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Visible Language

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Graphic Design of Pictograms Focusing on the Comprehension of People with Intellectual Disabilities – The Next Step in Standardization:

Pictogram Design and Evaluation Methods

Mao Kudo

Abstract

People with Intellectual disabilities understand Pictograms that require learning has been reported to be difficult. They exhibit difficulties understanding, including reading and writing, textual information, and often use images in the form of Pictograms to circumvent this difficulty.
Against the backdrop of research by AAC (Augmentative and Alternative Communication), TEACCH (Treatment and Education of Autistic and related Communication handicapped Children), and others, Pictograms have been used as tools for communication from school age onward. Thus, Pictograms displayed in public spaces are public support tools that enable people with intellectual disabilities to understand information.

However, in Japan, when some Pictograms were revised or added in preparation for the 2020 Tokyo Olympics in 2017, and paired comparison survey was carried out by the Japanese JIS standard Pictograms committee to determine whether JIS or ISO Pictograms were easier to understand. Some people with disabilities were included in the study, but only 20 out of 121 responded (16.5%), and the data was decided to be used only as a reference.

From the results of the author's previous surveys of people with Intellectual Disabilities, pictograms they understand are also well understood by people without disabilities.

In this study, 19 adults with intellectual disabilities and Pictograms of 16items from JIS for guidance were subjected to a comprehension survey where they recalled intended actions. As a result, graphic elements that increase comprehension were identified in each Pictogram. The study also suggested an association between comprehensible graphic elements and IQ.

Specifically, five graphic elements influence the comprehension of Pictograms: 1. person symbolizing location, 2. real orientation, 3. motion line (: effect line representing movement, emphasis, sound, etc.) 4. location element, and 5. arrow: the axis length affects the degree of comprehension. It was suggested that 1. lower IQ, 2. real orientation, and 3. motion line had more influence on the ease of understanding.

Keywords:

pictogram
Intellectual disabilities
testing
evaluation methods

1. Introduction

Pictograms are a means of communicating information that involves conveying concepts through images. Their primary feature is that they do not rely on words. However, for the cognitively impaired or people with intellectual disabilities, learning the meaning of new pictograms is reportedly difficult (Sadamura, 2022. Kudo, 2014).

People with intellectual disabilities may exhibit difficulties with comprehension, including reading, writing, and processing textual information. As a result, they often use images in the form of pictograms to circumvent this difficulty. Against the backdrop of research by Augmentative and Alternative Communication (AAC), Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH), and others, pictograms have been used as a tool for communication from school age onward. Thus, pictograms displayed in public spaces are public support tools that enable people with intellectual disabilities to understand information. However, it has been reported that many pictograms are hard for people with intellectual disabilities to understand.

Research on pictogram comprehension has been conducted under the standards established by International Organization for Standardization (ISO) 9186-1. This method involves displaying pictograms on paper of size A5 or larger, or a screen of 28 mm by 28 mm or larger, and asking people what they mean. When using a screen, the pictogram should be seen at a viewing distance of 40–70 cm (ISO, 2014). Japanese Industrial Standards (JIS), which specifies standards in Japan, first standardized pictograms for guidance in 2001. In this method, a questionnaire was administered online and by mail that involved having the participant match a pictogram, displayed at 3 cm in size, to its meaning from four possible choices. The participant was also asked to describe the meaning of a displayed pictogram that was accompanied by a textual description of where the pictogram is used, such as "In public facilities or public transportation." Also, in 2017 some pictograms were revised or added in preparation for the 2020 Tokyo Olympics, and JIS conducted a pair comparison survey to determine whether the JIS or ISO pictograms were easier to understand (Japanese Standards Association JIS Z 8210 drafting committee, 2017).

Some people with disabilities were included in the study, but only 20 of 121 responded (16.5%), and the data were used only as a reference (Japanese Standards Association JIS Z 8210 drafting committee, 2017). The reason only 20 responded is that the method used was the same as that for the general population. When potential research subjects have intellectual disabilities, the characteristics of those disabilities must be considered. In other words, it is essential to consider the duration of continued concentration required, the ease of understanding the instructions, and so on. The ISO did not include people with intellectual disabilities in its survey standard. The checklist of attributes for participants included physical disabilities and hearing and visual impairments, but there was no checklist item explaining how to survey people with intellectual disabilities (ISO, 2014) .

As mentioned earlier, the ISO and JIS have conducted studies regarding the *meanings* of pictograms themselves. However, only a few have studied understanding pictograms envisioning a situation where a person is trying to *navigate* their way.

A study with children and adults with intellectual disabilities performed by the author showed that pictogram comprehension was improved by designing and adding three graphic elements corresponding to their meanings: 1) *motion line* representing movement or sound; 2) person symbolizing the location; and 3) action taken in that location and the person performing that action (Kudo & Yamamoto, 2014). The same results were found among people without intellectual disabilities. By considering ease of understanding for children with intellectual disabilities, the universal design of pictograms becomes possible. For people with and without disabilities, pictograms are used as elements of signs in an environment. Signs help people navigate and find their way around. Thus, this study aims to identify which graphic designs of pictograms are easiest for people with intellectual disabilities to understand, envisioning a situation where a person is trying to navigate their way. A secondary aim is to determine the relationship between IQ level and pictogram comprehension.

2. Materials and Methods

2.1 Research Ethics Approval

Ethnic approval was granted by the Ethical Committee of Kyushu University Faculty of Design for this research work (Ref. No. 404).

2.2 Participants

Nineteen people with intellectual disabilities volunteered to participate in the study, which involved a two-choice task: 10 women and nine men. The mean age was 34 years, and the age range was 19–49 years. Of the 19 participants, 12 had Down's syndrome, four people had autism spectrum disorder, and four people had a simple intellectual disability. All participants provided written informed consent, and the Ethical Committee of Kyushu University approved the study.

