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Longitudinal Study of Narrative Development in Deaf and Hearing Children: Contributions of Executive Functions and Vocabulary

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ABSTRACT

Narratives are part of children's everyday language interactions and an important precursor to broader competences such as literacy. This longitudinal study explores the development of spoken narrative skills in a large group of typically hearing and deaf and hard of hearing (DHH) children. Narrative skills, executive functions and vocabulary were assessed at two time points and relations between these factors analysed. Data were collected from 30 DHH children and 42 hearing age-matched controls. Children were 6–11 years old at the first assessment point and retested two years later. Both groups improved their narrative scores over time. Despite a delay at T1, the DHH group narrowed the gap with their hearing peers two years later. EF predicted hearing but not DHH children's narrative development. In contrast, vocabulary predicted narrative for both groups. This study demonstrates that DHH children improve their narrative skills over time. There is a different association between EF and narrative in DHH children, which may be related to their wider spoken language development delays. This possibility is discussed along with clinical implications for future language interventions with DHH children.

1 | Introduction

One of the most important and complex uses of language is telling a story to another person. The production of a narrative requires real or imagined events to be recounted coherently and sequenced following a causal and temporal order. In development, the full growth of narrative skills unfolds throughout childhood and into young adulthood (Lindgren 2021). The ability to recount a narrative involves two levels of organisation of information (macro and micro-structure). The macro-structure refers to the global organisation of information including the story structure and content. The micro-structure relates to the local organisation of sentence constructions, grammatical elements, pronouns and connectors (Caballero et al. 2020; Lindgren 2021).

Children's first narratives are simple sequences of events without temporal or causal explanations (Westby 2012). At around 3–4 years the connectives 'and' and 'then' appear, and by age 5 years causal information starts to be included (Stein and Albro 1997). It is not until 9–10 years that all of these elements are put together to make complete maximally sophisticated event sequences with a goal, attempt and outcome (Caballero et al. 2020; Lindgren 2021; Trabasso and Stein 1994). Development of micro-structure includes devices for achieving cohesion and the unambiguous use of character reference and takes longer to master

> **Highlights**
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> - The development of narrative skills was significantly faster in the deaf group than in the hearing group.
> - Deaf children improve primarily in micro-structure, but their performance is still lower than that of their hearing peers.
> - Narrative skills in deaf children relate to vocabulary, while in hearing children, performance also involves executive functions.

than the macro-structure. From 4 to 8 years old children slowly use more grammatical elements (Caballero et al. 2020; Justice et al. 2006) provide more pragmatic information (Hemphill et al. 1991) and improve perspective taking (Tager-Flusberg and Sullivan 1995). At this age, children are able to think about how easy or difficult it is for listeners to understand the events they are recounting (Curenton and Lucas 2007). In terms of coordinating the macro and micro-organisation, young children find it difficult to simultaneously plan the description of events locally, as well as decide what aspect of the plot to recount next. In order to master narrative, children must develop control of both levels of organisation simultaneously (Lindgren 2021) and this is supported by wider cognitive abilities, in particular their Executive Function (EF) system (Schönberger et al. 2025; Veneziano and Bartoli 2022) and expressive vocabulary (Bitetti et al. 2020). Indeed, EF and expressive vocabulary have been found in hearing children to support each other in models of narrative production (Kim 2016, 2023).

1.1 | Role of EFs in Narrative Development

The EFs are a set of cognitive skills that help individuals plan, organise, and manage their behaviour and thoughts. There are different models for how the EFs work together. In the current study we use a model and a measurement based on Gioia et al. (2000). This model has a measurement tool called the Behavioural Rating Inventory of Executive Function (BRIEF, Gioia et al. 2000) which sets out two main indices: the Behavioural Regulation Index (inhibition, shifting, emotional control) and the Metacognition Index (initiation, working memory, planning, organisation of materials, and monitoring). Both Gioia's model and children's narrative competence are best understood as ecological constructs. This EF model was developed to capture the everyday behavioural manifestations of executive functioning in the home and school environments. In parallel, narrative is a naturally occurring, socially situated discourse practice: producing coherent stories in real contexts depends on planning the structure, switching between characters and events, and monitoring coherence. Precisely, the kinds of cognitive processes that become most visible in everyday communication (Scionti et al. 2023).

In previous studies of hearing children, narrative production is characterised as a multi-componential and complex ability (Schönberger et al. 2025; Scionti et al. 2023). Kalliontzi et al. (2022) showed that behavioural regulation skills such as inhibition are used for self-directed pauses for reflection and planning. Shifting is also implicated as children move between focusing on information concerning the overall plot and then local events (Friend and Bates 2014; Nelson and Khan 2019). Metacognitive skills are involved as working memory supports the online generation and sequencing of story elements and the organisation of a clear beginning, middle, and end, as well as the production of more complex syntax (Duinmeijer et al. 2012; Veraksa et al. 2020). When retelling a narrative, speakers must plan and monitor their discourse in line with communicative goals and select appropriate lexical and syntactic forms (Johnston 2008). Finally, children need to track plot-advancing events and include more complete story-grammar sequences as their narrative skills progress (Khan et al. 2016).

1.2 | Role of Expressive Vocabulary in Narrative

Vocabulary constitutes the building blocks of language and has been linked to hearing children's narrative development (Bitetti et al. 2020; Joffe et al. 2019) and the increasing ability to mentally represent objects that are absent from the immediate context (McGillicuddy-DeLisi and Sigel 1991). Sénéchal et al. (2008) demonstrated that the macro-structure of narratives was associated with vocabulary and morpho-syntax skills in typically hearing children aged 4 years. The explanation for the association was that children who had acquired more word meanings were able to access their vocabulary and word knowledge more efficiently during the demanding task of recounting a narrative and better able to select words against competing candidates (Bitetti et al. 2020; Joffe et al. 2019; Silva and Cain 2024). More highly developed vocabulary skills allow children to devote more of their cognitive resources to planning and sequencing events in narrative (Joffe et al. 2019).

