

# Interactive & Multiscale Thematic Maps

Preliminary Results from an Empirical Study



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Search an address, Zip code or city

# An Extremely Detailed Map of the 2016 Election

By MATTHEW BLOCH, LARRY BUCHANAN, JOSH KATZ and KEVIN QUEALY JULY 25, 2018

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VISIT A RANDOM:

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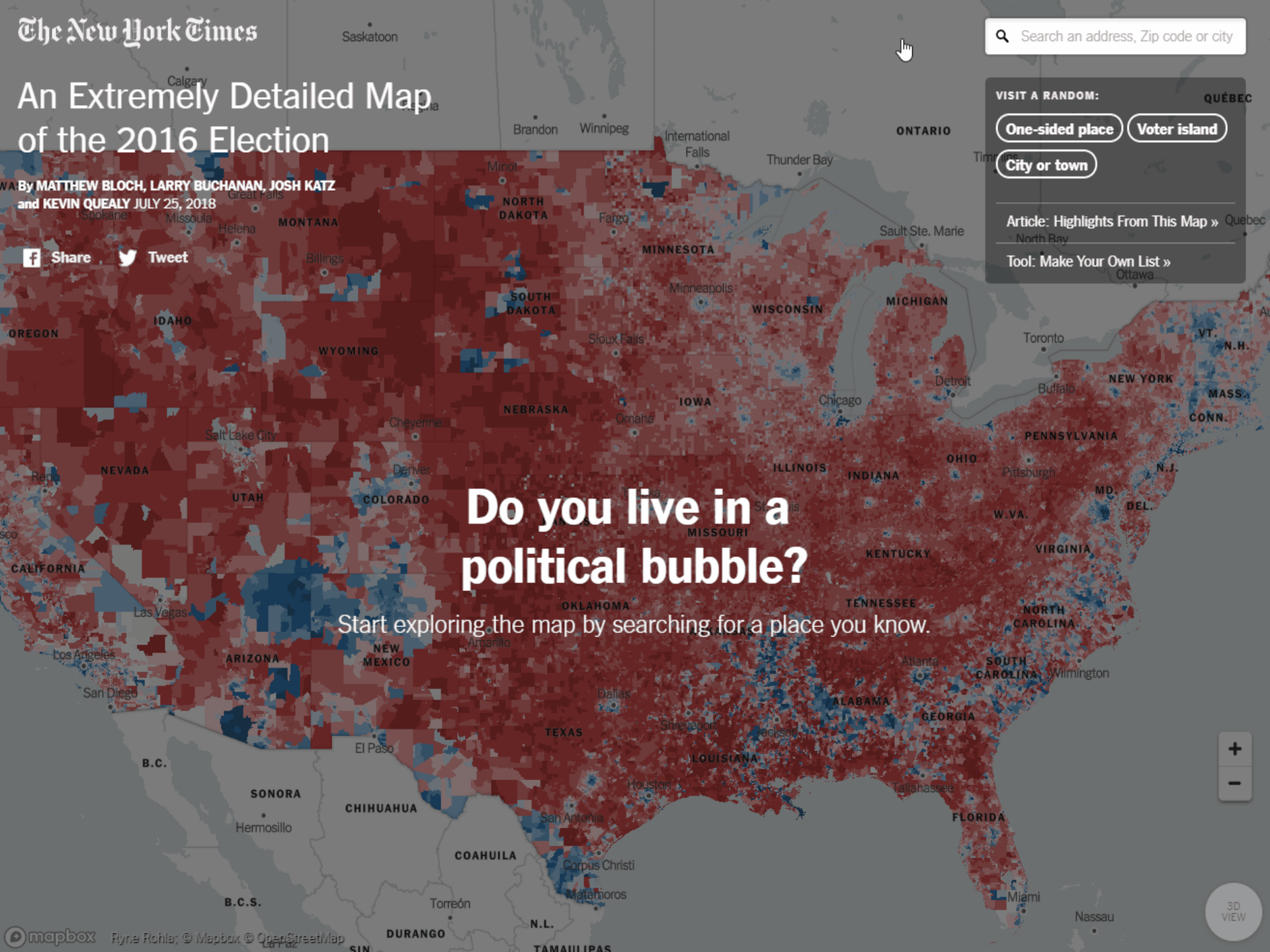
Article: [Highlights From This Map](#) »

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Tool: [Make Your Own List](#) »

## Do you live in a political bubble?

Start exploring the map by searching for a place you know.



# Cartography Representation + Interaction

**Table 1.** Opportunities for empirical research on the design and use of interactive maps and visualizations.

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## Basic research on interactive maps and visualizations

1. Expand qualitative and mixed-method research to confirm and enrich quantitative research in cartography
2. Improve consistency and detail in the reporting of method designs
3. Promote purposeful sampling of study participants and limit convenience sampling
4. Adopt new approaches to treat interactive, online, and mobile maps and visualizations as unique study materials
5. Define and assess high-level, insight-based tasks to complement benchmark tasks in user studies
6. Complement laboratory and online studies with field studies

## Adapting methods for UCD studies

7. Establish gold standards for administering and assessing UCD studies on interactive maps and visualizations
8. Streamline and contextualize the UCD process for interactive cartography and visualization
9. Promote comprehensive UCD case studies
10. Leverage UCD studies for participatory action research
11. Conduct user-centered studies on the political economy of interactive cartography and visualization

## Additional empirical needs in interactive cartography and visualization

12. Articulate dimensions of interface complexity in user studies
  13. Develop strategies to compare static and interactive maps
  14. Investigate the value of interactivity in new map use cases
  15. Evaluate non-cartographic and neocartographic interfaces supporting map design and production
  16. Evaluate mobile interactions
  17. Develop and integrate design guidelines for interaction and representation in cartography
-

# Background **Three Design Frameworks**

JACQUES BERTIN

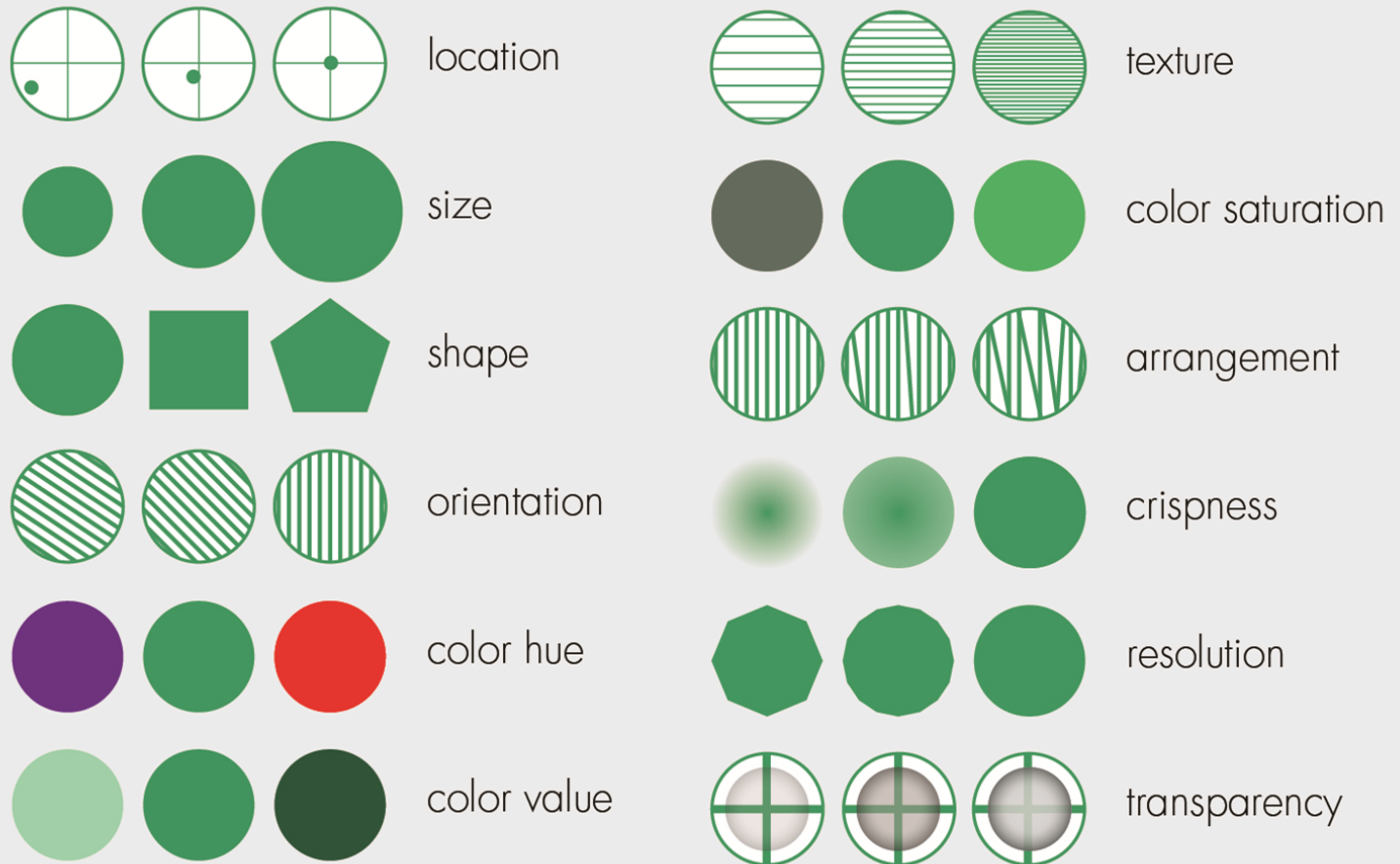
Semiology  
of  
Graphics

diagrams  
networks  
maps

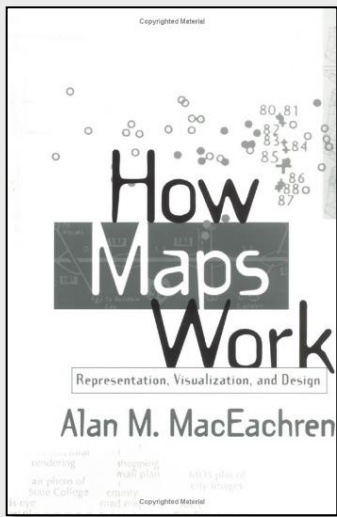


# 1. Visual Variables

The graphic building blocks of a map or visualization

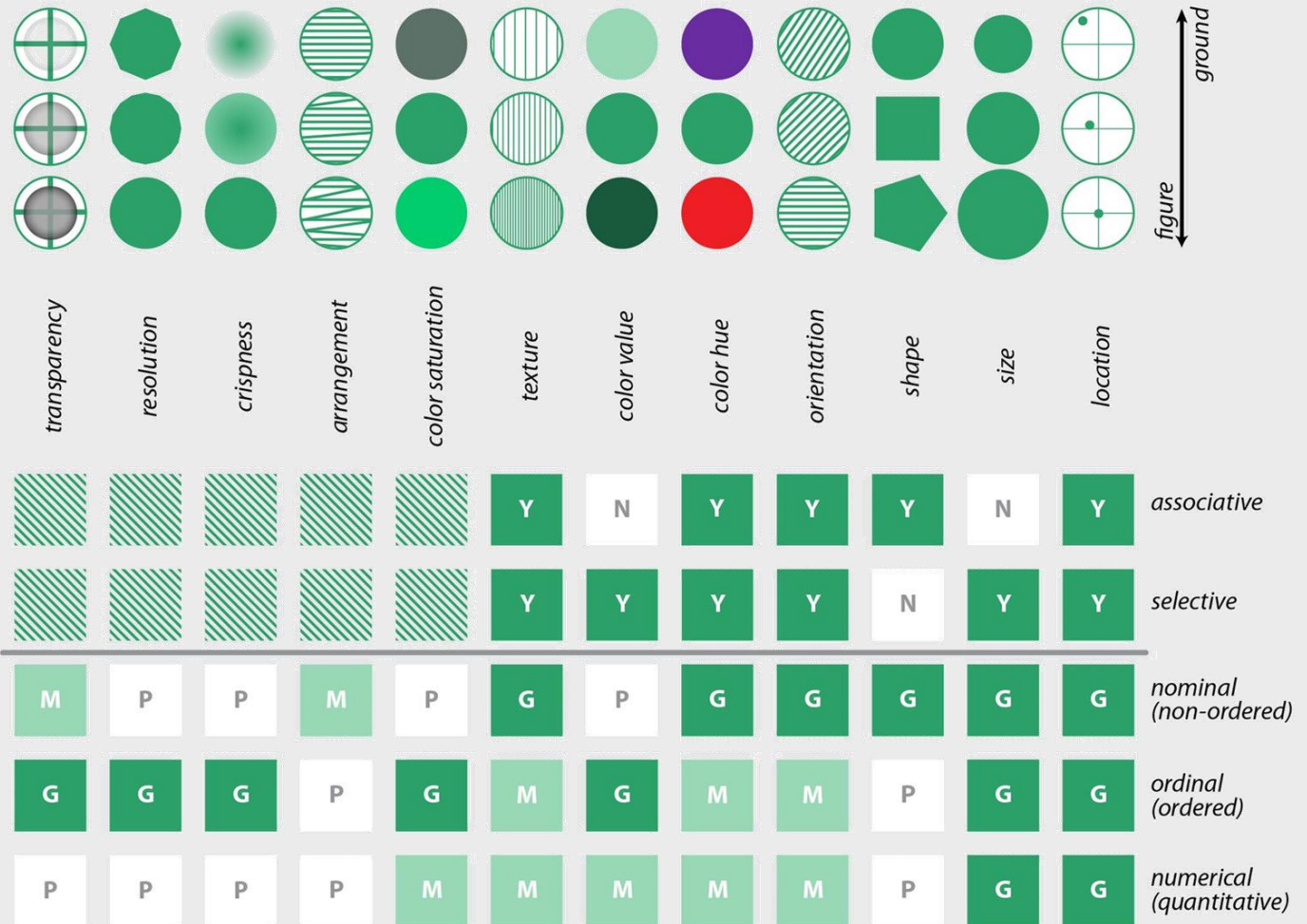






# 1. Visual Variables

## The Science of Representation



**Crampton (2002)**

Wehrend &  
Lewis (1990)

**Shepherd  
(1995)**

Becker &  
Cleveland (1987)

Haber &  
McNabb (1990)

Buja et al. (1996)

Yi et al. (2007)

**Peuquet (1994)**

**Andrienko  
et al. (2003)**

**MacEachren  
et al. (1999)**

Chi &  
Riedl (1998)

## 2. Interaction Primitives

The interactive building blocks of map or visualization; the Science of Interaction

Keim (2002)

**Dykes (1997)**

Wehrend (1993)

Zhou &  
Feiner (1998)

Shneiderman (1996)

**Masters &  
Edsall (2000)**

Amar et al. (2005)

**Persson et al. (2006)**

Dix &  
Ellis (1998)

