A Systematic Review of Experimental Studies on Data Glyphs

>Perception in Data Visualization<

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CPSC 547 Paper Presentation
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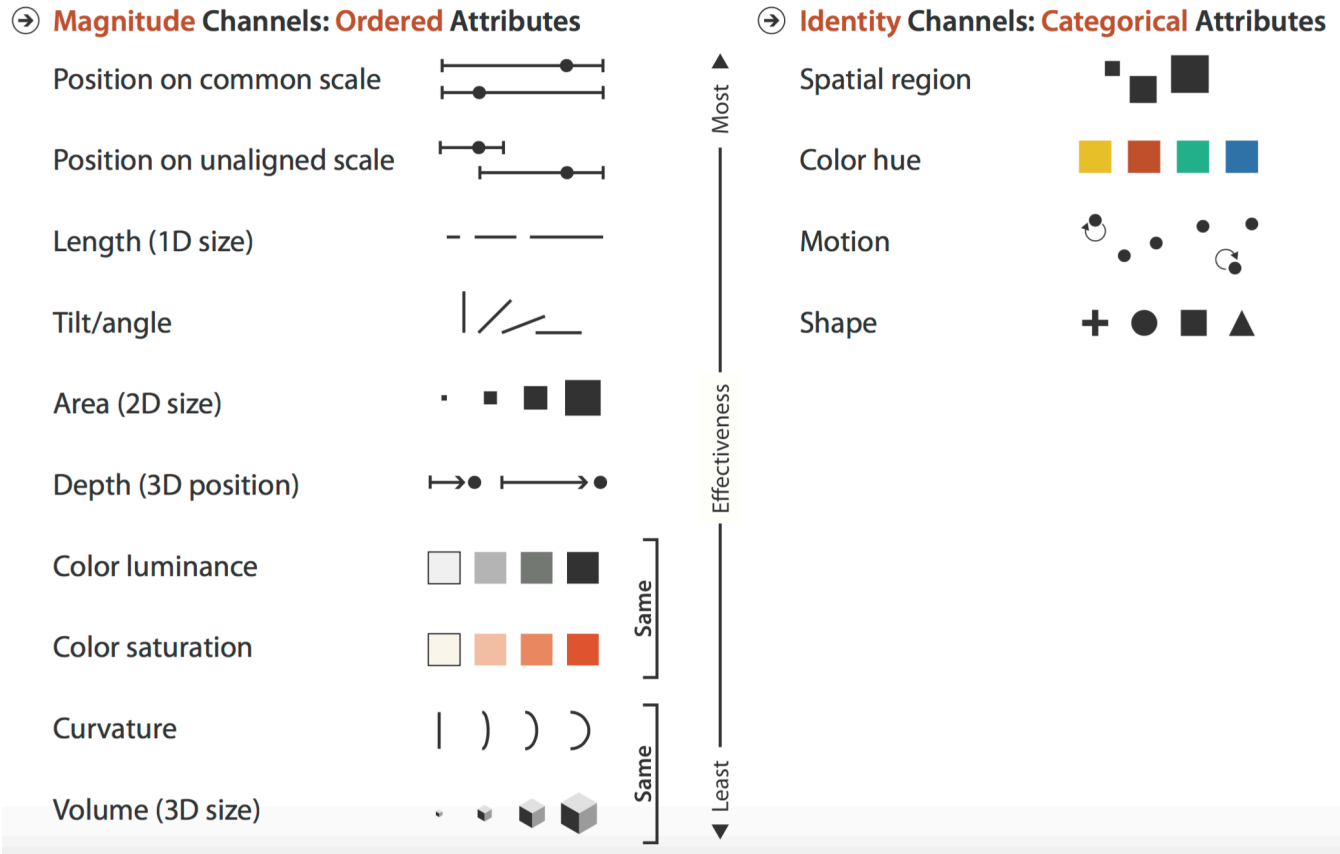
Glyphs in Visualizations

- Think chapter 5…



Glyphs in Visualizations

- Think chapter 5…

- How to encode multidimentional data?

