e-Book Design and Young Children's Behaviour: The Case of Alphabet Books

Mary Ann Evans

Abstract In the last few years, alphabet e-books have appeared, ranging from simple static displays with a narrated voiceover to books with animated displays, music and sound effects, and hotspots. This chapter addresses the association between the design characteristics of alphabet e-books and how children use them. Eleven commercially available e-books, ranging from a static one with narration to those with increasingly elaborate media and interactivity, were read, demonstrated, and provided to 35 4-year-olds in groups of three to four children. In each of 16 weeks, children accessed four of the books for independent reading and their behaviour was coded by an observer. An average of 660 observations per book across children showed positive associations of book use with tapping object hotspots and book interactivity. Tapping letter hotspots was less common across books with the exception of one e-book which also proved to be of intermediate popularity. Imitating letter names or letter sounds narrated was infrequent. The observations provide clues as to why alphabet e-books may not be much of a boost to emergent literacy, and to what parents, critics, and designers should attend in the purchase, review, and creation of interactive alphabet e-books.

Keywords Alphabet books · e-Book design · Behaviour with e-books · Emergent literacy

Many parents in North America highly value literacy and are active in reading to their preschoolers and teaching them emergent literacy concepts including letter

M. A. Evans (✉)
Department of Psychology, University of Guelph, Guelph, ON, Canada
e-mail: mevans00@uoguelph.ca

names and sounds. These efforts are well placed given research showing the positive contribution of shared book reading and alphabet knowledge to beginning reading comprehension and word recognition. There is a large and consistent research literature showing that mastery of the names and sounds of letters of the alphabet is a good predictor of achievement in reading and spelling (see for example reviews by Adams 1990; Foulin 2005). Accordingly, directives from the Head Start Outcomes Framework (Administration for Children and Families 2015) and guidelines from NAEYC (1998) have specified that preschoolers should be able to name at least half of the letters of the alphabet and provide the sounds made by many of the letters that they recognize.

Alphabet books are often read by parents to their children (Levy et al. 2001; McCormick and Mason 1986) and are among the first books purchased for them (Sawyer and Sawyer 1993; Zeece 1996). They have a long history of use, beginning with horn books and primers in the fifteenth and seventeenth centuries respectively, and progressing to the colourful highly illustrated paper books of today. Like their predecessors, each letter of the alphabet appears in sequence on its own page, paired with an illustration, the name of which exemplifies the phoneme associated with that letter via its initial sound. Reading alphabet books to young children is commonly regarded as a helpful approach to exposing young children to alphabet shapes and to teaching the names and sounds associated with these shapes (e.g., Bus and Van IJzendoorn 1999; NAEYC 1998; Nodelman 2001). When asked what their goals are for reading alphabet books with children, present day parents report that their highest goal for this activity is that of helping their child to learn to read (Nowak and Evans 2013). In accordance with this goal, they engage in more talk about letters, letter sounds, and print concepts during shared reading of alphabet books than storybooks (Stadler and McEvoy 2003), especially when the child begins to take on part of the reader role (Davis et al. 2010).

1   Alphabet e-Books

Like other genres of print books, in the last 9 years or so, alphabet e-books have been created in digital form to be easily and inexpensively downloaded on tablets. These devices are easy for young children to use and provide an attractive alternative to print books. A recent study in the United Kingdom (Marsh et al. 2015) found that half of 2-year-olds and two thirds of 3- and 4-year-olds were able to open apps, and swipe and turn the pages of e-books on tablets without assistance. Adults' keenness for their preschoolers' tablet use is evidenced in a report by Shuler (2009) in her analysis of the sales of iTunes apps. Among educational apps, those for toddlers and preschoolers were far more frequently downloaded than those for children in elementary through high school (60 vs 16%).

e-Books, by their digital nature, are virtually limitless in not only the texts and images that can be programmed and accessed through hyperlinks and hot spots, but also in the sounds, animated graphics, and interactive features such as games and

drawing that may be included. As such, the distinction between e-books and book apps is a blurry one. For Sargeant (2015), the distinction is that "people read e-books whereas they use apps" (p. 461) but both may contain written text, and imagery, and albeit to a lesser degree in e-books than apps, interactive elements. In contrast, paper books, by their material nature, have natural restrictions on the text and illustrations that can be presented within them. Their interactive enhancements are limited, for example, to pop-ups, open-the-flap and peep-through-the-hole pages, and textures to feel. The contrast between the two has prompted an increasing body of literature on the potential advantages of interactive multimedia storybooks over their print counterparts for vocabulary acquisition, reading skill, and comprehension.

For alphabet e-books the presumed and promised advantages focus on the assistance they offer for learning the alphabet. For example, Jenny Bristol (n.d.) for Common Sense Media.com, (a website that posts independent reviews of media including apps, websites, and books), reviewed the e-book app *Interactive Alphabet* as "an educational experience for toddlers and preschoolers that will help them learn the alphabet and the sounds letters make…Playing with *Interactive Alphabet* is an entertaining and clever way to learn the alphabet and the sounds letters make." This same interactive e-book is described (July 14, 2017) at the iTunes App store as "Positively, the BEST Alphabet experience from crib to kindergarten!" Similarly, as distributor of *ABC Magic 2*, this website described (July 26, 2017) *ABC Magic 2* as follows: "This app will help your child learn the sounds of the letters … Most young learners will enjoy repeating the sounds they hear on this this app…It has been tested and used with preschool children. The children loved it and it helped them learn the letter sound." As a final example, regarding *Z is for Zebra,* News in Education (n.d.) posted the following, "This app makes it easy and fun for the children to learn the sounds of the letters. Just tap on the letter or the object to hear the audio."

Whether e-books realize such claims is a natural and important question to address. Karemaker et al. (2017) noted that "One major drawback in a rapidly changing technological world is that many e-books are untested and potentially not of educational benefit" (p. 31). In their 2015 paper, Bus, Takacs, and Kegel called for well-controlled studies to determine the effect that e-books and apps have on children's emergent literacy skills. Reviews of the few studies comparing the effects of e-storybooks versus print storybooks present mixed finding (see reviews by Bus et al. 2015; Reich et al. 2016), lending caution to a blanket endorsement of the effectiveness of e-books over their print counterparts. Recent studies contribute further to the debate. For example, Karemaker et al. (2017) compared the effectiveness of two versions of enhanced e-books (one with definitions, the other with comprehension questions) versus a flat e-book counterpart containing simply the illustrations and narration of the text. While these six-year-old children indicated that they preferred reading e-books to paper books and made many positive comments about the enhanced e-books, the word recognition, story comprehension, and vocabulary proved no better among children using the enhanced e-books than those using the flat e-book. By contrast Zipke (2017) found that the word recognition but not story

comprehension was higher when four- and five- year-olds independently used e-storybooks with a read-aloud audio than when listening to group read-alouds of a print book with their teacher, and a Jordanian study by Ihmeideh (2014) found advantages in several emergent literacy skills among children whose teacher read e-books and gave them an opportunity to use them in their kindergarten.

