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Coláiste na hOllscoile Corcaigh

RESEARCH REPORT

Embedding key word sign prompts in a shared book reading activity: The impact on communication between children with Down syndrome and their parents

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Abstract

Background: Children with Down syndrome have speech and language difficulties that are disproportionate to their overall intellectual ability and relative strengths in the use of gesture. Shared book reading between parents and their children provides an effective context in which language development can be facilitated. However, children with Down syndrome often take a passive role in shared book reading and the use of key word signing (KWS) as a shared book reading technique has never been investigated.

Aims: This study aimed to compare children with Down syndrome's participation and use of KWS across two methods of shared book reading – one in which a book had key-word sign prompts embedded (signed condition) and the other in which a book was read as normal (unsigned condition). Measures of child and parent communicative behaviour were taken in each condition to establish if differences emerged.

Methods & Procedures: A total of 36 children with Down syndrome (aged between 18 and 61 months) and their mothers took part in the study. Parent-child dyads were videoed at home reading two books, one in a signed and one in an unsigned condition. Child measures included total number of signs produced in each condition and levels of attention and initiation as measured by the Pivotal Behaviour Rating Scale. Parent measures included total number of utterances, mean length of utterance (MLU) in morphemes and vocabulary diversity (VOCD). Parental measures were transcribed using the Codes for Human Analysis Transcripts (CHAT) software and analysed by the Computerised Language Analysis software (CLAN). Contrasts in outcomes between the signed and unsigned conditions were estimated using Poisson and linear mixed-effects models, determined by the type of data.

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Outcomes & Results: Results showed that children attempted to sign significantly more in the signed than unsigned condition, as well as showing significant increases in their levels of attention and initiation. There was also a significant increase in the total number of utterances used by parents in the signed versus unsigned condition and a decrease in MLU. VOCB was similar in both conditions.

Conclusions & Implications: This study shows that the simple act of embedding key word signs into commercially available books, during shared book reading between parents and young children with Down syndrome, positively affects children's participation (initiation and attention) and use of KWS. The use of KWS as a core shared book reading technique may therefore be a fruitful avenue to facilitate growth in the language abilities of young children with Down syndrome.

KEYWORDS

children, Down syndrome, key word signing, shared book reading

What this paper adds

What is already known on this subject

Most children with Down syndrome have significant speech and language difficulties, with relative strengths in the use of gesture. Shared book reading is an activity reported to positively affect language. However, children with Down syndrome are reported to take a passive role in shared book reading and are therefore more dependent on their parents to use techniques that facilitate their levels of participation, in order to maximise potential benefits. To the best of our knowledge, the communicative effects of embedding key word signing (KWS) in shared book reading have never been examined with children with Down syndrome.

What this paper adds to existing knowledge

This is the first study to investigate the communicative impact of parents embedding KWS in a shared book reading activity with their young children with Down syndrome. Our findings show that this relatively simple manipulation resulted in

- Increase in children's sign attempts.
- Increase in children's overall participation in shared book reading (indicated by levels of attention and initiation).
- Increase in the number of utterances produced by parents (primarily as a result of repetitions).
- Decrease in parental mean length of utterance.

These findings suggest that embedding KWS in shared book reading is likely to facilitate increased language abilities in this cohort.

What are the potential or actual clinical implications of this work?

Shared book reading is part of the daily routine for many parents and their children with Down syndrome. Integrating KWS is a relatively simple adaptation to this activity which is likely to enhance children's language skills. Therapists can

encourage parents to do this at home to support work carried out at school and in a clinical setting.

INTRODUCTION

Down syndrome is the most commonly identified genetic cause of intellectual disability. In the Republic of Ireland the incidence of Down syndrome is 1 in 444 live births, the highest rate in Europe (Ní She & Filan, 2014). The majority of individuals with Down syndrome have a moderate intellectual disability (Chapman & Hesketh, 2001); however, the reported range of IQ scores is expansive, extending from the severe to the average range (Roizen, 2007). Consequently, there is significant variability in how people with Down syndrome function in their daily lives.

Communicative characteristics of children with Down syndrome

Despite individual cognitive variability, people with Down syndrome demonstrate a particular behavioural phenotype that distinguishes them from other neurodevelopmental disorders. In relation to memory, verbal short-term and working memory tasks are particularly difficult for people with Down syndrome, relative to other groups with intellectual disability (Godfrey & Lee, 2018; Jarrold, & Baddeley, 2010). In contrast, visual memory skills are often superior to or at least in keeping with these groups (Chapman, 2006; Rowe et al., 2006). The use of gesture is also highlighted in the literature as a strength for people with Down syndrome. Zampini and D'Odorico (2009) reported that at 36 months, children with Down syndrome produce similar gesture types at equal or higher frequencies than their typically developing peers. They are also reported to have a preference for using gesture over spoken words in the early stages of expressive vocabulary development (Kay-Raining Bird et al., 2000; Stefanini et al., 2007).

With respect to language, difficulties across the domains of vocabulary, phonology, simple and complex syntax and morphology have been reported (Dodd & Thompson, 2001; Eadie et al., 2002; Price et al., 2007). Receptive skills are usually better than expressive language skills (Chapman et al., 2002; Laws & Bishop, 2003) and both understanding and use of vocabulary are superior to syntactic abilities (Abbeduto et al., 2003; Berglund et al., 2001). Significantly, people with Down syndrome have speech and language difficulties that are disproportionate to their level of intellectual disability (Cleland et al., 2010; Frizelle et al., 2018; Martin & McElree, 2009) which affects their

overall communicative trajectory. Consequently, they have a particular need to engage in activities that can ameliorate their language skills and ultimately enhance their functional communication. Shared book reading between parents and children and the use of key word signing (KWS) are two such activities and set the context for the current study.

