

## Media Form Effect on Children's Attention

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**Abstract**—Picture books are frequently used as teaching materials and have thus been published in diverse media forms. By exploiting visual, auditory, and tactile modalities, children can construct a reading context in which their attention is enhanced and they can learn effectively. In this study, picture books of various media forms are used as stimuli for examining the effect of various picture book types on children's attention. On the basis of the results of this study, the audiobook group demonstrates the highest attention performance. In the gender difference, a significant difference in attention response exists between the boys and girls. In particular, the attention performance of the boys is significantly higher than that of the girls in the e-book group.

**Keywords**—children's attention; picture books; media forms; electroencephalography (EEG).

### I. INTRODUCTION

Picture books are one of the most commonly used teaching materials from preschool to elementary school [1]. Because picture books are designed for children, they cater to children's characteristics and have features that are relevant to language development [2], cognitive engagement [3], artistic thinking, and entertainment [4]. The senses are used to communicate with the external world during early reading development in children. Various types of sensory stimulation help children construct a reading context, which enables children to learn independently [5]. Picture books are published in various media forms; thus, information contained in books can be expressed by text, images, symbols, sounds, and texture. Accordingly, children who easily receive sensory signals can directly communicate with the external world in visual, auditory, and tactile manners [6]. For example, pop-up books featuring three-dimensional (3D) images and operable interfaces, audiobooks with voice dubbing and sound, toy books comprising various tactile materials, and e-books containing multimedia animation can appeal to the senses of children and enhance their comprehension of the content.

This study determines that effectively using picture books that provide sensory stimulation to instruct children can enhance their attention and learning performance. Numerous studies on picture book instruction have revealed that picture books can increase children's interest in learning.

According to previous electroencephalography (EEG) studies [7][8], attention is a type of brain function, and based on the activation of the cerebral frontal lobe,  $\alpha$  and  $\beta$  waves

can be measured to investigate the degree of attention in learning. The EEG device, is used in the EEG experiment in this study for measuring children's attention. We anticipate that the results of this study can be applied to children's education and picture books design, help parents, teachers and designers select and design picture books for children, and improve the attention of children.

The research report comprises the following five sections: (1) introduction, (2) media forms of picture books, (3) experimental design, (4) quantitative analysis, and (5) conclusion.

### II. MEDIA FORMS OF PICTURE BOOKS

In the current mature publication market, because of reader sensory requirements and improved multimedia technology, the content of picture books is presented through text, illustration, symbols, and multimedia (e.g., various book materials, sounds, music, and animation), and diverse sensory stimuli and reading methods are used to attract children's attention and interest. Picture books are not limited to a two-dimensional (2D) design and are integrated media that provide various sensory stimuli. According to previous studies, picture books can effectively help children develop their language, cognitive, and aesthetic appreciation abilities [2][3].

This study explores the selection of picture books and media types of picture books that suit children and attract their attention. We collect the various forms of picture book designs that are currently commercially available. These picture books are then classified into four types according to the sensory perception methods used when reading books, as determined by a focus group of three designers with more than 5 years of design experience. These four types are (a) conventional book (visual perception), which is the most common book format and involves page turning when reading; (b) pop-up book (visual and tactile perceptions), which transcends the limitations of conventional books by including interactive components to present 3D concepts, thereby providing an enjoyable and interactive reading experience; (c) audiobook (audial and visual perception), which offers a multimedia presentation of the traditional storybook format with the addition of speech feedback (e.g., CD and MP3 formats) so that children can elect to hear the story read to them; and (d) e-book (multisensory perception), which includes multimedia effects such as oral reading, written text, oral discourse, music, sound effects, and animations, thereby enriching the content of picture books.

### III. EXPERIMENT DESIGN

An EEG experiment is conducted to investigate whether sensory stimulation provided by conventional books, pop-up books, audiobooks, and e-books affect children's attention performance.

#### A. Experimental Participants and Procedures

48 third-grade elementary school children aged 9 to 10 years are recruited as participants in this study. The participants are evenly divided into four groups (12 in each group). Each group comprises 6 boys and 6 girls. The participants are divided into four groups: the conventional book, pop-up book, audiobook, and e-book groups. The experimental procedure is as follows:

- Step 1: The researcher explains the purpose and procedure of the experiment to a participant and advises the participant to relax.
- Step 2: The researcher places an EEG cap on the head of the participant.
- Step 3: The participant begins reading a picture book from the first page. During the EEG measurement, the participant continues to read until he or she reaches the end of the book. The reading duration is not fixed.