Peer-reviewed research publications to address claims for alphabetic learning through alphabet e-books are sparser still. Willoughby et al. (2015) examined whether 4-and 5-year-olds' alphabet learning would be enhanced after hearing, and then interacting with alphabet e-books (including the three lauded above) twice a week over a 16-week period. Comparison groups, equated for pre-exposure letter name knowledge and for sex, were a group who heard and read a variety of illustrated print alphabet books, and a group who heard and read a variety of illustrated storybooks. All groups gained in letter name knowledge with the e-book group showing no advantage. The null results mirror those of Cubelic (2013) whose dissertation research found that preschool classes using iPad apps throughout the year that were selected by teachers to foster phonemic awareness and alphabet knowledge fared no better than those not provided these apps. Similarly, Brown and Harmon (2013), who studied 4-and 5-year-old children in Head Start, found no difference in letter knowledge between those instructed with versus without apps across their 10 weeks of intervention.

Such null results are surprising given the promotional claims associated with alphabet e-books and the many opportunities these e-books present for children to repeatedly hear the letter names and sounds by activating letter hotspots and to potentially imitate them. To investigate what the children actually did with the books as a possible explanation for the null effects noted above, Evans et al. (2017) analyzed the behaviours of the children in the study by Willoughby et al. (2015) that had been coded by observers during each of the 16 sessions. The counts for these behaviour codes, within each group, were collapsed across books read and across four-week periods of eight sessions each to examine whether and how behaviour changed across time. The data showed significant linear declines across these four time periods in the extent to which children activated letter hotspots, said letter sounds, and named objects illustrating the letter sounds. Overall, behaviours that might aid or reflect alphabetic knowledge declined from roughly 20% of coded behaviour in the first four sessions to just 5% in the last four.

2   The Present Study

These findings suggest that alphabet e-books as sampled by Willoughby et al. (2015) were not particularly effective in eliciting behaviour that might help young children to explore, learn, and consolidate alphabet knowledge, and fared no better in boosting alphabet knowledge that print alphabet books or storybooks. However, it may be that e-books within those sampled differentially elicited certain behaviours. For example, were the children more likely to say letter names (naming or

imitation) when using certain e-books? Did children say letter sounds more if only sounds and not names were narrated by an e-book? Answers to such questions could provide clues to design characteristics that might better realize the claim that alphabet e-books are effective learning tools and prompted the research reported here. The approach taken was to revisit the behavioural data analysed by Evans et al. (2017). Rather than collapsing across books by session as we then did, the data were collated across all 16 sessions by e-book being used. Books whose confidence intervals for the children's mean frequency of behaviour did not overlap with the mean of all books were then identified and their design characteristics examined in an attempt to discern what might have accounted for this.

3 Method

3.1 e-Book Materials

We restricted our selection of material to commercially available alphabet e-books/ book apps that mirrored print alphabet books in presenting pages that can be scrolled through and read in sequence from A to Z, each page having a featured letter and associated images. Within this constraint, we selected items varying in the amount of animation, audio enhancements, and interactivity. They are all referred to as e-books here. Letters on the pages were large, being between 3 and 6 cm. high, with the exception of one e-book where letter height was 1 cm. The average word frequency of the target objects displayed was 211.14 (SD = 76.83) per 1,000,000 printed words in books for children ages 5–9 in the Children's Printed Word Data Base (University of Essex 2002). As a reference point, this database lists the word frequency of kite, apple, bird, and lion as 133, 219, 287, and 314 per million respectively. Among the target words for vowels, 91% exemplified the short sounds /æ/ (ant), /ɪ/ (in), /ɛ/ (elf), /ɒ/ (on) and /ʌ/ (up). For the letters C and G, 82% exemplified the hard sounds /k/ (cat) and /g/ (gate) respectively. Given that the e-books were not in use in the children's classrooms and that few of the children were reported by their parents as using e-books at home, the e-books used were most likely unfamiliar to the children.

Table 1 presents the 11 e-books used and briefly details their design features according to what is in the initial display for each page, the nature of the audio that automatically occurs with each page, whether there are letter/word/sentence/object hotspots and what they activate, any additional icons and what they activate, and the approximate length of time to read the book if activating one hotspot on each page. As one moves down the page from top to bottom, the books become more elaborate and interactive through the inclusion of sound effects; music; animated images; letter hotspots to activate narration of the letter name, letter sound, or appearance of an object; object hotspots to activate noises, animation of the image or new images; and simple touch screen activities such moving a zipper up and down through

Table 1 e-Books used in the study with their elaborateness rank and design features

e-Book title (Publisher)	Abbreviation for figures	Rank	Features
A to Z Alphabet Book (3 Square)	AZB	1	Initial display is "Cc is for CARROTS" + illustration of carrot. Automatic audio in adult voice reads "C is for carrots"
			No hotspots but tapping object or letter sometimes takes reader to new page
			Pages are advanced by swiping. Approx. length 1 min 45 s
ABC Magic (Preschool University)	MAG	2	Initial display is c + illustration of cat. Automatic audio in child's voice repeats phoneme /k/ 2x, then names "cat", then repeats /k/ 3x
			Hotspot on letter activates audio "/k/"
			Hotspot on object activates audio "cat"
			Hotspot on icons at bottom brings the reader to random page or to menu of all letters
			Pages are advanced by swiping. Approx. length 2 min 45 s
ABC Magic 2 (Preschool University)	MA2	3	Initial display is "c" + 4 illustrated objects in row below. Automatic audio in child voice repeats phoneme /k/2 xs and names object for each of 4 objects
			Hotspot on letter activates audio /k/ + letter briefly flashes
			Hotspot on each of 4 objects activates audio naming object + object briefly flashes
			Hotspot on icons at bottom brings reader to random page or to menu of all letters
			Pages are advanced by swiping. Approx. length 6 min
Z is for Zebra! (Visions Encoded)	ZEB	4	Initial display is "Cc" + illustration of cat. No automatic audio
			Hotspot on letter activates adult voice saying letter name
			Hotspot on icon lower right activates adult voice /k/
			Hotspot on object activates child voice naming "cat"
			Pages are advanced by swiping. Approx. length 2 min 30 s

