Blind children recognizing tactile pictures respond like sighted children given guidance in exploration

AMEDEO D'ANGIULLI¹, JOHN M. KENNEDY¹ and MORTON A. HELLER²

¹*Department of Psychology, University of Toronto, Ontario, Canada*

²*Winston-Salem State University, North Carolina, USA*

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Theory of tactile pictures argues that untrained blind subjects can recognize raised, outline pictures. It contends the blind person's knowledge of the shapes of common objects is like that of the sighted, and the blind person's pictorial abilities use the same principles as the sighted person's. To test this theory, blind children (aged 8–13) and blindfolded age-matched sighted children were asked to identify raised-line drawings of common objects. Their performances were correlated. In addition, the blind children identified more than sighted children exploring the pictures actively, but the same number of pictures as sighted children who were given passive, guided exploration. We argue blind and sighted children use the same principles to identify the pictures, but the blind have superior exploration skills. The differences in the effects of exploration skills on recognition scores are minimized when the sighted children are given guidance, since the sighted children then have efficient contact with the displays, and the performance of the sighted and the blind is then governed by the same principles, without one group benefitting from advantages in exploration skills.

Key words: touch, blind, pictures, passive, guided, children.

Amedeo D'Angiulli, Department of Psychology, University of Toronto, 1265 Military Trail, Scarborough, Ontario, Canada, M1C 1A4. Email: kennedy@lake.scar.utoronto.ca

Two quite different factors should be involved when novices (such as children) try to comprehend novel perceptual displays, and, in particular, perceptual aids for the handicapped. One factor is the inexperienced person's basic skill at exploring the details of the display. The second is the untrained person's ability to make sense of the details that are discovered—the ability to interpret a perceptual display once some of its contents are apprehended.

Here, we compare blind and blindfolded, sighted children, aged 8–13, attempting to recognize tactile pictures (Edman, 1992; Heller, 1991; Kennedy 1993) for the first time. We hypothesize the blind and the sighted apply the same interpretation principles to tactile pictures. The key principles, we contend, are: First, that the lines in outline drawings stand for edges of surfaces, and the edges of surfaces are tangible as well as visible. Second, the shapes of common objects such as cups, keys and scissors are made of surfaces that are evident to touch as well as to vision (Morrongiello *et al.*, 1994). And third, that touch and vision both detect what surfaces of objects are in 'in front', facing towards the observer when other surfaces are 'to the rear', facing away from the observer. These principles are hypothesized to be understood by sighted subjects who grow up in non-pictorial cultures—Kennedy (1993) discusses evidence in support of this point—and also by blind subjects who have not had exposure to tactile pictures. Consequently, blind and sighted, blindfolded subjects can identify many tactile pictures on their initial attempts. Also, blind and sighted subjects from diverse backgrounds—such as North America, Europe and Japan—

identify raised-line pictures in similar ways (Kennedy, 1997). Here, we will compare blind subjects from Italy and sighted subjects from Canada, seeking to determine if the performances of the two groups are correlated i.e. whether on a given set of pictures, what one group finds easy (or difficult) to recognize the other group also finds easy (or difficult).

Besides reasons for expecting the performance of the blind to be correlated with that of the sighted, let us consider some reasons bearing on the mean scores of the two groups.

If the blind—being familiar with tactile displays such as Braille—have superior active, self-guided tactile exploration skills, they may identify more pictures than the sighted, without actually using different principles of interpretation than the sighted. That is, the blind can perform in a manner that is correlated with that of the sighted, and in addition their mean recognition score might be higher, in free exploration conditions.

Free exploration may not always be efficient. Indeed, inexperienced observers using touch will likely not manifest well-tuned exploratory skills. However, a group of inexperienced, blindfolded subjects can be given helpful guidance in a passive exploration condition. Usefully, Magee and Kennedy (1980) have shown passive, guided exploration facilitates recognition of raised-line displays. Magee and Kennedy's procedure can be used to advantage here. If the facilitation from passive, guided conditions were to result in minimal differences in identification rates, this outcome would support the main contention of theory of tactile

pictures: the view that the blind and the sighted interpret pictures of common objects similarly, and differences in recognition rates emerge from different levels of skill in tactile exploration. In sum, recognition performances by blind and sighted groups should be correlated, if our theory of touch and of outline pictures is correct. Further, differences in mean performance can be minimized, if they are due largely to the blind having superior exploration skills.