#### B. Experimental Tool

In this study, the EEG device, NeuroSky MindBand [7], is used for the EEG experiment. The sensors of the device are placed at the frontopolar (FP1) area of the forehead, which is the frontal lobe area of the attention network, to measure attention performance [8][9]. MindBand is lightweight, stable, easy to wear, and highly appropriate for children. Unlike a traditional EEG device, MindBand does not require wearing an electrode cap, applying gel, or washing hair after testing. For convenience, NeuroSky MindBand and related products are widely applied in EEG studies on education, psychology, and sports [10][11][12].

#### C. Electroencephalographic Data Collection

In the EEG experiment, we collect the EEG data of the participants while they read the books. Combined with the MindBand, a Universal Serial Bus (USB) brain-wave assessment and measurement system developed by Alchemy Technology [7] is used to collect data. The data is ranged from 0 to 100, enabling the collection of real-time information and analysis of EEG signals. Through the USB transmission hardware interface, the EEG charts and data on visual attention state are output [13].

#### D. Picture Book: *Guess How Much I Love You*

To prevent the story content and children's comprehension of the story content from affecting the attention performance of the children, a focus group method (based on the discussion of three language teachers at an elementary school) is employed for determining the use of the conventional book,

pop-up book, audiobook, and e-book versions of *Guess How Much I Love You* [14].

### IV. QUANTITATIVE ANALYSIS

A total of 48 children participate in this experiment and are assigned to four groups of 12 people each. The average score of all the participants for attention is 44.02. According to the average score of each group, the audiobook group exhibits the highest attention performance (52.92), followed by the e-book group (42.17), pop-up book group (41.42), and conventional book group (39.58).

#### A. Picture Book Media Types Independent Samples *t*-Test between Gender

An Independent Sample *t*-Test [15] is performed to examine whether a significant difference in attention response induced by picture books exists between the boys and girls. As shown in Table I, the number of boys is 24 and the average score is 52.08; the number of girls is 24 and the average score is 35.96. The *t* value is 2.60 ( $df = 46$ ,  $p < 0.01$ ), which is significant. Thus, a significant difference in average attention score exists between the boys and girls. The *t* value is a positive value (2.60), indicating that the attention performance of the boys are superior to that of the girls.

TABLE I. INDEPENDENT SAMPLES T-TEST OF GENDER

Gender	t	df	Sig.
	2.60	46	*0.01

Independent Sample *t*-Tests are performed to examine whether differences in attention response exist between the boys and girls in the various groups. As shown in Table II, a significant difference in attention response exists between the boys and girls in the e-book group ( $p < 0.01$ ). The *t* value (3.36) is a positive value, indicating that for the e-book group, the boys demonstrate a significantly higher performance than the girls (the average score for boys is 57.83, and the average score for girls is 26.50). No significant difference in attention response exists between the boys and girls in the other groups.

TABLE II. T-TEST OF GENDER FOR VARIOUS MEDIA PICTURE BOOKS

Media Forms	t	df	Sig.
Conventional	0.92	10	0.38
Pop-up	0.30	10	0.77
Audiobook	1.32	10	0.22
e-book	3.36	10	*0.01

#### B. The interaction effect between media forms and gender: Two-Way ANOVA (MANOVA)

To examine whether an interaction effect between media forms of picture books and gender on attention response exists, a two-way ANOVA is performed. Table III summarizes the results of the two-way ANOVA. As shown in Table III, the F

value of the group effect is 0.93 ( $p < .44$ ), indicating that no significant difference in attention response exists between the various groups.

TABLE III. THE INTERACTION EFFECT OF MEDIA FORMS AND GENDER

Source	SS	df	MS	F	Sig.
Media forms	1308.56	3	436.19	0.93	0.44
Gender	3120.19	1	3120.19	6.63	*0.01
Media forms * Gender	1149.40	3	383.13	0.82	0.49
Error	18812.83	40	470.32		
Corrected Total	24390.98	47			

The F value of the gender effect is 6.63 ( $p < .01$ ), indicating that a significant difference in attention response exists between the boys and girls. In addition, the attention performance of the boys is superior to that of the girls. The results are consistent with those presented in Section IV-A. The F value of the interaction effect of gender and group is 0.815 ( $p < .49$ ), indicating that no interaction effect between gender and group on attention response exists.

## V. CONCLUSION

In this study, third-grade elementary school children are recruited as participants for examining the relationship between children's attention and picture book reading. MindBand is used in the experiment to collect EEG data from the participants reading various picture book types.

Considering the attention performance of the boys, the audiobook group exhibits the highest attention performance, followed by the e-book group, conventional book group, and pop-up book group. Considering the attention performance of the girls, the audiobook group achieves the highest attention performance, followed by the pop-up book group, conventional book group, and e-book group. Both the boys and girls in the audiobook group display excellent attention performance. The result shows that audiobooks should be selected to help children establish reading contexts using the acoustic stimuli provided by reciting story contents, thus improving their reading comprehension and concentration [16][17].

