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The role of behavior-related comments in parent–child interactions with the digital audio learning system Tiptoi®

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Introduction: Whereas previous research has extensively explored shared reading of both print and digital storybooks, it has paid little attention to hybrid storybook reading. This study aims to address two gaps in the existing literature: First, we investigate the use of a hybrid reading medium, specifically Tiptoi®, in the Digital Home Literacy Environment (DHLE) of young children. Second, we examine parental comments during shared storybook reading, focusing particularly on the purpose of behavior-related comments.

Methods: We conducted a study involving 40 preschoolers and first graders (aged 4–7 years). Using a survey, we examined the use of Tiptoi® as a hybrid reading medium in children's DHLE. Additionally, we analyzed parent-child interactions during shared reading sessions with Tiptoi® through semi-naturalistic observation.

Results: Results indicate that children aged 4–7 use Tiptoi® regularly and mostly independently. For parent-child interactions, we found that behavior-related comments typically served to provide instructions, to structure the interaction, and to address the technology itself.

Discussion: Overall, this study provides valuable insights into the use of Tiptoi® in children's DHLE, and it highlights the importance of parental behavior-related comments in enhancing the practice of reading with hybrid storybooks.

KEYWORDS

Tiptoi®, digital storybook, literacy, parent–child interaction, behavior-related talk

1 Content- and behavior-related talk in shared storybook reading

1.1 Printed traditional storybooks

The home serves as the primary environment for children's initial learning and developmental experiences. Within this context, the Home Literacy Environment (HLE) emerges as a multifaceted construct encompassing a spectrum of literacy-related interactions, resources, and attitudes available within the household (Niklas et al., 2021). Extensive research indicates that the HLE, such as parental attitudes and the quality of verbal parent–child interactions, significantly predicts children's language (Wirth et al., 2020) and reading development (Hamilton et al., 2016). Building upon the crucial role of HLE in children's development, considerable attention has been devoted to investigating the impact of shared storybook reading (Heller and Rohlfing, 2017) on children's language skills (Flack et al., 2018). In a recent study with 9–18-month-olds, Clemens and Kegel (2020) demonstrated that common activities (e.g., toy play or mealtime) are not as effective in enhancing language development, because they elicit a significantly lower level of language use and interaction between parent and child compared to shared book reading. Through storybook reading, adults provide a greater lexical diversity compared to conversations for young children, whereby children gain access to new words that they

would not experience in a typical conversation (Montag et al., 2015) or during toy play (Heller and Rohlfing, 2017; Hoff-Ginsberg, 1991). Moreover, parental language contains more syntactically complex utterances during storybook reading than in natural parent–infant interactions (Ece Demir-Lira et al., 2019). Finally, book-reading interactions include a higher number of conversational turns, and a higher parent word count compared to other activities (Gilkerson et al., 2017).

Importantly, research underscores that shared storybook reading is an interactive activity in which parents not only read aloud but also engage their child in discussions about a book's content. With this reading technique, called dialogical reading (Olszewski and Hood, 2023; Whitehurst et al., 1988), adults encourage children to take an active part in the reading situation by talking about the content or asking questions. Shared dialogic reading facilitates language development and might be especially beneficial for the development of the expressive language in young preschoolers (Mol et al., 2008). Adults begin with simple questions until children are familiar with a story. Then they introduce more challenging, open-ended prompts such as asking children to predict what will happen next or to relate something in the story to their own lives (Zevenbergen and Whitehurst, 2003). In addition, adults provide feedback on children's talk and model complex responses to questions. The goal is to promote linguistically rich conversations that encourage children to express themselves. These dialogic strategies, such as questioning, labeling, providing contingent responses, and offering affirmations (Fletcher and Reese, 2005), scaffold an interaction or conversation about the book between the adult and child and contribute significantly to children's language development.

Research on dialogic or *content-related* reading indicates that caregivers' verbal input changes across children's preschool years (Goodsitt et al., 1988). For younger children, caregivers primarily use storybook reading as an activity for vocabulary teaching, focusing on what questions, attention direction, and picture labeling (Ninio and Bruner, 1978). Initially, caregivers emphasize labeling and word teaching, but as children grow older, the focus shifts to more complex utterances about the story content (Goodsitt et al., 1988). For instance, Heller and Rohlfing (2017) found that young children were first prompted to respond to what questions with pointing gestures; but later, they were encouraged to answer open-ended questions about the story, such as "What is happening here?" This shift in content-related dialogue suggests that caregivers adjust their cognitive and linguistic demands to align with their children's developmental levels (Goodsitt et al., 1988). Therefore, it is not solely the act of reading but also the extratextual discourse surrounding the book content that enhances language skills in children (Fletcher and Reese, 2005; Reese and Cox, 1999).

Whereas content-related reading practices have been researched extensively, there is much less literature on behavior-related reading practices. Through *behavior-related* reading practices, caregivers play a crucial role in teaching young children the conventions of reading. These early interactions help infants learn the basics of literacy such as holding books upright, not chewing them, and turning pages in the correct sequence (DeLoache and DeMendoza, 1987). For example, mothers often

share the task of turning pages with their two-year-olds to involve them in the reading process and give them the opportunity to practice this rule (Goodsitt et al., 1988). Such behavior-related talk is also described as *orientation*, highlighting that these actions aim to maintain the child's attention and guide their behavior (DeLoache and DeMendoza, 1987). Together, these two reading practices—content- and behavior-related reading—create a well-rounded experience that supports children's overall learning and development.

1.2 Digital storybooks: e-books

Similarly to children's HLE, their DHLE (Digital Home Literacy Environment) can be characterized by several key dimensions such as children's access, frequency of digital media usage, and parents' quality of support (Bonanati et al., 2022; Lehl et al., 2021). Although it is widely agreed that children benefit from engaging in rich verbal and affective interactions during traditional storybook reading, recent studies comparing parent–infant interactions with analog (print) vs. digital storybooks have yielded mixed results (Hassinger-Das et al., 2019). Some studies have found no significant differences between the two book formats (e.g., De Jong and Bus, 2003; Lauricella et al., 2014). For instance, no differences were found in children's visual attention (Richter and Courage, 2017) nor in the quality of parent–infant interactions (Strouse et al., 2023) when comparing paper and digital books. Other studies show an advantage for digital storybooks in parent–infant interactions (e.g., Etta and Kirkorian, 2019; Strouse and Ganea, 2017). For example, Strouse and Ganea (2017) found that e-books elicited more pointing gestures, more book-related utterances, and longer visual attention in children compared to printed books. Another study revealed that children learned more words from an e-book with built-in narration compared to a condition in which parents read the book (O'Toole and Kannass, 2018). In contrast, other research indicates significant differences in children's information recall (Dore et al., 2018), child utterances and story comprehension (Miosga, 2020), parents' scaffolding strategies (Miosga, 2020), dialogic reading (Parish-Morris et al., 2013), and behavior and content-related talk (e.g., Miosga, 2020; Munzer et al., 2019; Parish-Morris et al., 2013).

