

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

1. What is Accessibility? (#a11y)

a. 无障碍设计

b. 设计亲和力

1. What is Accessibility? (#a11y)

- a. The quality of being easy to **obtain** or **use**. (ability to access)
- b. The quality of being easy to **understand**.

Accessibility

HCI

Computing

Disability



Web

UX

Accessibility by Disability



VISUAL



AUDITORY



MOTOR



COGNITIVE

Web Accessibility

clear headings



audio description



alt text



W3C

adding tags to PDF



2.Data Visualization Accessibility

Color Blindness

Visual Impairment

2.Data Visualization Accessibility

Color Blindness

Accessible color palette builder



Accessible color combinations

Please don't use these color combinations; they do not meet a color contrast ratio of 4.5:1, so they do not conform with the standards of Section 508 for body text. This means that some people would have difficulty reading the text. Employing accessibility best practices improves the user experience for all users.

	White text #FFFFFF Aa	Color 2 text #FEDC2A Aa	Color 3 text #5A3B5D Aa	Color 4 text #8B538F Aa	Color 5 text #C3A3C9 Aa
Color 5 background #C3A3C9					
Color 4 background #8B538F	Aa				
Color 3 background #5A3B5D	Aa	Aa			
Color 2 background #FEDC2A			Aa		
White background					

Accessible Color Palette Builder -
User Defined Color Palette

2.Data Visualization Accessibility

Color Blindness



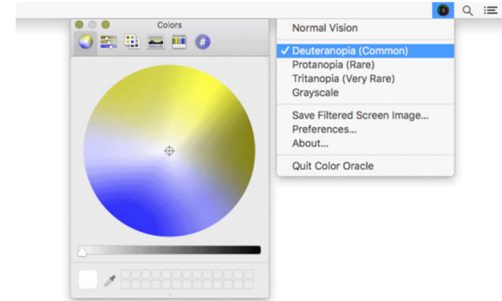
Color Oracle - Usage



Design for the Color Impaired

The system-wide menu quickly converts your art into a palette that simulates what colorblind people see. Color Oracle integrates smoothly in your workflow. Select the type of color-blindness in the menu or press one of the keyboard shortcuts while you are working with your preferred graphics software. Color Oracle immediately filters your screen image and hides itself automatically when you press any key or click the mouse button.

See the [Manual](#) for more details.



Forms of Color Vision Impairment

Color Oracle simulates deuteranopia, protanopia and tritanopia. These are extreme forms of color blindness.

Color Oracle -
Colorblind Simulator

2.Data Visualization Accessibility

Color Blindness

The screenshot shows the 'Colorable' website's 'Text/Background Contrast Ratio Checker' tool. The interface is dark purple. At the top, there are navigation links: 'Colorable', 'Demos', 'Text Demo', 'Matrix Demo', 'npm', and 'GitHub'. The main content area features a large yellow 'AA' rating on the left and a yellow '6.98' contrast ratio on the right. Below the 'AA' rating is the heading 'Contrast' and a paragraph explaining that contrast is the difference in luminance or color that makes an object distinguishable. At the bottom, there are two color swatches: 'Foreground' with hex code #FEDC2A (Hue 50°, Saturation 99%, Lightness 58%) and 'Background' with hex code #5A3B5D (Hue 295°, Saturation 22%, Lightness 30%).

Colorable Demos Text Demo Matrix Demo npm GitHub

AA

6.98

Contrast

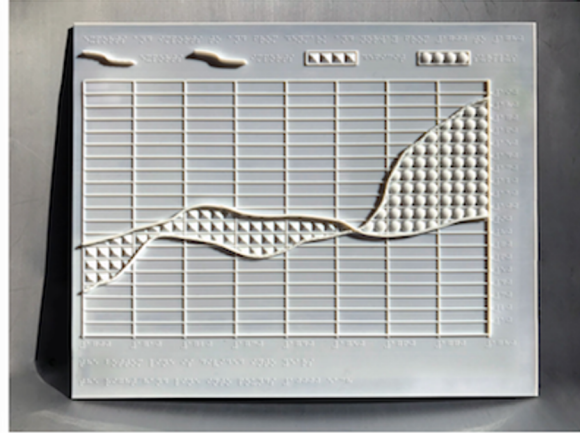
Contrast is the difference in luminance or color that makes an object (or its representation in an image or display) distinguishable. In visual perception of the real world, contrast is determined by the difference in the color and brightness of the object and other objects within the same field of view. Because the human visual system is more sensitive to contrast than absolute luminance, we can perceive the world similarly regardless of the huge changes in illumination over the day or from place to place. The maximum contrast of an image is the contrast ratio or dynamic range.