Table 1 (continued)

e-Book title (Publisher)	Abbreviation for figures	Rank	Features
Animal ABC (Ooh Lovely)	ANI	5	Initial display is "Cc" + illustration of cat + printed word "Cat". No automatic audio
			Hotspot on animal name icon activates audio naming" cat" + c
			Hotspot on animal sound icon activates cat noise (meow)
			Pages are advanced by swiping. Approx. length 2 min 45 s
Animal Alphabet (7H)	ALP	6	Initial display is large "C" with object in/on it + object name + two smaller objects below with names. Sidebar has smaller C with object +2 adjacent letters with object in/on them. Automatic audio is music
			Hotpot on letter activates voice naming object + simple animation. Music throughout
			Hotspot on word activates voice naming object + simple animation. Music throughout
			Hotspot on smaller objects activates voice naming object + simple animation. Music throughout
			Pages are advanced by tapping letter on side bar or scrolling sidebar for other letters. Approx. length 6 min 15 s
Alphabet Zoo (Third Rail Games)	ZOO	7	Initial display is large C + smaller C in highlighted colour flanked by fainter 2 previous and 2 next letters in row at bottom. Automatic audio names letter
			Hotspot on letter activates audio /k/+ letter pulsates
			Third tap of letter cause image of cat to replace letter
			Hotspot on object activates audio of animal's noise ("meow") and image shakes
			Touching object hotspot again causes "C" + its hotspot to replace image
			Touching small "C" at page bottom activates audio /k/+ letter pulsates. After second tap object appears. After third tap object shakes
			Pages are advanced by tapping bottom letter. Approx. length 4 min

(continued)

Table 1 (continued)

e-Book title (Publisher)	Abbreviation for figures	Rank	Features
This Place is a Zoo! Captain Wallace's Alphabet Expedition (Multimedia)	EXP	8	Initial display is animation of animal (e.g. camel) of 5 to 15 s. + sound effects
			"Cc" appears after animation ends, sometimes integrated into illustration, + animal name "camel"
			Hotspot on "C" activates adult voice saying letter name
			Hotspot on "c" activates child's voice saying letter name
			Hotspot on object cause voice naming the object
			Hotspot on animal activates audio of animal's noise
			Pages are advanced by swiping but not until page animation is done. Approx. length 7 min
Letters A to Z (Refresh Media)	LAZ	9	Initial display is "C" + colourful scene with object (car). No automatic audio
			Hotspot on letter activates voice saying letter's name
			Hotspot on object causes animation of object + sound effects
			Pages are advanced by swiping. Approx. length 3 min 45 s
ABC Funnimals (Sythego Kids)	FUN	10	Initial display is "pulsating C" + phrase "IS FOR CAT" + object, some animated. Automatic audio in child voice names letter + says "C is for cat + provides sound effects
			Hotspot on letter activates child voice naming letter + letter pulsates
			Hotspot on phrase/word CAT activates child voice reading phrase + C in word pulsates
			Hotspot on object activates elaborate animation. C pulsates throughout
			Pages are advanced by swiping or arrow icon. Approx. length 5 min 30 s

Table 1 (continued)

e-Book title (Publisher)	Abbreviation for figures	Rank	Features
Interactive Alphabet (Pi'ikea St.)	INT	11	Initial display is "c" + "is for cake" + illustrated object, some animated. Automatic audio reads letter name + sentence + gives letter's sound + object name. Music + sound effects in background and continue when all hotspots are activated
			Hotspot on "c" causes voice to name letter + letter pulsates. Second activation provides letter's sound
			Hotspot on "cake" causes voice to read word and word to pulsate
			Hotspots on "is" and "for" cause voice to read sentence + letter "c" to pulsate
			Hotspot on object causes animation + sound effects. Up to 11 additional taps produce new animation + sounds + sometimes a new object for the letter + narration. Some "hotspots" require dragging object to create animation
			Previous + next letter at page top turns page + ABC brings home page with all letters, each with hotspot to advance to its page. Approx. length 7 min

touching along the image. As such, the books were ranked 1–11 in order of increasing elaborateness of media and interactive features and are arranged in the Table 1 from top to bottom in that same sequence.

The simplest e-book, *A to Z Alphabet Book*, (rank 1) described in the top row, presents on each display (or page) one letter, a static image of an object beginning with the letter, and the text "Xx is for object" along with audio reading that text. It was selected as one of the first books to present to the children to familiarize any children who might have had no iPad experience with this medium and swiping to turn the pages. It along with the e-books in the next four rows has no animations. The books in the sixth and seventh rows have no automatic animation but included a few animal noises and a few hotspots activating simple animations respectively. More hotspots and more elaborate animations characterize those in the last four rows. The most elaborate e-books were those described in the last two rows. These books have sound effects and/or music as well as animated images in the initial display on each page, and word/sentence and object hotspots that activate additional animations.

3.2   Participants

The sample consisted of 35 children (19 boys and 16 girls) recruited at the outset of junior kindergarten in the public school system of a small city in south-western Ontario. The children ranged in age from 3 years, 9 months to 4 years, 9 months (mean age 4 years, 3 months) and attended nine publicly funded schools. Among the mothers of these children, 14% had not graduated from high school, 17% had high school diplomas, 31% had a college diploma or trades certificate, and 37% a university undergraduate degree or postgraduate/professional degree. This distribution of maternal education was similar to that of women ages 25–44 in the province of Ontario for which, according to 2011 National Household survey, the figures are 8%, 21%, 34% and 37% respectively (Statistics Canada 2011). According to parental report, child usage of a tablet in the past was never for 11 of the children, once a month for three of them, once a week for three of them, a few times a week for seven of them and every day for 11 of them.

3.3   Procedure

After receiving parental consent for participation and children's own assent, the children were assessed in the fifth or sixth week of the new school year. Letter knowledge was tested by asking them to name all the letters of the alphabet presented in uppercase and then lowercase form, with four randomly selected letters on each card presented. The children were then asked to give the sound for all 26 letters presented in uppercase form. If a child answered with the soft sound /s/ for C or /dʒ/ for G, or long vowel sounds such as the name of the letter E instead of sound /ɛ/, the examiner asked "What other sound does the letter make?" On average, the children were able to name 11.83 (SD = 10.81) uppercase letters and 9.80 (SD = 8.22) lowercase ones, and to give the sounds for an average of 4.89 (SD 6.41) letters. In addition, children's vocabulary was assessed using the Receptive One-Word Picture Vocabulary Test (Brownell 2000) in which the child points to one of four pictures named by the examiner. The mean standard score obtained on this test was 102.32 (SD 14.11). As reported previously by Willoughby et al. (2015), gains in letter knowledge at post- test after 16 sessions with the books were eight letter names and three letter sounds which did not differ from the two control conditions of paper alphabet books and storybooks.