METHOD

Subjects

Seven congenitally totally blind children and two groups of seven blindfolded sighted children participated. The blind children, aged 8 to 13, came from a school for the blind in Milan (Unione Italiana Ciechi) and were tested in Italian. Sighted children, tested in English, were recruited from an English-language school in Montreal, and matched to the blind children in age. Neither group had used raised-line pictures previously. One reason for comparing Italian and Canadian groups was to check for correlations in performances across two cultures, to test the contention that pictorial principles are similar in a wide variety of groups. Also differences between the Montreal groups allow comparisons between active and passive, guided exploration. (We note that replications with sighted groups in Toronto produced the same results as those reported here.)

The choice of an Italian blind group and Canadian sighted groups can be disputed. It would be controversial if major differences appeared, since these could be due to culture or to sensory status. However, as will become evident, there was a remarkably close fit in the performances of the various groups. Also, the one major difference that appeared was the subject of an active/passive experimental manipulation with the Canadian groups. Interpretation of the active/passive manipulation is not subject to cultural and visual-status differences.

Stimuli and apparatus

The stimuli were 8 raised-line configurations taken from Heller (1989): face; bottle; cup; person; telephone; umbrella; scissors; key (Fig. 1). Their largest dimension varied from 16.5 cm (telephone) to 14.5 cm (cup). The lines were circa 0.5 mm high, on flat plastic sheets.

Each sighted child matched to a blind child was given the same presentation order (and stimuli to copy in a drawing task). Presentation orders were randomized across subjects and differed in test and in re-test. Correct performance involved offering the labels listed above (face, bottle, etc.) or close synonyms (e.g. man for person; phone for telephone, etc.).

Procedure

Blind children and one group of sighted children were tested in active-exploration conditions throughout. The third group was given passive guided exploration in the initial test, and active exploration thereafter.

Practice. A raised-line drawing described as 'an apple' was shown, tactually to the blind and visually to the sighted. Then, the sighted children were blindfolded. Next, the children were given a raised-line picture of 'a shoe'. If the child was in the passive condition, the experimenter guided the child's index finger twice around each figure, from the bottom of the figure. Then, all children were asked to make a raised-line copy of the shoe, 'thoroughly and completely'.

First Recognition Test. The children were asked to identify a set of pictures, one picture at the time, being sure to touch everything on the page.

In the passive condition the experimenter guided the child's index finger around each figure twice. Exploration continued until the first response or for two minutes. All subjects gave one scorable response per trial.

Further practice. The experimenter selected three pictures the subject had not managed to recognize and asked the child to explore them actively and to copy them as accurately as possible. Sighted

Fig. 1. Versions of figures from "Picture and Pattern Perception in the Sighted and the Blind: The Advantage of the Late Blind," by M. A. Heller, 1989, *Perception*, 18, p. 383. Copyright 1989 by Perception. Adapted with permission.

Table 1. Mean recognition scores by blind children and blindfolded sighted children

	First recognition test	Second recognition test
Group		
Blind	3.6	4.3
SD	1.6	1.7
Sighted		
Active (first test)	0.7	2.1
SD	0.7	2.3
Passive (first test)	2.8	4.4
SD	2.4	2.5

children copied the same drawings as the blind children to whom they were matched—drawings the blind and the sighted children had not recognized.

Second Recognition Test. The subjects attempted to recognize the same displays as in the first recognition test, but in different order and using active exploration.

Results

Two of the blind children only attempted 7 of the 8 pictures. They indicated they did not wish to attempt any more pictures. For ethical reasons, the subjects' requests were respected. Consequently, the sighted subjects who were matched to these two blind subjects were also given 7 pictures only. Only displays that had actually been given to a subject in the first test were administered to that subject in the second test. That is, the blind subjects who only attempted 7 pictures in the first test, and the sighted children matched to them, only attempted the same 7 pictures in the second test.

The blind children initially recognized 25 of the pictures they attempted (cf. 30 in the second test), the sighted children initially given passive exploration recognized 20 (cf. 31 on the second test), and the sighted children who initially undertook active exploration recognized 5 (cf. 15 on the second test). The mean recognition scores (see Table 1) on the first test were blind subjects 3.6, active subjects 0.7 and passive-guided subjects 2.8. On the second test the scores were higher—4.3 for the blind, 2.1 for the sighted children active on both tests, and 4.4 for the sighted children who had been passive-guided initially.