Foreground
#FEDC2A
Hue 50° Saturation 99% Lightness 58%

Background
#5A3B5D
Hue 295° Saturation 22% Lightness 30%

Colorable -
Text/Background Contrast Ratio Checker

2.Data Visualization Accessibility

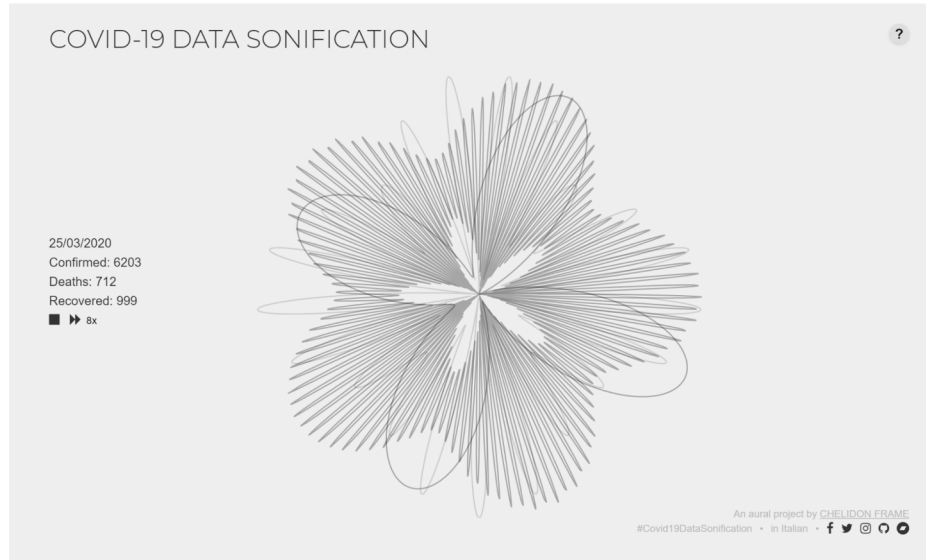


Visual Impairment

3D Printed Tactile Translation Of A Time-series Chart By William Playfair

2.Data Visualization Accessibility

Visual Impairment



Covid19 Data Sonification

2.Data Visualization Accessibility

≠ Visual Accessibility

2.Data Visualization Accessibility

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.

3. Can People with IDD Use Visualization?



3.Can People with IDD Use Visualization?

Yes!

