TACTILE MAP OPEN STIMULUS SET:

A Database of Tactile Maps for Empirical Research

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# 1. OVERVIEW OF THE TACTILE MAP OPEN STIMULUS SET

The “Tactile Map Open Stimulus Set” is a database of tactile maps for empirical research, created by Valerie Morash, Allison E. Connell Pensky, and Joshua A. Miele. The database consists of 56 tactile maps, subdivided into groups of 8, such that many of the map parameters are controlled across the groups. When map groups are randomly assigned to experimental conditions, this ensures that parameters are balanced (controlled) across the conditions allowing for within-subjects designs. Each map represents a fictitious park, and is pseudo-randomly generated: random except for maintaining the controls detailed below. This document describes the motivation, design, construction, and potential uses of these stimuli.

# 2. MOTIVATION

These stimuli were originally designed for use in particular experiments on tactile perception, where several distinct tasks needed to be embedded and controlled across the stimuli. However, because there is a dearth of well-controlled tactile stimuli, this stimulus database is likely to be generally useful to a wide range of researchers in the fields of tactile (haptic) perception and tactile maps.

## 2.1 Why tactile maps?

We considered several possible tactile stimulus types, many of which have been used in previous research, including: braille, raised-line drawings, tactile maps, randomized simplistic stimuli, common three-dimensional (3D) objects, and 3D objects designed with a computer and specially manufactured. It was important that the stimuli provided a variety of tasks (e.g., naming, searching, and distance estimation) in such a way that could be controlled.

We were particularly interested in two-dimensional (2D) stimuli, because these stimuli could be better controlled than common 3D objects, such as those bought in a store. Additionally, our scientific questions could be addressed with 2D stimuli, so we chose to avoid the unnecessary complexity of designing and manufacturing 3D objects. It is much easier to design and create 2D objects. Each researcher will need to decide if her scientific enquiry can be adequately addressed using 2D stimuli before deciding to use this stimulus database.

Amongst the 2D stimulus possibilities, both braille and raised-line drawings presented problems. Reading braille is a highly stereotyped behavior, and we questioned its relevance to other tactile procedures. We were also concerned that braille stimuli could not be naturally used for several different tasks. Raised-line drawings, which are like conventional line drawings except the lines have been raised off the surface, are similarly problematic. The typical measure of performance with raised-line stimuli is accuracy and speed in naming the depicted object. These stimuli afford only one natural task: naming. Additionally, failure at performing this task with high accuracy may be a semantic deficit, rather than a perceptual deficit (Heller 2002; Révész 1950); and line-drawings often contain vision-specific information, such as depth-cues, that are normally irrelevant to the tactile system (e.g., Edman, 1992; Lambert & Lederman, 1984).

We decided on tactile maps over randomized simplistic stimuli. A simplistic stimulus could be two bumps, for which we would ask a participant to measure the distance between the bumps, or the angle of the line connecting the bumps. Tactile maps have the advantage of being relatively engaging and easier to remember than such random patterns. Also, any results with tactile maps are immediately and directly relevant to tactile-map users. Lastly, we were unconvinced that randomized simplistic stimuli would offer any advantage, such as greater controllability, over tactile maps. Essentially, we embedded these randomized simplistic stimuli into our tactile maps (e.g., measuring distances between two elements on the map rather than two solitary bumps).

Additional benefits of tactile maps as stimuli include the fact that maps represent a 2D layout in 2D, unlike raised-line drawings, which represent a 3D object in 2D. Also, several tasks can be naturally embedded within a map in a controlled manner, and there is a wealth of information on tactile map parameters that can be used to promote legibility and avoid issues such as crowding. The design of the Tactile Map Open Stimulus Set, in particular what is discussed in the next section, makes heavy use of this previous research.

# 3. MAP DESIGN: MATERIALS, SCALE, SIZE, & SYMBOLS

## 3.1 Map Scale

The map scale is consistent throughout each map layout, i.e., one inch represents the same distance on all parts of a single map and across all maps. This is not always true of tactile maps, because the scale is often distorted to increase legibility by separating map features (Bentzen, 1972; Edman pp. 135 & 195), or to increase saliency by enlarging map features (Edman, p. 135). However, for experimental purposes, having a non-constant scale introduces unneeded complexity.

## 3.2 Map Size

The maps are 12 in. by 12 in., which is approximately the recommended size by Wiedel and Groves (1969), who promote the standard Braille page size (11 in. by 11.5 in.) as the most practical and appropriate for tactile maps. This size allows a decent amount of map area to be represented in a single hand span, and is conveniently divided into 6 in. by 6 in. quadrants.

