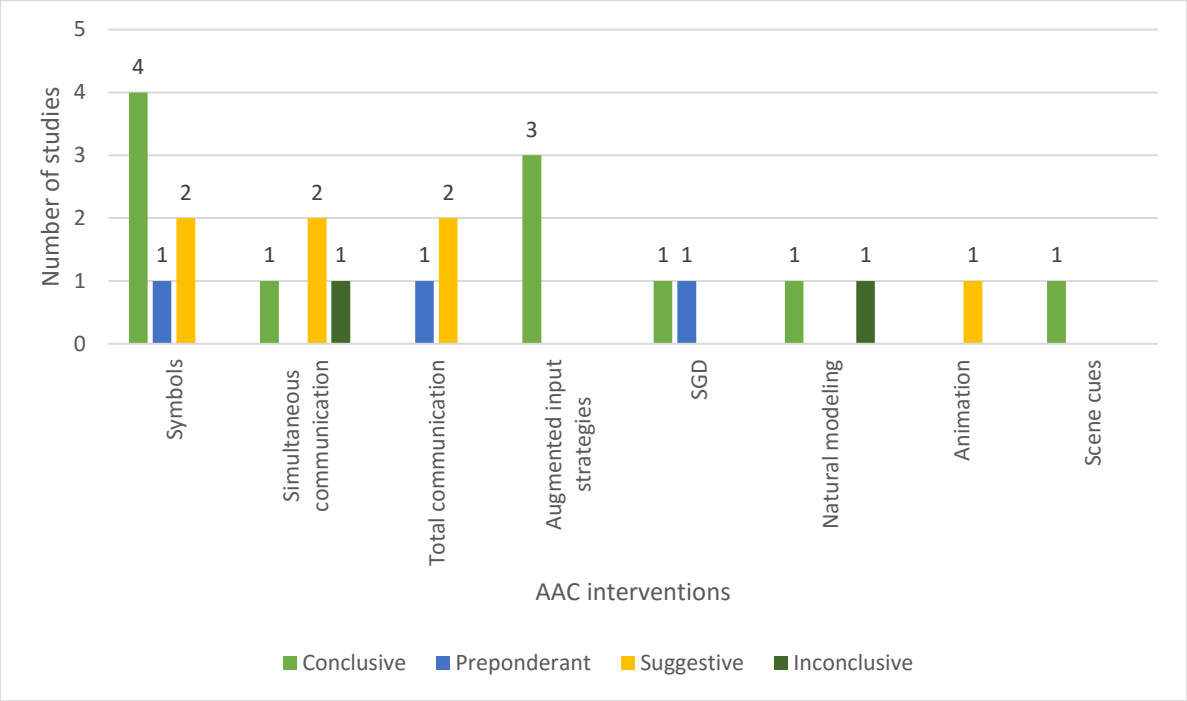


Figure 14. *Quality of evidence per intervention strategy*

Twenty-three studies met the inclusion criteria and were included in this scoping review. An overview of these studies has been provided in terms of number of publications, participant characteristics, research design, AAC interventions, intervention outcomes, intervention effects, and quality appraisal. The majority of the studies were conducted in the last decade, between 2006 and 2017. In addition, the majority of the studies included male participants, with a focus on children below four years of age. A single-subject research design was used most frequently. A trend in the use of aided augmented input was found. A lack of clear descriptions of the interventions in terms of a specific aided augmented input strategy was seen. The following receptive language skills were addressed in the various studies: word comprehension, symbol comprehension, sentence comprehension, and literacy

comprehension. The majority of the interventions resulted in complete effects on the dependent variables.

Three strands of research were identified: (i) the effects of unaided AAC interventions, (ii) the effects of aided AAC interventions, and (iii) a comparison of two AAC interventions. These strands of research are discussed in the sections that follow.

3.5 The effects of unaided AAC intervention on the receptive language skills of children with developmental disabilities

The five studies (Acosta, 1981; Kennedy, 1994; Poulton, 1981; Romski & Ruder, 1984; Weller & Mahoney, 1983) that evaluated the effects of unaided AAC interventions on the receptive language skills of children with developmental disabilities are summarised in Table 9 in order of the quality of evidence of each study. Four of the studies were conducted between 1980 and 1985 and one study was conducted in 1994. A total number of 59 children, ranging in age from 1 years 6 months to 14 years 2 months (mean age of five years) participated in the study. The majority of the participants were male (*n* = 31; 63.3%) and 36.7% were female (*n* = 18). One study with ten participants did not specify the gender of the participants. Three studies focused on children with DS and two studies included children with autism. PDD, CP and DD were each included in one study. One study included participants with a variety of disabilities. A single-subject design was used for three of the studies and a group design was used for the other two studies.

Total communication (*n* = 3) and simultaneous communication (*n* = 2) were the unaided AAC interventions that were included in the studies. A trend in addressing word comprehension (*n* = 4) is noticed, with the fifth study addressing phrase comprehension. In terms of effect, one study proved to be completely effective and four were partially effective. Three of the studies were appraised as providing suggestive evidence, one was classified as preponderant and the final study was classified as inconclusive.

As the majority of the studies were conducted between 1980 and 1985, more recent studies into the effects of unaided AAC intervention on the receptive language abilities of children with developmental disabilities are needed. Goldbart and Caton

(2010) also found that unaided AAC approaches do not appear to have been the subject of recent evaluation studies.

The majority of the studies addressed word comprehension. This is in line with the literature; Mirenda (2003) noted that almost all of the research studies in the area of total communication were designed to teach receptive or expressive *labels*. Further research into the effects of unaided AAC interventions on other aspects of receptive language would be of interest. In addition, further research using other unaided AAC interventions, such as Makaton, may be useful. None of the included studies used Makaton as the intervention in the study, despite Makaton being used in over 40 countries worldwide (Sheehy & Duffy, 2009).

In the literature, unaided AAC approaches, such as manual signing, have been found to be significantly more effective than aided approaches, such as graphic symbols, in the acquisition of new communicative behaviours (Mirenda, 2003; Schlosser & Lee, 2000). Therefore, further research on the effects of unaided AAC interventions on the receptive language skills of children with developmental disabilities would be of interest.