For the e-book group, the attention performance of the boys is significantly higher than that of the girls. The results suggest that visual and auditory stimulation provided by the e-book elicit excellent attention performance in the boys. The auditory stimulation provided by the audiobook elicits excellent attention performance in the girls, whereas dynamic visual stimulation provided by the e-book elicits the poorest attention performance in the girls. The result show multimedia effects of audiobook and e-book with immediate feedback might help male learners to increase attention and comprehension [18].

According to the results of this study, we suggest that the audiobooks can be adopted to instruct third-grade elementary school children in reading to enhance the attention performance of children. Audiobooks and e-books that provide auditory and visual stimulation can be used to instruct

boys and audiobooks can be used to instruct girls. The results of this study can serve as a reference for parents, teachers and designer to select and design picture books and to enhance the attention of children.

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## REFERENCES

- [1] R. Barr, "Memory Constraints on Infant Learning from Picture Books, Television, and Touchscreens," *Child Development Perspectives*, vol. 7, 2013, pp. 205-210.
- [2] A. G. Bus, M. H. van IJzendoorn, and A. D. Pellegrini, "Joint book reading makes for success in learning to read: a meta-analysis on intergenerational transmission of literacy", *Review of Educational Research*, vol. 65, 1995, pp. 1-21.
- [3] I. Elia, M. van Den Heuvel-Panhuizen, and A. Georgiou, "The role of pictures in picture books on children's cognitive engagement with mathematics," *European Early Childhood Education Research Journal*, vol. 18, 2010, pp. 125-147.
- [4] M. Y. Lin, *Appreciation and application of picture books*, Taipei: Psychological Publishing, 2000.
- [5] J. Holt, "The underachieving school," Sentient Publications, 2005.
- [6] C. Briggs and D. Elkind, "Cognitive development in early readers," *Developmental Psychology*, vol. 9, 1973, p. 279.
- [7] Alchemy Technology: <http://www.alchemytech.com.tw/>.
- [8] M. B. Serman, D. A. Kaiser, C. A. Mann, B. Y. Suvenobu, D. C. Bevma, and J. R. Francis, "Application of quantitative EEG analysis to workload assessment in an advanced aircraft simulator." In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, vol. 37, 1993, pp.118-121.
- [9] A. Gevins, M. E. Smith, L. McEvoy, and D. Yu, "High-resolution EEG mapping of cortical activation related to working memory: effects of task difficulty," type of processing, and practice, *Cerebral Cortex*, vol. 7, 1997, pp. 374-385.
- [10] J. I. Ekandem, T. A. Davis, I. Alvarez, M. T. James, and J. E. Gilbert, "Evaluating the ergonomics of BCI devices for research and experimentation. *Ergonomics*", vol. 55, 2012, pp. 592-598.
- [11] D. V. Poltavski, D. Biberdorf, and T. V. Petros, "Accommodative response and cortical activity during sustained attention," *Vision research*, vol. 63, 2012, pp. 1-8.
- [12] C. S. Lin, Y. C. Lai, J. C. Lin, P. Y. Wu, and H. C. Chang, "A novel method for concentration evaluation of reading behaviors with electrical activity recorded on the scalp." *Computer methods and programs in biomedicine*, vol. 114, 2014, pp. 164-171.
- [13] K. Crowley, A. Sliney, I. Pitt, and D. Murphy, "Evaluating a brain-computer interface to categories human emotional response", In *Advanced Learning Technologies, 2010 IEEE 10th International Conference*, July 2010, pp. 276-278.
- [14] S. McBratney, *Guess how Much I Love You*, Candlewick Press, 2000.
- [15] H. Timothv. and R. D'Agostino, "Robustness of the two independent samples t - test when applied to ordinal scaled data. " *Statistics in medicine*, vol. 6, 1987, pp. 79-90.

- [16] M. Furini, "Digital audiobook: from passive to active pursuit," *Multimedia Tools and Applications*, vol. 40, 2008, pp. 23-39.
- [17] C. C. Lu, Y. Y. Chen, and C. W. Chen. "A Correlative study of CD-ROM picture books in classrooms and school children's formation of descriptive concepts." *International Journal of Science and Mathematics Education*, vol. 9, 2011, pp. 47-67.
- [18] S. P. Lee, H. K. Su, and S. D. Lee. "Effects of computer-based immediate feedback on foreign language listening comprehension and test-associated anxiety," *Perceptual and motor skills*, vol. 114, 2012, pp. 995-10