## 3.3 Map Symbols

### 3.3.1 Symbol Types

Map symbols are classified using the typical map-symbol terms: area symbols, line symbols, and point symbols (Barth, 1982; Gardiner & Perkins, 2003; Lambert & Lederman, 1984; Potash, 1977).

**Area symbols** depict extended regions. The dimensions of these symbols represent the shape, size, and location of the real-world feature. Area symbols are used to represent grass and water.

**Line symbols** depict boundaries or paths. The length and location of these symbols represent the length and location of the real-world feature, but the widths do not relate to the real-world widths. Line symbols are used to represent walking paths and the map boundary.

**Point symbols** depict specific locations, landmarks, or objects. These symbols are symbolic, and their size (2D height and width) do not have any relationship to the real-world size of the represented feature. The location of the symbol indicates the location of the real-world feature. Point symbols are used to represent picnic tables, drinking fountains, play areas, rest rooms, and trash cans.

### 3.3.2 Symbol Dimensions and Textures

We will adopt Jehoel, Sowden, Ungar, and Sterr’s (2009) terms “size,” “width,” and “height” to refer to the 2D area of a map symbol, and “elevation” to refer to the vertical height the symbol is raised or inset into the map. We will also use the term “shape” to refer to the 2D shape of a symbol, such as circle or square.

#### 3.3.2.1 Elevation

To ensure map legibility, point, line, and area symbols have different elevations and textures (Edman p. 121; Perkins & Gardiner, 2003; Wiedel & Groves, 1969). In accordance with James (1982) and Wiedel and Groves (1969), area symbols have the lowest elevation, being flush with the map (grass: 0.00 in. elevation) or inset into the map (water: -0.02 in.). Line symbols have a middle elevation (0.04 in.), and point symbols have the highest elevation (0.06 in.).

#### 3.3.2.2 Texture

All symbols, except for water, are non-textured (smooth). The water area symbol has a rough texture. The contrast between smooth and rough, together with an elevation difference, is more effective for differentiating area symbols than elevation alone (Bentzen, 1972; Jansson, & Monaci, 2003).

#### 3.3.2.3 Shape and Size: Area Symbols

Each map contains two area symbols: smooth “grass,” and rough inset “water”. Water only appears as a single connected area on each map and represents a lake. These lakes are at least 0.5 in. square to ensure readability (Nolan & Morris, 1963).

#### 3.3.2.4 Shape and Size: Line Symbols

Each map contains two line symbols: the bumpy map border, and smooth “walking paths.” These were selected based on recommendation from Edman (p. 215), who cites the work of Berlin and Nyman (1971) and Jansson and Monaci (2003), in suggesting that a dotted 0.06 in wide line (0.06 in. sized dots spaced 0.06 in apart) and a solid 0.06 in. wide line are highly differentiable. Barth (1982) also suggests that continuous and interrupted lines are highly discriminable. Therefore, we use a dashed line for the map border and a solid line for the walking paths. The dashed line is made with the dimensions recommended by Edman, but is dashed instead of dotted due to production constraints. Other researchers may choose between dotted and dashed based on their own production methods. The map border forms the outline of an 11.5 in. by 11.5 in. square centered on the map. All line symbols are more than 1 in. long, as suggested by Nolan and Morris (1971).

#### 3.3.2.5 Shape and Size: Point Symbols

In selecting point symbol shapes to ensure high legibility, we considered that point symbols shown as an outline are more legible than those shown as a solid form (Edman p. 209; Rener, 1993). We did not want our symbols to be overly intricate, because simple shapes (e.g., circle) are more readable than complex ones (e.g., star) (Edman p. 210). Additionally, point symbols that are essentially visual symbols directly presented to the tactual mode are found to be meaningless by congenitally-blind participants (Lambert & Lederman, 1984).

The point symbols are the outline shapes of an oval, circle, square, and triangle, and the letter T. These shapes, except for the triangle, are recommended by Rener (1993) based on a meta-analysis. Additionally, the outline circle, triangle, and square are amongst the most differentiable symbols of those tested by the Virginia State School for the Deaf and Blind (Wiedel & Groves, 1969); and the T, outline triangle, and outline circle are highly differentiable according to Barth (1982). Lastly, Jehoel et al. (2009) note that outline circles, squares, and equilateral triangles are “the most basic and most commonly used shapes for map symbols.”

