

# Understanding Data Accessibility for People with Intellectual and Developmental Disabilities (IDD)

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David Burlinson, Emily Shea Tanis, Danielle Albers Szafir



**ATLAS**

VisuaLab

# Accessibility

# Disability



# Accessibility by Disability



**VISUAL**



**AUDITORY**



**MOTOR**



**COGNITIVE**

# Data Visualization Accessibility



**most researched**

**VISUAL**



**AUDITORY**



**MOTOR**



**COGNITIVE**

# Data Visualization Accessibility



**most researched**

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**largest population**

**COGNITIVE**

# Data Visualization

**Data visualization** is the graphical representation of information and data. By using visual elements like charts, graphs, and maps, data visualization tools provide an accessible way to see and understand trends, outliers, and patterns in data.

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**#1 Visualization is a cognitive tool.**

**#2 Using visualization requires a good mastery of numeracy, graphicacy, and data & vis literacy.**

# Data Visualization

Data visualization is the graphical representation of information in a way that is easy to understand. It uses charts, graphs, and maps to present data in a visual format. This makes it possible to see and understand trends, outliers, and patterns in data.

**Visualize the invisible!**

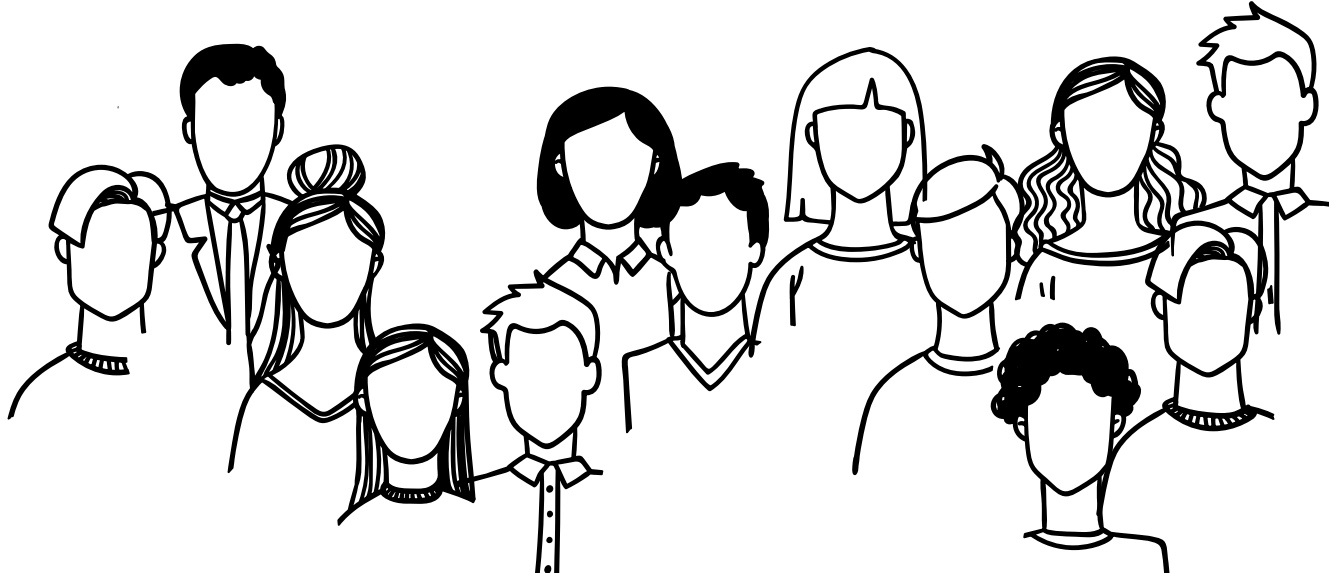
# Understanding Data Accessibility for People with Intellectual and Developmental Disabilities (IDD)



1,000,000,000



15 % of the  
population



1 in 6 children  
in the US



# What is IDD?



Related to Thought Process



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## Related to Thought Process

Intellectual Functioning (e.g., reasoning, learning, problem-solving)

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Adaptive Behavior (e.g., social & practical skills)

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## People with IDD

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## People with IDD

Struggle with abstract thinking, spatial reasoning

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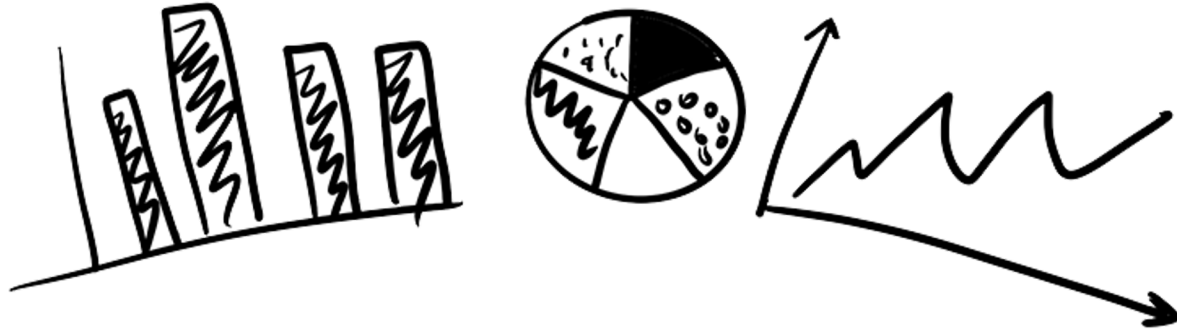
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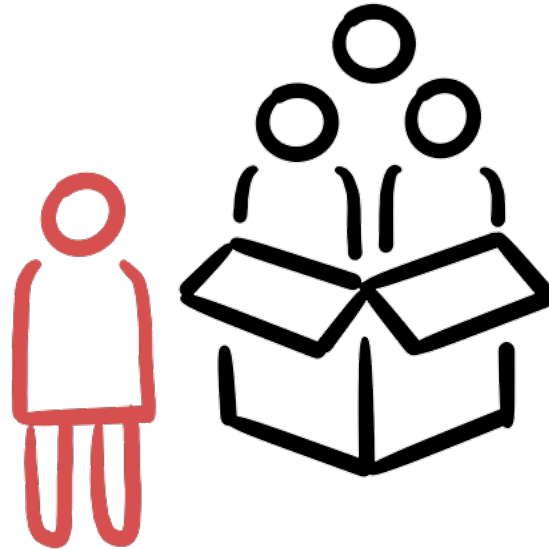
## People with IDD

