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ABSTRACT

The aim of this study was to develop a core vocabulary list for young children with intellectual disabilities between 2 and 7 years of age because data from this population are lacking in core vocabulary literature. Children with Down syndrome are considered one of the most valid reference groups for researching developmental patterns in children with intellectual disabilities; therefore, spontaneous language samples of 30 Dutch children with Down syndrome were collected during three different activities with multiple communication partners (free play with parents, lunch- or snack-time at home or at school, and speech therapy sessions). Of these children, 19 used multimodal communication, primarily manual signs and speech. Functional word use in both modalities was transcribed. The 50 most frequently used core words accounted for 67.2% of total word use; 16 words comprised core vocabulary, based on commonality. These data are consistent with similar studies related to the core vocabularies of preschoolers and toddlers with typical development, although the number of nouns present on the core vocabulary list was higher for the children in the present study. This finding can be explained by manual sign use of the children with Down syndrome and is reflective of their expressive vocabulary ages.

Introduction

Clinicians need to apply a structured and scientific approach to augmentative and alternative communication (AAC) interventions aimed at improving quality of life through achieving the most effective communication possible for individuals who rely on AAC. However, AAC support teams rarely have sufficient knowledge and experience to select vocabulary for functional use for specific contexts, activities, ethnicity, or language groups (Beukelman & Mirenda, 2013). Language sample collection and analysis is an historically used evidence-based practice (Aitchison, 2003) for selecting vocabulary for AAC systems (Kovacs & Hill, 2015). For vocabulary selection, there appears to be a certain set of core words that can be widely used in a range of communicative settings (Banajee, DiCarlo, & Buras Stricklin, 2003). These core words can maximize the potential for spontaneous language generation in spoken, signed, graphic, and/or written (output) modalities. Incorporating core vocabulary into an AAC system may give individuals the opportunity to be engaged in communication and interaction in an appropriate, efficient, and relatively quick manner (Hill, Kovacs, & Shin, 2015; Weighton & Dodd, 2011).

Lee (2001) described a number of features of words characterized as core vocabulary. Such words tend to be (a) the most frequent words in language as a whole, (b) words that are most general, unmarked, or central to the language, (c) the most frequent words in a particular medium;

(d) words that are cognitively basic or most salient, (e) the most frequent words for a particular demographic group, (f) words that have the most widespread usage across a wide range of genres, situations, and conversational partners, and (g) words useful for dictionary definitions. In the field of AAC, core vocabulary is most often defined as a small set of approximately 20–50 words for young children and up to 200–400 words for adults and used consistently across environments and between communication partners (Baker, Hill, & Devylder, 2000; Chen et al., 2011; Renvall, Nickels, & Davidson, 2013; Weighton & Dodd, 2011; Witkowski & Baker, 2012; Yorkston, Dowden, Honsinger, Marriner, & Smith, 1988). Core vocabulary may account for up to 80% of all words used within communicative contexts. Vocabulary sets described as core vocabulary consist of high-frequency words and represent various parts of natural speech or text (i.e., mostly function words such as pronouns, conjunctions, prepositions, auxiliary verbs, modals, determiners, interjections, and adverbs (Renvall et al., 2013; Witkowski & Baker, 2012). Effective communication requires the combination of both core and fringe vocabulary. Fringe vocabulary items are often large in number, change frequently, and are highly individualized (Yorkston, Honsinger, Dowden, & Marriner, 1989). With these fringe words, which are often content words, an individual is able to reflect on his or her own activities, interests, environments, and personal style (Stuart, Beukelman, & King, 1997).

Spoken language sample studies identifying core vocabulary are available for a variety of groups with no identified

disabilities, including toddlers (Banajee et al., 2003), pre-school children (Beukelman, Jones, & Rowan, 1989; Fallon, Light, & Paige, 2001; Trembath, Balandin, & Togher, 2007), school-aged children (Robillard, Mayer-Crittenden, Minor-Corriveau, & Bélanger, 2014), adults (Balandin & Iacono, 1999), and elderly adults (Stuart et al., 1997). Core vocabulary has also been identified for children with specific language impairments (Robillard et al., 2014); second-language learners (Boenisch & Soto, 2015); individuals with physical disabilities, some of whom used AAC (Boenisch & Sachse, 2007; Dark & Balandin, 2007; Yorkston, Smith, & Beukelman, 1990); and school-aged children with autism spectrum disorders (Chen et al., 2011). Based on these studies, it can be concluded that the core vocabulary of these populations is highly overlapping. Within the clinical field of AAC, the question has often been raised whether core vocabulary sets are also applicable for children, teens, or adults with intellectual or multiple disabilities.