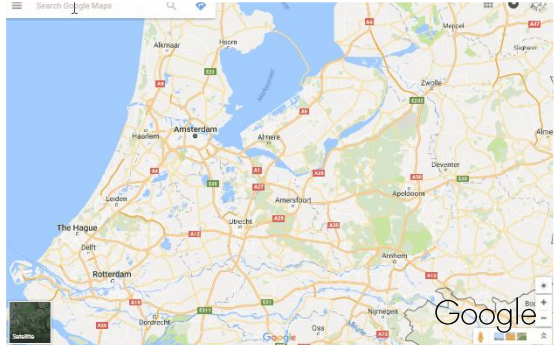
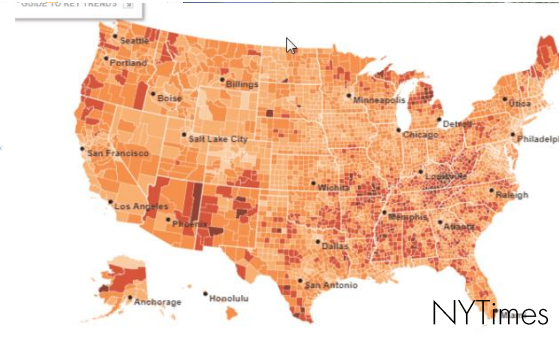
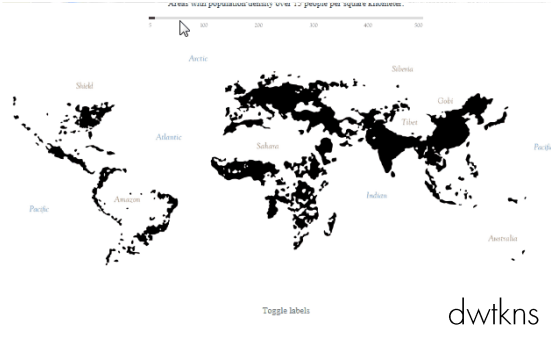
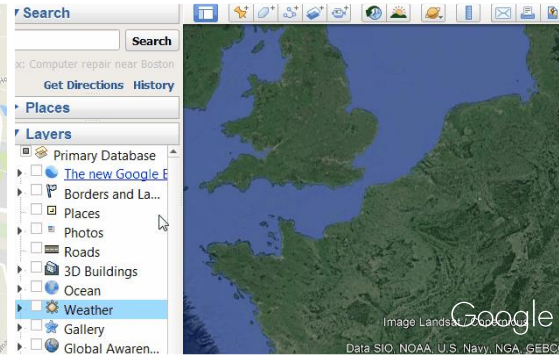
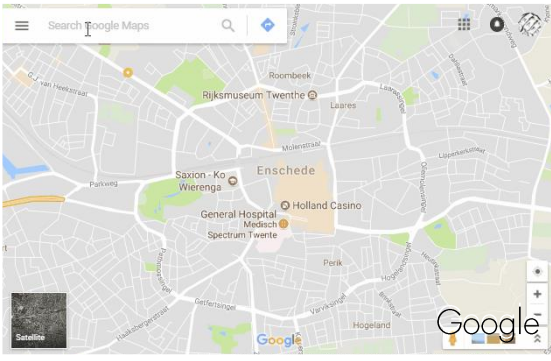
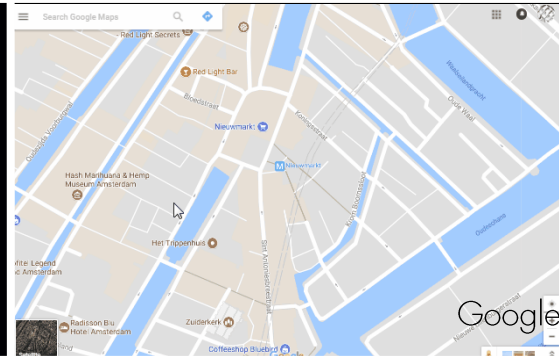
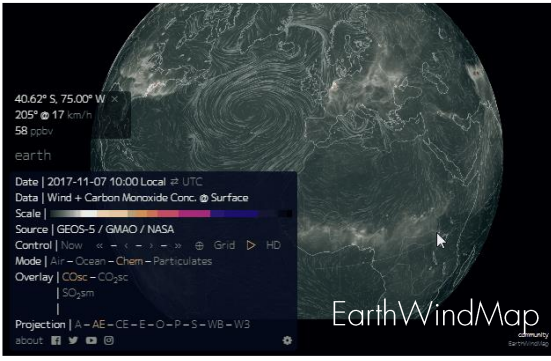
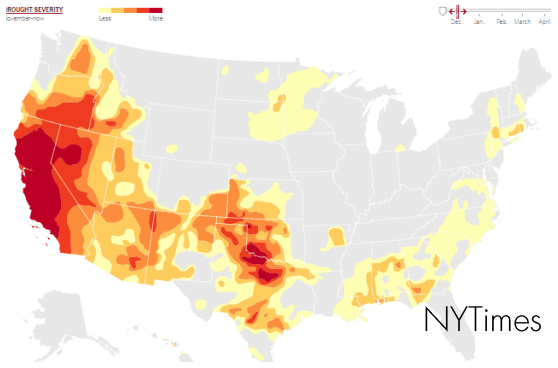
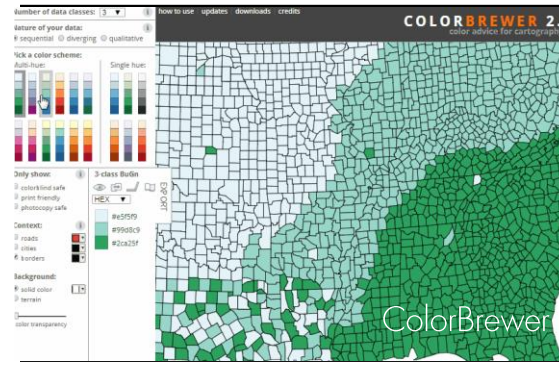
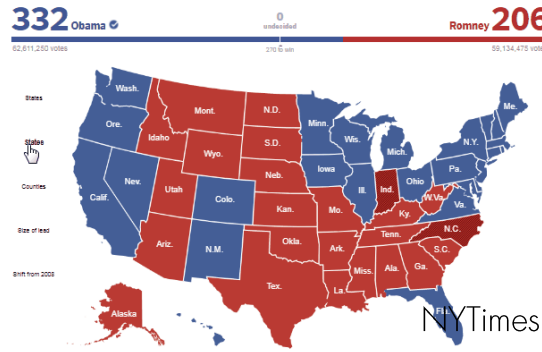
**Blok et al. (1999)**

Chuah &  
Roth (1996)

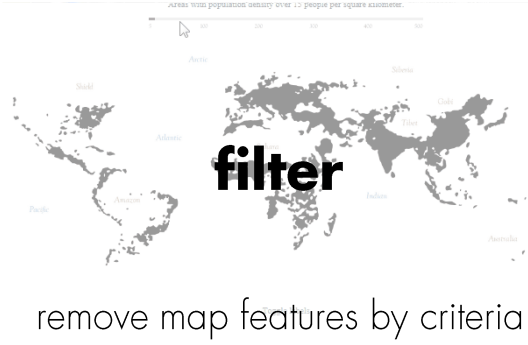
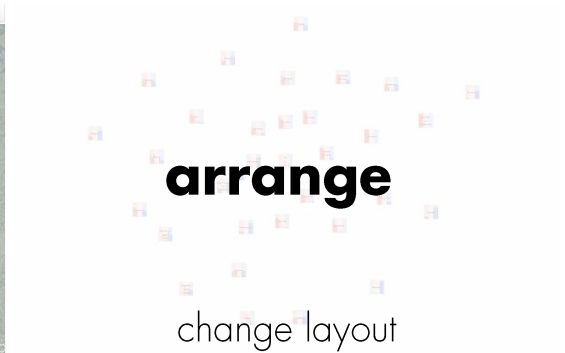
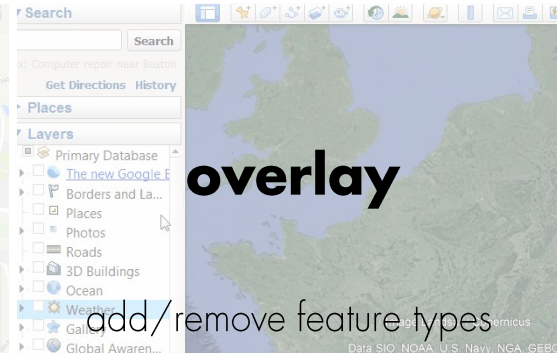
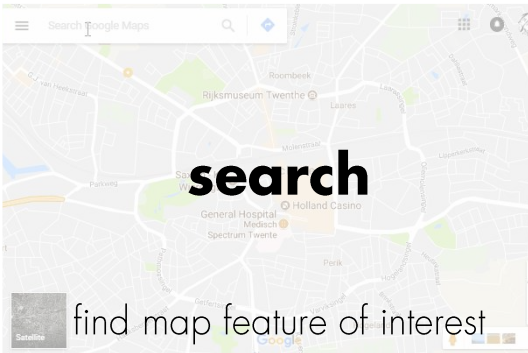
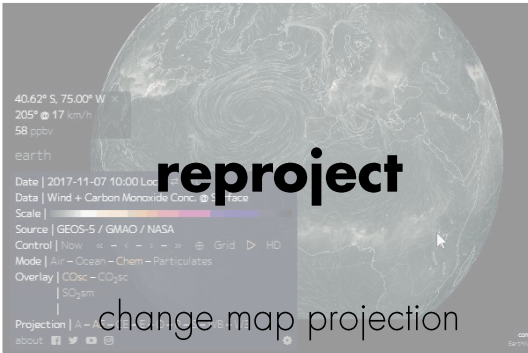
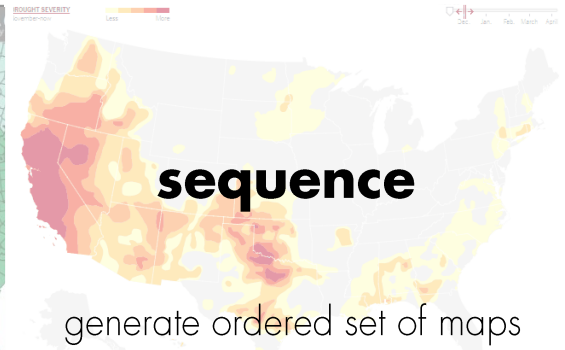
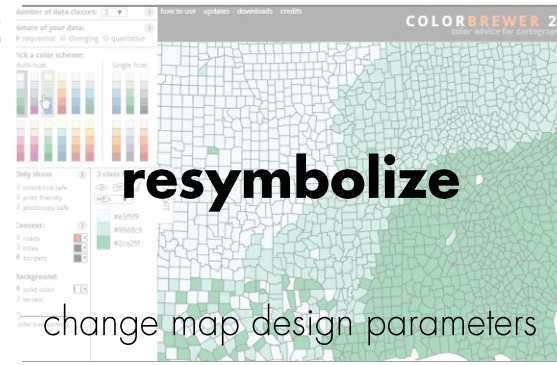
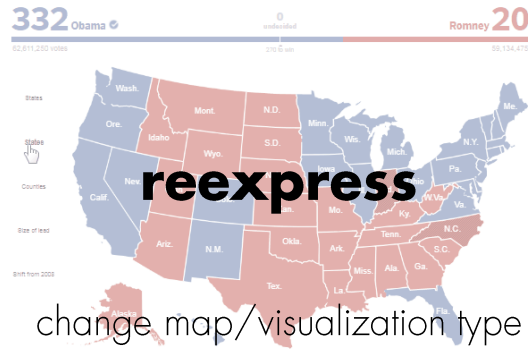
Ward &  
Yang (2003)

**Edsall et al. (2008)**

Source: Roth (2013) An Empirically-derived Taxonomy of Interaction Primitives





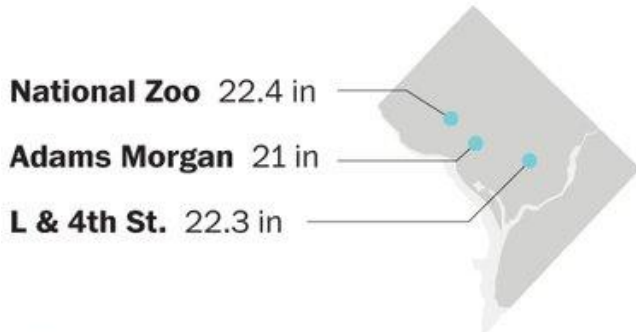


# 3. Metaphor (in Storytelling)

A figure of speech that brings together complex concepts in a simpler, but non-literal way

## How big is 'Snowzilla?'

An average of more than 20 inches of snow covered the D.C. area after the weekend's snowstorm. Twelve to 20 inches fell in the city's south and southeast, while areas in the west and northwest saw 24 to 36 inches.



### SNOWZILLA IN VOLUME



Source: Washington Post (2016)



Note: D.C. total recorded at White House by National Park Service.

Source: Staff reports





# 3. Metaphor (in Storytelling)

a figure of speech that brings together complex concepts in a simpler, but non-literal way



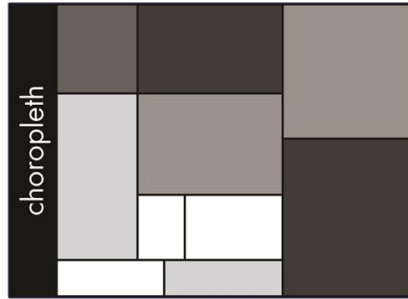
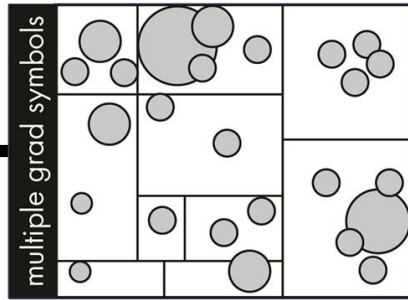
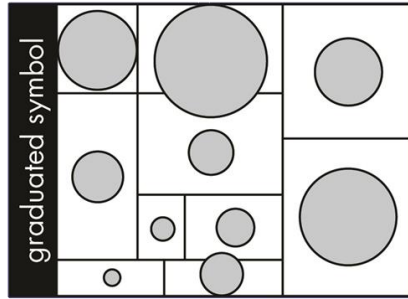
**Source:** The New York Times (2017)



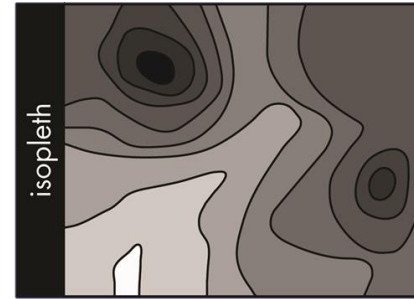
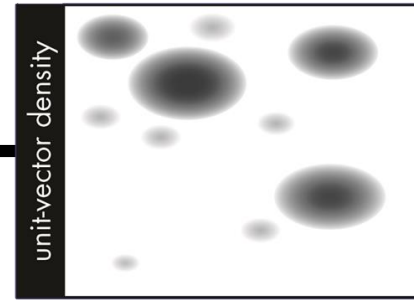
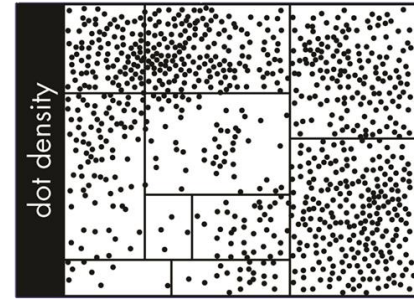
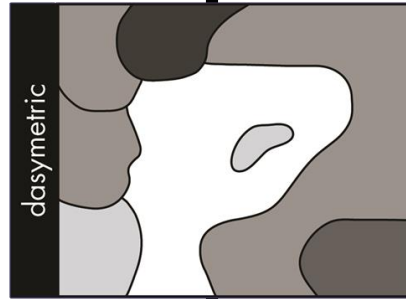
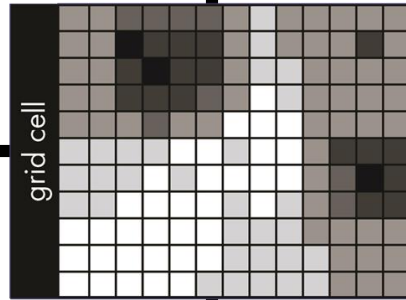
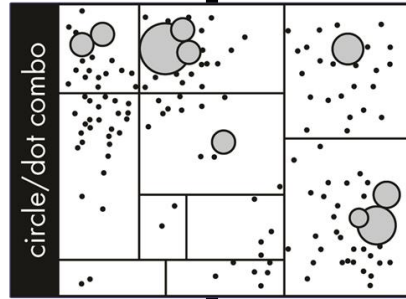
# 3. Metaphor