2.3 Stimuli

Twenty stimuli were flipped horizontally for 40, adapted from those used in the wayfinding study involving 450 patients with dementia, conducted in Germany (Marquardt & Schmieg, 2009). In the middle of the diagram showing a space, a red dot has been added to indicate the current location. Pictograms were placed on the space diagram left- and right-hand sides (Figure 1). Adapted from the JIS standard, 16 pictograms were used as control stimuli. The stimuli to be compared with the control (referred to as "stimuli for comparison" going forward) included three versions of "station" and two versions of "information," prepared by the author based on the results of previous research. Another 14 items for comparison had one version each (Figure 2).

Figure 1.

Visual stimuli and size of each graphic element

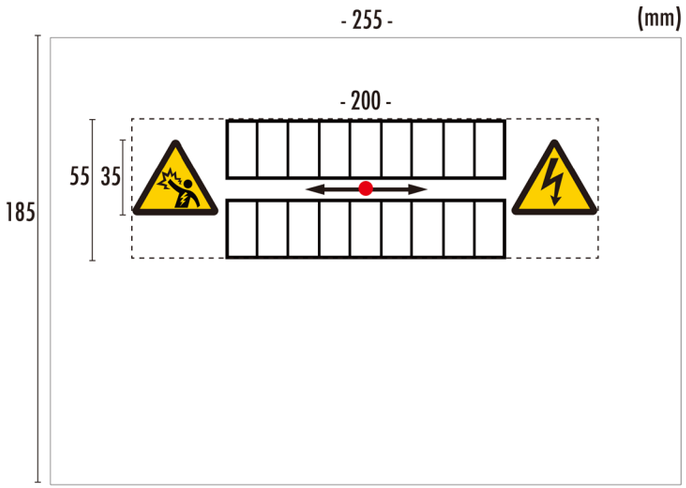
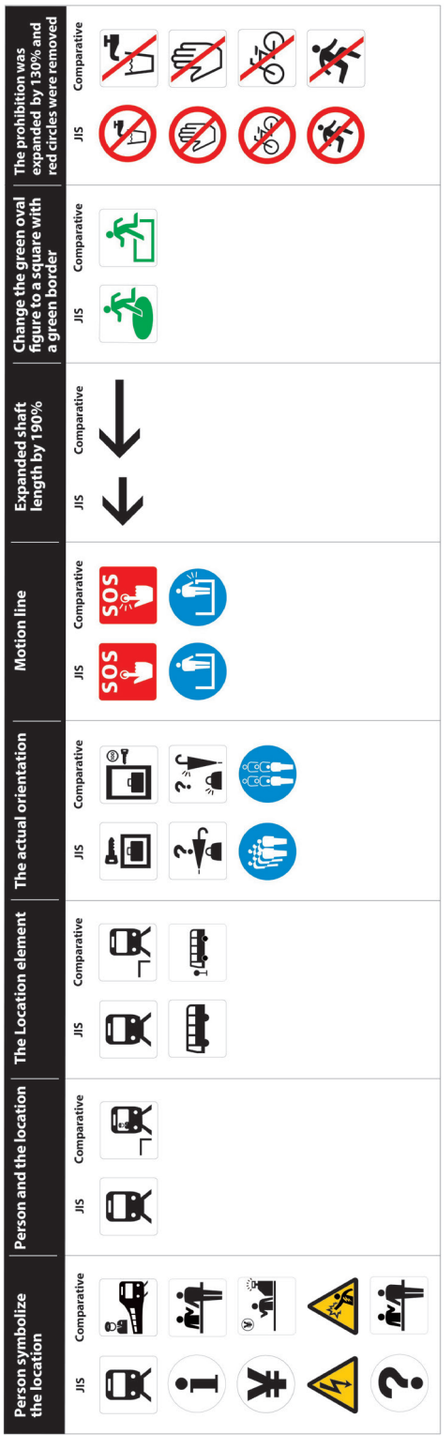


Figure 2.

JIS and stimuli for comparison: Pictogram variations for each of the eight conditions

(see opposite page)



The stimuli presented are shown in the chart. They measured 18 cm by 25.5 cm, of which 5.5 cm by 20 cm was used for the figures. The height of each pictogram was 3.5 cm. The viewing distance was 70 cm with a viewing angle of 16° (Figure 3).

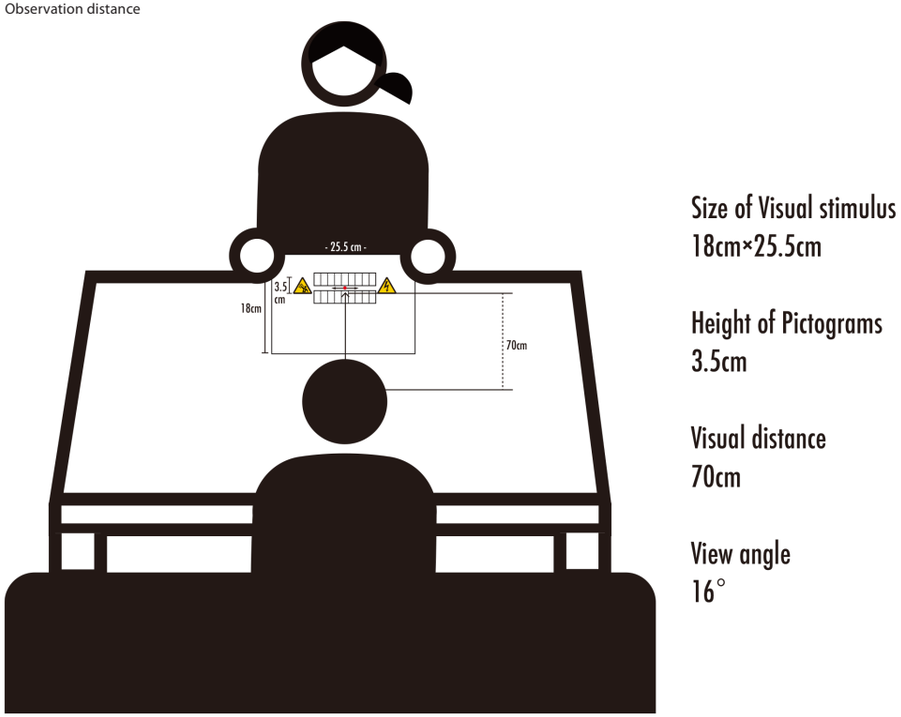
Figure 3.