Table 9

Studies on the effects of unaided AAC interventions

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable	Effect	Appraisal
1. Acosta (1981)	To investigate the effects of the use of total communication on receptive vocabulary acquisition	1: 3, DS 2: 4;11, DS 3: 3;5, DS 4: 4;6, DS	Multiple baseline across subjects design with reversals	Total communication (TC) or oral communication	Vocabulary acquisition	Complete Level of correct responding in oral phases did not reach criterion for any participant. In TC phases the opposite was true. Plots of mean values showed ascending trends for all TC phases for all participants.	Preponderant; strong design; IOA and TI not reported.
2. Kennedy (1994)	To investigate the impact of total communication on comprehension	1= 5;8, CP 2= 4;11, DD 3= 4;3, PDD 4= 4;11, PDD 5= 4;5, PDD 6= 3;6, PDD 7= 3;7, PDD 8= 3;9, DD 9= 5;1, PDD 10= 6;2, PDD 11= 7;0, DD 12= 5;4, DD 13= 4;2, CP 14= 2;3, DD 15= 2;4, DD 16= 2;1, BD 17= 1;6, DD 18= 2;6, LD 19= 2;10, DD 20= 2;8, DD 21= 1;8, CP 22= 2;1, DD 23= 2;5, LD 24= 2;11, PDD 25= 2;4, BD 26= 2;6, PDD	Group	Total communication	Comprehension gain score (post-test score minus pre-test score) Word comprehension	Partial/mixed A highly significant main effect for intervention was found. TC gain score was significantly higher than the speech only gain score and significantly higher than both speech-only and control word scores considered together.	Suggestive: flaw in design; inadequate IOA; TI not reported

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable	Effect	Appraisal
		27= 2;6, BD					
3. Poulton (1981)	To investigate the effects of the components of simultaneous communication on language comprehension in autistic children	A: 14;2, autism B: 8;6, autism C: 7;10, autism	Single-subject	The three components of simultaneous communication 1. Signs 2. Speech 3. Signs and speech together	Comprehension of object labels Word comprehension	Partial One separate component of SC is the most effective teaching method for a given participant and that particular component is just as effective alone as it is when combined in SC.	Suggestive: sound design; IOA and TI not reported.
4. Wellller & Mahoney (1983)	To compare the relative effectiveness of oral and total communication modalities in a language intervention program	Between 1;6 and 3 years. Down syndrome	Pre-test post-test group design	Oral or Total communication	Word and sign comprehension	Partial There were group differences approaching significance for the treatment factor. Results indicated that the TC group possessed a greater Total Lexicon than the Oral Language group.	Suggestive: flaw in design; IOA and TI not reported
5. Romski & Ruder (1984)	To compare the effects of speech and speech + sign instruction on the comprehension of action + object relational meanings	1: 3;11, DS 2: 4;3, DS 3: 4;5, DS 4: 4;9, DS 5: 5;2, DS 6: 6;4, DS 7: 6;11, DS 8: 7;2, DS 9:7;2, DS 10: 7;10, DS	Single-subject	Speech or speech + sign instruction	Comprehension of action + object relational meanings Phrase/ sentence comprehension (relational meanings)	Partial 7/10 children took fewer trials to reach criterion (100%) in the Speech-Sign condition than in the Speech condition. There were no significant differences between instruction using speech and speech paired with manual signs.	Inconclusive: flaw in design; IOA adequate or better; TI not reported

3.6 The effects of aided AAC intervention on the receptive language skills of children with developmental disabilities

Table 10 provides a summary of 15 studies that evaluated the effects on an aided AAC intervention on the receptive language skills of children with developmental disabilities. Two studies were conducted between 2000 and 2005, eight between 2006 and 2010, and five between 2011 and 2017. A total number of 191 children, ranging in age from 2 years 3 months to 18 years (mean age of 7 years, 8 months) participated in the study. The majority of the participants were male (*n* = 117) and a smaller percentage was female (*n* = 74). The majority of the studies included children with DS (*n* = 4 studies) and intellectual disability (*n* = 4 studies), followed by CP (*n* = 3 studies), multiple disabilities (*n* = 3 studies), autism (*n* = 3 studies) and DD (not specified) (*n* = 2 studies). Other disabilities were also included. These disabilities include apraxia and closed head trauma. Several studies included more than one developmental disability.

A single-subject design was used for the majority of the studies (*n* = 10). Of these studies, two studies included two participants, two studies included three participants, four studies included four participants, one study included five participants, and one study included 16 participants. The number of participants included in the various studies using a single-subject design meets the standards set forth by Horner et al., (2005), as multiple participants are typically included in a single study using a single-subject design. Five studies used a group design of which one was a randomised control group design.

The following AAC interventions were included in the 15 studies: use of symbols (*n* = 7), Aided Language Stimulation (*n* = 2), natural modelling (*n* = 2), speech-generating device (*n* = 2), Aided Language Modelling (*n* = 1) and animation (*n* = 1). Symbol comprehension was the most common dependent variable (*n* = 6). This was followed by word comprehension (*n* = 4), literacy (*n* = 4) and sentence comprehension (*n* = 1).

Of the studies, nine were appraised as providing conclusive evidence, two were classified as preponderant, three were appraised as suggestive, and three were classified as inconclusive. Eight studies were considered completely effective, five were considered partially effective and two were considered ineffective.

All of the studies involved aided augmented input, yet the majority of the interventions were not referred to as being a specific aided augmented input strategy. This highlights a gap in the literature. General descriptions of interventions instead of explicitly stating the specific intervention package components was also described in the systematic review by Sennott et al. (2016). A need for clarity on the definitions of aided augmented input strategies is needed. A need for studies investigating the effects of SAL on the receptive language skills of children with developmental disabilities is identified, as none of the included studies used this aided augmented input strategy. Surprisingly, considering the mobile technological revolution in the AAC field (McNaughton & Light, 2013; Shane et al., 2012), there were no studies utilising mobile technologies to provide aided augmented input. Further research with application to the effects on receptive language skills is required. In addition, a gap in research on the recent developments in AAC input interfaces such as visual scene displays, scene cues and animated graphic symbols is noticed and is supported by the literature, which has also identified such a need (Schlosser & Koul, 2015). A trend in the use of graphic symbols (n = 5) was found. Aided AAC intervention with the use of graphic symbols has resulted in quicker acquisition of the AAC system over unaided interventions. This may be due to the graphic symbol functioning as a prompt or reminder (Gervarter et al., 2013). Tangible symbols are also applicable in AAC interventions for individuals with developmental disabilities. Compared to other AAC options, such as manual signs or abstract graphic symbols, tangible symbols place relatively low demands on memory and representational skills (Roche et al., 2014). A gap in the research on the effects of tangible symbols on receptive language skills of children with developmental disabilities was identified with this scoping review and should be addressed in future research.