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- How to encode multidimentional data?
- Use glyphs:
  - "single data points are encoded individually by assigning their dimensions to one or more marks and their visual variables"

Glyphs in Visualizations

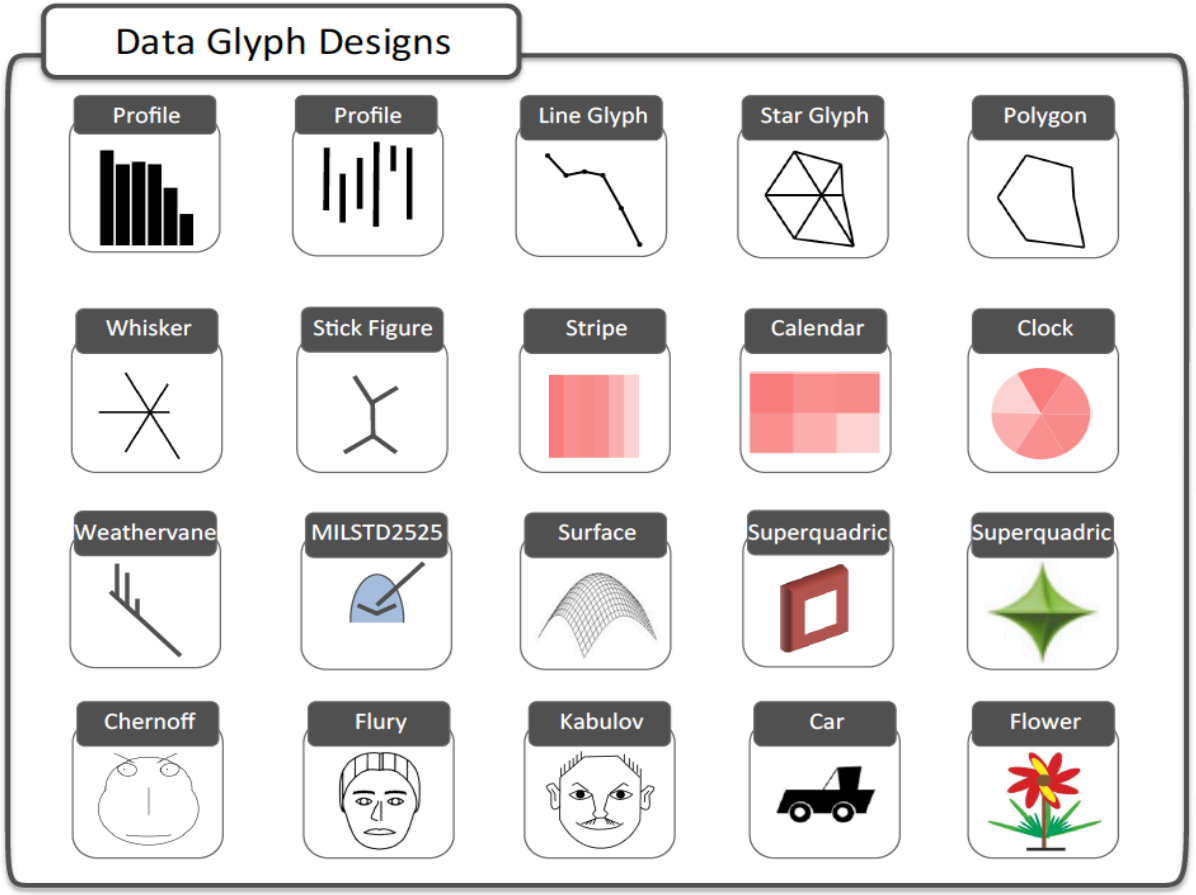

Fig. 1. **Data Glyphs:** A selection of the different data glyph designs used in the quantitative experiments we analyzed.

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…but *how* to answer them???