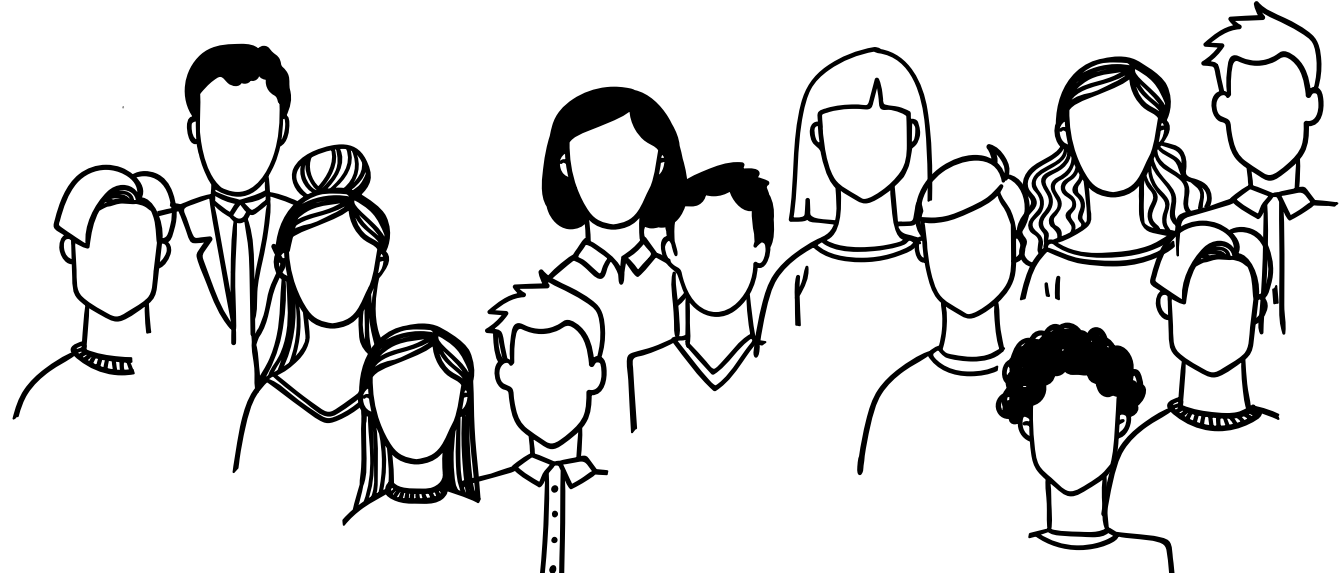
Understanding Data Accessibility for People with Intellectual and Developmental Disabilities (IDD)



1,000,000,000



15 % of the
population



1 in 6 children
in the US



What is IDD?



Related to Thought Process

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

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

What is IDD?



Related to Thought Process

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

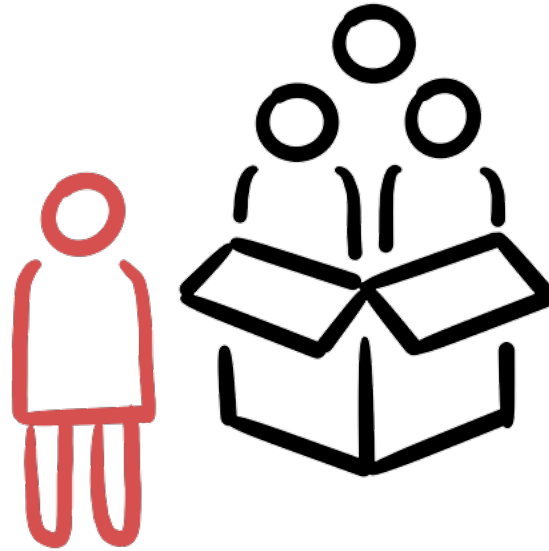
Adaptive Behavior (e.g., social & practical skills)



