

Perceived Meanings of Graphical Elements

Perceived Meanings Relative to Intended Meanings  
of Common Graphical Elements in Instructional Illustrations:  
U.S. and Taiwanese College Students Compared

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## Abstract

Human beings have made graphical marks and signs from the earliest times we can discover (Fein, 1992). Some general classes of signs have persisted since then and show up in modern illustrations as lines, arrows, circles, and other primary elements. Instructional illustrators (and cartoonists, interface designers, and others) use variations of these primary graphical elements within illustrations to convey meanings that cannot be expressed simply by drawing pictures of “things.” While designers may agree widely on their intention to convey such extended meanings in illustrations through metaphorical, iconic and indexical uses of these elements, empirical research on the nature of the meanings actually communicated by these elements is sparse.

This study investigated perceived meanings of common graphical elements used in 16 simple instructional illustrations among 95 undergraduate students at Indiana University Bloomington and IUPUI, and among 114 undergraduate students at Yuan Ze University in Taiwan, as well as between these two groups of respondents. The subjects saw a survey consisting of 16 hand-drawn images, and were asked to write a sentence below each image conveying the same meaning as was conveyed by that image. Subjects' answers were scored to determine whether or not they matched the meaning intended by the designer of the images. Consistency between the designer's intended meanings and meanings perceived by the U.S. respondents was high for one graphical element, very low for several others, and variable for the images overall.

Human beings have made graphical marks from the earliest times we can discover. Through the extensive collection of ancient and modern signs provided by Sylvia Fein (1992), it is possible to trace general classes of marks that persist in the human graphical repertoire. These include straight lines, curved lines alone and in parallel, arrows of all kinds, depictions of human and animal forms, human faces, and various enclosed shapes (circle, spiral, triangle, square).

Some of these earliest marks may be simply the index of human activity; ancient hand prints on the walls of canyons or caves may not communicate anything except that humanoids once dipped their hands in pigment there and enjoyed themselves by pressing their hands to stone. However, it is clear that most marks have served as signs. In his introduction to semiotics, or the study of signs, *Sign, Thought and Culture*, Danesi (1977) explains the notion of "sign":

A sign is anything—a word, a gesture, etc.—that stands for something other than itself. The word *cat*, for instance, is a sign because it does not stand for the sounds c-a-t that comprise it, but rather for "a carnivorous mammal (*Felis catus*) domesticated since early times as a catcher of rats and mice. Similarly, an open hand directed at a person is a sign because it does not stand for itself, the hand, but rather for a warning motion alerting the individual to stop. The 'something other than itself' that the sign stands for is called the referent (Danesi, 1997, p.11).

A review of several collections of symbols used for widely disparate purposes by human beings (Dreyfuss, 1984; Modley, Meyers & Comer, 1977) shows basic marks from earliest time being used over and over again in abstract symbols that we know are meant to communicate from one human being to another. As studies have shown (Boling, Beriswill, Xaver, Hebb & Frick, 1997; Brugger, 1990; Mackie, 1966), abstract symbols are not well understood without accompanying text, even when they do contain basic graphical elements that have been in use for ages.

But what about such marks in the context of larger illustrations or works of art?

Cartoonists rely on abstract symbols added to the panels of sequential art to convey meanings that simple pictures of objects cannot express (Eisner, 1994; McCloud, 1994). Nöth (1995) points out an example:

Among the graphic elements that have become specific to the genre [of comics] are the so-called speed lines or action lines. These serve to convey a dynamic dimension to the otherwise static drawing. Contents of such lines are direction, mode, and intensity of movements (p. 473).

Implicit in this argument is the assumption that the comics reader will interpret the “speed line” as a symbolic reference to the actual physical qualities of the object it modifies.

Instructional graphics are also presumed to benefit from the addition of graphical elements. Winn (1991) explains that the use of such elements in instructional charts and diagrams (including maps) works metaphorically. A mark rising from the bottom of a chart toward the top, as defined by the viewer’s orientation, can function as a sign communicating a rising value in some measurement because human beings can use a form of mental analogy to translate the quality of the mark (moving upward) into an understanding of some different quality (a rising value).