survey and size of each element

Note : The formula for calculating the viewing angle is as follows

v=360/π*{arctan(s/d/2)}

v: visual angle, s: size of object, d: Observation distance



2.4 Procedure

Participation in the study took place in a standard working room of an office to reduce the psychological burden on the participants. As described earlier, people with intellectual disabilities may struggle to read and write text. In light of the characteristics of their disabilities, it is necessary to consider the duration of continued concentration required, the ease of understanding the instructions, etc. To try to mitigate some of these potential challenges, this experiment was conducted as a one-on-one interview. This way, if there was a problem, the researcher was allowed to make adjustments by observing the participant. In addition, to maintain participants' ability to concentrate, the entire experiment, from explanation and informed consent to the end, was planned to take approximately 20 minutes, and the survey was to be conducted multiple times. The researcher showed the participant one stimulus at a time and explained the instructions. The participant listened to the researcher's instructions and explanation about a situation wherein they would need to navigate their way. The participant was asked to imagine themself in the situation being described, and indicate which pictogram they would follow to reach their desired destination.

A participant could express their decision verbally or by pointing. Instructions about each situation were 60 characters long on average and based on those from the WISC-IV intelligence test and the manual for the Tanaka-Binet Intelligence Test. To eliminate left-right differences, the positions were reversed. This is a method to eliminate the possibility that you chose the right or left side because it is easier to see or because you like. And each participant underwent the experiment a second time. If there were no differences with a participant the second time, they went through the investigation a third time. Intellectual disabilities people have swings in their thinking, and this is a way to eliminate as much of it as possible.

2.5 Data Analysis

1. Design of easy-to-understand pictograms

A chi-square test was performed for the control stimuli (JIS) pictograms and the stimuli for comparison. Results for a select number of people were examined to determine whether there was a significant deviation.

2. Pictogram comprehension and IQ

Intelligence Quotient (IQ) scores were based on participants' personal disability record books. Correlation with pictogram comprehension was examined between Group A, which included people with IQs in the range of 21–35, and Group B, which included people with IQs ranging from 36–50.

3. Results

The results are shown in Table 1. Category a includes pictograms that were significantly more comprehensible in the comparison stimulus than in JIS, category b shows pictograms for which there were no differences between JIS and the comparison stimulus, and category c lists pictograms for which JIS was significantly more comprehensible.

TABLE 1

[ALSO see facing page)

Survey results and pictograms used as visual stimuli

Note: a) Significantly more comprehension of comparative stimuli, b) No significant difference between comparison stimuli and JIS, c) a Significantly better understanding of JIS

(n=19)

	Refarent	Point of comparison stimuli	JIS	Comparison stimuli	x^2	p
a	Caution, electricity	• Add person symbolize location • Add "motion line"			15.21	p<0.001
	Information i	• Add person symbolize location • Add Location element			8.89	p<0.01
	Coin locker	• Change key' s orientation to real orientation and shape of the locker to rectangle • Add coin			8.89	p<0.01
	Station	A • Add platform			6.37	p<0.05
	Emergency call button	• Add "motion line"			6.37	p<0.05
	Information ?	• Add person symbolize location • Add Location element			6.37	p<0.05
	Lost and found	• Real orientation • Add "motion line"			6.37	p<0.05
	Arrow	• Expanded shaft length by 190%			6.37	p<0.05
	Bus stop	• Add bus stop symbol			5.32	p<0.05
	Cashier	• Add clerk, cash register and "*motion line*"			4.26	p<0.05
	Station	B • Add perspective expression of train and conduntor			4.26	p<0.05
b	Station	C • Add platform and train conduntor			1.316	—
	Please stand on the right	• Add "*motion line*"			0.89	—
	Line up two	• Change the person's orientation to the real orientation			0.47	—
	Safety evacuation area	• Change the green oval figure to spuare with green border			0.05	—
	Please stand on the left	• Add "*motion line*"			0.05	—
	Not drinking water	• Remove Red circle outlier • Expanding the figure of prohibited items by 130%			0.05	—
	DO NOT touch				1.32	—
c	No bicycles				4.26	p<0.05
	Do not rush				4.26	p<0.05

3.1 Stimuli for Comparison Were Easier to Understand Than JIS

As seen in Table 1, the stimuli for comparison were easier to understand than the JIS pictograms were in common use. The following stimuli showed significant deviation:

- "Caution, electricity"
- "Coin locker"
- "Information"
- "Bus stop"

_ "Station + Train platform,"
"Station + Train in perspective + Train conductor"

_ "Emergency call button"

_ "Casher"

_ "Lost and found"

_ "Arrow"

3.2 The "Prohibited Activity" Red Circle Outlier

Participants indicated that JIS pictograms were easier to understand for all four items related to prohibited activities. A significant deviation was found for "Do not rush" and "No bicycles." The round border on three pictograms gave a stronger impression of prohibition than a diagonal slash. Stimuli for comparison diverged from the JIS pictograms in that the black graphic depicting the target activity was enlarged by 13%. This was done because, in previous research, a red "NO" overlapping the target activity in black was thought to reduce visibility (Murray et al, 2009). However, increasing the size of the black graphic depicting the target activity while expressing "prohibited" with just a diagonal line did not lead to greater comprehension.

This finding may have also resulted from a question in the instructions that asked, "Which feels stronger?" The red "NO" in the pictogram took up four times the area of the diagonal slash; hence, the word "stronger" may have led participants to choose the red graphic with its more extensive place.

3.3 No Difference

The following pictograms were the result of not knowing whether the JIS or comparative stimuli were easier or harder to understand.