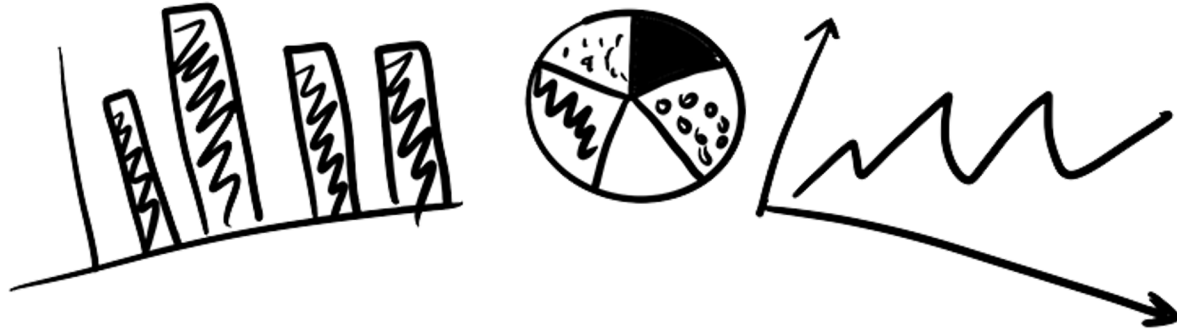
People with IDD

Struggle with abstract thinking, spatial reasoning

Have limited exposure to mathematical & statistical training

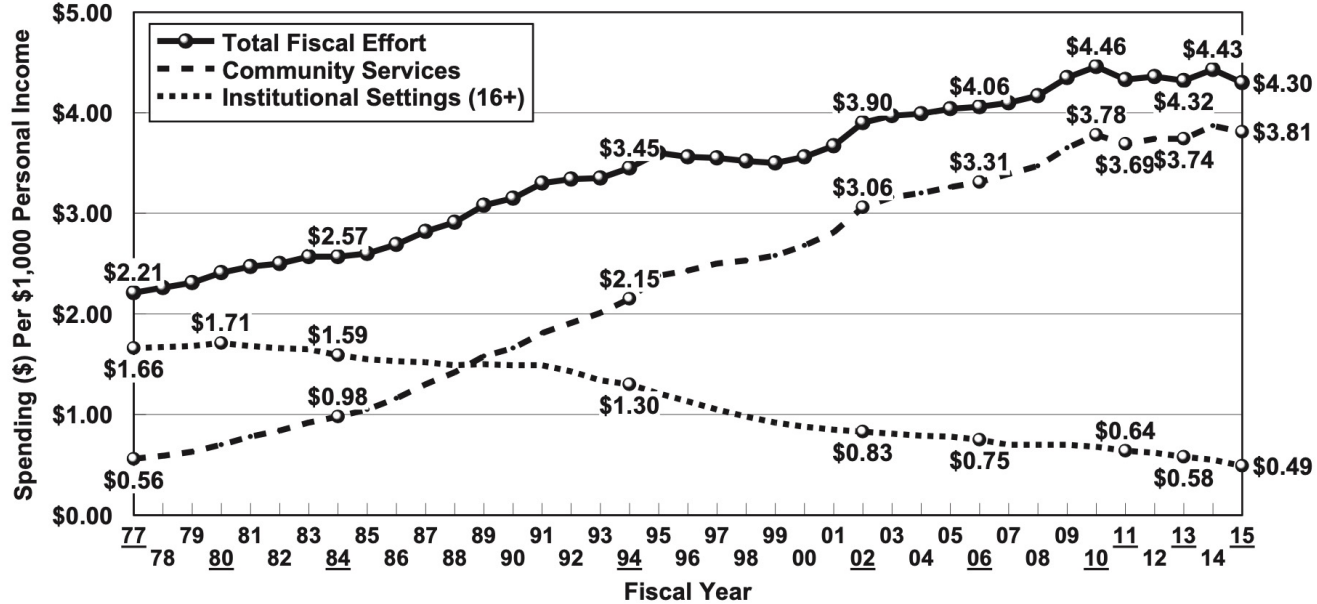


People with IDD been Excluded from
Data Visualization



People with IDD been Excluded from
Data Visualization

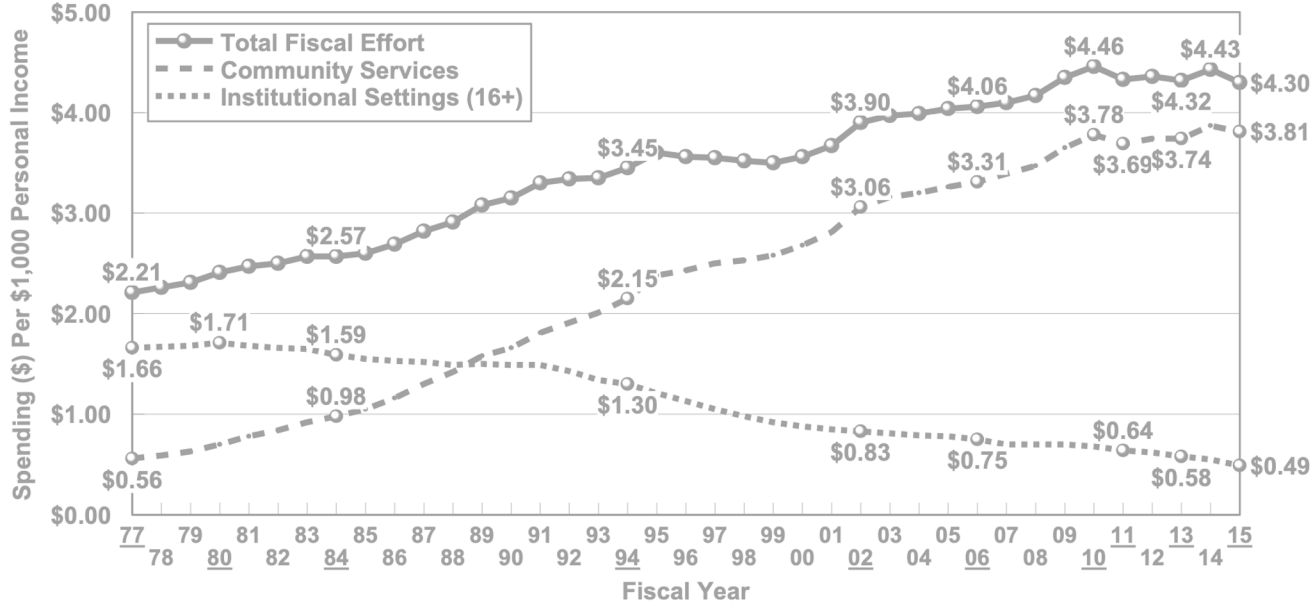
Figure 4
FISCAL EFFORT FOR INTELLECTUAL AND DEVELOPMENTAL
DISABILITIES SERVICES IN THE UNITED STATES: FY 1977-2015