In the context of both comics and instructional illustration, it is important to remember that the basic graphic elements do not appear in isolation. In fact, all parts of the image work together to create the impression that one is seeing a representation of something with a known referent. Shapiro (1969) describes this phenomenon:

Taken out of the image, the parts of the line will be seen as small material components: dashes, curves, dots which, like the cubes of a mosaic, have no mimetic meaning in themselves. All these assume a value as distinct signs once they enter into certain combinations, and their qualities as marks contribute something to the appearance of the represented objects. According to the context of adjoining or neighboring marks, the dot may be a nail-head, a button, or the pupil of an eye; and a semi-circle may be a hill, a cap, an eye-brow, the handle of a pot, or an arch. (p. 238)

and he also recognizes the difference between marks that merge to form a recognizable image and marks that do not when he says, "There are, it is true, on a represented object in a drawing or print many lines which are not viewed as signs of the real object and its parts in a morphological sense."

In *Visual Intelligence* (1997), Anne Marie Barrie argues that visual cognition is our primary means for understanding, and that our cognition using pictures follows logical rules for interpretation to arrive at meaning. To what extent is this true, however? If human beings do not understand abstract symbols without some process of learning their meanings or some method of labeling to fix their meaning, and if lines and dots taken out of the context of a whole image no longer convey their intended meaning, what must the viewer of an instructional illustration make of the graphical elements added to it to augment its meaning?

In the example shown here (Figure 1.) some of the lines and dots work together to produce mimesis, or the mental illusion of a car being driven by a person. The lines behind the car, however, are not required for the sake of the illusion. The designer of the image has placed these lines in the image to communicate some extended meaning. Will viewers of the image understand this extended meaning, or even attend to the presence of the additional elements in the graphic?

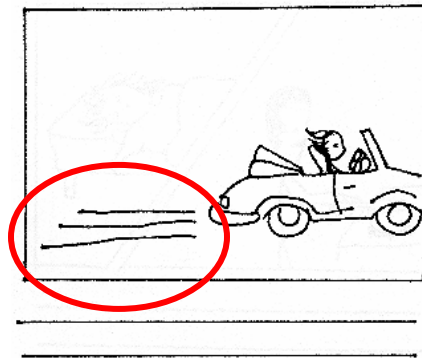


Figure 1. Illustration with graphical element highlighted

#### Purpose of the study

This study was conducted to answer the following questions about graphical elements added to illustrations for the purpose of extending the meaning of the illustrations:

- 1) Will viewers of the illustrations attend to the presence of the graphical elements, as evidenced by their including some extended meaning in the text equivalent they provide for the images?
- 2) Will viewers who do include some extended meaning in the text equivalent for the images provide a meaning similar to the one intended by the designer of the images?

## Methodology

### *Population and Sample*

Two populations were surveyed. The 96 U.S. respondents were undergraduate students from a Midwest university, and the 141 Taiwanese respondents were undergraduate students in graphic design programs at a private university in northwestern Taiwan. These populations were selected partially through convenience, and partially through the desire to contrast two similar groups from different cultural backgrounds.

### *Survey and scoring guide*

The study was conducted via a paper questionnaire self-administered by respondents (see Appendix B). The survey process took an average of 10 - 15 minutes per student, and was conducted at the end of regular class periods for those students who volunteered to participate. The survey consisted of a few demographic questions, one sheet of instructions, and 16 hand-drawn images (see Appendix B).

The images incorporated graphical elements that appear commonly in interventions carried out by one of the primary investigators. The graphical elements extend the meanings of the basic images by implying such qualities as movement, emotion, simultaneity, articulation, and transformation. This is accomplished through the application of dashed lines, regular and irregular circles, arrows, curved lines, and combinations of these simple elements.

For each picture the subjects were asked to write a sentence that had the same meaning that the pictures communicated to them. The instructions were given only once at the beginning of the

survey, and were accompanied by two samples of drawings with their interpretation. Under each of the 16 pictures were two blank lines on which to write a response.

### Data Analysis

Each survey was scored twice, once to determine the percentage of responses that matched the intended meanings for the images, and again to determine the percentage of responses for each item that indicated some attention was paid to the graphical elements in the image.

#### *Scoring for a match with the intended meaning*

The first scoring procedure consisted of checking each response to each image against a scoring guide (see Appendix C). A given answer could be scored with only one of two alternatives; either a response matching the intended meaning (1 point) or a response not matching the intended meaning (even if the response was a reasonable one (0 point)).