Struggle with abstract thinking, spatial reasoning

Have limited exposure to mathematical & statistical training



People with IDD been Excluded from  
Data Visualization



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**Access to data is...**



**Access to data is...**

A basic human right

# **Access to data is...**

A basic human right

The prerequisite for decision-making  
& independent living

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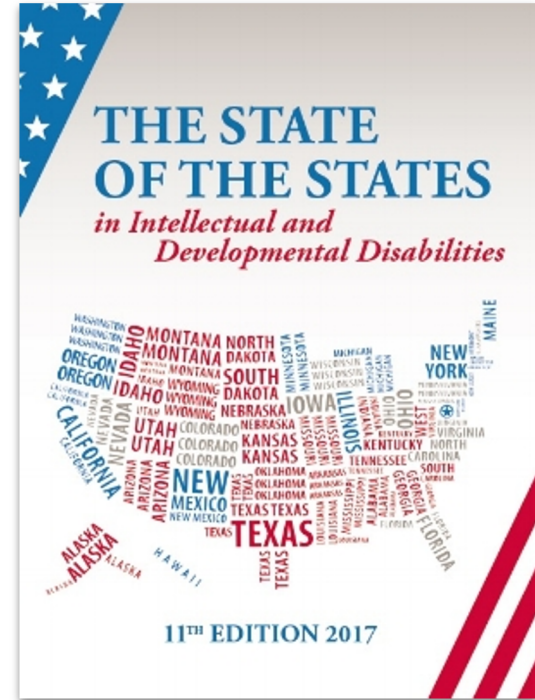
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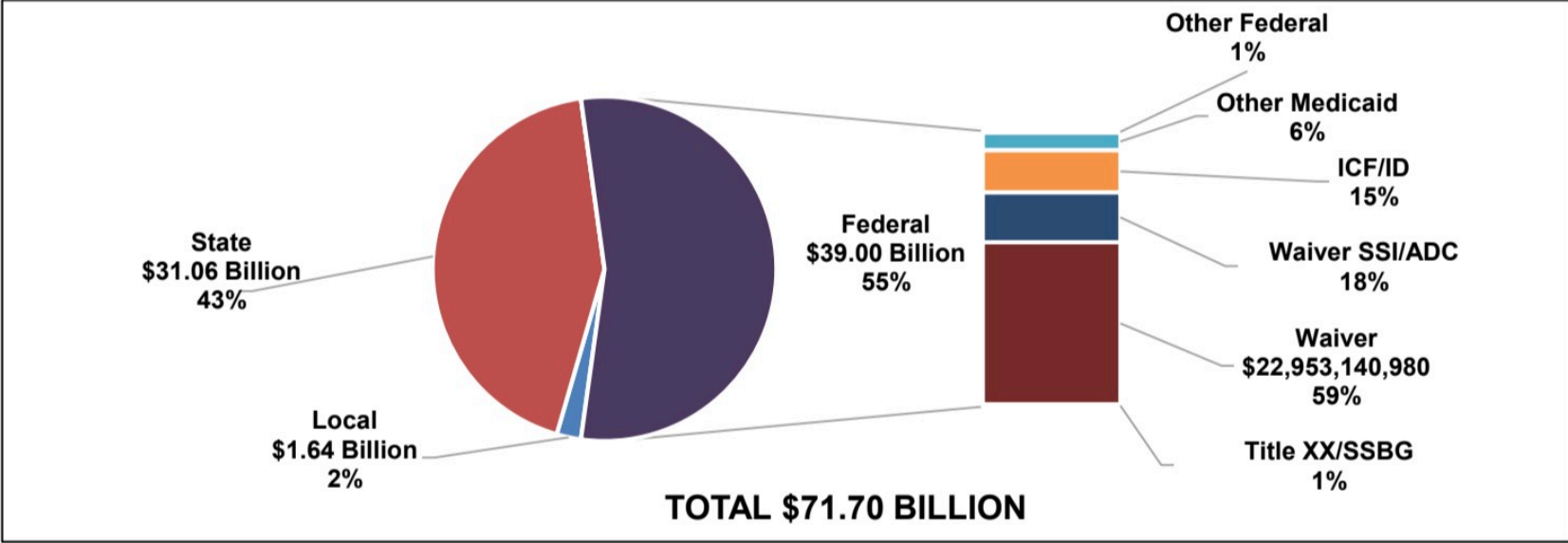
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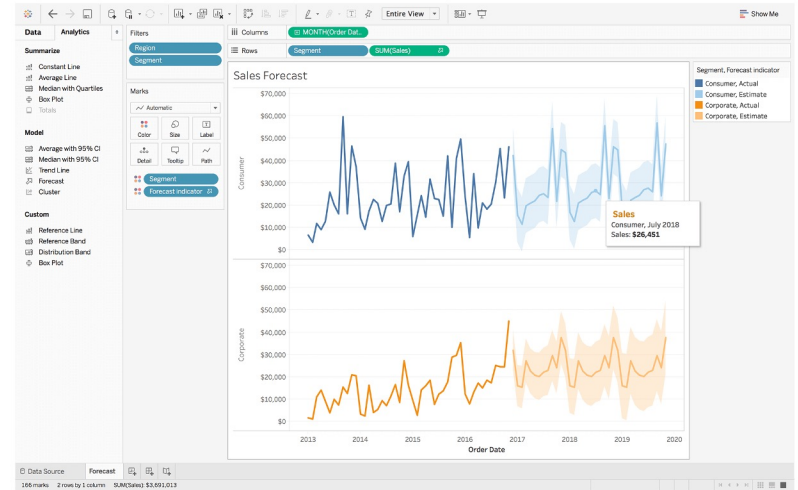
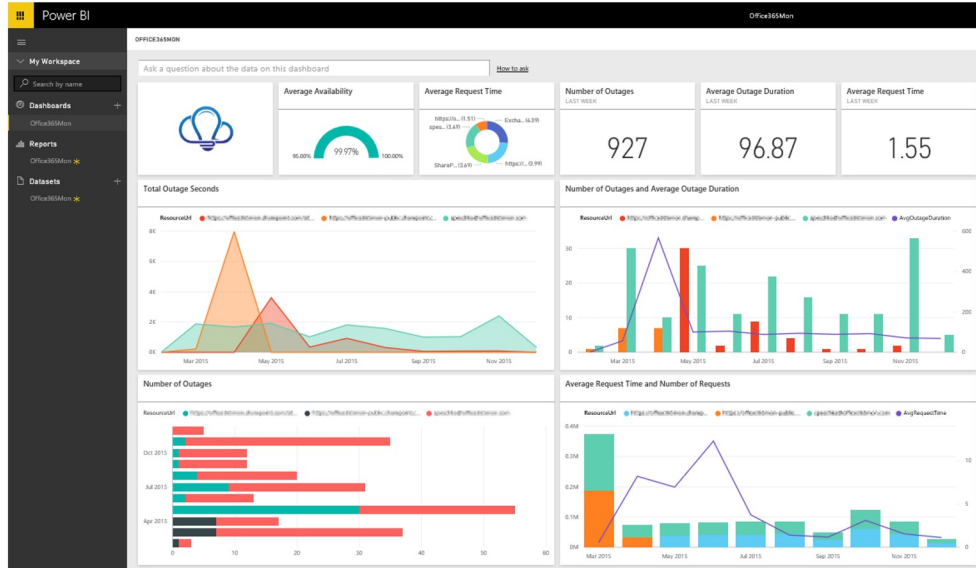


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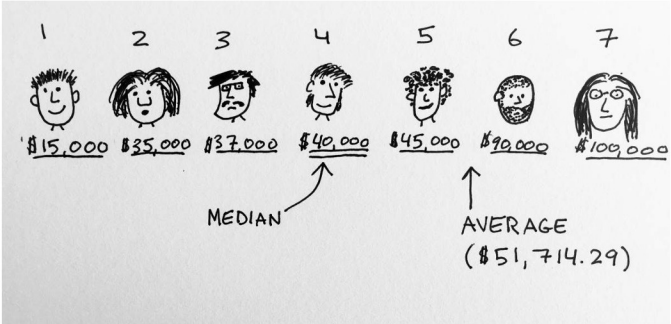
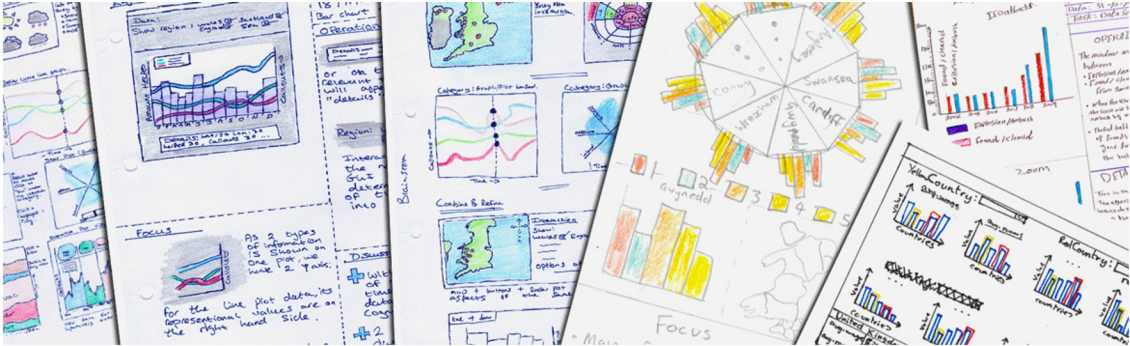
**PUBLIC IDD SPENDING BY REVENUE SOURCE: FY 2017**



# Tableau / Power BI



# Paper-based Sketch

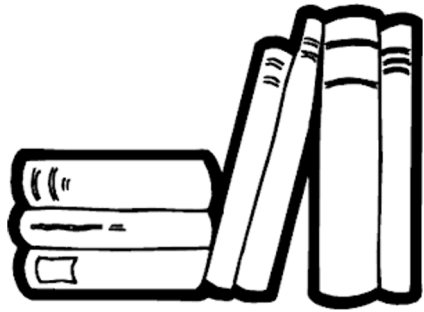




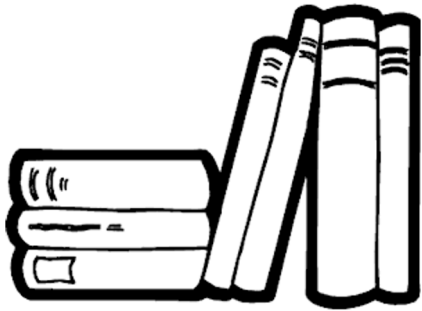
**How do People with  
Intellectual and Developmental Disabilities  
Interpret Data Differently?**



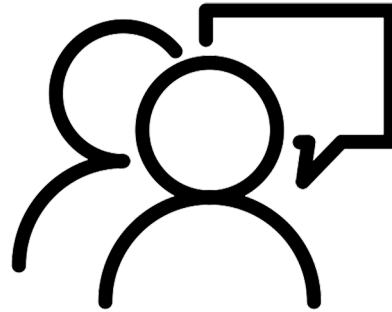




## Literature Review



Literature Review



Informal Interview

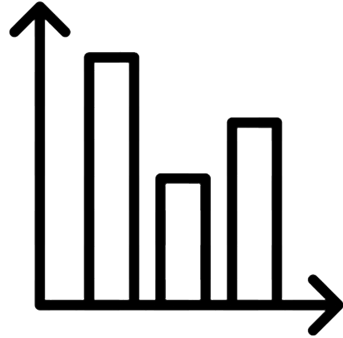
# **Three Hypotheses**

# Three Hypotheses

**H1: The best chart type for a given task will differ  
between people with and without IDD**

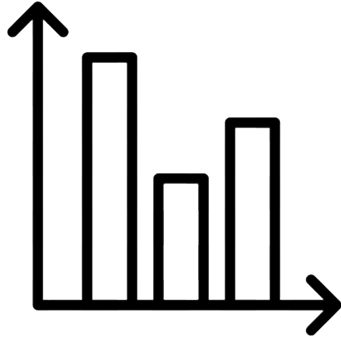
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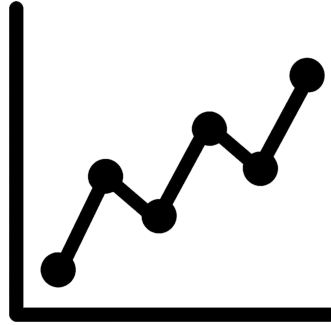


data across categories

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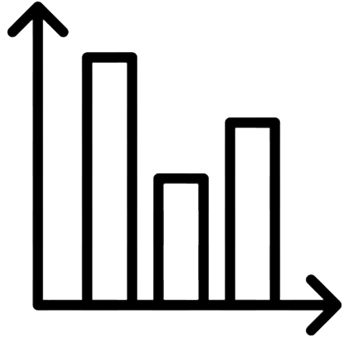