Congruency Principle

**abrupt**



**discrete**



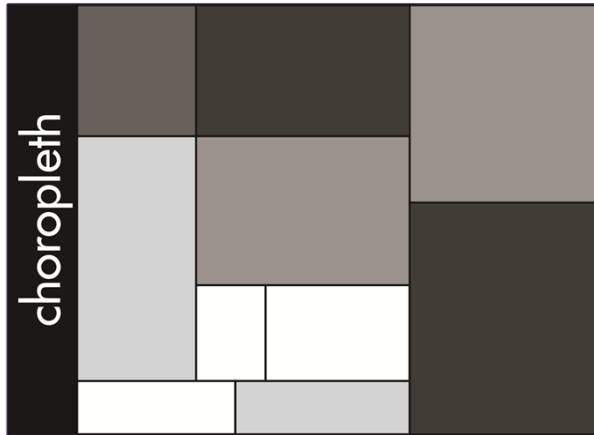
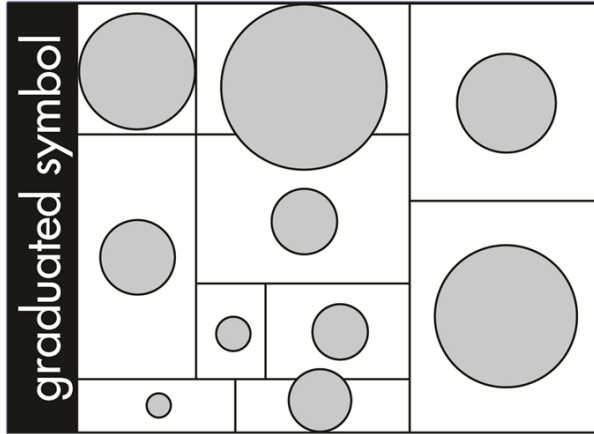
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**continuous**

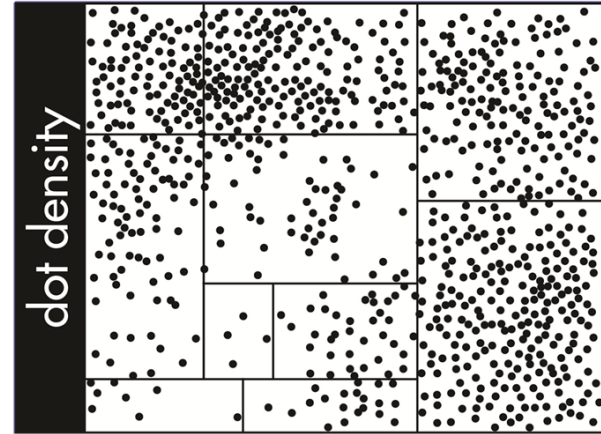
### 3. Metaphor

Congruency Principle

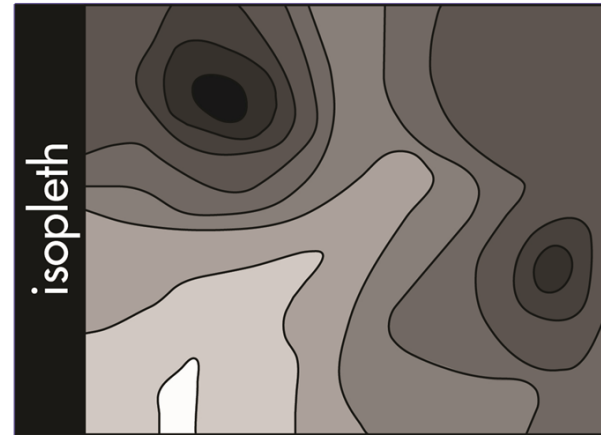
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**discrete**



**smooth**

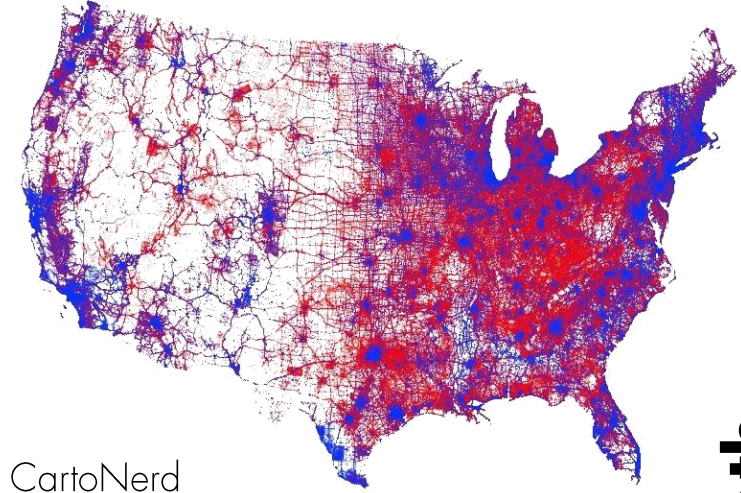
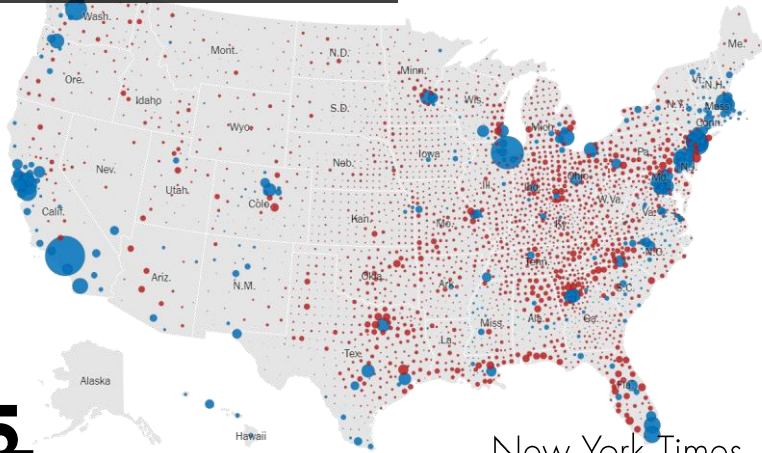


**continuous**

# 3. Metaphor

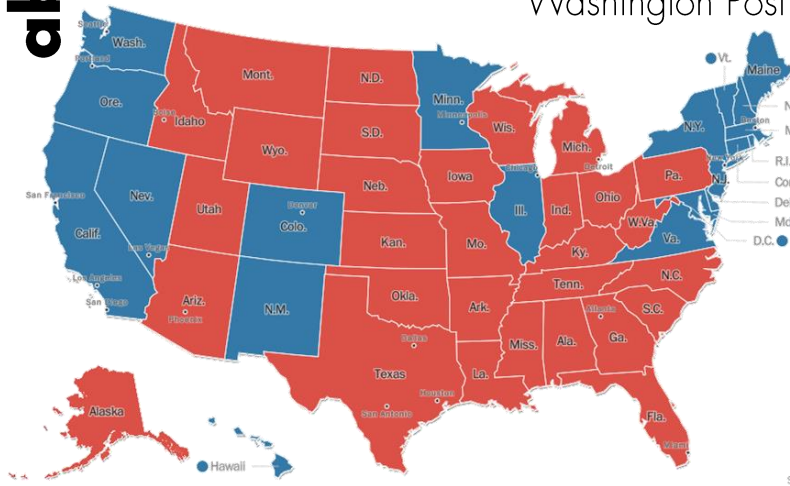
## 2016 US Election

discrete



abrupt

Washington Post



New York Times



smooth

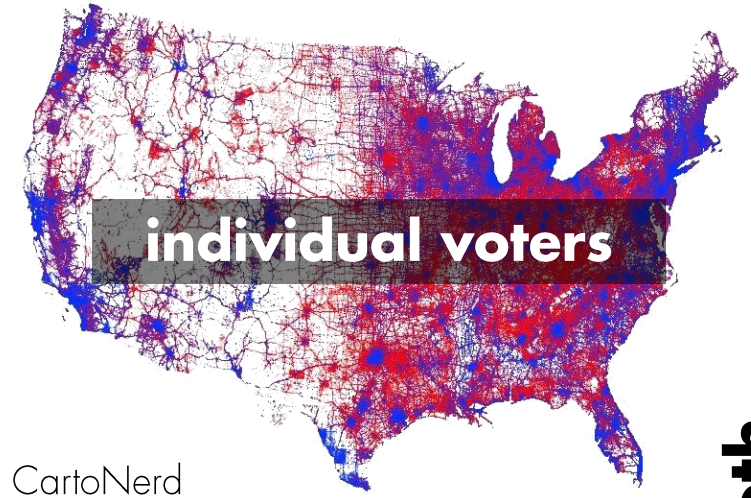
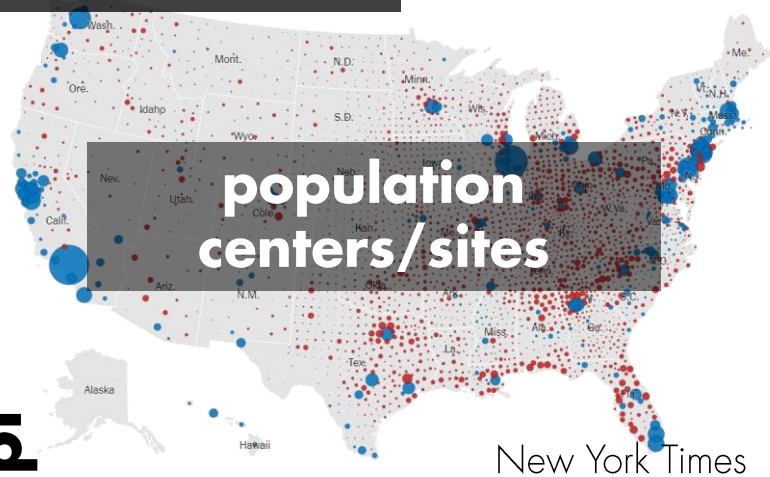
continuous



