Visual Attention to Print-salient and Picture-salient Environmental Print in Young Children

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Abstract

Environmental print is composed of words and contextual cues such as logos and pictures. The salience of the contextual cues may influence attention to words and thus the potential of environmental print in promoting early reading development. The present study explored this by presenting pre-readers (n = 20) and beginning readers (n = 16) with environmental print that was print-salient or picture-salient. Children's visual attention to environmental print was measured using an eye tracker. Pre-readers were found to attend more to words in print-salient rather than picture-salient environmental print. In contrast, no difference in attention to words in print- or picture-salient environmental print was found in beginning readers. This suggests that although visual features of environmental print influence attention to words, children may preferentially attend to print according to their reading ability. Print-salient environmental print may be more beneficial for enhancing pre-readers' visual attention to words, whereas print salience may be less important for beginning readers.

Keywords: environmental print, reading development, young children, eye tracker, visual attention

Introduction

Ubiquitous environmental print plays a functional role across cultures and communities, such as signifying a location, promoting a product, or providing information (e.g., Horner, 2005; Liu, 2011; Neumann, Hood, Ford, & Neumann, 2011; Yannicopoulou, 2006). This type of print consists of both the print itself (e.g., words, product name, numerals) and accompanying contextual cues (e.g., pictures, logos). The contextual cues in particular are typically designed to attract the visual attention of the reader by having colours, bold logos, or being large in size. An important research question has been the role that contextual cues play in the reading of environmental print by young children. The answer to this question has important implications for whether environmental print can serve as a useful tool to support early reading development.

Research has shown that young children who possess limited alphabet knowledge can gain meaning from and identify environmental print through its contextual cues (e.g., Blair & Savage, 2006; Share & Gur, 1999). This is demonstrated in the classic study by Masonheimer, Drum, & Ehri (1984) who examined young children's ability to identify environmental print under different decontextualised print conditions. Signs and product labels commonly found in the children's local community were collected and a photograph of each was taken (e.g., Pepsi label on its bottle). The photographs were manipulated to create stimuli that differed in the amount of contextual cues present: (1) environmental print word with its full context, (2) environmental print word with its logo only, and (3) environmental print word with no logo. Pre-reading children (N = 96) were shown each photo and asked to "tell what it says in each picture" (p. 263). Masonheimer et al. (1984) found that 81% of pre-reading children could correctly identify environmental print in context, but their ability to identify environmental print decreased when presented with the environmental print word

and logo (67% of pre-readers) and decreased further with the environmental print word only (23% of pre-readers).

Pre-readers with little alphabet knowledge and who rely on contextual cues to read environmental print are known as context dependent (Mason, 1980) or logographic readers (Frith, 1985). Pre-readers are situated in Ehri's (2005) pre-alphabetic phase of reading development. In contrast, beginning readers who have mastered alphabet letters are able to read environmental print correctly in context with and without logos (Masonheimer et al., 1984). Beginning readers are increasing their ability to use letter-sound correspondence skills and are progressing through Ehri's (2014) partial-alphabetic (little or no word decoding ability) and full-alphabetic (growing ability to decode unfamiliar and non-words) phases. Skilled readers have progressed through Ehri's (2014) consolidated phase and have an accurate and automatic sight word memory and can decode unfamiliar and non-words rapidly and proficiently.

It has been suggested that environmental print reading ability and environmental print experiences in pre-readers do little to transition them into the next phase of reading development (Ehri, 2005; Ehri & Roberts, 2006; Masonheimer et al., 1984). This is because pre-readers, who have not mastered the alphabet, attend to the salient visual cues, such as pictures and logos, to identify environmental print rather than the letters and words (Ehri, 2014). Consistent with this notion, studies have shown that pre-readers exhibit minimal attention to print during shared story book reading (e.g., Evans & Saint-Aubin, 2005; Justice & Lankford, 2002; Justice, Skibbe, Canning, & Lankford, 2005).

Eye tracker technology is a reliable and accurate behavioural measure of children's visual fixations during linguistic tasks (e.g., Oakes, 2010; Rayner, 1985). Justice and Lankford (2002; $N = 4$) and Justice et al. (2005; $N = 10$) used this technology to show that pre-readers visually attended to words only 2.5 % and 2.7%, respectively, of the time during

shared picture book reading. Furthermore, following a comparison between picture books that were print-salient (large print) and picture-salient (small print), pre-reading children fixated more on words (6-7% of the time) in print-salient books than picture-salient books (Justice & Lankford, 2002; Justice et al. 2005). Roy-Charland, Saint-Aubin, and Evans, (2007) extended the studies by Justice and colleagues (Justice & Lankford, 2002; Justice et al., 2005) to examine visual attention to words across reading development. The children who participated were from kindergarten to grade 4 (N = 30). During shared storybook reading, pre-readers spent little time on the print (5-10%). In contrast, beginning readers spent between 45% - 65% of their time fixating on the print.