The size of the point symbols are based on Nolan and Morris (1971), who use the outline oval, circle, and letter T in their study, and recommend their sizes as highly readable. Using commercial image-editing software, we measured the size of their stimuli, which were printed to-size in their manuscript. Their symbol line width was 0.04 in, symbol heights were 0.3 in., and symbol widths were as follows: oval 0.19 in., T 0.23 in., and triangle base 0.3 in. These sizes are consistent with the recommendations from Edman (p. 209) that symbols should fit under a fingertip, and with those from Nolan and Morris (1971) that symbols should be at least 0.2 in. on a side. Furthermore, Jehoel, et al. (2009) found that discrimination of outline square, circle, and equilateral triangle symbols does not improve with increased size beyond 0.2 in. for circle diameter, 0.25 in. for equilateral triangle side, and 0.20 in. for square side.

### 3**.3.3 Symbol Separation**

Symbols are placed with a minimum inter-symbol distance of 0.25 in. to ensure legibility (Amick & Corcoran 1997; Gardiner & Perkins, 2003; Nolan & Morris, 1963). The only exception to this is that paths begin and terminate at map boundaries. Lakes are placed at least 1.5 ins. from the map border, which allows a symbol to be placed between the lake and map border without violating the minimum inter-symbol distance.

### 3.3.4 Point Symbol Meanings

As mentioned above, point symbols represent picnic tables, drinking fountains, play areas, rest rooms, and trash cans. Lambert and Lederman (1989) suggest that symbols be chosen to represent features intuitively. Therefore, we collected pilot data from 6 blindfolded-sighted participants, asking them to create an intuitive mapping between our symbols and meanings. Based on these data, we assigned circle to trash can, triangle to restroom, oval to drinking fountain, T to picnic table, and square to play ground.

### 3.3.5 Symbol Summary Table

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Table 1.* Symbol Summary for Quick Reference | | | | | |
|  | | | | | |
| **Area Symbols** | | | | | |
| *Symbol* | *Feature* | *Elevation (in.)* | | | |
| Rough | Water / Lake | – 0.02 | | | |
| Smooth | Grass | 0.00 | | | |
|  | | | | | |
|  | | | | | |
| **Line Symbols** | | | | | |
| *Symbol* | *Feature* | *Width (in.)* | *Elevation (in.)* | *Dash Size (in.)* | *Dash Separation (in.)* |
| Solid Line | Path | 0.06 | 0.04 | N/A | N/A |
| Dashed Line | Map Boundary | 0.06 | 0.04 | 0.06 | 0.06 |
|  | | | | | |
|  | | | | | |
| **Point Symbols** | | | | | |
| *Symbol* | *Feature* | *Height (in.)* | *Width (in.)* | *Elevation (in.)* | *Line Thickness (in.)* |
| Oval | Drinking Fountain | 0.30 | 0.19 | 0.06 | 0.04 |
| T | Picnic Table | 0.30 | 0.23 | 0.06 | 0.04 |
| Circle | Trash Can | 0.30 | 0.30 | 0.06 | 0.04 |
| Square | Playground | 0.30 | 0.30 | 0.06 | 0.04 |
| Triangle | Restroom | 0.30 | 0.30 | 0.06 | 0.04 |
|  |  |  |  |  |  |

# 4. MAP DESIGN: CONTROLLED PARAMETERS ACROSS MAPS

## 4.1 Number of Point Symbols

The number of point symbols per map is 13, which maintains a relatively uncluttered layout. This decision was informed by a survey (Barth, 1982) of different types of graphical displays, including those from math, science, business, and textbooks. Most graphical displays can be depicted with less than 7 point symbols, 5 linear symbols, and 4 area symbols, and use of more than this number on a particular display can make the display illegible due to perceived clutter.

Additionally, no more than 6 point symbols are placed in any quadrant of a map, which ensures relatively low symbol density. High visual map-symbol density is known to produce cluttered maps, which are difficult to read (Potash, 1977). The limit of 6 point symbols per quadrant also forces there to be point symbols present in at least 3 map quadrants.