_ "Station + Train platform + Train conductor inside train"

_ "Please stand on the right (left)."

_ "Line up two."

_ "Safety evacuation area"

For "Station," JIS pictograms and three versions from the stimuli for comparison were tested. Among these, only "Station + Train platform + Train conductor inside train" failed to deviate from the JIS pictograms. The "Station + Train platform" graphic proved more straightforward and easier to understand than the JIS pictograms. Thus, adding the train conductor inside was ineffective for making "Station" easier to understand. The highest degree of comprehension for "Station" was achieved by "Station + Train in perspective + Train conductor." This suggests that the conductor's graphic elements, size, and position may affect the degree of comprehension.

_ "Please stand on the right (left)."

The overall results show no variation from the JIS pictograms for either side, left or right. The graphic element of a motion line was added to the stimuli for comparison to emphasize the left- and right-hand sides of the image. However, emphasizing the left- and right-hand sides could have made the spatial positional relationship easier to understand. The level of comprehension for "Please stand on the right (left)" was also low for the JIS pictograms, meaning significant design improvements are needed.

_ "Line up in two."

In the stimuli for comparison, the rows were shown from the front, and the figure-ground reversal of the people was removed. The first person in line had a white, whereas the second person and those after were outlined in white. In addition, the number of people was reduced from 10 to 6. Previous research showed that the figure-ground reversal of human figures, as well as having many human figures, impeded comprehension. However, the changes were not found to be effective. Other design approaches should be considered, such as changing the image's perspective and drawing lines to represent the lines of people.

The degree of comprehension for "Form two lines" was also low for the JIS pictograms, meaning that significant design improvements are needed.

_ "Safety evacuation area"

In the case of the JIS pictogram for "Safety evacuation area," the oval used to represent "location" was shown to have been misunderstood as a hole in the ground for Hearing deaf people and non-deaf people (Inoue, 2012).[11] To correct this, the center of the stimulus for comparison was outlined in white. The green outline was rectangular to reflect the evacuation site and have the viewer imagine the school ground where it is located. However, this was not effective in conveying "location."

3.4 Pictograms comprehension and IQ

As shown in Tables 2 and 3, results were compared based on approximate IQ ranges determined by participants' personal disability record books.

— Group A: IQ 21–35

— Group B: IQ 36–50

TABLE 2

Pictograms easily understood by IQ21-35 group

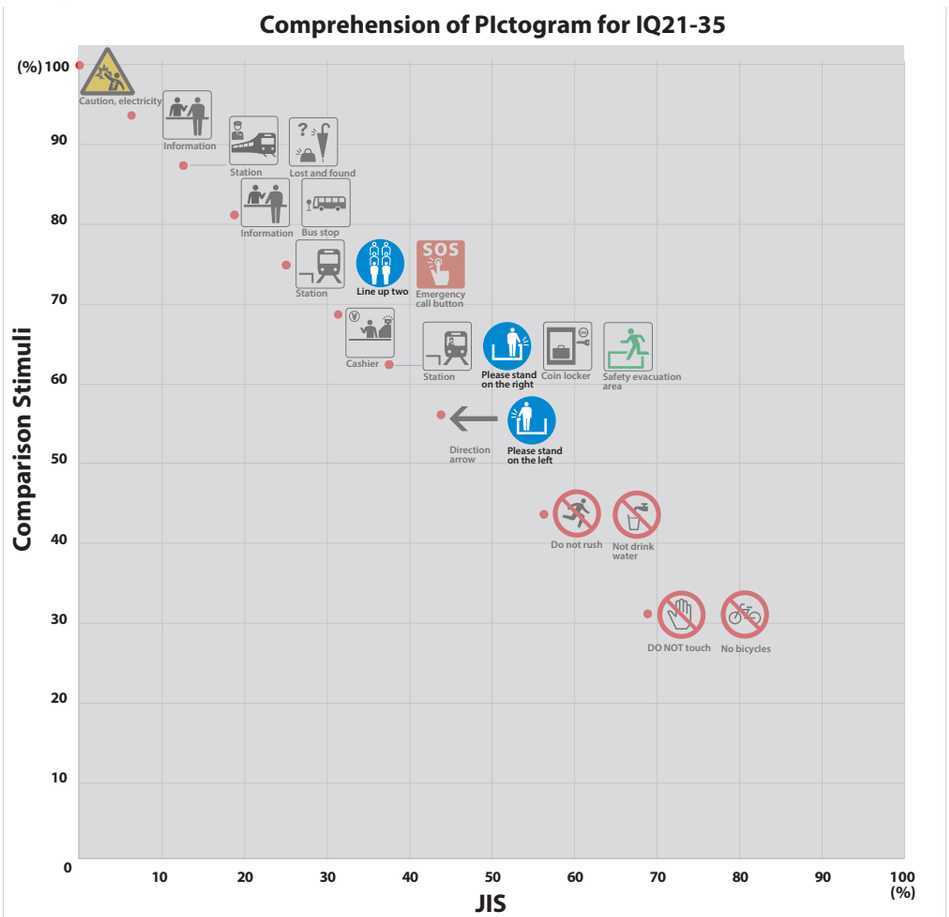
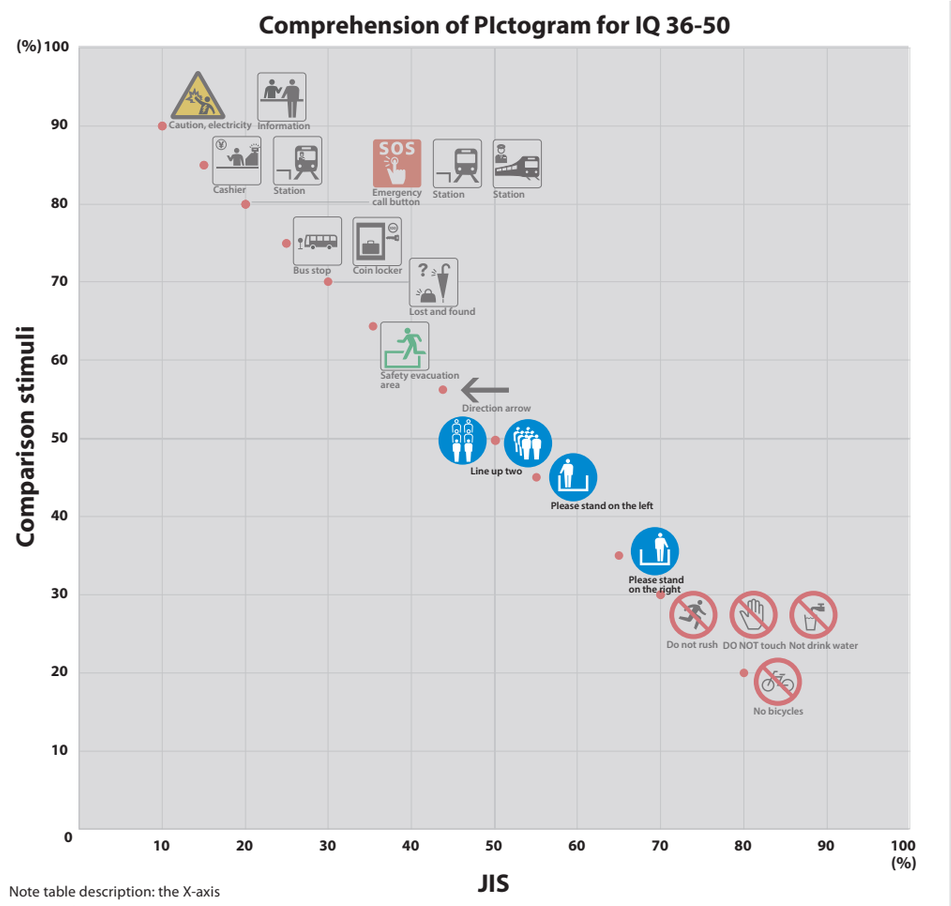


