Research Report

Raised-Line Pictures, Blindness, and Tactile "Beliefs": An Observational Case Study

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There seems to be a fundamental similarity in the way that persons who are blind and those who are sighted process and use pictorial information (Kennedy, 1993). A possible reason for this similarity is the partial overlap (D'Angiulli, 2004) between vision and haptics; namely, the notion that some core principles of the depiction of objects in the form of an outline are based on "objective shapes" (Kennedy & Bai, 2002) that contain a few essential structural features that are accessed in the same physical space and are perceived equivalently through haptics and vision.

An alternative view, however, is that similarities in the processing of pictures by people who are blind and those who are sighted are not the result of the direct perception of the shape of objects. Rather, these similarities are by-products of tactile "beliefs" (Hopkins, 2000), specifically, of inferences that are based on aspects that are related to touching objects without visual feedback. That is, although visual experience itself "presents" one with the shape of an outline, tactile experience may not do so; it may enable one only to construct some form of indirect knowledge that describes the shape of an outline. Haptics would enable a person to "deduce" the shape of an object by going beyond perceptual experience. Thus, in most cases, the partial overlap that entails the identification of raised-line pictures is based on the perception of patterns, as in vision. In contrast, tactile beliefs imply elaborate mental representations that build on haptic experience but are unrelated to vision.

In this study, a child, Carlo, who was born completely blind, was invited to explore and identify, by name, a set of raised-line pictures without receiving feedback about the accuracy of his identification. He was then asked to explain, verbally or by drawing, why he believed that the names he suggested accurately identified the depicted objects. If the processing of raised-line pictures is indeed based mainly on the perception of the shape of objects shared by vision and haptics, Carlo's identification rate would be similar to the rate that was previously reported for participants who are blind and sighted, who attempted to identify raised-line pictures without the availability of visual information from the pictures (see, for example, D'Angiulli, Kennedy, & Heller, 1998; Kennedy & Bai, 2002). In addition, there would be no relationship between the accuracy of identification and Carlo's tactile beliefs (about what the pictures may represent). If the identification of raised-line pictures was based primarily on inferring a meaning-based interpretation of the picture (even if the two accounts were not mutually exclusive and beliefs somehow compounded or added to partial overlap), then Carlo's beliefs would be related to the accuracy of identification.

Method

Participant

Carlo, a 13-year old boy who was born completely blind and who attended a school for children with visual impairments in Milan, Italy, was recontacted from a pool of candidates who were initially recruited but found ineligible for another study. The present investigation was conceived as a single-case pilot study. A follow-up developmental study with comparison groups of various ages and visual statuses is under way. The presumed cause of Carlo's blindness was an uncon-

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firmed rare genetic disease. The standard pediatric evaluation revealed no pupillary reflex or reaction to light at birth. Carlo was writing and reading braille by age 7 and was experienced in exploring and making pictures. Both he and his parents gave their consent for Carlo to participate in the study. Ethical approval was obtained by the board of the Italian National Institute for the Blind (Unione Nazionale Ciechi, Milan).

Materials

The stimuli were nine raised-line pictures. Eight pictures, taken from D'Angiulli et al. (1998), were used as targets on the first and second blocks of identification trials (henceforth referred to as the "introductory" and "experimental" blocks or trials, respectively); these pictures represented an apple, cup, scissors, telephone, key, happy face, bottle, and table. Another picture, representing a tree, was used for practice before the introductory block. The total number of trials (17) was deliberately chosen to limit fatigue and keep the study to less than 45 minutes, following the recommendations of the institutional review board and the general practices of developmental research. Each picture was made on a separate Mylar plastic sheet using a raised-line drawing kit.

Procedure

The procedure, adapted from D'Angiulli et al. (1998), consisted of one introductory and one subsequent experimental block of identification trials that were conducted in a quiet room in Carlo's school. After Carlo practiced with a raised-line picture of a tree, he was asked to explore the pictures in the introductory block quickly, one at a time, and attempt to identify them by name.

After the introductory trial and a break, the experimental block was introduced. The experimental trial included the same pictures as in the introductory trial (presented in a different random order), except that Carlo was allowed to reflect on his responses by thinking aloud. He was also invited to provide one final identification response only and to give one final response even if he was unsure. Correct identification required offering the names of the objects listed earlier (such as an apple or a key) or synonyms (for example, *phone* for *telephone*). No feedback about identification was provided during any trial, except in the practice trial, in which Carlo was told the name of the stimulus (a tree) and shown its parts (the trunk, branches, and leaves) in the picture. Debriefing was provided after all the trials were completed.