# 3. Metaphor

## 2016 US Election

discrete

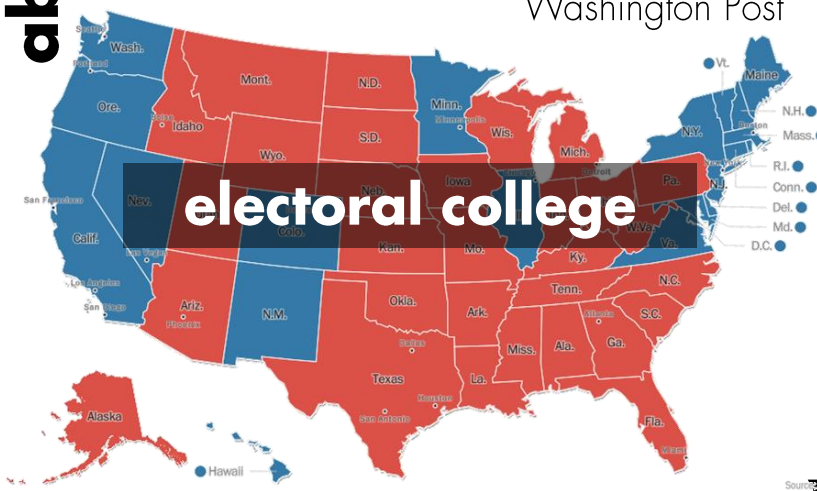


abrupt

smooth

Washington Post

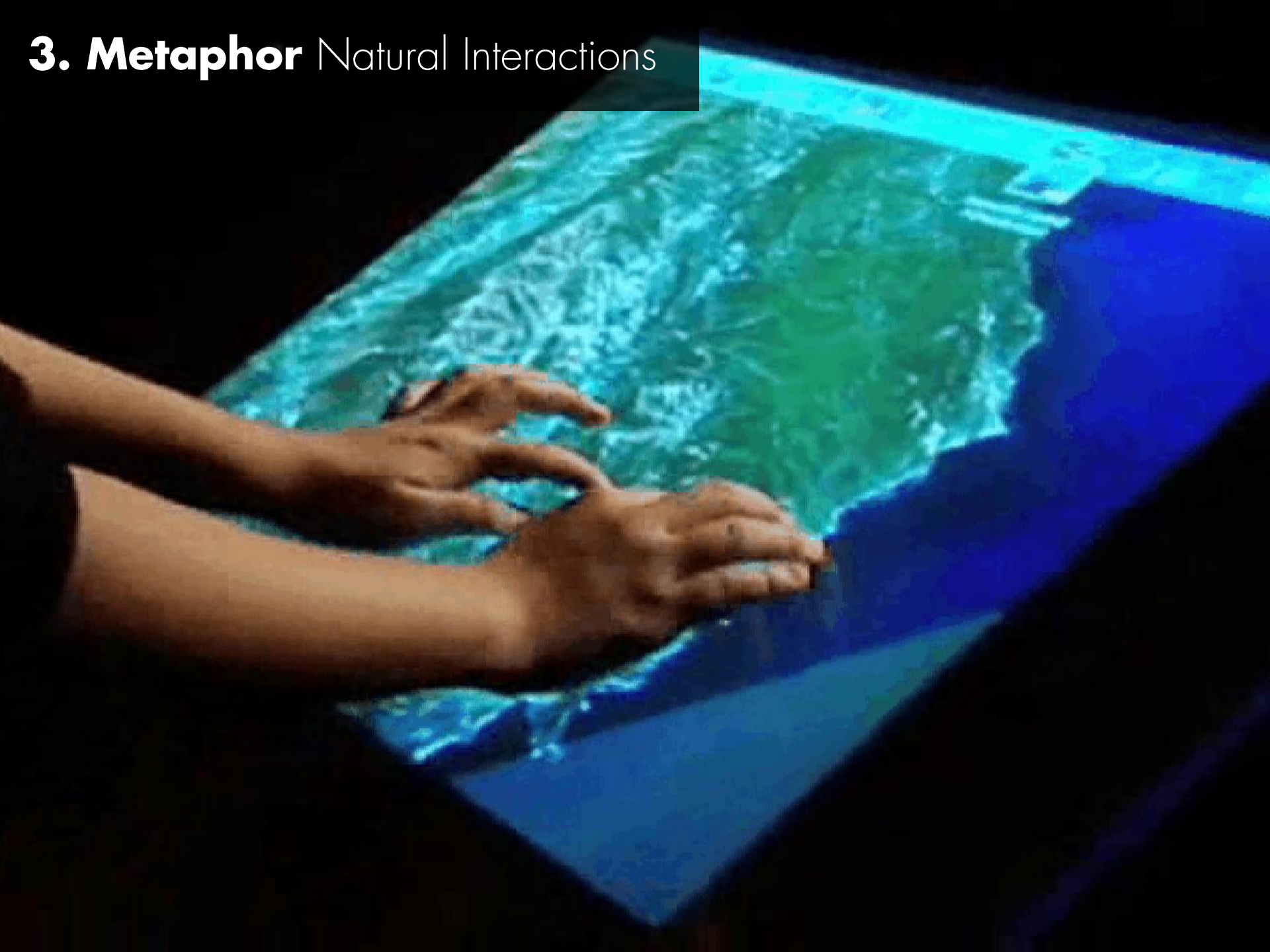
New York Times



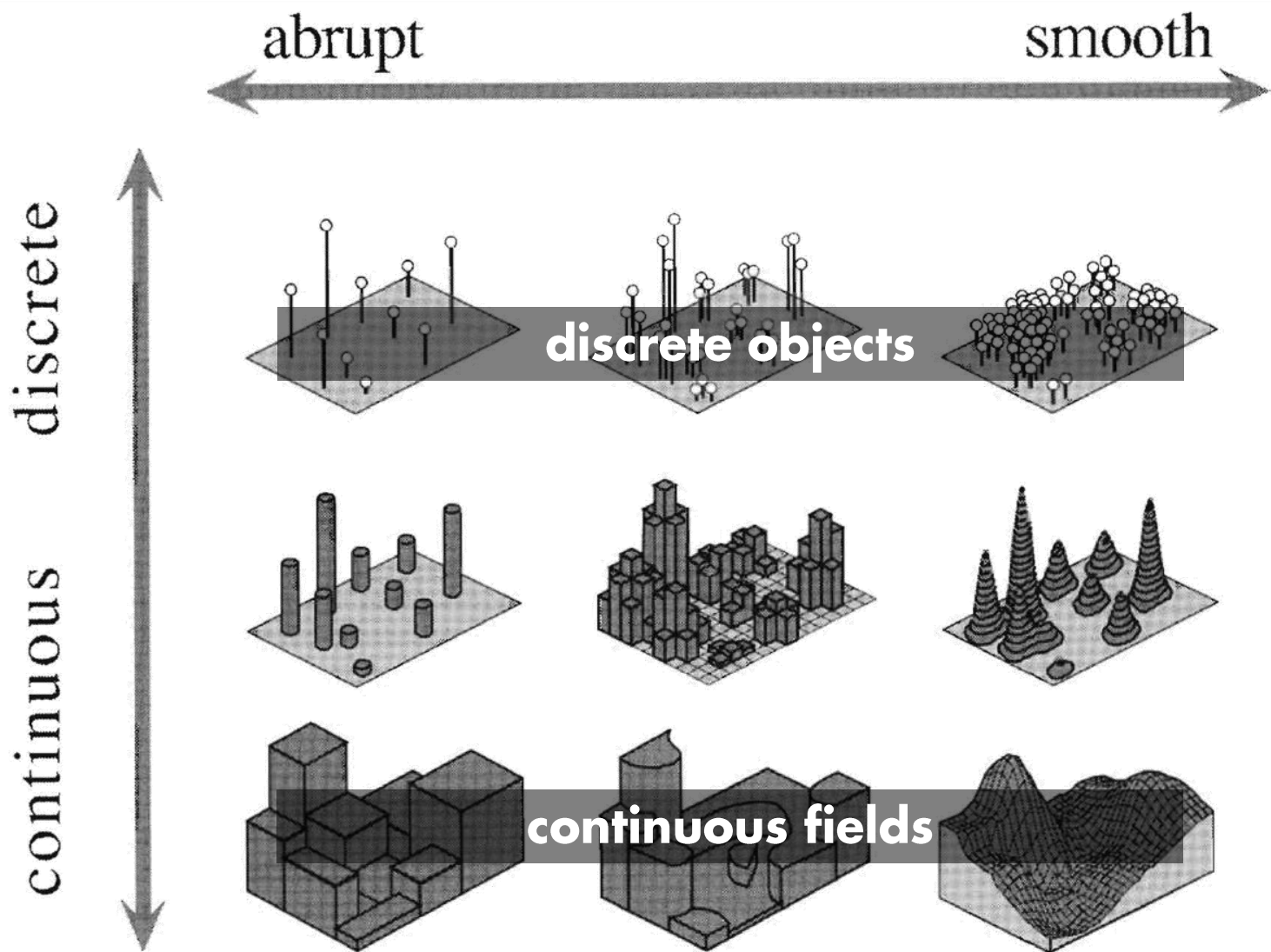
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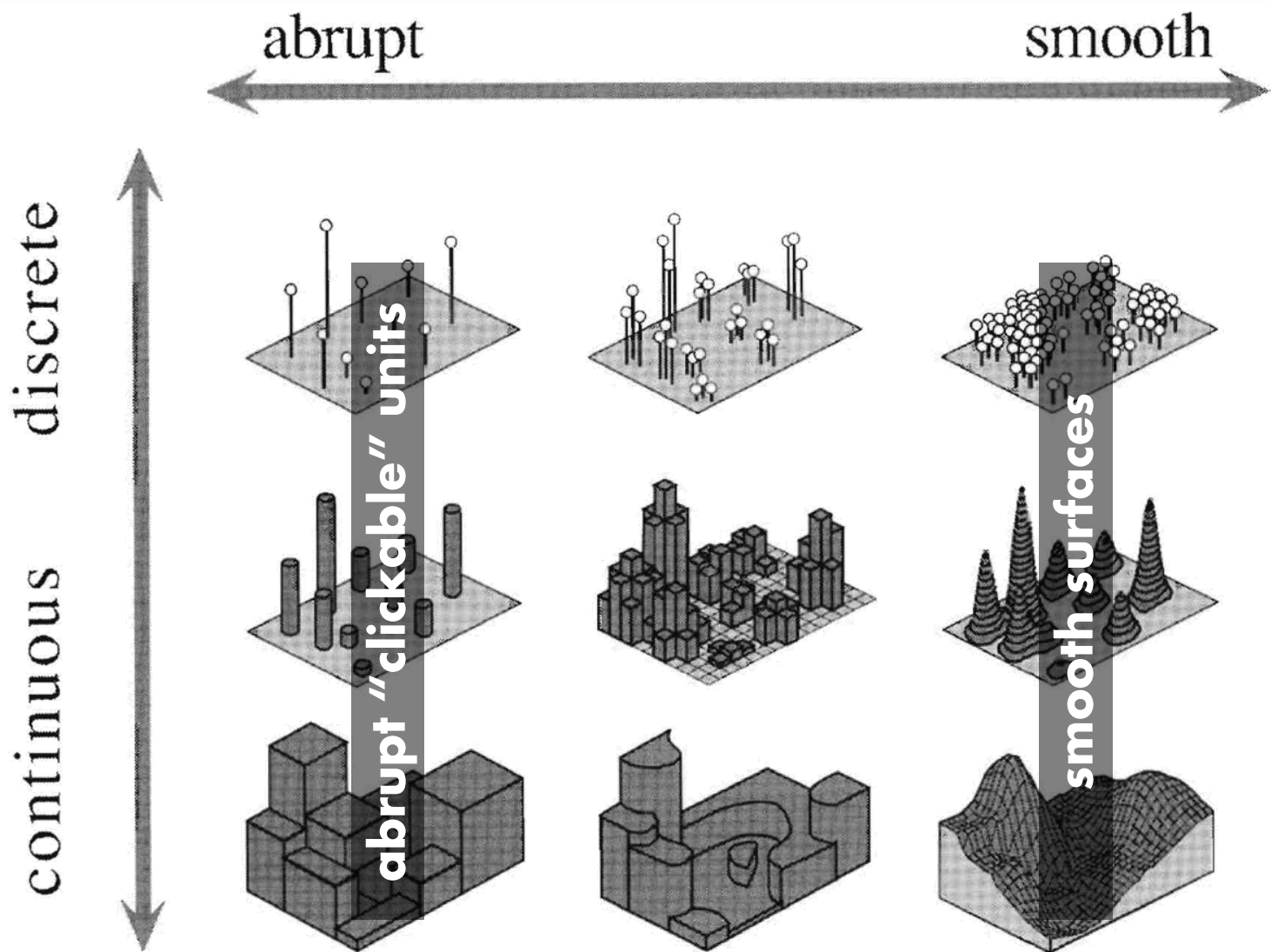
### 3. Metaphor Natural Interactions



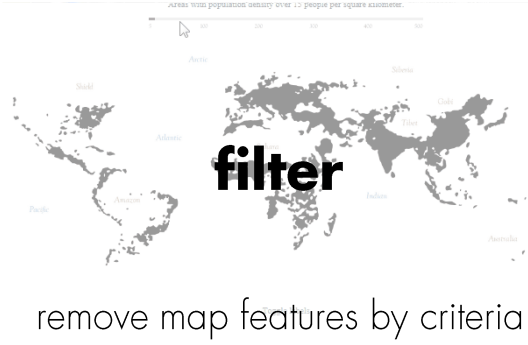
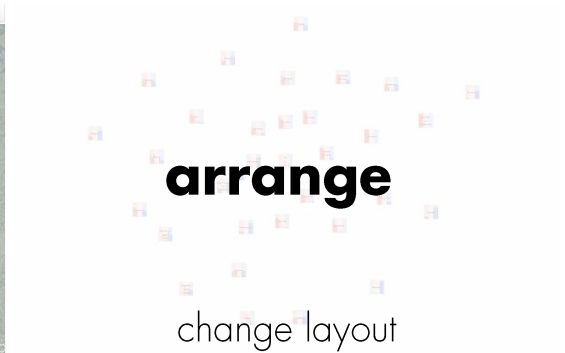
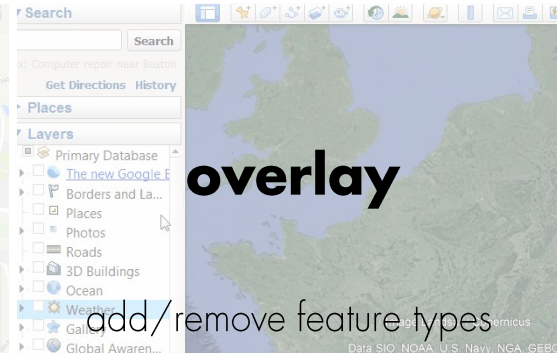
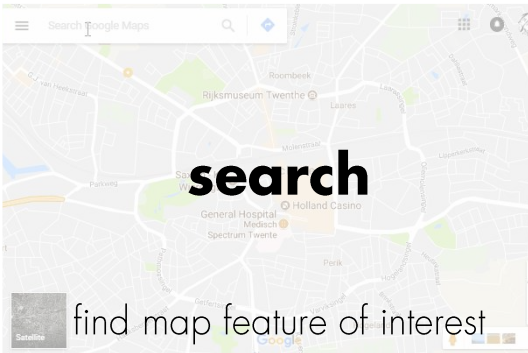
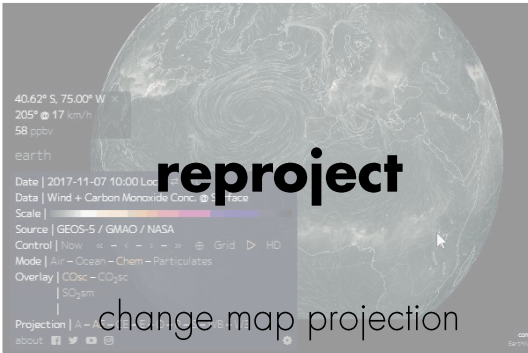
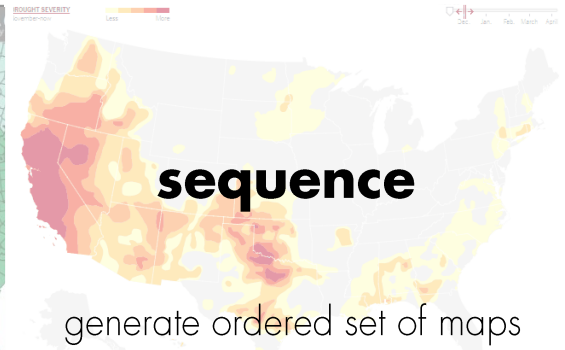
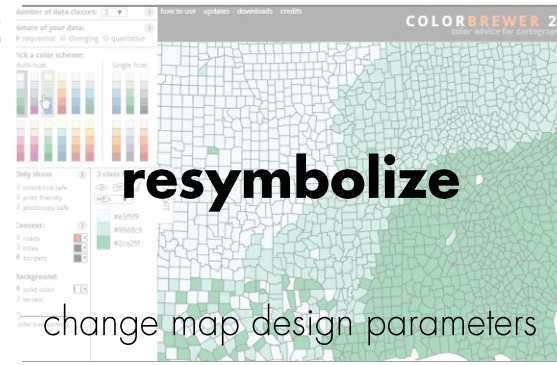
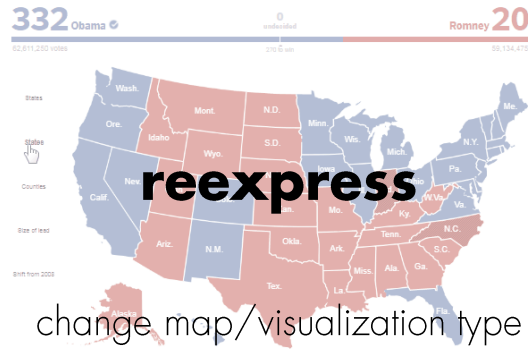
### 3. Metaphor Natural Interactions



### 3. Metaphor Natural Interactions









# Methods **Online User Study**

**Participants:** 171 participants from Amazon Mechanical Turk

- Followed a pilot of 74 participants
- Excludes duplicates, participants that did not interact at least once

**Materials:** One factor, four condition experimental design using MapStudy

- **Representation (4):** choropleth, dot density, tinted isoline, prop symbol
  - Within-group design
  - All maps include five classes, other design elements controlled
- **Interaction (3):** pan, zoom, retrieve (i.e., “slippy” web map functionality)

**Procedure:** 16 experimental trials

- **Data:** Synthetic twitter data in western Kansas
- **Tasks:** Compare & rank versus elementary & general (4 tasks x 4 maps)
- **Order:** Latin Squares balancing (4 groups), training block

**Analysis:** Accuracy, confidence, difficulty, interaction frequency, free responses



# MapStudy



**\*\*Latest stable development version \*\***

## What is MapStudy?

MapStudy is an integrated, modularized framework for the creation of survey applications designed to test cartographic design and interaction hypotheses in a modern web map environment. It leverages Postgresql and PHP on the server side and Javascript, jQuery, Leaflet, and D3 on the client. MapStudy is being developed specifically for use in the University of Wisconsin-Madison Cartography program through the support of the UW-Madison Cartography Lab and the Wisconsin Alumni Research Foundation.

## What is the status of MapStudy?

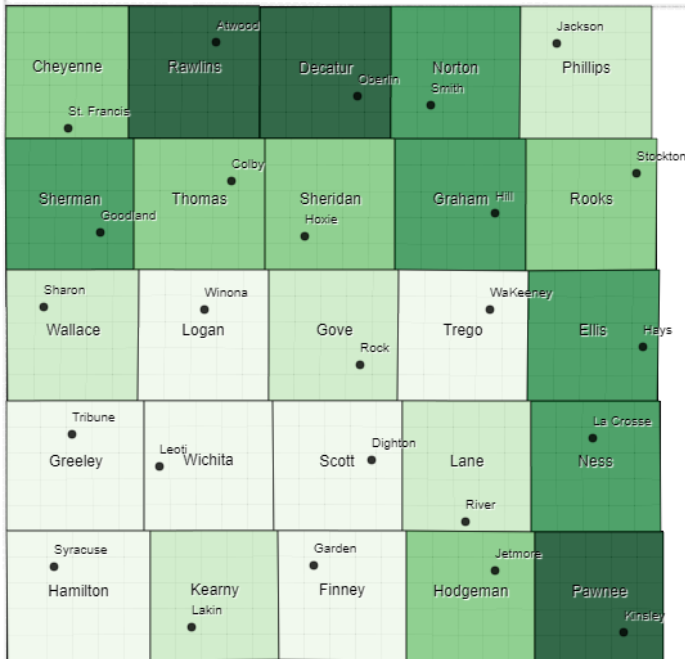
The MapStudy framework is currently in beta release, version 0.1. Note that not all functionality is complete. At this time, Leaflet is the only active map library.