TABLE 3

Pictograms easily understood by IQ36-50 group



Note table description: the X-axis is the % of comparison stimuli selected, and the Y-axis is the % of JIS chosen.

Each item of the pictogram with the highest percentage selected is indicated. However, IQ36-50 group in table 3, the "line up two" was at the same rate, so the pictograms for both JIS and comparison stimuli were centered.

Group B showed less scattering between a selection of the JIS and the stimuli for comparison. The degrees of comprehension for "Please stand on the right," "Please stand on the left," and "Line up two" were reversed between the stimuli for comparison and the JIS for both Group A and Group B. Participants in Group A had a high rate of choosing the stimuli for comparison in each case, whereas participants in Group B had either the same or a higher rate of choosing JIS versus the stimuli for comparison. The learning effect likely influences this. In other words,

people in Group B probably saw and became familiar with "Please stand on the right side," "Please stand on the left side," and "Form two lines" in the course of their daily lives, causing them to conclude that the JIS pictograms were easier to understand. Those in Group A, on the other hand, saw the pictograms less frequently and thus had less chance to become familiar with them, so they chose the stimuli for comparison. When comparing the results of Groups A and B for "Line up two" and "Please stand on the right (left)," the pictograms of the comparison stimulus with the graphic elements of "actual orientation" and "motion line" were selected more frequently in Group A. The "actual orientation" pictogram is "Line up two," while the "*motion line*" pictogram is "Please stand on the right (left)." This may indicate that the lower a person's IQ, the more practical "actual orientation" and "*motion line*" are in understanding pictograms.

4. Discussion

4.1 Five Traits of Graphic Elements for Easy-to-Understand Pictograms

Five graphic elements were effective in increasing the understanding of pictograms (Figure 4).

Figure 4.

Five traits of graphic elements for easy-to-understand pictograms

Graphic element conditions	Better understood pictograms
① **Person symbolize the location**	① 
② **The Location element**	② 
③ **The actual orientation**	③ 
④ **Motion line**	④ 
⑤ **Arrow: the longer the axis, the easier it is to be understand**	⑤ 

1. Person symbolizing the location

– "Station + Perspective + Train Conductor,"

– "Cashier," "Information," and

– "Caution, electricity."

Adding human figures then symbolizing location to JIS pictograms that did not already have them significantly increased comprehension ("Station" and "Cashier" *(p<.05)*, "Information Desk" *(p<.01)*, and "Caution, electricity" *(p<.001)*. According to a survey by Zwaga and Easterby (1984) on the comprehension of pictograms for "Information," as shown in (Figure 5), 29% of the respondents answered incorrectly, and 36% did not know, while 35% answered correctly for the pictogram of "i" in a circle, which is a frequently used pictogram for "information."

Zwaga and Easterby concluded that, *"Overall, the results of the information symbols suggest that new proposals for this symbol should at least incorporate a question mark together with some pictorial elements"* (Zwaga & Easterby, 1984). Of the three pictograms, the one with the highest percentage of correct answers was International Civil Aviation Organization (ICAO) pictogram with a question mark between a seated and standing person.

These results are similar to the results of the present study in that the person symbolizing the location affects the level of comprehension.

Figure 5.

Results of a recognition test of three symbol versions for "Information" by H. Zwaga and R. Easterby

B Information

Variant	Sample size	Responses	%
	257	correct	52
		school	5
		individual	35
		don't know	8
	236	correct	35
		letter 'i'	7
		individual	22
		don't know	36
	260	correct	47
		question marks	8
		individual	22
		don't know	23

2. Real Orientation

- "Lost and found" and
- "Coin locker."

In the JIS pictograms where the orientation of a graphic element did not match the real-life layout, comprehension was increased by changing it to fit ("Lost and Found" *(p< .05)* and "Coin Locker" *(p<.01)*). The JIS pictograms are standardized to be recognizable at a size of 8 mm. Perhaps this led to the size of graphic elements being prioritized at the cost of matching real-life orientation.

