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Lin, Yung-Chun
Kyushu University, Graduate School of Design | Kyushu University, Faculty of Design

Ihara, Hisayasu
Kyushu University, Graduate School of Design | Kyushu University, Faculty of Design

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An Analysis of Visual Communication in Science Picture Books by Visual Social Semiotics Approach

Yung-Chun Lin* and Hisayasu Ihara **

** Kyushu University, Graduate School of Design*
Japan, junlin404@yahoo.co.jp
*** Kyushu University, Faculty of Design*
Japan, ihara@design.kyushu-u.ac.jp

Abstract: Unlike the reading experience of fictional picture books is to enjoy the story, the reading experience of science picture books is to join the story. In order to link the knowledge with children's experience, it has developed a unique process to communicate with children. In this paper, a science picture book, *Paper Plane* is analyzed to discover how science picture books communicating with young readers. The analysis of visual text and verbal text is respectively based on the interpersonal meaning of visual social semiotics developed by Kress and van Leeuwen and the specific words used in science picture books, called "trigger words", in Takigawa's research. The results of our analysis shows that not only words can trigger readers but also images. We can see how verbal texts and visual texts working together to lead young readers to link their daily life experience with the world of science picture books.

Key words: Science picture books, Information picture books, Science education, Visual social semiotics.

1. Introduction

There is a kind of special genre called "science picture book" or "information picture book." in children's literature. Broadly speaking, science picture books are picture books dealing with all kinds of specific phenomena in our world, including nature science, social science and human science. Pappas (2006) states that information picture books include only certain topics: animals (or plants); objects (machines, weather, states of matter); and places (city port, zoo, park). Nevertheless, it refers to nature science picture books in most cases. (Takigawa, 2002; 2006) Although there are many science books use both words and pictures to convey science information, not all of them can be called science picture books. The biggest difference between science picture books and other kinds of science books with pictures, for instance, illustrated handbook, is that a science picture book always focusing on one main topic and express it by a narrative way. Like fictional picture books, science picture books also have the beginning, middle and the end (Takigawa, 2006; Kako, 1999), but the plots in science picture books are more similar to process used in science inquiry conducted by scientists. (Pappas, 2006) Therefore, science picture books not only convey science information, but also train young readers scientific inquiry ability. (Kako, 1999)

According to the description above, two aspects have to be considered when discussing science picture books. One is communicating science information to young readers and inducing them to think by themselves and with the function of science education. The other is that the essence of science picture books is the same with other picture books, it has complete narrative structure and the words and the illustrations are related to each other.

This paper attempts to elucidate how science picture books work by analyzing the verbal and visual texts used in them, especially visual text. For this purpose, we will try to analyze visual texts by the approach of visual social semiotics (Kress and van Leeuwen, 1996) and verbal texts based on Takigawa' s research (2006) on characteristic words in science picture books. In order to determine the design point of science picture books we have to first consider the reading model of children and the communicating model of science picture book authors.

2. The Reading and Communicating Model

2.1 The Reading Model of Children

According to cognitive psychology, young children's knowledge about our world is not a collection of fragmentary facts but a system of "theory", called "naïve theory" or "misconception", inducing from their daily experience (Takahashi, 1996, pp.7-8). Of course it's different from the "theory" we used in science, it's just systemizing day-to-day phenomena by their instincts without scientific inquiry process (Inagaki, 1996, p.63). For example, the understanding of young children about the relation between earth and sun is similar to Ptolemaic system. This is because what they see everyday is the sun rising in the morning, setting in evening and what they walk everyday is flat earth ground (Imai and Nojima, 2003, p.106). It is easy to lead them to the result of the sun is rotation around the flat earth.

Children acquire knowledge through learning activities and transform naïve theory to refined theory. Knowledge acquisition includes two kinds of forms: enrichment and restructuring. Enrichment is adding new information on existing knowledge to let the knowledge become more mature. Restructuring is discarding misconception and accepting a different theory (Imai and Nojima, 2003, p.104). The behavior of reading science picture books can be considered as a science learning activity. Therefore we can use the theory above to build the reading model like figure 1.