#### *Scoring for attention to the graphical elements*

The second scoring procedure consisted of checking each response to determine if the respondent's text indicated some attention to the graphical elements extending the meaning of each image. In this procedure the investigators conducting the scoring asked themselves for each answer, "Could the respondent reasonably have given this text equivalent for the image if the added graphical elements were not present in the image?" Responses showing no indication of attention to the graphical elements were scored as 0 points, and those indicating attention to the graphical elements (even if the response did not match the previous scoring guide) were scored as 1 point.

Three of the investigators, one a native speaker of Chinese and two native speakers of English, conferred regarding questionable responses, or responses in which the scoring was deemed difficult, and resolved ambiguous cases jointly. At the time of writing the investigators have not resolved ambiguities in the second scoring method, and the data from that scoring will not be reported in this paper.

#### *Intended meaning vs. perceived meaning for U.S. and Taiwanese respondents*

For each picture, a 2x2 contingency table was constructed. A Chi-square analysis was performed on each contingency table. (See Table 1.) Chi-squares with p levels of .01 or less were considered to be statistically significant. If a chi-square value is significant, it means that the difference in percent correct between US and Taiwan groups was not likely due to sampling error (less than 1 in a hundred) -- i.e., real differences were observed to occur between the groups.

Table 1: *Proportions of US and Taiwanese Subjects Who Correctly Perceived Intended Meanings of Images*

Image	U.S. subjects (n=96)	Taiwanese subjects (n=141)	Overall	Pearson Chi-square
1	.72	.55	.62	.010*
2	.54	.79	.69	.000*
3	.55	.64	.60	.183
4	.63	.72	.68	.110
5	.72	.48	.57	.000*
6	.73	.60	.65	.045
7	.90	.89	.89	.957
8	.89	.90	.89	.707
9	.75	.49	.59	.000*
10	.93	.88	.90	.233
11	.64	.65	.64	.875
12	.31	.70	.54	.000*
13	.42	.59	.52	.009*
14	.68	.52	.59	.019
15	.81	.65	.72	.007*
16	.59	.57	.58	.768

\*Chi-square values statistically significant at  $p < .01$

### Summary of Findings

There was considerable variation in each subject's ability to interpret the 16 items consistently with the meanings intended by the designer of the images. While the highest percentage of consistent answers was acceptable at the level required for correct interpretation of highway signs (Brugger, 1990), a third of the images were not interpreted consistently with the designer's intended meaning even 50% of the time across these subjects. Subjects' interpretations of meaning compared to the designer's intention is, therefore, quite variable and disappointing. Realistically speaking, designers may want to know that people interpret images enhanced with graphical elements consistently with their intentions no more than an average 66% of the time.

Even worse, the lowest rate of successful interpretation was 31%, and only 4 images did better than 80% with one population or the other, while the means across countries were no better than 72% for all but three images (see Table 2).

Table 2: Overall means with indication of subjects performing closer to the intended meaning by country, and images for which no significant difference was found

	Mean	U.S.	Taiwan	No difference
1 ... bunny hopping	.62	X		
2 ... flower bending in the wind	.69		X	
3 ... car going fast	.60			X
4 ... happy person getting present	.68		X	
5 ... running from house to house	.57	X		
6 ... wondering what happened to his hat	.65	X		
7 ... ball about to break window	.89			X
8 ... talking	.89			X
9 ... man cooking while woman sleeps	.49	X		
10 ... no running	.90			X
11 ... communicating in sign language	.64			X
12 ... transformation into a bird	.54		X	
13 ... man speaking on television	.52		X	
14 ... seeing someone; looking at someone	.59	X		
15 ... dog wagging tail	.72	X		
16 ... dead dinosaur	.58			X

#### Limitations of the study

College student populations are a narrow portion of the potential users of instructional illustrations. The investigators plan to extend the study to other populations, including teachers and children.

The original images were developed to mirror images used in a real world intervention carried out by one of the investigators, but they were consequently inconsistent in graphical style, which

may have led to differences or difficulties in interpretation. The survey has been redrawn by a professional illustrator to reduce as much as possible differences in line style, characterization of human beings, and extraneous image elements. The revised survey will be used in subsequent studies. If significant differences are discovered with the new survey when it tested with populations similar to those in this study, the data from earlier surveys will be abandoned.