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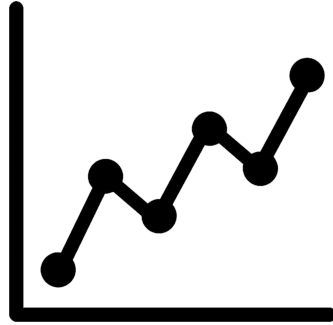


change over time

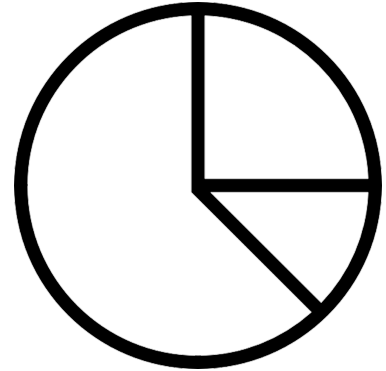
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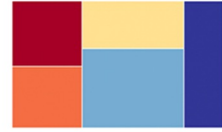
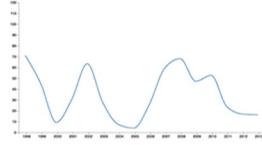
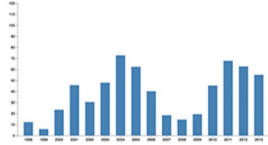


part-to-whole



# Three Hypotheses

Chart Type



# Three Hypotheses

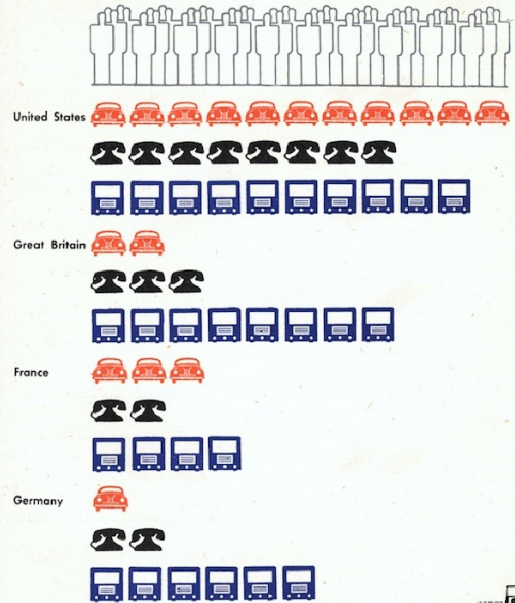
**H1: The best chart type for a given task will differ between people with and without IDD**

**H2: Discrete data representations will lead to more accurate performance for people with IDD**

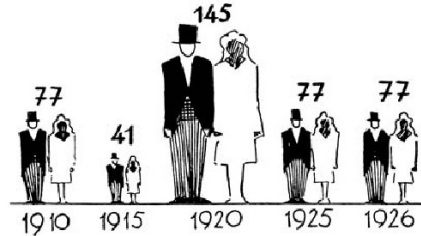
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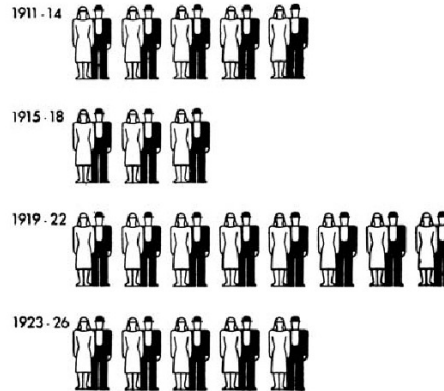
Motor Cars, Telephones, Radio Sets 1937  
per 50 population



Britain is close to America in radio sets per head, but in motor cars and telephones European countries lag far behind American standards.

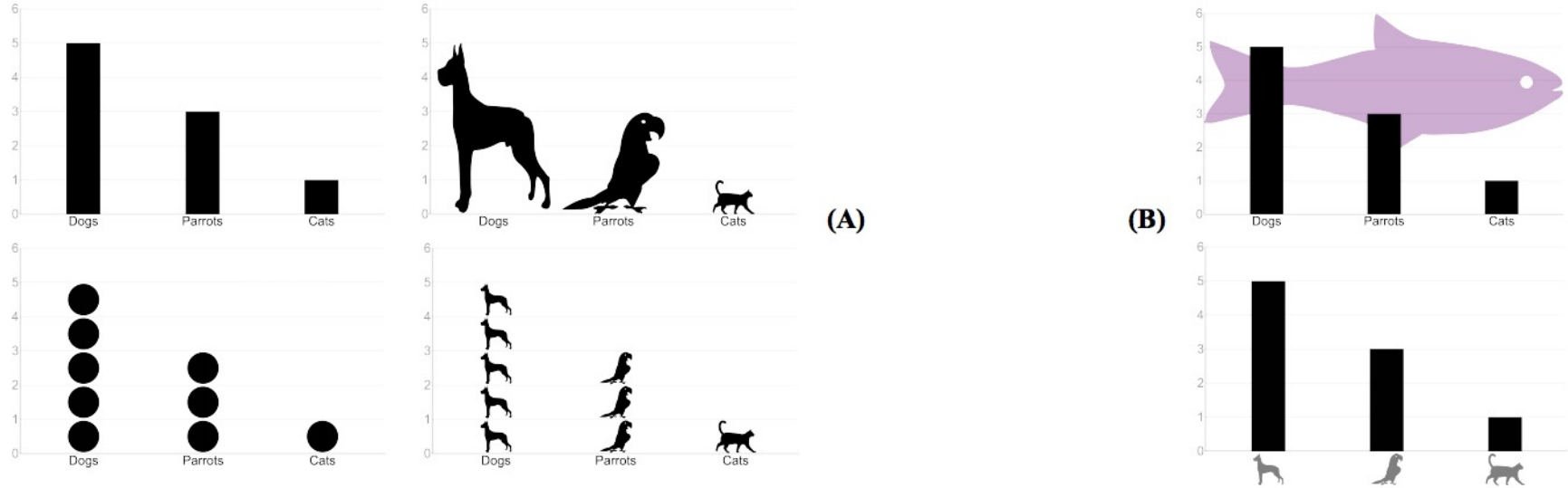


Men Getting Married in Germany in a Year



1 sign for 100,000 a year

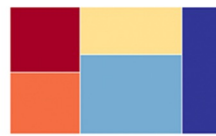
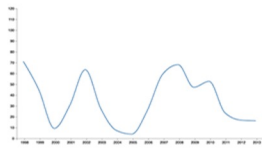
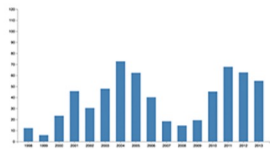
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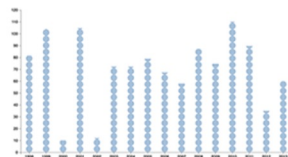
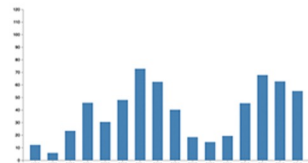
\*Haroz et al. 2015. ISOTYPE Visualization: Working Memory, Performance, and Engagement with Pictographs.