So far, only three studies have targeted this issue. The first (Mein & O'Connor, 1960), reported spoken core vocabularies of 80 individuals ranging in age from 10 to 30 years, with severe intellectual disabilities and a mental age ranging from 3 to 7 years. Words that were used by more than 50% of the participants were indicated as core vocabulary, leading to a core list of 218 words, which was relatively comparable to the core vocabulary of young children with a comparable developmental age in the 1957 study by Burroughs (1957). The second study, by Chen, Chen, and Chen (2013), explored the spoken core vocabulary of 15 children with intellectual disabilities and their peers without disabilities in fifth and sixth grades during an approximately 30-min dyadic conversation at school. Chronological ages of the children were between 10 and 12 years; IQ scores of the children with intellectual disabilities ranged from 55 to 69. There was 94% overlap for the top 70% most frequently used words in both groups. The third study, by Boenisch (2014), compared the core vocabulary of German children and teenagers ($n = 58$) with typical development with the core vocabulary used by children with intellectual disabilities of different etiologies. The children with intellectual disabilities were between the ages of 6 and 16 years, with an IQ below 70, attended special schools for children with intellectual disabilities, and were able to use natural speech ($n = 44$). Language samples were obtained throughout the school day. Boenisch found a very large overlap between the top 20 (95%), top 50 (94%), and top 100 (87%) words most frequently used by both groups of students. Almost no differences were found between both groups in the frequency of use of different word classes, indicating that the language use of the children and teenagers with intellectual disabilities closely resembles that of peers with typical development.

Van Tilborg and Deckers (2016) reviewed all previously mentioned core vocabulary studies and concluded that core vocabulary, no matter the modality, seems to be comparable for individuals with typical development; monolingual and bilingual individuals with primary language impairments; second language learners; people who rely on text-based AAC; and individuals with physical and/or intellectual disabilities. However, it should be mentioned that many of the

studies used different research designs and most analyzed language use only in one setting; core vocabulary, as previously defined, is used consistently within and across environments and over a wide range of communication partners. In addition, the few studies of individuals with intellectual disabilities focused mainly on those with mild intellectual disabilities or developmental ages of 4 years and above, and populations with chronological ages of 6 and above. To date, no studies exist that focused on children with intellectual disabilities with chronological ages below school age and developmental ages below 4 years.

Down syndrome is the most common genetic cause of intellectual disability (Sherman, Allen, Bean, & Freeman, 2007). Owing to its homogeneous etiology, children with the syndrome are considered to be among the most valid reference groups for researching developmental patterns in individuals with intellectual disabilities (van Duijn, Dijkxhoorn, Scholte & van Berckelaer-Onnes, 2010). These children are usually delayed in learning to speak (Brady, 2008; Kent & Vorperian, 2013) and even after they begin to speak, may be difficult to understand (Roberts et al., 2005). Compared to children with typical development matched on developmental age and based (primarily) on parental reports, Bello, Onofrio, and Caselli (2014) found that children with Down syndrome experience delays in the production of nouns, verbs, and adjectives. Nouns were used significantly more frequently than verbs and adjectives. Other characteristics of spontaneous spoken language of children with Down syndrome include speaking in one-word utterances using nouns or verbs, and limited use of question words, articles, and conjunctions (Abbeduto et al., 2001; Bol & Kuiken, 1989; Chapman & Kay-Raining Bird, 2012). In addition, these individuals may omit grammatical markers and verbs more frequently than peers with the same mean length of utterance (Hesketh & Chapman, 1998).

Gesture production is considered a strength of children with Down syndrome compared to their spoken language skills and also compared to peers with typical development (Galeote, Sebastián, Checa, Rey, & Soto, 2011). In a study by Galeote et al., young children with Down syndrome were found to have comparable vocabulary sizes to those of peers with typical development when the number of gestures was included in vocabulary counts. This shows the importance of accounting for multimodal communication in language studies, particularly in those involving children with Down syndrome. Poor intelligibility and significantly delayed onset of speech are two primary reasons to introduce AAC to children with Down syndrome (Brady, 2008). In Dutch clinical and educational practice, Sign Supported Dutch (SSD) and manual key-word signing are commonly used for this population, as manual sign systems are an important mode of communication, next to or preceding speech (Deckers, Van Zaalen, Mens, Van Balkom & Verhoeven, 2016; Smith & Grove, 1999). The manual signs in Sign Supported Dutch are iconic or arbitrary signs that are deliberately taught by parents, teachers, or speech-language pathologists (Özçalışkan, Adamson, Dimitrova, Bailey, & Schmuck, 2016) and are based on Dutch Sign Language. Manual signs that are iconic in form depict the characteristic actions or attributes of the referent they

represent. Different from spontaneous iconic gestures, iconic manual signs are either produced in identical handshape form repeatedly by both the communication partner and the child or by the child alone to refer to the same referent within an observation session. This similarity of form is never observed in spontaneous iconic gestures (Özçalışkan & Goldin-Meadow, 2011), which makes the interpretation of gestures more subjective than when interpreting manual signs.