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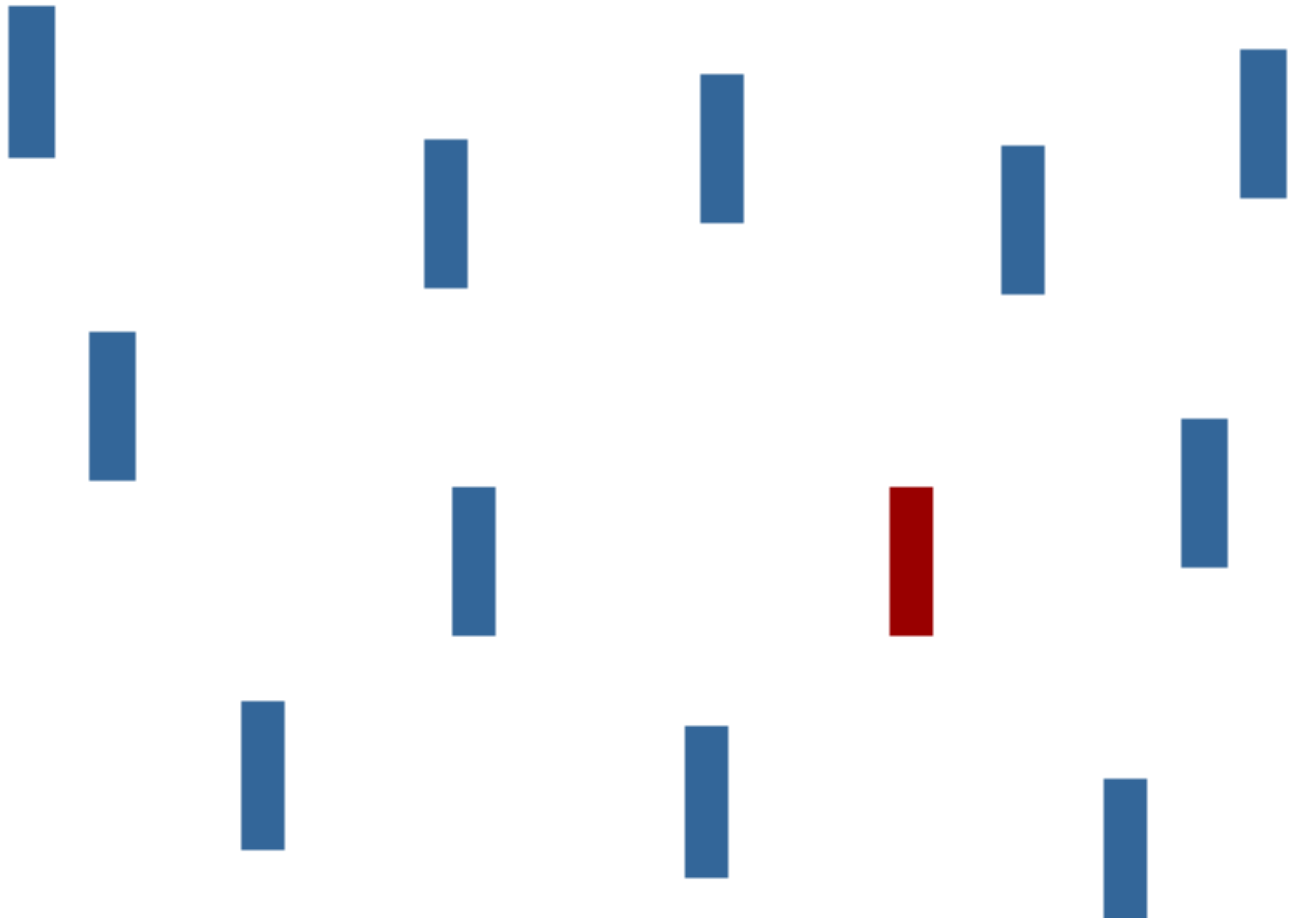
  - Other behavioral tasks such as **Visual Search** or **Ensemble Tasks (averaging)** can reveal perceptual thresholds and performance descriptors for visualizations