Shared book reading in typical development

Shared book reading refers to a procedure in which children who are not yet literate listen to a competent reader read a book to them, while using planned interactive techniques to engage children in the process. This may involve the adult drawing children's attention to the pictures or the word meanings and asking questions or making comments about the story; or it may include discussions focusing on understanding the meaning or sequence of events in the story (What Works Clearinghouse, 2015). Although shared book reading is common with preschool children, children in the early years of schooling can also benefit from shared book reading. Due to the specific features incorporated in children's picture books, they provide a particularly powerful context for capitalising on children's language learning opportunities (Wasik et al., 2016). For example, through books children are exposed to vocabulary and concepts beyond those that feature in everyday discourse (Hindman et al., 2014). Book reading interactions have also been shown to elicit a greater number of conversational turns compared to other routines (Gilkerson et al., 2017). Moreover, parents have been found to increase their vocabulary diversity and syntactic complexity during shared book reading interactions, compared to those outside the book reading context (Demir-Lira et al., 2019; Hilvert et al., 2022; Noble et al., 2018).

The techniques Integral to shared book reading are aligned with Vygotsky's sociocultural theory of learning and development (1978), in that children's exposure to new information is mediated by an adult, through a process of scaffolding and gradual extension of knowledge. Through shared book reading parents can enhance children's emergent language and literacy skills by extending what children would have learnt on their own. Overall, the literature converges on the view that parent-child shared book reading has positive effects on vocabulary,



morphology and reading abilities in children with typical development (e.g., Bus et al., 1995; Mol & Bus, 2011; Sénéchal et al., 1996, 2008). However, more recent systematic reviews and meta-analyses have reported effect sizes for language development to be small (e.g., expressive language: $d = 0.41$; receptive language $d = 0.26$, Dowdall et al., 2020; overall language: $g = 0.194$, Noble et al., 2019). Research has also shown that effect sizes may be mediated by how parents engage in shared book reading and that parental engagement has an effect on what children learn from the experience. For example, when mothers engage in varied ‘talk’ that relates the meaning of the story to children’s own experiences, children have been found to have stronger language skills (Hindman et al., 2014). In addition, children are thought to benefit most from shared book reading when parents make the experience engaging/reciprocal (Landry et al., 2012) and when children are encouraged to be active participants rather than listening to the story passively (Mol et al., 2008). Moreover, parents’ pointing with simple questioning to elicit an object label during shared book reading has been positively associated with toddlers speech production (Unlutabak et al., 2022). These findings highlight the importance of how interaction with book reading can have an impact on a child’s language and participation.

Shared book reading in Down syndrome

Shared book reading in children with Down syndrome has received less empirical attention than in those with typical development. A number of studies have focused on describing home literacy environments, and findings show that the majority of parents engage their child with Down syndrome in shared book reading on a very regular basis, ranging from several times a week to several times a day (Lusby & Heinz, 2020; van Bysterveldt et al., 2010a). This is broadly in keeping with parents of typically developing children (Hindman et al., 2014). Other studies have trained parents of children with Down syndrome in shared book reading techniques (van Bysterveldt et al., 2006) or used shared book reading as one of a number of approaches to support children’s development of vocabulary, letter knowledge, print concepts, phonological awareness and speech articulation (Bonagamba & Schmidt, 2019; van Bysterveldt et al., 2010b). Based on a small sample and a low dose of three sessions, Bonagamba and Schmidt (2019) reported that their shared book reading procedure was not effective for teaching nouns to young children with Down syndrome. In contrast, findings suggest that targeting parent–child interactions in shared book reading is an effective intervention approach to promote phonological awareness and letter knowledge

(van Bysterveldt et al., 2006) and, when integrated with other approaches, to remediate speech error patterns (van Bysterveldt et al., 2010b). Lastly, there are a group of studies examining the quality and quantity of parental language used with children with Down syndrome during shared book reading activities, where explicit instruction on the techniques involved is not given (e.g., Barton-Hulsey et al., 2020; Hilvert et al., 2022). Barton-Hulsey and colleagues compared mothers of children with typical development with mothers of those with Down syndrome and found the latter group used more utterances but with reduced grammatical complexity. While Hilvert et al. compared the quality and quantity of language input between mothers and fathers of young children with Down syndrome, reporting mothers to be more talkative and descriptive in the language they produced.

Given the pervasive language learning difficulties of children with Down syndrome, to maximise the effects of shared book reading, it would seem prudent to adapt shared book reading techniques to reflect the strengths and weaknesses of this group. Because books integrate pictures with repeated and consistent text, their use would seem advantageous for children with Down syndrome, in that they can compensate for poor verbal short-term memory (Jarrold & Baddeley, 2010) and capitalise on relative visuospatial memory strengths (Bower & Hayes, 1994). However, children with Down syndrome are reported to be less interested, less persistent and more passive in shared book reading than their typically developing peers (Ricci, 2011; van Bysterveldt et al., 2010a). Parents report a lack of motivation and attention during shared book reading and highlight these factors as significant barriers when reading with their child with Down syndrome (Lusby & Heinz, 2020). This passivity can result in parents taking on a more directive role and is corroborated by findings that compared to mothers of typically developing children, mothers of children with Down syndrome use more utterances and ask more questions to try and engage their child in greater communication (Barton-Hulsey et al., 2020).

Supporting parents to use techniques that facilitate children’s active participation in shared book reading is therefore important. Studies have shown that when parents are trained to use interactive reading techniques, shared book reading is more effective in improving language in children with language delays (Crowe et al., 2004; Dale et al., 1996). In a recent study, Burgoyne and Cain (2020) investigated the effects of embedded question prompts on the active participation of children with Down syndrome, aged 4–6 years, during shared book reading. Parents read two books with their child, one with embedded question prompts and one without. They found that when parents asked questions about the story, children increased their participation, produced significantly more



words and used a greater range of words. The questions also prompted both parents and children to engage in more extra-textual talk. While the use of verbal strategies such as questioning have been shown to be effective in enhancing the interactions between parents and young children with Down syndrome, in the current study we were interested to explore the effects of a different embedded learning opportunity, without the requisite of verbal language – key word signing.

Key word signing

KWS is form of augmentative and alternative communication, which involves using manual signs simultaneously supported by speech to highlight the most salient/content words in a sentence (Rombouts et al., 2017). KWS is used primarily for and by people with intellectual disabilities, some of whom rely on manual sign as they do not have any intelligible speech and others who use speech much of the time but who use KWS as a backup when necessary. When used as a form of input (supporting comprehension and expression), KWS is always accompanied by speech. However, young children with limited verbal skills can attempt to use KWS without the simultaneous production of speech.