A gap in the research on the effects of AAC interventions on sentence, grammar and discourse comprehension was identified. This is supported by Romski et al. (2015), who suggested that language interventions for young children who rely on AAC should target language skills beyond single word vocabularies in order to take a child through the stages of language development.

Table 10

Studies on the effects of aided AAC interventions

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
6. Bailey, Angell and Stoner (2011)	To determine the effects of a structured intervention package on sound-to-letter matching skills and decoding of novel words	Lucy, 15, DS Randy, 15, ASD. Amy, 12, ASD. Matthew, 13, ASD	Single subject multiple baseline replicated across participants	Use of symbols in a direct, structured literacy intervention	Sound-to-letter matching skills and single-word decoding tasks involving novel words (Literacy)	Partial Gains were observed for two participants in the whole-word decoding task. Two participants did not make consistent or lasting progress in word decoding.	Conclusive: Sound design, adequate or better IOA and TI
7. Dada & Alant (2009)	To describe the effects of aided language stimulation on the acquisition of target vocabulary items	A: 8;5, CP B: 10;1, CP C: 8;1, CP D: 12;1, DS	Single-subject, multiple probe across three activities, replicated across four participants	The aided language stimulation provided to a teaching criterion of five sessions	The number of target items identified when responding to verbal stimuli (Vocabulary acquisition)	Complete The introduction of the aided language stimulation programme facilitated the acquisition of the target vocabulary items for that activity. This performance was maintained during the weeks when aided language stimulation ceased for that particular activity.	Conclusive: Strong design, adequate or better IOA and TI
8. Drager, et al., (2006)	To examine the effectiveness of aided language modelling on symbol comprehension and expression	Maggie: 4;5, ASD Sam: 4;0, ASD	Single-subject multiple baseline design across sets of symbols	Aided language modelling	a.) Number of target items correctly identified when responding to graphic and verbal stimuli b.) Number of target items correctly identified when responding to graphic stimuli only c.) Number of target items correctly identified when	Complete The results of this investigation demonstrated that ALM was an effective intervention to increase symbol comprehension.	Conclusive: Strong design, adequate or better IOA and TI

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
					responding to verbal stimuli only d.) Number of referents correctly labelled using graphic symbols		
9. Harris & Reichle (2004)	To determine whether aided language stimulation increased symbol comprehension	Jennie: 3;10, DS; Niles: 5;4, DS; Edie: 4;2, unspecified	Single-subject, multiple probe design across symbol sets/activities	Aided language stimulation	Symbol comprehension	Complete The number of instructional opportunities required to meet the pre-established acquisition criterion decreased considerably for two of the children after the introduction of the second symbol set. Niles showed a 54% decrease in instructional opportunities required to reach criterion for Symbol Set 2, and Edie showed a 75% decrease in instructional opportunities required to reach criterion for Symbol Set 2. The number of teaching opportunities required to reach criterion for Symbol Set 3 was nearly identical to that required for Symbol Set 2 for Niles and for Edie. Although Jennie only showed a 10% decrease in instructional opportunities required to reach criterion for Symbol Set 2, she displayed a 50% decrease in instructional opportunities required to reach criterion for Symbol Set 3 (compared to Symbol Set 2).	Conclusive: sound design, adequate or better IOA and TI

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
10. Ho (2000)	To compare the effectiveness and efficiency of modelling to PA instruction for teaching graphic symbols to young children	1: 7;8, CP 2: 4;7, CP 3: 5;10, CP	Single-subject parallel-treatment design	Teaching symbols by modelling symbol use in a natural context during a storybook reading activity, and; teaching symbols through paired-associate instruction	The percentage of symbols accurately identified Number of sessions to criterion	No effect: higher percentage of symbols identified for PA word sets rather than modelling word sets.	Conclusive: Sound design, adequate or better IOA and TI
11. Mims, et al. (2009)	The study evaluated whether a least-a-most prompting system would increase the number of independent comprehension responses during a story-based lesson	1: 6, CP+VI 2: 9, CP+VI	Multiple probe across materials design with concurrent replications for two students	Objects embedded in story book	The number of correct independent selections of one or two objects to answer comprehension questions asked throughout the read aloud of the story.	Partial Increase from baseline, after intervention seen across participants and books. Criterion for success not mentioned.	Conclusive: Sound design, adequate or better IOA and TI
12. Preis (2006)	To compare the presence or absence of pictures when giving verbal directions and to examine which condition generalised and maintained over time	Susan: 6;0, ASD Aaron: 6;0, ASD Colleen: 6;7, ASD John: 6;1, ASD Kirsten: 5;3, ASD	Single subject alternating treatments design	Presence or absence of pictures	Follow-through of command Sentence comprehension	Complete The results of the study indicated that there was no therapeutic difference between treatments for the participants' response to verbal requests presented with a picture communication symbol (Treatment A) during the initial acquisition of verbal commands.	Conclusive: sound design, Adequate or better IOA and TI