The latter studies highlighted that printed books encourage more content-oriented talk compared to digital books, whereas digital books elicit more behavior- and technology-related talk (Parish-Morris et al., 2013; Ozturk and Hill, 2020). Further studies indicate that parents talk more about the book content (Munzer et al., 2019), ask more story-related questions (Krcmar and Cingel, 2014), and use more distancing prompts (Parish-Morris et al., 2013) when reading printed books compared to digital books with their children. Conversely, parents talk more about the book format and the environment (Krcmar and Cingel, 2014), use more technology-related comments such as "Swipe with your finger" or "Don't touch that button" (examples from Munzer et al., 2019), ask their children fewer questions, and stop less often to discuss the story when reading digital books (Wainwright

et al., 2020). According to recent studies, behavior-related talk in parent–child reading interactions is considered less important compared to content-related talk, because meaningful engagement time is taken up by instructional comments (Hassinger-Das et al., 2019). This parallels the argumentation of the “displacement hypothesis” (Neuman, 1988). This line of research adds that while traditional books facilitate rich dialogic interactions linking story content to children’s experiences, digital books lead to more discussions about the child’s behavior, potentially hindering beneficial dialogic interaction (Parish-Morris et al., 2013). This leads to the conclusion that children comprehend significantly more in the traditional book condition than in the electronic book condition (Krcmar and Cingel, 2014) due to the lower proportions of behavior-related utterances (Parish-Morris et al., 2013).

1.3 Hybrid storybooks: the digital audio learning system Tiptoi®

Hybrid reading media, which include digital audio systems (Tiptoi®, BOOKii, TING, LeapReader) or digital reading companions (Luka, Reading Sidekick with Alexa), represent a special reading format. They merge the traditional printed book with digital components, and are distinct from screen media such as e-books that engage users through visual and acoustic means on a screen. Instead, hybrids blend a printed book with digital elements specifically for audio enhancement. The Tiptoi® digital audio learning system features a digital pen equipped with sophisticated technology to allow interaction with the printed book. The reading experience can be enriched with additional explanations or interactive activities by tapping on icons such as “Explore,” “Learn,” “Storytelling,” “Music,” and “Game.” By then placing the digital pen on different parts of the book—images or text—audio files are activated and played through an integrated speaker in the pen. These audio files range from sounds and words to complete sentences. This multifaceted engagement provides children with various ways to interact with the book according to their interests and preferences. Recent versions of Tiptoi® also support the recording of custom audio files directly onto the pen, enabling multilingual families to add content in their heritage languages (Rohlfing et al., 2024). Rechlitz et al. (2016) highlighted user-friendliness as a standout feature of the Tiptoi® system along with the ease of downloading audio files to set up the pen. The capacity for children to use the pen independently stands out as particularly beneficial. Given the pen’s explanatory functions within the book, it enables young readers, who might not yet have independent reading skills or who can manage only limited text, to use the device autonomously (Choi et al., 2020). According to reports from 61% of parents, children always use the digital pens by themselves, with only 15.6% indicating that use was primarily or exclusively with parental involvement. This independent usability is attributed to the design of digital reading and learning pens, which are intended for solo use by children (Pfof et al., 2018; Rechlitz et al., 2016; Schmitt et al., 2022), suggesting their value as supplements to

traditional reading activities at home or in educational settings. However, it is essential to acknowledge certain limitations of the Tiptoi® system. One major constraint is that digital pens are only compatible with their corresponding books; for instance, Tiptoi® pens cannot be used with TING books. Additionally, while e-book readers often offer options on how to receive the book content—whether statically, through voice-over only, or with all features activated—Tiptoi® books are ideally used with the digital pen to fully utilize their features. Without the pen, it is not possible to access the full book content such as character speeches, additional explanations, or information necessary for playing embedded games.

In recent years, an increasing preference for hybrid reading media has been observed among German families. Research by Stiftung Lesen, a national German nonprofit organization dedicated to promoting reading competence, revealed that in 2014, only 8% of German households owned a digital learning system (Maas et al., 2014). At that time, smartphones and tablet PCs were more prevalent in the surveyed families. In contrast, a later survey by Pfof et al. (2018) indicated that ownership of digital learning systems in homes had increased to 65.7%, although only 21.6% had ever used an e-book. Whereas the digital learning system has gained popularity as a reading tool for children in Germany, how widely it is used in other countries remains unclear. For example, the Tag reading system, LeapReader, introduced to children in Scotland as part of a study, illustrates the novelty of such technology in this region (Stephen et al., 2013). In addition to the limited international research on the usage and familiarity of digital audio systems in other countries, there is also a lack of studies examining parent–child reading interactions with these devices.

Stephen et al. (2013) provided access to various technologies, including the LeapReader, to a small sample of predominantly high-income families. They observed that some parents adopted a more “teacher-like” approach when their children interacted with the Tag compared to other technologies such as gaming consoles. Specifically, they introduced the Tag to their children, guided them toward interactive symbols on the page, and showed them how to access the story elements (Stephen et al., 2013). A similar study by Schmitt et al. (2022) focused on the LeapReader, aiming to describe how parents and their young children used the LeapReader over several months. This study also reported that parents demonstrated teaching behaviors, instructing their children on how to listen attentively to the text rather than randomly tapping hotspots. Even if parental comments were not coded explicitly, these two studies suggest that parents use behavior-related talk when using digital audio systems such as the LeapReader with their children. This also indicates that behavioral comments serve an important purpose, such as teaching children how to interact with the technology.