There are a number of key differences between KWS systems and natural signing systems (e.g., of the Deaf community). Firstly, they are devised rather than developing naturally over time. A limited set of signs are chosen through careful observation of the words acquired by typically developing children while at the same time considering how they might apply to those with communication difficulties (Frizelle, 2019). Secondly, to alleviate parental anxiety that the use of manual sign would negatively affect speech acquisition, developers have always highlighted the function of KWS as a supplement to speech. Consequently, KWS input involves simultaneous production of the visual and spoken word. Thirdly, while much of the lexicon is drawn from natural sign language and can include features of natural sign (such as directionality in signs such as GIVE), KWS have been developed to be more iconic, focus only on the key information carrying words in the sentence and do not mark grammatical forms such as possessive or past tense (Rombouts et al., 2020). Lastly, complex hand positions are simplified and finger spelling is much less prominent. *Lámh* (which means ‘hand’ in Irish) is the KWS system used by people with communication difficulties in the Republic of Ireland.

There are a number of key advantages to the use of KWS for people with Down syndrome, not least that it has been shown to promote the development of their spoken language (Launonen, 2019; Vandereet et al., 2011). KWS

capitalises on core strengths for people with Down syndrome in the areas of visual memory and the use of gesture. In keeping with developmental research on the gesture–language continuum (Goodwyn et al., 2000), KWS can be used to scaffold spoken language and studies show that as spoken vocabulary increases in children with Down syndrome, their use of gesture decreases (Romano et al., 2020). Moreover, the use of communicative gestures is considered a predictor of later language comprehension, expressive vocabulary and syntactic development in children with Down syndrome (Iverson et al., Longobardi et al., 2003; Zampini & D’Odorico, 2009, 2011).

Further support for the use of KWS comes from cognitively based information processing models of language learning (Just & Carpenter, 1992). Because signs are produced 1.5 times more slowly than speech, they allow more time to process information and facilitate comprehension (Emmorey, 2002). Signing the key words in a sentence reduces the complexity of the message and makes word boundaries more distinguishable (Rombouts et al., 2017). KWS helps to overcome the oromotor difficulties evinced by people with Down syndrome in that it involves using the hands (with simplified hand positions) and body (Woll & Grove, 2019). In contrast to other more high-tech augmentative and alternative communication systems, KWS reduces demands on verbal working memory in children with Down syndrome and takes advantage of their visual processing and imitative skills (Vavuchelen et al., 2011). In addition, the need for the signing partner to gain eye contact before signing, ensures joint attention, an essential prerequisite to maximise language learning opportunities (Clibbens et al., 2002). These characteristics of KWS have ensured its continuous use with people with Down syndrome in Ireland (Frizelle & Lyons, 2022).

Parental KWS modelling and children’s language learning

Interactions between parents and children occur naturally throughout daily routines. These interactions offer many opportunities to create language rich environments for children, by embedding appropriate language and communication techniques into these routines (Woods et al., 2004). The practice of modelling KWS in a shared book reading context is one such technique. By modelling KWS, parents are providing simultaneous input in both oral and visual modalities. This is considered to support children’s learning on the basis that simultaneous input from more than one modality creates a stronger memory trace and therefore facilitates easier access to vocabulary items in the mental lexicon (Clarke & Paivio, 1991) as well as strengthening and stabilising syntactic representations. By



embedding signs in the context of a book reading activity, they offer the opportunity for a high dose frequency of exposure to sign-word pairings (Lederer & Battaglia, 2015). Increased dose frequency has been shown to improve vocabulary outcomes for young children with Down syndrome (Yoder et al., 2014). The process is further reinforced by the ability of the child to produce a sign (in imitation to begin with) where speech may not yet be possible. Because pictures are incorporated into young children's books the signs and images share a referential context. This is further enhanced by the iconicity of many KWS such that they provide additional semantic information. Consequently, children with Down syndrome can capitalise on the beneficial effect of dual coding, to reduce the linguistic load when processing language. KWS can therefore serve to scaffold more efficient language learning in people with Down syndrome.

The current study

Despite the many advantages of KWS and parental modelling, Glacken et al. (2019) note the challenges and consistent effort required to incorporate KWS into the daily routines of family life. Given the frequency with which shared book reading is used internationally (Hindman et al., 2014; Lusby & Heinz, 2020) it would seem like a worthwhile routine in which to embed signs. However, to the best of our knowledge the communicative impact of parents embedding key word signs in a shared book reading activity with their children with Down syndrome, has never been investigated, and this was the aim of the current study. The following research questions were addressed:

- What is the impact of parental embedding of KWS (Lámh) in a shared book reading activity, on children's use of Lámh signs in that activity, compared to when no signs are used?
- What is the impact of parental embedding of KWS (Lámh) in a shared book reading activity, on children's participation in the activity, compared to when no signs are used?
- Does the use of Lámh prompts affect the quality and quantity of parental language used, compared to when no prompts are used?

Because KWS is a technique tailored to suit the communication profile of this cohort and is particularly suited to those emerging from the prelinguistic stage, we hypothesised that parental modelling of signs would enhance children's participation and use of signs within the book reading activity. Given that KWS focuses on salient points of information within a given structure and that signing

mothers have been shown to use a shorter mean length of utterance (MLU; Fieldsteel et al, 2020) than that of hearing mothers interacting with hearing children of the same age (Rowe, 2008), we hypothesised that parents would reduce the syntactic complexity of their utterances in the signed condition. We also hypothesised that as none of the parents were fluent signers, they might feel constrained by their KWS knowledge and consequently would reduce the number of utterances they produced in the signed condition. Contrastingly, because vocabulary use was likely to be guided by the content of the books, we hypothesised no differences in parental lexical diversity between the signed and unsigned conditions.