During the design of the U.S.DOT and AIGA pictograms, 13 different "Lost and Found" pictograms were collected, categorized into three concepts, analyzed and evaluated (AIGA, 1974). The three concept categories were: 1. suitcases and question marks; 2. umbrellas, gloves, and items associated with question marks; and 3. tagged items (see Figure 6). After evaluation by five design professionals, the second category (umbrellas, gloves, and items associated with question marks) was adopted for implementation. Three of the six pictograms in concept 2 had the umbrellas lying on their sides, and three had the umbrellas standing up. There was no evident consideration for which orientation, horizontal or vertical, the umbrellas or bags should take. The focus seemed to be on which object symbols should be combined to represent a "lost and found" handling office. The final U.S.DOT and AIGA pictogram "Lost and Found" was standardized in a layout with the umbrella lying on its side (Figure 7).

Figure 6.

Thirteen symbols of "Lost and Found" collected for analysis and evaluation by AIGA

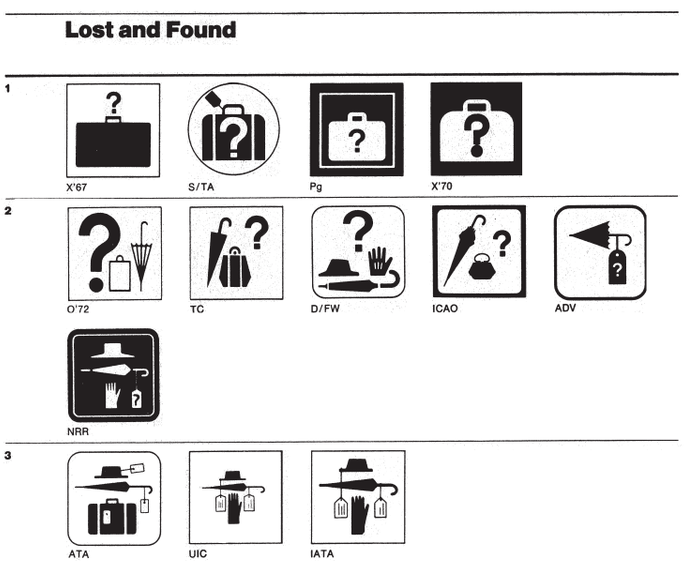
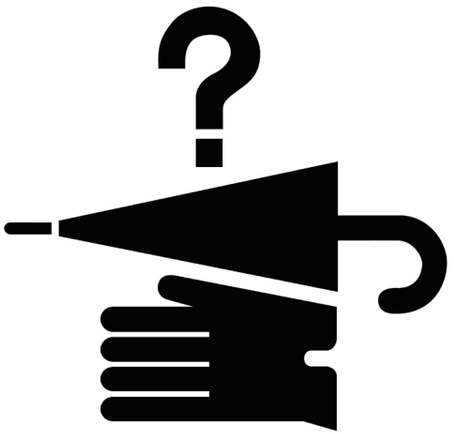


Figure 7.

U.S.DOT & AIGA pictogram "Lost and Found"



The JIS umbrella in "Lost and found" lies horizontally, whereas in reality, it would be more natural to stand vertically. The "Coin Locker" design has the key above the locker; however, the more natural location for the key is on the side of the locker where the key is inserted. The correct orientation would be for the key to point toward the locker.

JIS pictograms "Lost and found" and "Coin locker" use objects in a literal way. In the "Coin locker" pictogram the key picture represents a key object. When describing extremely literal interpretation of pictographic objects, such as the objects in the AIGA pictogram "Rent a car," Lupton and Miller said, "Some characters appear to be simple, direct depictions of objects .... Others, however, are more obscure. Consider, for example, the character that shows a giant key floating above a car: if we interpreted this sign as a literal depiction of a scene, we might read "a car dream of a key" (Lupton & Miller, 1994. p.48). Lupton and Millers article was about Chinese characters, so they use the word "character" to mean a drawn symbol, however complex it may be. They suggest that a drawn symbol of an individual object when read as a "character" can be interpreted literally whereas when a number of drawn objects are combined into a single "character" they not make sense if interpreted literally.

In keeping with Lupton and Miller, the JIS pictogram "Lost and found" could be interpreted as "umbrella and bag riddle," and "Coin locker" as "a locked bag dreaming of a key" because the objects are not oriented as they are in reality. We found that the natural or literal orientation of the drawn object is comprehended better in this context.

3. Motion line

- "Emergency button,"
- "Cashier,"

"Lost and found," and

"Caution, electricity."

Adding motion lines to represent movement or sound was shown to increase comprehension ("Emergency button," "Cashier," "Lost and found" *(p<.05)*, and "Caution, electricity" *(p<.001))*. In the field of manga studies, motion lines and other lines used to convey information are called "deictic lines," a type of path line. The end of the line guides the viewer's eye, so they have the function of drawing attention (Cohn, 2020). The addition of the motion line may have attracted visual attention and contributed to understanding.

In the case of these pictograms (except "Emergency button"), motion lines were not the only graphic element added; hence, they cannot be given full responsibility, but the pictograms did achieve a higher level of comprehension. In *HANDBOOK OF PICTORIAL SYMBOLS* (Modley, 1976), pictograms with motion lines are found throughout. For example, in "Woman," motion lines are depicted at the mouth of a woman singing or speaking something, which can be interpreted as "speaking and out loud" (Figure 8) (Modrey, 1976). It is unclear what medium these pictograms were used in, to whom they were directed, and what they were intended to communicate, but exploring how pictograms were used before standardization may provide hints for pictograms that embrace diversity.

Figure 8.

Modley's pictograms

Note: The use of motion lines makes it easy to understand the context of the movement and behavior of people.

4. Location element

"Bus stop" and

"Station + train platform."

"Bus stop" pictograms with added symbols were chosen more often than JIS *(p<.05)*. For people with intellectual disabilities, buses are the most commonly used means of transportation. Results of our research revealed that the pictogram for "bus stop" was easier to understand when not only the bus itself, but also the location of the bus stop were shown.