Children were met in their classrooms, given information about the study, and following their assent, individually assessed in a quiet corner of the school library or in an unoccupied meeting room, resource room, or office. Following the testing, the children were grouped into heterogeneous groups of three to four children through random stratified sampling according to the children's letter knowledge, so that each group contained children with varying levels of letter knowledge. Over a period of 8 weeks, each group met with a member of the research team for

approximately 20 min, twice a week. In each session, the researcher demonstrated one of four e-books to be used in each of the two sessions in any given week. The reader showed the title screen and introduced the e-book by its title and publishing company and kept the screen of the iPad visible to the children as the pages were scrolled through. One hotspot was activated per page, alternating between letter and object hotspots in e-books with both to demonstrate hotspot activation. In e-books with no automatic audio of the letter and object appearing on the page, the researcher named these before activating any hotspots, and occasionally paused before doing so in order to give children room to verbally participate. Otherwise no questions, remarks or comments on the book were made by the reader in order to standardize the reading and keep the book at the forefront. Observations by a second researcher during 19% of the read-aloud sessions indicated that readers followed the protocol in 100% of these observations.

Following the reading, four iPads, each with one of the four e-books for the week, was distributed to the children. Each week a different combination of books was used, with books reappearing in different combinations in later weeks. Given that groups contained a maximum of four children, four books were available each week to allow children to each look at a different book or to look at the same book together, and to potentially cycle through all the books within the 15 min provided after the read aloud. The researcher told the children to pick a book to read and that they could trade iPads as they wished during this group time to access a different book or read a given e-book together with one or more of the other children. After approximately 13 min of independent reading time, the children were advised that there were 2 min left. During the independent reading time, in addition to a researcher who coded behaviour, a second researcher was always present to assist a child with an e-book if needed without delay. In a sampling of sessions, this observer also coded behaviour to establish coding reliability.

In the first two sessions, or first week, three of the simplest e-books were used to gradually introduce any children who had no experience with e-books to this medium and to scrolling the pages and tapping hotspots. Children quickly caught on. In the first session, 155 observations entailed activating object hotspots, 133 observations activating letters, and 30 observations navigating from the start menu. In addition, each child viewed a variety of pages in the books they looked at, and only 19 requests for help were coded.

3.4   Behaviour Coding

During the independent reading portion of the sessions the observer rotated through the children in 5-s observation intervals and coded their behaviour. The codes used were an adaptation of the observational typology for e-book engagement in Roskos et al. (2012). Codes (see Table 2) captured which e-book was being used by the child, where the child was oriented, (i.e., looking at the book, at another child, at the researcher, or elsewhere/off task), whether the child looked at the book alone or

Table 2 Coding categories for observations of children's e-book behaviour

Record	Detail
Group composition	Number of children reading given e-book from 1 (alone) to 4 (maximum group size)
e-Book	Which book is with the child
Letter	Which letter is displayed on the page
Orientation	Where child is oriented: to book, other child, researcher or none of the above (i.e., off task)
Letter sound	Whether child said the sound of a letter (e.g., /c/ as in cat)
Letter name	Whether child named a letter
Object name	Whether child named the object shown on the page (e.g., Apple)
Pointing to picture	Whether child activated picture hotspot on the page
Pointing to letter	Whether child activated letter hotspot on the page
Telling a story	Whether child talked in narrative or reading style while using the book
Search for hotspot	Whether child touched various parts of page in attempt to find hotspots
Navigating	Whether child was on a navigation page of the book/ scrolling through multiple pages
Ask for help	Whether child seeks researcher assistance with e-book
Unknown verbalization	Whether child said something but it cannot be interpreted as telling a story
None	None of the above behaviors such as child behaviour unrelated to book (e.g., looking around room) or looking at book with no other behaviour to code

with 1/2/3 other children, and behaviors with the book such as saying (correctly or incorrectly) a letter name, letter sound or object name; searching for or activating letter or object hotspots; asking for help, and navigating the start menu. Given that more than one behaviour could occur in any one 5-s interval, codes were not mutually exclusive. Inter-rater reliability was substantial for coding children's orientation during independent reading time, $K = .66$, $p < .001$ and for coding specific book behavior, $K = .70$, $p < .001$.

3.5   Data Preparation and Analytic Approach

The data were sorted according to which book was being used and frequencies were calculated for each book per child, collapsed across sessions, for the following book behaviours: looking at the book, saying the letter name, saying the letter sound, saying the object name, and touching/activating letter and object hotspots. Saying the object name may be considered to be a letter-related behavior because in naming an object associated with a letter, the child would be pronouncing the letter's sound as part of that name. A tally was also made of the number of observations made of each child, the number of different books each child used, and the number of

observations in which each book was used by each child. The last served as the denominator in calculating proportions per child for the coded behaviours pertaining to each book. In cases where a child was observed using a book less than five times, the average of the other children was substituted and used in the analyses rather than a proportion based on a denominator of such small frequency. It was felt that a sample of four or fewer observations was too small to be reliable, and would unduly influence book means and standard deviations, in that a large change in proportion would result from a small change in frequency (e.g., the difference between 3/4 and 2/4 is .25).

Means and standard deviations and confidence intervals for behaviours for each book were calculated and compared to the mean of all 11 books. The elaborateness ranks (1–11) assigned to each book were correlated with the book's mean for coded behaviours using Spearman correlation to examine linear associations. Finally, books were identified for closer consideration of their design features when the confidence interval for their mean of a given behaviour did not overlap (be it higher or lower) with the mean of that variable for all 11 books.

4 Results

A total of 7438 observations were made across the 16 sessions. Between 30 and 35 children were present at each session, with each child attending an average of 14.89 (SD = 1.59) sessions. An average of 212.79 (SD 55.52) observations collected from each of them. In 7255 or 98% of the observations, the child had a tablet in his/her hands as the sole viewer or a joint viewer with another child. Sixteen children used all 11 books at least once. Twelve children used different assortments of ten of the books. For seven children this number was nine of the books, and for two children eight of the books. Collapsed across children and sessions, an average of 658.33 (SD = 258.20) observations were made for each book with an average of 19 observations (SD = 7.29) per book per child.

It is worth noting here that Evans et al. (2017) previously reported that there was no significant correlation between pre-test knowledge of letter name or letter sounds and the extent to which children were observed, collapsed across all the e-books, to be oriented to the book, say letter names, say letter sounds, point to or activate letters, or name objects during the first eight sessions (i.e., Weeks 1 and 2) using the books. Additional analyses for the present paper showed that this was also true for all the remaining eight-session periods (i.e., Weeks 3–4, 5–6, and 7–8) in the study. All these correlations were less than .25. Thus there was little relation between children's letter knowledge coming into the study and how they interacted with the e-books.