METHOD

Participants

Thirty-six parent-child dyads took part in the study which was conducted in the Republic of Ireland. In order to achieve a reasonable sample size, recruitment took place in two phases (phase 1 from October 2019 to February 2020 and phase 2 from November 2020 to February 2021). Sixteen of the final sample were recruited in phase 1 and 20 in phase 2. Children were included on the basis that they had a diagnosis of Down syndrome; were no more than 5 years old at the time of recruitment; and were at a one-to-two-word level in either spoken language or sign. Preschool age was targeted as parents of preschool children with Down syndrome report creating less literacy-rich home environments than when their children reach school age (Ricci, 2011). During the first recruitment phase parents were required to have attended a certified Lámh course; however, this criterion was relaxed in the second phase and parents were included provided they had been taught Lámh by a qualified individual, such as a speech and language therapist. Moderation of this criterion was as a result of the COVID-19 pandemic, which prevented Lámh training from taking place over a protracted period.

A total of 49 parent-child dyads expressed an interest in taking part. Seven were excluded due to the child presenting with a language level that did not align with our inclusionary criteria (language level too high [$n = 1$] or too low [$n = 3$]), or parents having already taken part in phase 1 of the data collection ($n = 3$). A further six were excluded as a result of children refusing to engage with the activity ($n = 2$) and parents not following the protocol (i.e., not sending their video to the researchers [$n = 1$] or sending a video which was not the child's first exposure to the book [$n = 3$]). The participating children were between the ages of 18 and 61 months ($M = 35$ months, $SD = 12.02$) (20 male, 16 female) and were

recruited through Down syndrome Ireland and the Lámh Development office. Both organisations facilitated recruitment through their existing databases and social media platforms. Parents were emailed an information sheet and asked to contact either organisation if they wished to take part in the study. Parents were required to give written consent before they were contacted by the researchers to proceed with the study. Parents were asked to complete a background questionnaire which included information on parental education, book reading frequency and their children's medical conditions. Demographic information for participating parents and children are presented in Table 1.

Materials

DSE checklist

The Down syndrome Education (DSE) Vocabulary Checklist 1 (Down syndrome Education International, 2012) was used to profile children's level of language. The checklist (based on the MacArthur-Bates Communicative Development Inventories; Fenson et al., 2007) accounts for the first 120 words understood and used by typically developing children, respectively (Down syndrome Education International, 2012). The DSE checklist was chosen as it documents both receptive and expressive language and includes both KWS and words spoken as indicators of expressive vocabulary.

Books

Four commercially available children's books were used in the study. By using commercially published books we aimed to show how they could be readily adapted by parents to embed Lámh signs for use with their children. The books used were *Spot Bakes a Cake* and *Spot Visits His Grandparents* by Eric Hill, and *Bing: Get Dressed* and *Bing: Bedtime* by Ted Dewan. The books were chosen on the basis that they used language appropriate to children who were at a one-to-two-word level and the language level was similar across the four books. The number of utterances in each book varied and ranged from 28–31 ('Spot' books) and 50–62 ('Bing' books). While both books included a combination of nouns, verbs and prepositions, the signed utterances in the Spot books focussed primarily on noun-verb combinations and the Bing books focused on a combination of nouns and prepositions. The researchers modified each book such that text to be signed was underlined in red marker. Two to three utterances were signed per page. Additional words (to be signed) were added to increase the number of opportunities for parents to provide

a sign prompt. These were a combination of repetitions and new words, for example the phrases 'sad Bing' and 'stop Spot' were added to *Bing: Bedtime* and *Spot Bakes a Cake* respectively, where *sad* and *stop* were new signs and the signs for *rabbit* (Bing) and *dog* (Spot) were repetitions. This resulted in 48 signs (including repetitions) in *Bing: Bedtime*; 42 signs in *Bing: Get Dressed*; 28 signs in *Spot Bakes a Cake*; and 28 in *Spot Visits His Grandparents*. The 'Spot' books originally had interactive flaps throughout; however, these were removed prior to distribution to the parents as we believed they might distract children from the signs. Figure 1 shows an example of how the books were adapted.

Procedure

In the first phase, one of two researchers contacted the parents who agreed to participate in the study and arranged to visit them in their homes. Both researchers were final year undergraduate speech and language therapy students. To profile children's language ability parents were asked to complete the DSE Vocabulary Checklist 1–First 120 words (see Table S1). Data were collected in a single home visit, in which one parent, their child and the researcher were present. During the visit, parents were asked to read two books to their child as they normally would: but with the addition of specific signs in one book and no signs specified in the other book. Immediately prior to reading the signed book, parents were taught each sign embedded in the book and the rules of signing were revised, that is, signing within a designated space, always speaking when signing and keeping both hands free. We chose to teach the signs immediately prior to reading the book so that parents were recently familiarised with each sign; were given a 'live' model of the signs; had the opportunity to ask for clarification about handshape or any other sign feature about which they were unsure; and had reasonable fluency in administering the signs as they progressed through the signed book. Teaching the signs took between 10 and 20 min, depending on how many times the parent wanted to practice the signs. Parents were taught the exact number of unique signs per book, that is, 19 in *Spot Bakes a Cake*; 22 in *Spot Visits His Grandparents*; 33 in *Bing: Bedtime*; and 16 in *Bing: Get Dressed*. The researchers requested that children were not present during the teaching session. Book readings took approximately 7 min for those reading the 'Bing' books and 5 min for those reading the 'Spot' books. To control for any specific book effect, half of the parents were given 'Spot' books and the other half were given 'Bing' books. The signed book within each book pair was counterbalanced for each parent–child dyad. In addition, the sequence in which each book was read was