These images were tested in isolation; in real settings these images might be connected to further sources of interpretation by viewers (Schriver, 1997). Future studies will incorporate contextual cues into the survey, although the investigators intend to continue experimentation with images out of context since our own experiences convince us that many designers believe commonly used graphical elements in instructional illustrations are intuitively understood, or are readily understood by learners who have been exposed to a lot of media (computer games, cartoons, animated films). If the images we are testing out of context do not perform well, the implication may be that contextual cues are imperative if learners are expected to arrive at an interpretation consistent with the one intended by the designer of the image.

Two limitations of the study are related. First, coding responses is difficult without access to the thinking of the respondent. Second, coding responses is difficult between languages; images that were produced from English-speaking perspective do not always match Mandarin expression very well, so the judgment that an interpretation matches the designers' intention can be difficult to make. For example, the distinction between a rabbit running or moving and a rabbit hopping is important to the English-speaking designer who uses a series of connected curves to indicate the character of the rabbit's movement. While this distinction may also strike the Mandarin speaker, the common expression available in Mandarin for a rabbit's movement incorporates the notion of hopping or jumping. Without access to the respondents' explanations for their responses, the investigators could not tell whether some responses matched the designer's intention or not. This difficulty also applies to situations in which the sentence provided by respondents were ambiguous. The investigators intend to conduct some extended studies in which individual respondents are selected to talk through their interpretations as well as providing written responses.

### Future directions for study

In addition to surveying more varied populations, the investigators expect to pursue several potentially fruitful extensions of this research. The current surveys will be recoded using the second coding method described in this paper (judging whether or not respondents have attended to the graphical elements regardless of the meaning they have perceived), and those data compared to the existing data for meaning. We anticipate that some respondents whose interpretation of the images did not match that of the designer will, nevertheless, have attended to the graphical elements in the images. Whether or not a significant number have done so is not yet known. In addition to the stylistically consistent version of the survey we have developed, we have created a version in which the critical graphical elements are simply left out of the images (or modified to be neutral, as in the case of facial expressions). These versions of the survey will be administered to randomly selected members of similar populations to expand our understanding of the role that the graphical elements may be playing in the interpretations of the images.

### Acknowledgements

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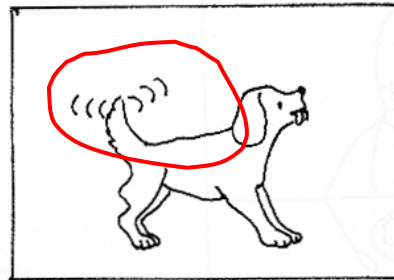
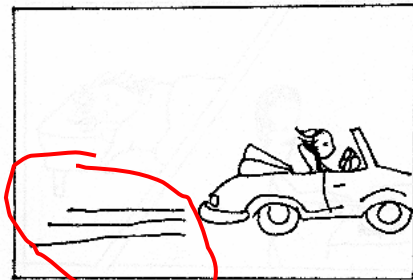
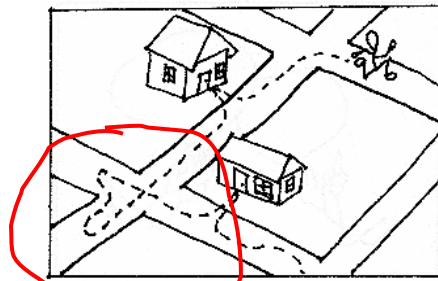
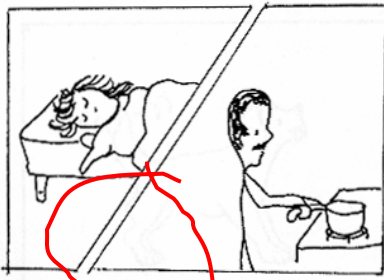
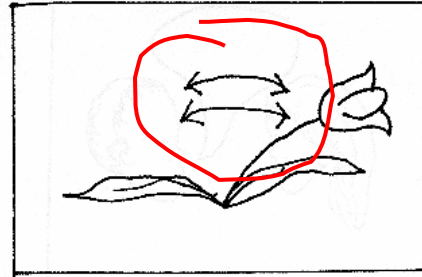
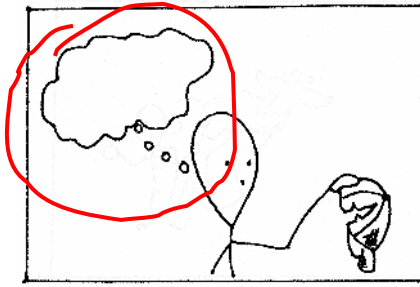
*Rodrigo del Valle*, Ph.D. student, Instructional Systems Technology, Indiana University, Bloomington