1.3 | Deaf Children's Development of Language, EFs and Narrative

One group with high variability in narrative development are children who are deaf and hard of hearing (DHH). Children who are identified as DHH are diverse and have differences in development influenced by a range of factors (age of cochlear implantation, use of hearing aids, other neurological conditions, severity of hearing loss, and how DHH children access language prior to implantation). The DHH children whom speech-language pathologists encounter most often in clinical settings are the 90%–95% of the population who are born to hearing parents (Mitchell and Karchmer 2004). In the western hemisphere, these hearing parents of DHH children with severe and profound deafness often opt to follow the route of their child receiving a cochlear implant (CI). Other DHH children with less severe hearing losses will be users of hearing aids. Research looking at how hearing parents talk to their DHH children shows that DHH children are exposed to words and sentences in fewer contexts, which contributes to delays in language development (Dirks et al. 2020; Spencer and Marschark 2010). In addition to differences in parent–child interaction, spoken language is more challenging for DHH children to acquire because of limited auditory access (Lund 2018). Thus, the DHH child population is highly diverse, and their language skills are very variable. Early exposure and consistent access to a complete language (signed, spoken, or both) are critical for communication development for all children.

1.4 | DHH Development of Macro and Micro-Structure of Spoken Narratives

The current study focuses exclusively on DHH children's development of spoken language narratives. DHH children using spoken language typically have difficulties in the development of narratives (Jones et al. 2016; Lau et al. 2019). Jones et al. (2016) showed that DHH children in their sample produced narratives with intact overall structure (macro-structure) but delayed sentence level connections (micro-structure). However, other studies of spoken narrative development in DHH children have produced mixed results. For example, Crosson and Geers (2001) found DHH children with CIs had delays with both macro and micro-levels. Explaining these inconsistencies in results, there were some possible differences in the two studies regarding the tasks used. Crosson and Geers (2001) elicited stories using an eight-picture sequence while in the Jones et al. (2016) study children had to watch a silent video with real actors before recounting the story. Retelling from pictures is considered more difficult for children than from video (Diehm et al. 2020), and this may have put more demands on macro-structure.

There are some studies which have followed DHH children's narrative development longitudinally. In general, these show that despite early difficulties with narrative, DHH children improve over time. Klein and Wie (2014) looked at children with early CI and evaluated their narrative skills regularly over 4 years post-implantation. The results indicated age-appropriate (results comparable to hearing peers) narrative skills by school age. Predictors of later narrative skill included early auditory skills, expressive and receptive language, and favourable linguistic input by parents/educators. Similarly, Murri et al. (2015), found that spoken narrative development in terms of both macro and micro-structure was highly related to age at CI activation. Finally, in Persian speaking DHH children, Zamani et al. (2018) reported children made significant improvements in macro and micro-structure skills over a 2-year period.

Several studies attribute difficulties in DHH children's narrative development to limited early access to language. For example, Lau et al. (2019) concluded that reduced linguistic interaction, delays pragmatic and mental-state understanding in DHH children. Any delays in narrative skill development are clinically important because of the established link between narrative, literacy, mathematics, and wider school success (Khan et al. 2021; Shaqiri et al. 2020). Any delays in acquiring narrative abilities are therefore of concern. In explaining why narrative is particularly difficult for some DHH children to master, we return to the combined influences of EFs and vocabulary reviewed in the previous section on hearing children's development. For instance, Schönberger et al. (2025) showed that narrative is supported by the development of the EFs (both metacognitive and behavioural skills) of inhibition, shifting, working memory, and monitoring. Several studies with DHH children with different levels of language skills have addressed their concurrent EF abilities (Beer et al. 2014; Botting et al. 2017; Dye and Hauser 2014; Jones et al. 2020; Pisoni et al. 2011; Vissers and Hermans 2018). The combined findings from these studies indicate much individual variability in EFs but overall, DHH children (especially those with hearing parents) perform significantly poorer on EF tasks in comparison to their hearing peers, particularly in tests of working memory and inhibition. This EF difference may be one explanation for delays in narrative production. For example, Arfé et al. (2015) found that verbal working memory significantly contributed to DHH children's ability to produce both oral and written narratives at micro- and macro-structural levels.

Considering the importance of vocabulary skills for narrative development in hearing children, several studies have also highlighted this as contributing toward DHH children's delays. DHH children with hearing parents often have smaller vocabularies than hearing peers due to limited early access to language. However, early intervention and consistent exposure to language (signed or spoken) can improve outcomes (Caselli et al. 2021; Yoshinaga-Itano 2003). Receptive vocabulary levels appear to play an important role in EFs, especially in DHH children (e.g., Botting et al. 2017; Merchán et al. 2022). Jones et al. (2020) showed DHH and hearing children's vocabulary scores (both signed and spoken language) predicted group differences (in longitudinal growth) in EF skills. Highlighting the importance of language abilities on EF, DHH children with DHH parents have been shown to perform better on EF tasks (Dye and Hauser 2014; Marshall et al. 2015).

With this background complete we turn to the current study which examines both the contribution of EF and vocabulary to DHH and hearing children's narrative skills over time. We hypothesise that both EF and vocabulary will relate positively to narrative skills in both DHH and hearing children. We also hypothesise this relationship will be consistent over time.

1.5 | Research Questions

1. Do DHH children have the same trajectory in terms of narrative skills compared to their hearing peers?
2. What is the relationship between EF and narrative development in DHH and hearing children across time?
3. How are narrative scores related to expressive vocabulary across time in DHH and hearing children?

2 | Methodology

2.1 | Participants

A total of 72 children (30 DHH and 42 hearing) took part in this study. Children diagnosed with additional disabilities were not included in the sample. Children were aged between 6 and 11 years and had been previously recruited as part of a larger sample (Jones et al. 2016). The smaller sample size in the current study was because only 57% of the original sample (51% DHH; 63% hearing) was available to follow up at time 2. Similar attrition rates are reported in other longitudinal studies (e.g., Gustavson et al. 2012). The main reason for the reduction in sample size is related to the fact that the older children transitioned to secondary/high school between testing points, making

TABLE 1 | Participant characteristics of DHH and hearing children.

	DHH group ($N = 30$)	Hearing group ($N = 42$)		
	M_{score} (SD)		t	*p*
Age (years; months) T1	8; 4 (1; 6)	8; 9 (1; 6)	1.29	0.20
Age (years; months) T2	10; 0 (1; 6)	10; 6 (1; 6)	1.17	0.25
WASI matrix T-score T1	50.53 (10.48)	52.26 (8.58)	0.77	0.44
WASI matrix T-score T2	53.57 (7.48)	54.54 (7.24)	0.56	0.58
Metacognition T1	52.00 (11.28)	50.00 (11.43)	−0.73	0.47
Behavioural regulation T1	56.07 (13.38)	49.54 (12.04)	−2.13	0.04
Global index BRIEF T1	53.83 (11.65)	49.63 (11.65)	−1.47	0.15
EOWPVT T1	76.57 (20.07)	98.73 (14.93)	5.26	< 0.001
	Percentage		χ^2	*p*
Gender (% boys)	43	52	0.58	0.45
Parent with further education	79	81	0.06	0.81
Parent in employment	78	83	0.33	0.57

Note: Higher scores on BRIEF scales reflect increased incidence of problematic behaviour. DHH (Deaf/Hard of Hearing), WASI (Wechsler Abbreviated Scale of Intelligence), EOWPVT (Expressive One-Word Picture Vocabulary Test), BRIEF (Behavioural Rating Inventory of Executive Function), parent with further education (percentage of parents who went to college or university).

them more difficult to recruit at T2. There were no statistical differences in terms of age, gender, nonverbal cognitive ability, expressive vocabulary, narrative skills, or overall EF scores at T1 between the original and this study's sample.