Extending this research on story books, a recent eye tracker study examined children's visual attention to words in environmental print (Neumann, Acosta, & Neumann, 2014). Pre-reading children (N = 39) aged 3 to 5 years were presented with photographs of nine different environmental print items (e.g., BUS STOP sign; HUNGRY JACK'S). The pre-reading children spent between 4% and 36% of their time on words in environmental print which is higher than visual fixations to words during shared story book reading (2-7%; e.g., Justice et al., 2005). Neumann et al.'s (2014) results suggest that pre-readers do not attend to contextual cues all of the time, potentially providing opportunities for letter and word learning. Furthermore, the amount of time the pre-reading children attended to words varied across the different samples of environmental print used. The authors suggested that the physical features of the print, such as the size and spatial position of the contextual cues, may influence the amount of time children spend looking at words in environmental print. Such factors may influence how pre-reading and beginning readers interact with words embedded in environmental print, and its relevance as a resource to help children progress into their next phase of reading development.

The present study

Neumann et al.'s (2014) study was limited because it did not examine attention to environmental print across levels of reading development. As reading skill increases, more time is spent attending to print during storybook reading (Roy-Charland et al. 2007). Therefore, the present study used eye tracker technology to examine the extent that pre-readers and beginning readers attend to words in environmental print. Another limitation of Neumann et al.'s (2014) study was that they did not systematically manipulate the contextual features of their environmental print items. As such, differences across items in the size of the contextual cues (e.g., picture/logo) were confounded with changes in other features (e.g., spatial location, colour). For this reason, the present study included print-salient and picture-salient forms of each environmental print item. These research questions were examined:

(1) Do pre-readers attend more to words in print-salient than words in picture-salient environmental print?

(2) Are beginning readers less influenced than pre-readers by the salience of pictures in environmental print?

As found in previous eye tracker research on shared storybook reading (Justice & Lankford, 2002; Justice et al. 2005) it was hypothesized that pre-readers would attend to the words in environmental print more for print-salient forms than for picture-salient forms. Beginning readers tend to pay more attention to words than pre-readers (Masonheimer et al., 1984; Roy-Charland et al., 2007) and were expected to be less influenced by the salience of the pictures in environmental print.

Method

Participants

Thirty-eight children were invited to participate after obtaining parental consent. The children spoke English as their main language and were recruited from two preschools and the local community. Children were screened using the Kay Picture Test (2013) which is a

reliable measure of normal visual acuity (Elliot & Firth, 2009). No children were excluded following screening. The final sample consisted of 24 girls and 14 boys with a mean age of 5.42 years (range = 3.0 – 7.92 years; *SD* = 1.39).

Screening Measures

Kay Picture™ Visual Acuity Test. Children stood 3 m from a visual screening chart containing pictures (e.g., a duck) and an eye patch was placed over their left eye. The children were asked to name each picture in the vertical and horizontal column at the smallest size with central crowded pictures. Following this, the eye patch was placed over the right eye and the procedure repeated. Normal visual acuity was confirmed with children achieving the standard LogMAR scores for their age (3 years = 0.100 LogMAR; 4 to 5 years = 0.050 LogMAR; 6 years and older = 0.00 LogMAR).

Eye-Tracker Assessment

Eye-Tracker Apparatus. The Tobii TX300 Eye Tracker provided a non-invasive and accurate measure of visual attention to specific areas within a visual display (Tobii Technology, 2011). Stimuli were displayed on a 23 inch colour monitor (1920 x 1080 pixel resolution). Binocular eye movements are tracked at a sampling rate of 300 Hz, with accuracy reported as < 1° visual angle on the screen at a viewing distance of 70 cm. The eye tracker has an immediate tracking recovery for blinks and a 10-165 millisecond recovery following lost tracking.