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
13. Romski et al. (2010)	To compare the symbolic language development of children who were randomly assigned to one of three early parent-coached language interventions; spoken communication, augmented communication input and augmented communication output	Mean age: 2;6, Developmental delay	Group	Spoken communication (SC) Augmented communication input (AC-I) Augmented communication output (AC-O)	Vocabulary acquisition	Complete Tukey ad hoc test revealed that the SC group mean was significantly lower than both the AC-O and AC-I group means at session 24, with regards to vocabulary size.	Conclusive: sound design, adequate or better IOA and TI
14. Shurr & Taber-Doughty (2012)	To combine visual supports and discussions to read-alouds to enhance the comprehension abilities of typical age-appropriate texts	Sarah: 14, ID Ellen: 14, ID William: 15, multiple Louis: 12, ID	Single subject, multi-probe across participants	A combined intervention with visual support as well as discussion	The student's response to a series of four multiple-choice questions about the text content (Literacy)	Partial Intervention indicated stability or upward trending across all participants. Louis: 43% rise over baseline mean Sarah: 39% rise over baseline mean Ellen: 30% rise over baseline mean William: 58% rise over baseline mean	Conclusive: strong design, adequate or better IOA and TI
15. Barton, Sevcik & Romski (2006)	To determine the effects of using a computerised medium and observational experience on the learning of arbitrary	1: 3;3, Apraxia & DD 2: 3;3, DD 3: 2;4, Apraxia & DD 4: 3;8, No formal diagnosis	Observational experience	Use of graphic symbols (Blissymbols and lexigrams), using an observational language learning strategy	Symbol comprehension	Partial In comprehension, three out of four participants demonstrated at least emerging symbol-referent relationships.	Preponderant: strong design, IOA not mentioned but the computer was programmed to show symbols for

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
	lexigram-referent relationships versus comparatively more iconic Blissymbol-referent relationships						three seconds, followed by the word being said in digitised speech. TI not reported.
16. Lee, Jeong & Kim (2013)	To investigate the efficacy of AAC intervention using a VOCA in improving communicative behaviours	1: 11;1, HL+MR 2: 11;0, HL +MR+CP 3: 9;7, HL+MR 4: 6;7, HL+MR+CP 5: 5;10, HL+MR	One-group pre-test and post-test design	AAC intervention using a VOCA	General performance and communicative behaviours (Vocabulary acquisition)	Complete The results revealed that performance on three formal tests demonstrated that all children exhibited significant improvement after AAC intervention.	Preponderant: sound design, adequate or better IOA, TI not reported
17. Browder, et al. (2008)	To evaluate the impact of a curriculum (Early Literacy Skills Builder) on language and early literacy skills	Mean age in treatment group: 9;36 Diagnosis: intellectual disability	Randomised control group design	The type of reading instruction: Early Literacy Skills Builder curriculum or sight words and pictures.	Two measures created for the study: Nonverbal Literacy Assessment (NVLA) and Early Literacy Skills Assessment (ELSA). Two standardised measures: Peabody Picture Vocabulary Test (PPVT-II) and two subtests of Woodcock Language Proficiency Battery (WLPB) (Memory for Sentences and Letter-word Identification) (Literacy)	Complete There were large effect sizes for all the measures of the treatment group. The effect sizes for the control group were small to moderate, except for one measure which was large.	Suggestive: sound design, IOA inadequate, TI adequate or better

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
18. Fujisawa, Inoue, Yamana & Hayashi (2011)	To examine the effects of animated symbols on the comprehension of action verbs	A: 12;1, ID B: 17;2, ID C: 18:0, ID D: 15;6, ID E: 11;4, ID F: 16;4, ID G: 18;0, ID H: 17;0, DS I: 17;8, ID J: 18;0, DS K: 11;9, CP L: 17;10, ID M: 17;6, ID N:17;3, ID O: 17;8, ID P: 17;3, ID	Within subject	Animation	Comprehension of action words	Partial/mixed The results showed that the recognition of pictograms was better in the experimental condition than in the control condition, indicating that animation provided the participants with valuable learning cues to name each static symbol correctly.	Suggestive: sound design, IOA and TI not reported
19. Trief, Cascella & Bruce (2013)	To track the rate of identification of symbols by each participant	3- 5;11: 16 participants 6- 11.11: 14 participants 12 to 21;11: 14 participants Multiple disabilities	Pre-test post-test group design	Use of tangible symbols during daily activities	Rate of identification of symbols (Symbol comprehension)	No Objective pre- and post-intervention data found no measurable gains in the participants' identification of tangible symbols.	Suggestive: flaw in design, IOA not reported, adequate or better TI

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/ AAC intervention	Dependent variable/ Intervention outcome	Effect	Appraisal
20. van der Schuit, et al. (2010)	To explore the effectiveness of an intervention, the KLINc Studeo designed to increase a broad range of early language, literacy and communication skills	1: 2;9, psychomotor disability 2: 3;4, psychomotor 3: 4;2, VSF syndrome 4: 3;4, Cognitive disability (cog dis). 5: 4;5, cog dis 6: 2;11, cog dis 7: 4;0, ASD 8: 5;0, DS 9: 5;3, DS 10: 6;8, psychomotor	Group	Multifaceted and experiential intervention programme: “Kids Learning to take Initiatives in communication” (KLINc Studio) Anchor-based intervention: incorporation of AAC into the learning environment in the most natural way possible	Vocabulary acquisition	Complete Highly significant progress and large effects sizes for all of the curriculum-based tests across all of the anchored cycles was obtained. All of the children made significant gains in both receptive and expressive language during the nine-week anchored cycles.	Inconclusive: sound design but IOA and TI not reported

3.7 Comparisons of AAC interventions

The three studies that compared one AAC intervention with another are summarised in Table 11. A total number of 20 children, ranging in age from 3 years 9 months to 16 years 8 months (mean age of 8 years, 1 months) participated in the study. The majority of the participants were male (55%, *n* = 11) and a smaller percentage was female (45%, *n* = 9). Types of disabilities included in the studies are: Down syndrome (*n* = 1), autism (*n* = 1) and intellectual disability (*n* = 2). A single-subject design was used for all three of the studies.

The following AAC interventions were compared in the three studies: dynamic versus static scene cues (*n* = 1), extensive versus mediated sign training using simultaneous communication (*n* = 1), and extensive versus differential sign training using simultaneous communication (n = 1). Word comprehension was studied in two of the studies and sentence comprehension was studied in the third. Two of the studies were appraised as providing conclusive evidence, the third study was appraised as providing suggestive evidence. Two studies showed partial effects on receptive language skills, one study showed complete effects.