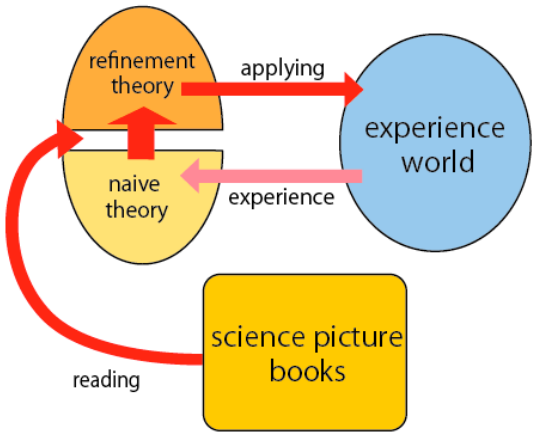

Figure 1 Reading Model of Children

Children get naïve theory from "experience world" or we can say from daily life. They acquire knowledge when reading science picture books and the naïve theory become refinement theory (although it's still immature, it's more refined than naïve theory). After the reading, they can bring the knowledge they learned in science picture books to their daily life. In other words, we can say that children experience theory transformation when reading science picture books.

2.2 The Communicating Model of Science Picture Books Authors

Since science picture books can be considered as a kind of science communication media, we can refer to science communication theory for building the communicating model. According to science communication theory, to convey science information, concept or theory is not only the moving of knowledge but also includes a transformation process of knowledge. It always has to use a lot of intricate formulas and science terms to interpret science theory precisely. They are always hard to understand for public. The transformation process is to simplify those theories by using daily language instead of science terms and using the method of analogy and contrast to add science theories into daily life context. The transformation consequently accompanies the lost of information and the decline of precision, so it is important to decide which part of theory is not so important that it can be discarded. (Hirono, 2008, p.125)

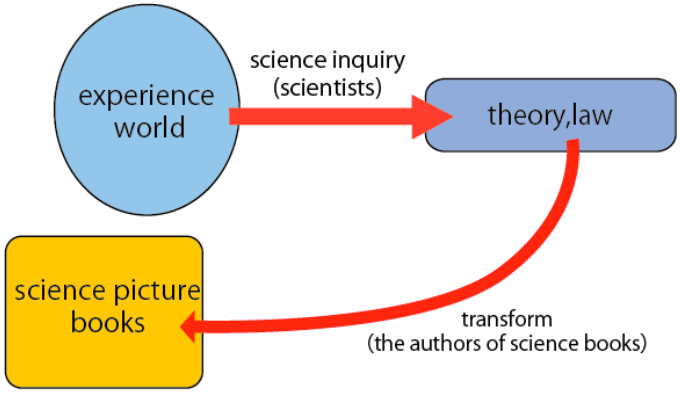

Figure 2 Communicating Model of Science Picture Books Authors

The communicating model refers to science communication theory is shown as figure 2. The scientists build theories or laws from experience world through science inquiry process, a process of observing, proposing hypothesis and proving. The authors transform the laws, theories and inquiry processes to the "language" which children can understand and use the media picture book to show them.

What we can see from the reading model and communicating model of science picture books is the authors trying to lead young readers establishing a link between experience of daily life, science knowledge and their way of thinking by reading science picture books. Unlike the reading experience of fictional picture books that is to enjoy the story, the reading experience of science picture books is to join the story. Therefore, the interaction between science picture books and young readers is so important. This paper will analyze the visual and verbal elements of a science picture book in order to establish a method to find out how science picture books interact with readers.

3. Theoretical Background

3.1 Characteristic Words in Science Picture Books

Takigawa's research (2006) on science picture books has concluded that authors often use specific words to induce readers reminding of their daily life, paying attention on pictures or thinking about something. He called those words "trigger words" because they trigger the thinking and acting of readers. Takigawa also divide trigger words into two different groups by the act they want readers to do: thinking or paying attention. For example, the authors use "have you seen," "do you know" to induce readers thinking of their experience; use "how," "why," to require readers giving some assumptions or finding the answer by themselves; and use "here are," "see carefully" to let readers pay attention on pictures. The words (or sentences) "have you seen," "do you know," "how," "why," are in the first group, thinking, and "here are," "see carefully" are in the second group, paying attention.

Excepting trigger words in Takigawa's research, the verbal elements in science picture books also include normal narrations like other picture books do. If we consider the relationship between verbal texts and readers we will see that comparing to narration words, trigger words have more interaction with readers. Therefore, we can divide the verbal elements in science picture books according to the way they interacting with readers like figure 3.