## 4.2 Point Symbol Clusters

To provide the stimuli with unique features that can be referenced, point symbols are arranged into clusters. These are important because each map contains multiple of the same point symbol, so it is difficult to reference a particular symbol unambiguously. However, a unique cluster can be referenced, e.g., in the question: “Where is the cluster of circles?” Each map contains 3 clusters composed of 3-4 point symbols. The clusters on a map are unique; they always differ in their contained symbols, and often differ in their configuration. Each individual cluster is made up of the same symbol. For example, a square configuration may be composed of 4 ovals, but not 3 ovals and a square. The clusters and their dimensions are listed in Table 2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Table 2.* Symbol Clusters | | | | | |
|  | | | | | |
| *Cluster* | *Number of Symbols* |  | *Illustration (30%)* | *Horizontal and Vertical*  *Center-to-Center Distances (in.)* | |
| Horizontal Line | 3 |  |  | 0.6 | |
|  |  |  |  |  | |
| Triangle | 3 |  |  | 0.6 | |
|  |  |  |  |  | |
| Vertical Line | 3 |  |  | 0.6 | |
|  |  |  |  |  | |
| Square | 4 |  |  | 0.6 | |
|  |  |  |  |  | |
| Diamond | 4 |  |  | 0.6 | |
|  |  |  |  |  |  |

## 4.3 Lake Perimeter

Every lake has a constant perimeter of 14 in.

# 5. MAP DESIGN: CONTROLLED PARAMETERS ACROSS MAP GROUPS

Each map belongs to a group of 8 maps. Some parameters are not the same for every map, but are the same for every group of maps.

## 5.1 Path Quantities, Loops, and Lengths

Half of the maps in a group have 1 walking path and half have 2 paths. Half of each of maps have a path that contains a loop, and half contain no loop. Therefore, in each map group there are 2 maps with one non-looped path, 2 maps with one looped path, 2 maps with 2 non-looped paths, and 2 maps with 2 paths: one with a loop and one without.

This is implemented through 8 unique path specifications, each defining the number of paths, the lengths of these paths, whether each path has a loop, and if it does have a loop the length of the loop. These 8 unique path specifications are randomly assigned to the 8 maps in every group.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Table 3.* Path Specification | | | | | |
|  |  |  |  |  |  |
| *Identifier* | *Number of Paths* | *Contains Loop* | *Length Path 1 (in.)* | *Length Loop (in.)\** | *Length Path 2 (in.)* |
| 1 | 1 | No | 18.1 | 0 | 0 |
| 2 | 1 | Yes | 8.8 | 0 | 21.2 |
| 3 | 2 | No | 10.5 | 11.9 | 0 |
| 4 | 2 | Yes | 6.7 | 10 | 17.9 |
| 5 | 1 | No | 25.7 | 0 | 0 |
| 6 | 1 | Yes | 9.4 | 0 | 22.4 |
| 7 | 2 | No | 8.7 | 14.7 | 0 |
| 8 | 2 | Yes | 8.7 | 15.7 | 12.2 |
|  |  |  |  |  |  |
| \* Loop attached to Path 1 | | | | | |

## 5.2 Point Symbol Clusters

In total, there are 24 unique clusters. This includes every permutation of point symbol (square, circle, oval, T, and triangle) with configuration (4 symbols in a square, 3 symbols in a triangle, 4 symbols in a diamond, 3 symbols in a horizontal line, and 3 symbols in a vertical line), with the exception of the triangle configuration of ovals, which was randomly chosen to be omitted. Each map group contains all 24 unique clusters: 3 per map.

The location of each of the clusters’ center is measured in X and Y coordinates, where the X axis is aligned with the bottom of the map and the Y axis with the side of the map, and the origin is placed at the bottom left corner of the map. We compared the X-values across the map groups using a one-way analysis of variance, and similarly for the Y-values, both of which were non-significant, *F*(6,161) = 0.30 *p* = 0.94 and *F*(6,161) = 0.22 *p* = 0.97 respectively. This indicates that there is no evidence that cluster placement is different across groups.

## 5.3 The Distribution of Unique Point Symbols

Half of the maps in a group contain 3 of the 5 unique point symbols, and the other half have 4. The 13 total point symbols on each map are randomly assigned, with the constraint that there be 1-5 of each unique symbol on the map. There must be at least 3 unique point symbols to compose the required 3 clusters discussed above. For example, one map may have 4 types of point symbols distributed as 4 circles, 5 squares, 3 ovals, and 1 triangle; with the 3 clusters made of circles, squares, and ovals.

The number of each unique point symbol is roughly equal across the groups, with each group containing 20-22 squares, 17-20 ovals, 20-23 circles, 21-23 Ts, and 21-22 triangles. If the point symbols were equally distributed, taking into account that there are 3 less ovals than the other symbols (due to the exclusion of the cluster: triangle configuration of ovals), we would expect 18.4 ovals, and 21.4 of each other symbol per group. These expected values are very close to the actual number of unique point symbols per group.