TABLE 1 Participant demographics

Child age (years; months)	Male		Female		Total	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
1;06–2;06	8	22.2	5	13.9	13	36.1
2;07–3;06	8	22.2	4	11.1	12	33.3
3;07–4;06	3	8.3	5	13.9	8	22.2
4;07–5;01	1	2.8	2	5.6	3	8.3
Total by sex	20	55.5	16	44.5	36	
Child background information			Yes		No	
			<i>n</i>	%	<i>n</i>	%
Language other than English in home			4	11.1	32	88.9
Vision difficulties			18	50.0	18	50.0
Hearing difficulties			21	58.3	15	41.7
Additional diagnosis			1	2.8	35	97.2
Attends creche, Montessori/preschool			20	55.6	16	44.4
Significant health condition			18	50	18	50
Caregiver works outside of the home			17	47.2	19	52.8
Caregiver participated in Lámh course			<i>n</i>		%	
Little Lámh			14	38.9		
Family Lámh part 1 and/or 2			24	66.7		
Module 1 Lámh course			6	16.7		
Taught by trained professional			3	8.3		
Caregiver highest level of education			Maternal		*Paternal	
			<i>n</i>	%	<i>n</i>	%
Secondary school			1	2.8	4	11.1
Post Leaving Certificate training			10	27.8	10	27.8
Undergraduate degree			9	25.0	10	27.8
Postgraduate degree			16	44.4	11	30.6
Frequency of reading to child at home			<i>n</i>		%	
More than once a day			2	5.6		
Once a day			29	80.5		
A few times a week			1	2.8		
Once a week			3	8.3		
Once a month			1	2.8		

Note: Little Lámh is an introductory course to using signs and covers 26 signs; family Lámh is designed to support signing at home with family and friends and covers 152 signs; module 1 is a generic course covering 100 signs. The Leaving Certificate is the final secondary school exam in Ireland. One participant omitted paternal education level.

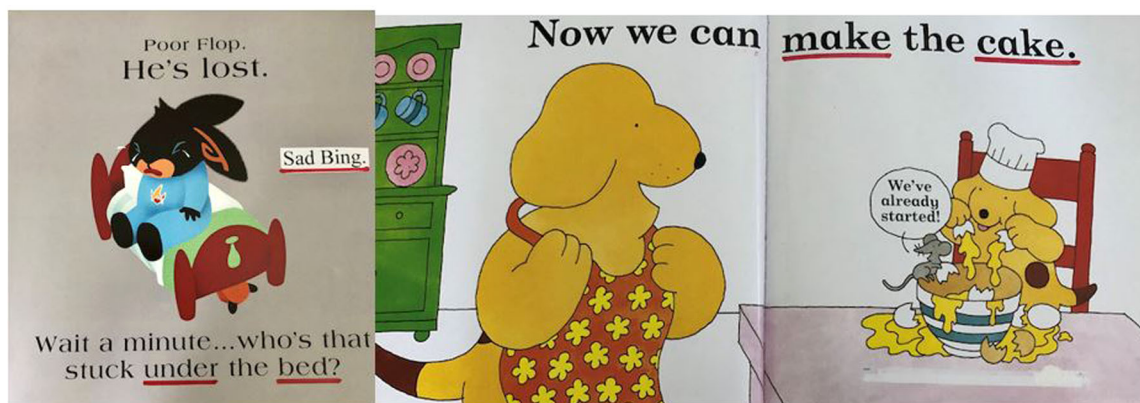


FIGURE 1 Excerpts from an adapted 'Bing' and 'Spot' book [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/1469-6994.12842)]

counterbalanced, such that half of the parents read the signed book first while the other half read the unsigned book first. Book assignment (Bing or Spot), the book to be signed within each pair and the order of reading (signed first vs. unsigned first) were all assigned randomly. In the signed condition parents were asked to sign the underlined words as they read the book, this included the words added to create additional signing opportunities. The reading of both books was video recorded on a password-protected iPad and the data were then transferred and stored on an encrypted computer.

In the second phase, which took place during the COVID-19 pandemic, data were collected remotely, again by two final year speech and language therapy students. Parents were sent a study pack which included the background questionnaire; the DSE checklists; the books to be used and instructions on how to read the books and video the session. Following this, parents were given the opportunity to ask the researchers for clarification on any aspect of the protocol that was unclear. The books were placed in a sealed envelope and parents were asked not to open it until the day of the session recording. This was to ensure that the video captured the first time that the parent and child read the books together. Parents were asked to complete the background questionnaire and the DSE checklists and to forward them to the researchers by email. The researchers then organised a video call with the parents using the Zoom platform. The video call took place immediately prior to parents reading the signed book so that signs and signing rules could be revised. Apart from the addition of signs (in the signed condition) parents were asked to video themselves reading the books with their child as they normally would. The protocol mirrored that described in phase 1, but with the parents recording their own video. Parents then sent the videos to the researchers using Google Drive, OneDrive or WeTransfer, depending on which software they had access to.

Measures

Child measures

Two measures were used to investigate the impact of embedding KWS on children's communicative behaviour during the book reading activity: the number of Lámh sign attempts made by the child and children's level of participation as indicated by the Pivotal Behaviour Rating Scale (PVBRS) (Mahoney, 1998). Prior to analysis, the researchers discussed the criteria for accepting a gesture as a sign, which included similarity and temporal proximity to the target sign, as well as the parents' reaction to the gesture (i.e., whether they accepted it as a sign attempt). For each phase, Lámh sign attempts were manually counted by two researchers simultaneously and the a priori criteria were applied.

The PVBRS (Mahoney, 1998) measures children's participation under the headings of *attention* and *initiation* and has been used in previous research with children with Down syndrome (Mahoney et al., 2006). Guidelines for the use and analysis of the scale were followed, published by Mahoney (1998). The attention component is divided into

- the child's general ability to attend to an activity;
- their level of persistence within an activity (i.e., how much effort a child makes to participate, indicated by vocalisations or Lámh sign repetitions);
- their involvement in the activity (i.e., how involved the child is in reading the book, described as passive or active); and
- their level of compliance/cooperation (i.e., how well a child responds to and cooperates with overt and subtle suggestions from the parents, for example, asking them to turn the page, or holding the page suggestively to encourage the child to turn it).



Ratings of one to five are used across these variables with a score of one meaning the child presented with very low attention and a score of five meaning the child had very high levels of attention.

The initiation component of the scale measures

- how often the child initiates activities (for example, independently turning a page, pointing to a picture in the book, using a Lámh sign independently);
- how often the child initiates an interaction with the adult (for example, eye contact);
- and affect which is characterised by the child's emotional state during the interaction.