Eye Tracker Stimuli. Eight environmental print items (BAND AID, COCO POPS, EXIT, iPhone, KFC, McDonald's, Target, and The Wiggles) commonly found in the local community were used. A digital image of each item was manipulated using picture editing software to create a picture-salient, print-salient, and standard print (colour and picture removed from the environmental print item) image. For each picture-salient and print-salient image, the word(s) (e.g., COCO POPS) of the item was presented at a constant size and

appeared in the same spatial location on each image. Any additional print in the image such as the manufacturer's name was removed. The picture-salient items were manipulated to ensure the picture (e.g., COCO POPS monkey) was four times larger in area than the words in the display. The print-salient items were manipulated to ensure the picture was four times smaller in area than the words in the display. A third condition, standard print images, consisted of the same environmental print words printed in black on a white background with no pictures. The words in the standard print images were the same size and placed in the same position as their corresponding print-salient and picture-salient images. For each type of item, the words were thus all the same size across the picture-salient, print-salient, and standard print forms with the size or presence of the surrounding contextual cues varied[1].

Eye Tracker Task. The 24 environmental print images (8 picture-salient, 8 print-salient, 8 standard print) were presented using the Tobii Studio software (Tobii Studio™ 2.X, Software Release 2.2) which also recorded the eye gaze data. The picture-salient, print-salient, and standard print images were presented on the monitor screen against a white background. At the viewing distance of 65 cm, the entire screen subtended 44.96 × 24.68° visual angle. Table 1 presents the degree of visual angle for words and pictures in each image. The 24 images were arranged into four blocks of six trials with a rest image (picture of a cartoon cat) displayed in between each block to allow participants to rest and refocus their attention on the task. Within each block, there were two picture-salient images, two print-salient images, and two standard print images selected at random without replacement from the total set of stimuli. Trial order was randomised within each block and the same sequence of items was presented to each participant. Each image was presented for 8 s with a 2 s interval showing a white screen between each image.

[1] The experimental protocol and item set was tested on a group of 22 skilled adult readers (M_{age} = 23.32 years; SD = 7.56). A repeated measures MANOVA with item type (print-salient and picture-salient) as the repeated measures factor and log10 time to first fixation, percent to total fixations, and percent of fixation duration as the eye tracking measures confirmed that the experimental manipulation influenced attention to the word area in the items, $F(3, 25) = 5.98$, $p = .003$, $\eta_p^2 = .42$.

Table 1

Degree of Visual Angle at a Viewing Distance of 65cm for the Words and Pictures in the Print-salient and Picture-salient Items

Environmental Print Item	Words	Pictures	
		Print-salient	Picture-salient
BAND AID	5.29 × .88°	1.94 × 2.12°	4.94 × 5.38°
COCO POPS	6.17 × 3.97°	2.38 × 2.56°	7.14 × 8.29°
EXIT	5.29 × 2.64°	3.09 × 2.38 °	7.76 × 6.26°
iPhone	3.09 × .88°	0.79 × 0.97°	4.85 × 8.81°
KFC	4.85 × 2.20°	1.94 × 2.20°	3.44 × 3.97°
McDonald's	10.58 × 1.76°	2.38 × 1.85°	11.12 × 9.26°
Target	7.49 × 2.20°	2.12 × 2.12°	10.67 × 10.67°
The Wiggles	4.85 × 2.64°	1.94 × 1.67°	8.11 × 7.85°

Note. The degree of visual angle for words were identical across the print-salient, picture-salient, and standard print items. Visual angle is shown as width × height.

Eye Tracker Analysis. During the 8 s presentation of an item, the Tobii studio software recorded the locations of the eye gazes at all spatial locations of the monitor display using a sampling rate of 300 Hz. Processing of the gaze data was done using the Tobii studio software. The default fixation filter settings were used (Tobii Fixation Filter; Olsson, 2007), which is based on a sliding window averaging algorithm to detect changes in gaze point. Interpolation was used for missing data sections less than 100 ms. For missing data sections greater than 100 ms, the data was separated into 100 ms subsets prior to interpolation on each subset independently. The fixation threshold was defined as the maximum distance between

two data points to be considered as part of the same fixation. It was set at 35 pixels per sample measured over 5 samples. For the 1920 × 1080 pixel monitor that was used and the 300 Hz eye tracker sampling rate, the fixation threshold thus corresponded to 2.1 pixels per ms. Furthermore, the minimum fixation duration was 5 samples (16.6 ms). The study hypotheses were related to visual attention directed at the word(s) in each picture-salient and print-salient item (the standard print items were used as filler trials and not analysed further). A *word* area of interest (AOI) was created for each item by manually drawing a rectangular border closely around the word(s). A full-screen zone of the entire display was also created for each image to quantify the total number of fixations on the whole screen during the stimulus presentation. Similar to Neumann et al. (2014) the following independent measures were measured: (a) Time to first fixation on words, (b) Percentage of total fixation count on words, calculated as number of fixations on words / total number of fixations on the screen * 100; and (c) Percentage of total fixation duration on words, calculated as total duration of fixations on words / total duration of fixations on the screen * 100. The use of percentage scores corrected for the fact that not all children fixated on the screen during the entire 8 s item presentation. The Cronbach's alpha for each of time to first fixation on words ($\alpha = .69$), percent of total fixation count ($\alpha = .67$), and percentage of total fixation duration ($\alpha = .76$) was acceptable.