# Three Hypotheses

Chart Type



Data Continuity



# Three Hypotheses

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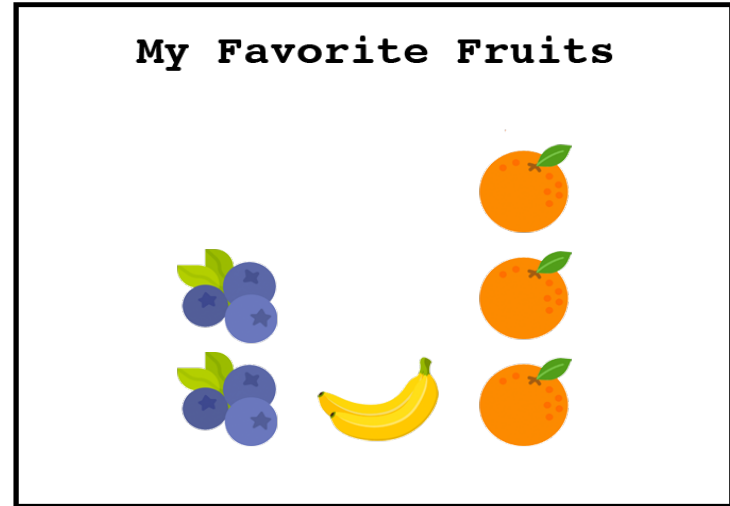
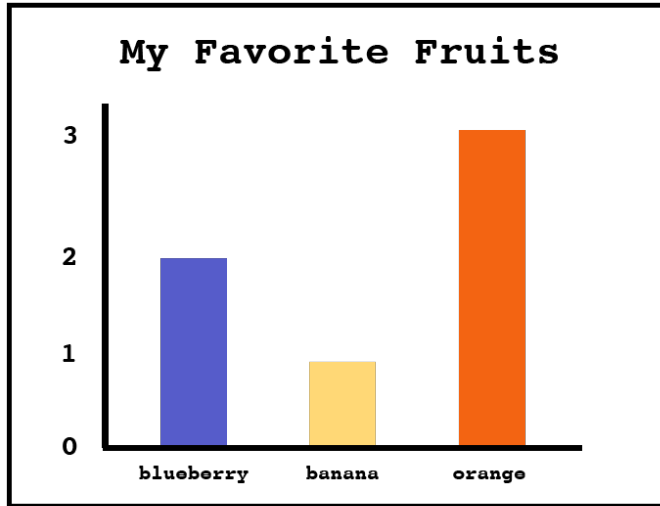
**H2: Discrete data representations will lead to more accurate performance for people with IDD**

**H3: Semantically meaningful chart embellishments will enhance data interpretation for people with IDD**

# **DataVis 101: Embellishments Can Connect Data to Meaning**



# DataVis 101: Embellishments Can Connect Data to Meaning

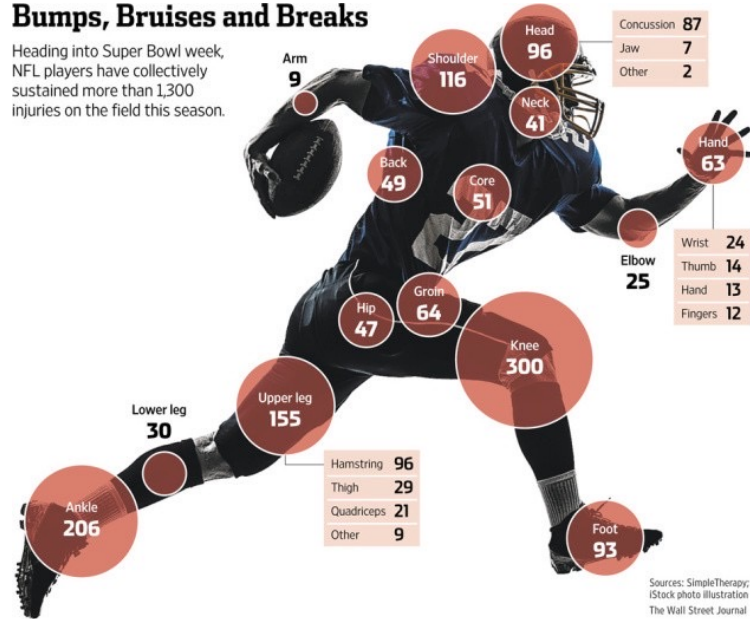


Icon

# DataVis 101: Embellishments Can Connect Data to Meaning

## Bumps, Bruises and Breaks

Heading into Super Bowl week, NFL players have collectively sustained more than 1,300 injuries on the field this season.



## Beep, beep! Big cars being overtaken

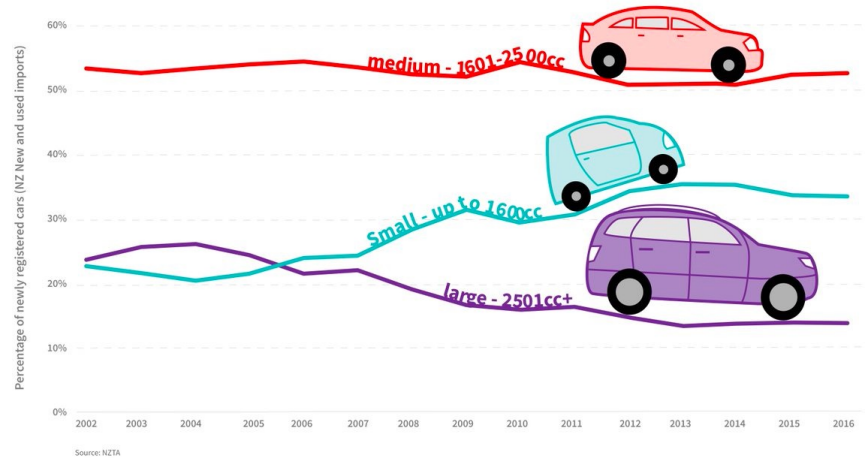
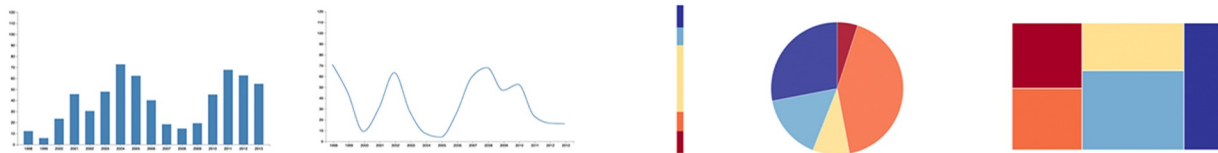


Chart Junk

# Three Hypotheses

Chart Type



Data Continuity

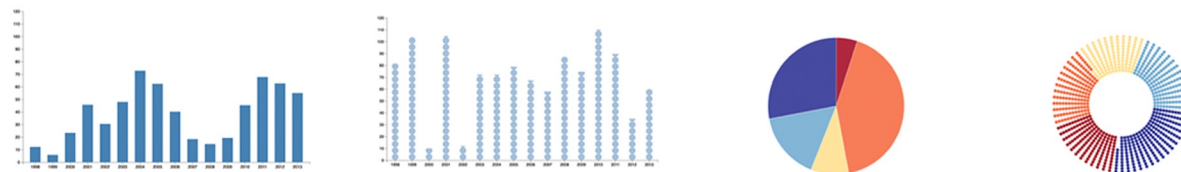
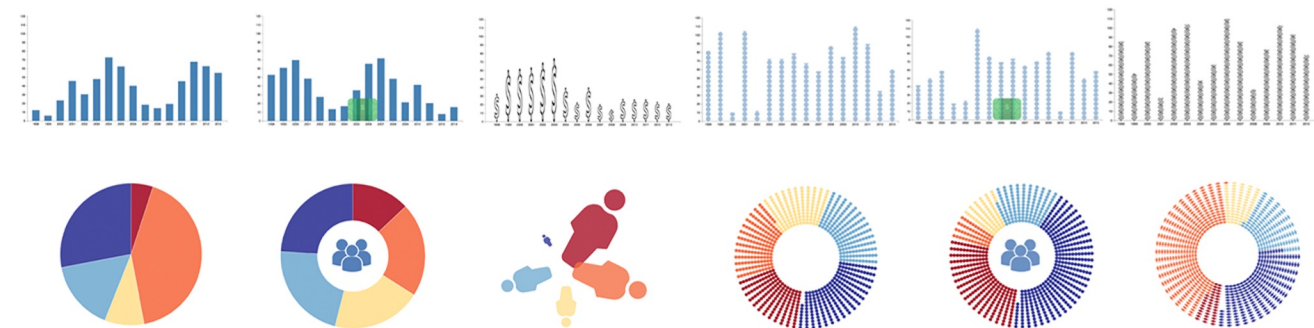


Chart Embellishment



# Recruitment

**ACCESSIBLE**  
**VISUALIZATION**

*We are looking for participants to join our research to  
design visualizations for people with  
Intellectual Developmental Disabilities*

.....

**WEB-BASED EXPERIMENT**  
**35 - 45 MIN | 21 - 60 YEARS OLD**

.....

**\$10 GIFT CARD**

*Questions? Contact:  
Keke.Wu@colorado.edu*

STATE OF THE STATES  
IN INTELLECTUAL AND  
DEVELOPMENTAL DISABILITIES

VisuaLab

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STATE OF COLORADO  
IN INTELLECTUAL AND  
DEVELOPMENTAL DISABILITIES



VisuaLab



## Designing Accessible Visualization



### Do you have an intellectual or mental disability? We want your help!

We are doing a study to learn what kinds of data visualizations (charts, graphs, etc.) help people with an intellectual or mental disability analyze financial data best and what kinds of visualizations they prefer. We are doing this in order to design more accessible visualizations that are customized for people with cognitive impairments.

### What do I need to know about the study?

- We are looking for participants ages 21-60, with or without cognitive impairments.
- The study will take place over a Zoom video call with a researcher. You will sign up for a date and time and we will send you a link to the meeting.
- You will look at different visualizations online, answer questions, and give your opinions.
- The study can be expected to last about 45-60 minutes.
- As a thank you for your time and effort, you will receive a \$10 giftcard after the study.

\$10 GIFTCARD FOR PARTICIPATION!

Questions? Contact: keke.wu@colorado.edu  
or emma.petersen@colorado.edu

## How to Join a Zoom Meeting

This document will show you step by step how to join a zoom meeting using the link in your email invite and then how to begin the study. You can also watch Zoom's video on how to join a meeting here: <https://support.zoom.us/hc/en-us/articles/201362193-Joining-a-Meeting>.