See Table 1 for characteristics of the DHH group and their age-matched hearing peers. The *t*-tests were used to analyse the differences between groups for the variables age, Behavioural Rating Inventory of Executive Function (BRIEF, Gioia et al. 2000), expressive vocabulary, and Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler 1999); chi-square was used for gender, parental education and work.

The DHH group consisted of children with prelingual bilateral deafness (congenital or occurrence at age ≤ 1 year) whose preferred communication method was spoken English, and 50% of them were reported by teachers to have good sign language skills. All wore hearing aids or CI (age of implantation in months: $M = 47.0$; SD = 28.6). See Table 2 for characteristics of the DHH group. Analysed by ethnicity, 87% of DHH children were White British ($n = 26$) and 13% with other backgrounds (two were mixed ethnic background or other, one was Asian British, and one was Black British). Ethnicity of the hearing group was the same. In order to control for socioeconomic background, hearing and DHH children were recruited from schools with similar demographics. Despite controlling for these factors, as shown in Table 1, differences in language and EF skills at T1 were found between DHH and hearing children.

TABLE 2 | Background characteristics of the DHH participants.

Background characteristic	*N*	% of *N*
Total *N*	30	
Aetiology of deafness		
Genetic	10	33
Illness	5	17
Unknown	15	50
Degree of hearing loss		
Mild/moderate	4	13
Severe	11	37
Profound	15	50
Bilateral hearing aids	15	50
Unilateral cochlear implant	10	33
Bilateral cochlear implants	4	13
Unilateral hearing aid and cochlear implant	1	3
No amplification	0	0

2.2 | Measures

Various methods have been developed to measure children's narrative skills including story generation, story retelling, and personal narratives. Moreover, different narrative assessment tools exist to assess either narrative production or narrative comprehension at different levels (Curenton and Lucas 2007). Some of these tests have been standardised and provide clinical cut-offs.

A common methodology in the evaluation of narrative development is to ask children to retell stories from non-verbal stimuli (pictures or a video). During such a retelling, children use their EF system to inhibit recounting the most memorable event first (often the climax) and instead set the opening scene and introduce characters. They also need to retain the story plot (i.e., the arc of the narrative) as they recount individual events in chronological order. Thus, one of the most important EFs is the contribution of working memory which enables children to coordinate the different levels of the story organisation (Johnston 2008). This level of cognitive control is obviously challenging for young children and appears gradually during the years leading up to adolescence and beyond (Mascolo and Fischer 2010; Ye and Zhou 2009).

Not all narrative assessments are equally demanding for children (Gagarina and Bohnacker 2022). For example, the re-tell method reduces the working memory load during narrative production and is therefore easier for children than spontaneously constructing a story (Colozzo and Whitely 2014), and consequently this method is employed with children with language development delays (Duinmeijer et al. 2012), including studies of DHH children (Herman et al. 2004; Jones et al. 2016).

2.2.1 | Narrative Skills

The current study uses a story retell paradigm and includes a measure of macro-structure (narrative content and structure) and micro-structure (grammatical elements) adapted from Herman et al. (2004) as described in Jones et al. (2016). In carrying out the evaluation, first the child watches a short (2 min), silent story on a laptop. In the story, the two children in the video act out a series of events without the use of language (see Table 3 for story episodes).

TABLE 3 | Story episodes.

Episodes	
1	The girl brings in a tray of food and drink
2	The boy is watching TV
3	The girl helps herself to sweets, which the boy demands (using an outstretched arm movement and an insistent facial expression) and she gives to him
4	Episode 3 is repeated with a cake
5	Episode 3 is repeated with a drink
6	The girl sees a spider
7	She tiptoes over to pick up the spider (whilst the boy continues to watch TV)
8	She makes a sandwich by placing the spider be- tween two pieces of bread
9	She pretends to eat the sandwich
10	The boy demands the sandwich
11	The girl hands over the sandwich to the boy
12	The boy bites the sandwich (and realises there's a spider inside)
13	He takes the spider out of his mouth
14	He chases the girl round the room
15	He throws the spider at the girl
16	Additional information provided, for example, the boy is lazy or the spider is horrible

Participants are instructed to watch the story carefully and to remember it so they can retell it immediately after viewing. To encourage the child to tell the whole story, the experimenter leaves the room and returns once the video has finished. The child is able to watch the film a second time if he/she wishes. When the experimenter returns, the child is asked to tell the story and the experimenter listens to the child's response without prompting. After completion, children are invited to add more information if they wish. Once the children finish retelling the story, they are asked two comprehension questions: (1) Why did the boy throw the spider? and (2) Why did the girl tease the boy?

The children's narratives and answers to questions were audio recorded and transcribed for analysis. All transcripts were checked against the recordings by a second examiner. The narratives were evaluated following the scoring guidelines of Jones et al. (2016). See Table 4 for a summary of the narrative scoring system.

The scores for macro and micro-structure were combined for some analyses to obtain a single measure of narrative expressive skills. This variable will henceforth be referred to as the global narrative score and did not include the two questions used to measure story comprehension.

In more detailed analyses, separate scores were obtained for macro-structure (narrative content and structure), micro-structure (grammatical morphemes, conjunctions, referential cohesion and evaluative devices). Examples of grammatical morphemes are past tense (–ed), plurality (–s) or possession (′s) and conjunctions “and, because, when”. Referential cohesion examples are use of pronouns for anaphoric reference when a pronoun refers back to a previously mentioned noun and demonstrative reference such as “this, that or those”. We also looked at scores for story comprehension.