In summary, in addition to traditional storybooks, children have access to a wide range of digital reading devices that allow them to engage with books even if they have limited or no literacy skills. Recent evidence suggests that a quarter of children aged two to five use digital devices daily (miniKIM, 2023). This underscores the importance of the extensive research that has been devoted to exploring both digital and print book formats. The primary goal of prior studies has typically been to compare the effects of different book formats on parent–child interactions, assessing how

the same book content—whether presented in print, as a static e-book with no interactive features, or as an interactive e-book with additional features such as sound effects and animation—can influence the dynamics of parent–child verbal and nonverbal exchanges (e.g., Munzer et al., 2019). Thus, parents' extratextual talk in shared storybook interactions, especially behavioral and content-related talk, plays a central role in studies that compare different forms of storybook. It is worth noting that in our literature review, we found studies that focus primarily on young infants up to preschool-aged children. Studies exploring parent–child reading interactions with school aged children are still lacking in this field. This might be explained by noting that especially the period before school entry is considered crucial for later language and literacy development. Therefore, research and interventions focus on this critical period when parent–child interactions are thought to be particularly influential. Another reason might be that shared storybook reading with school-aged children is less common in family routines. Whereas most children between the ages of three and five are read to at home, a significant number of parents discontinue this practice once their child enters school (Stiftung Lesen, 2022), even though most first graders are not able to read independently.

Our review of existing studies reveals that parents' frequency of behavior and content-related talk differs when comparing digital and print book formats. Moreover, in the context of traditional storybook reading, parental behavioral talk is generally described as a key practice for teaching young children the basic “rules” of reading. In the context of digital storybook reading, comments unrelated to content are often evaluated negatively and described as detracting children from meaningful engagement with the story. Whereas there has been extensive research on digital and analog media, hybrid reading media remain understudied, both in terms of their presence in children's DHLE statistics and in terms of parent–child interactions. To address these research gaps, our pilot study investigates parent–child interactions with the digital audio learning system Tiptoi® and specifically examine parents' behavioral talk.

2 The present study

The present pilot study addresses three main objectives: (1) Given the sparse existing research on hybrid reading media in children's DHLE (Pfost et al., 2018; Rechlitz et al., 2016), our initial goal is to extend current statistics on children's DHLE by adding digital audio systems. Our questionnaire is designed to identify which reading media are currently favored among preschoolers and first graders including analog, digital, and hybrid reading devices along with other media. Furthermore, we seek to examine the frequency, autonomy/type, and location of usage of the digital audio learning systems. (2) Our second objective is to assess parental comments during shared reading interactions with this hybrid book format, under consideration of children's age and Tiptoi® experience. We hypothesize that the age of children may influence parental comments, with younger children potentially being more distracted by interactive features. This assumption is grounded on prior literature on printed books with manipulative features (Chiong and DeLoache, 2012; Muhinyi

et al., 2024; Shinsky, 2021) demonstrating that interactive features, such as “pop-up” elements or lift-the-flap features, can distract children's attention from the book's content. These studies focused primarily on young children, but our research aims to compare preschoolers with first graders to determine whether preschoolers may require more behavior-related comments from parents who navigate the reading interaction. Additionally, we posit that parents of children with minimal or no experience with this format might employ more behavior-related language than parents of children who are familiar with it. This assumption is justified by literature indicating that during early interactions with traditional books, parents focus initially on helping infants grasp the basics of reading, gradually shifting to more complex discussions about the story content (DeLoache and DeMendoza, 1987; Goodsitt et al., 1988). Whereas all children in our study are generally comfortable with printed books, there are some children for whom digital books introduce a novel technology and storybook format that may initially be explored more for its functionality than for its content. (3) In light of the diverse evaluations of behavior-related talk in printed and digital storybooks (e.g., Parish-Morris et al., 2013; Munzer et al., 2019), our third goal is to investigate the purpose of behavior-related talk in parent–child interactions with Tiptoi®. This involves categorizing parental behavioral comments to understand their role in reading interactions with hybrid storybooks.

2.1 Participants

This pilot study was conducted with 40 German-speaking children ($M_{\text{age}} = 4,8$ years; 20 male and 20 female children) and their parents who were reading a storybook with the Tiptoi®-pen. Of these children, 26 were preschoolers ($M_{\text{age}} = 4.0$ years; 11 male and 15 female children), and 14 were first graders ($M_{\text{age}} = 6.3$ years; 9 male and 5 female children). We chose preschoolers and first graders as our target group for two important reasons: First, one of our goals was to consider children's age as a possible factor influencing parents' comments during reading interactions. Second, most research focuses on shared storybook reading with children up to the age of five. Because previous research has focused primarily on toddlers and preschoolers, we aim to broaden the scope by including an older group: first graders.

We justified our sample size of $n = 40$ based on two main considerations: First, because this is a pilot study exploring a hybrid reading medium within a seminaturalistic parent–child interaction, our research is inherently exploratory. Given the novelty of our topic and the lack of comparable data from similar studies involving digital audio systems, we had no prior effect sizes to guide our sample size estimation. The exploratory nature of our discourse analysis necessitates this approach, and we opted not to conduct a *post hoc* power analysis as critically discussed in literature “[b]ecause a *post-hoc* or retro-spective power analysis is based on the effect size observed in the data that has been collected, it does not add any in-formation beyond the reported p value, but it presents the same information in a different way” (Lakens, 2022, p. 17). Second, our sample size is justified heuristically. We aimed

to have a balance between a practical and statistically meaningful sample size, setting 30 participants as the minimum required and 50 as the upper limit (Lakens, 2022). We successfully collected data from 40 participants, which we deemed adequate for our study's objectives, and a good starting point for further replication studies with larger samples. In reporting our results, we include partial eta squared (η^2) as recommended for effect size measures (Cumming et al., 2012). Because even small differences can become significant with larger sample sizes, effect sizes provide a way to assess not only statistical significance but also practical relevance (Lakens, 2013).

Our sample was recruited from our database of families who had agreed to be contacted for participating in studies as well as through advertisements (Flier) in kindergartens in the region of Paderborn (Germany). We invited all contacted families who agreed to participate in our study, regardless of their experience with Tiptoi®. When participants visited the laboratory, they completed a consent form and a questionnaire¹ that included questions about general demographics and their child's DHLE prior to participation. Based on the general demographic questionnaire, children were from families with a middle or higher socioeconomic (SES) background as measured by their caregivers' level of education. All children were monolingual with typically developed hearing and language abilities. For the standardized questionnaire on children's DHLE, we based our approach on Pfost et al.'s (2018) survey of children's use of digital media, including digital audio systems. Our survey aims to provide recent statistics on children's usage of printed books and digital (reading) media. In particular, parents reported on their children's frequency of usage of not only traditional picture books but also digital (reading) media including digital audio systems, E-books, audiobooks, TV, Smartphone, Tablet, and voice assistant. For those children with Tiptoi®-familiarity, we additionally assessed usage patterns such as the location (at home, on the go, or both) and type/autonomy (independently, jointly, or both) of usage.