*Jalin Huang*, Assistant Professor, Department of Information Communication, College of informatics, Yuan Ze University, Taiwan

*Daud Watts*, Ph.D. student, Instructional Systems Technology, Indiana University, Bloomington

Appendices

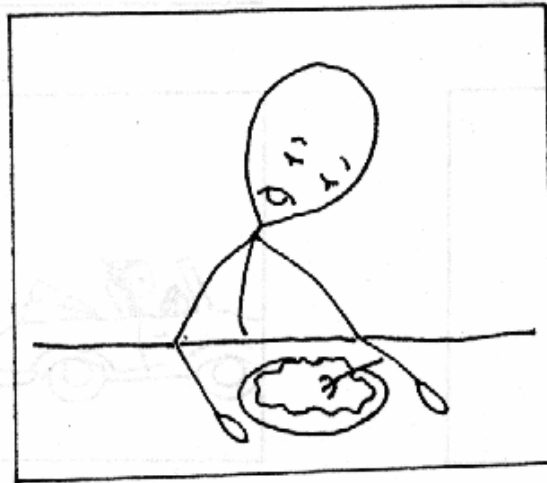
Appendix A: Examples of graphical elements



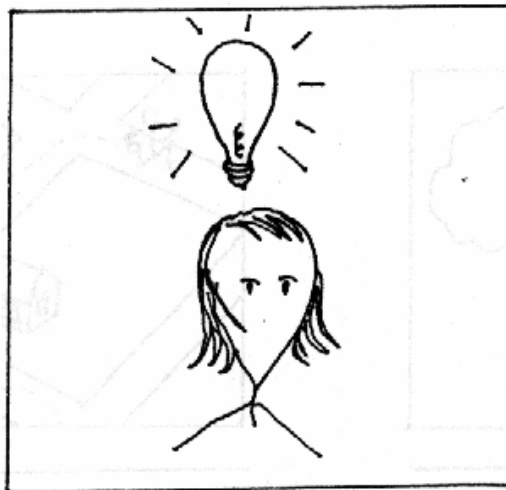
Appendix B: The Instrument

On the next three pages, you will find 16 pictures. Assume that you can see each picture, but that no one else can. Write a sentence that has the same meaning that the picture communicates to you.

Here are two examples, with possible sentences written under them.