There is a gap in the research where two AAC interventions are compared, based on this scoping review. The comparison of AAC interventions may help in the decision-making process. Comparison efficacy studies help to inform the decision-making process but appraisal of the research evidence is needed to identify the best and current research evidence (Schlosser, 2003; Schlosser & Sigafoos, 2006). The studies in this scoping review that compared two AAC interventions either compared two aided AAC interventions or two unaided AAC interventions. Therefore, a gap in the research is noticed in the comparison of unaided and aided interventions. Similar findings were found by Mirenda (2003), who concluded that a need for focused, systematic research is present, which directly compares unaided and aided AAC approaches.

Table 11

Comparisons of two AAC interventions

Study	Purpose	Participants (name/N, CA [years], diagnosis	Design	Independent variable/AAC interventions	Dependent variable/ Intervention outcomes	Effect	Appraisal
21. Schlosser et al. (2013)	To compare spoken input to too augmented input modalities in terms of their effects on the ability of children with autism to carry out directives	1: 8;1, Autism 2: 10;9, PDD 3: 5;6, Autism 4: 3;9, PDD 5: 14;8, Autism 6: 8;10, Autism 7: 6;2, Autism 8: 6;10, PDD 9: 16;8, Autism	Within subjects design	Directives assigned to one of three conditions: 1. Spoken 2. Spoken + static scene cues 3. Spoken + dynamic scene cues	The accuracy with which a child followed the experimenter's directive	Complete (Both dynamic and static scene cues were significantly more effective than spoken input condition).	Conclusive: sound design, adequate or better IOA and TI
22. Remington & Clarke (1993a)	To compare the efficacy of Extensive and Mediated Sign Training for ensuring the speech comprehension functions were present at the termination of sign training using simultaneous communication	Study 1: Mick: 12;6, phenylketonuria Gary: 12;5, unknown Tina: 10;4, DS Dave: 11;6, DS Study 2: Bill: 12;10, unknown Linda: 6;8, DS	Single subject alternating treatment design	Extensive or Mediated Sign Training	Speech comprehension	Partial All four of the participants met criterion in the Extensive condition. Only two reached criterion in the Mediated condition before training was stopped. With the exception of one participant, who did not learn any speech comprehension functions in either condition, all children developed some skills as a result of training.	Conclusive: Sound design, adequate or better IOA and TI
23. Remington & Clarke (1993b)	To compare whether Extensive or Differential Sign Training was more effective in removing or reducing stimulus over-selectivity	Dawn: 4;3, DS Neil: 5;3, DS Keith: 6;2, DS Linda: 7;9, DS Tina: 11;5, DS	Single subject alternating treatments design	Extensive of Differential Sign training	Word and sign comprehension	Partial Improvements in speech comprehension were generally a function of the manual sign training in the Differential condition. The first stage of the Extensive training procedure was far less successful in terms of facilitating speech comprehension performance.	Suggestive: sound design, adequate or better IOA, TI not reported

3.8 Limitations

An attempt was made to locate unpublished theses and dissertations. This resulted in the inclusion of three theses. Although this is more than what most systematic reviews and scoping reviews in AAC have done to retrieve unpublished documents (Millar et al., 2012; Schlosser & Koul, 2015; Schlosser & Wendt, 2008; Sennott et al., 2016), we cannot completely rule out publication bias. Additionally, the search strategy was restricted to studies published in English. Therefore, it cannot be ruled out that the findings are due to a language bias (Schlosser & Wendt, & Sigafoos, 2007). Thirdly, this review used a certainty of evidence framework for quality appraisal of the included studies. This entailed an assessment of (i) design, (ii) inter-observer agreement, and (iii) treatment integrity. The results of the quality assessment may not generalise to other quality appraisal tools (Schlosser & Koul, 2015). Additionally, although the author coded all of the studies, it is acknowledged that the second coder coded one of her own studies (Schlosser & Wendt, 2008). Furthermore, as randomised-controlled trials are scant in the field of AAC, other research designs had to be included and certain study design restrictions could not be enforced (Schlosser et al., 2007). This is not so much a limitation of this review but a limitation in the research base. Also, the research base did not permit a subgroup analysis of the findings for specific subtypes of developmental disabilities (e.g., autism). Lastly, there is a significant gap in the literature in terms of limited conclusive data addressing the impact of AAC interventions on adolescents with developmental disabilities, as well as the disability groups represented, as the population of individuals with developmental disabilities is diverse (Sennott et al., 2016).

4. CONCLUSIONS AND RECOMMENDATIONS

Research activity (23 studies including 270 participants) on the effects of AAC interventions on the receptive language skills of children with developmental disabilities is indicated by the evidence map generated by this scoping review (Schlosser & Koul, 2015). This includes research in three areas: (i) unaided AAC interventions, (ii) aided AAC interventions, and (iii) comparison of two AAC interventions. The body of research on the use of aided AAC interventions on receptive language skills is ripe for a focused systematic review. There are some high-quality studies demonstrating that aided AAC interventions support the receptive language skills of children with developmental disabilities.

Further research into the use of unaided AAC interventions and its effects on receptive language skills would be useful. Additionally, future research on the effects of AAC interventions on receptive language skills should target adolescents as the majority of the studies in this scoping review focused children below ten years of age. It may also be interesting to determine whether AAC interventions are effective at addressing receptive language skills across the lifespan. A need for research on the effects of AAC intervention on grammar and discourse intervention was identified in the scoping review. The use of mobile technology and its effects on receptive language skills would be of interest, considering the mobile technology revolution in the AAC field (Light & McNaughton, 2013; Schlosser & Koul, 2015; Shane et al., 2012). A need for better clarity on the various aided augmented input strategies was identified due to the high number of aided AAC interventions that did not specify a specific augmented input strategy. In addition, research into new AAC input interfaces such as visual scene displays, scene cues and animated graphic symbols would be of interest (Schlosser & Koul, 2015). Comparison efficacy studies aimed at addressing receptive language skills appear to be lacking, therefore future research comparing the effects of two or more AAC interventions on receptive language skills of children with developmental disabilities would be valuable, especially considering how this may guide decision-making processes. Research with larger, more heterogeneous samples of participants is needed.

Future research should be designed with sufficient methodological rigour in order to establish experimental control, ensure the reliability of the dependent

measures of receptive language skills and ensure appropriate AAC intervention integrity (Millar et al., 2006).