4.1   Children's Book Behaviours by e-Book

Book Use   Table 3 shows the number of participants who were observed using each book at least five times. Books with the highest ranking of elaborateness (ranks 7–11) never had too few observations per child for calculating proportions for the behaviour codes, being used at least five times by all 35 children. Books of intermediate ranks 6–8 as well as the simplest book (rank 1) were used at least five times by 33 or 34 of the 35 children. For books with lower ranks (2–5) seven of the children were observed using them only 4 times or less across the 16 sessions.

The linear correlation between a book's ranking of elaborateness and the average number of times it was observed being used by a child was $r = .55$, $p = .083$. Figure 1 displays this by graphing the mean number of observations and 95% confidence intervals per book arranged across the x axis in increasing order of elaborateness. The mean and 95% confidence interval across all books is also displayed. The graph shows that the mean usage for the four most animated books falls above the average for all books, and for the five least animated books below the average. In addition, the lower boundary of confidence intervals for the two most interactive e-books (*ABC Funnimals* and *Interactive Alphabet,* ranks 10 and 11) is higher than the mean for any other book. The high frequency of usage counts for these books partly stems from these being used by more than one child at once. On average across books, 87% of the observations of children looking at books entailed the child looking at the book alone. However, when children read *ABC Funnimals* and *Interactive Alphabet,* they did so alone just 64% and 63% of the time respectively. Instead 28% and 33.5% of the observations with these e-books respectively entailed two children reading the book together, and in 11.3% and 6.4% of the observations, three/four children together. These same two e-books were also the favoured e-books in all six sessions in which they had been offered to the children, irrespective of what were the other three books in the session.

Table 3 Number of participants using e-book at least five times across the study

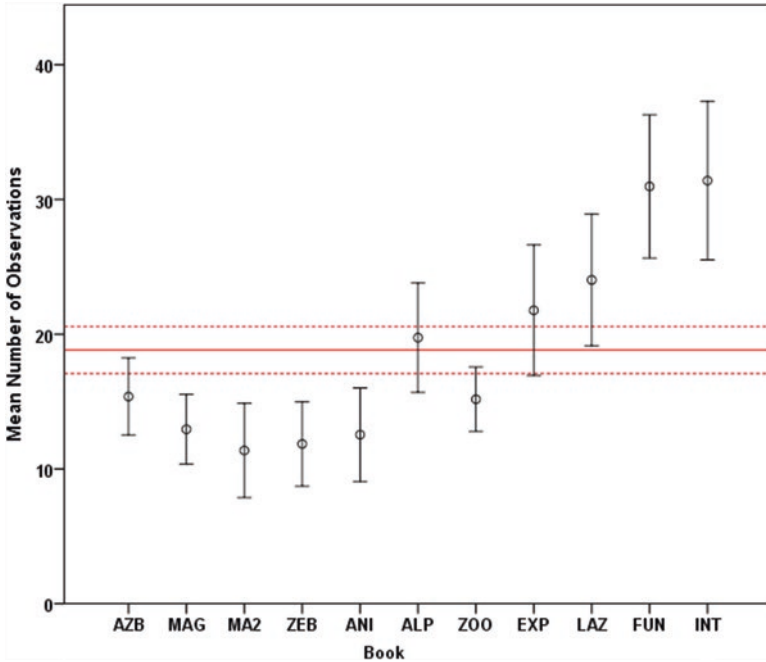| e-Book	Rank	Participants
Z is for Zebra	4	27
ABC Magic	2	28
ABC Magic2	3	28
Animal ABC	5	28
A-Z Alphabet Book	1	33
Animal Alphabet	6	28
Captain Wallace's Animal Expedition	8	28
Alphabet Zoo	7	34
Letters A-Z	9	35
ABC Funnimals	10	35
Interactive Alphabet	11	35

Fig. 1 Mean number of observations and 95% confidence interval per by e-book ordered on x axis according to elaborateness of e-book. Y axis reference line provides mean and CI across all e-books

The graph also shows one e-book that does not appear to conform to the linear association described above—*Alphabet Zoo*—in being used less than the lower bound of its ranked book neighbours, but at about an average usage level across all the e-books. This e-book requires the user to activate the letter hotspot three times, causing the letter to grow in size and its sound to be heard, in order for the associated animal to appear in place of the letter. Tapping the animal activates a noise for the animal noise and a simple animation.

Looking at Book　Figure 2 shows that the amount of just looking at the screen of an e-book was inversely related to the elaborateness of the book ($r = -.62, p < .04$). There were two clear outliers to this linear pattern. *This Place is a Zoo! Captain Wallace's Alphabet Expedition* deviated in having a higher proportion of observations in which the child looked at the books during the 5-s observation intervals, with no other behaviour to be coded. This is likely because as each page is scrolled to, this e-book immediately displays the letter in upper- and lowercase along with an animation lasting between five and 15 s with accompanying sound effects. After the animation, hotspots activate the letter name, letter sound, or animal noise but no further animation. Conversely, *Z is for Zebra* elicited less just looking than would be expected given its ranking. This e-book has no animations. Hotspots on the upper/lower case letters and objects activate only a narration of the letter name and
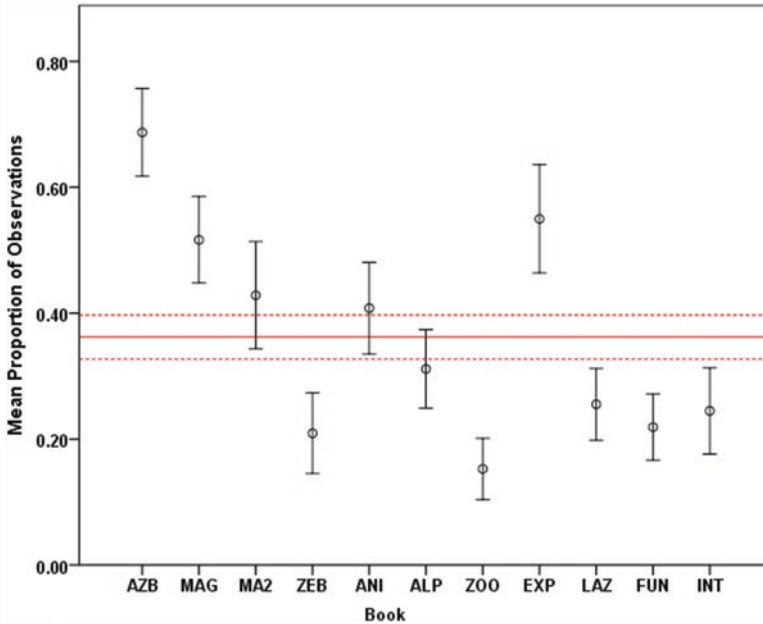
Fig. 2 Mean proportion of observations and 95% confidence interval in which children were observed looking at e-book. e-Books are ordered on *x* axis according to elaborateness of e-book. *Y* axis reference line provides mean and CI across all e-books

object name respectively, and a separate icon activates the letter's sound. For each of these a different voice is heard.