### How to Join a Zoom Meeting With an Email Invite:

1. Click on the link in the email we sent you. It will be below the text "Join Zoom Meeting", as in the image below.

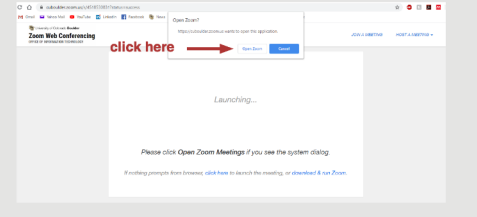
click here

Join Zoom Meeting

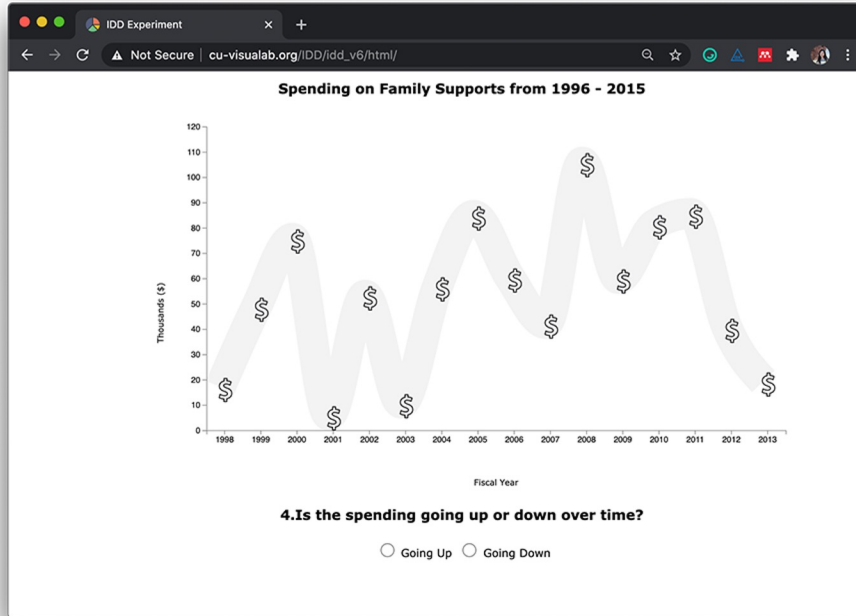
<https://cu.boulder.zoom.us/j/4518530831>

Meeting ID: 451-853-0831

2. This will open a new tab and your web browser will prompt you to open Zoom. Press "Open Zoom". The example below is in Google Chrome, some web browsers will say something slightly different (ex. in Safari you will hit "Allow" to open Zoom).

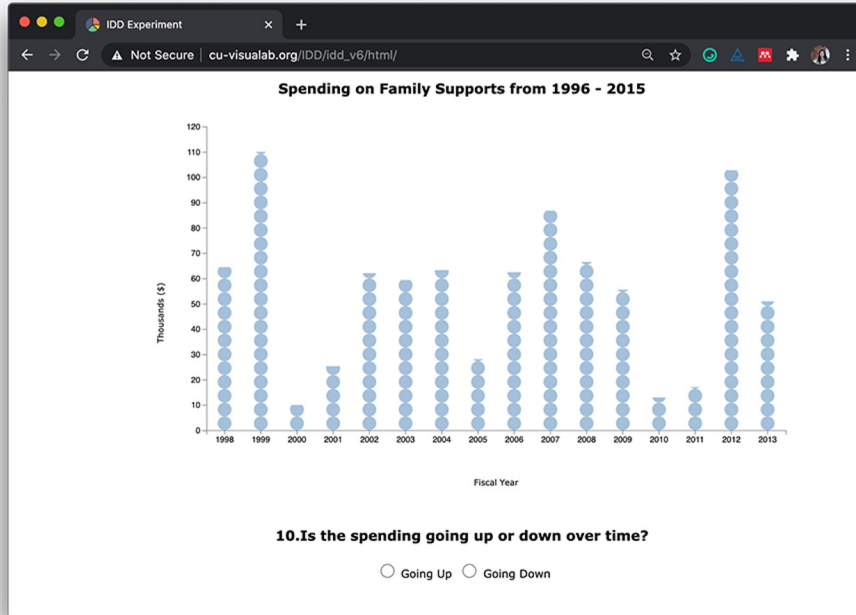


# Mixed-Methods Experiment



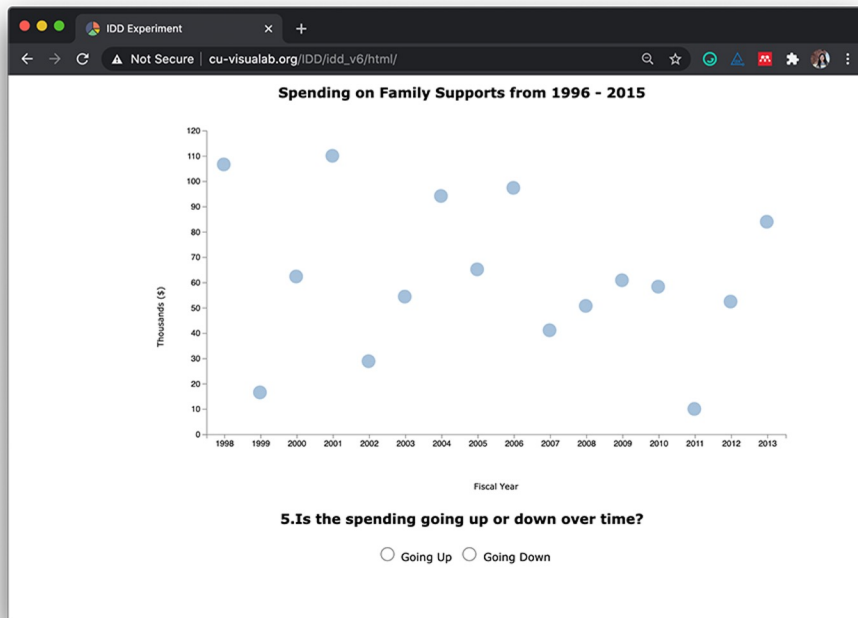
34 Participants  
with and without IDD

# Mixed-Methods Experiment



**34 Participants  
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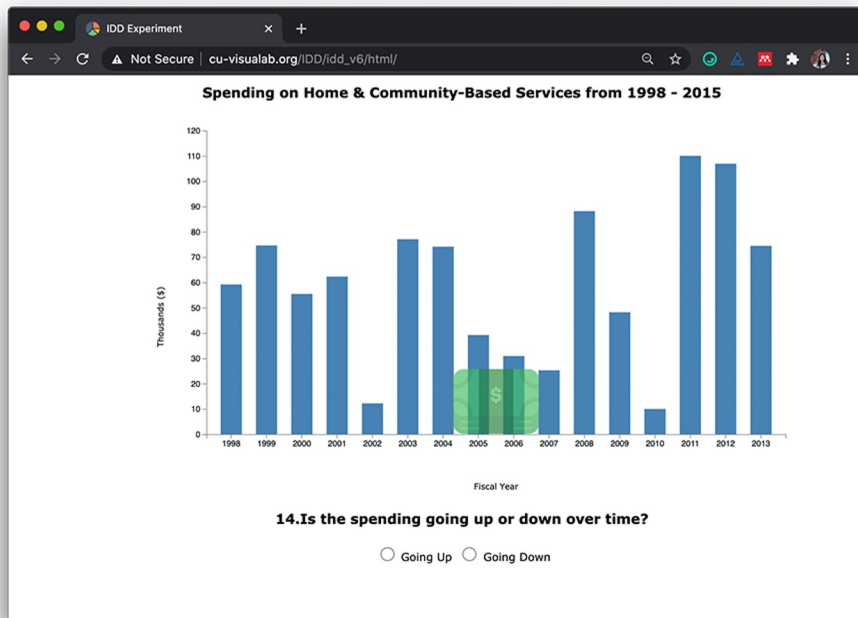
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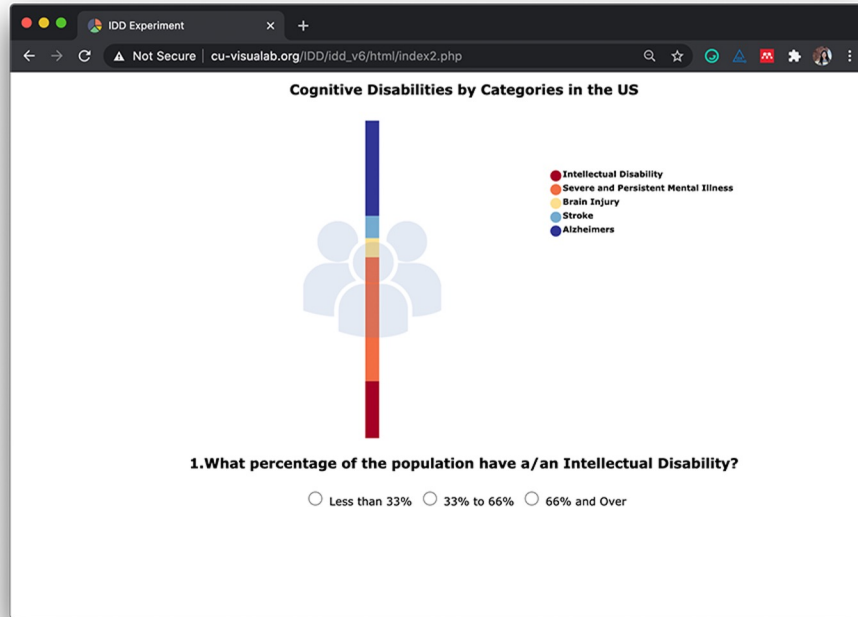
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34 Participants  
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Time Series &  
Proportion Data