When manual signs are incorporated in studies of expressive vocabulary development of children with Down syndrome, the vocabulary size is relatively comparable to that of peers with typical development matched for developmental age (Chan & Iacono, 2001; Te Kaat, 2013; Zampini & D'Odorico, 2009). Although several studies show the merits of using manual signs, most studies investigating vocabulary sizes in individuals with Down syndrome only accounted for spoken vocabulary and most often relied only on parental reports, not accounting for the use of other modalities of communication. None of the studies focused on functional use of language in spontaneous language samples in children with Down syndrome. Where noun use seems to be a relative strength in children with Down syndrome, compared to other word classes (Bello et al., 2014), it is not known whether these noun forms are used consistently within environments and between communication partners. The goal of the present study was to determine core vocabulary and the contribution of content and function words to core vocabulary in young children with Down syndrome with a chronological age between 2 and 7 years, by analyzing (spoken and sign supported) spontaneous language samples in different settings and with several communication partners.

Methods

Participants

Children with Down syndrome were recruited for this cross-sectional study from specialized Down syndrome polyclinics associated with several hospitals in the Netherlands, through Stichting Downsyndroom, the Dutch association for parents with children with Down syndrome; and speech-language pathologists (SLPs) in clinical practice. Because the Berglund, Eriksson, and Johansson (2001) study showed that some children with Down syndrome do not develop speech by age 5, we decided to include children with a broader age range. Children were included in the study if they met the following inclusion criteria: (a) developmental age below 48 months, as measured by the Vineland Screener (Van Duijn, Dijkxhoorn, Noens, Scholte, & van Berckelaer-Onnes, 2009), (b) lived in a Dutch-speaking home environment, and (c) had a diagnosis of Down syndrome (trisomy 21). The present study was approved by an institutional review board (NL38926.091.12).

In all, 30 children with Down syndrome participated in the present study: 14 boys and 16 girls. The participants had a mean chronological age of 57 months ($SD = 16$; range: 28–84 months) and a mean developmental age of 28 months ($SD = 10$; range: 12–47 months). Expressive vocabulary ages were determined with the Dutch version of the MacArthur Communicative Development Inventory: Words and Sentences version (N-CDI), which is recognized as a valuable and valid measure of expressive vocabulary in children with Down syndrome (Deckers et al., 2016). The N-CDI is developed to measure the vocabulary size of children with a chronological or mental age of 16–30 months. Three children reached ceiling levels on the N-CDI. Their expressive vocabulary age was therefore assessed with the Expressive One Word Picture Vocabulary Test (Brownell, 2000). The mean expressive vocabulary age of the children with Down syndrome was 25 months ($SD = 7$; range: 17–42 months). The participants in the study lived throughout the Netherlands in different socioeconomic areas. All of the children came from Dutch-speaking households; however, the parents of four of the children had a Turkish background. Of the 30 children, 19 attended schools or daycare centers for mainstream education and 11 attended schools or daycare centers for special education. At the time of the present study, all of the children were attending SLP sessions at least once a week. All of the parents indicated that Sign-Supported Dutch was used at home by both the parents and the child, and during speech-language therapy sessions by both the SLP and the child. All of the children could speak at least one word, and 17 used manual signs. No picture communication symbols or other AAC devices were used.

Procedure

As defined in the introduction, core vocabulary comprises a set of words consistently used within and across environments and between communication partners. In the present study, participants' core vocabulary was identified by collecting language samples during interactions in multiple settings and with multiple communication partners during (a) unstructured free play with a parent at home, (b) snack- or lunch-time with a parent at home or with a teacher at school, and (c) speech-language therapy sessions with the SLP. Materials used during free play differed for each child because the children were allowed to play with their own toys, although some common material use was observed (e.g., dress-up games, toy kitchen with equipment, blocks and art). Parents were instructed to (a) play with their child like they normally would, (b) include toys or games according to the child's preference, and (c) allow the child to take the initiative to engage in play with other toys. Snack- or lunch-time activities took place at designated tables, where the children were used to spending their snack- or lunch-time (e.g., at a kitchen table at home, at a table in the school lunchroom). Parents and teachers were instructed to follow the usual mealtime routine. SLPs were instructed to provide therapy as they normally would but to use the recorded therapy session to work specifically on the child's goals related to communication or language in order to evoke sufficient spontaneous language. The language samples taken during these 15- to 20-min interactions were audio- and video-recorded. Video recording was chosen to identify manual

signing used by the children and for visual context when speech intelligibility was decreased.