Reading Assessment

Alphabet knowledge. This task assessed children's ability to identify uppercase (max = 26) and lowercase (max = 28; two forms of the letters 'a' and 'g' were presented) letters. Letters were printed in black and presented in random order on individual 8 × 8 cm white cards and children were asked to identify each letter. The correct name or sound of the letter was given 1-point and an incorrect response scored 0. Cronbach's alpha was .98 for

uppercase letters, .98 for lowercase letters, and .99 for both upper and lowercase letters. The scores for uppercase and lowercase letters (max = 54) were combined prior to analysis.

Sight word reading. Children were presented with 23 high-frequency words from Clay (2005). Children scored 1-point for each correct word (max = 23) and 0 for an incorrect response. Cronbach's alpha was .99 for the 23 words.

Environmental print and standard print reading. All children were presented with individual A4 size photographs of eight environmental print items in random order (BAND AID, COCO POPS, EXIT, iPhone, KFC, McDonald's, Target, and The Wiggles) and were asked to read the word on the item. Based on Lomax and McGee (1987), children scored 2-points for each item they read correctly, 1-point for providing a meaningful answer (e.g., "cheeseburger" in response to McDonald's) and 0 for an incorrect response (max = 16). Cronbach's alpha for the environmental print reading test was .69.

Standard print reading was assessed by presenting the same eight environmental print words printed in black manuscript form 72-point Century Gothic font on individual white cards with all contextual cues (i.e., colours and pictures) removed and asking the child to read the word. A correct response scored 2-points, a part-item response (e.g., reading 'POPS' but not 'COCO') was scored as 1-point and an incorrect response was scored as 0 (max = 16). Cronbach's alpha for the standard print reading test was .97.

Procedure

Children completed the visual acuity test, eye tracker task, and reading assessments in a single session lasting approximately 30 min in a quiet room at the university campus or the child's preschool. The visual acuity test was conducted first and was completed within 2 min. Next, children completed the 10 min eye tracker task. Each child sat 65 cm from the screen and the eye tracker was calibrated using a five-point calibration sequence in which children were presented with a picture of a cartoon cat in each corner and the centre of the display.

The researcher then provided the following instructions “Now you will be shown some things on the screen. All you need to do is look at whatever appears on the screen”. Finally, the children were administered the reading assessments over 15 min in the order of alphabet knowledge, sight word reading, environmental print, and standard print reading. After completing the session, children were given a story book in appreciation for their participation.

Results

Preliminary Analysis

Based on Masonheimer et al. (1984), children who could identify all upper and lower case letters and read four or more sight words were classified as beginning readers (*n* = 16). Children who performed below these requirements were classified as pre-readers (*n* = 20). The descriptive statistics for reading assessments for the two groups of children are presented in Table 2.

Table 2

Mean Scores for the Reading Assessments in the Pre-readers and Beginning Readers (Standard Deviations and Range in Parentheses)

	Pre-Readers (*n* = 20)	Beginning readers (*n* = 16)
Upper case letter knowledge (max = 26)	11.40 (8.44; 0-24)	26
Lower case letter knowledge (max = 28)	9.95 (8.67; 0-23)	28

Environmental print reading (max = 16)	10.60 (1.60; 8-13)	15.06 (1.53; 12-16)
Standard print reading (max = 16)	0.60 (1.14; 0-4)	12.88 (4.33; 3-16)
Sight word reading (max = 23)	0.15 (0.49; 0-2)	19.81 (6.06; 4-23)

Preliminary analysis of the eye-tracker measures showed that the environmental print item iPhone attracted unusual eye-movement patterns in comparison to all the other environmental print items. Significantly higher total fixations and total fixation duration was directed towards an irrelevant area of the item (specifically, the camera lens on the phone), than the words or picture (all $t > 7.66$, $p < .001$, $d > 1.37$). Based on the unusual visual patterns and its marked statistical influence, the iPhone item was excluded from further analyses.