2.2.2 | Executive Functions (EFs)

EFs were evaluated using the BRIEF (Gioia et al. 2000) filled out by the participants' school teachers. The BRIEF is a standardised 86 item questionnaire that measures various aspects of EF at home and at school for children and adolescents ages 5–18. The tool typically takes 10–15 min to administer and 15–20 min to score. The inventory is comprised of the Behaviour Regulation Index (ability to inhibit, shift, and emotional control) and the Metacognition Index (ability to initiate, use working memory, plan/organise and monitor). Both indexes form the Global Executive Composite. The BRIEF has been used previously with DHH participants (e.g., Hintermair 2013; Kronenberger et al. 2020). A T-score of 50 corresponds to the average of the distribution, whereas a T-score of 65 reflects a value 1.5 SDs above the mean. Scores

TABLE 4 | Summary of narrative scoring system.

	Scoring	Points allocated
Macro-structure		
Narrative content	Reference to 15 key story episodes, plus a point for additional information, to measure level of detail in a narrative.	0–16
Narrative structure	Global organisation of story content. Inclusion of detail given based on key elements: orientation, two complicating actions, climax and resolution. A further point for evaluation and correct narrative sequencing of story episodes.	0–12
Micro-structure		
Referential cohesion	Points awarded for clarity of first introduction of story characters (i.e., maximum points for the use of indefinite article), and for maintenance of clear references (i.e., correctly using pronouns to contrast characters).	0–4
Conjunction score	Points awarded for inclusion of coordinating conjunctions, logical markers and subordinate clauses to link semantic relations in stories.	0–6
Grammatical morphemes	Comprises the correct inclusion of articles and prepositions, regular verb inflections, irregular verb inflections, agreement in gender, agreement in person, and use negatives and modal verbs.	0–15
Narrative and evaluative devices	One point awarded for including one example of each of the following: direct or indirect speech or thought; adjectives; adverbs describing manner; intensifers or deintensifers.	0–4
Story comprehension	Two probe questions testing understanding of actions and intentions of story characters. 1 point was awarded for each valid point made (maximum 2 in each question).	0–4

at or above 65 are typically regarded as potentially clinically significant.

2.2.3 | Vocabulary

The vocabulary assessment focused on expressive vocabulary, as measured by the Expressive One-Word Picture Vocabulary Test (EOWPVT; Brownell 2000). This standardised test evaluates single word vocabulary production following the manual guidelines. The EOWPVT is a standardised assessment of how well individuals can name objects, actions, or concepts. This measure was used reliably with DHH children in other studies (e.g., Kyle and Harris 2006). The recorded measure corresponds to the number of correct responses, which is then converted into a standardised score. Scores reported correspond to standardised scores with a normative mean of 100 and SD of 15.

2.2.4 | Non-Verbal Ability

Scores on the Matrix Reasoning subset of the WASI (Wechsler 1999) were obtained to assess non-verbal ability. The WASI is a standardised tool that delivers an estimation of a student's general intellectual ability by measuring the verbal, non-verbal, and general cognition of individuals from 6 to 89 years of age.

2.3 | Procedure

The study was approved by the UOC Research Ethics Committee (Project number: CE24-TE12). Informed written consent was obtained from all parents. Children gave verbal consent and were informed that they could opt out at any time. Researchers recommended that parents complete the BRIEF form in a quiet setting and that completion of the form should not take longer than 15 min. Once forms were completed and returned by one of the parents, children were evaluated in two sessions on the same day, with a pause between test sessions. In the first session, the narrative task and the non-verbal intelligence test were administered. The estimated time for the session was less than 45 min. The EOWPVT was used in the second session with an estimated duration of 20 min. Two years after the first wave, children were assessed again with the narrative task and the non-verbal intelligence task.

For the group of DHH children no adjustments were required to instructions or the methods of administration used in the original tests. All testing was administered by an experienced researcher and clinician in a quiet room at school or at the child's home. All sessions were video recorded and later the participants' narratives were transcribed and scored blindly by two different researchers following the procedure outlined in Jones et al. (2016). The test instructions were the same for both the hearing and DHH children. Fidelity to the test administration procedures was determined prior to testing by training testers to administer the evaluation in a systematic manner following the administration protocol.

To further ensure fidelity, testing was piloted on a small group of hearing children prior to evaluating the sample in this study. The pilot sessions were recorded and reviewed by the research team for accuracy of administration. The same testers re-administered the same narrative task two years later to avoid bias.

2.4 | Analysis

Before analysis of the narrative samples was carried out, data quality control was performed through inter-rater agreement using SPSS 26. Inter-rater agreement of scoring was assessed by two independent and experienced coders. Both coders were native English speakers. Transcribers and coders were blind to diagnosis, test visit (T1/T2), and the results of other measures completed by the participants. Disagreements were resolved by discussion among the coders until consensus was reached. Cohen's Kappa (Cohen 1960) resulted in mean inter-rater reliability values of 0.89 (95% CI 0.87–0.91, $p < 0.001$).

To test RQ1, whether DHH children's narrative skills improved over time (T1–T2) in comparison to a group of hearing children, we carried out a series of repeated measures analyses of variance (ANOVAs). Partial eta squared (n_p^2) is reported in Table 6 as a measure of effect size, and small, medium, and large effects are represented by 0.01, 0.06, and 0.14.

Correlation and regression analyses were employed to analyse the relationship between narrative skills, EF (RQ2) and expressive vocabulary (RQ3). These analyses comprised two components: (1) a cross-sectional analysis for T1 measures and (2) longitudinal analyses of the effect of expressive vocabulary and EF at T1 on narrative skills at T2. Pearson correlations were conducted, and the effect sizes were set at 0.10 (small effect), 0.30 (medium effect), and 0.50 (large effect).

3 | Results

3.1 | Preliminary Analysis

First, differences between groups were calculated between T1 and T2 using *t*-tests. Table 5 displays means, standard deviations, and *p* values. At T1, *t*-tests revealed significant group differences in the global narrative score and in one aspect of micro-structure (referential cohesion). The DHH group performed less well than their hearing peers (see Table 5). However, similar performance between groups was found in macro-structure (narrative content and structure and story comprehension). At T2, the results indicated a similar performance between groups in their global narrative scores and also in all the narrative variables except referential cohesion, which continued to present challenges to the DHH group.

RQ1. Do DHH children have the same trajectory in terms of narrative skills compared to their hearing peers?

3.2 | Global .Narrative Score

In order to examine the trajectories of narrative skills and to examine the effects of time, group and the interaction between

TABLE 5 | The *t*-tests of the narrative performance in the first and second wave.