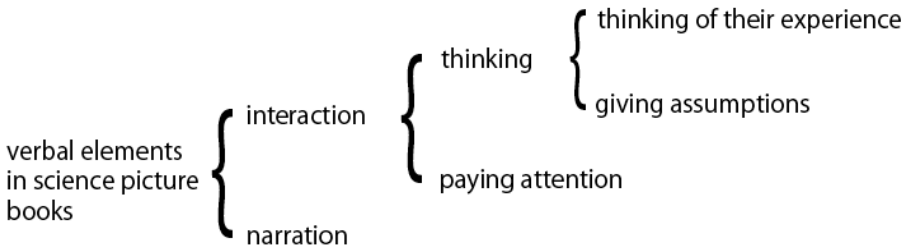

Figure 3 Verbal Elements in Science Picture Books

3.2 Visual Social Semiotics

Visual social semiotics is an analysis method of visual communication, developed by Kress and van Leeuwen (1996) based on Holiday's systemic functional linguistic (henceforth SFL). SFL theory deals language as a social semiotic process and provides a model of how contextual variables, field (what the text treat), tenor (who is communicating) and mode (by what means the message is transmitted) determine the choices in the linguistic system (Moya and Pinar, 2008). Kress and van Leeuwen (1996) refer to those contextual variables of SFL and turn them into representational (the relationship between elements depicted in images), interpersonal (the interaction between the producers and viewers of images) and compositional (the placement of the elements in images) meanings of images. Since the purpose of this paper is to discover how science picture books interact with young readers, we will focus on interpersonal meaning of image in our analysis.

When we communicate with someone face-to-face, we can receive the person's message by his/her body languages and give some reactions. For example we respond to a friendly smile with a friendly smile or to an arrogant stare with a deferential lowering of the eyes (Kress and van Leeuwen, 1996). Those body languages are a kind of social institutions and if an image is made in the context of social institutions we can understand how the

author addresses us whether or not we identify with the way we are addressed. The study of interpersonal meaning of image will explicate the visual techniques used to address the viewers in images.

According to Kress and van Leeuwen (1996), the formation of interactive meanings in images includes four basic characteristics: the gaze, the size of frame, and the vertical and horizontal angle of view. The visual elements' (usually human or animals) gaze demand the viewers enter into some kind of imaginary relation with him/her, addressing the viewers with a visual "you". Images without gaze communicate with viewers by a less strong way, they tend to just offer some information instead of "do" something to the viewers. The size of frame, the choice between close-up, medium shot and long shot, shows the degree of social distance and intimacy between the visual elements and the viewers. Close-ups generate involvement with the characters by showing us visual elements' facial expression; medium shots tend to emphasize the relationship between elements and viewers; and long shots imply objectivity and distance (Nodelman, 1988). The horizontal angle presents the involvement of the viewers: a frontal point of view means the viewers are involved in the image's world but an oblique point of view shows the viewers are detached from the image's world. Finally, the vertical angle reveals power relationships between visual elements and viewers: the visual elements are seen from the high angle suggests the viewers have power over the elements and vice versa. An eye-level angle implies a sense of equality between the visual elements and viewers (Kress and van Leeuwen, 1996).

4. The analysis

4.1 The analysis material

This paper will make an analysis on a science picture book, *Paper plane*, written by Kobayashi Minoru and illustrated by Hayashi Akiko. The book is selected from children's science books bestselling list in the online bookstore amazon.jp and the awareness of the authors is also considered. Kobayashi Minoru is one of the famous science educators and takes an important position in science picture books history in Japan (Takigawa, 2002). Hayashi Akiko is a world famous picture books author; *Miki's First Errand* is her representative work.

Paper plane is a picture book about simple fluid mechanics that children can encounter in their daily life: flying paper planes. The book shows children flying paper planes with different wing shapes will get different flying results by the play of three main characters (two boys and one girl). The narrative structure of this book is shown as below.