These three variables are graded using a five-point scale with a score of one meaning the child shows very low initiation and a score of five demonstrating a high level of initiation. An overall score is derived by adding the scores for each sub-component and dividing by 4 for a total attention score, or dividing by 3 for an initiation score.

Parental measures

Three measures were used to explore the quality and quantity of parental language used during each book reading. In keeping with prior research (e.g., Barton-Hulsey et al., 2020) quantity was evaluated as the total number of parental utterances and quality as MLU in morphemes and vocabulary diversity (VOCD). The number of parental utterances included those scripted in the book and any spontaneous extra-textual utterances produced by the parents. Extra-textual utterances were those not referred to prior to book reading. In most cases an utterance was defined as a string of words with a complete grammatical structure, however in keeping with Bernstein Ratner and Brundage (2015) we also recognised instances where a stand-alone single word was the intended utterance. Given that parents were reading from a book this meant that much of the language used was scripted. However, we still wanted to capture variation in how parents used the books such as the degree of commenting, questioning and length and diversity of extra-textual utterances. VOCD was the measure of parental lexical diversity and MLU in morphemes was the parental measure of linguistic productivity.

Data coding and analysis

Parental and child utterances were transcribed using the Codes for Human Analysis Transcripts (CHAT) software. Two researchers transcribed 20% of the data.

Inter-rater reliability was calculated using the formula $\text{agreements}/(\text{agreements} + \text{disagreements}) \times 100$. Inter-rater reliability was 89.1%. Uncertainties and disagreements were resolved through discussion. Prior to rating on the PVBRs, researchers discussed the tool in the context of book reading, citing different examples to ensure that both researchers had the same understanding of each of the parameters. Researchers then practiced rating some videos to highlight potential differences in interpretation. Following this they rated 20% of the videos independently and inter-rater reliability was calculated at 91.2%. Again, any disagreements were resolved through discussion.

Parental and child utterances were analysed using the Computerised Language Analysis software (CLAN), which is part of the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). Once transcriptions were in the correct format in CLAN, the data were run through the KIDEVAL programme, which generated an Excel spreadsheet of the three parental language measures of interest: total number of utterances, MLU in morphemes, and VOCD. Total scores for each of the child measures (number of Lámh signs, *attention* and *initiation*) were also calculated in the signed and unsigned conditions. Data were entered into csv files and statistical analyses were performed using R (version 4.0.3; R Core Team, 2018). Contrasts in outcomes between the signed and unsigned conditions were estimated using Poisson mixed-effects models (to account for the paired nature of the data) for the children's number of attempted Lámh signs and parents' number of utterances; and linear mixed-effects models for children's attention and initiation scores, and parents' MLU and VOCD scores. Effect estimates from the Poisson models are reported as incidence rate ratios (IRRs) while effect estimates from linear models are reported as differences in means. All estimates are reported alongside 95% confidence intervals (CIs) and *p* values. The R package lme4 was used to estimate models, while gtsummary and ggplot2 were used to produce results tables and figures, respectively.

RESULTS

Child outcomes

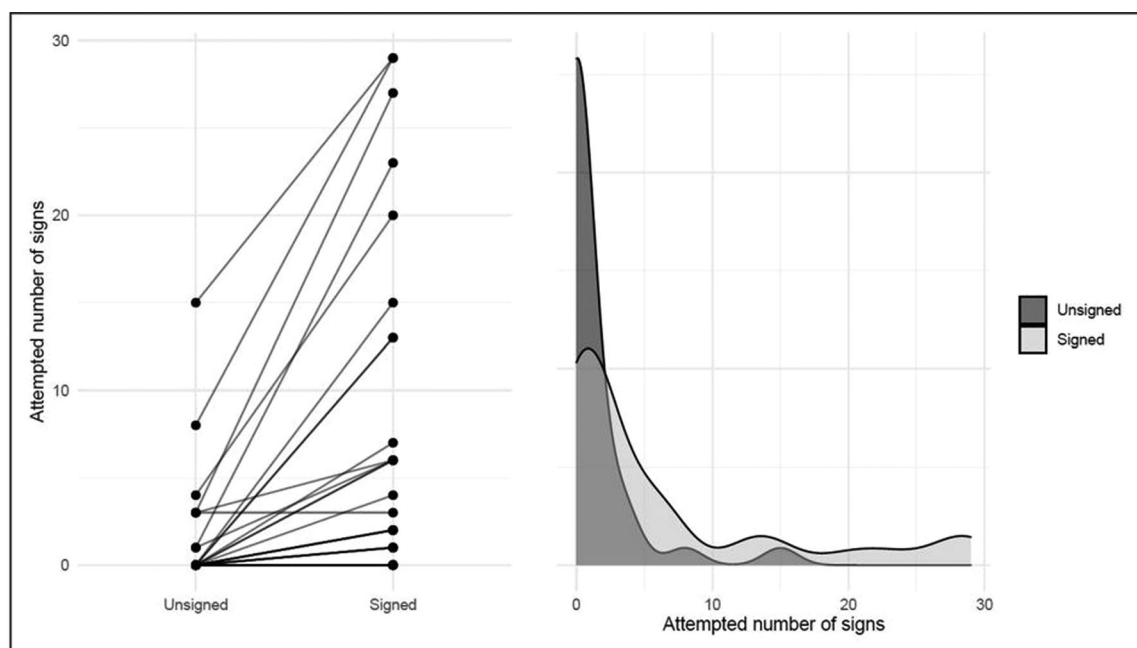
Our first research question addressed the impact of embedding Lámh signs in a shared book reading activity, on children's signing. Results indicated that children used an average of six signs in the signed condition compared to one sign in the unsigned condition. The IRR for signed versus unsigned was 5.84, 95% CI 4.2 to 8.37, $p < 0.001$ (Table 2). An increase in sign use was the case for 24 of the 36 children (Figure 2). A total of 11 children did not produce