In each experimental trial, once Carlo provided the name of an object as his final identification response, the experimenter elicited his tactile beliefs about a picture by asking, "Why do you believe this is a drawing of a ____?" (and repeated the name that Carlo provided, such as a butterfly). If Carlo's identification response was correct, the experimenter simply moved on to the next picture. If the identification response was incorrect (as in the example just presented, since the picture was not of a butterfly), the experimenter followed up by asking, "May this be a drawing of a ____?" (and provided the correct name of the object, such as a table). "Could you explain why you believe that this may [may not] (depending on Carlo's response) be the drawing of a ____ [correct name of the object]?" The purpose of the follow-up questions was to obtain verbalizations that were still referenced to the unidentified correct target stimuli (for details, see D'Angiulli et al., 1998). If Carlo did not respond after one minute or declared or showed that he was not to be able to explain himself, for example, by hesitating to respond, the experimenter handed him a drawing kit with a blank Mylar sheet and a pen and asked, "Would you like to show me how a ____ [correct name of the object] should be drawn?"

Tactile beliefs were operationally defined in terms of the names of the objects that Carlo

Table 1
Identifications (in experimental trials) and accepted names of objects for haptic pictures by Carlo, a 13-year-old boy who was born completely blind.

Picture	Identified (Incorrect suggestions)	Accepted
Apple	No (Head with bump)	Yes
Cup	No	No (D)
Scissors	Yes (Butterfly)	No
Telephone	Yes	Yes
Keys	No (Guitar)	No (D)
Face	Yes	Yes
Bottle	Yes	No
Table	Yes	No (D)
Proportion	5 of 8	3 of 8

Note: "D" in parentheses means that Carlo provided a drawing of the object. See the text for the description of accepted (or rejected) responses as operational indicators of tactile beliefs.

"accepted" (or "rejected") in relation to the experimental trials. For each picture, Carlo's acceptance (or rejection) was based on his response to the first belief-eliciting question following his accurate identification or on his response to the second belief-eliciting question following his inaccurate identification.

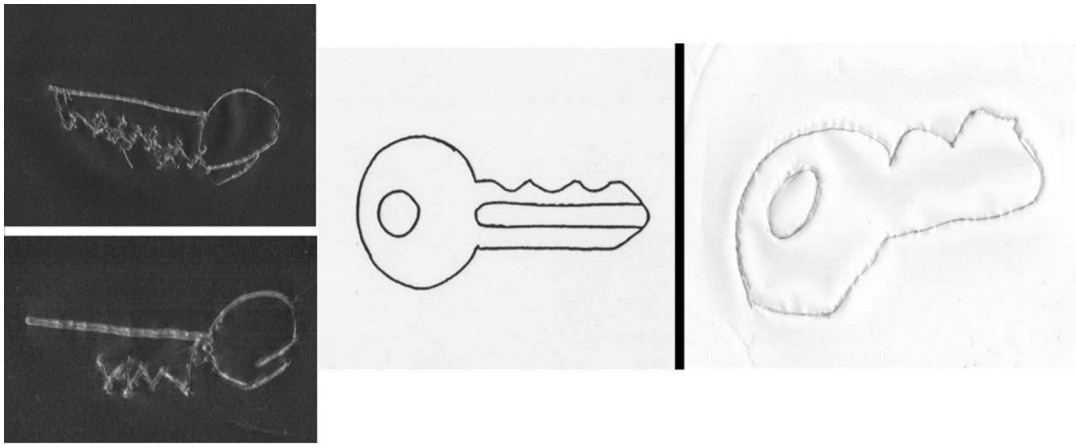
Results

Carlo identified 62% of the target pictures (see Table 1). Most of his verbalizations contained descriptions of salient parts of possible object referents that fit the configuration of the raised lines, such as (1) buttons for a telephone; (2) the eyes, nose, and mouth for a happy face; (3) the bottleneck for a bottle; and (4) the overall shape of a circle connected to a handle or stick, which Carlo interpreted as a lollypop, rather than as a key. Carlo confidently provided one final response for all the targets except while exploring the apple, for which he commented: "[This picture] looks like the face of a man who has a bump [referring to the stem of the apple] and is happy [referring to the cavity where the stem is inserted]."