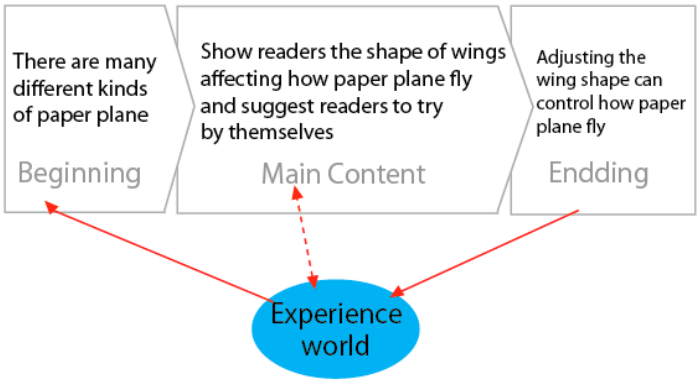

Figure 4 The Structure of *Paper Plane*

4.2 Method of Analysis

As previously stated, the analysis of verbal text will be based on Takigawa's trigger words (2006) and the analysis of visual text will be based on interpersonal meaning of visual social semiotics (Kress and van Leeuwen 1996). The characteristics of visual and verbal elements will be recorded respectively. In order to simplify the recording, I will give each characteristic an abbreviation notation. The analysis will be followed next few steps:

1. Dividing the picture book into visual part and verbal part. Besides, in *Paper plane,* the visual part can be divided into people (P, the three children) and object (O, the paper plane). This is because the play of children and the describing of paper plane are two parallel message lines.
2. Based on the characteristic words in science picture books, the verbal text can be classified by the function they have: suggesting readers to do something (Aa); making readers to think of the answer (At); evoking readers their experience (Ae) and narration (N).
3. According to the interpersonal meaning in visual social semiotics, each visual element will have three (if the element doesn't have eyes) or four characteristics: the gaze (G); the size of frame (S); vertical angle (V) and horizontal angle (H).
4. Making a recording table. The picture book will be divided into front cover, back cover, title page and thirteen different scenes in this table. Filling the table by recording the function of verbal text and the variation of visual characteristics of each page.

4.3 Result of Analysis

4.3.1 Recording Result

The recording result of *Paper plane* is showing as table 1:

Table 1 The recording of *Paper plane*

page			front cover	title page	2,3	4,5	6,7	8,9	10,11	12,13	14	15	16,17		18,19		20	21	22,23	back cover
scene					1	2	3	4	5	6	7	8	9		10		11	12	13	
verbal text					N,At	N	N	Aa,At	Aa,N	Ae,N	×	Aa,N	Aa,At,N		At,Aa		At,Aa	×	N	
visual text	P	G	ng	g	×	ng	ng	×	ng	ng	×	ng	×	ng	×	ng	ng	×	ng	ng
		S	long	mid		mid	mid		clo	mid		mid	clo	mid	clo	mid	clo		long	mid
		V	high	eyel		eyel	eyel		eyel	eyel		eyel	eyel	eyel	top	eyel	eyel		eyel	eyel
		H	frt	frt		frt	frt		frt	frt		frt	frt	frt	frt	frt	frt		frt	back
	O	S	clo	×	clo	clo	clo	×	×	×	clo	×	clo		clo		×	clo	×	×
		V	high		high	eyel	eyel	top			top		eyel		top			eyel		
		H	frt		frt	frt	frt	×			frt		frt		frt			frt		
part of the book			beginning			main content													ending	

verbal text		visual text	P: figure (kids)	O: object (paper plane)
Aa	suggesting readers to do something.	C	the gaze	g: gaze at the viewer ng: absence of gaze at the viewer
At	making readers to think of the answer.	S	size of frame	long: long shot mid: medium shot clo: close-up
Ae	evking readers their experience	V	verital angle	high: see from high angle low: see from low angle top: see from the top of the things eyel: eye-level angle
N	narration	H	horizontal angle	frt: frontal point of view back: look at the visual element from back

I marked the variables that should be discussed by gray background. For example, most of the visual elements do not have eye contact with readers excepting the elements in title page, thus the title page's variable of the gaze (G) is in gray background. The discussion of those variables will show in the following sections.

4.3.2 The Beginning: entering into the picture book

In *Paper plane,* the front cover and title page take important positions for inviting readers entering into the world of picture book even there is not a single word excepting the information of this book. There are two visual techniques used here to ask readers into picture book's world. One is the moving of viewpoint and the other is the gaze of character (the girl).