TABLE 2 Signed versus unsigned condition for each of the outcomes

Child outcomes	Condition		Estimated effect (95% CI) ^b	P value
	Unsigned, <i>N</i> = 36 ^a	Signed, <i>N</i> = 36 ^a		
Attempted number of signs	1 (3); 0 [0, 0]; (0 to 15)	6 (9); 2 [0, 6]; (0 to 29)	5.84 (4.2 to 8.37)	<0.001
Attention	3.01 (0.94); 3.00 [2.25, 3.56]; (1.25 to 4.75)	3.40 (1.13); 3.50 [2.69, 4.25]; (1.00 to 5.00)	0.38 (0.16 to 0.61)	0.002
Initiation	2.58 (0.82); 2.66 [2.00, 3.00]; (1.30 to 4.66)	2.93 (1.06); 2.83 [2.25, 3.66]; (1.30 to 5.00)	0.35 (0.11 to 0.6)	0.007
Parent outcomes				
Utterances (UTT)	51 (22); 50 [35, 60]; (13 to 135)	64 (35); 55 [44, 72]; (33 to 225)	1.26 (1.18 to 1.34)	<0.001
Mean length of utterance (MLU)	4.68 (0.78); 4.64 [4.12, 5.09]; (3.51 to 6.89)	4.25 (0.58); 4.22 [3.82, 4.61]; (3.31 to 5.67)	−0.43 (−0.74 to −0.11)	0.012
Vocabulary diversity (VOCD)	44 (9); 44 [38, 49]; (29 to 72)	42 (7); 41 [37, 47]; (29 to 62)	−2.13 (−5.19 to 0.93)	0.177

^aMean (SD); Median [interquartile range]; (Range).

^bEstimated effects of signed condition (vs. unsigned). For UTT and Attempted number of signs, incidence rate ratios were estimated with mixed effects Poisson models. For Attention, Initiation, MLU and VOCD, differences in means were estimated with linear model mixed effects models.

**FIGURE 2** Plotting Children's use of sign in the signed and unsigned conditions

any signs in either condition.

Our second research question addressed whether there was an increase in children's participation in the book reading activity (indicated by levels of attention and initiation) when sign prompts were embedded in the books compared to when they were not. Results showed that the signed condition was associated with an increase in both attention and initiation scores (the difference in mean attention scores for signed versus unsigned was 0.38 units, 95% CI 0.16 to 0.61, $p = 0.002$; the difference in mean initi-

ation scores for signed versus unsigned was 0.35 units, 95% CI 0.11 to 0.6, $p = 0.007$; Table 2). An increase in attention score was shown for 25 children and increased initiation scores were evident for 20 children (Figures S1 and S2). An increase in attention was reflected in

- Attention to the activity: Sitting throughout the activity, looking at the book, and allowing the parent to control the pace of reading the book rather than throwing the book away or trying to move rapidly ahead.



- Persistence: Repeating vocalisations, repeating Lámh signs modelled by the parents.
- Involvement: Attempting to turn the page, pointing to the words on the page, commenting/laughing in reaction to the story.
- Compliance/cooperation: Responding positively to parent requests to sit down and look at the book, or to suggestions to turn the page.

An increase in attention was shown in relation to

- The activity: Independently pointing to the book, independently using a Lámh sign.
- The parent: Actively making eye contact, looking at the adult while pointing to the book.
- Affect: Smiling or laughing showing that they were enjoying the activity.

See Table S2 for complete list.

Parent outcomes

Our third research question addressed whether there was a difference in the quality and quantity of parental language used when Lámh signs were embedded in the books, compared to when they were not. Results showed that the signed condition was associated with a 26% increase in the number of parental utterances used (IRR 1.26, 95% CI 1.18 to 1.34, $p < 0.001$; Table 2). This increase was evident in 26 of the 36 parent participants (Figure S3). The signed condition was also associated with a reduction in mean MLU in morphemes (a difference in means of -0.43 units, 95% CI -0.74 to -0.11 , $p = 0.012$; Table 2), evident for 22 of the 36 participants (Figure S4). Mean VOCD was lower in the signed condition, but the difference was non-significant (a difference in means of -2.13 units, 95% CI -5.19 to 0.93 , $p = 0.177$).

DISCUSSION

This study is the first to examine the effect of embedding KWS on the communicative interaction that occurred between parents and young children with Down syndrome, during a shared book reading activity. Specifically, with respect to children, we investigated whether parents' embedding of Lámh signs in shared book reading would affect children's use of Lámh, or their level of participation in shared book reading. Our findings are clear and show that when parents signed key words during book reading, children significantly increased the number of signs they produced, compared to when parents read without

signing. Reading books with embedded signs also resulted in an increase in children's participation in the activity, measured by levels of attention and initiation.

Previous findings show that in order for shared book reading to support growth in child language, it is not sufficient to merely read the text of the book (Landry et al., 2012). Rather, parents need to make reading engaging by 'scaffolding the language of the book for optimal engagement and reciprocal communication' (Barton-Hulsey et al., 2020 p. 1476). For typically developing children who are verbal, there are a number of established techniques that have been reported to achieve this, such as those outlined in the process of dialogic reading (e.g., using questions to encourage the child to talk about the pictures, providing informative feedback using expansions and corrective modelling [Mol et al., 2008]). Some of these techniques have also been shown to be effective with children with Down syndrome whose language is at a sufficiently high level (e.g., Burgoyne & Cain, 2020 – embedded questioning). However, achieving active engagement and reciprocity is more challenging for those with limited verbal language skills or whose language is impaired, as many of the established techniques may require a verbal response or may not be suitable. Our study shows that by simply embedding key word signs into commercially available books, we can enhance the participation and attention of young children with Down syndrome (at a 1–2 word expressive language level) in shared book reading. Given that responsiveness to joint attention has been found to predict early vocabulary development and later language outcomes in children with Down syndrome (Mason-Apps et al., 2018; Zampini et al., 2015), it is important for children with Down syndrome to engage in activities that can foster the development of this skill. Embedding key word signs in a shared book reading activity would seem like a relatively uncomplicated way to achieve this. From a clinical perspective embedding signs is something that parents, therapists and early years educators can readily do, with limited training, to enhance children's attention and therefore their capacity to learn.