Testing of normality across the dependent measures revealed that time to first fixation on words had a significant positive skew and required a Log10 transformation. The total percentage of fixations and total percentage of fixation duration on words were normally distributed, although two outliers were evident. Investigation of each case revealed that one pre-reader and one beginning reader displayed unusual behaviour. Whilst the pre-reader had no alphabetic knowledge or sight word reading ability, their total fixations and total fixation duration on words were greater than 1.5 *SD* above the mean when viewing picture-salient stimuli. The beginning reader had full-alphabetic knowledge (correctly identified all letters) and good sight word reading ability (correctly read seven words), but their total fixations on words were more than 3 *SD* below the mean when viewing print-salient stimuli. Therefore, these two outliers were excluded from the analyses.

Bivariate correlations were calculated among the three measures of log10 transformed time to first fixation, percent count of total fixations, and percent fixation duration. As shown in Table 3, all measures were significantly correlated for the same item type (print-salient or picture-salient). Due to the correlations among the measures, a 2 × 2 MANOVA was conducted with the between-groups factor of Group (pre-readers and beginning readers) and the within-subjects factor of Item type (print-salient and picture-salient) for the three dependant measures. All assumptions of the MANOVA were met. Simple effects analysis to examine significant interactions employed *t*-tests with a Bonferroni correction (α') to protect against inflated Type I error. The familywise error rate was set at $\alpha = .05$.

Table 3

Bivariate Correlations among the Eye Tracker Measures for Print-salient and Picture-salient Items

	1	2	3	4	5	6
1. Print-salient log10 time to first fixation	-	-.33*	-.38*	.37*	-.31*	-.39*
2. Print-salient percent of fixations		-	.68**	-.25	.47**	.48**
3. Print-salient percent fixation duration			-	-.50**	.62**	.50**
4. Picture-salient log10 time to first fixation				-	-.53**	-.48**
5. Picture-salient percent of fixations					-	.76**
6. Picture-salient percent fixation duration						-

* $p < .05$, ** $p < .01$

Visual Attention to Words in Environmental Print

The mean scores in the pre-reader and beginning reader groups are shown in Figure 1 (log10 time to first fixation), Figure 2 (percent of total fixations), and Figure 3 (percent of total fixation duration). As also shown in Table 4, there were differences between the reading groups and between the item types for all eye tracking measures. Analyses using a 2 × 2 (Group x Item Type) MANOVA confirmed these impressions with a multivariate main effect of group, $F(3, 32) = 66.69$, $p = .001$, $\eta_p^2 = .39$, and main effect of item type, $F(3, 32) = 17.38$, $p < .001$, $\eta_p^2 = .62$. The group × item type interaction was also statistically significant, $F(3, 32) = 3.57$, $p = .025$, $\eta_p^2 = .25$.

Further analyses examined interaction components for group and item type separately for each measure by comparing print-salient and picture-salient stimuli in each of the pre-reader and beginning reader groups. A Bonferroni correction for 6 comparisons ($\alpha' = .008$) was applied to these analyses. Log10 time to first fixation was not significantly different between print-salient and picture-salient items in pre-readers, $t(19) = 0.38$, $p = .71$, $d = 0.08$, or beginning readers, $t(15) = 0.78$, $p = .45$, $d = 0.19$. For percent of total fixations on words, significantly more fixations occurred for print-salient items than for picture-salient items in pre-readers, $t(19) = 8.51$, $p < .001$, $d = 1.90$. In contrast, this difference was substantially reduced in magnitude and not statistically significant in beginning readers, $t(15) = 2.30$, $p = .04$, $d = 0.56$. A similar pattern emerged for percent total fixation duration. Pre-readers fixated significantly longer on words for print-salient items than for picture-salient items, $t(15) = 3.78$, $p = .001$, $d = 0.85$. In contrast, there was no significant difference between print-salient and picture-salient items for beginning readers, $t(15) = 1.90$, $p = .08$, $d = 0.47$.