Data transcription and analysis

For each child, at least the first 10 min of each recorded setting were transcribed. During the transcription process, videotapes were stopped after each utterance and a verbatim transcription was completed of the utterance for both the child and his or her communication partners. Both spoken and signed utterances were transcribed. For every word transcribed, the modality in which that word was produced, either spoken (Sp) or via a manual sign (Si), was added to the transcript. A sample of 100 words per child was constructed, ideally consisting of roughly 33 used words (i.e., 100 words divided by three settings) collected per setting. Of the 30 participating children, 19 had recordings in all three settings. Not all of the children's SLPs participated, which meant that some children took part only in two settings. The 33-word target was not always reached during spontaneous language use during lunch- or snack-time. This was because mealtime interactions were sometimes constrained by parents who did not want their children to talk while eating (as noted also by Banajee et al., 2003). Therefore, more words uttered during interactions in the other settings had to be included to reach the 100 words threshold for each child.

Transcription rules were based on Trembath et al. (2007) as follows: (a) each utterance was transcribed separately and utterance boundaries were defined by intonation or a pause of longer than 2 s, (b) when sound repetitions and syllable repetitions occurred, only one whole word was transcribed, (c) fillers or interjections (e.g., *oh/ooh*) and conventional gestures (e.g., waving "hello" and nodding "yes" or shaking the head "no" that are part of a learned, shared, symbolic system) were typed orthographically in a consistent form and counted as words, (d) different forms of a word (e.g., *jump/jumped*) were transcribed as different words, but combined in the analysis to examine lemma-based words, (e) numbers were typed as nouns, (f) imitated speech, noises, and signs were not included, (g) imitated words, either spoken or in manual signs, were not included, (h) words used in songs and repetitive games were not included, (i) any comments by the children related to recording equipment were omitted from transcription, and (j) names were omitted from transcripts in order to protect confidentiality.

We used the principles of inter-judge agreement, which can be used to measure reliability of transcripts of utterances of individuals who have limited speech intelligibility (Kovacs & Hill, 2015). Complete inter-judge agreement is obtained by independently transcribing and analyzing a language sample and then resolving discrepancies by consensus as needed (Hegde, 2003). Agreement is usually 100%, unless the raters are unable to reach a consensus (Kovacs & Hill, 2015). Given known problems with both speech and manual sign intelligibility in children with Down syndrome (Kumin, 1994), which can heavily influence the reliability of transcripts, we chose to ensure that all language samples were transcribed by two independent raters. Differences that were found in the transcripts, (approximately 2% of the total transcript), were reconsidered by the two raters collectively. In all instances, consensus agreement was reached on appropriate alterations in the transcriptions. About 10% of all utterances were considered unintelligible by both transcribers.

Core vocabulary literature describes several ways to determine which words are core (Van Tilborg & Deckers, 2016). One commonly used metric is to include those words that have an occurrence of at least 0.5 per 1000 words in a sample (e.g., Balandin & Iacono, 1999; Robillard et al., 2014; Trembath et al., 2007). However, given the relatively small language sample of the present study (i.e., 3000 words), applying this threshold would indicate every word used at least twice to be a core word. Instead, we chose to determine core vocabulary in two ways: (a) As the 50 most frequently used words (Chen et al., 2013) in the total sample of 3000 words, because Boenisch and Soto (2015) showed a significant drop in frequency of word use after the 50th most used words on core vocabulary lists, and (b) on the basis of the principle of commonality. Words were determined as core vocabulary based on commonality, when a particular word was used by 50% or more (i.e., $n \geq 15$) of the children in the total sample (Robillard et al., 2014; Trembath et al., 2007). Applying these two criteria resulted in two word lists with core vocabulary. For both word lists it was determined whether a word was a function (i.e., prepositions, auxiliary verbs, conjunctions, determiners, and pronouns) or a content (i.e., nouns, main verbs, adverbs, adjectives, and negatives) word. Word frequency counts from the transcripts and compilation of both the frequency and commonality list were conducted with R, a platform for statistical computing and graphics (The R foundation, n.d.)