## 5.4 Distances Between Symbol Clusters

There are 8 unique distance specifications that define the distances between the 3 symbol clusters on a map, measured from closest edge to closest edge (met to within ±0.2 in.). These 8 unique cluster-distance specifications are randomly assigned to the 8 maps in every group.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 4.* Distances Between Clusters | | | |
|  |  |  |  |
| *Identifier* | *Distance Between*  *Cluster 1 & 2 (in.)* | *Distance Between*  *Cluster 1 & 3 (in.)* | *Distance Between*  *Cluster 2 & 3 (in.)* |
| 1 | 5.4 | 5.8 | 7.2 |
| 2 | 5.1 | 6.0 | 8.1 |
| 3 | 2.5 | 5.3 | 7.2 |
| 4 | 3.6 | 4.4 | 4.8 |
| 5 | 2.0 | 4.9 | 7.0 |
| 6 | 2.7 | 5.6 | 6.8 |
| 7 | 3.0 | 5.8 | 7.8 |
| 8 | 3.2 | 4.7 | 8.6 |
|  |  |  |  |

## 5.5 Distances Between Symbol Clusters and Lake

Similar to the distances between clusters, there are 8 unique specifications that determine the distance between each cluster and the lake perimeter (met to within ±0.2in). These 8 unique cluster-lake specifications are randomly assigned to the 8 maps in every group.

|  |  |  |  |
| --- | --- | --- | --- |
| *Table 5.* Distances Between Clusters and Lake | | | |
|  |  |  |  |
| *Identifier* | *Distance Between*  *Cluster 1 & 2 (in.)* | *Distance Between*  *Cluster 1 & 3 (in.)* | *Distance Between*  *Cluster 2 & 3 (in.)* |
| 1 | 1.2 | 3.0 | 3.1 |
| 2 | 0.9 | 1.2 | 4.5 |
| 3 | 0.8 | 2.5 | 3.2 |
| 4 | 1.9 | 2.6 | 3.6 |
| 5 | 0.9 | 1.8 | 3.0 |
| 6 | 1.4 | 1.4 | 4.2 |
| 7 | 1.0 | 1.4 | 3.9 |
| 8 | 1.3 | 2.7 | 6.0 |
|  |  |  |  |

## 5.6 Relationships Between Symbol Clusters and Other Symbols

There are 2 types of additional relationships that are imposed on point symbols: symbols closest to a cluster, and the symbol(s) in ordinal direction(s) from a cluster. These constraints are based off of specific questions that might be asked, such as “What symbol is closest to the cluster of squares?” and “What symbol is directly above the cluster of squares?”

### 5.6.1 Closest to Clusters

There are 20 unique distances between a cluster and its closes symbol that are distributed over the 8 maps in each group (met to within ±0.2 in.). The symbol that is closest to a cluster can be one of the symbols composing another cluster or can be a solitary symbol. The closest symbols are equally distributed: 4 ovals, 4 squares, 4 circles, 4 Ts, and 4 triangles per group. The angles from the clusters to their closest symbols are equally distributed between: 5 upwards, [45°,135°); 5 downwards, [225°, 316°); 5 rightwards, [315°,45°); and 5 leftwards, [135°, 225°). Lastly, 10 of the clusters and their closest symbols, per group, are separated by only a path, while the other 10 are not separated by any other symbol. There are 4 clusters per group whose closest symbols are unconstrained (the distance, angle, etc. are not controlled as detailed above). This is because only 20 are constrained of the 24 total clusters per map group.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Table 6.* Closest to Clusters Distances | | | | |
|  |  |  |  |  |
| *Identifier* | *Distance (in.)* |  | *Identifier* | *Distance (in.)* |
| 1 | 1.8 |  | 11 | 1.0 |
| 2 | 2.5 |  | 12 | 1.4 |
| 3 | 2.9 |  | 13 | 0.8 |
| 4 | 1.4 |  | 14 | 1.8 |
| 5 | 1.0 |  | 15 | 1.8 |
| 6 | 0.9 |  | 16 | 2.7 |
| 7 | 1.8 |  | 17 | 2.2 |
| 8 | 2.1 |  | 18 | 1.5 |
| 9 | 3.2 |  | 19 | 1.0 |
| 10 | 1.0 |  | 20 | 0.9 |
|  |  |  |  |  |