Visual Search

Visual Search



Visual Search

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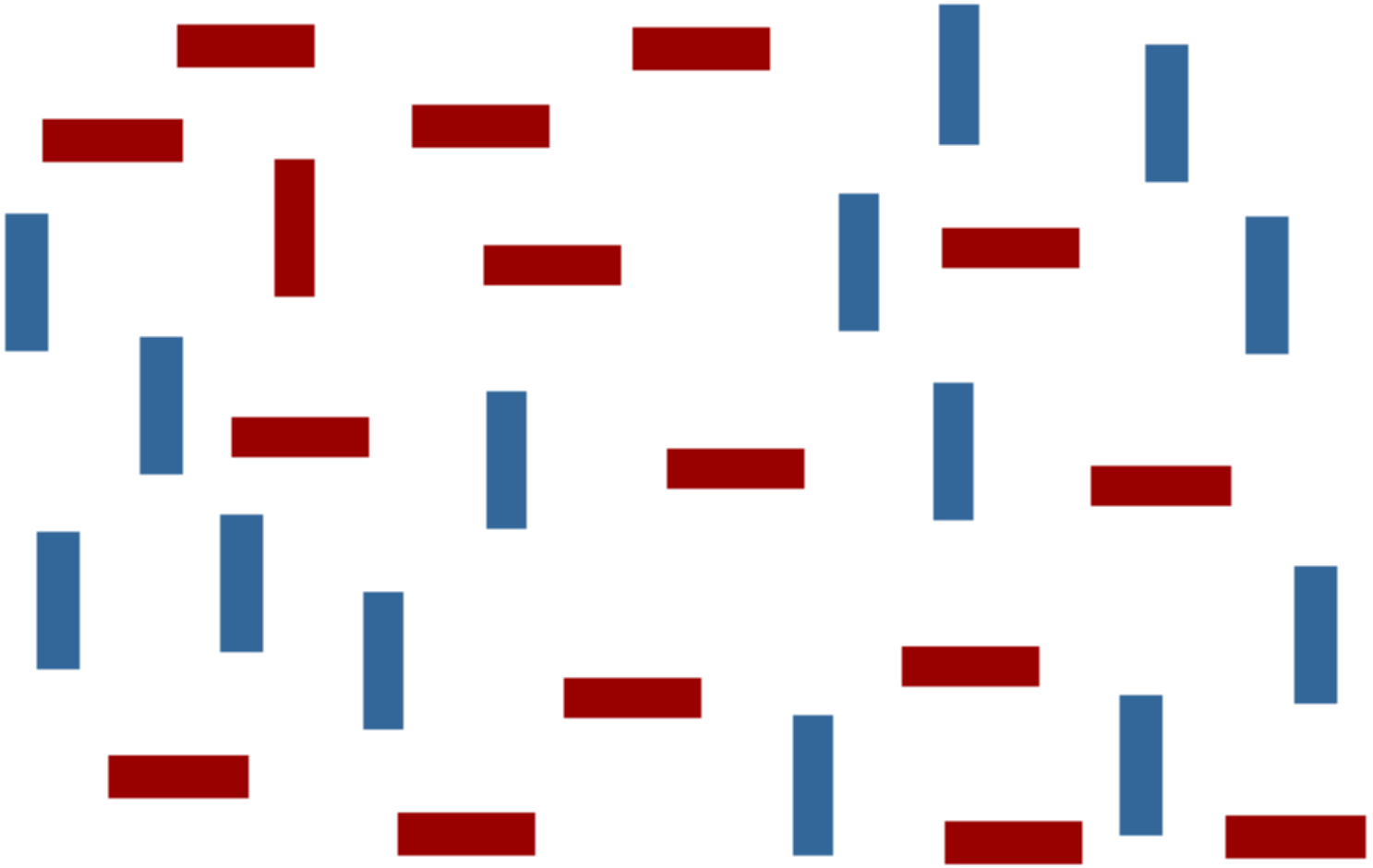
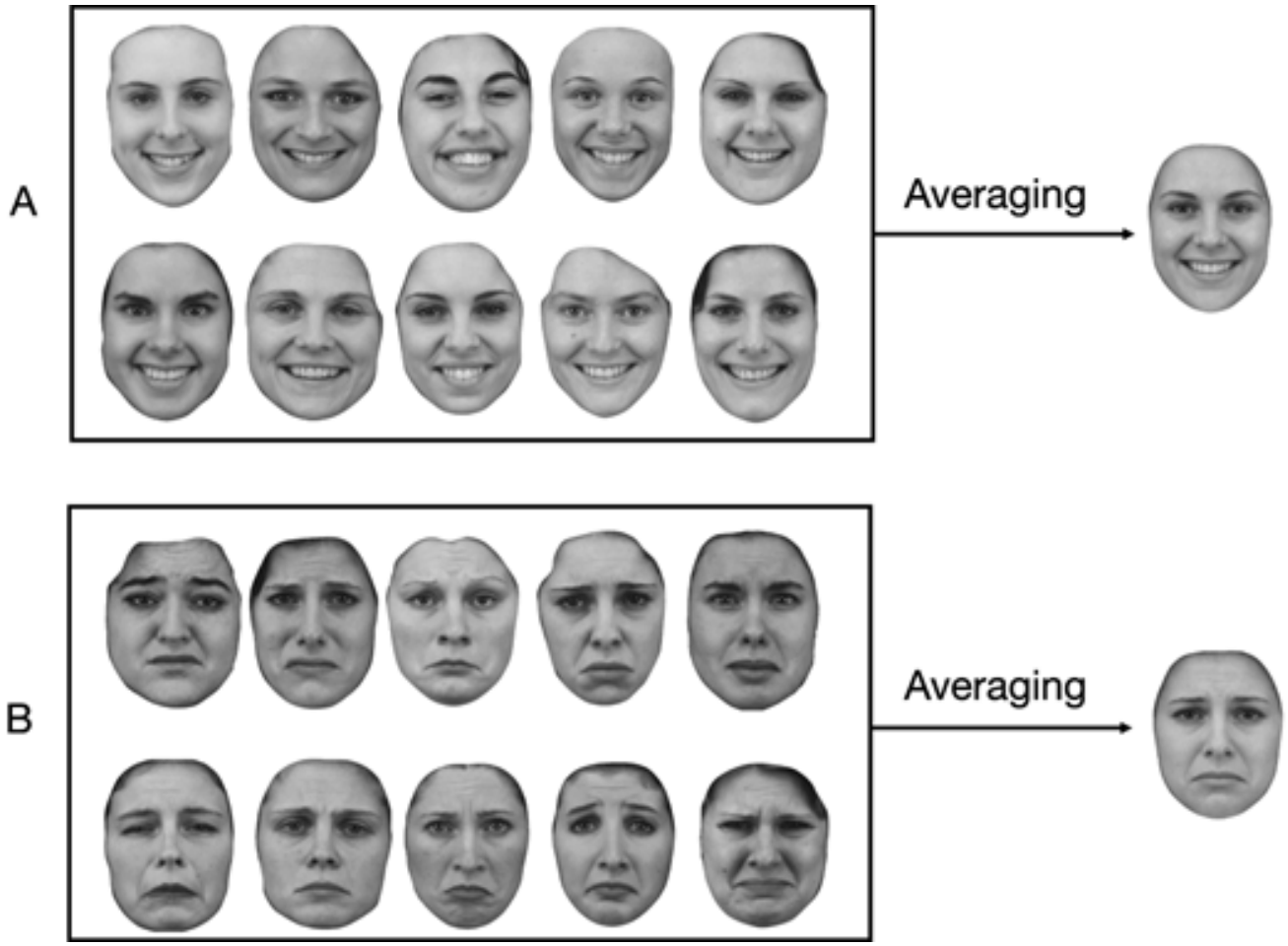