AAC interventions offer meaningful outcomes in terms of receptive language skills for children with developmental disabilities. This scoping review provides valuable preliminary evidence and promising results that AAC interventions support receptive language skills of children with developmental disabilities. Further intervention development and research on AAC interventions and the effect on receptive language skills would be valuable.

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Appendix A

Ethical Clearance

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Humanities
Research Ethics Committee

2 December 2016

Dear Prof Bornman

Project:	**The effect of augmentative and alternative communication interventions on the receptive language skills of children with developmental disabilities: A systematic review**
Researcher:	**C Flores**
Supervisor:	**Prof S Dada**
Department:	**Centre for Augmentative and Alternative Communication**
Reference number:	**23048672(GW20161132HS)**

Thank you for the application that was submitted for ethical consideration.

I am pleased to inform you that the above application was **approved** by the **Research Ethics Committee** on 1 December 2016. Data collection may therefore commence.

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

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

We wish you success with the project.

Sincerely

pp.

Prof Maxi Schoeman
Deputy Dean: Postgraduate Studies and Ethics
Faculty of Humanities
UNIVERSITY OF PRETORIA
e-mail:tracey.andrew@up.ac.za
Kindly note that your original signed approval certificate will be sent to your supervisor via the Head of Department. Please liaise with your supervisor.

Appendix B

Pilot searches in ERIC, Academic Search Complete, PsychINFO and LLBA

	Preliminary search 1	Preliminary search 2	Preliminary search 3	Preliminary search 4	Final search
Search concept 1	Disab* OR development* delay* OR “special needs” OR impairment OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab* OR development* delay* OR “~~special~~ needs” OR ~~impairment~~ OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab* OR ~~development* delay* OR OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”~~	Disab*	Disab*
Search concept 2	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	child* OR ~~youth OR adolescen* OR teenage* OR toddler* OR infan* OR~~ pediatric OR paediatric	child* OR pediatric OR paediatric	child* OR pediatric OR paediatric
Search concept 3	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication"	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR **symbol** OR **“graphic symbol”**	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR ~~“scene cues” OR “speech technology”~~ OR “speech generating device*” OR “voice output communication aid*” OR ~~"synthetic speech" OR "digital speech"~~ OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR symbol OR “graphic symbol”	Augmentative and alternative communication OR communication aid* OR "communication system*" OR ~~augmented input~~ OR “~~aided language stimulation~~” OR ~~“system for augmenting language~~” OR “~~natural aided language~~” OR ~~aided modelling OR~~ “speech generating device*” OR “voice output communication aid*” OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR symbol OR “graphic symbol”	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “speech generating device*” OR “voice output communication aid*” OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR symbol OR “graphic symbol”
Search concept 4	Comprehension OR receptive language OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	

Appendix C

Pilot searches in Medline

	Preliminary search 1	Preliminary search 2	Preliminary search 3	Preliminary search 4	Final search
Search concept 1	Disab* OR development* delay* OR “special needs” OR impairment OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab* OR development* delay* OR “~~special~~ ~~needs~~” OR ~~impairment~~ OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab*	Intellectual disability OR language development disorders	Intellectual disability
Search concept 2	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	Child OR pediatric OR paediatric		Autistic disorder
Search concept 3	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication"	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR **symbol** OR **“graphic symbol”**	Communication Aids for Disabled OR “total communication” OR “manual communication” OR “sign language” OR “gestures”	Language OR manual communication OR sign language OR communication aids for disabled	Communication aids for disabled
Search concept 4	Comprehension OR receptive language OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	Comprehension OR understand*	Comprehension	Language development disorder

Appendix D

Pilot searches in CINAHL

	Preliminary search 1	Preliminary search 2	Preliminary search 3	Preliminary search 4	Final search
Search concept 1	Disab* OR development* delay* OR “special needs” OR impairment OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab* OR development* delay* OR “~~special~~ ~~needs~~” OR ~~impairment~~ OR autis* OR “pervasive developmental disorder” OR “down syndrome” OR “cerebral palsy”	Disab*	Developmental disabilities OR Intellectual disability	Intellectual disability
Search concept 2	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	child* OR youth OR adolescen* OR teenage* OR toddler* OR infan* OR pediatric OR paediatric	Child OR pediatric OR paediatric		
Search concept 3	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication"	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR “natural aided language” OR aided modelling OR “scene cues” OR “speech technology” OR “speech generating device*” OR “voice output communication aid*” OR "synthetic speech" OR "digital speech" OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR **symbol** OR **“graphic symbol”**	Augmentative and alternative communication OR communication aid* OR "communication system*" OR augmented input OR “aided language stimulation” OR “system for augmenting language” OR aided modelling OR “~~scene cues” OR “speech technology”~~ OR “speech generating device*” OR “voice output communication aid*” OR ~~"synthetic speech" OR "digital speech"~~ OR gesture* OR “finger spell*” OR “manual sign*” OR sign* OR "simultaneous communication" OR symbol OR “graphic symbol”	Alternative and augmentative communication OR communication aids for disabled OR nonverbal communication OR sign language OR communication methods, total	Alternative and augmentative communication
Search concept 4	Comprehension OR receptive language OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	Comprehension OR “receptive language” OR understand* OR interpret* OR receptive vocabulary	Language development OR vocabulary	Language disorders

Appendix E

Yield of each pilot search

	Preliminary search 1	Preliminary search 2	Preliminary search 3	Preliminary search 4	Final search
ERIC	1345	1067	684	40	687
Academic Search complete	4180	3269	2178	124	2218
PsychINFO	4902	3892	2075	138	2092
LLBA	180	91	31	33	31
Medline	564	446	1681	2	11
CINAHL	153	1248	668	-	343

Appendix F

Title and Abstract Screening Relevance Tool

The effect of augmentative and alternative communication on the receptive language skills of children with developmental disabilities: A scoping review.