The pictogram for "station," plus the location of the train platform, was also chosen significantly more often than JIS *(p<.05)*. When "train platform" and "train conductor" were added, there was no difference from JIS. This suggests that adding "platform," a location element, as a pictogram for a train station is understandable. When developing the JIS Pictorial Symbols for Communication Support (PIC), the appropriateness of each pictorial symbol was measured using a survey given to a total of 187 people: 83 students at schools for the mentally disabled, 20 older adults, and 84 people aged 20-64 (Japanese Standards Association, 2003).

Both the PIC bus stop (Figure 9) and station (Figure 10) have locations represented with the exact location symbols as the pictograms in this case.

The appropriateness of each is rated as high as 97% for bus stops and 80% for train stations, which is consistent with the present results. In the context of primary information, symbols representing places are necessary to improve comprehension.

Figure 9.

Japanese Standard symbols for communication support PIC "bus stop"

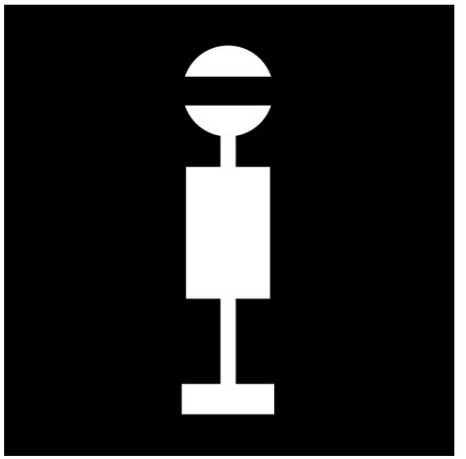


Figure 10.

Japanese Standard symbols for communication support PIC "bus stop" "station"

5. Arrow: the length of the axis affects the degree of comprehension

Arrows with longer shafts were considered easier to understand, which confirmed the results of previous research (Nishikawa,1997. Garvey et al, 2004).

Arrows with long shafts were used at international exposition 1967 in Montreal and were already recommended by Passini and Authur (1992). In "Arrow," as in other JIS pictograms, the shaft and pointed part of the arrow are the same size, perhaps because it is easier for the layout on signs to be composed of square units. However, given that a longer arrow shaft makes the arrow easier to understand, attention should be dedicated to ease of layout in units, and ease of understanding. This means, of course, that there will not always be one best design for an arrow. Depending on the media, there may be cases where the arrows must be contained within a square to balance information with available space. However, this should not be held as valid for all person. An arrow with a longer shaft can be used in situations where comprehension is prioritized, and an arrow with an equal-sized shaft and point can be used in media with limited space, such as handheld maps. Scalability should be sought in this manner when it comes to pictogram standards.

4. 2 Graphic Elements That Increase Understanding of Pictograms are Also Accompanied by Additional Conditions

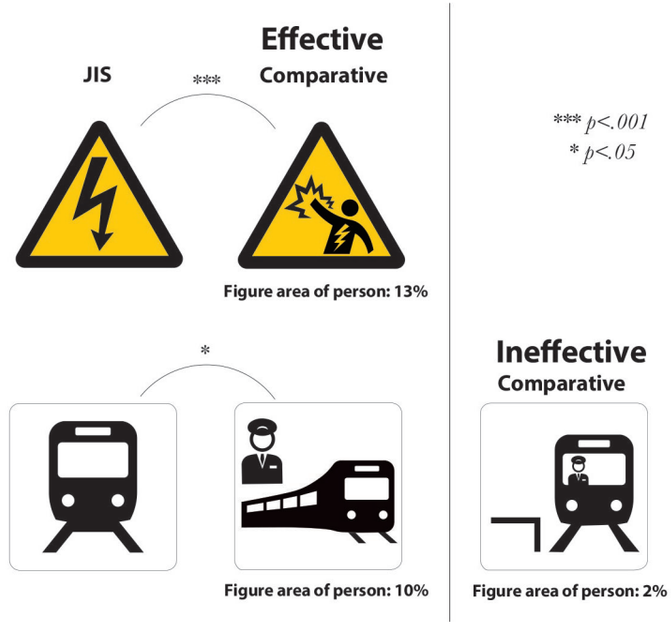
Further results show that the five graphic elements are ineffective in some pictogram conditions.

1. People who symbolize the location

It was found that some pictograms were effective, and some were not, depending on the area ratio of people to the total pictogram. As shown in Figure 11, "Caution, electricity," and "Station + conductor" had 13% and 10% of people, respectively, and these results were better understood than JIS. Therefore, it can be said that the people who symbolize the place were adequate.

Figure 11.

People who symbolize the location are significant in size.



*** $p<.001$
* $p<.05$

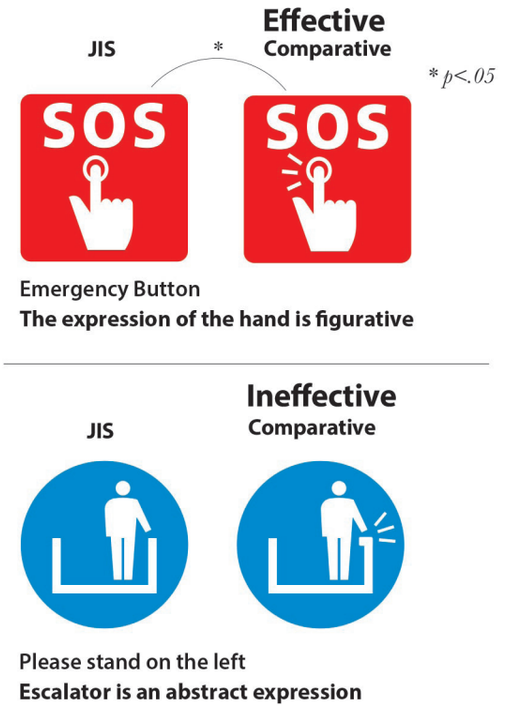
However, even when people were added the same way, 2% did not differ from JIS and were ineffective. It is necessary to clarify where the numerical value of the area of people percentage borders for effectiveness.