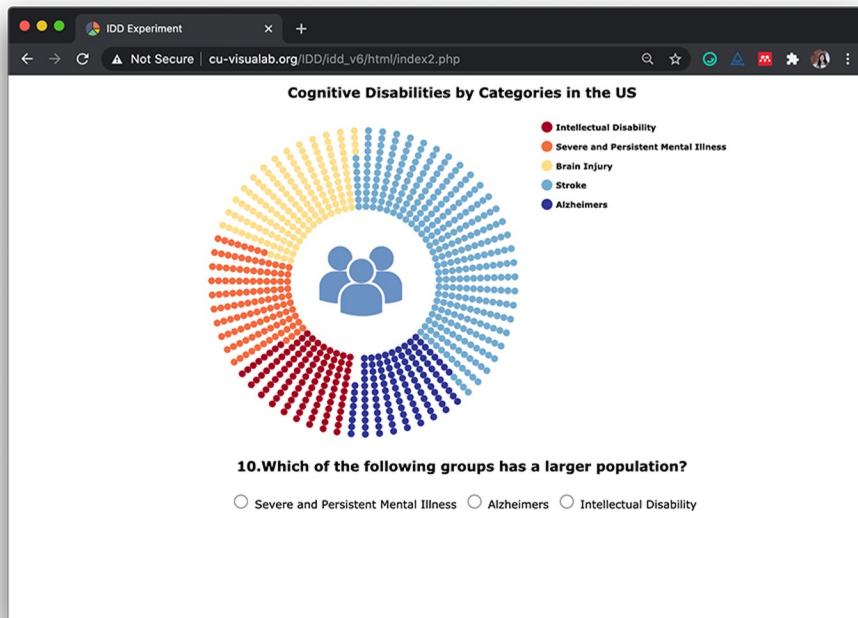
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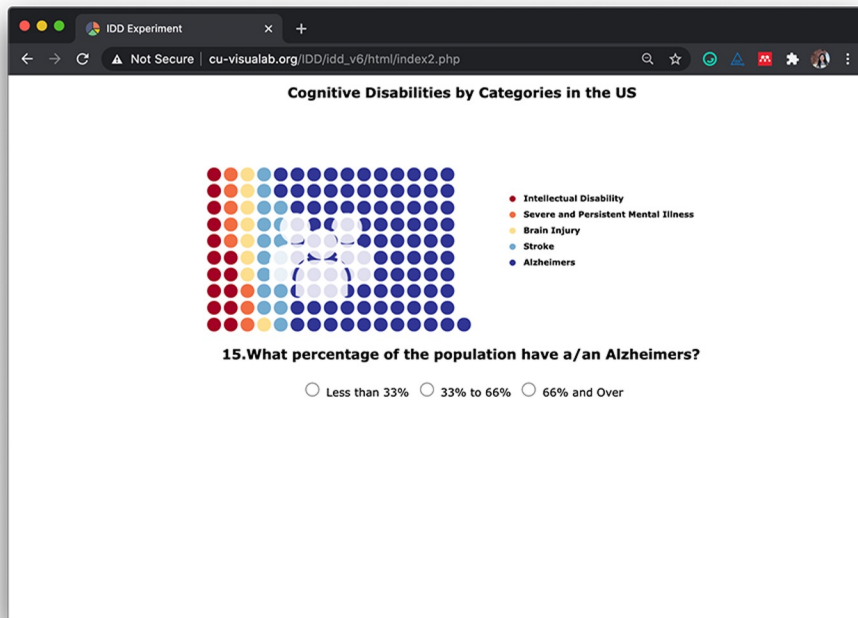


34 Participants  
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Task Performance &  
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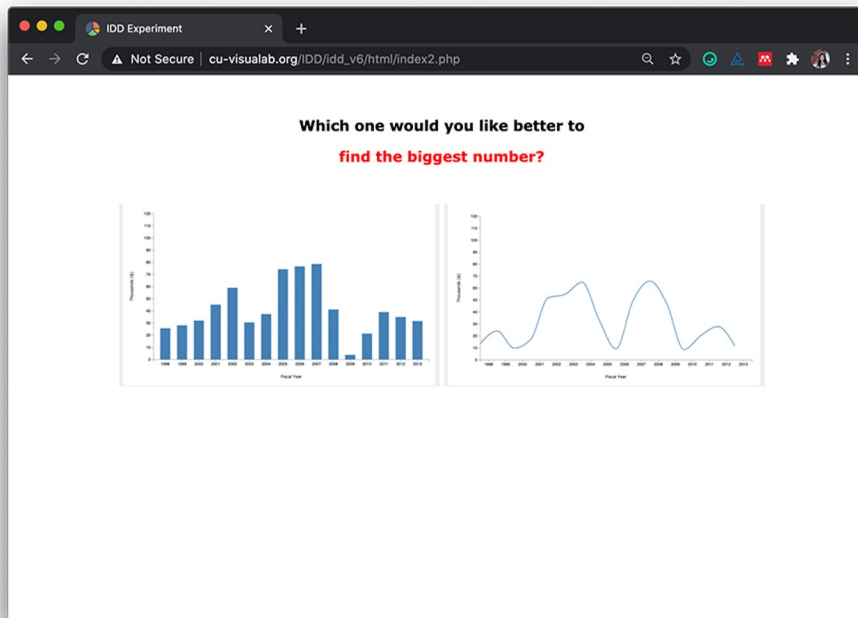


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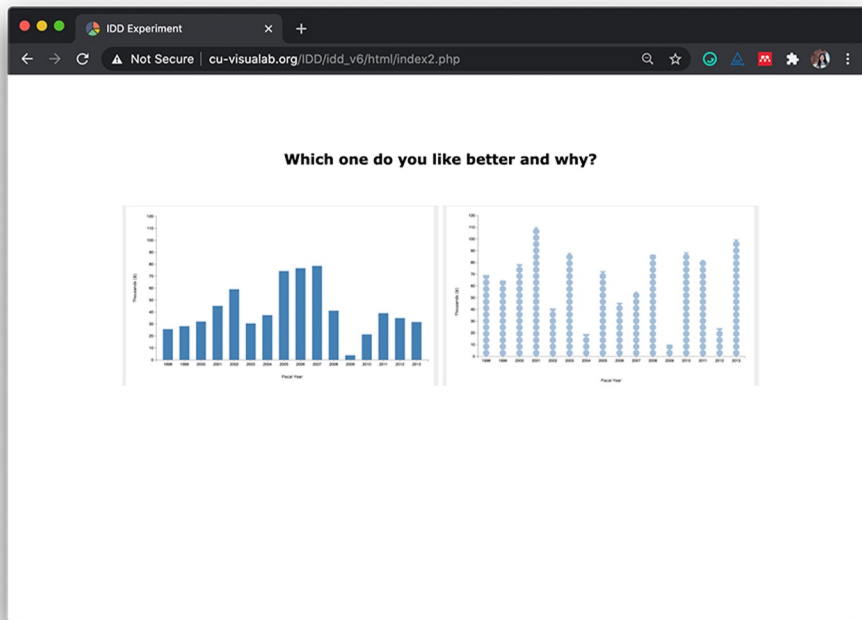


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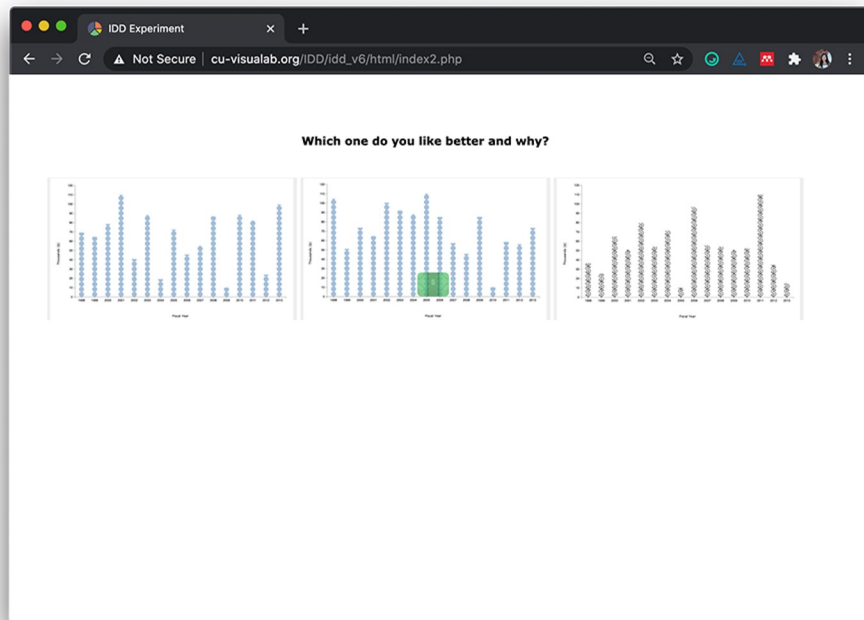