	Time 1					Time 2				
	DHH group	**Hearing group**	***t***	***p***	n_p^2	**DHH group**	**Hearing group**	***t***	***p***	n_p^2
Global Narrative Score	33.5 (9.4)	38.4 (6.6)	2.67	0.01	0.09	41.8 (4.6)	43.0 (5.2)	0.92	0.36	0.01
Narrative content	10.0 (3.1)	10.0 (3.2)	−0.11	0.92	0.00	12.6 (1.9)	12.3 (2.8)	1.17	0.25	0.02
Narrative structure	8.9 (1.9)	9.0 (2.1)	0.28	0.78	0.00	10.4 (1.4)	10.6 (1.4)	0.77	0.44	0.01
Micro-structure	14.6 (5.6)	19.5 (2.7)	4.49	<0.001	0.22	18.8 (2.6)	20.0 (2.4)	1.92	0.06	0.05
Referential cohesion	1.8 (1.2)	3.2 (1.0)	4.98	<0.001	0.26	3.1 (1.0)	3.7 (0.5)	3.59	0.002	0.16
Conjunction score	2.8 (1.0)	3.3 (0.9)	2.03	0.05	0.06	3.0 (0.9)	3.1 (1.2)	−1.07	0.29	0.02
Grammatical morphemes	7.5 (3.9)	11.4 (1.2)	5.19	<0.001	0.28	10.9 (1.6)	11.4 (1.0)	1.51	0.14	0.03
Narrative and evaluative devices	1.9 (1.0)	1.7 (1.1)	−0.73	0.47	0.01	1.8 (0.9)	1.7 (1.0)	0.62	0.54	0.01
Comprehension questions	1.7 (1.0)	2.6 (1.1)	3.54	0.001	0.15	2.4 (0.9)	2.5 (0.8)	0.75	0.45	0.01

TABLE 6 | Narrative performance analysed by mixed ANOVAs.

	Group				Time			Group × Time		
	F	*Df*	*p*	n_p^2	*F*	*p*	n_p^2	*F*	*p*	n_p^2
Global narrative score	5.60	1.70	0.02*	0.07	52.71	> 0.001	0.43	4.86	0.03†	0.07
Narrative content	0.11	1.70	0.74	0.00	45.56	> 0.001	0.39	0.09	0.77	0.00
Narrative structure	0.31	1.70	0.58	0.00	48.07	> 0.001	0.41	0.06	0.81	0.00
Micro-structure	20.78	1.70	> 0.001*	0.23	16.55	> 0.001	0.19	24.92	> 0.001†	0.26
Referential cohesion	28.77	1.70	> 0.001*	0.29	46.95	> 0.001	0.40	6.72	0.01†	0.09
Conjunction score	2.97	1.70	0.09	0.04	0.01	0.98	0.00	0.76	0.39	0.01
Grammatical morphemes	26.60	1.70	> 0.001*	0.28	37.46	> 0.001	0.35	36.41	> 0.001†	0.34
Narrative and evaluative devices	0.85	1.70	0.36	0.01	0.08	0.78	0.00	0.02	0.90	0.00
Comprehension questions	8.65	1.70	0.003*	0.11	3.47	0.07	0.05	5.45	0.03†	0.07

Note: *$p < 0.05$ DHH group obtained lower scores than the hearing group. † $p < 0.05$ DHH group improved their performance significantly more than the hearing group.

them, a mixed ANOVA was performed. The analysis of the effect of time on global narrative scores showed that all children significantly improved their performance from T1 to T2 (see *p* values in Table 6). When the interaction between time and group was analysed, the results revealed that the gap between DHH and hearing children's global narrative scores was significantly reduced between T1 and T2 (see Figure 1A). However, considering T1 and T2 scores, and after comparing estimated marginal means (EMM), the hearing group still outperformed the DHH children (*EMM* = 40.71, SD = 0.8 and *EMM* = 37.65, SD = 1.0 respectively; see Figure 1B for a comparison between estimated marginal means and the Supporting Information for differences between estimated marginal means).

3.3 | Macro-Structure

Next, we applied the mixed ANOVA for each macro-structure variable (narrative content and structure). The analysis of the effect of time showed that all children demonstrated higher macro-structure skills at T2 compared to T1 (see Table 6). The interaction between time and group was not significant for narrative content and structure skills, indicating that both groups developed macro-structure skills at a similar rate. A mixed ANOVA revealed that there were no differences between groups for macro-structure after comparing marginal estimated means for narrative content (hearing children: *EMM* = 11.14, SD = 0.4; DHH children: *EMM* = 11.33, SD = 0.4) and structure (hearing children: *EMM* = 9.82, SD = 0.2; DHH children: *EMM* = 9.63, SD = 0.3; see Supporting Information).

3.4 | Micro-Structure

The analysis of the development of micro-structure skills showed that all children significantly improved their performance after two years. This improvement was different in the hearing and DHH groups, as a significant interaction between group and time was found. Comparison of trajectories revealed that the performance of the DHH group improved at a higher rate in comparison to their hearing peers (see Figure S5). Despite this improvement, when means were estimated, the DHH group obtained significantly lower scores on micro-structure than the hearing group (hearing children: *EMM* = 19.75, SD = 0.4; DHH children: *EMM* = 16.68, SD = 0.5; see Table 6).

Next, we analysed micro-structure skills in more detail. To recap, this looked at: grammatical morphemes (e.g., "ing"), conjunctions (e.g., "next"), referential cohesion (e.g., "he"), evaluative devices (e.g., "carefully") and scores on story comprehension. When we calculated the effect of time, the results yielded significant differences in referential cohesion and grammatical morphemes between hearing and DHH children, but no significant differences in the use of conjunctions or evaluative devices (see Table 6). The interaction between group and time confirmed that the change in scores for referential cohesion and grammatical morphemes was driven by the DHH group (see Figures S7 and S9). This meant that between T1 and T2, these micro-structure skills increased at a faster rate in the DHH group than their hearing peers. However, as T1 scores were very low for these aspects of micro-structure in the DHH group, the hearing children still outperformed their DHH peers at T2 (performance of hearing children in referential cohesion: *EMM* = 3.45, SD = 0.1 and performance of DHH children: *EMM* = 2.47, SD = 0.1; performance of hearing children in grammatical morphemes: *EMM* = 11.39, SD = 0.3 and performance of DHH children: *EMM* = 9.22, SD = 0.3).