2.2 Materials

The three books used in the study were all nonfiction books integrating factual knowledge into a story. They were chosen in line with the children's age (preschoolers vs. first graders). Preschool children could select a book from the "Wieso? Weshalb? Warum?" (English: "Why? Why? Why?") series, choosing between a fire station theme or a forest theme, both suitable for ages four to seven. Because this book series is also available in an analog format (without the Tiptoi® pen) and is very popular among preschool children in Germany, we decided to offer both options to ensure that children had a choice in case they were already familiar with one of the books. For the first graders, we offered a book from the "Expedition Wissen" (English: "Expedition Knowledge") series with a dinosaur theme, suitable for ages seven to ten. This book was a new publication available exclusively for Tiptoi®.

¹ The questionnaire (English and German Version) and the data files can be found on the OSF: Wildt, E. (2024, September 24). Reading with Digital Audio Pens (RAUPE). <https://doi.org/10.17605/OSF.IO/WK4ZQ>.

2.3 Procedure

To elicit spontaneous communicative behavior from both caregivers and children, they were observed in a seminaturalistic setting within a laboratory room equipped with a couch and a table where the reading interaction took place. After children chose a book, the experimenter requested the dyad to explore this book together after she left the room. However, they were allowed to contact the experimenter, who sat in the room next door, at any time if they had any issues (e.g., if the pen battery ran out or they wanted to stop the experiment). After the experimenter turned on both video cameras and left the room, dyads were allowed to open the book and turn on the pen. Dyads were free to choose the type and duration of interaction. On average the reading interactions lasted 33.34 min ($SD = 15.83$; minimum = 10; maximum = 65). The whole interaction was recorded from two viewpoints: One camera was positioned in front of the dyad; the other, above with a bird's eye view (so that it was possible to recognize the book page).

2.4 Coding schema

The videotaped data were transcribed with the annotation software ELAN (Eudico Linguistik Annotator) (Sloetjes and Wittenburg, 2008). In contrast to other studies (Parish-Morris et al., 2013) in which video data was coded for ~5 min of parent-child interaction, we decided to transcribe the entire reading interaction to assess parents' comments throughout. This is crucial, because at the beginning of an interaction, parents might explore how to activate the digital reading pen, thereby using more behavior-related language than in the middle of the interaction. The coding of an interaction started once the experimenter left the room, and it concluded either when the dyad turned off the digital pen or verbally indicated that they had finished reading. Based on the coding categories in prior literature (e.g., Strouse and Ganea, 2017; Parish-Morris et al., 2013), we categorized parents' comments into four main categories (Table 1): content-related, behavior-related, off-topic, and other. Parents' content-related comments refer to either the book content or the audio file. These utterances may encompass reading the book text aloud (coded as one annotation [reading]), verbal repetitions (e.g., of the audio file) (see also Strouse and Ganea, 2017), further content-related descriptions of things directly observable in the book (e.g., pictures) (see also Strouse and Ganea, 2017), decontextualization (see also *distancing prompts* in Parish-Morris et al., 2013), and additional explanations.

In contrast, the category *behavior-related comments* encompasses a range of verbal interactions initiated by parents that specifically aim to guide, modify, or reflect upon not only their own but also the child's behaviors and actions within the reading interaction. Because our third goal was to explore the purpose of parents' behavior-related comments, we carefully observed all behavior-related comments and categorized them into subcategories. Because there is limited literature on behavior-related talk in shared storybook reading, we began our exploration with the descriptions and codings we found in research on analog and digital storybook reading. For example, *orientation* to emphasize that these behaviors are intended to hold the child's

TABLE 1 Coding categories, definitions, and examples of parent comments during shared storybook reading.

Category	Definition	Examples
Content-related	Parents' content-related comments relate to either the book content or the audio file. These utterances may encompass reading the book text aloud (coded as one annotation [reading]), verbal repetitions (e.g., of the audio file), further content-related descriptions of things directly observable in the book (e.g., pictures), decontextualization, and additional explanations.	<p>"There is a lot going on here. There was an accident!" (description of a picture)</p> <p>"That sounded like rain, didn't it?" (description of the sound)</p> <p>"Documenting means to record something." (explanation of a word meaning)</p> <p>"The larch was the one that loses its needles in winter." (additional explanation)</p> <p>"Headphones, just like your dad wears in a meeting." (decontextualization)</p>
Behavior-related	These comments relate to parents' own or the child's behavior in the reading interaction that can be further differentiated into three subcategories.	
	<i>Operations:</i> This subcategory focuses on the immediate, local aspects of an interaction in which the child is directed to perform a specific action, typically within the confines of a game or a structured task. Operations are characterized by their directive nature, aiming to guide the child's physical engagement with the task <i>without</i> providing an extra explanation to the requested action. These prompts are usually framed as direct imperatives (positive or negative formulated) or as suggestive invitations that are often accompanied by a pointing gesture.	<p>"Please stop clicking now!" (negative formulated directive)</p> <p>"Switch it [the pen] on!"; "Just try it out!" (positive formulated directives)</p> <p>"Should we click on this symbol [pointing]?"; "Do we want to try again?" (invitations formulated as questions)</p> <p>"We could listen to the cat." (invitation)</p>
	<i>Structure and organization of interaction:</i> Here, parents discuss the overarching framework of the parent-child reading interaction. This includes metaconversations about the general procedural elements such as the order of the exercises or icons, whether they should turn the page, the repetition of certain sections, and clarifying who takes on the role of the reader (the parent or the pen). The language used by parents often includes temporal adverbs such as "first," "then," and "again" that emphasize the sequential or structured nature of the suggested actions, and they often make suggestions by offering two options.	<p>"Do you want to explore anything else on this page?"; "Are you done?"</p> <p>"What do we want to do?" (general procedure)</p> <p>"Should we move on, or do you want to play a game?"; "Which one do you want: a quiz or a game with sounds?" (offering two options how to proceed)</p> <p>"Should I read what it says here, or do you just want to click?"; "Should I read? Should the pen read?" (defining the reader)</p>
<i>Function of the technology:</i> This subcategory delves into the exploration and elucidation of the functionalities of the reading device (e.g., a digital pen, icons) used within the activity. Parents either adapt to a tutor-like demeanor, offering explicit guidance on using the tool's features and assuming the role of a curious companion, or they adapt to the role of a companion by encouraging exploratory interaction with the tool. These interactions are often framed using conditional "if-then" statements, aiming to provoke curiosity and understanding of the tool's potential uses.	<p>"If you press the light bulb here, then it will explain more." (tutoring: explanation by using if-then statements)</p> <p>"What happens if you press on this?"; "What happens if you click on the stars [icons] here?"; "Can it also read that aloud?" (exploring in the role of a curious companion)</p> <p>"Maybe they will explain something if you click on it." (companion role by encouraging)</p>	
Off-topic	These comments occur within the reading situation but are not related directly to the reading activity itself. Instead, they focus on the environment (e.g., questioning about the experiment, the cameras) or the child's need (e.g., wants to drink).	<p>"They [the experimenters] observe what we are doing with the pen."; "It [the camera] is recording us." (environment)</p> <p>"Apparently, I do not have a tissue."; "Do you need to go to the toilet?"; "You are pretty tired, right?"; "Do you also want to drink a bit of sparkling water?" (child's need)</p>
Other comments	These are incomplete or interrupted utterances of parents, or one-word interjections, including exclamations, expressions of feedback, short agreements or disagreement or thinking aloud.	<p>"Well, ..." (interruption)</p> <p>"eh"; "oops" (interjections)</p> <p>"Super!"; "Wow!" (short feedback)</p> <p>"mhm" (agreement)</p> <p>"mmh" (disagreement)</p> <p>"Hmm" (thinking aloud)</p>