Tapping Object Hotspot On average across books, in 40% of the observations, children tapped on the object displayed. As would be expected the more elaborate the book in terms of what the object hotspots produced, the more tapping of these hotspots $r = .70$, $p = .02$. Figure 3 shows that when children were using *ABC Funnimals* and *Interactive Alphabet,* tapping of object hotspots was highest, and well above the average of all the e-books, occurring in approximately 70% of the observations. In these two books, the resulting animations frequently introduce new animations, additional characters, and sound effects. In contrast, while *This Place is a Zoo! Captain Wallace's Alphabet Expedition* has elaborate animations, tapping on the object produces only an animal noise. Accordingly, it elicited less object hotspot tapping (19% of the observations.) Lastly, it might be noted that despite the absence of hotspots in *A to Z Alphabet Book*, tapping objects (and letters, see Fig. 4) was coded occasionally when children attempted to interact with this e-book in the way that they did with the others having hotspots.

Tapping Letter Hotspot Overall, there was little tapping of letter hotspots to activate the name or sound of the letter. This behaviour was coded on average in just 12% of the observations. In addition, as can be seen in Fig. 4, there was no linear
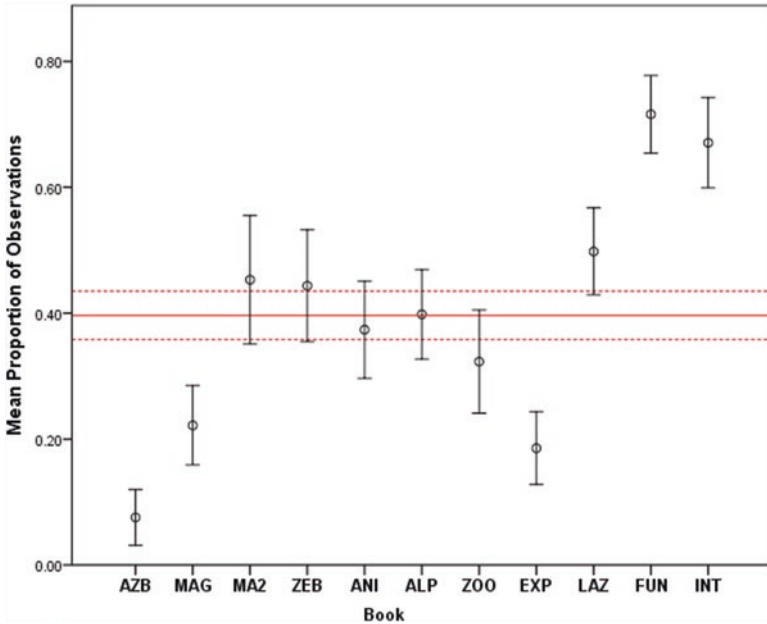
Fig. 3 Mean proportion of observations and 95% confidence interval in which children were observed touching/activating object. e-Books are ordered on *x* axis according to elaborateness of e-book. *Y* axis reference line provides mean and CI across all e-books

relation of tapping letter hotspots with the ranking of the books in terms of how elaborate a book was (*r* = .03, *p* = .99) However the graph signals three things of note.

First, when children used *ABC Funnimals* and *Interactive Alphabet,* the two e-books with the most elaborate and engaging object hotspot animations, they very rarely tapped the letters, the mean across children being just 1.53% and .08% of observations for these two books respectively. In fact, only 11 children were observed even just once to activate a letter hotspot and hear its sound or name when using *ABC Funnimals* and only six were observed to do so when using *Interactive Alphabet.* This is even more remarkable given that these two books had an average of over 30 observations per child.

The second item of note is that *Alphabet Zoo* elicited an extraordinarily high activation of letter hotspots (45% of observations) compared to all of the other e-books. The reason likely is that in this book, the only way to access the object hotspot is by first tapping the large letter hotspot three times. Tapping the image again brings back the letter to potentially begin the cycle again. The same sequence holds for the tapping the same letter in smaller font appearing at the bottom of the page.

The last item of note is the contrast between *ABC Magic and ABC Magic 2.* The former elicits more tapping of the letter hotspots (12% of observations) than the
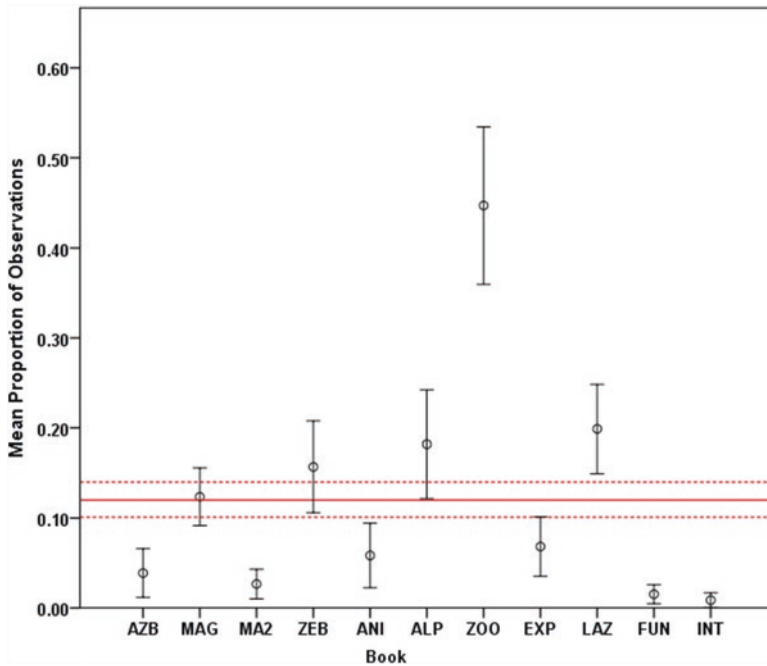
Fig. 4 Mean proportion of observations and 95% confidence interval in which children were observed touching/activating letter. e-Books are ordered on *x* axis according to elaborateness of e-book. *Y* axis reference line provides mean and CI across all e-books

latter (3%) and the confidence intervals for these means do not overlap. In both of these books, at each page there is an automatic audio in a child's voice of the letter's sound two times, followed by the name of the object displayed. Also in both books, each letter on a page has a hotspot producing an audio of the letter sound, and each object has a hotspot producing the object's name. The difference between the two books is that *ABC Magic2* pairs each letter with four objects while *ABC Magic* provides just one object per letter. It appears that the more objects on a page to tap, the less tapping of letters, even if the former results in nothing more than the object's name being heard. This also held true when the data examined was restricted to the 24 children who used both books. Tapping letter hotspots was significantly lower (3.22%) for *ABC Magic 2* having four pictures per letter than *ABC Magic* (12.02%) having one object per letter, $F = 10.64$ (*df* 1, 23), $p = .003$. In fact, only four of these 24 children were ever observed to tap a letter hotspot to hear the letter sound when using *ABC Magic2,* in contrast to 20 children when using *ABC Magic.*