Ensemble Tasks



Back to the paper…

- What did the authors do here?
  - **Systematic review of 64 quantitative studies on glyphs in data representation**

Study Goals

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2. Comparison of different variations of a single glyph, to detect visual features improving a specific glyph design
3. Comparison of single glyphs vs. data tables, to motivate the use of these visual objects over textual representations

Rough Methods

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- Defined elementary vs. synoptic tasks:
  - Elementary: focus on single, specific characteristics of a glyph
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- Defined elementary vs. synoptic tasks:
  - Elementary: focus on single, specific characteristics of a glyph
  - Synoptic: look at glyph as a whole, i.e. singleton search, similarity search, trend detection.
- Document all glyph mappings and representations in selected literature

Rough Methods

TABLE 3

Presentation Setting: This table distinguishes between the number of data points shown to the participants during the studies and the used layout. Color is used to better distinguish between the different categories.

	Layout	References
Single		[48][49][50][54][64][91]
	Text	[55]
Multiple Glyphs	Grid	[17][21][24][33][39][45][47][51][52][53] [57][58][59][61][66][67][71][72][73][74] [75][76][77][78][80][84][85][86][87][89]
	Geo map	[36][37][38][40][60][65][68][69]
	Scatterplot	[34][88][90]
	Other	[32][35][56]
	Node-link	[41][70]
Varying	Grid	[46][62][79][82][83][92]
	Node-link	[43][44][63]
	Geo map	[42][81]

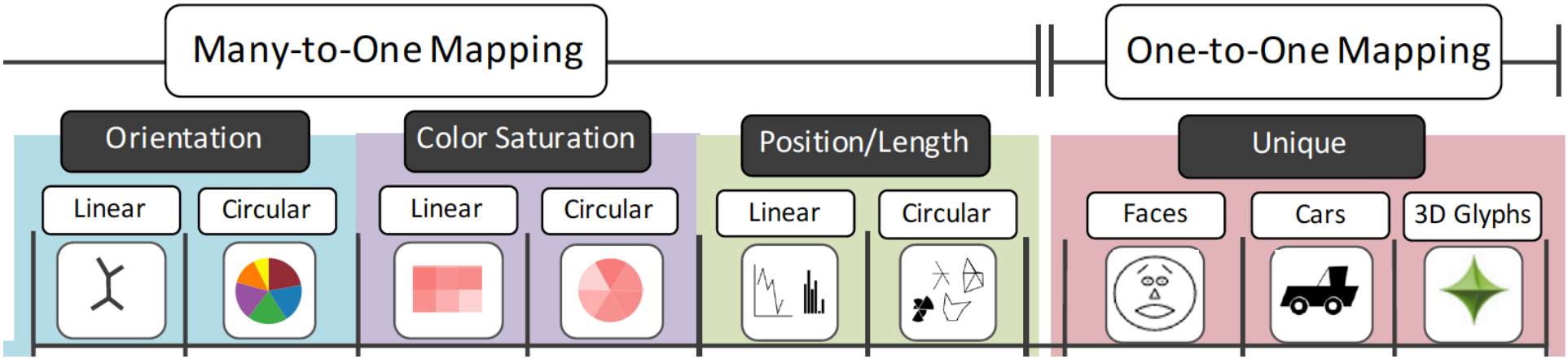
Rough Methods

TABLE 4

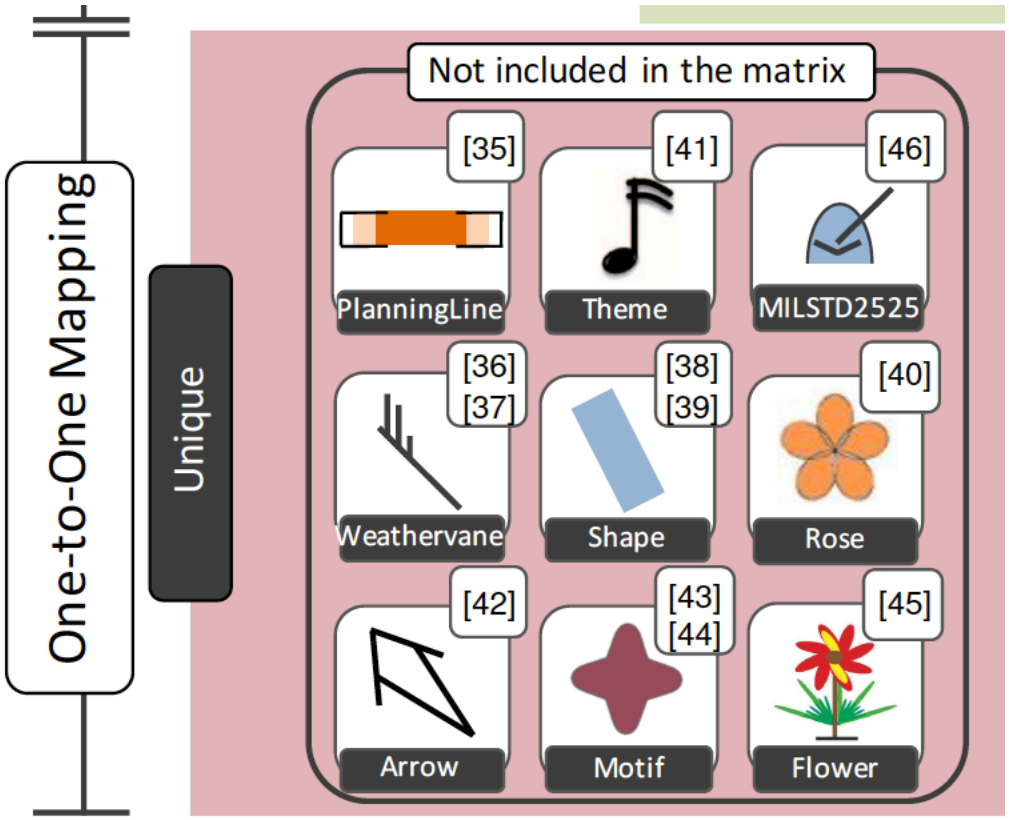
Number of Dimensions: This table illustrates the different data dimension densities used in the studies. Color is used to better distinguish between the different categories.