attention and guide their behavior (DeLoache and DeMendoza, 1987), and *format-related vs. negative format-related instructions* (Munzer et al., 2019) that tell the child to do or not do something related to the book or tablet features. This bottom-up approach of observing and categorizing these utterances took many iterations to arrive at a final coding scheme with three subcategories—*operation*, *structure*, and *function* of the technology (see Table 1 for coding schema)—to encapsulate the nuanced ways in which parents invite their child or direct their child's behavior during such interactions. *Operations* entail prompts pertaining to the *local* level of an interaction, which means that the child is prompted to perform a specific action (e.g., within a game). In this context, parents typically frame operations as imperatives ("Please stop clicking now!") or as invitations ("Should we click on this symbol

[pointing]?"). These prompts are often accompanied by a pointing gesture using either a finger or the pen. In contrast to the category *function*, operations occur without any accompanying explanation. With *structure*, parents focus on *global* aspects of the reading interaction such as page turning, repetitions, and clarifying who takes on the role of the reader. These discussions revolve around actions that are independent of the specific content of the Tiptoi® book. Moreover, these prompts are often marked linguistically by temporal adverbs such as "first," "then," or "again." When exploring the potential *functions* of the digital pen, parents often adopt either a tutor role providing guidance such as "If you press the light bulb here, it will explain more," or a companion role posing questions about functions such as "What happens if you press on this?" These utterances are frequently marked by "if-then" statements.

Off-topic comments concern aspects that do not relate to the reading interaction at all, but rather to the environment (e.g., questioning about the experiment, the cameras) or child's need (e.g., wants to drink). Thus, these utterances occur within the reading situation, but do not pertain to the reading activity itself. The category *other comments* relates either to incomplete or interrupted utterances or to one-word interjections, including short exclamations, short expressions of feedback, short agreements or disagreements, or thinking. The total scores for each category were compiled for each participant. This compilation resulted in a dataset representing the quantitative frequency of all categories of parental comments.

All video data were coded by one independent coder. Reliability was assessed by giving 20% of the data to a second coder and calculating Krippendorff's alpha (Krippendorff, 2011). Inter-coder reliability was high for all variables ($\alpha = 0.53\text{--}0.98$).

3 Results

3.1 Parent questionnaire on digital media experience

Regarding our first objective and the limited statistical data on children's DHLE that specifically incorporate digital audio systems, we surveyed the parents participating in our study. This gives interesting insights into how digital audio systems are integrated into children's DHLE and helps us to understand the patterns of their use (Table 2). Findings from the parental questionnaire revealed that traditional storybook reading predominates as the most frequent media engaged with in children's HLE. One quarter (25%) of the surveyed parents reported that they read aloud to their children at least once a day, and the remaining 75% indicated that their children experience storybook reading multiple times per day. When shifting focus to hybrid and digital reading media, audiobooks emerge as the most popular platform. Parents reported that their children engage with audio stories through various sources such as CDs, Tonie box, Spotify, or the Mira Podcast. Out of 40 children, only a minority of 12 (30%) had either no prior experience with digital audio learning systems or had tried them only once, whereas a significant majority of 28 (70%) were familiar with Tiptoi® and owned this device at home. A large portion of the children ($n = 37$) had not been exposed to or had only minimal interaction with e-books, with merely three participants using e-books regularly. Regarding other digital devices, results show that most children have regular access to television (92.5%) and tablets (72.5%) at least once per month. In contrast, familiarity with certain other devices is lower; for example, 75% of the children have never used or have tried voice assistants (e.g., Alexa) only once, and 55% demonstrate a similarly low level of familiarity with smartphones.

Our survey on children's usage patterns with Tiptoi® explored the nuances of their interaction with this hybrid reading tool, focusing on both the locations where they use it and the ways in which they engage with it. Regarding the location of usage, a significant portion of the children (46.4%) engage with Tiptoi® exclusively at home. This preference underscores the tool as a familiar, home-based learning medium. On the other hand, exactly one half of the participants report a mixed use of the tool,

integrating it into both home environments and mobile contexts. Only 3.6 % report that Tiptoi® is used only for activities on the go. This adaptability is particularly facilitated by the device's headphone functionality, which parents noted as especially useful during periods of waiting or during car journeys, allowing children to have enriching engagements outside the confines of their home. Regarding the type/autonomy of use, most children (67.9%) use Tiptoi® independently. This emphasizes the tool's capability to foster autonomous learning and exploration among its users. Conversely, 32.1% of the children experience Tiptoi® not solely by themselves but also jointly with others. This mode of mixed use, combining independent and shared reading, was predominantly observed in preschoolers ($n = 8$), with a much smaller occurrence in first graders ($n = 1$). It is particularly interesting to note that none of the parents reported using Tiptoi® exclusively with their children, highlighting the opportunity for children to engage with this hybrid reading device unaccompanied.