Results

The total sample consisted of 3000 words uttered by the 30 participants, of which 420 words were unique. The number of unique words equates to the number of different words used in the transcripts, irrespective of their frequency of use by the children with Down syndrome. Of the total sample, 407 words (i.e., 13.6%) were uttered using a manual sign or via a conventional gesture (e.g., *yes, no, bye*), 49 of which were unique (i.e., 12%). Of these 49, 32 were nouns. During lunch- or snack-time, 585 words were used, 148 of which were unique (i.e., 25.3%). During sessions with an SLP, 751 words were used, 199 of which were unique (i.e., 26.5%). In the play setting with parents, the children uttered 1664 words, 301 of which were unique (i.e., 18.1%). Language sample recordings to acquire 100 words per child had a mean recording time of 23 min (SD = 6; range: 15.24–36.15 min); mean recording time for lunch- or snack-time was 10 min, for sessions with an SLP 7 min, and for play with parents 6 min. Type-token ratios (i.e., the number of different words divided by the total number of words per setting) were calculated for every child (M = .47, SD = .09).

Table 1 (which includes English translations) shows the core vocabulary list based on the 50 Dutch words that were most frequently used by the children in the present study

Table 1. The 50 most frequently used words by Dutch children with Down syndrome across three settings.

	Words in Dutch	Translation	Percentage
1	Ja[a,c]	Yes	11.20
2	Nee[a,c]	No	7.80
3	Die[a,c]	This, that	5.10
4	Daar[a,c]	There	3.83
5	Mama[b,c]	Mama, mom	3.47
6	Ik[a,c]	I	3.10
7	Een[a,b]	A, one	2.00
8	Klaar[b,c]	Ready, finished	1.67
9	Zo[a]	So	1.43
10	Jij[a,c]	You	1.30
11	Hier[a]	Here	1.17
12	Nog[a,c]	More	1.17
13	Niet[b,c]	Not	1.13
14	Papa[b,c]	Papa, dad	1.10
15	Deze[a]	This, these	1.03
16	Ben, Is, Zijn[a]	To be	1.00
17	Op[a]	On, all done	1.00
18	De[a]	The	0.90
19	Kijk(t), Kijken[b]	To look	0.90
20	En[a]	And	0.77
21	Weg[b]	Away	0.77
22	In[a]	In	0.73
23	Oh/Ooh[a]	Oh	0.70
24	Wil/Wilt[b]	To want	0.70
25	Dag/Doei[b,c]	Bye	0.67
26	Hallo, Hoi[b]	Hello	0.67
27	Ook[a]	Also, as well	0.67
28	Pop(je), Poppen[b,c]	Doll, puppet	0.63
29	Mij, Mijn[a]	My, mine	0.60
30	Nou, Nu[a]	Now	0.60
31	Dit[a]	This	0.57
32	Kaas[b]	Cheese	0.57
33	Paard[b,c]	Horse	0.57
34	Doen, Doet[a]	To do	0.53
35	Koe[b,c]	Cow	0.53
36	Lekker[b,c]	Yummy, tasty	0.53
37	Meisje[b,c]	Girl	0.50
38	Dat[a]	That	0.47
39	Hond[b,c]	Dog	0.47
40	Voor[a,b]	In front of, for	0.47
41	Appel[b,c]	Apple	0.43
42	Au[a]	Ouch	0.43
43	Drie[b]	Three	0.43
44	Geel, Gele[b]	Yellow	0.43
45	Huis[b,c]	House	0.43
46	Mag[a,c]	To may	0.43
47	Open[b]	Open	0.43
48	Banaan[b,c]	Banana	0.40
49	Heb, Heeft[a,b]	To have	0.40
50	Blauw[b]	Blue	0.37

[a]Function word.
[b]Content word.
[c]Word is uttered in both spoken and signed modalities.

Table 2. Core vocabulary based on commonality.

	Words in Dutch	Translation	n
1	Ja[a,c]	Yes	30
2	Die[a,c]	This, that	29
3	Nee[a,c]	No	28
4	Mama[b,c]	Mama, mom	26
5	Daar[a,c]	There	24
6	Ik[a,c]	I	22
7	Zo[a]	So	22
8	Een[a,b]	A, one	21
9	Klaar[b,c]	Ready, finished	20
10	Hier[a]	Here	18
11	Papa[b,c]	Papa, dad	18
12	Niet[b,c]	Not	17
13	Nog[a,c]	More	17
14	Op[a]	On, all done	16
15	Deze[a]	This, these	15
16	Kijk(t), kijken[b]	To look	15

[a]Function word.
[b]Content word.
[c]Word uttered in both spoken and signed modalities.
n: number of children that uttered a particular word.

in Table 1, 22 words were uttered in both spoken and signed modalities, seven of which were function words and 15 of which were content words.