2. Motion line

It has been shown that motion lines are effective as a graphic element to increase comprehension (Figure 12), but their effectiveness varies depending on the subject of the pictogram. In other words, although motion lines can be effective, there are cases wherein they could be more effective with specific pictograms. For example, compare the "Emergency button" and "Please stand to the right (or left) side" with the stimuli for comparison with added motion lines. For "Emergency button," the stimulus for comparison was more often selected ($p<.05$), while there was no difference for "Please stand to the right (or left) side."

Figure 12.

The degree of figurativeness of the object to which the Motion line is attached is essential.



"Emergency button" includes depictions close to reality in terms of the proportion between the back of the hand and fingers and the treatment of the tip of the thumb, the second knuckle on the middle, ring, and pinky fingers, and the bulge of the padding on the pinky, as well as the white outline on the button. In "Please stand to the right (or left) side," the escalator is abstracted and drawn in a shape like a bathtub. Parts of the escalator seen in real life, such as the handrail and steps, are left out. In other words, adding motion lines to abstract pictograms does not make them easier to understand.

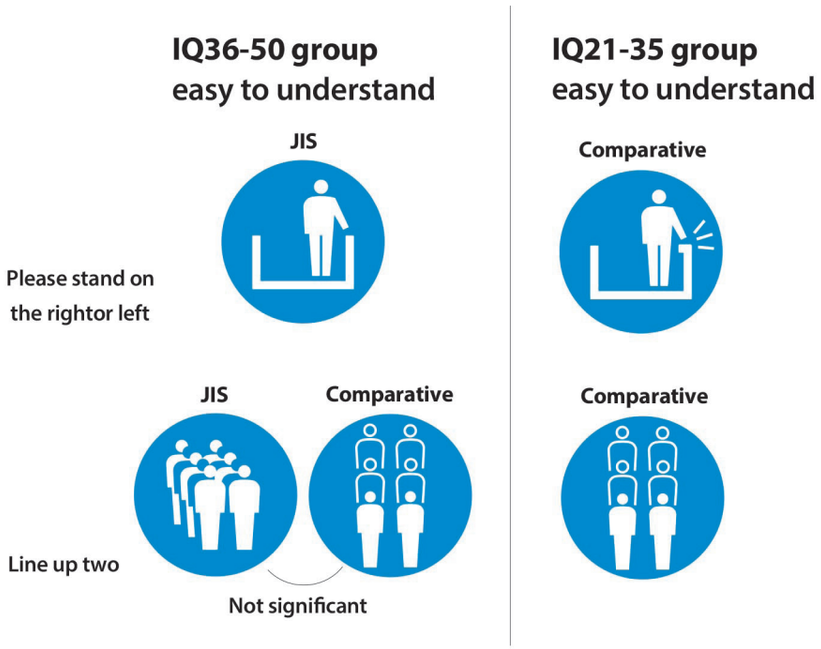
In manga studies, motion lines and other lines that indicate the information are included in the category of "bound morphemes." Bound morphemes are characterized by the fact that they do not exist independently—they only gain meaning in conjunction with some other graphic element (Cohn, 2020). In other words, it can be concluded that the motion lines added to "Please stand to the right (or left) side" were not effective because the subject of the pictogram (the escalator and left-right directionality) was not clear.

4.3 Pictogram Comprehension and IQ

On the IQ, the reversal in the understanding of the JIS and comparative stimuli were in "Please stand on the left or right" and "Line up two" (Figure 13). This may indicate that the lower the IQ, the more practical "actual orientation" and "motion line" are in understanding pictograms. Interviews suggest that visual experience and memory are related.

Figure 13.

Stimulus comprehension compared to JIS is almost reversed by IQ.



5. Conclusion

This study examined the designs of pictograms to aid comprehension for adults with intellectual disabilities, envisioning a situation where a person is trying to navigate their way. As seen in previous research, adding human figures to pictograms improves comprehension. Motion lines can be effective, depending on the pictogram, but they do not aid comprehension of pictograms with a high level of abstraction. This

can be explained by the characteristics of bound morphemes described in manga studies. Bound morphemes do not exist independently; they must be paired with a subject to gain meaning. In other words, motion lines added to issues with a high degree of abstraction are not meaningful. When adding graphic elements, the pictogram must first be revised when it has a high degree of abstraction. In this study, "Please stand to the right (left) side" was not made more effective by motion lines, so this pictogram needs to be fundamentally revised. The pictograms for "Form two lines" and "Evacuation area" also require fundamental revision.

Regarding the relationship between pictogram comprehension and IQ, Group B (IQ 36–50) showed less variation in their responses than Group A (IQ 21–35) did. Groups A and B had roughly the same rates of choosing the stimuli for comparison versus JIS in terms of comprehension, except in the case of "Please stand on the right side," "Please stand on the left side," and "Form two lines," for which selection of the stimuli for comparison and JS was reversed for the two groups. Group A (IQ 21–35) had a higher rate of choosing the incentives for comparison, whereas Group B (IQ 36–50) selected JIS as much as or more than the stimuli for contrast. Interviews suggest that this is connected to the relationship between IQ and the perception of left, right, depth, memory, and visual experience—that is, the learning effect. However, the same factors are yet to be determined.

However, the broad issue to be addressed is what is needed for pictograms to go from standardized to inclusive. For this purpose:

1. We need to develop appropriate comprehension survey methods for people with disabilities, and establish a plan for surveying the comprehension of people with disabilities who are not included in the standard pictogram survey (like people with intellectual disabilities) so that the results can be included in the general results.

2. They can be selected according to the target and the media planning the scale design of pictograms. Depending on the characteristics of the people and media, pictograms have different graphic designs that are easy to understand.

Currently, it is impossible to standardize in a way that ensures that a single pictogram corresponds to a single meaning. Therefore, we would like to draft a scaled pictogram design that can be chosen according to the people and media.

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