3.5 | Story Comprehension

Lastly, the effects of time on story comprehension scores were analysed, revealing that growth in the whole sample did not reach statistical significance between T1 and T2. However, there was a significant effect of time × group. As can be seen in Table 6, the DHH children significantly improved their performance in comparison to the hearing group. Despite this growth, when means were estimated, the DHH children were observed to obtain significantly lower scores than their hearing peers over this period (hearing children: *EMM* = 2.55, SD = 0.1; DHH children: *EMM* = 2.02, SD = 0.1; see Supporting Information).

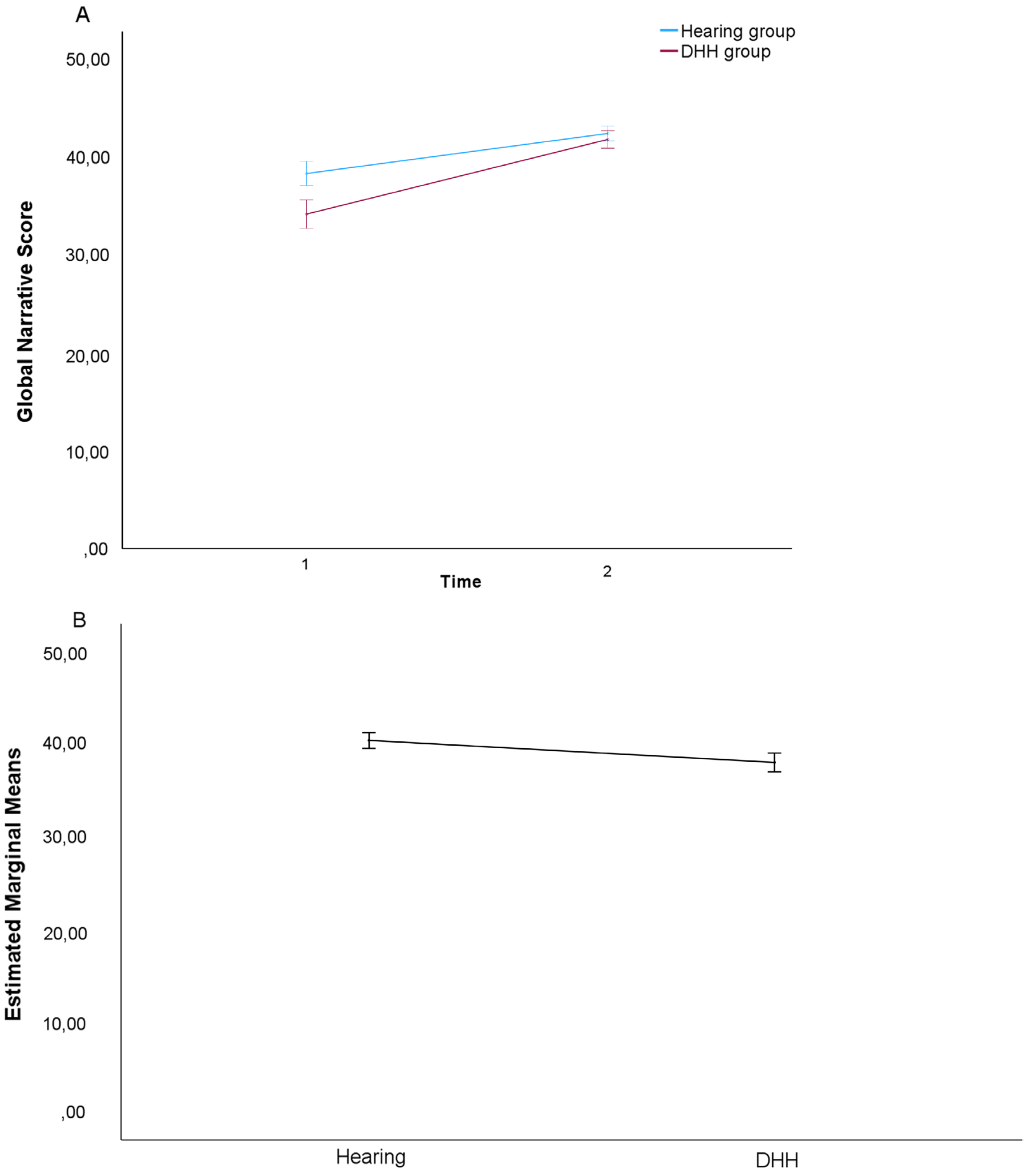

FIGURE 1 | Hearing and DHH trajectories in expressive narrative skills during two years. Figure A shows how the DHH group reduces the gap in narrative skills with their hearing peers in a two-year period and Figure B shows the estimated means of the DHH and hearing groups during two years.

RQ2. What is the relationship between EF and narrative development in DHH and hearing children across time?

As previously reported at T1, the DHH group exhibited more concerns for behavioural regulation development on the BRIEF than the hearing group, while similar scores were obtained in the metacognition index (see Table 1). When the relationship between EF and global narrative scores was analysed at T1, only a significant correlation in the hearing group was observed (see Table 7). Therefore, we conducted a

TABLE 7 | Pearson correlations between executive functions and vocabulary at Time 1 and narrative skills at Time 1 and 2.

Group	Subscale/Index	Time 1 Executive functions	Time 1 Vocabulary
DHH		Time 1	
	Global narrative	−0.28	0.73***
	Content	−0.28	0.59**
	Structure	−0.22	0.66***
	Micro-structure	−0.24	0.67***
	Inference questions	0.24	0.30
		Time 2	
	Global narrative	0.10	0.53**
	Content	−0.01	0.27
	Structure	0.10	0.34
	Micro-structure	0.13	0.56**
	Inference questions	−0.41**	0.03
Hearing		Time 1	
	Global narrative	−0.32*	0.46**
	Content	−0.44**	0.41**
	Structure	−0.48**	0.38*
	Micro-structure	0.06	0.35*
	Inference questions	−0.01	0.45**
		Time 2	
	Global narrative	−0.19	0.40**
	Content	−0.13	0.40**
	Structure	−0.24	0.10
	Micro-structure	−11	0.34*
	Inference questions	0.04	0.41*

Note: $^{*}p<0.05$; $^{**}p<0.01^{*}$; $^{***}p<0.001$.

more detailed analysis to explore the relationship between EF and each of the narrative skills across both hearing and DHH groups. This analysis showed significant correlations between EF and macro-structure skills in the hearing group but no significant correlations between macro- or micro-structure skills and EF in the DHH group. The correlation between EF and story comprehension scores was not significant in either group.

TABLE 8 | Longitudinal regressions adjusted for baseline narrative scores.