Table 2 shows the list of words that achieved a commonality score of at least 15, indicating the words that were used by at least half of the children in the present study. Sixteen unique words were used by at least half of the children, of which only *mom* and *dad* are nouns. These core words based on commonality account for 47.1% of the total word use. Ten of these core words based on commonality were uttered in both spoken and signed modalities.

Discussion

The present study is the first to identify the core vocabulary of young children with Down syndrome (i.e., chronological age between 2;4 (years/months) and 7 years) and a developmental age below 4 years. Developmental ages of the participants were between 1 to 4 years ($M = 2;4$), reflecting a period of early language and communication development. Language samples of 100 words per child were collected across several settings and with different communication partners, resulting in a total language sample of 3000 spoken and signed words. The 50 most frequently used words accounted for more than 67% of the total sample, indicating that a small set of words, i.e., a core vocabulary, can be identified for young children with Down syndrome. Of the 50 core words, 16 were used by at least half of the participating children. When comparing core words of children in the present study with those of toddlers (Banajee et al., 2003) and preschool children (Beukelman et al. 1989; Fallon et al., 2001; Trembath et al., 2007), it can be concluded that, based on spoken and signed modalities, the core vocabulary of young children with Down syndrome and intellectual disabilities, closely resembles the core vocabulary of young peers with typical development. Recent studies (e.g., S.R.J.M. Deckers, Y. Van Zaalen, H. Van Balkom, L. Verhoeven, personal communication; Polišenská & Kapalková, 2014) showed that the language development of children with Down

across all three settings. These 50 words account for 67.2% of total word use, and the 100 most frequently used words account for 80.3% of total word use. Also indicated in the table is whether a word is a content or function word. Of the 50 core words, 27 can be considered function words and 25 as content words. Three words – *hebben* (to have), *een* (a, one), and *voor* (in front of, for) – are counted as both function and content words. *To have* was used as both an auxiliary and a verb. It is important to note that some Dutch words have multiple meanings, such as the word *een,* which may be the article *a* or the numerical *one*; and *voor*, which may function as an adverb (*in front of*) or a preposition, as in *this is for you* (i.e., *dit is voor jou*). Of the 50 core words listed

syndrome, when measured in both spoken and signed modalities, is delayed rather than deviant relative to patterns of typical development. Combined with the results of these recent studies, the findings in the present study may provide additional evidence that the lexical development of children with Down syndrome seems to closely resemble that of children who are developing typically, differing only in the use of multimodal communication.

The core vocabularies of children in the current study serve several syntactic, semantic, and pragmatic functions (see also Banajee et al., 2003; Miller, 1989). Core vocabulary words contained demonstratives (that, these), verbs (to be, to want), pronouns (my), prepositions (on), and articles (the). Semantic functions included use of agents (I), objects (you), labeling objects (that), actions (to look), possession (my, mine), affirmation (yes), negation (no), location (in), and termination (finished, ready). Pragmatic functions included initiating interaction by attracting attention (you), maintaining joint attention (this, that, these), indicating recurrence (more), and terminating interaction (finished, ready). The types of words in the core vocabulary of participants in the present study appear to be similar in terms of syntax, semantic, and pragmatic functions to those core words identified by previous research with other populations, as mentioned in the introduction. Similarities of the present results to this past research help strengthen the definition of core vocabulary and show the application of core vocabulary across activities, environments, and communication partners, for individuals with typical development as well as children with Down syndrome and intellectual disabilities. Having access to core vocabulary enables young children with intellectual disabilities to meet a variety of syntactic, semantic, and pragmatic functions (Banajee et al., 2003).

As in most clinical core vocabulary studies, the words yes and no are frequently used by children with Down syndrome. In the current study, these two words alone made up 19% of the total word sample. Investigating the transcripts in closer detail, the overrepresentation of affirmations and negations seems to be due to the fact that communication partners frequently ask yes/no questions of children with Down syndrome. Parents of young children with typical development with language and developmental ages similar to the children in the current study, ask many yes/no questions during interactions with their young child (Eriksson, 2014). This feature is also observed by van Balkom, Verhoeven, Van Weerdenburg, and Stoep (2010) in the communication between children with developmental language delay (i.e., late talkers) and their mothers. These interactions showed lower levels of conversational coherence (i.e., the way both communication partners cooperate to maintain the thread of the conversation), indicating difficulties in fine-tuning and mother's adjusting their language input to the developmental level of their child to establish a coherent conversational context. Iverson, Longobardi, Spampinato, and Caselli (2006) analyzed child-directed language produced by five mothers of children with Down syndrome during a 30 min free-play session. They found that these mothers produced significantly fewer utterances than mothers of younger children with typical development and comparable expressive