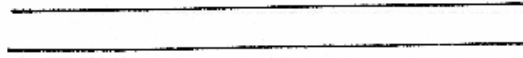
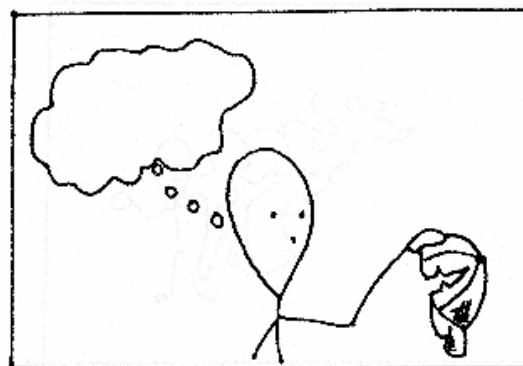
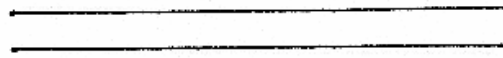
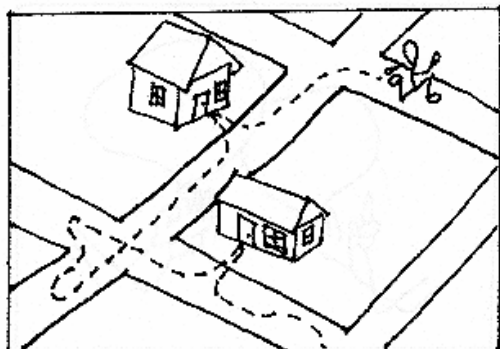
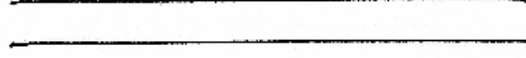
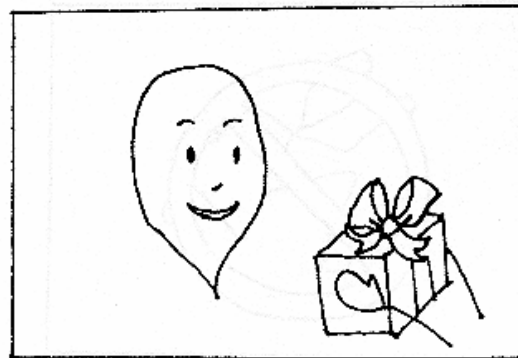
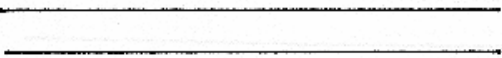
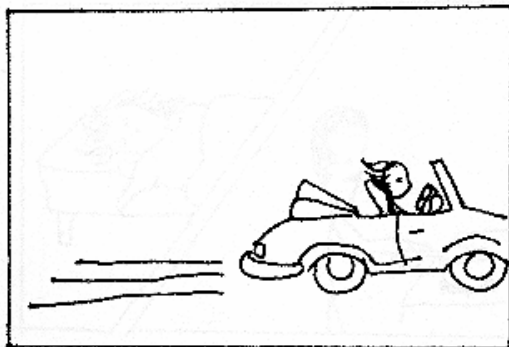
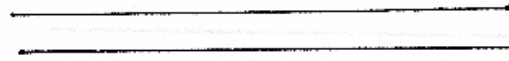
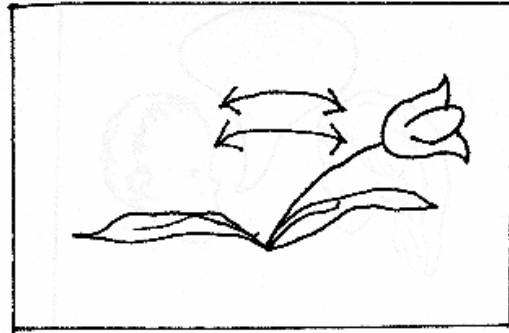
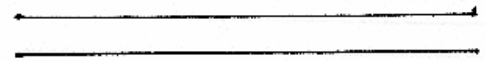
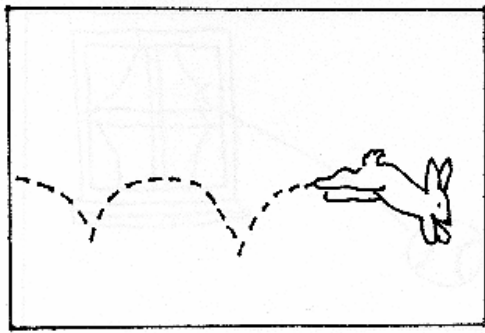