Saying Letter Name This behaviour was very infrequent. Between 24 and 32 of the children were never observed to say the name of a letter when using a given e-book, making calculation of means and confidence intervals per book inappropriate. Rather, the number of children who were observed to say a letter name at least once when using a given book was counted. Table 4 displays this data. On average

Table 4 Percentage of children observed at least once saying letter name, letter sound, or object name by book used

e-Book	% letter name	% letter sound	% object name
A to Z Alphabet Book	24.2	6.1	35.3
ABC Magic	10.3	13.8	20.7
ABC Magic 2	6.9	6.9	31.0
Z is for Zebra!	10.7	7.1	35.7
Animal ABC	0.0	0.0	17.2
Animal Alphabet	18.2	3.0	18.2
Alphabet Zoo	8.8	8.8	17.6
This Place is a Zoo!	27.3	6.1	27.3
Letter A to Z	17.1	8.6	34.3
ABC Funnimals	14.3	3.0	28.6
Interactive Alphabet	20.0	2.9	40.0

across the 11 e-books, 15% children were observed to name letters but for three books--*ABC Magic 2*, *Animal ABC*, and *Alphabet Zoo* this figure was considerably lower (7%, 0%, and 9% respectively). Again, the features of the books help to explain why.

In *ABC Magic 2,* the letter name is never heard in the audio and, as seen above, children opted to tap the four object hotspots which activated the object's name. In *Animal ABC*, there is no automatic audio. Only if the icon at the page's top right is tapped does the child hear the name of the beginning letter followed by the name of the animal. The bottom left icon competes by providing the noises that go with the animal. Finally, in *Alphabet Zoo*, the sound of the letter predominates. The name is heard once after scrolling to a page and that is all. Tapping the large letter hotspot produces the letter's sound and as noted earlier, this must be done three times to access the object hotspot and its simple animation consisting of the object shaking back and forth. Tapping the image again brings back the letter to tap, hear the sound, and begin the cycle again. This sequence also applies to the same letter in a smaller font at the bottom of the page.

Two books diverged in the opposite direction with letter naming being more frequent. When using *A to Z Alphabet Book,* the simplest of all 11 books with no animations or hotspots, the child heard only the phrase "letter is for object" (e.g. "C if for cat"). This parsimony and absence of any distractions may have encouraged relatively more children to name the letter. In fact, 25% of them did so at least once. In the second book, *This Place is a Zoo! Captain Wallace's Alphabet Expedition*, there is no automatic audio of the letter name. Rather this is activated by tapping the upper/lower case letter displayed after the animation. Importantly, many of the animal animations end with a paw, hoof, horn, nose, tongue, or tail pointing at or holding the page's letter, as though inviting or cueing the children to take their turn and name or activate the letter. For this book 27% of children said a letter name at least once. It may be that attention to the letter and naming of it was encouraged by integrating the letter and object together. This interpretation is supported by the chil-

dren's behaviour with *Animal Alphabet.* Although naming the letter was not observed as often here, with this book as high a percentage of children named letters at least once as children who named objects at least once (18%). This e-book super-imposed letters of equal size as the accompanying object over that object.

Saying Letter Sound This behaviour was the least frequent. This is not surprising given than these young children knew fewer letter sounds than letter names and were just beginning to grasp the alphabetic principle that letters make sounds. As shown in Table 4, for 10 of the 11 books, fewer than 9% of the children were observed to a letter sound even just once during the observations.

Saying letter sounds was highest of the books with *ABC Magic* (14%) but not second highest with *ABC Magic2* (7%). The contrast is again instructive. *ABC Magic* displays a letter and one object along with automated audio providing the letter sound two times and the name of the object once, followed by three repetitions of the letter sound. The letter hotspot if activated provides the letter sound a sixth time. In all, the ratio of letter sounds to object names is five or six to one. By contrast in *ABC Magic 2,* with four objects per letter, the automatic audio provided the letter sound two times, followed by the object's name once. This is repeated for each of the four objects paired with the letter for a ratio of two letter sounds to one object name. In other words, letter sounds are provided proportionately less often than object names in *ABC Magic 2* than *ABC Magic*.

Saying Object Name This verbal behaviour was more common than the other naming behaviours, being observed at least once on average in 30% of the children. This percentage was lower (under 19%) for three of the books. *Animal Alphabet*, automatically plays music throughout which may have reduced the likelihood of children naming objects as often as they otherwise might have. *Alphabet Zoo* has no automatic or hotspot activated narration of the object name, providing instead letter name, letter sound, and animal noises. *Animal ABC* does not present the object name unless the hotspot on a peripheral icon in the corner is activated.

5 Discussion

The strength of this study lies in its observational data of repeated interactions with a sample of alphabet e-books over a period of time across a sample of 35 preschoolers. The limitation is that it sampled 11 alphabet e-books from the many, many alphabet e-books that can be downloaded from websites. In addition, the behaviour when reading the e-books stem from children of a certain age (4–5 years) in a relatively controlled experimental context, and as such may not generalize to older children or to younger children (see Courage this volume, for a discussion of age-related and individual differences in executive function and attention) or to situations such as those in which children may intersperse e-book use with play or read an e-book with an adult.

Nonetheless, it is felt that these observations in concert with the analysis of the features of the books provide some helpful clues regarding the effect of e-book design on your children's behaviour with them and potentially regarding the learning that they derive from them. With this in mind, many a time the author went back to an e-book to carefully note further aspects of how it worked, adding details to the essential features noted in Table 3 to capture its design. This level of detail, through verbal descriptions or brief videos of the e-book in action, should be made available to potential buyers of these materials before downloading them to allow them to make their own informed choices. It is hoped that readers will have read through the table to enable them to draw their own conclusions about the linkages between e-book design and behaviour presented earlier, and the generalizations summarized below.

5.1   The Double Face of Animations

While the children were not asked about which e-books they liked the best, the extent to which they used them strongly suggests a preference for the ones with elaborate animations. The more entertaining and interactive the animations were, the more children selected the book for use. The four books with the highest usage *This Place is a Zoo? Captain Wallace's Alphabet Expedition, Letter A-Z, ABC Funnimals,* and *Interactive Alphabet*, were ones which the paired letters with clever object animations of this nature. Moreover, the two e-books with the highest usage were the ones in which the children could control what happened in at least some of these hotspots, such as making an apple increasingly be eaten through multiple taps, or making a zipper go up and down by dragging the tab with a finger. However even the simple effects of having an object shake or make a noise at the touch of its hotspot seems to have positively affected children's e-book choice. This is hardly surprising and mirrors previous research papers showing children's preference for looking at pictures over print when listening to storybooks (Evans and Saint-Aubin 2009; Roy-Charland et al. 2007; Justice et al. 2005) or alphabet books (Evans and Saint-Aubin 2005) and preference for moving letters over static ones when watching Sesame Street (Fisch and Truglio 2001; Flagg 1982). For an alphabet e-book to even "out of the gate" and be selected repeated by a child over and above other alphabet e-books, it needs to be animated.