In sum, the questionnaire revealed that all children experience picture book reading at least once a day, making it a part of their everyday life. However, digital reading media appear to be used in addition to rather than as a replacement for traditional reading routines, serving as supplementary rather than primary reading media in children's literacy environment. The parental questionnaire also revealed that children's digital audio systems were used very frequently, second in popularity after audiobooks. The similarities between these two media types suggest that parents may follow certain principles when selecting a reading device for their DHLE: Both media types are easy to handle and can be used independently by children, as evidenced by our findings showing that most children use Tiptoi® autonomously. Additionally, both devices are screen-free, relying solely on auditory digital enhancements. From this we conclude that parents might prefer screen-free reading devices that can be used by children on their own.

3.2 Parental comments

Given the extensive research on printed and digital storybook reading, we have only limited understanding of hybrid storybook reading with digital audio learning systems. Our second objective was to examine parental comments during hybrid storybook interactions with their child while taking children's age and Tiptoi®-experience into account. For the following analyses, we examined whether parents' content-related, behavior-related, off-topic, and other comments (dependent variables) differ depending on their children's age and Tiptoi®-experience (independent variables). We conducted a mixed-design ANOVA in SPSS. This type of analysis captures both within-subject factors and between-subject factors. In the present study, the between-subject factor was *age group* (preschoolers, first graders), and *Tiptoi® experience* (with vs. without experience). The within-subject factors consisted of *parental comments* (content-related, behavior-related, off-topic, other comments) as a repeated measure variable. The Greenhouse-Geisser adjustment was used to correct for violations of sphericity.

A mixed ANOVA with a Greenhouse-Geisser correction determined a significant effect of parental comments, $F_{(1.3,46.9)} =$

TABLE 2 Frequency of usage of various media types (analog picture books, hybrid and digital reading media, other digital devices) among preschool and first-grade children.

Media type	Frequency of use	Preschoolers (n = 26)	First graders (n = 14)	All children (n = 40)	All children
Picture books	No regular experience	0	0	0	0%
	1 x per month	0	0	0	0%
	> 1 x per month	0	0	0	0%
	1 x per week	0	0	0	0%
	> 1x per week	0	0	0	0%
	1 x per day	4	6	10	25%
	> 1x per day	22	8	30	75%
E-Book	No regular experience	25	12	37	92.5%
	1 x per month	0	1	1	2.5%
	> 1 x per month	0	0	0	0%
	1 x per week	0	0	0	0%
	> 1x per week	1	0	1	2.5%
	1 x per day	0	1	1	2.5%
	> 1x per day	0	0	0	0%
Audiobook (e.g., CDs; Toniebox; Mira-Podcast; Spotify)	No regular experience	0	1	1	2.5%
	1 x per month	1	0	1	2.5%
	> 1 x per month	1	0	1	2.5%
	1 x per week	0	1	1	2.5%
	> 1x per week	1	3	4	10%
	1 x per day	10	4	14	35%
	> 1x per day	13	5	18	45%
Digital audio systems (e.g., Tiptoi)	No regular experience	8	4	12	30%
	1 x per month	5	7	12	30%
	> 1 x per month	2	1	3	7.5%
	1 x per week	2	0	2	5%
	> 1x per week	7	0	7	17.5%
	1 x per day	3	1	4	10%
	> 1x per day	0	0	0	0%
TV	No regular experience	3	0	3	7.5%
	1 x per month	2	0	2	5%
	> 1 x per month	0	1	1	2.5%
	1 x per week	1	1	2	5%
	> 1x per week	9	4	13	32.5%
	1 x per day	10	7	17	42.5%
	> 1x per day	1	1	2	5%
Smartphone	No regular experience	16	6	22	55%
	1 x per month	2	0	2	5%
	> 1 x per month	0	2	2	5%
	1 x per week	0	2	2	5%
	> 1x per week	4	1	5	12.5%
	1 x per day	3	3	6	15%

(Continued)

TABLE 2 (Continued)

Media type	Frequency of use	Preschoolers (n = 26)	First graders (n = 14)	All children (n = 40)	All children
Tablet	> 1x per day	1	0	1	2.5%
	No regular experience	10	1	11	27.5%
	1 x per month	5	3	8	20%
	> 1 x per month	2	2	4	10%
	1 x per week	9	1	1	2.5%
	> 1x per week	3	4	7	17.5%
	1 x per day	6	3	9	22.5%
Voice assistant (e.g., Alexa)	> 1x per day	0	0	0	0%
	No regular experience	19	11	30	75%
	1 x per month	1	0	1	2.5%
	> 1 x per month	1	0	1	2.5%
	1 x per week	0	0	0	0%
	> 1x per week	1	0	1	2.5%
	1 x per day	2	3	5	12.5%
> 1x per day	2	0	2	5%	

Percentages are calculated based on the total number of children surveyed (n = 40). The term “no regular experience” refers to children who have either not used a specific device at all or whose experience with it is limited to only a few occasions (e.g., trying it out at a friend’s home).

70.94, $p < 0.001$, partial $\eta^2 = 0.66$, when considered independently of age group and children’s Tiptoi[®] experience. However, we found no significant interaction of parental comments, implying that parental comments differ depending on children’s age [$F_{(1.30,46.91)} = 0.44$, $p = 0.56$, $\eta^2 = 0.01$], children’s Tiptoi[®] experience [$F_{(1.3,46.91)} = 0.19$, $p = 0.73$, $\eta^2 = 0.01$], or age and Tiptoi[®] experience [$F_{(1.30,46.91)} = 1.12$, $p = 0.31$, $\eta^2 = 0.03$]. Moreover, the analysis revealed no main effect of children’s age [$F_{(1,36)} = 0.36$, $p = 0.55$, $\eta^2 = 0.01$], of Tiptoi[®] experience [$F_{(1,36)} = 0.001$, $p = 0.98$, $\eta^2 = 0.00$], or any interactions between age and experience [$F_{(1,36)} = 0.09$, $p = 0.77$, $\eta^2 = 0.002$].

Because there were no significant interaction effects, but a main effect of parental comments, we ran additional pairwise comparisons to determine where significant differences in parental comments occurred. Bonferroni-adjusted *post hoc* analyses revealed significantly ($p < 0.001$) more content-related than behavior-related ($M_{Diff} = 88.43$, 95%-CI [53.91, 122.96]), off-topic ($M_{Diff} = 144.93$, 95% CI [101.98, 187.87]), and other comments ($M_{Diff} = 92.47$, 95% CI [60.21, 124.73]). The analysis also revealed significantly ($p < 0.001$) more behavior-related than off-topic comments ($M_{Diff} = 56.49$, 95% CI [43.10, 69.88]), and more other comments than off-topic comments ($M_{Diff} = 52.46$, 95% CI [34.2, 70.71]) (see Table 3 for descriptive statistics).