Explanatory variables	B (SE)	β	t
DHH group			
Vocabulary	0.14 (0.06)	0.58	2.45*
Executive functions	0.01 (0.07)	0.01	0.05
Hearing group			
Vocabulary	0.08 (0.06)	0.22	1.42
Executive functions	−0.01 (0.07)	−0.01	−0.09

Note: $^{*}p<0.05$.

Examining the relationship between EF at T1 and global narrative scores at T2 (see Table 7), the results showed no significant association in either group. The analysis between EF at T1 and macro- or micro-structure skills at T2 did not yield a significant relationship either. However, the correlation analysis between EF at T1 and story comprehension at T2 showed a significant association in the DHH group. This association was not significant in the case of the hearing group. Table 8 also shows the outcomes of longitudinal analysis to test if EF predicts global narrative scores. With regard to the DHH group, no significant relationships were identified either with an adjustment for baseline values. In the case of the hearing group, the analysis also revealed that EF did not predict subsequent performance in global narrative scores.

RQ3. How are narrative scores related to expressive vocabulary across time in DHH and hearing children?

In general, the DHH group obtained lower expressive vocabulary scores than the hearing group (see Table 1). In order to examine the longitudinal predictors of narrative skills, correlation analyses were carried out. Table 7 shows the correlations between predictors and narrative skills at T1, and also the correlations between predictors at T1 and narrative skills at T2.

Regarding the relationship between expressive vocabulary and narrative skills at T1, it can be observed that expressive vocabulary is associated with global narrative scores and with macro- (content and structure) and micro-structure (narrative cohesion) at T1. This relationship is similar in both groups, although it is stronger in the DHH group. However, when the relationship between expressive vocabulary and story comprehension was analysed, significant associations were only observed in the hearing group.

The correlation analysis between expressive vocabulary at T1 and the global narrative score at T2 also showed significant associations in both groups. When narrative skills were analysed in more detail, significant associations were only found between micro-structure skills and expressive vocabulary in the DHH group. In the hearing participants, vocabulary was significantly associated with one area of macro-structure (narrative content) and one aspect of micro-structure (referential cohesion). The correlations between expressive vocabulary and story comprehension showed a significant association, but again only in the hearing group.

To test whether this pattern was established over time, adjusted regressions were calculated. After adjustment for the baseline value (T1 global narrative scores), expressive vocabulary remained a significant predictor of narrative development for the DHH group ($F_{(2,27)} = 5.38$, $p = 0.011$, adj. $R^2 = 0.23$; see Table 8 for estimates and p values of predictors). In the case of the hearing group, the strength of the longitudinal association between expressive vocabulary and change in narrative skills was substantially reduced after controlling for the baseline narrative score. After accounting for the effect of the baseline narrative score, the contribution of expressive vocabulary was no longer significant and expressive vocabulary ceased to predict narrative skills at T2 ($p = 0.16$; see Table 8). This means that the longitudinal relationship between expressive vocabulary and narrative skills is largely explained by children's prior narrative skills.

4 | Discussion

The ability to recount a narrative is an important indicator of children's language development and possible delays can have negative consequences for academic and social development (Eekhof et al. 2022). As a positive outcome when we compared the trajectories of narrative development across the groups of hearing and DHH children we found that narrative scores improved over the 2-year period for both groups of children, and importantly, the gap between DHH children and their hearing peers was narrowing by the end point of data collection. However, hearing children were still ahead in their narrative abilities. We also found narrative scores at T1 predicted development at T2 for both groups, suggesting a continuity of development for all the children.

In terms of organisation of information at different levels, both DHH and hearing groups developed narrative in predictable ways with higher scores on macro-structure and more difficulties in micro-structure. There has been some debate about the question of macro-structure in the literature. For example, in an early study, Crosson and Geers (2001) found DHH children had delays with both macro- and micro-levels, whereas more recent studies report difficulties only at the micro-level (Lau et al. 2019; Nicholas and Geers 2007). These mixed results may have been related to the methodologies used (pictures vs. video respectively: Diehm et al. 2020) and improvements in hearing technology and educational interventions for DHH children over time (Hall et al. 2019; Lederberg et al. 2013).

In the current study despite improvements over time points being at a higher rate in the DHH group in comparison to their hearing peers, when means were estimated, the DHH group obtained significantly lower scores on micro-structure than the hearing group. This reinforces the finding that it is specifically micro-structure (e.g., use of grammatical morphemes and referential cohesion) that presents most difficulties for DHH children. The DHH group also improved in story comprehension although they still lagged behind their peers.

Next, we looked at the role of EFs and vocabulary on narrative functioning in both groups. Previous studies with hearing children characterise narrative as a complex and multi-component process which calls upon the coordination of domain-general cognitive skills, including EFs and language abilities (Friend and Bates 2014; Gardner-Neblett 2022; Kim 2023; Scionti et al. 2023). The argument being children with better expressive vocabulary are more able to manage cognitive load via EFs and recount complex narratives with less effort. The results from the current study suggest that children use their EF abilities to free up cognitive load. They do this by the ordering, planning, and monitoring of information during their expression of narrative but we saw this relationship only in the hearing children. In the hearing children group higher scores on the BRIEF (equating to poorer EF skills) predicted difficulties in the organisation of narrative. For example, difficulties inhibiting irrelevant information when organising the story or challenges with keeping emotions under control so that personal interests do not override the coherence of the narrative. Limitations in shifting may also make it harder to move flexibly between ideas and integrate different parts of the story toward a clear conclusion.

In the DHH group we did not find this relationship between EF and narrative scores. There are several possible explanations for this. The absence of a relationship between EFs and narrative at T1 and T2 within the group of DHH children could be because the DHH group presents generally lower EF scores at T1 and T2 compared to the group of hearing children. This left little variability for meaningful correlations to emerge. This has been suggested in studies of children with other cognitive differences, e.g., ADHD (Moonsamy et al. 2009). It may also be that narrative production relies on an integration of EF and language elements (Kim 2016) and that weaknesses in one or more areas will have consequences for the connectedness of the different processes (Mascolo and Fischer 2010). The DHH group have delays in both EF and language development, thus, the characterisation of the EF system supporting narrative may be more applicable when children have typical language exposure and development. A final other possibility is that for the DHH group, language skills have a much stronger influence on narrative performance than EF. As the narrative stimuli was non-verbal the verbal working memory load may have been reduced and this minimised the role of EF.