Title and Abstract Relevance Screening Tool

Title of article:_____

Authors:_____
Year:_____

1. Does the citation report on **children** (younger than 18)?
   - ☐ Yes
   - ☐ No
   - ☐ Can't tell

2. Does the citation report on a **developmental disability?**
   - ☐ Yes
   - ☐ No
   - ☐ Can't tell

3. Does the citation include an intervention classified as being within the **scope of AAC?** (See Table 2 for a list of AAC interventions)
   - ☐ Yes
   - ☐ No
   - ☐ Can't tell

4. Is the citation published in English?
   - ☐ Yes
   - ☐ No
   - ☐ Can't tell

Reviewer Decision:

- If the reviewer answered NO to any of the questions, the citation will be excluded.
- If the reviewer answered YES to all questions, the article will be included for full-text screening.
- If the reviewer answered CAN'T TELL to any or all of the questions, the article will be included for full-text screening

Table 1
Summary of the inclusion and exclusion criteria

Criteria	Inclusion Criteria	Exclusion Criteria
Population	Children 0 – 18 years old	All those older than 18 years
Population	Children who have a developmental disability, including but not limited to: - autism, - autism spectrum disorder, - intellectual disability, - related syndromes (e.g. Downs) - cerebral palsy	Children with typical development Children diagnosed with mental health disorders Children with a hearing impairment (with or without hearing aids and/or cochlear implants) and no other concomitant disabilities Children with visual impairments and no other concomitant disabilities Children with a specific language impairment, learning disabilities/difficulties, dyslexia, developmental language delay Children who are poor readers and/or late talkers
AAC intervention	The intervention should be classified as being within the scope of AAC: 'an area of research,clinical and educational practice. AAC involves attempts to study and when necessary compensate for temporary or permanent impairments, activity limitations, and participation restrictions of individuals with severe disorders of speech-language production and/or comprehension, including spoken and written modes of communication' (ASHA, 2005). An AAC intervention should facilitate a child's communicative competence through the use of multiple communication modalities that supplement ("augmentative") or replace ("alternative") natural speech (Light, Beukelman, & Reichle, 2003; Schlosser & Wendt, 2008). Please see Table 2 for a list of possible AAC interventions	Pseudoscientific interventions such as facilitated communication training (FCT) or Rapid Prompting Method Interventions using audio-taped instruction (video modelling and no spoken input) Reading word/text Direct teaching of symbols or interventions focused on teaching symbols (e.g. effect of iconicity) with no AAC intervention Effects of different display designs, use of colour Behaviour analysis training interventions Discrimination training Picture Exchange Communication System
Design	Experimental design (including true experimental, quasi-experimental and single subject experimental designs (SSED), group designs)	- Pre-experimental designs (e.g. AB designs, pre-post designs) - Case studies (including use of two case studies), literature reviews, systematic reviews, meta-analysis, scoping reviews

		- Opinion pieces, policy reviews, editorials - Qualitative studies - Mixed method designs - Observational studies - Assessment using different measures - Comparisons to typical development without intervention
Time period	Published between January 1970 and February 2017. As an independent field, AAC has been recognised since the 1970s.	All publications prior to January 1970
Outcome/ Concept of receptive language skills	- **Receptive language** is the understanding of linguistic information - It is synonymous with language comprehension - Aspects of receptive language include comprehension of: ○ **Vocabulary**: comprehension on a single word level ○ **Grammatical morphology:** the internal organisation of words. A morpheme is the smallest grammatical unit ○ **Syntax**: governs the form or structure of a sentence. These rules specify word, phrase and clause; sentence organisation; relationship between words, word classes and other sentence elements ○ **Discourse:** understanding language on a conversational level ○ **Literacy:** the act of reading, decoding and comprehending language (Shurr & Taber-Doughty, 2012) ○ **Symbols:** "something that stands for or represents another thing or concept" (Alant, Bornman & Lloyd, 2006, p. 145). For example, 3D objects, pictures with a high resemblance to their referents, line drawings (coloured and black and white), and abstract forms such as Blissymbols, lexigrams and printed words	Expressive language skills - Expressive vocabulary development - Sentence production - Spelling skills - Narrative skills Interaction skills Pragmatics; including humour comprehension and facial expression comprehension Attitudes of others towards persons who rely on AAC Learnability, translucency, iconicity Parents perceptions and understanding of AAC Intelligibility Emotion comprehension Studies that use gaze fixation or looking at the symbol/object/ photograph as an indication of comprehension

Table 2
List of AAC intervention terms that may be applicable

Augmentative and alternative communication	Speech technology
Communication aid	Speech generating device (SGD)
Communication system	Voice output communication aid (VOCA)
Augmented input	Synthetic speech
Aided language stimulation (AiLgS)	Digital speech
System for augmenting language (SAL)	Finger spelling
Natural aided language	Manual sign
Aided modelling	Sign
Symbol	Simultaneous communication
Graphic symbol	Total communication
Scene cues	Makaton

Appendix G

Data extraction form

The effect of augmentative and alternative communication on the receptive language skills of children with developmental disabilities: A scoping review.

Data Extraction

	Variable & Key	Category	Reporting Objectives
1	Identification number (ID)		None
2	Date form completed		None
3	Name of person extracting data		None
4	Author/s		None
5	Year		To determine a trend in the number of publications by determining the frequency of publications per year
6	Title		None
7	Aim of the research study: - Purpose - Dependent variable - Independent variable		Allow qualitative analysis of research aims Facilitate linking aims to main findings, research limitations and future research recommendations
Methods			
8	Study design	□ True experimental □ Quasi-experimental □ Single-subject □ Group □ Other, please specify	To determine the frequencies of different types of study designs
9	Sampling	□ Probability □ Random □ Simple random □ Systematic □ Stratified random □ Cluster □ Nonprobability □ Convenience □ Purposeful □ Quota □ Other, please specify	To determine the frequencies of different sampling methods
10	Study participants and sample size	□ Number of children with disabilities =	To calculate the overall number of participants included in the scoping review
11	Sample size breakdown in terms of gender	□ Number of boys = □ Number of girls =	To determine frequencies of the genders who participate in the research studies
12	Name and age of child	□ □ □	To determine frequencies of the ages included in research studies
13	Disability description	□ Autism □ Pervasive developmental disorder □ Cerebral Palsy □ Intellectual disability □ Down Syndrome □ Severe □ Multiple □ Other, please specify	To determine the frequencies of the type of disabilities included in research studies
14	Test used to assess receptive language skills (indicate edition of test if applicable)	□ Clinical Evaluation of Language Fundamentals (CELF) □ Comprehensive Assessment of Spoken Language (CASL) □ Comprehensive Receptive and Expressive Vocabulary Test (CREVT) □ Emerging Literacy Language Assessment (ELLA) □ MacArthur-Bates Communicative Development Inventory – words and gestures □ Mullen Scales of Early Learning (MSEL) (Receptive Language Subscale) □ Peabody Picture Vocabulary Test (PPVT)	To determine the frequencies of the type of receptive language tests used to assess receptive language