Carlo accepted only a minor proportion of the pictures as appropriate representations of the named objects. As Table 1 indicates, there seems to be no relationship between Carlo's acceptance or rejection of the names and identifications shown by the difference in proportion of rejected versus accepted pictures (.62 vs. .37). What is evident by visual inspection of Table 1 is confirmed by the lack of significant agreements with beliefs about the stimuli. Table 1 also shows that Carlo drew three of the stimuli that he rejected as inadequate; his drawings and relevant verbalizations are examined next.

Figure 1a presents his two drawings of a key. Both drawings were considerably smaller than the picture he attempted to identify. (During debriefing, Carlo commented that he "would have never guessed that an object of that size [referring to the raised-line drawing of the key] could be [an illustration of] a key"). He stated that there were two aspects that he could not "understand": the groove of the key, which "felt too widely spaced," and the big hole in the circular handle of the key. His remarks and Figure 1a suggest a discrepancy between the specific kind of key that Carlo had in mind and the one depicted by the stimulus. The stimulus represents a standard key for wooden doors, whereas Carlo had in mind the key to his home, which had a fortified locked door. (Since the experimenter had the same type of key, during debriefing he showed Carlo his own key and then asked and received positive confirmation that this was indeed the kind of key that Carlo intended to represent in Figure 1a.)

Carlo stated that the graphic detail representing the cup handle was sufficiently appropriate. However, he noted that, in the picture, there was no indication of the "internal cavity that usually contains liquids." To explain, Carlo made the drawing shown in Figure 2a. He then stressed that, to him, a prominent aspect of a cup was "the hollow space that can be felt by the fingers and the lips." Carlo



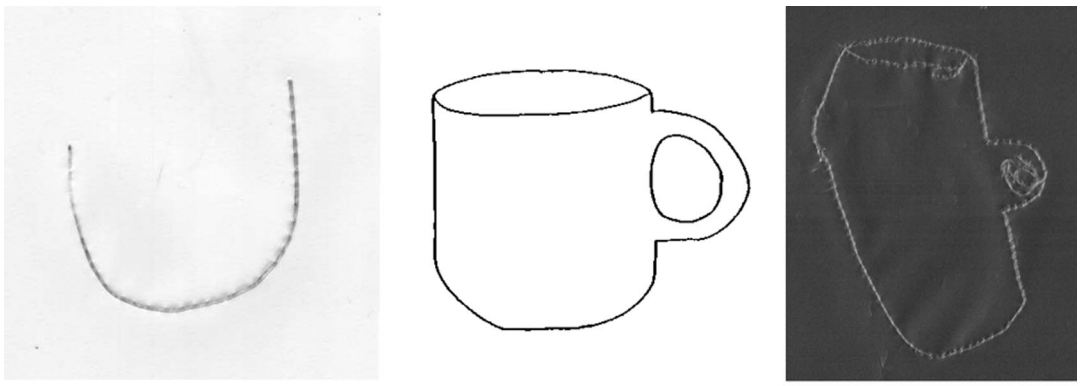
(a) Suggested (after "rejection") (b) Stimulus (c) Copy

Figure 1. (a) Two free drawings of a key (rejected by Carlo), (b) the stimulus depicting a key (not identified by Carlo), and (c) copy of the picture stimulus "key" made by Carlo during debriefing.

made a similar remark about the opening of the bottle and said that was the reason why he did not find either stimulus to be a "good" haptic picture.