## Can I have a preview please?

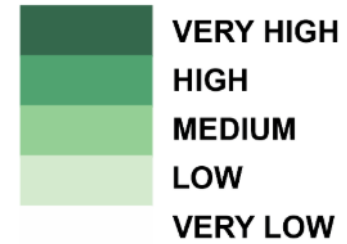
To see a demo app created with the MapStudy framework, [click here](#).

To access the setup application (which has a live preview feature), [click here](#)

**Documentation - Version 0.1**



Volume of tweets about GLOVES



\* Which CITY had the most tweets about HIKING?

- 
- 

Next

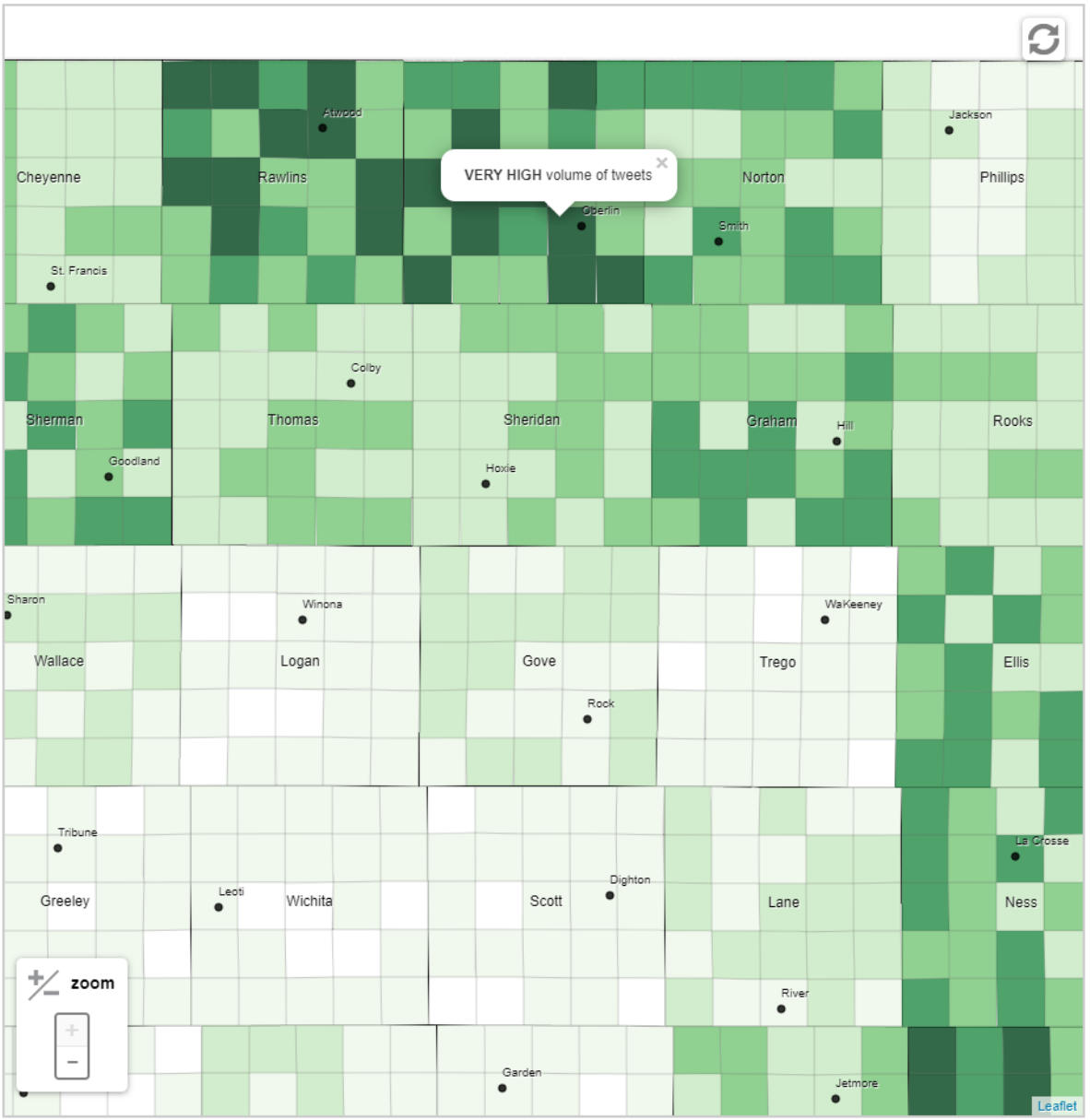
zoom



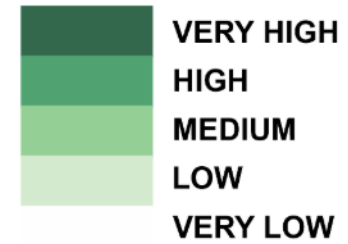
Leaflet



# Elements of Interactive Cartography



## Volume of tweets about GLOVES



\* Which **CITY** had the most tweets about **HIKING**?

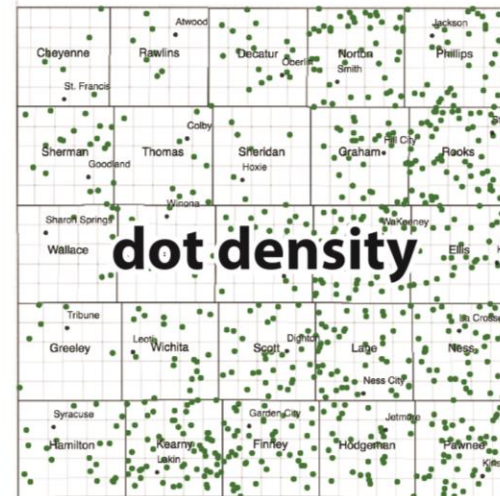
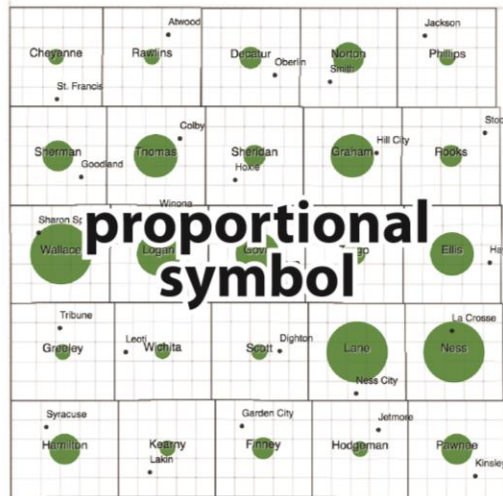
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Next

Leaflet

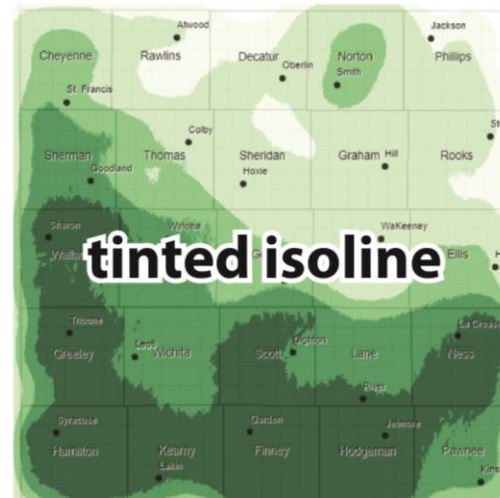
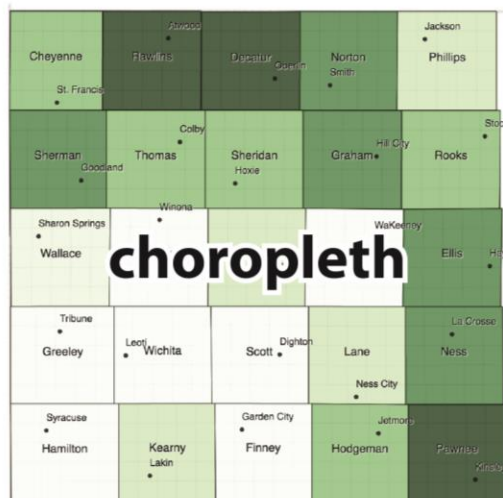
# Materials

discrete



abrupt

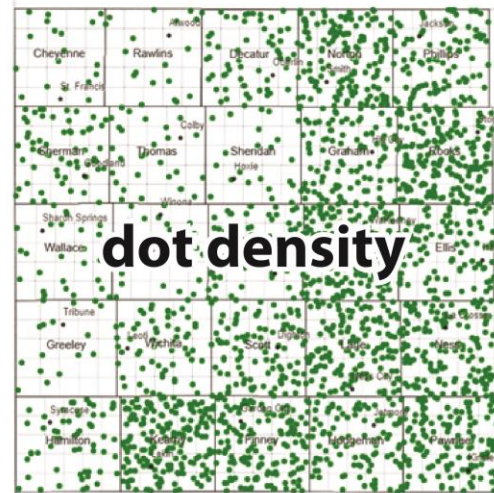
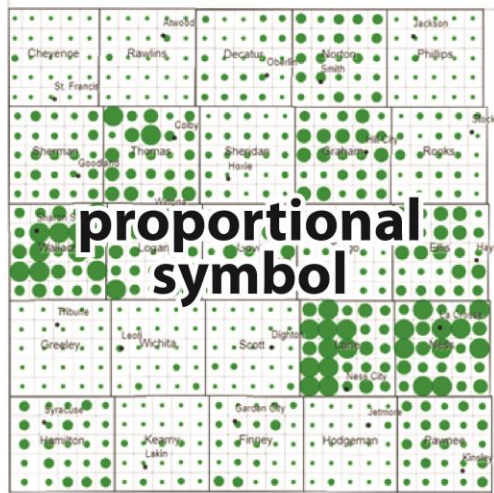
smooth



continuous

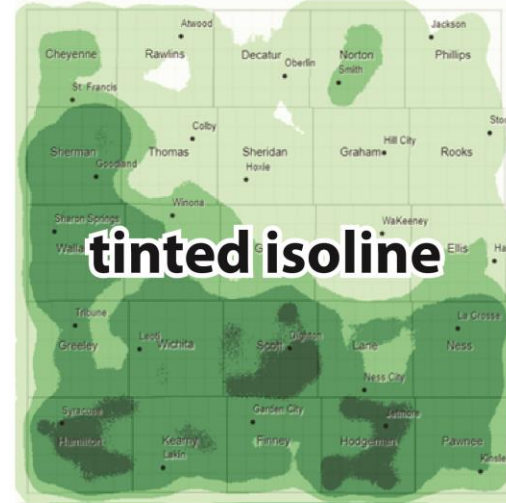
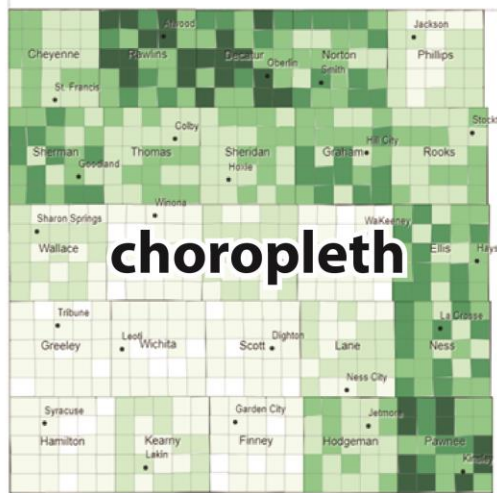
# Materials

discrete



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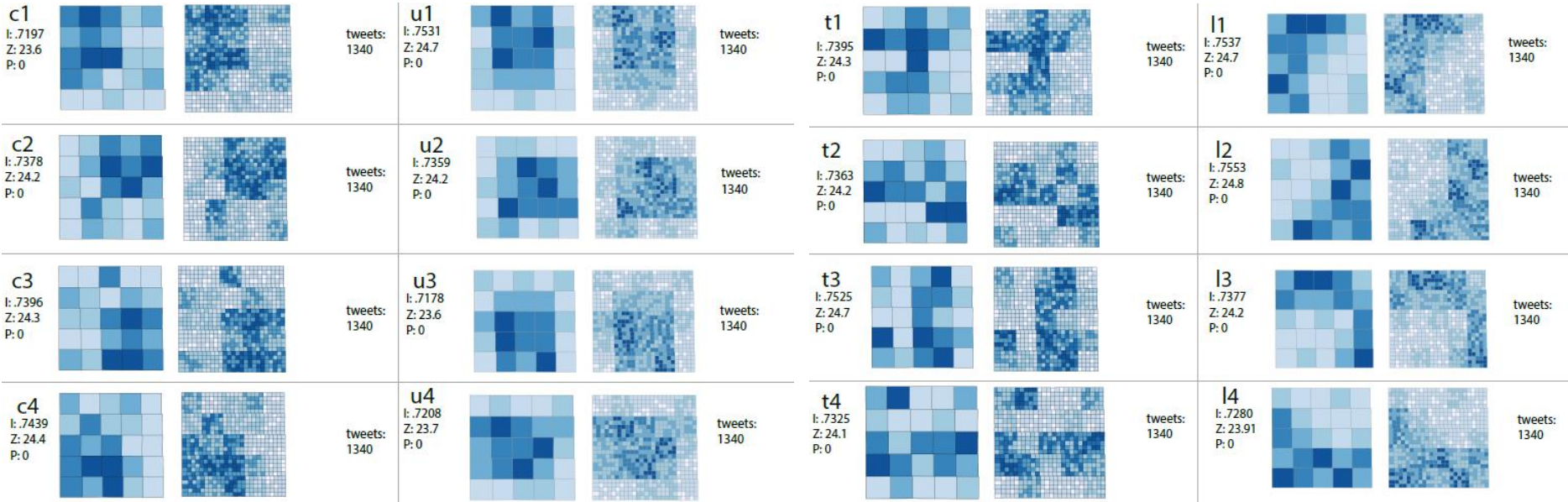
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continuous