These results demonstrate that parental comments during hybrid storybook interactions with Tiptoi[®] differed significantly in frequency, regardless of children’s age group (preschoolers and first graders), or experience with the device. This suggests that parents adapt their interaction style to the hybrid storybook format rather than to the child’s age or familiarity with the device. Content-related comments were the most frequent type of parental utterance during these interactions. *Post hoc* analyses revealed that after content-related comments, parents made

behavior-related and other comments more frequently than off-topic comments.

3.3 Purpose of parental behavior-related comments

Our third goal was to explore the purpose of parents’ behavior-related comments. We found that parents predominantly use *operations* ($M = 35.05$, $SD = 17.3$) to direct their child to perform specific actions in the reading interaction. Furthermore, parents lead discussions about the *structure* and organization of their reading interaction with the child by talking about the framework of their interaction ($M = 22.65$, $SD = 12.07$). The category *function* represents the smallest proportion ($M = 9.57$, $SD = 6.06$).

In the next step, we examined whether the categories operation, structure, and function (dependent variables) differ depending on their children’s age and Tiptoi[®] experience (independent variables). Again, the between-subject factor was *age group* (preschoolers, first graders), and *Tiptoi[®] experience* (with vs. without experience). The within-subject factors consisted of *parental behavior-related talk* (operation, structure, and function) as a repeated measure variable. A mixed ANOVA determined a significant effect of parental behavior-related talk, $F_{(2, 72)} = 58.4$, $p < 0.001$, partial $\eta^2 = 0.61$, when considered independently of the age group and children’s Tiptoi[®] experience. However, we found no significant interaction of parental behavior-related talk, implying that these comments did not differ depending on children’s age [$F_{(2, 72)} = 0.64$, $p = 0.53$, $\eta^2 = 0.02$], Tiptoi[®] experience [$F_{(2, 72)} = 0.05$, $p = 0.95$, $\eta^2 = 0.00$], or age and Tiptoi[®] experience [$F_{(2, 72)} = 2.21$, $p = 0.12$, $\eta^2 = 0.06$]. Moreover, the

TABLE 3 Descriptive statistics on each parental comment type within the reading interaction.

Parental comments	M	SD	Min	Max	Percentage
Content-related	158.43	88.15	42	446	53%
Behavior-related	67.28	30.16	11	42	22%
Off topic	10.18	10.69	0	52	3%
Other comments	64.58	39.36	8	164	22%
Comments total	300.38	150.85	80	788	100%

analysis revealed a marginal effect of children's age [$F_{(1, 36)} = 3.89$, $p = 0.06$, $\eta^2 = 0.1$], no effect for Tiptoi[®] experience [$F_{(1, 36)} = 0.28$, $p = 0.6$, $\eta^2 = 0.01$], and a marginal interaction between age and experience [$F_{(1, 36)} = 0.344$, $p = 0.07$, $\eta^2 = 0.09$].

Because there were no significant interaction effects, but a main effect of parental behavior-related talk, we ran additional pairwise comparisons to determine where significant differences in parental comments occurred. Bonferroni-adjusted *post hoc* analyses revealed significantly ($p < 0.001$) more parental comments on operations than on the structure of the interaction ($M_{\text{Diff}} = 12.46$, 95% CI [6.12, 18.8]), and on the function of technology ($M_{\text{Diff}} = 25.83$, 95% CI [19.26, 124.73]). The analysis also revealed significantly ($p < 0.001$) more comments on the structure of the interaction than on the function of technology of the interaction ($M_{\text{Diff}} = 13.37$, 95% CI [8.41, 18.34]).

Although we did not find significant differences in parental behavior-related comments based on the children's age or their experience with Tiptoi[®], the overall pattern of parental behavioral talk shows a clear preference for discussing operations over the structure of interaction and the function of the technology. Operational comments are formulated directly and are action oriented without further explanations. With structure-related comments, parents help create a framework for the reading experience, potentially enhancing the child's understanding of the reading process with this hybrid format. Interestingly, parents spend less time explaining or exploring the technological features of the Tiptoi[®] system. Moreover, the varying linguistic structures used in each category (e.g., imperatives for operations, temporal adverbs for structure, and "if-then" statements for function) demonstrate how parents adapt their language to effectively communicate different aspects of the reading interaction.

4 Discussion

The market for storybooks has experienced rapid growth in recent years, and now includes a variety of printed, digital, and hybrid book formats. Whereas previous research has extensively investigated shared reading of both print and digital storybooks, hybrid storybook reading has received relatively little attention. In the present study, we investigated how the digital learning system Tiptoi[®] is integrated into the DHLE of 4- to 7-year-old children. Moreover, we examined parental comments in the parent-child reading interaction, controlling for children's age and for Tiptoi[®] experience.

Research widely agrees on the benefits children gain from engaging in verbal and affective interactions during traditional printed storybook reading (e.g., Baker et al., 2001). In these contexts, parents' behavior-related talk is described as a common practice to teach children the "rules" of reading (Goodsitt et al., 1988), while content-related talk has been shown to facilitate language development (Fletcher and Reese, 2005; Reese and Cox, 1999). However, findings on the potential benefits of digital storybooks are mixed regarding whether this format reshapes the dynamics of shared reading interactions in positive or negative ways. Upon the reviewed literature, there is strong evidence that parents produce a higher proportion of behavior-related talk when reading digital compared to printed books, with some critical voices describing behavior-related talk as less meaningful compared to content-related talk. Drawing on parental comments, we additionally explored the purpose of behavior-related talk in hybrid reading interactions.

We found that digital audio systems (especially Tiptoi[®]) are a popular reading device across surveyed families. Most children use Tiptoi[®] regularly, at least once a month; and, in most cases, at home and predominantly independently. The predominance of independent usage suggests that children are comfortable in navigating digital interfaces at a young age. This finding aligns with previous research (Pfoest et al., 2018; Rechlitz et al., 2016). Given the findings that audio books and Tiptoi[®] are the most popular literacy devices in children's DHLE and meet the criteria of being easy to use and possible to use independently, we conclude that this might be one of the criteria for using digital reading devices in addition to shared traditional reading. Further questionnaires with parents and teachers could provide more valuable insight into their attitude toward digital reading devices and on which criteria they rely when choosing a digital reading device for preschoolers and elementary school children.