language skills, and interpreted these results as a maternal simplification strategy to prevent the child from being overloaded with verbal information, which may be the case when asking more closed questions. Zampini, Fasolo, and D'Odorico (2011) found that the frequency of maternal utterances towards children with Down syndrome was influenced by the children's linguistic skills. Mothers tended to talk more when their children's communicative ability was limited, mostly filling in the pauses in their interaction. They gradually reduced their utterance frequency as the child's ability to interact increased, and asked different and more open questions, reflective of a growth in conversational coherence.

In most core vocabulary studies (see Van Tilborg and Deckers, 2016, for a comprehensive overview) nouns are underrepresented or even absent in core vocabulary lists. In comparison, the core vocabulary list of children with Down syndrome in the current study consisted of slightly more nouns (i.e., 11 out of 50 core words) than core vocabulary lists of peers with typical development. This result may be due to the expressive language ages of the children, with a mean around 2-years of age, and the use of many one-word utterances, in which a noun is more often used by a child to provide content to the utterance. Also, manual signs were counted in the spontaneous language samples in the current study. It is important to note that not every spoken word has a direct translation into a manual sign, especially when it comes to function words such as articles (Bolier, 2010) or manual signs of nouns taught during speech-language therapy or AAC interventions (Adamson, Romski, Deffebach, & Sevcik, 1992). In the current study, of the 49 unique words in the total language sample uttered via manual signs, 32 were nouns, and 10 of these made it to the core vocabulary list of 50 most frequently used words. In Sign Supported Dutch, manual signs are learned in the immediate everyday context of repeated one-to-one communication with a communication partner. Manual signs are most often used to support speech about an object or action. This creates a highly scaffolded, interactive routing centered on referent-symbol mappings (Özçalışkan et al., 2016). Children with Down syndrome may, therefore, rely on manual signs in particular to convey information about objects and actions in their immediate environment (Dimitrova, Özçalışkan, & Adamson, 2016), explaining the number of signed nouns. The language level of the children and the use of manual signs as an AAC strategy are thus possible reasons for the increased number of nouns on the core vocabulary list in the present study.

A parent or SLP might make a link between a novel word and referent more transparent by calling attention to an object and then stating its name or producing the sound it makes, or following the child's lead and producing labels for objects only after they have entered the child's field of attention (Adamson, Bakeman, & Brandon, 2015). These strategies are more easily related to concrete concepts or content words, such as nouns or nouns used as action verbs (e.g., bike), than to most function words, which often do not have a concrete direct referent in the child's environment. Mothers of children with Down syndrome talk significantly more about objects, using nouns, than mothers of children with language impairments (Kay-Raining Bird & Cleave, 2016).

Still, children are able to learn and use more abstract function words, as reflected in the core vocabulary of children with Down syndrome in the current study. In his theory on modeling and vicarious processes, Bandura (1969) states that individuals acquire words and syntactic structures by exposure to verbalizing models. Some amount of modeling is therefore indispensable for language acquisition. According to this theory, language is learned from models in the environment, and as such, children will have many experiences with and will learn from language used by communication partners in daily life (Tomasello, 2003). Therefore, children encounter core vocabulary used by communication partners from early in their language development. Children are more extensively exposed to specific function words than to specific content words (Segalowitz & Lane, 2000), because these words are more often used by all of the child's communication partners across several activities and settings.