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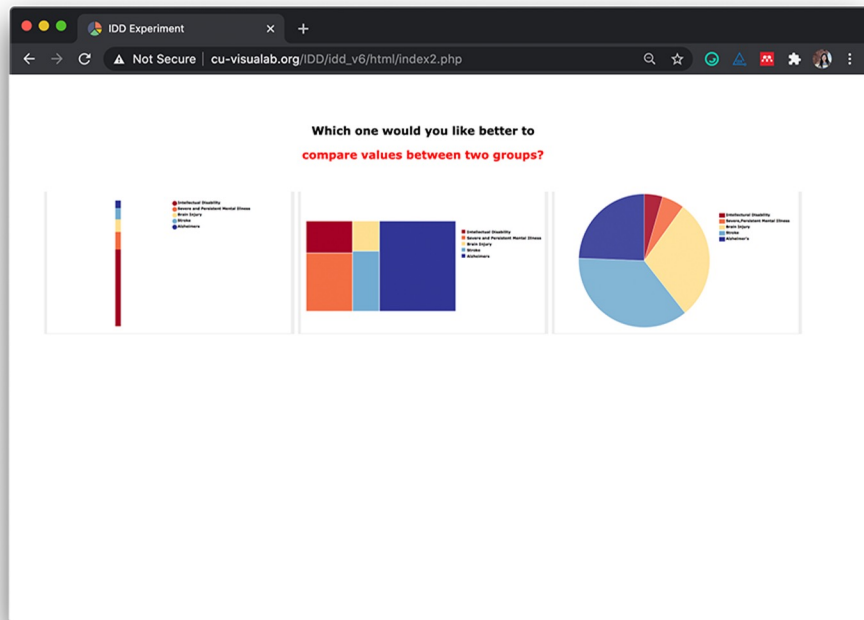


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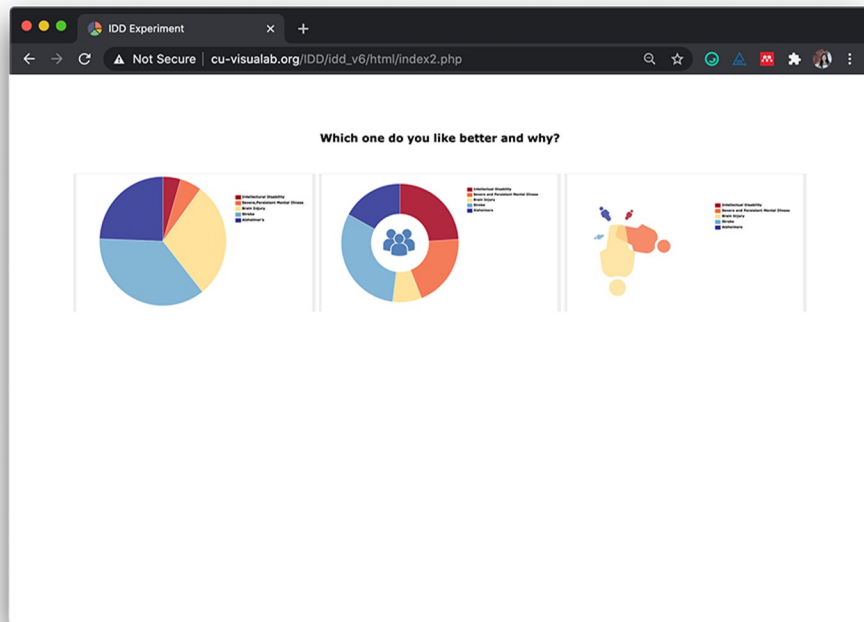
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34 Participants  
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# **Four Design Guidelines**

# Design Guidelines

**Avoid pie charts**

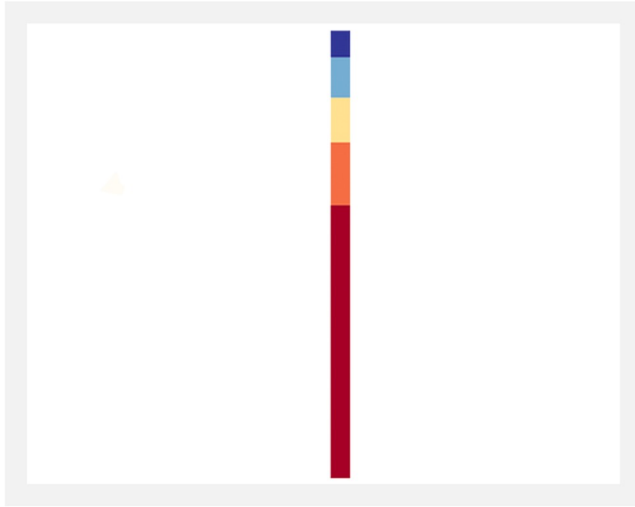
**Use familiar metaphors**

**Manage visual complexity**

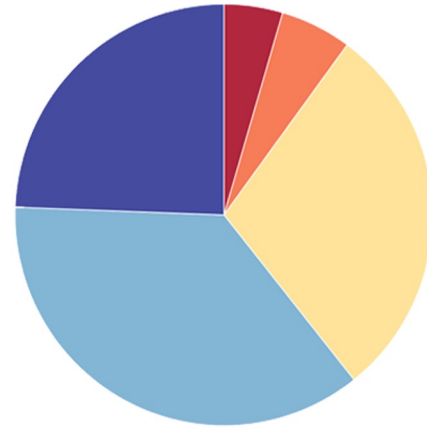
**Use discrete encodings for axis-aligned representations**

# Design Guidelines

## Avoid Pie Chart



**Accessible**



**Not Accessible**

# Design Guidelines

**Avoid pie charts**

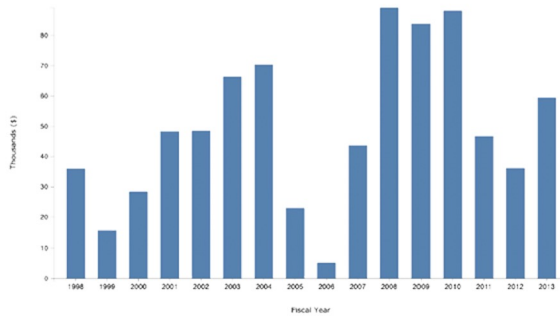
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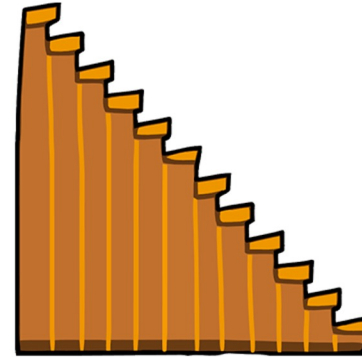
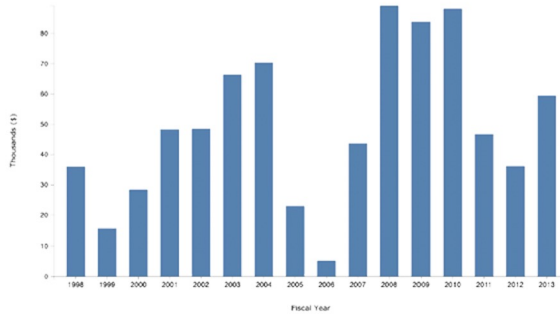
# Design Guidelines

## Use Familiar Metaphors



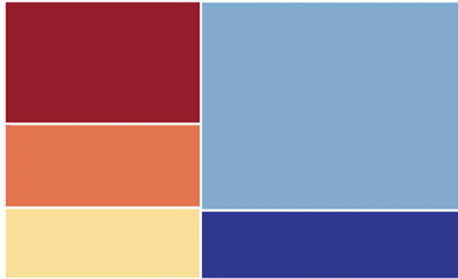
# Design Guidelines

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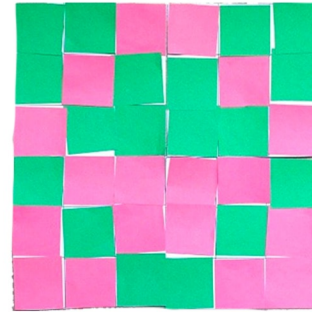
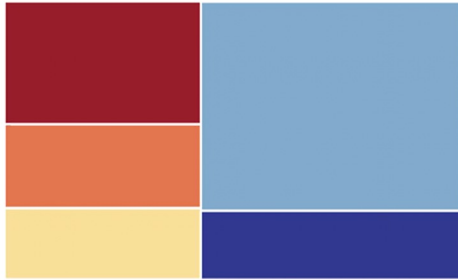
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# Design Guidelines