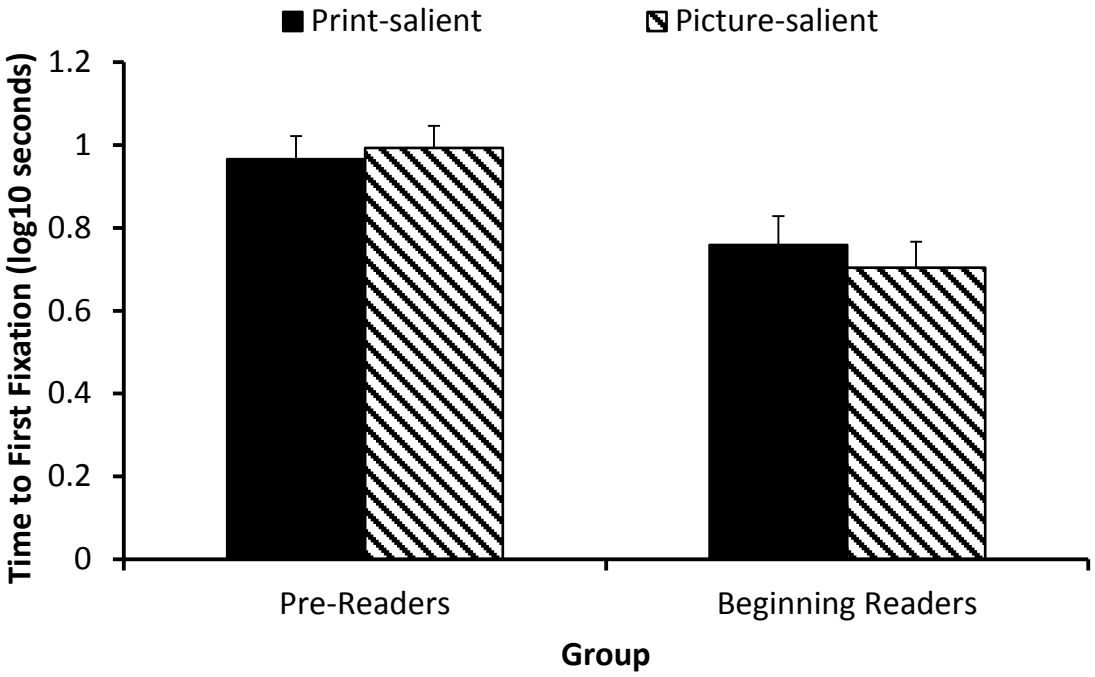

Figure 1. Mean time to first fixation on words for print-salient and picture-salient items in both reading groups. Error bars represent standard error of the mean.

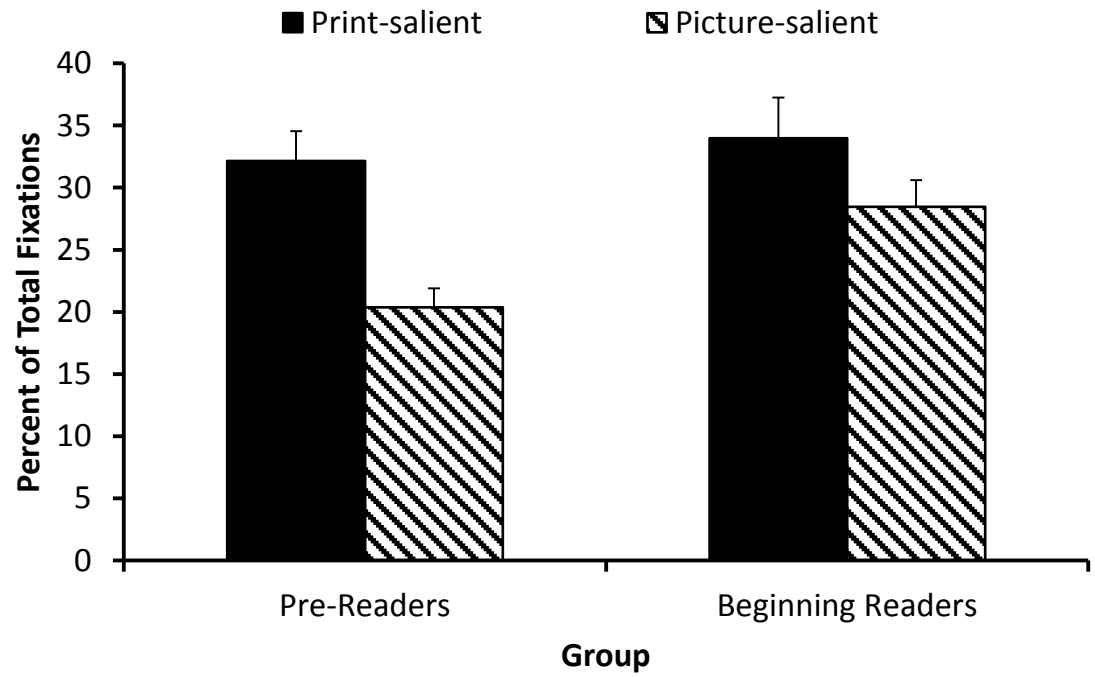

Figure 2. Mean percent of total fixations on words for print-salient and picture-salient items in both reading groups. Error bars represent standard error of the mean.