Number of Dimensions	References
2 & 3 Dimensions	[32][35][36][37][38][39][40][44][48] [51][60][67][71][89][91][92][96]
4 & 5 Dimensions	[21][41][42][45][46][49][50][64][65] [68][69][72][80][81][82][83][88][90]
6 & 7 Dimensions	[77][85]
8 & 9 Dimensions	[33][34][53][59][61][73][79]
10 - 15 Dimensions	[54][66][70][75][84][87]
17 - 20 Dimensions	[17][52][57][74][76][78][86]
Varying	[24][47][58][63]

Many-to-One
vs.
One-to-One Mappings



Anomalous Mappings



Notable Results

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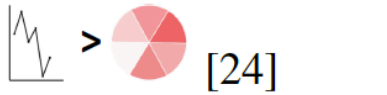
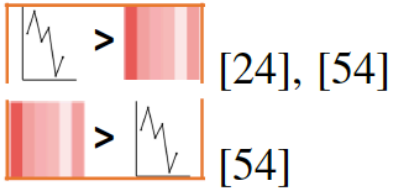
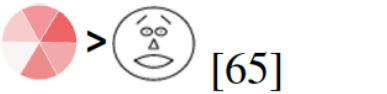
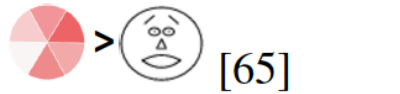
- Increasing the number of dimensions negatively affects the performance of data glyphs
- Background and neighborhood of a glyph did not affect glyph readability

Fuzzy Results

- *Tasks and visual encoding:*
  - study results differed based on individual factors like number of dimensions, task, number of data points, or slight variations to the designs

Fuzzy Results

TABLE 9
Studies and their result rankings: color saturation vs. profiles. Conflicting results are marked with orange color.

Elementary Task	Synoptic Task
 [24]	 [24]
 [24], [54]	 [24], [54]
 [65]	 [65]
 [65]	 [65]
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- *Metaphoric glyphs:*

(i.e. Car glyphs: map horsepower to the size of the engine of the car, which is metaphorically reflected in a bigger hood.)

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- *Metaphoric glyphs:*

(i.e. Car glyphs: map data to parts of the glyph with related meaning. For example the attribute horsepower can be mapped to the size of the engine of the car, which is metaphorically reflected in a bigger hood.)

  - A small number of previous studies suggest that metaphors may help to better understand the underlying data.

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  - Someone needed to catalogue and systematically evaluate how glyphs are used in visualizations
  - The original research questions are really important
  - This work lays a solid framework to promote future studies about tasks and data dimension density subsets, in particular

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  - Heavy emphasis on faces as glyphs in the literature, not really enough statistical power to perform a meta-analysis on different kinds of glyphs as they aid certain encodings or tasks
  - Not exactly clear that authors' met their study goals

Conclusion (from the authors)

"At the present time we caution against making overly general recommendations for using one type of glyph over another, given in particular the many criteria we needed to use to distinguish and categorize past studies (e. g., datasets, tasks, encodings). There are still several years of research possible to understand how humans perceive and use glyphs".

Questions?