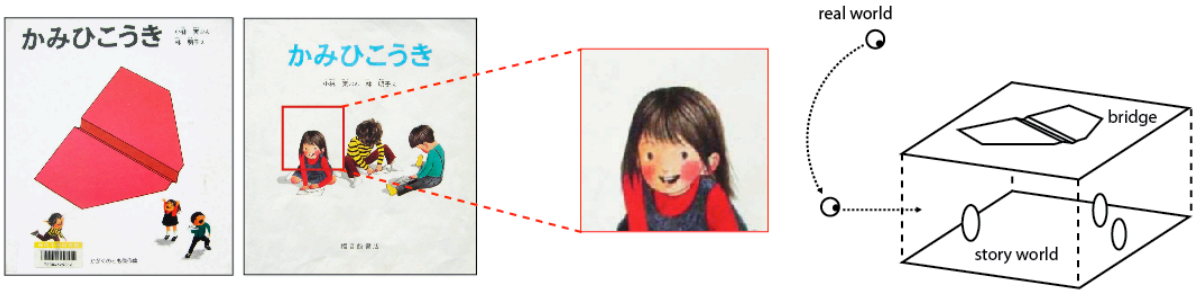

Figure 5 The front cover and title page

Figure 5 shows the front cover and title page; we can see the moving of viewpoint in the right part of Figure 5. Readers first see the visual elements from high angle with long shot on front cover and than, moving their viewpoint down to eye-level with medium shot in title page. The fact shows that the reader is looking at those characters from a far distance at first, and the distance becomes shorter when they open the book. The girl's gaze also sends an inviting message welcoming readers to join in their play.

4.3.3 The Ending: leaving from the picture book

The ending of *Paper Plane* includes the last scene and the back cover. Although there are words in the last scene, the words are only final summary of this book and do not have the function to induce the readers leaving from the world of picture book. The picture of the last scene and back cover is shown as below:

Figure 6 The last scene and back cover

Here again, the author uses long shot to distance the readers from the world of picture book. As we can see in table 1, the characters are always in medium shot or close-up excepting the front cover and the last scene. Long shot in this book could imply that the readers are no longer belonging to the picture book's world. Besides, we have to notice the back view on back cover. According to Kress and van Leeuwen (1996) the back view means, "the viewer looks at the represented participants (visual elements) and has an attitude towards them, but does not imaginarily engage with them." Thus the back view of the boy on back cover can be decoded as, "I know you still want to play with us, but you are no longer belonging to our world. You should play in your world."

4.3.4 The Main Content: the visual elements and trigger words

The visual elements include close-up paper plane (excepting the paper plane that children play with) and the three children. The close-up paper plane can be divided into two groups according to the vertical angle: seeing from high angle, eye-level (shown as Figure 7 A) and seeing from top (shown as Figure 7 B).

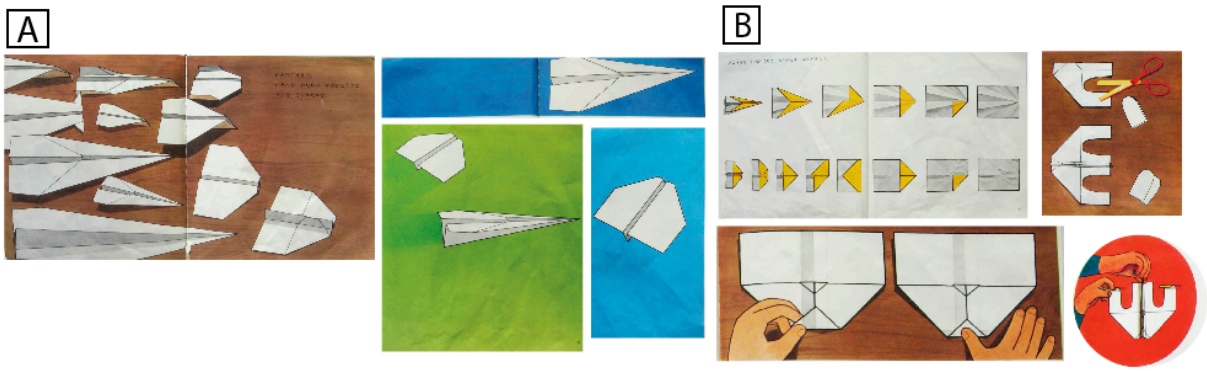

Figure 7 The paper planes see from high angle, eye-level (A) and top (B)