# Procedure



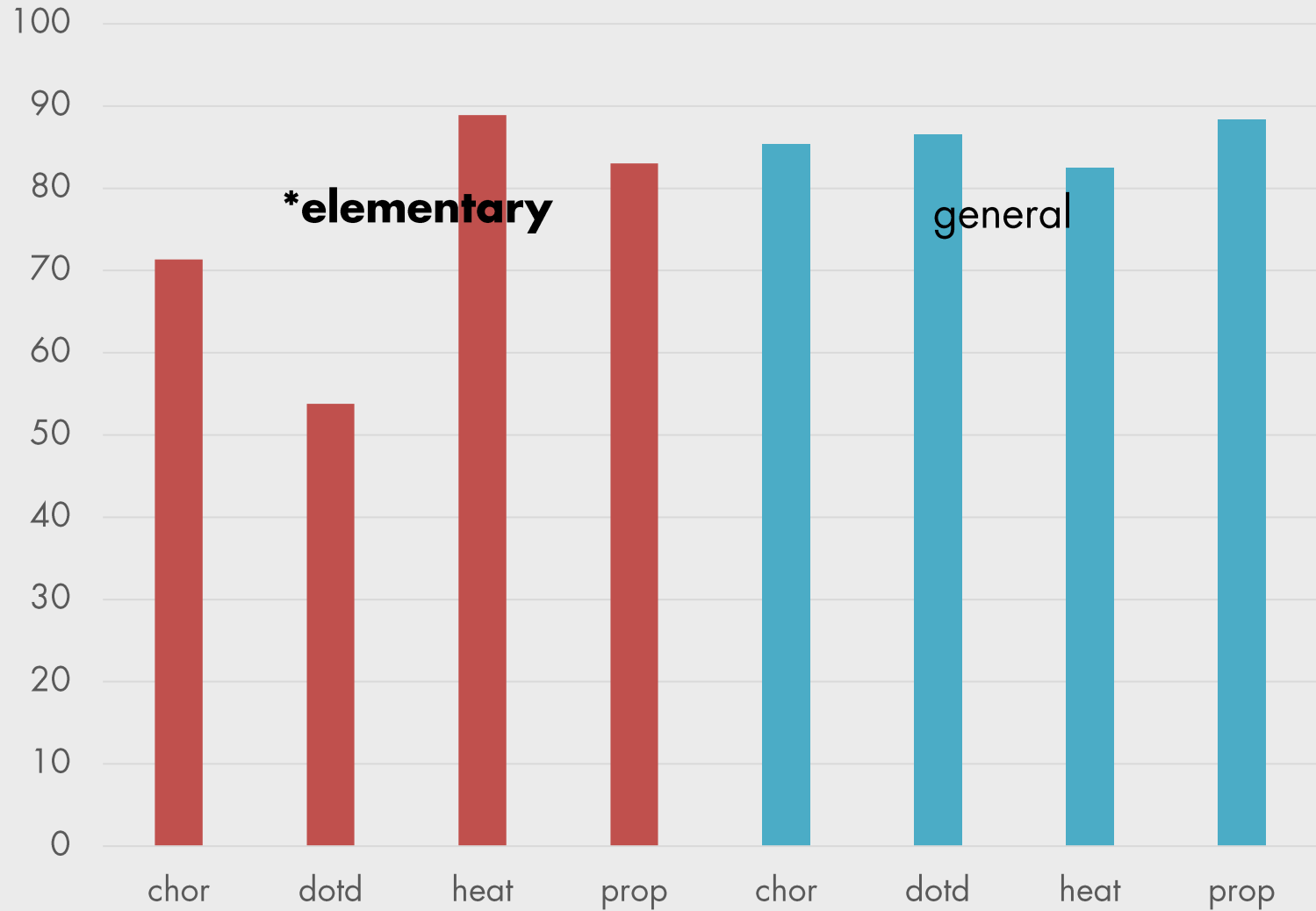
chor			dotd			heat			prop		
map#	dist	task	map#	dist	task	map#	dist	task	map#	dist	task
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2	L2	2	6	L3	4	10	L4	3	14	L1	1
3	T3	3	7	T4	1	11	T1	2	15	T2	4
4	U4	4	8	U1	3	12	U2	1	16	U3	2

# Results **Preliminary Analysis**

# Preliminary Results

## Accuracy

### Percentage Correct



$\chi^2=64.263, p=0.000^*$

$\chi^2=2.525, p=0.471$

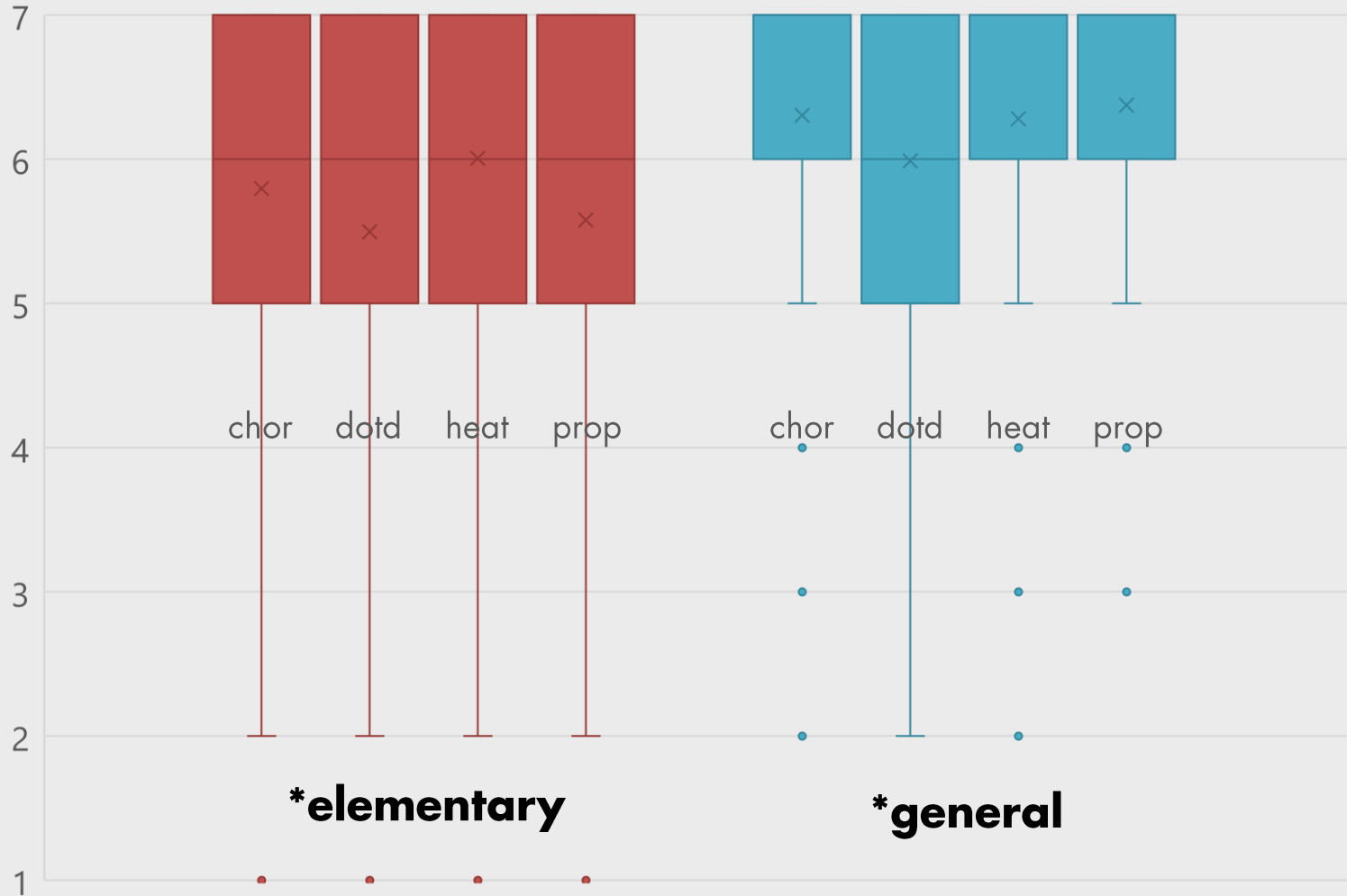


# Preliminary Results

## Confidence

### Likert Ratings

(7=very confident)



**H=12.858, p=0.005\***

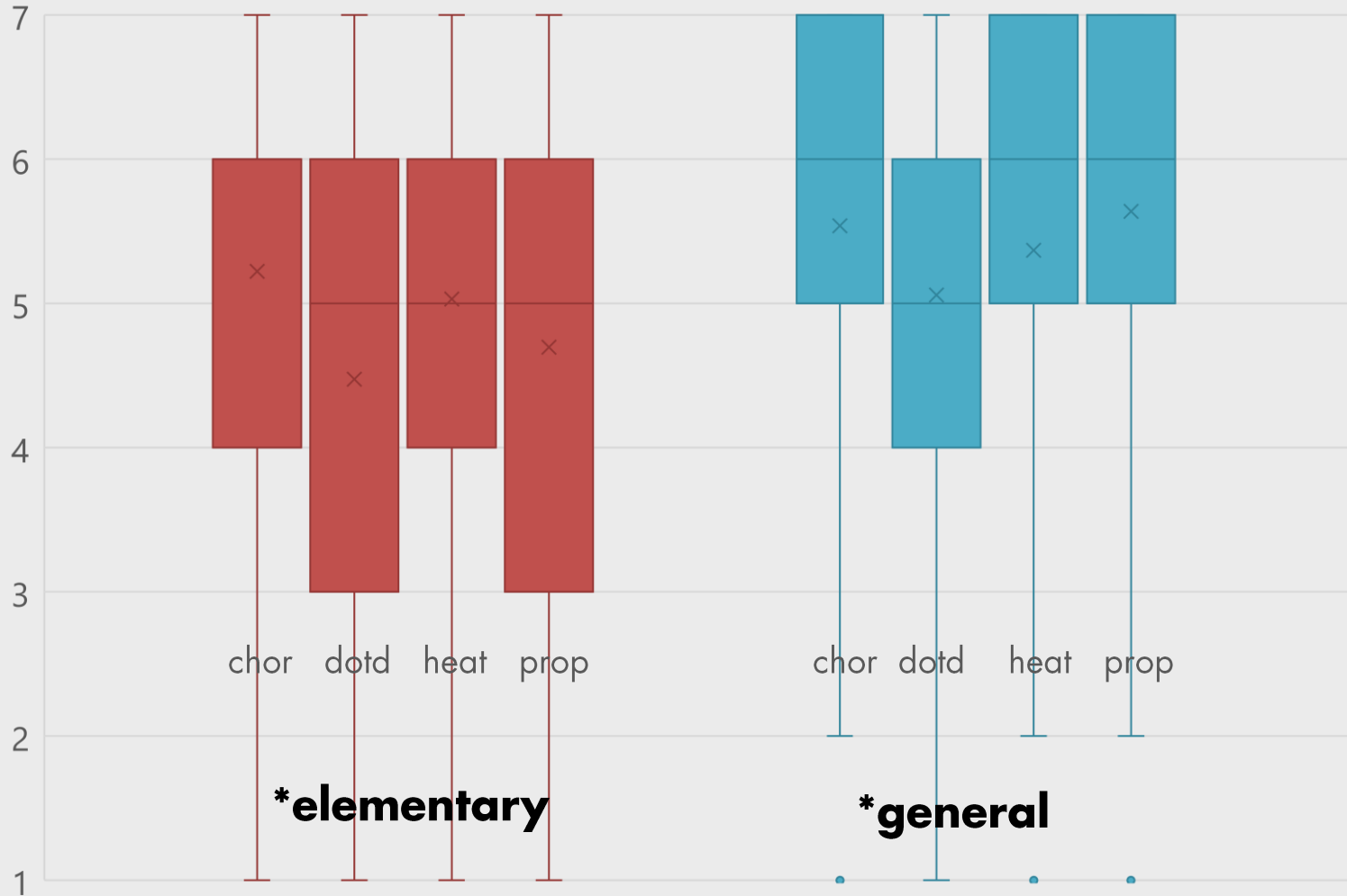
**H=14.886, p=0.002\***

# Preliminary Results

## Difficulty

### Ratings

(7=very easy)



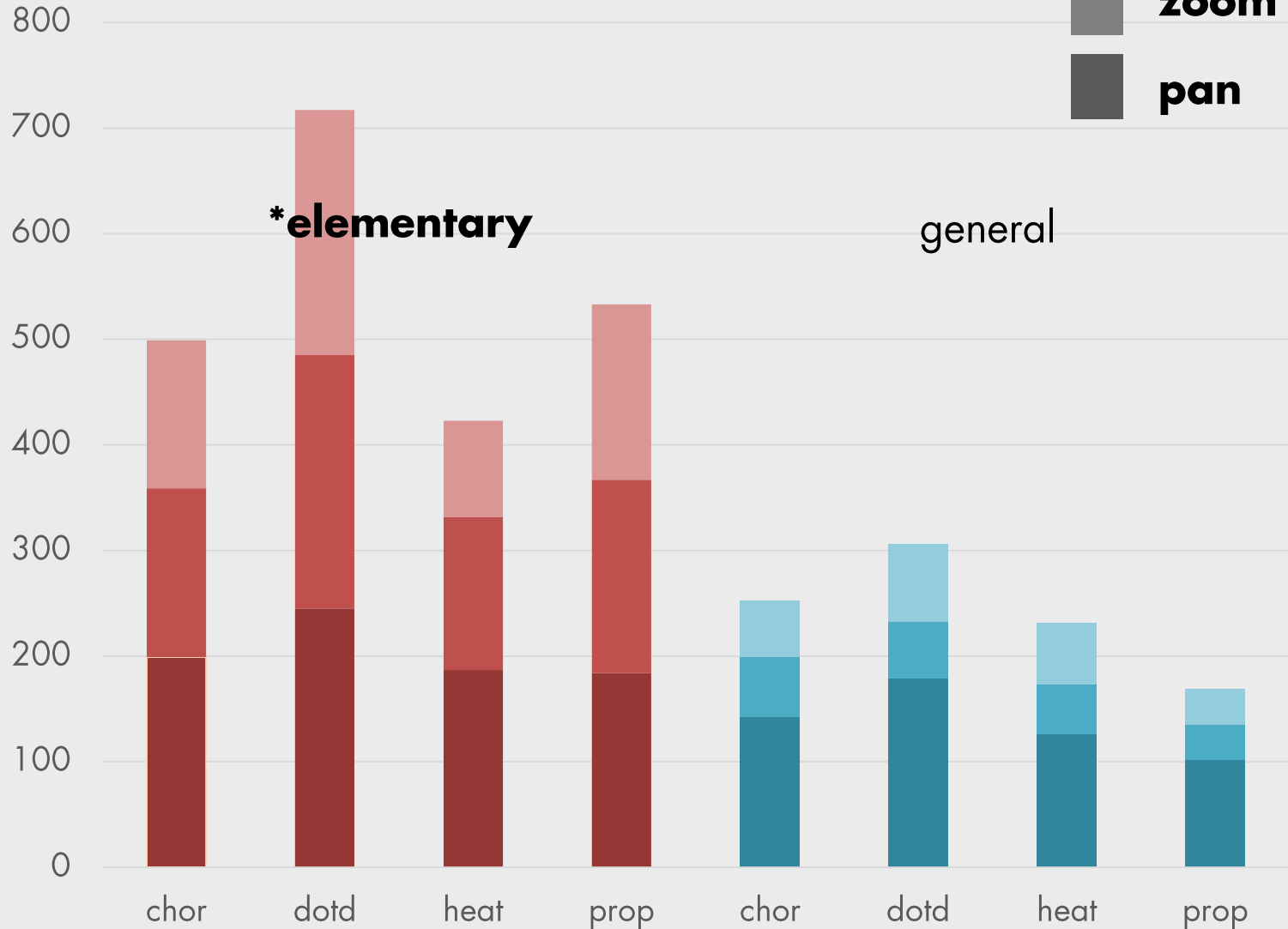
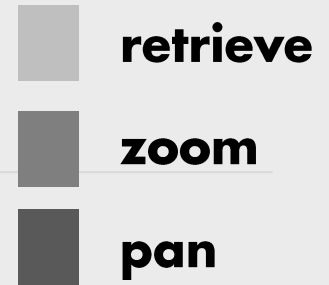
**H=19.604, p=0.000\***