Analyses on number correct (analyses on percent correct provide similar results) indicate visual status/mode of exploration was significant, $F(2, 18) = 4.47$, $p = 0.027$, as was the effect of trials, $F(1, 18) = 7.93$, $p = 0.011$, but not the interaction ($F < 1$). Since the interaction was non-significant, a Newman-Keuls test can be performed on the means collapsed over trials. The sighted-active group was significantly lower than the other two groups (both $p < 0.05$), but the sighted-passive group and the blind group were not different ($p > 0.05$).

The recognition scores by the blind children on the first test correlate with the recognition scores by both the sighted children in the passive condition (Spearman correlation coefficient $r = 0.73$; $n = 8$; $p < 0.05$), and the sighted children in the active condition ($r = 0.81$; $p < 0.02$). In the second test, recognition scores per picture by the blind correlate with the scores by the sighted who had been in the passive condition initially ($r = 0.71$; $n = 8$; $p < 0.05$), but do not correlate with the scores of the sighted in the active-only condition ($r = 0.30$; $p > 0.05$) which may be due largely to an especially high recognition by this group of the bottle figure, which was recognized 5 times.

The subjects were not told whether their responses on the first identification task were correct or not. We suggest that it is particularly instructive that despite this absence of feedback, correct identifications were repeated (on 25 trials) more frequently than incorrect identifications (7 trials) by the blind children ($t = 3.7$; $df = 6$; $p < 0.01$) and the passive-guided sighted children (19 correct responses repeated vs 1 incorrect, $t = 2.7$; $df = 6$; $p < 0.05$). The sighted children who underwent the active condition initially repeated few responses of any kind (2 correct responses repeated vs 2 incorrect).

DISCUSSION

The blind children recognized tactile pictures, and were superior to blindfolded sighted children exploring the tactile displays actively, but not to passive, guided children. The fact that the blind children could identify many of the pictures is a central piece of evidence indicating the blind and the sighted children may use similar principles in identifying tactile pictures. In addition, the results support the contention that the blind children have superior exploration skills, but systematic, guided exploration can facilitate recognition by the sighted children.

In the second recognition test, the mean scores of all three groups of children increased and the scores by the blind children and the sighted children who were originally in the passive condition remained close (the blind recognizing 55% and the sighted 57%), indicating the sighted children retained benefits from the systematic passive guidance. The blind children and the sighted children who were in the passive condition repeat their correct responses in the second test more frequently than they repeat erroneous responses. Interestingly, it seems the blind children and the sighted children in the passive condition 'know when they are right'.

It is impressive that the blind children, who had not used outline pictures previously, are able to distinguish their own correct responses to pictures from their incorrect responses, and to use the distinction to advantage, changing their incorrect responses at a higher rate than their correct responses at their own behest. This further supports the contention that pictures can be understood by a variety of subjects without training in a convention.

The correlation results indicate pictures frequently recognized by the blind were also pictures frequently recognized by the sighted, on both first and second recognition trials. This is the key evidence that suggests similar knowledge of shape of common objects and similar principles of depiction are being used by the blind and the sighted in interpreting pictures.

If blind children used different principles of picture recognition than the sighted, they could have recognized the same number as a sighted group, but the performances of the blind and sighted children would likely have been uncorrelated. The similar knowledge of shape of common objects, in blind and sighted subjects, is obtained, Heller (1991) and Kennedy (1993) contend, largely from percep-

tual effects of surfaces. Vision deals with flat and curved surfaces, and so too does touch. In addition, knowledge of shapes of objects must take into consideration the observer's vantage point, which allows for foreground surfaces, plus front, rear and side surfaces of detached objects, and background surfaces. But further, vision and touch must use outline in similar fashions to access knowledge of shapes of object surfaces. In particular, both visual and tactile outline can depict edges of flat-surfaced objects and the occluding boundaries of rounded objects i.e. the locations of tangents to the observer's vantage points, dividing frontal surfaces from rear surfaces. In addition, many objects must be relatively accessible by both vision and touch (for example: balls, utensils, cups, glasses, plates, chairs, etc.) even if some objects are used much more by the sighted (flashlights, for example) and some by the blind (folding canes, for example). Theory of surface perception, object shape, use of the observer's vantage point, and the use of outline are all in a developing state at present, but our results indicate strongly that both vision and touch require such theories, and they are not matters for vision alone.

In sum, like the sighted, the blind possess cognitive and perceptual abilities that can be employed by pictorial aids.

The ability of the blind can be tapped on first exposure to picture-recognition tasks, our results indicate.

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