Comparing to the three children are mostly shown in medium shot, the paper planes are always shown in close-up. The fact suggests that the distance between paper planes and readers is closer than it between three children and readers. The paper plane on front cover (see figure 5) also tells us the same thing. Therefore, the paper planes can be considered as bridges between the real world and the world in picture books. The paper planes in figure 7 (A) are always followed by narration words, thus the function of narration becomes a trigger to make readers paying attention on the paper planes in the picture and the paper planes will become a trigger to recall their experience. Another group of paper planes are shown as figure 7 (B). They are seen from top and tend to explain how to make the paper planes or how to change their wing shape. Those pictures can be a working direction or an experiment suggesting depending on they are cooperating with Aa (suggesting readers to do something) or At (making readers to think of).

Although there are two kinds of frame size, close-up and medium shot, when showing characters, it doesn't matter when we discussing the meaning of the pictures. Whether close-up or medium shot could show that the readers have imaginary relationship with characters and join in the play of the characters in the world of picture book. What affects the meaning of those pictures is which kind of words they are together with.

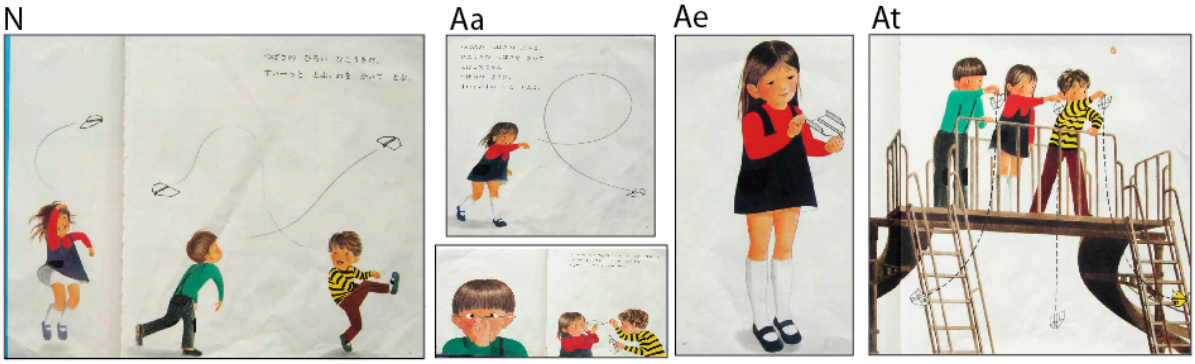

Figure 8 the visual elements and the words

The example of pictures with different kind of words is shown as figure 8. When the picture is with narration words means that it shows the contents of narration. The characters also can do what the words suggest readers to do for the readers when with Aa (suggesting readers to do something.) or showing the action to help readers recalling their experience with Ae (evoking readers their experience). Finally, At (making readers to think of the answer) become the function of paying attention to the pictures because of the pictures always show the answers of the questions which the author asked.

5. Conclusions

The aim of this paper was to discover how science picture books interacting with readers. Takigawa (2006) implied that science picture books use characteristic words to trigger readers thinking of or doing something. The result of our analysis found out that not only words can trigger readers but also images. The using of eye contact, changing viewpoint and frame size could build an imaginary relationship between the visual elements and readers or force readers to leave the relationship. In addition, the result also shows that images could change the function of words. For example, words originally mean suggesting readers to think of the answer could become paying attention on the pictures when they are with image. In other words, the same verbal text could induce readers doing different action when they cooperating with different visual text. Actually, the cooperation between verbal text and visual text is the essence of the picture book, and in fictional picture books the relationship between the two kinds of text is complicated and subtle (Sipe, 1998). But according to our analysis result, the relationship is not so complicated in a science picture book. We can find that the cooperation model seems to follows some rules. In order to clarify the general rules, it is necessary to analyze more science picture books.

This paper suggested an analysis method. By this method, we could find out the visual technique used in order to interact with readers, and clarify the relationship between verbal and visual text in one science picture book. Though that the analysis of *Paper Plane* is just a beginning, the method could be applied on other science picture books and through the analysis we could discover the general rules in the future.

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