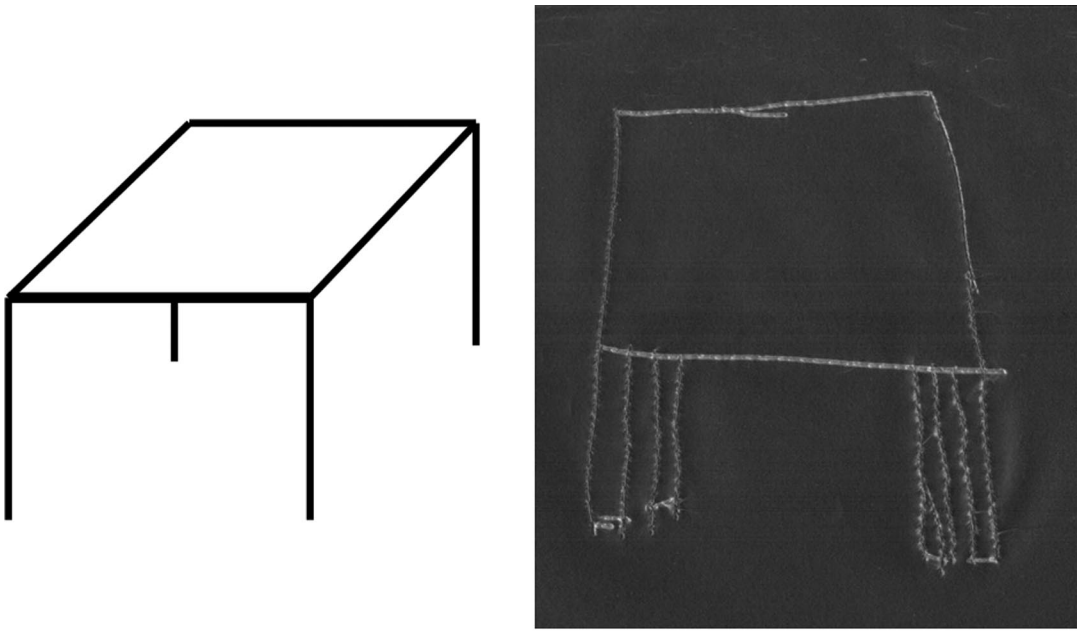
Figure 3 shows Carlo's drawing of a table. In contrast with the stimulus, Carlo's drawing has no perspective (oblique projection); it shows a rectangle as the tabletop and, attached to it, extending legs of approximately the same length, with no hint of occluded parts of any of the legs. As Carlo stated, the picture of a table should show the most salient features in terms of what can be touched: "You can run your hand . . . fingers . . . on the table, . . . and your legs often run into one of the legs that stick out from the empty spaces below the top of [the table]."

Regarding the scissors, Carlo commented



(a) Suggested (after "rejection") (b) Stimulus (c) Copy

Figure 2. (a) Sketch of a cup by Carlo, (b) the stimulus depicting a cup (not identified by Carlo), (c) copy of the picture stimulus "cup" made by Carlo during debriefing.



(a) (b)

Figure 3. A free drawing (b) of the picture stimulus "table" (a) correctly identified by Carlo.

that the "funny" orientation made the picture ambiguous: If the picture was of scissors, he would have expected the two blades "not pointing upward and not so much apart." At the same time, the handles suggested to him that the picture could be showing scissors.

Discussion

In summary, Carlo's picture-identification rate supports the findings of previous research (such as D'Angiulli et al., 1998) and supports the hypothesis that the depiction of objects through raised-outline drawings may be based on some principles of perception of the shape of objects that are common to vision and haptics—that is, partial overlap. However, further research using a larger sample is necessary. The finding that Carlo correctly identified pictures that he did not deem adequate or "good" raised-line representations indicates a dissociation between identification and beliefs, which does not support the hypothesis about tactile beliefs.

One concern may be that Carlo may not have explored the unidentified stimuli efficiently or systematically enough to note or integrate some parts of the pictures, and therefore his beliefs may have been biased by this variable. Because copying reflects how systematically haptic pictures are explored (D'Angiulli & Kennedy, 2001), during debriefing, Carlo was asked to copy the two unidentified, rejected pictures, of a key and a cup, for which he also provided his own free drawings. These copies are shown in Figures 1c and 2c beside the drawings of the same objects that Carlo provided when he was asked to describe what he believed to be an appropriate picture of a key and a cup. The drawings suggest that, although Carlo could not provide a correct identification and believed that he was touching another object, he considered all parts of the two stimuli.

Further support for the dissociation between identification and belief may be seen in the converse case, illustrated by Figure 3, in

which Carlo suggested another way to draw a table even though he could identify the raised-line picture that was presented. These examples of dissociation may reflect partial overlap, in that picture processing seems to be as "modular" and "belief independent" (Fodor, 1983) in haptics as it is in vision.

In sum, the findings of this case study support the notion that the identification of raised-line pictures is based on principles of the perception of the shape of objects, independent of tactile beliefs. These principles seem to overlap, at least partially, in vision and haptics. The findings, however, need to be replicated with a larger sample.

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