Without any known focus on teaching core vocabulary within speech-language therapy, these core words seem to emerge in the spontaneous interactions of the children with Down syndrome in the current study, either in spoken or in signed modalities. This may not be the case in other children with complex communication needs, who rely on significant others to add core vocabulary to their AAC devices. As stated by Banajee et al. (2003), some words might be difficult to represent visually either through graphic symbols or manual sign, which may result in SLPs not teaching children to use these words during intervention. However, words that are difficult to represent graphically may be taught to young children by modelling the use of these words within activities, as implied by Bandura's theory of language acquisition. Based on clinical evidence, Van Tatenhove (2009) suggests that, in clinical practice, the balance of core to fringe vocabulary should be at least four to one in AAC systems or on language activity cards. For example, a child with Down syndrome who relies on AAC is engaged in a sandpit activity in a classroom. The child's AAC system is a communication board with, following the examples of Van Tatenhove (2009), up to 50 core vocabulary words. Attached along the top of this core vocabulary board is a spiral bound row of 20 strips, each displaying 10 specific activity, place, topic, or partner-specific, fringe vocabulary words. In one of the rows, sandpit vocabulary (i.e., fringe vocabulary), such as sand, water, scoop, castle, and bucket, is accessible. Once the activity is finished, the fringe vocabulary can be exchanged with fringe vocabulary for a subsequent activity. The core vocabulary on the communication board never changes and, following the findings of the present study and the larger research base in core vocabulary, would be the same for other children in the classroom as well. The fringe vocabulary should be individualized to the person's needs, wants, and communication environment. Vocabulary, core and fringe combined, must reflect children's changing and evolving communication needs and contexts, in order to allow for successful interactions in a variety of contexts and maintain sensitivity to the child's current and future developmental language abilities and skills (Marvin, Beukelman, & Bilyeu, 1994). The core vocabulary list for young children with Down syndrome who

rely on AAC should at least include the 16 core words based on commonality found in the present study.

Limitations

Three possible limitations of the present study require consideration. First the sample size is relatively low, at just 30 participants. Although small sample sizes are common in core vocabulary studies and the recruitment of participants with Down syndrome is not easy, this restriction may limit the generalizability of the findings of this study. In small sample sizes, wide variability in performance, as reflected in the range of both developmental age and expressive vocabulary scores in the present study, may limit conclusions about development of children with Down syndrome as a group (Patterson, Rapsey & Glue, 2013). However, the wide variability between children is found to be common in the vocabulary development of children with Down syndrome (Galeote et al., 2008), indicating that our research group may closely resemble the characteristics of the Down syndrome population.

A second limitation is the relatively small language samples collected – 100 words per child – although influential studies such as Banajee et al. (2003) collected only 150 words per child. Given the delayed vocabulary development and increased degree of unintelligible speech common in young children with Down syndrome (Brady, 2008), collecting and transcribing reliable language samples is time consuming. Thus, in order to include the same number of words in the total sample for every child, we chose the 100-word threshold. The children with higher expressive vocabulary scores reached this threshold after about 15 min of recording, while others did not reach threshold until 35 min or more. Nevertheless, given that the present study is the first to focus on children with intellectual disabilities and developmental ages below 4 years, the results provide important insights into core vocabulary and functional vocabulary use in this participant group. In addition, the results are highly comparable with core vocabulary lists of studies in other populations. Future studies should investigate the core vocabulary of this group in more detail, including participants whose intellectual disability is not related to Down syndrome.

A final limitation is the uneven distribution of words uttered in the three different settings. Although language samples in different settings and with different communication partners were collected, about 50% of the total sample of words were uttered in the play setting with parents and under 20% of the words were uttered in the lunch- or snack-time. Lunch- or snack-time settings may evoke fewer utterances among children because they are discouraged from talking and eating at the same time. Future studies of core vocabulary in children with intellectual disabilities should consider other contexts as well (e.g., pre-school classrooms, activities with siblings or peers) in order to identify commonality of vocabulary use over a range of contexts and communication partners. Nonetheless, given the definition of core vocabulary as a small set of words, used consistently across environments and communication partners, and that changes

little over time (Baker et al., 2000; Chen et al., 2011; Renvall et al., 2013; Weighton & Dodd, 2011; Witkowski & Baker, 2012; Yorkston et al., 1988), we hypothesize results will be comparable to the results of the present study.

Conclusions

The goal of the present study was to determine core vocabulary in children with Down syndrome and a developmental age below 4 years, by analyzing spontaneous language samples in different settings and with several communication partners. The 50 most frequently used core words accounted for 67.2% of total word use; 16 words were determined to be core vocabulary based on a commonality criterion (i.e., a word was used by at least half of the participants). Words in the core vocabulary of young children with Down syndrome appear to be similar in syntactic semantic, and pragmatic functions to core words identified by research into other populations, although the contribution of content words to the core vocabulary of the children with Down syndrome seems higher than in other groups. As reflected in the present study, AAC use and vocabulary selection during AAC intervention, such as the overrepresentation of noun use in Sign Supported Dutch, influences functional word use and determination of core vocabulary lists. A higher number of content words, relative to function words, may also reflect the expressive vocabulary age of the children with Down syndrome in the present study. The results of the present study strengthen the definition and applicability of core vocabulary as a construct for the field of AAC. To achieve the most effective communication possible, vocabulary selection in AAC should best be based on the emerging evidence relating to functional language use of children with intellectual disabilities.

Disclosure statement

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