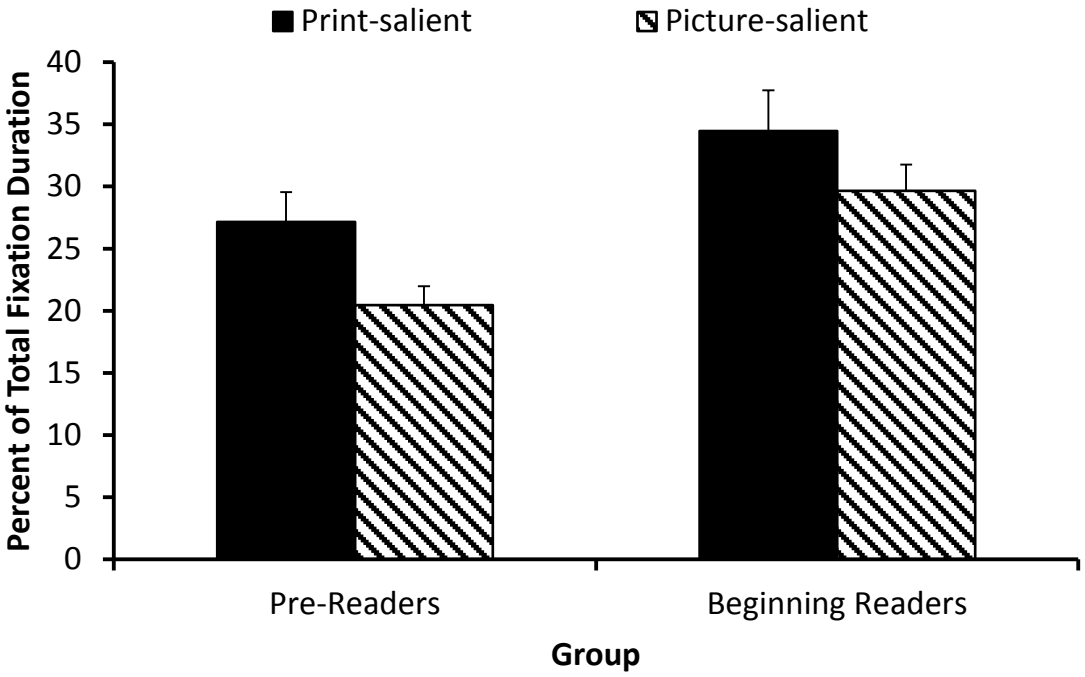

Figure 3. Mean percent of total fixation duration on words for print-salient and picture-salient items in both reading groups. Error bars represent standard error of the mean.

Table 4

Mean Log10 Time to First Fixation, Percent of Total Fixations, and Percent of Total Fixation Duration on Words for Print-salient and Picture-salient Items in both Reading Groups (Standard Deviations are in Parentheses)

Measure	Pre-Reader Group		Beginning Reader Group	
	Item Type		Item Type	
	Print-salient	Picture-salient	Print-salient	Picture-salient
Log10 time to first fixation	0.97 (0.24)	0.99 (0.22)	0.76 (0.25)	0.70 (0.25)
Percent of total fixations	0.32 (0.06)	0.20 (0.05)	0.34 (0.10)	0.30 (0.06)

Percent of total fixation duration	0.27 (0.07)	0.20 (0.06)	0.34 (0.09)	0.30 (0.10)

Discussion

The present study extended previous eye tracker research by examining attention to environmental print in pre-readers and beginning readers. In addition, the effect that the size of the contextual cues has on attention to the words in environmental print was examined. No research employing eye tracker methodology currently exists which has examined the effects of these two factors on attention to environmental print. Without prompts, pre-readers and beginning readers attended to words embedded within environmental print and as expected, beginning readers attended more quickly to words in print-salient and picture-salient environmental print than did pre-readers. As measured by number of fixations and fixation duration, pre-readers attended significantly more to words in print-salient items than for picture-salient items. In contrast, this difference was smaller for beginning readers such that there was no significant difference between attention to words in print-salient and picture-salient items. This suggests that beginning readers' apparent affinity for print reflects emerging attention for its information content, an appreciation not yet fully developed in pre-readers.

Print-salient and picture-salient effects

Attention to environmental print words differed as a function of both reading ability and size of the words relative to the contextual cues. Consistent with our predictions and previous eye tracker research with story books (Justice & Lankford, 2002; Justice et al., 2005) pre-readers attended more to words in print-salient environmental print than in picture-salient environmental print. Being logographic readers, enlarging the words relative to the pictures appears to have lessened pre-readers' attention towards the contextual cues. This

suggests that using environmental print with large words relative to the picture is better at enhancing pre-readers' visual attention towards words.