Our second finding of increased sign use in the signed book condition was in keeping with our hypothesis and is supported by evidence that children with Down syndrome are good imitators (Vanvuchelen et al., 2011). Lederer and Battaglia (2015) highlight books as an important context in which to embed signs as they offer the opportunity for frequent exposure to sign-word pairings, which in turn promotes vocabulary development. Our study shows that parental use of sign during book reading not only allows for frequent sign-word exposures but also increases children's sign imitation and repetition and that this form of 'expressive practice' is expected to lead to improved language learning outcomes (Launonen, 2019; Vandereet



et al., 2011). While our study explored the effects of embedding signs in a one-to-one activity at home, there is also potential for educators and clinicians to engage in a similar activity with small groups of children, so that several children could simultaneously benefit from repeated sign-word exposures in a structured context. However, we do not yet know if effects shown in a one-to-one context would translate to a group setting and this would need to be empirically examined.

With respect to parent outcomes, we were interested to explore if embedding Lámh prompts would have an impact on the quality or quantity of the language they used compared to when they read without signing. Our data show that when reading the book with embedded signs, parents increased the number of utterances they used and reduced their syntactic complexity. Additionally, whether signs were embedded or not had no bearing on parents' lexical diversity.

At first glance, an increase in the number of utterances produced by parents appears to be in keeping with Burgoyne and Cain (2020), who reported an increase in extratextual talk when parents engaged their children with Down syndrome in shared book reading, with embedded question prompts. However, while we did not formally analyse the function of parent talk, informally it was evident that the increase in utterances was due to parental repetition of the signed word or phrase, rather than the production of novel utterances. We hypothesised that parents might feel constrained by their limited key word sign knowledge and therefore reduce the number of utterances produced. Our findings are partially aligned with our hypothesis in that increased utterance use was as a result of repetitions rather than additional extra-textual talk. It may be the case that because parents were very focused on their own signing, as well as that of their child, they were not thinking about how they might add new language or move away from the prescribed text in the books. However, the increase in utterance/word exposure resulted in an increase in the number of times each vocabulary item was modelled, both orally and in sign. This in turn increased the 'dose' which is reported to be particularly beneficial for people with Down syndrome (Neil & Jones, 2019; Yoder et al., 2014).

Our findings of parents' reduced syntactic complexity in the signed condition is also in keeping with our hypothesis. Based on findings by Fieldsteel et al. (2020) and because the focus of KWS is on the content rather than functional words in the sentence, we expected that this might result in reduced syntactic complexity. Previous studies suggest that parental language input is closely linked with child language ability, and that during book reading, mothers use more complex language with children who have better expressive language skills (Hilvert

et al., 2022). Children included in this study were at a 1–2 word expressive level, and therefore we anticipated a low level of syntactic complexity overall. It is noteworthy that within participants, the addition of signs reduced the complexity of utterances produced by parents even further. For children at a 1–2 word expressive level, an average MLU of 4.25 could be deemed desirable as it is just beyond the language level of the child. However, for other children whose language is developmentally more advanced, the modelling of more syntactically complex utterances would be important to promote growth in syntactic development.

Lastly, our finding of no significant difference in lexical diversity between the signed and unsigned conditions was not unexpected, particularly in the context of such a scripted activity. Given that our prompts focused only on key words in the text or added phrases (also added to the unsigned books) to create additional signing opportunities, we did not expect that when signing, parents would use more diverse vocabulary. We did note a small reduction in VOCB in the signed condition, likely caused by the extra concentration required by parents to produce accurate signs; however, this was not significant.

Limitations and future research

There are some limitations to the current study which we note here. During the first phase of data collection the researchers brought the books to the session and recorded the videos in person. As unfamiliar adults, their very presence in the home may have influenced the interaction that took place between parents and their children. In contrast, because the second phase of data collection was carried out during COVID-19, data were collected remotely. Parents were forwarded the books in advance and completed their own videos. While this may have resulted in a more 'natural' interaction, the disadvantage of this method is that we cannot be 100% sure that the videos reflected the first time that children were exposed to the books. However, our findings did not differ whether we analysed the data collected in each phase separately, or as one cohort.

Secondly, our findings are reflective of only two examples of shared book reading interactions per parent–child dyad. Therefore, we do not know if the changes in interaction we observed here would be similar if parents engaged in shared book reading with embedded sign over a more protracted period, how these changes might effect children's functional use of sign outside of the book reading context or if these changes would lead to significant growth in children's language ability. Furthermore, we do know



how the specific features of the books used in this study may have affected our findings.

Future research on parents' experiences would add to our findings. While some parents volunteered qualitative feedback on signing while at the same time reading the book (e.g., highlighting practical issues of optimal positioning for both themselves and the book), it would be interesting to gather this information systematically. It would also be interesting to explore the effect of embedding signs in books aimed at a broader level of language ability and range of ages, that we might evaluate the potential for heterogeneity of treatment effects. Moreover, given the benefits shown here, along with those reported by Burgoyne and Cain (2020) with respect to embedded questions, exploring the effects of both techniques combined would seem a fruitful avenue for further research. In addition, it would be beneficial to complete longitudinal work to explore if children's use of sign in this structured activity generalises to more functional use over time. Lastly, it would be interesting to explore how this approach might work for children with other language and communication difficulties.

We recommend the development of a set of resources, where appropriate books are identified and adapted for use with KWS, to support parents in maximising the benefits of shared book reading at home, with young children with Down syndrome.

CONCLUSION

Our data show that the simple act of embedding key word signs into commercially available books, during shared book reading between parents and young children with Down syndrome, positively affects the communicative interaction that occurs between parents and their children. Children signed more and became more active participants and through repetition, parents increased the dosage of word/sign pairings. Each of these factors have been shown to facilitate growth in children's language abilities. Given the frequency with which many parents report reading with their children with Down syndrome at home, the act of embedding signs in to this relatively structured activity has the potential to yield significant effects with minimum burden.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data for this work are available from the authors on request.

PARTICIPANT CONSENT

Parents provided written consent to participate in the study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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