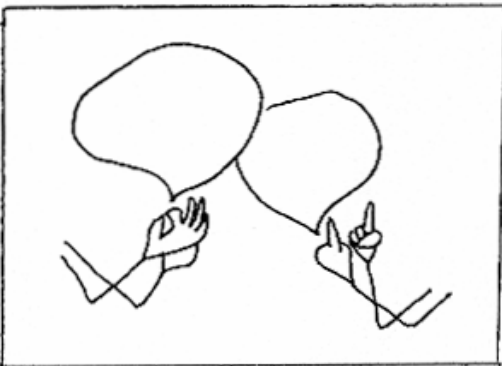
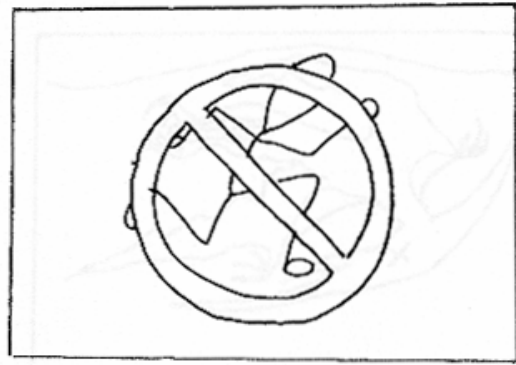
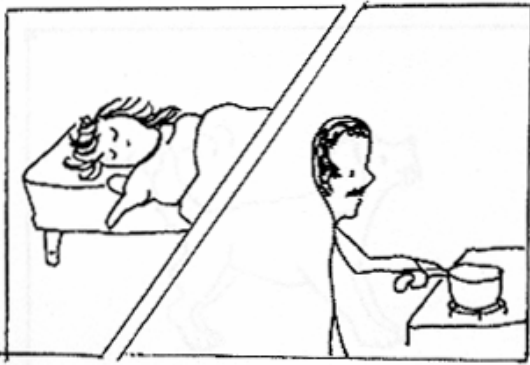
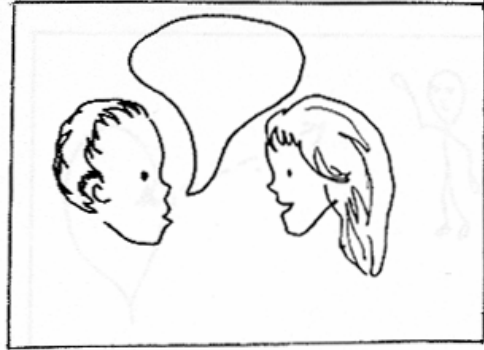
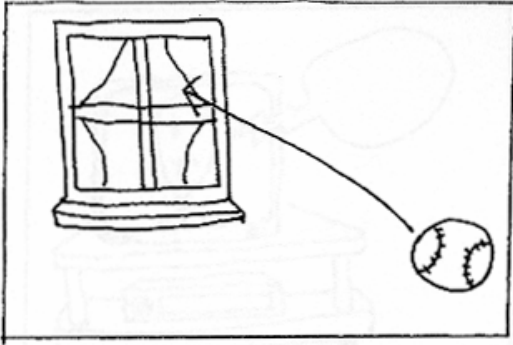
You might say: The food made him sick.

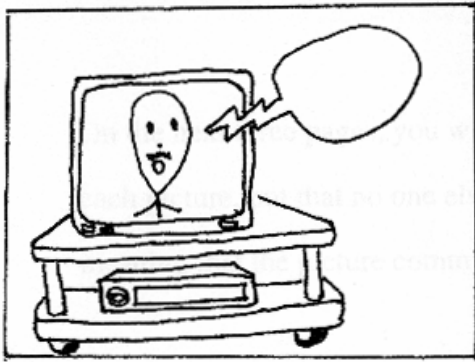


You might say: She had a good idea.

Appendix C: The survey

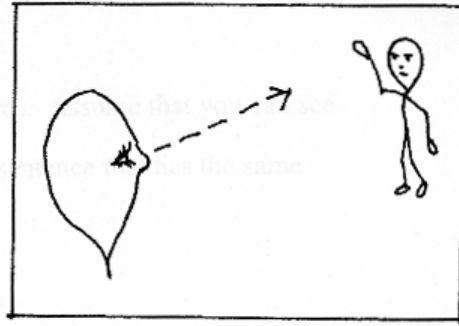






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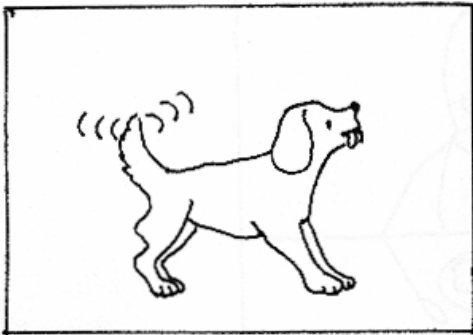
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write on under these

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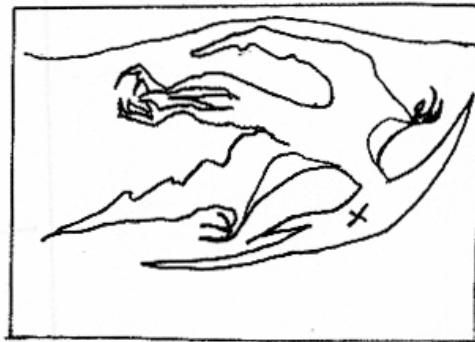
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You might say: The first time

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Appendix C: Scoring Guide

Interpretation of Graphic Elements Study  
Scoring Guide

→ Overall Directions:

Assign 1 point only if:

- The sentence contains a specific label (word or phrase) for the device meaning.
- The sentence contains a vocabulary choice directly prompted by the device.
- The sentence has a general meaning prompted by the device.
- The sentence is the contents of a speech, sign, or thought balloon (when approp.)