However, when the environmental print was presented as picture-salient items, pre-readers attended less to the words indicating that the contextual cues were more engaging to look at than the print. It is also possible that during the process of gaining meaning from environmental print, visual cues distract pre-reader's attention to words as highlighted by Masonheimer et al. (1984). Therefore, guided experiences with environmental print (Reutzel, Fawson, Young, Morrison, & Wilcox, 2003) may be necessary to maintain pre-reading children's visual focus on the words. For example, parents or educators could point to the words embedded within environmental print to direct pre-readers attention to words and letters (e.g., Neumann, Hood, & Neumann, 2009; Neumann & Neumann, 2010; Neumann, Hood, & Ford, 2013).

Beginning readers' attention to words in environmental print was less influenced by the contextual cues. In other words, beginning readers were less likely than pre-readers to have their attention drawn away from the print by logos. Beginning readers had mastered letter name and sound knowledge with most being able to read environmental print words in context (on average 94% correct) and environmental print out of context (on average 81% correct). Their emerging ability to read words may have stimulated their attention towards print and prompted them to preferentially seek out and analyse words. It is possible that beginning readers' knowledge about the print may have increased their attention to words allowing them to discriminate between features of environmental print, employing print rather than pictures to gain meaning. Although speculative, these findings suggest that using environmental print may help foster beginning readers' word knowledge regardless of whether the words are printed in small or large sized font.

Practical implications

The main finding of the present study is that attention to words in environmental print differs depending on reading ability and the size of the word relative to the contextual cues. This finding is particularly important for pre-readers who are progressing through the pre-alphabetic phase (Ehri, 2005) of reading development. Masonheimer et al. (1984) emphasised that environmental print on its own does not lead children into word reading. Therefore, pre-readers may benefit from guided instruction during experiences with environmental print in order to foster reading growth. Our findings indicate that pre-readers' attend more to words in print-salient than picture-salient environmental print. In order to capitalise on pre-readers' attention to print-salient environmental print it is recommended that educators select environmental print where the words are larger than the contextual cues (pictures/logos). Using large-sized environmental print words would also allow pre-reading children to focus on analysing letters and enable them to engage in multisensory activities such as tracing letter shapes with their fingers to help consolidate learning of letters and words (Neumann et al., 2013).

In contrast to pre-readers, beginning readers who already possessed alphabetic and word decoding skills visually attended to environmental print words regardless of whether words were large or small relative to the contextual cues. Therefore, educators may use a range of environmental print containing large and small sized print during reading activities with beginning readers. For example, the back of cereal boxes are printed with a wide range of words and this print can be used to enhance vocabulary and spelling skills. Children could be encouraged to segment environmental print words into phonemes, blend them together and spell them. Ehri (2014) highlights the importance of practicing decoding skills in order to foster spontaneous orthographic mapping. Using environmental print as a reading resource may facilitate this.

Limitations and Future Research

In light of the current findings it is important to outline certain limitations of the present study. Firstly, during the eye tracker task, the participants were not required to make any specific response to the visual stimuli. Therefore, it is possible that the attention to features of the stimulus may have been initiated by children's idiosyncratic choices rather than by specific task demands. Therefore, future studies may address this by incorporating a naming task, for example, into the eye tracking procedure to ensure that all features of the test stimuli (e.g., words/logos) are driving attention. Secondly, it is important to test a wider range of environmental print items from a range of communities and cultures to strengthen the generalizability of the current findings. Other physical characteristics of environmental print, such as the location, colour, and font type of the words may also influence attention. For instance, the faces of "The Wiggles" characters and their colourful clothing may be more engaging than the simple image on the BAND AID box. Examination of a greater variety of systematically manipulated contextual cues will help determine the effects of these factors on attention to words.

More comprehensive and longitudinal research is also required that follows changes in children's attention to environmental print across each of the phases of reading development from pre-school into the school years. As speculated by Neumann et al. (2014), the current study confirms the importance of emphasising the size of the environmental print words in order to enhance pre-readers' engagement with print. A pre-post-test designed intervention study that compares the instructional use of either print-salient or picture-salient environmental print to enhance early reading skills would determine the types of environmental print that are most beneficial for pre-readers and beginning readers. These findings would also help inform early childhood educators of the best ways to utilise environmental print as a literacy learning resource.

Conclusion

The present study showed that the salience of contextual cues influenced attention to environmental print words. Pre-readers attended more to words in print-salient environmental print whereas the size of the word relative to the contextual cues did not affect beginning readers' attention. This suggests that using larger environmental words relative to the contextual cues may be better at stimulating pre-reader's attention to words. However, environmental print containing large and small sized words is suitable for beginning readers and could be a useful resource for practicing decoding skills and word learning.

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