**H=13.788, p=0.003\***

# Preliminary Results

## Interactions

### All Interactions



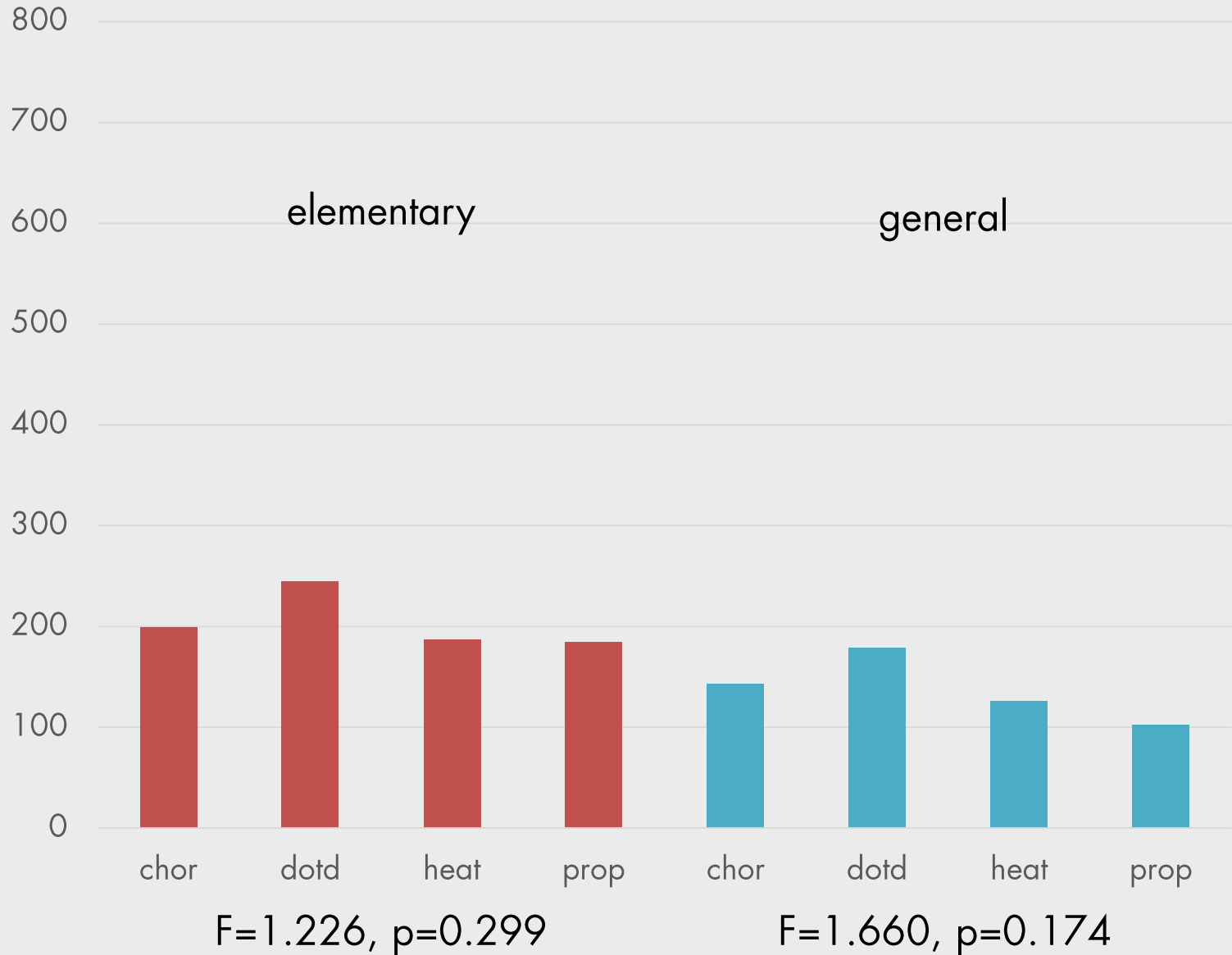
**F=6.111, p=0.000\***

F=2.450, p=0.063

# Preliminary Results

## Interactions

### Retrieve

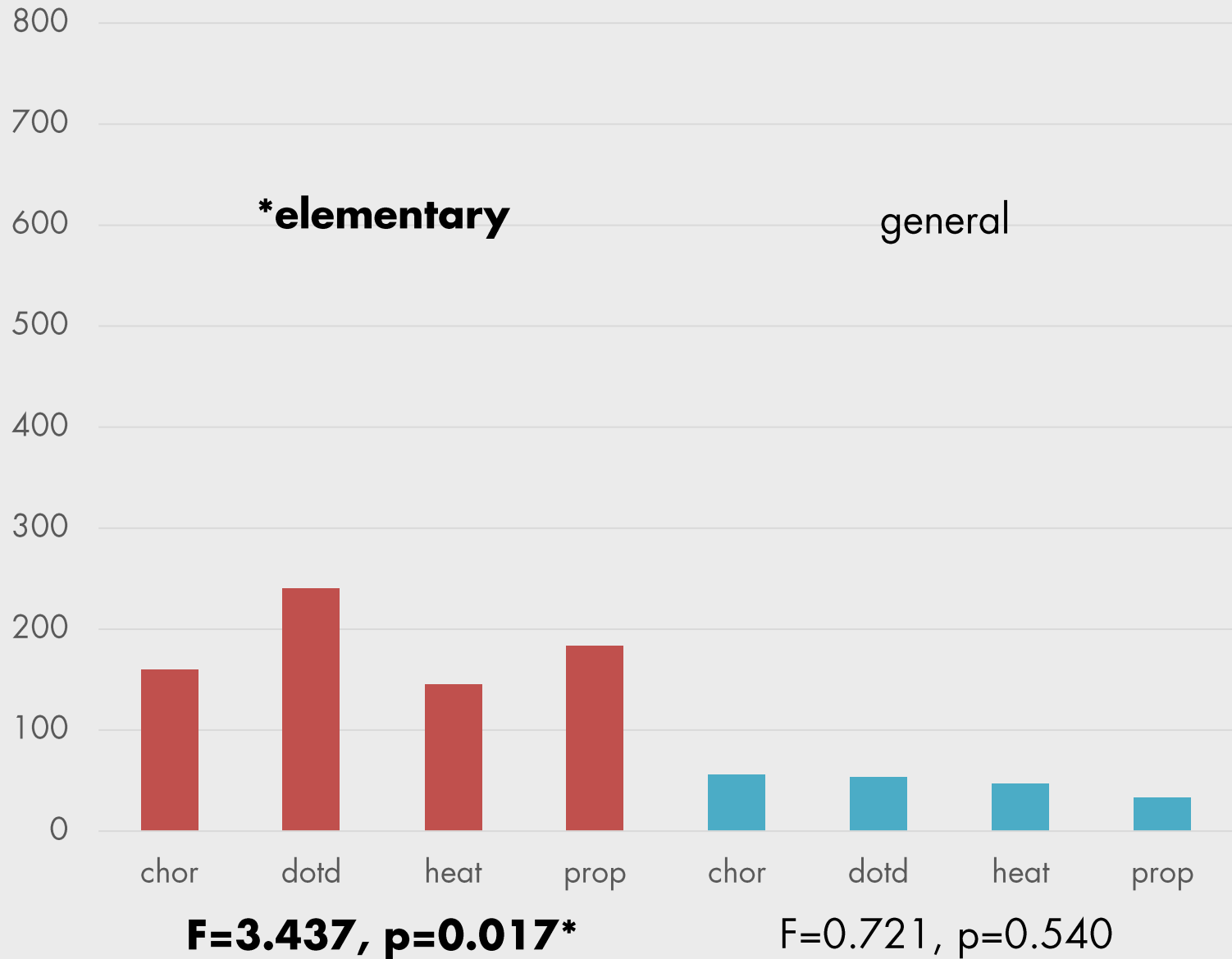




# Preliminary Results

## Interactions

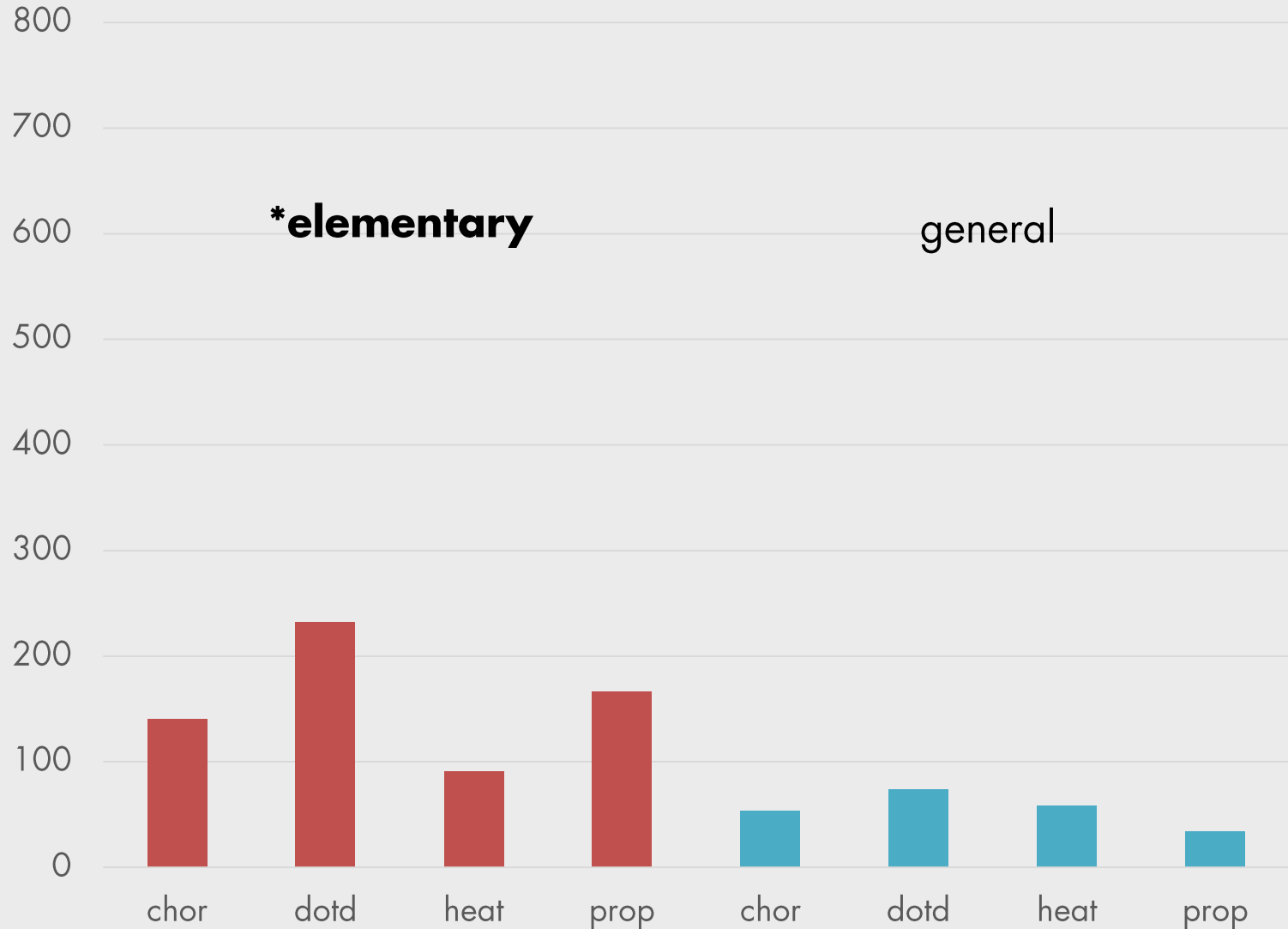
### Zoom



# Preliminary Results

## Interactions

### Pan



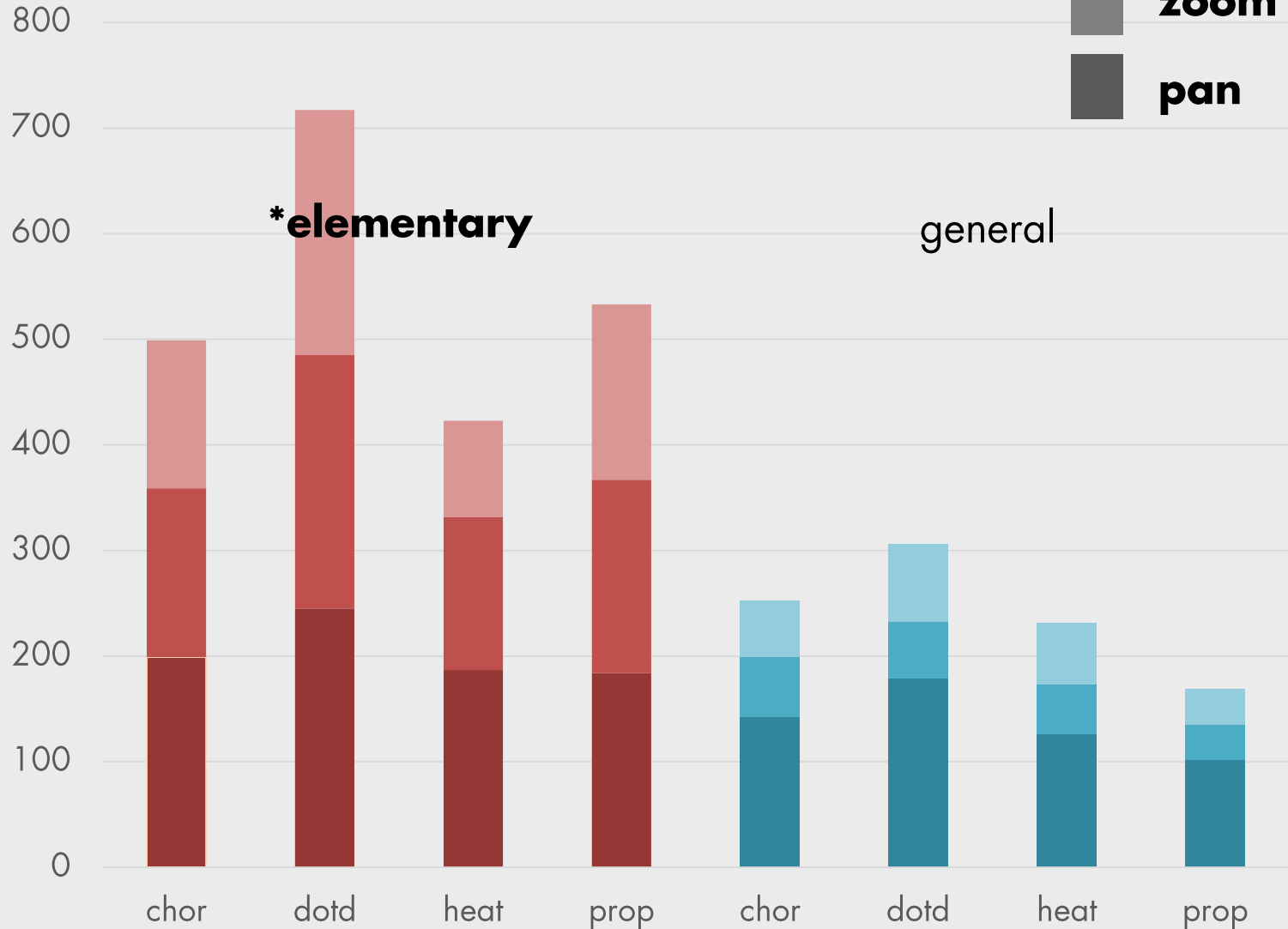
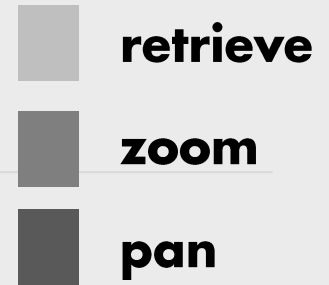
**F=5.688, p=0.001\***