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# Design Guidelines

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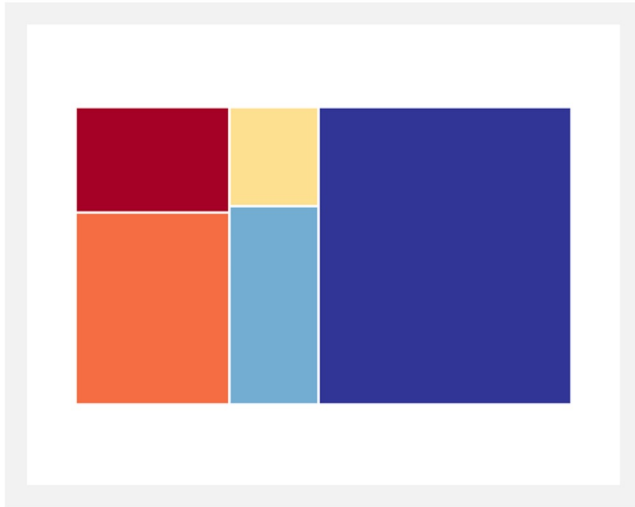
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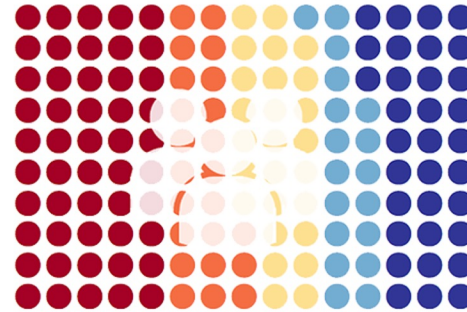
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# Design Guidelines

## Manage Visual Complexity



Accessible



Not Accessible

# Design Guidelines

**Avoid pie charts**

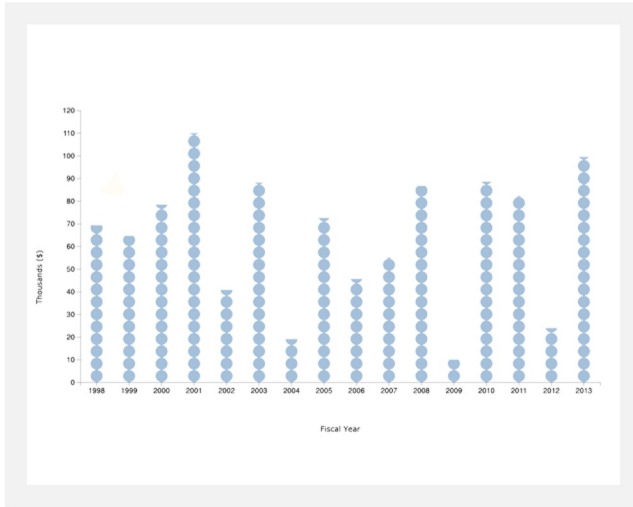
**Use familiar metaphors**

**Manage visual complexity**

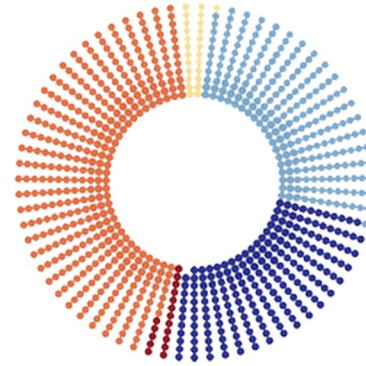
**Use discrete encodings for axis-aligned representations**

# Design Guidelines

## Use Discrete Encodings for Axis-aligned Representations



**Accessible**



**Not Accessible**



<http://cu-visualab.org/IDD/demo/>

**Variation is the Norm.**



# **Creativity is a Spectrum!**







# Design Guidelines




**Avoid pie charts**


**Use familiar metaphors**



**Manage visual complexity**



**Use discrete encodings for axis-aligned representations**



# Design Implications

**Avoid pie charts**

**Use familiar metaphors**

**Manage visual complexity**

**Use discrete encodings for axis-aligned representations**



# Design Implications




**Discover better ways to represent proportion**


**Use familiar metaphors**



**Manage visual complexity**



**Use discrete encodings for axis-aligned representations**





# **Design Implications**




**Discover better ways to represent proportion**

**Add context to the data**



**Manage visual complexity**



**Use discrete encodings for axis-aligned representations**



# Design Implications




**Discover better ways to represent proportion**

**Add context to the data**



**Understand individual differences**



**Use discrete encodings for axis-aligned representations**





# Design Implications



**Discover better ways to represent proportion**

**Add context to the data**



**Understand individual differences**



**Repurpose old charts for new use**



**What's Next?**



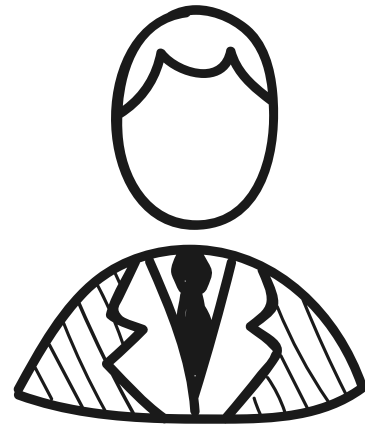


**How do People with  
Intellectual and Developmental Disabilities  
Encounter Data and Build Visual Representations?**





**“Nothing About  
Us Without Us!”**



—SOMEONE FAMOUS

# Semi-Structured Interview

# Semi-Structured Interview

What does data mean to people with IDD?

# Semi-Structured Interview

What does data mean to people with IDD?

When & Where do they experience data ?

# Semi-Structured Interview

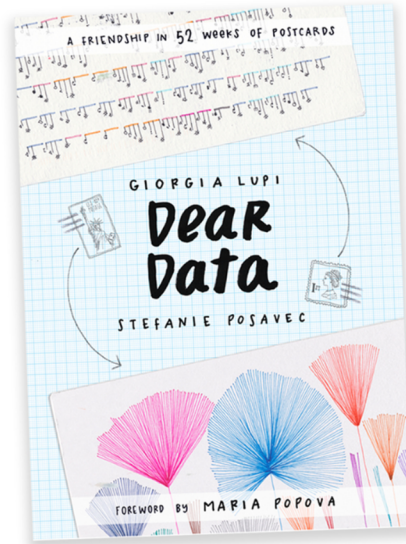
What does data mean to people with IDD?

When & Where do they experience data ?

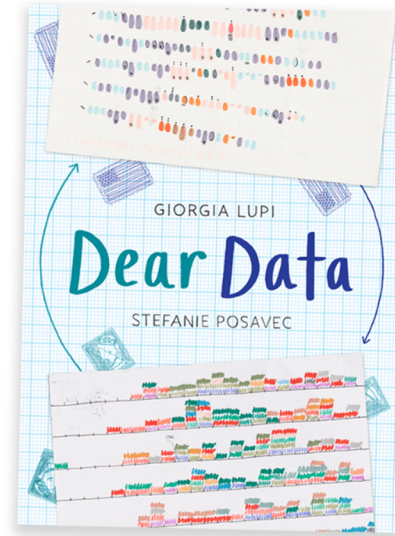
What do they do with data?

# Participatory Design Workshop

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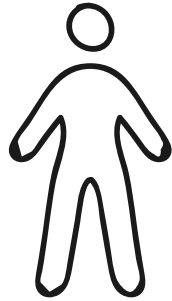


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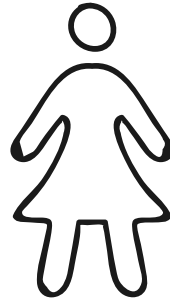
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THE UK BY



# Participatory Design Workshop



Data-Pal



Role-Playing

# Participatory Design Workshop

## SCHEDULE

**01** **World of Objects**  
Categorical Data  
(Week 1 & Week 2)

**02** **Past, Present, and Future**  
Time-Series Data  
(Week 3 & Week 4)

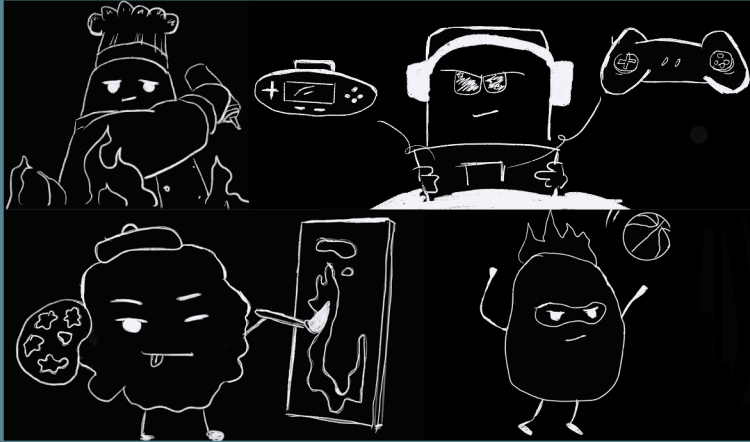
**03** **Me, You, and Us**  
Proportion Data  
(Week 5 & Week 6)

**04** **BONUS**  
We'll also meet at Week 0 (today)  
and Week 7 for a short interview!



# Participatory Design Workshop

**Pick Your Favorite!**



**Who's your favorite alien?**

**Foodie Alien**

**Gamer Alien**

**Artist Alien**

**Athlete Alien**

# Participatory Design Workshop



How can we encourage **creativity** & **self-expression** through data visualization?



# THANKS!

Project Page: <https://cu-visualab.org/IDD/idd/>

Contact Me: [keke.wu@colorado.edu](mailto:keke.wu@colorado.edu)