However, highly elaborate animations likely detract from the educational content of alphabet e-books and compete for cognitive and attentional resources. A like concern has been raised by several other researchers with respect to animated storybooks and the playful enhancements within them (e.g., De Jong and Bus 2002, 2003; Korat and Falk 2017; Takacs et al. 2015; Trushell et al. 2001; Sargeant 2015, and chapter by Bus et al. this volume). In fact, within the books sampled here, the e-books with the most entertaining animations were also the ones where tapping letter hotspots to hear letter names/sounds was the least frequent. In addition, Evans et al. (2017) found that children activated letter hotspots less over time as the ses-

sions progressed, and hypothesized that it may be because the novelty of trying out these letter hotspots wore off as they discovered the more entertaining displays and sounds resulting from object hotspots.

5.2 Enhancing the Alphabet Aspect of Alphabet e-Books

Notably none of the e-books sampled included an animation of the letter itself, but this would not necessarily be a help to letter learning if other aspects of the illustration are more eye-catching or if the way letters are animated does not highlight their differentiating features or provide a mnemonic for remembering them. A challenge for the design of animations in alphabet e-books is to support the alphabet and its learning, and not detract from it. One approach, as shown by Shidman and Ehri (2010) and Ehri et al. (1984), is to create displays that highlight the shape of a letter within an object whose name exemplifies that letter's sound (e.g., an S in a picture of a snake), providing a mnemonic for the letter's sound to facilitate alphabet learning.

One of the books, *Alphabet Zoo,* does not have accompanying objects in the initial display. This in itself may have drawn children's attention to the letter on the screen as the only object to look at. But *Alphabet Zoo* goes two steps further. Appearance of the object and its hotspot is contingent on the letter hotspot being activated three times, with the first two taps causing the letter to pulsate and the letter's sound to be heard. Only the third tap produces the accompanying object and hotspot for a simple animation of the object and accompanying noise. A second tap of the object causes the animation not to be repeated, but rather to disappear and the letter to appear again. In this way this e-book was engineered to emphasize the letters and their sounds over the accompanying objects.

It is not surprising that the children rarely were observed to say the sounds of the letters, given than on average they knew just on average just five of them at the start of the study. However, they could do so by imitating what they heard. The promotional blurb for *ABC Magic* 2 notes that most young children will enjoy repeating the sounds they hear on this app. In the present study, while the children may have enjoyed repeating sounds when they did it, the reality is that they rarely did it. Nonetheless, compared to the other books *ABC Magic* was more successful in eliciting this behaviour and provides a clue as to why. It presents the letter sounds proportionately more often than other labels and more so than the other e-books, in that six letter sounds are heard to two object labels. A simple conclusion is that children are more likely to say what they more often hear, and that for letter names and sounds on alphabet e-books to influence children's letter behaviour and potentially alphabet knowledge, they must not only be there, but be there frequently and more prominently than competing labels, music, and noises. As shown by Robbins and Ehri (1994) at least four repetitions of a new word are a necessary, but not sufficient, condition for young children to acquire vocabulary from storybooks, a generalization which would likely apply to the alphabet vocabulary of letter names and sounds.

Children knew on average about 12 uppercase and 10 lowercase names. A third of them could name at least 20 uppercase letters. However, they were infrequently observed to say the names of the letters. It is possible that the children were "reading" silently, but the fact that they often overtly named objects suggests that this is not the explanation. It is more likely because the object labels were better known to them and because the objects and animations were more the focus of their attention. What seems to encourage letter naming is cuing the child to "read" a letter name by ending an animation to point at the featured letter in some way, as was the case for *This Place is a Zoo! Captain Wallace's ABC Expedition.* Another approach is simply having no hotspots at all as in *A to Z Alphabet Book*, or providing a few seconds of silence at each new page before the audio names a letter to afford the child space for children to name what they see. As suggested by Karemaker et al. (2017) in their study of enhanced and non-enhanced e-storybooks, it also may be that the absence of supportive features (in this case an immediate audio of the letter name) encourages children to put more effort into the activity.

6 Conclusion

The linkages between book design and book behavior highlighted here suggest some ways that education/learning may be enhanced by designers of alphabet e-books without a reduction in entertainment/enjoyment. They are at this point only suggestions, begging for experimental studies comparing the behavior of children with alphabet e-books differing on one design dimension only. The author does not doubt that the designers of the various e-books sampled here put considerable thought into creating what they hoped would be both entertaining and educational products. The promotional blurbs echo these intents, but the limited extant research suggests that the educational value may be overstated. This is especially concerning given a report by Vaala and Takeuchi (2012) that a majority of parents felt that the features of e-books enable children to read alone and another by Neumann (2014) showing that the majority of parents agreed that touch screen tablets would help their child's early literacy development, Also, Etta (this volume) describes that parents report e-books to be educational regardless of the interactive features present. Similarly, Higgins et al. (2000) found that many teachers of special education believed that software marketed for educational purposes provided these benefits.

While parents can augment the educational value of these books by reading them with their child, the format of interactive e-books seems to lend itself less well to supportive parent interactions than do print books. In a study by Strouse and Ganea (2017) parents reported that they engaged in more interaction with their child when reading print books than e-books. Observational studies support this in showing that when reading e-storybooks compared to print storybooks, parents initiate less talk about the story and engage in more talk managing the child's behaviour (Chiong et al. 2012; Kim and Anderson 2008; Krcmar and Cingel 2014; Lauricella et al. 2014; Parish-Morris et al. 2013). These observations underscore the importance of

alphabet e-book features that encourage the child to attend more to the educational material and less to unrelated animations.

Finally, it might also be noted that many items for children feature the alphabet, such as wooden blocks, lacing cards, toy boxes, clothing, dinnerware, and blankets, but have purposes unrelated to alphabet learning. For some, it may be heretical here to note that there is a place within the range of alphabet e-books for ones that are primarily entertaining, with the alphabet as an incidental organizing principle for the activities, animations and sound effects within them. What should be is essential and noncontroversial, however, is that (1) creators and distributors be transparent in how they describe and present alphabet e-books in their promotional material so that buyers can make informed choices for their purposes and goals, and (2) that they refrain from claims about children's behaviours and learning in using them without well controlled research behind them.

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