F=1.444, p=0.229

# Preliminary Results

## Interactions

### All Interactions

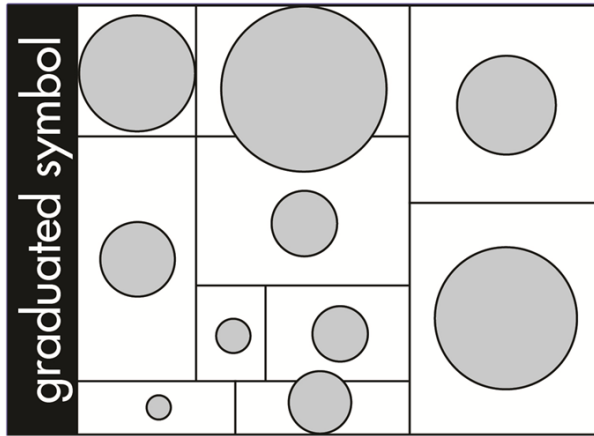


**F=6.111, p=0.000\***

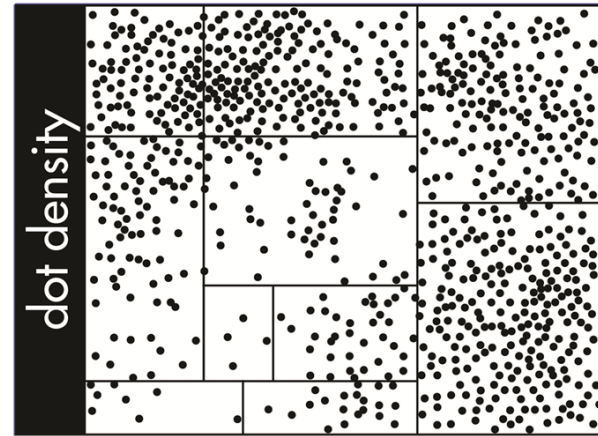
F=2.450, p=0.063

### 3. Metaphor in Representation

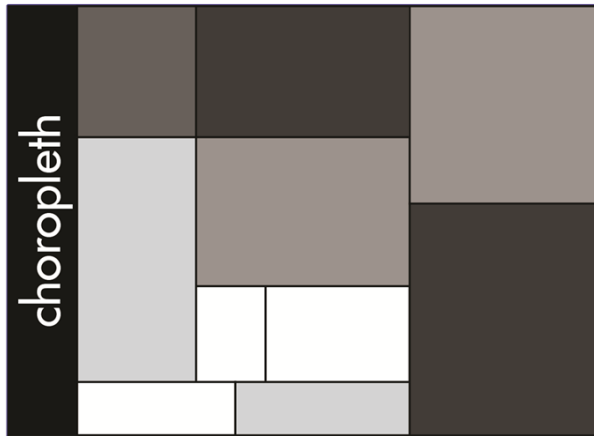
**abrupt**



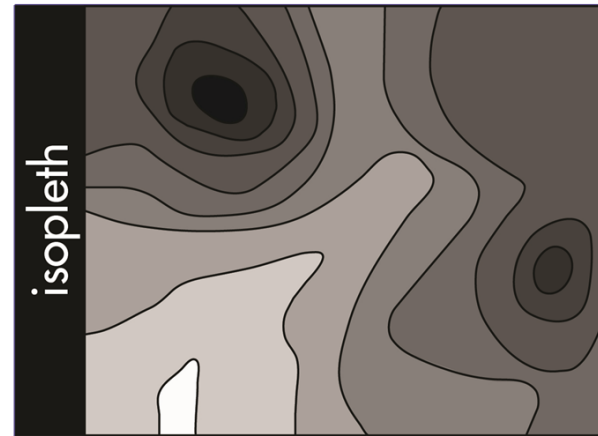
**discrete**



**smooth**



**continuous**





# Preliminary Observations

- **All (thematic) mapping is metaphorical**, and metaphor gives us new ways to think about both representation and interaction design
- **Interactivity** may make elementary tasks as/more difficult than general map reading tasks, given the interaction **operators** needed to access increasingly detailed data
- Slippy map interactions (pan, zoom, retrieve) appear most useful for **abrupt** multiscale representations (**choropleth, prop symbol**) given the natural object-based metaphor
- Multiscale **dot density maps** are potentially confusing, leading to many map reading errors & excessive interactions
- Multiscale **tinted isoline/heat maps** might actually be the more successful metaphor for the hypothetical twitter data, as they elicit relatively few interactions but still have low map reading error rates

## Next Steps...

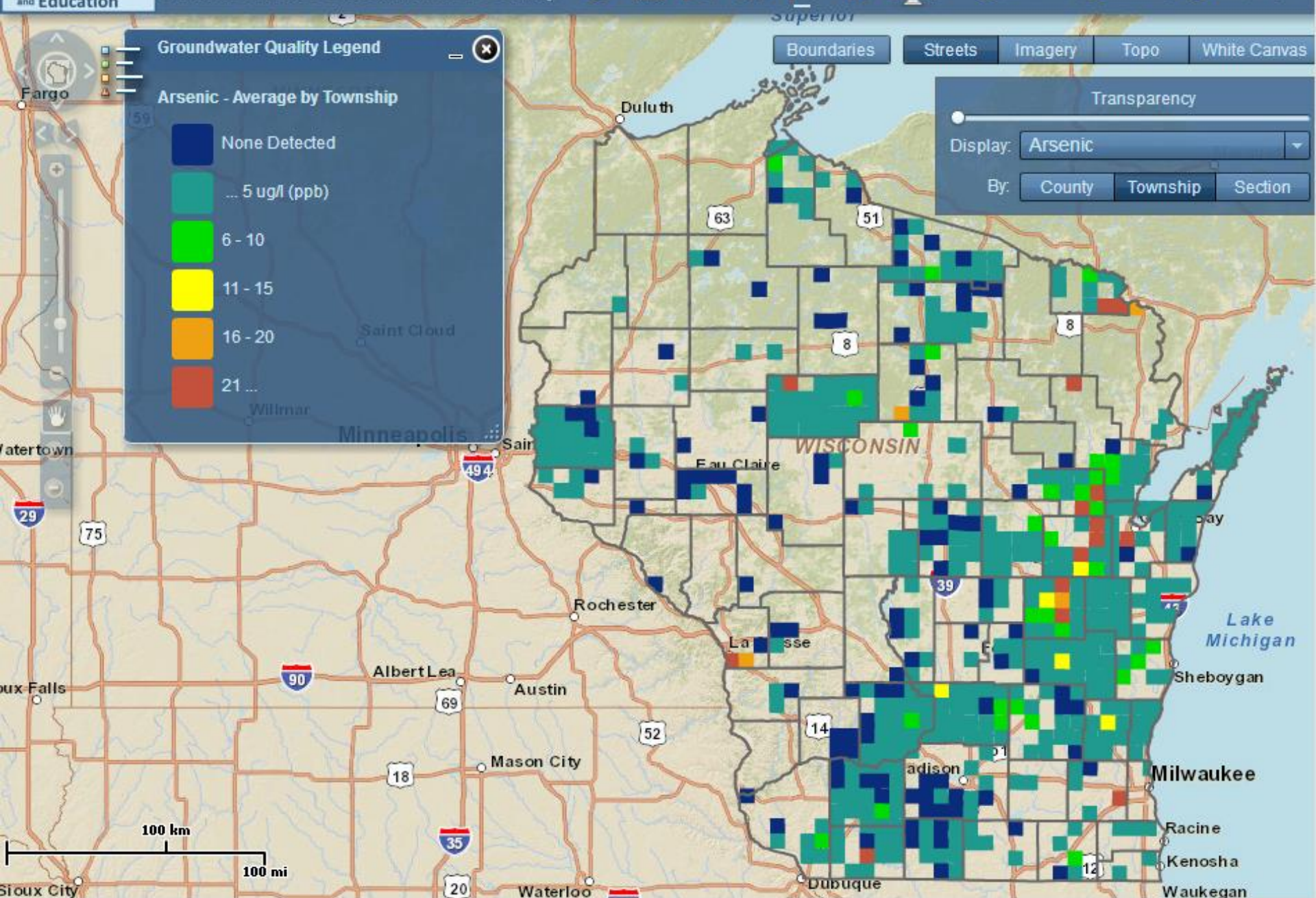
1. Run **post-hoc** inferential tests to determine if dot density is the outlier for elementary tasks
2. Examine unique **interaction sequences** in addition to interactions in aggregate: do participants who complete a task incorrect interact differently?
3. Examine interaction effects with **individual differences** and **preferences**
4. Triangulate findings with the more difficult **rank tasks**
5. Triangulate with **qualitative feedback** about the interactive, multiscale solutions

# Interactive & Multiscale Thematic Maps

Preliminary Results from an Empirical Study



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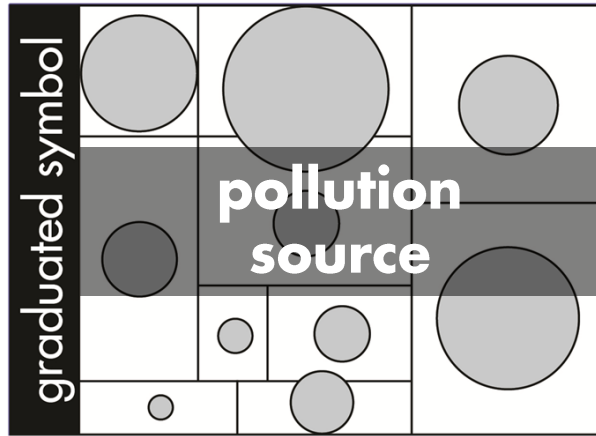
**Source:** Roth et al. (2014) *Interactivity, Privacy, & Uncertainty: Mapping Drinking Water Quality in Wisconsin*



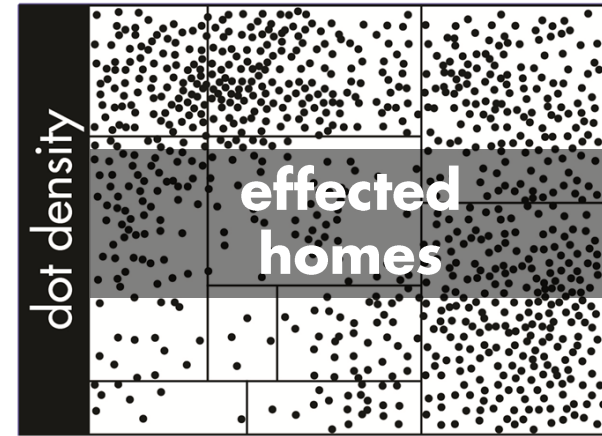
### 3. Metaphor

Drinking Water Pollution

**abrupt**



**discrete**



**smooth**



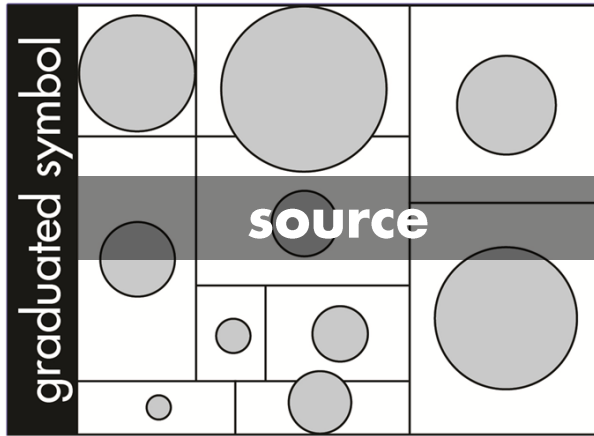
**continuous**



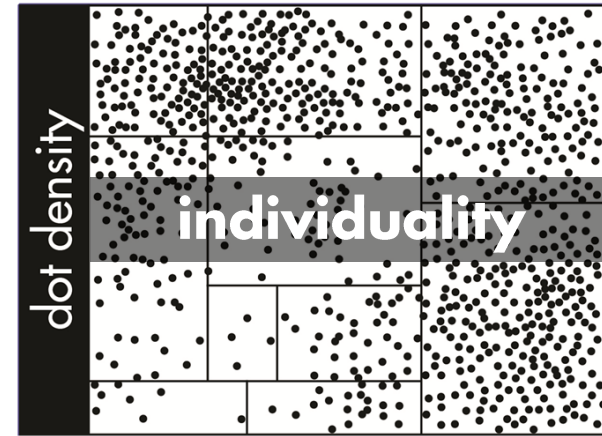
### 3. Metaphor

Drinking Water Pollution

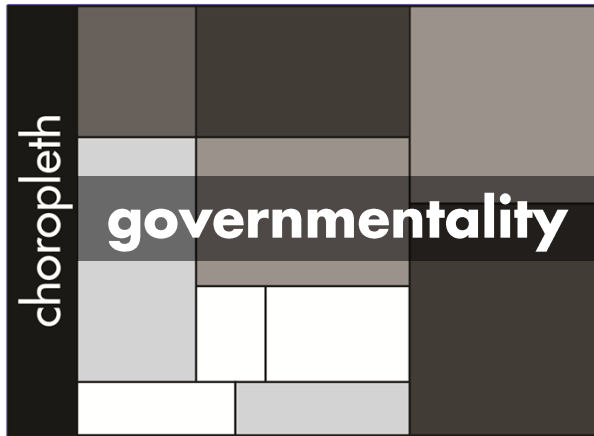
**abrupt**



**discrete**



**smooth**

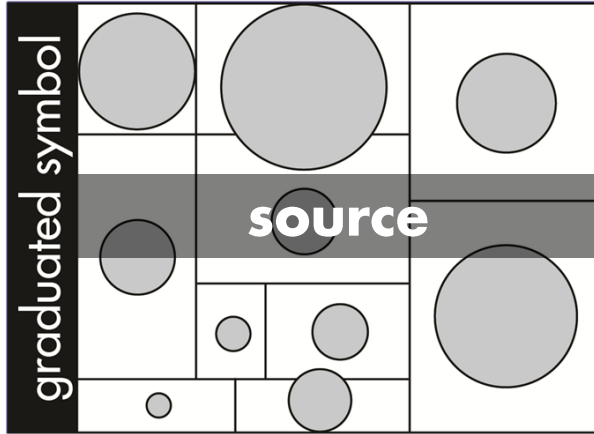


**continuous**

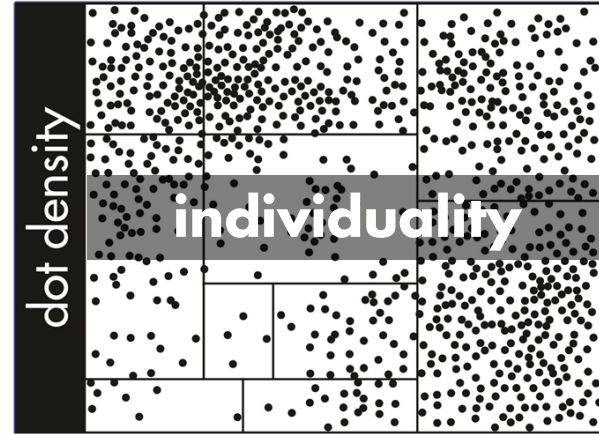
### 3. Metaphor

Drinking Water Pollution

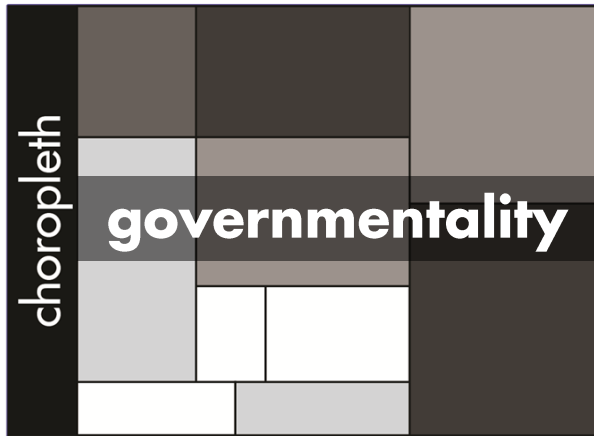
**abrupt**



**discrete**



**smooth**



**continuous**