### 5.6.2 Ordinal Directions from Clusters

There are 20 unique distances established between a cluster and the symbol in an ordinal direction from the cluster: up, down, right, and left (alternatively: North, South, East, and West). The ordinally-located symbol can belong to another cluster or can be a solitary symbol. These symbols are equally distributed: 4 ovals, 4 squares, 4 circles, 4 Ts, and 4 triangles per map group. The ordinal directions are also equally represented (i.e., 5 of each). Tracing between the clusters and the ordinally-located symbols is interrupted by nothing in 9 instances, by a single path on 9 in 10 instances (9 on 50%), and by the lake on 1 or 2 instances (2 on those that had 9 path interruptions), per group. A cluster can be used multiple times for this purpose, e.g, “What is directly above the cluster of Ts?” and “What is directly to the right of the cluster of Ts?” may both be asked with the same map. Therefore, as with the closest symbols to clusters, several clusters in a map group are unconstrained in regards to their ordinal relationships to other symbols.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Table 7.* Ordinal Directions from Clusters Distances | | | | |
|  |  |  |  |  |
| *Identifier* | *Distance (in.)* |  | *Identifier* | *Distance (in.)* |
| 1 | 1.0 |  | 11 | 3.1 |
| 2 | 2.4 |  | 12 | 5.8 |
| 3 | 4.2 |  | 13 | 2.1 |
| 4 | 2.0 |  | 14 | 6.9 |
| 5 | 5.4 |  | 15 | 5.2 |
| 6 | 5.2 |  | 16 | 1.6 |
| 7 | 5.6 |  | 17 | 2.8 |
| 8 | 4.6 |  | 18 | 2.6 |
| 9 | 4.8 |  | 19 | 2.7 |
| 10 | 4.1 |  | 20 | 6.0 |
|  |  |  |  |  |

# 6. CONSTRUCTION

Tactile maps have historically been constructed from a wide array of materials, including embossed paper, thermoformed plastic, and glued odds-and-ends (e.g., buttons, string, etc.) to a paper base (Barth, 1982). We chose to cut our maps out of clear acrylic using a laser cutter for the following reasons: (1) The laser cutter afforded high precision, (2) We were not concerned with creating many copies of the same map, as is often the case with thermoformed materials, (3) The clear material enabled video-recording of the hands and fingertips through the bottom of the map, which was relevant for our research questions, and (4) We had access to and knowledge on how to use a laser cutter. An example of a laser-cut map is shown below, in Figure 1. The maps in the Tactile Map Open Stimulus Set can be recreated using other means, such as with a paper embosser or thermoformed, depending on the needs of the researcher.

|  |
| --- |
| **Figure 1.** Example Laser Cut Map. |
| C:\Documents and Settings\Banks Lab\My Documents\My Dropbox\Research - Lab Presentations\L1050624.JPG |

# 

# 7. POTENTIAL USES

The Tactile Map Open Stimulus Set was created to examine several specific tasks in a controlled manner, including searching for symbol clusters, determining quantity of paths, finding loops in paths, comparing distances between clusters, comparing distances between clusters and the lake, finding symbols closest to clusters, and finding symbols in ordinal directions from clusters. For these tasks, controls have been explicitly implemented. Therefore, examining these tasks under various conditions (e.g., visual experience or explicit strategy instruction) would be facilitated with the Tactile Map Open Stimulus Set.

Other tasks could also be examined using these stimuli. Here is a list of example questions that could be asked about these maps:

* Are there any squares on this map?
* Are there any squares on the left side of this map?
* How many squares are there on this map?
* How many inches are between the cluster of squares and Ts?
* Are the configurations the same for the cluster of circles and the cluster of ovals?
* Is the cluster of squares or the cluster of Ts more North in the park?

Lastly, we hope that Tactile Map Open Stimulus Set may be used as a launching point to develop alternative stimuli that may best suit research needs.

# 8. EXCEL DOCUMENT

Which symbols, clusters, and parameters are assigned to which map, and specific values (e.g., specific lengths and angles) can be found in the Map Randomization excel document.

# 9. MAP IMAGES

Map images are supplied in Corel Draw format (cdr) and as Portable Network Graphics (png). Images depict the symbol shapes, sizes, and locations, but not elevations. The Corel Draw format images are more appropriate for the purpose of manipulation.

# 10. CONTACT

Questions about the Tactile Map Open Stimulus Set can be sent to one of the following:

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Additional information and files can be found at the website [www.valeriemorash.com/TactileMaps](http://www.valeriemorash.com/TactileMaps)

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