

## A STUDY ON THE DISCRIMINABILITY OF TACTUAL POINT SYMBOLS

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### ABSTRACT

Thirty tactual-point symbols were tested for discriminability by the method of pair comparisons. The 194 visually-handicapped subjects included schoolchildren, adults who read braille, and adults who were nonbraille readers. The results indicated that 13 point symbols met the criteria of discriminability suggested by Nolan and Morris (1971).

### INTRODUCTION

Tactual maps and diagrams are composed of three categories of symbols: line symbols to designate boundaries or lines, areal or texture symbols for areas, and point symbols to show specific locations or landmarks. This study is concerned only with point symbols.

The three major factors influencing the discrimination of tactual symbols are:

Size. Tactual symbols have to be constructed at a much larger size than visual ones because of the relative inadequacy of touch when compared with vision. Nolan and Morris (1971) found that symbols of 5 mm. side length were considerably less confused than those at a smaller size. This prompted the recommendation that point symbols should not be smaller than 5 mm. The shortcoming of trying to define a minimum size for point symbols is that difference in size may be one of the major factors contributing to legibility among point symbols.

Height. Psychophysical studies of stimulus height or relief have been mainly concerned with the braille dot. For instance, Meyers (1955) found that differences of 0.025 mm between heights of neighboring dots could be distinguished with 68 percent accuracy, and this improved to near 100 percent when the height differed by 0.127 mm. This indicates that variation in the height of tactual symbols may be a good distinguishing feature. Variation in height has been used to differentiate between point, areal, and line symbols in the context of a tactual map (Wiedel, 1969) but not within these categories of symbols.

Schiff (1967) suggested that a pattern or a pattern unit providing differential rates of digital skin deformation gives an excellent basis for tactile discrimination in that this provides an intensity basis for tactile perception. Schiff, Kaufer, and Mosak (1966) developed a tactual line whose properties specify direction, in that the line felt smooth in one direction and rough in the other direction. Schiff and Isikow (1966) studied the effect of redundant information in a tactual histogram and found that a redundant presentation provided the fewest errors when size differences were small.

Form or Configuration. A low two-point limen, or threshold of touch, for the fingers is important in determining the form or configuration of a tactual symbol. Boring (1942) and Weinstein (1968) found

this was 2.3 mm for static touch. This corresponds to the interdot spacing for standard braille. The two-point limen is reduced if active touch is employed and allows "micro-dot" braille (1.9 mm spacing) to be legible. However, braille reading speed is considerably reduced when the interdot distance is reduced to 2 mm (Calvin and Clark, 1958; Meyers, Ethington, and Ashcroft, 1958).

Schiff and Dytell (1971) recommend that "although the terms tactual and tactile are used interchangeably throughout most of the literature, we suggest that tactual specify the active use of part of or the entire hand as a 'sense organ system' (Gibson, 1966), including the obtaining of stimuli from muscles and joints as well as the skin, while tactile should specify skin sensitivity per se, implying 'passive' touch (Gibson, 1962) in most cases."

Major (1898) tested both solid and outline circles and triangles. He ranked the outline circles as the easiest to discriminate and the solid circles as the most difficult. Zigler and Barrett (1927) tested solid, outline, and punctate symbols and found that the outline figures gave the most accurate scores. It appears that the pad of the finger feels an outline shape more easily than a solid one, but this does not hold when the size is reduced. Austin and Sleight (1952) examined the static and active discriminability of both outline and punctate point symbols and found that outline figures with tactual reading were the most discriminable.

The two-point limen of touch may be lowered by the use of active touch and by training (Boring, 1942; Weinstein, 1968). Consequently, these factors may be important in the discrimination of embossed symbols.

Nolan and Morris (1971) studied 12 point symbols embossed in plastic at 5 mm size and found 8 to be discriminable. They also tested 19 symbols embossed in paper of which the largest was 14 mm and found 11 to be discriminable. Wiedel and Groves (1969) tested 15 point symbols and found 3 to be discriminable, but details of their testing procedures are not reported.

The aim of this experiment is to study the discriminability of 5 mm tactual point symbols for four groups of subjects. The four groups of visually-handicapped subjects are schoolboys, schoolgirls, adults who read braille, and adults who are non-braille readers. The data obtained from this experiment is to be used in the future design of tactual maps and diagrams.

## EXPERIMENT 1

### Method

Subjects. Forty-five blind schoolboys, 52 blind schoolgirls, 32 blind adults who read braille, and 27 blind adults who do not read braille were used as subjects; they were not paid for their services. The adults were a convenience sample of those who agreed to be tested at various centers for the blind. The mean ages for these groups are shown in Table 1.

For the schoolchildren, IQ scores, ages, and braille reading speeds were obtained from the schools. They assessed braille reading speed in the following way:

1. The child read braille text out loud to the whole class for 3 minutes,
2. A score was taken for the number of braille lines completed,
3. The number of lines completed was then multiplied by 0.75 to give an average speed in pages of braille per hour.

The adults were asked for their age, date of becoming registered blind, degree of blindness, and their experience with tactual maps. Braille readers were defined as those who said they were proficient Grade 2 braille readers. The degree of blindness, as reported by the subjects, was specified as three groups--totally blind (T), perception of light (PL), and perception of hand movement (HM). Experience with tactual maps was subdivided into--a good deal (A), some (B), and very little or none (C). The results are summarized in Table 2.

TABLE 1

Ages and Length of Time Registered Blind in Years

	<u>Boys</u>	<u>Girls</u>	<u>Adult Braille Readers</u>		<u>Adult Non-Braille Readers</u>	
	age	age	age	onset	age	onset
Mean	15.1	15.7	44.6	29.2	54.4	13.7
S.D.	2.1	2.0	15.8	21.4	13.4	17.1

TABLE 2

Number of Adult Subjects by Sex, Degree of Blindness and Experience with Tactual Maps

	N	<u>Sex</u>		<u>Degree of Blindness</u>			<u>Experience with Maps</u>		
		male	female	T	PL	HM	A	B	C
Braille readers	32	18	14	23	4	5	5	12	15
Non-braille readers	27	11	16	6	7	14	0	3	24

Selection of symbols. A pilot study was conducted using symbols based on those tested by Nolan and Morris (1971), Schiff (1967), Wiedel and Groves (1969), and those in current use in Britain. Symbols consisting of groups of dots were rejected since these were considered to be multiple symbols. Fifty different symbols with a maximum side length of 5 mm were produced in 0.18-mm semi-rigid vinyl sheet with 1.5-mm relief. The symbols were vacuum-formed from a master made by a computer-aided production system (Gill, 1972).

Following a pilot study, 30 symbols were chosen for testing and divided into three groups of ten

(Figure 1). The allocation into different groups was done so that symbols thought likely to be confused were in the same group.

Apparatus. The apparatus is shown in Figure 2. The screen excluded the use of residual vision. The symbols were mounted 50 mm apart on three disks, 55 pairs on each disk. The disks were rotated by the experimenter so that the symbols were in the same place under the subject's fingers. The order of the pairs and the order of presenting the pairs was determined randomly. The order of presenting the disks and the direction of rotation was also determined randomly, giving 18 different orders of presentation.