#	Picture	1 point	0 point
1	Rabbit	(Movement up and down) <i>hop, leap, jump</i>	(Straight line movement) <i>run, escape, scamper</i>
2	Flower	(Device label) <i>back and forth</i> (Vocabulary) <i>sway, blow in the wind</i> (Total meaning influenced) <i>trying to find the sun, flexible, wind blowing</i>	<i>wilting, falling over, dying</i>
3	Car	(going quickly) <i>speed, fast, zoom away, quickly</i> (sentence implies speed) <i>She was in a hurry</i> (moving away) <i>drove away</i>	<i>She went to the store. Time to drive.</i>
4	Birthday	(reference to feeling) <i>happy, excited, feeling glad</i> (feeling implied in sentence) <i>looking forward to opening, what fun to get a present, he liked getting gifts.</i>	(reference only to present or birthday) <i>He is getting a present. It is his birthday.</i>
5	Neighborhood	(specifically movement from place to place—one person) <i>all over town, ran around the neighborhood, errands all over, from house to house.</i> (reason for multiple stops without label) <i>had to find his way home, lost and confused, frantically searching</i>	(no mention of several stops) <i>running from the police, around the block</i>
6	Hat	(reference to mental activity—not just feeling) <i>deciding, thinking, wondering, contemplating, figuring out, knowing</i> (inside the balloon) <i>How did my hat get torn? I have no idea what this is.</i>	(just feeling reference, based on picture only without thought balloon) <i>hat is worn out, ran his hat over with the lawn mower, he is sad.</i>

7	Baseball	(in the process of moving, future tense) <i>about to break, going towards, will go</i> (result of movement, past tense) <i>went through, was thrown at the window, broke the window with his baseball.</i>	(no reference) <i>trying to get new windows,</i>
8	Talking	reference to speaking) <i>talking, speaking, conversation, said, telling</i>	(no reference to balloon) <i>They are starting to like each other.</i>

		(balloon contents) <i>What are you doing after school?</i>	
9	Sleeping and Cooking	(distance in space but same time period) <i>while, at the same time, during</i> (both mentioned and the time-space connection implied by a conjunction or phrase) <i>and, but, in the next room</i>	(only one person, alternative "or") <i>He is making her breakfast. The child is sick.</i>
10	"Do not" sign	(negation plus running) <i>do not run, no running</i>	(unrelated, no reference to symbol) <i>He won't jump through hoops.</i>
11	Sign Language	(reference to communication with hands) <i>communicating with sign language, talking with hands, spoke with sign language, sign language</i> (reasonable balloon contents) <i>It was like this.</i>	(no reference to hands) <i>they were talking together</i>
12	Transformation	one thing becoming Another) <i>became, turning into, changes into, metamorphosis</i> (something inside coming out) <i>spirit flies away, soul going to heaven</i>	(wishing or pretending—no thought balloon in picture) <i>feeling of freedom, pretending to be a bird</i>
13	TV	(electronic source of speech) <i>telling the news, talking on TV, TV anchor giving the news</i> (balloon contents) <i>blah, blah, blah..., War is coming!</i>	(mention of TV [hearing] without mentioning communication) <i>Commercials are too loud.</i>
14	Looking	(reference to looking) <i>watch, see, look, eye contact.</i>	(no reference to seeing) <i>He waved at his friend.</i>
15	Dog	(reference to tail movement) <i>wagging, waving</i> (logical emotion expressed by movement) <i>happy to see me, happy</i>	(no direct reference to movement or implications) <i>The dog stands there.</i>
16	Pterodactyl	(reference to death, dying, or illness) <i>drowned, dead, extinct</i> (reference to a different but well known meaning for X symbol) <i>X marks the spot.</i>	(misinterpretations of both picture AND symbol)

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