Furthermore, we found that parents predominantly engage in content-related comments (53%) during reading interactions with children using Tiptoi[®], followed by behavior-related (22%) and other comments (22%). These results are in line with research on digital books (Parish-Morris et al., 2013, p. 204), indicating that only nearly one half of all comments (50–57%) are content-related and 35–42% relate to behavior-related talk. In contrast, printed books elicit about 73–76% comments on story content and a lower proportion (10–18%) of behavior-related talk (p. 204). From this, we can conclude that similar to digital books, hybrid book formats such as Tiptoi[®] also tend to elicit a high proportion of behavior-related talk from parents. However, it is important to note that our

study did not include a comparison group using traditional printed books. Moreover, we found no main effects of children's age (see also Parish-Morris et al., 2013) or Tiptoi[®] experience, indicating that these variables do not influence the types of comments made by parents during storybook interactions. However, despite children's familiarity with the book format, it should be noted that for all children, the book they chose was new. Because reading and exchange about story content also depends on whether the dyad reads a novel or a familiar book (Goodsitt et al., 1988), there is a crucial need for longitudinal studies investigating parent-child interaction as they become more familiar with the story content across sessions.

Previous research has suggested that behavior-related talk during parent-child interactions may be less meaningful, because it tends to involve fewer dialogic comments (use fewer story-related utterances and more behavior-related utterances). However, our study extends this line of research by delving deeper into the purpose and significance of behavior-related comments within the context of parent-child interactions during hybrid storybook reading. From the categorization of behavior-related comments, we can discern three types of behavior-related comments—operation, structure, function of technology—that serve the goal of guiding children on how to interact appropriately with the digital reading medium. This guidance is achieved by providing clear instructions on what actions to take and what actions to avoid with Tiptoi[®]. Because the digital pen serves as a medium that becomes part of the triadic reading interaction and can also assume the role of a reader, it was also important for parents to discuss the structure of interaction with their children. This includes clarifying roles, such as who is using the pen or who is reading the text, as well as explaining the sequence of steps required to access the book content with the help of the digital pen (“*first*, you have to, and *then*...”). Such discussions are essential to prevent children from randomly tapping images and icons in the book and to encourage and enable them to use Tiptoi[®] autonomously. Commenting on the function of technology is another important category, because parents not only provide instructions but also offer explanations or questions to children. Even if the parent is not fully acquainted with the technology, it is still valuable to engage in discussions with the child about its functions (e.g., the pen has a sensor) and to discuss its capabilities and limitations (e.g., the pen has a limited range of audio files for each page; the pen cannot write) in order to foster children's critical technological thinking (Tolksdorf et al., 2024). Moreover, it is worth noting that the identified categories primarily relate to the book format, and thus, would not occur in analog reading sessions. However, the category *structure* seems to stand out as the only one in which parents provide some comments within the interaction without specifically referring to digital features, but rather to global reading interactions (“should we read again?”).

While our pilot study provides valuable insights into parental comments during shared storybook reading with Tiptoi[®], it is important to acknowledge several limitations. First, our sample size was relatively small, and the number of preschoolers and first graders was not equally distributed. Future research with larger and more diverse samples could help validate and extend our findings. Second, participants in our study

came predominantly from middle- or high-SES backgrounds. Literature consistently reports SES-linked disparities in quality and quantity of HLE (Buckingham et al., 2014). For example, children from low-income households often have fewer picture books and other educational resources at home compared to their higher SES peers. In our study, a substantial number of participants reported owning a Tiptoi[®] set at home. It might be that Tiptoi[®] is more likely to be found in households with greater financial resources, which are typically those of middle or high SES. Future studies should aim to include participants from a wider range of SES backgrounds to better understand the influence of SES on children's DHLE. Moreover, our study primarily examined the quantity and types of parental comments during digital storybook reading, but did not explore the quality or effectiveness of these interactions in promoting children's literacy skills or word learning. Future research could investigate the impact of different types of parental comments on children's word learning, or text comprehension. Further research on which features of Tiptoi[®] are cognitively engaging for children could provide a valuable perspective for research in this field. For instance, further analyses of children's interactions with Tiptoi[®] (Wildt, in preparation) suggest that preschoolers primarily engage in listening to theme-related content (“knowledge” icon), and playing interactive games (“games” icon), whereas engaging with the story itself by tapping on the text is utilized infrequently or not at all. Furthermore, our study was cross-sectional in nature, capturing a snapshot of parent-infant interactions at a single point in time. Longitudinal studies could offer valuable insights into parental engagement and comments during parent-child reading interactions over time. Additionally, it is worth noting that none of the dyads in our study were familiar with the books that were offered. Therefore, in future longitudinal research, it would be pertinent to investigate whether behavior-related talk might decrease while content-related talk increases as the features in the book become more familiar to both parents and children. Finally, future research on behavior-related talk could be expanded by comparing different book formats—printed books without interactive features, printed books with interactive features, hybrid and digital storybooks. Chiong and DeLoache (2012) demonstrated that interactive features such as “pop-up” elements can distract children's attention from the text itself, potentially hindering their ability to comprehend the relationship between the elements and their referents. Furthermore, another study found that young infants exposed to touch-and-feel patches in books exhibited decreased performance in subsequent word learning tasks, indicating potential disruptions in their learning process (Muhinyi et al., 2024). Similarly, Shinsky (2021) observed that two-year-olds' word learning was hindered when reading books with lift-the-flap features compared to those without, suggesting that tactile features distract attention from the book's content.

In sum, our study shows that with the rise of digital and hybrid book formats, traditional reading practices need to be expanded to incorporate new “rules” for these evolving media. This is evidenced by the numerous behavior-related comments through which parents' guide their children on how

to use or not use the medium (e.g., where to tip with the digital pen), how to structure the reading process to access the book content, and in order to discuss the technology and its functions. Given these findings, it is recommended that educators and caregivers participate in the reading interaction, accompany the child in the practice of digital reading, and include explanations of functions, possibilities, and limitations of interaction with the book format. This is particularly important as hybrid media are often used autonomously by children, who need to be well-prepared to engage effectively with the reading medium. Hence, adults have a critical role to play in helping children navigate and become comfortable with the reading medium and its features, thereby fostering their digital literacy.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: Wildt, E. (2024, September 24). Reading with Digital Audio Pens (RAUPE). <https://doi.org/10.17605/OSF.IO/WK4ZQ>.

Ethics statement

The studies involving humans were approved by Prof. Dr. Peter F. E. Sloane, Head of the Ethic Committee, Paderborn University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

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EW: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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