	Variable & Key	Category	Reporting Objectives
		☐ Receptive One Word Picture Vocabulary Test (ROWPVT) ☐ Sequenced Inventory of Communication Development (SICD) ☐ The Listening Comprehension Test ☐ Test for Auditory Comprehension of Language (TACL) ☐ Test of Adolescent Language (TOAL) ☐ Test of Early Language Development (TELD) ☐ Test of Written Language (TOWL) ☐ Own, researcher developed ☐ Other, please specify	
15	Receptive language skills before intervention		To determine the effect of the intervention on receptive language skills
16	Setting	☐ Home ☐ Preschool ☐ School ☐ Community ☐ Therapeutic ☐ Other, please specify	To determine trends in settings where intervention was provided
AAC approach used			
17	Independent variable: type of intervention	☐ Aided language stimulation ☐ Natural aided language ☐ Aided language modelling ☐ Aided AAC modelling ☐ Scene cues ☐ Visual Scene Displays ☐ Animation ☐ System for Augmenting Language ☐ Graphic symbols ☐ Communication board ☐ Speech generating device ☐ Gestures ☐ Finger spelling ☐ Manual signs ☐ Sign language ☐ Simultaneous communication ☐ Total communication ☐ Other, please specify	To determine trends in the types of AAC intervention used when targeting receptive language skills. This will also highlight where gaps in the research lie
18	Receptive language skills targeted	☐ Receptive language ☐ Vocabulary acquisition ☐ Symbol comprehension ☐ Word comprehension ☐ Sentence comprehension ☐ Discourse comprehension ☐ Grammar comprehension ☐ Other, please specify	To determine trends in the receptive language skills targeted in AAC interventions
19	Duration of intervention		To determine trends in the duration of interventions
20	Mechanism of input of message to participants	☐ Object ☐ Photograph ☐ Graphic symbol (line drawing) ☐ Gesture/sign ☐ Animated symbols ☐ Speech generating device ☐ Spoken word ☐ Other, please specify If used in combination: ☐ Simultaneous combination ☐ Sequential combination ☐ Other, please specify	To determine how receptive language was facilitated in each study
21	Instructional format	☐ Individual ☐ Small group	To determine frequencies of various instructional formats

	Variable & Key	Category	Reporting Objectives
		□ Large group □ Other, please specify	
Results and Discussion			
22	Receptive language post-test measure	□ Clinical Evaluation of Language Fundamentals (CELF) □ Comprehensive Assessment of Spoken Language (CASL) □ Comprehensive Receptive and Expressive Vocabulary Test (CREVT) □ Emerging Literacy Language Assessment (ELLA) □ MacArthur-Bates Communicative Development Inventory – words and gestures □ Mullen Scales of Early Learning (MSEL) (Receptive Language Subscale) □ Peabody Picture Vocabulary Test (PPVT) □ Receptive One Word Picture Vocabulary Test (ROWPVT) □ Sequenced Inventory of Communication Development (SICD) □ The Listening Comprehension Test □ Test for Auditory Comprehension of Language (TACL) □ Test of Adolescent Language (TOAL) □ Test of Early Language Development (TELD) □ Test of Written Language (TOWL) □ Own, researcher developed □ Other, please specify	To determine how receptive language was measured after intervention was provided
23	Receptive language post-test score		To compare to the pre-test score
24	Intervention effect on receptive language	□ Complete □ Partial/mixed □ No	To determine trends in the effects of various AAC interventions provided
25	Mechanism of output measurement for receptive language	□ Object □ Photograph □ Graphic symbol (line drawing) □ Gesture/sign □ Animated symbols □ Speech generating device □ Spoken word □ Other, please specify If used in combination: □ Simultaneous combination □ Sequential combination □ Other, please specify	To determine how the participants demonstrated their receptive language skills-what participant factors were observed when determining comprehension
Quality appraisal			
26	Design	□ Sound design □ Strong design □ Flaw in design	In order to determine the quality of the included study
27	Inter-observer agreement (IOA)	□ Adequate or better □ Inadequate □ Not reported	
28	Treatment integrity	□ Adequate or better □ Inadequate □ Not reported	
29	Quality appraisal based on design, IOA and treatment integrity	□ Conclusive evidence □ Preponderant evidence □ Suggestive evidence □ Inconclusive	In order to compare the certainty of evidence if the included studies
Future Research			
30	Future research	□ None reported □ Specified by researcher	In order to determine gaps in the research conducted to date

Appendix H

Declaration of originality

UNIVERSITY OF PRETORIA

DECLARATION OF ORIGINALITY

This document must be signed and submitted with every essay, report, project, assignment, dissertation and/or thesis.

Full names of student: CATHERINE ALEXANDRA FLORES

Student number: 23048672

Declaration

1. I understand what plagiarism is and am aware of the University's policy in this regard.

2. I declare that this mini-dissertation (eg essay, report, project, assignment, dissertation, thesis, etc) is my own original work. Where other people's work has been used (either from a printed source, Internet or any other source), this has been properly acknowledged and referenced in accordance with departmental requirements.

3. I have not used work previously produced by another student or any other person to hand in as my own.

4. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

SIGNATURE OF STUDENT: 

SIGNATURE OF SUPERVISOR:

Appendix I

Declaration of language editor

Toni Muir
Writer and Editor

To Whom It May Concern,

I hereby confirm that I conducted the language editing of the Master's dissertation/mini-dissertation of Catherine Alexandra Flores. The document with my edits was sent to the student on 6 June 2017.

Toni Ingrid Muir

6 June 2017