There were other results in our analysis that require some consideration. With age, the group of hearing children no longer required EFs to organise narratives at the macro level as they did two years previously. Two developmental processes may explain this. First, the organisation of discourse becomes progressively more automatic with age, reducing the need for active executive control. Second, children develop internal narrative "scripts" that guide the structure of a story, so they no longer need to plan each step from scratch. It is also possible that EF and macrostructure follow diverging developmental trajectories, making EF less relevant once macrostructure becomes stable (Friend and Bates 2014).

Finally, although in the DHH group, EFs did not correlate with micro or macro narrative skills, we did find a relationship at time 2 with story comprehension. Continuing with the previous hypothesis, perhaps at T1, the EFs of deaf children were so poor that they were unrelated to narrative skills. But, as EFs improved, they began to have a greater influence. While EF skills in DHH children were initially too weak to relate to narrative abilities, as they improved over time, their influence on comprehension became more visible. It is also important to note that inferential processes involved in comprehension are input-level mechanisms that rely heavily on EF (working memory, inhibition, shifting), whereas micro- and macrostructural production depends more on expressive language skills. In deaf children, expressive language limitations may overshadow the potential contribution of EF to narrative output. This point relates to the impact of different family communicative experiences between DHH and hearing children.

Several other studies emphasise that oral narrative ability depends on children's experiences in different family, school and peer contexts (Dealy et al. 2019; Schick and Melzi 2010). DHH children find it difficult to establish good communicative routines with their hearing parents (Hintermair 2013), experience less overheard conversations, including narratives, from which to model and practice their narrative skills (Crais and Lorch 1994; Davidson et al. 2014; Lund 2018). This would be in line with the hypothesis that the strength of the relationship between EF and language depends on extensive exposure to narratives (Scionti et al. 2023).

The final research question in the current study concerned the relationship between expressive vocabulary skills and narrative. This relationship is reported inconsistently in the wider literature (Bitetti et al. 2020; Joffe et al. 2019). In the current study, for all aspects of narrative organisation and across both DHH and hearing groups, expressive vocabulary predicted T1 and T2 narrative scores, and more so in the DHH children. Our results are in line with those of Silva and Cain (2024), suggesting that expressive vocabulary may play a supporting role for narrative skills.

These findings strengthen the argument that DHH children with better language development (as indexed by vocabulary scores) were more able to free up their EFs. Better vocabulary might be indicative of more automatic language processing (Matthews et al. 2018), enabling children to implement EFs to focus attention, handle multiple sources of information simultaneously, monitor, remember, and plan their narratives (Diamond 2013; Weiland et al. 2014). While vocabulary predicted narrative growth in DHH children especially, the wider literature suggests this is a relationship found in early development between 4 and 7 years that gradually disappears (Friend and Bates 2014; Scionti et al. 2023; Suggate et al. 2018). Our finding that vocabulary skills are linked to narrative growth more than EF in DHH children is perhaps indicative of an earlier developmental stage in narrative (Karlsen et al. 2021).

4.1 | What Implications do Results Have for Professionals to Include in Their Narrative Skills Programs Aimed at DHH Children?

Our findings make it clear that narrative mastery is demanding and develops gradually. For DHH children, who typically have reduced access to oral narratives, early and regular exposure at home and school is essential. Helpful approaches include caregiver-supported narrative activities (e.g., Carden et al. 2024) and structured narrative interventions delivered by professionals, guided by established frameworks such as Spencer and Petersen (2020). A broad evidence base also supports the effectiveness of these interventions (Pico et al. 2021), and recent work highlights the value of integrating vocabulary instruction within narrative-based programmes.

Regarding how DHH children organise narrative information, our results show that macrostructure was not an area of difficulty. This suggests that they may have internalised a stable macro-level template for story organisation, despite continuing challenges with microstructural elements (e.g., grammar, connectives, cohesion). Speech and language therapists can build on these macrostructural strengths to target microstructure more effectively. For children with significant grammatical vulnerabilities, specialised tools such as Shape Coding, originally developed for hearing children with language impairments, may also benefit DHH children (Haines and Ebbels 2025).

Finally, the strong gains shown by the DHH group at Time 2 may relate to the demanding nature of the decontextualised narrative tasks typically used in research. Everyday narratives, grounded in real experiences and co-constructed with listeners, may be more manageable for DHH children (Carden et al. 2024). Future interventions may therefore profit from encouraging DHH children to practise real-experience narratives, helping them recognise and expand on the strengths they already display in naturalistic storytelling (see Pico et al. 2021).

4.2 | Limitations

This study analysed the roles of EF and expressive vocabulary knowledge in the development of narrative skills in DHH children. A more exhaustive evaluation of language beyond expressive vocabulary would have added to the study. Future studies could include other language skills such as formal assessments of grammar or pragmatic skills. The BRIEF is a teacher reported measurement of EF and it is possible that performance-based measures could have produced different results. The current study is one of the few longitudinal studies in DHH children assessing narrative skills. In this study we have focused on concurrent relationships at T1 and longitudinal relationships two years later. Since our results indicate some differences between concurrent and longitudinal relationships (e.g., EF and narrative skills in hearing children), it would be interesting to examine what these concurrent relationships look like over time. Finally, as DHH children improved significantly over the time period, future studies could also document more information about the speech and language therapy interventions received by DHH children in order to identify specific therapy effects on narrative skills.

Author Contributions

Mario Figueroa: methodology, writing – original draft, investigation, formal analysis, conceptualization, funding acquisition. **Ros Herman:** writing – review and editing, methodology, formal analysis, supervision. **Gary Morgan:** conceptualization, funding acquisition, writing – review and editing, project administration, data curation, supervision.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are openly available through the Open Science Framework at https://osf.io/d938f/?view_only=629a8db8c97b4e95ad076a19ec2ef9eb.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Figure S1:** Mean difference between DHH and hearing group in global narrative scores during two years. **Figure S2:** Mean difference between DHH and hearing group in narrative content during two years. **Figure S3:** Mean difference between DHH and hearing group in narrative structure during two years. **Figure S4:** Mean difference between DHH and hearing group in micro-structure during two years. **Figure S5:** Trajectories of DHH and hearing group in micro-structure at T1 and T2. **Figure S6:** Mean difference between DHH and hearing group in referential cohesion during two years. **Figure S7:** Trajectories of DHH and hearing group in referential cohesion at T1 and T2. **Figure S8:** Mean difference between DHH and hearing group in grammatical morphemes during two years. **Figure S9:** Trajectories of DHH and hearing group in grammatical morphemes at T1 and T2. **Figure S10:** Mean difference between DHH and hearing group in story comprehension during two years. **Figure S11:** Trajectories of DHH and hearing group in story comprehension at T1 and T2.