Source: Braddock et al., Coleman Institute and Department of Psychiatry, University of Colorado, 2017.

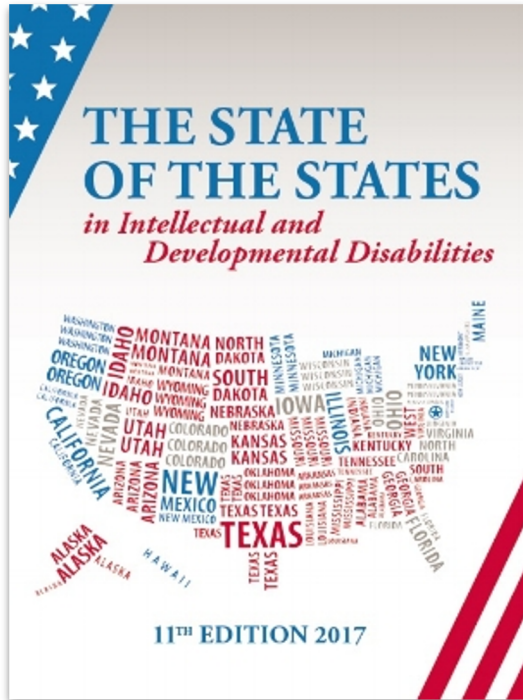
No Access to Personal Important Data

Figure 4
FISCAL EFFORT FOR INTELLECTUAL AND DEVELOPMENTAL
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Source: Braddock et al., Coleman Institute and Department of Psychiatry, University of Colorado, 2017.

No Access to Personal Important Data

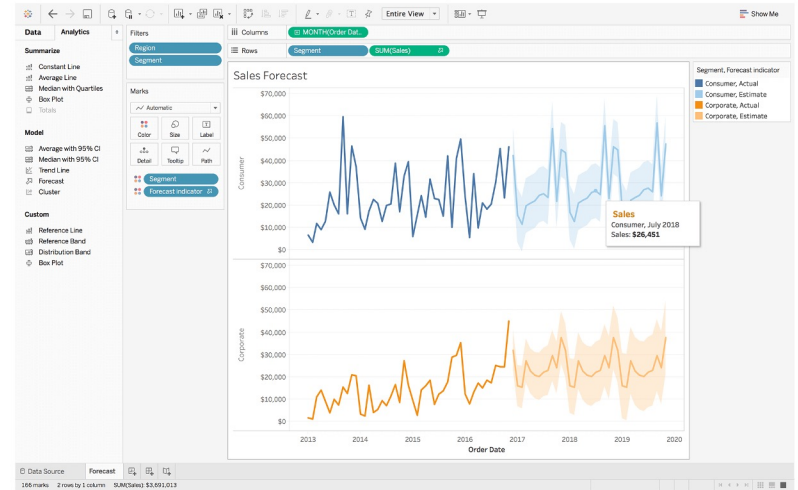
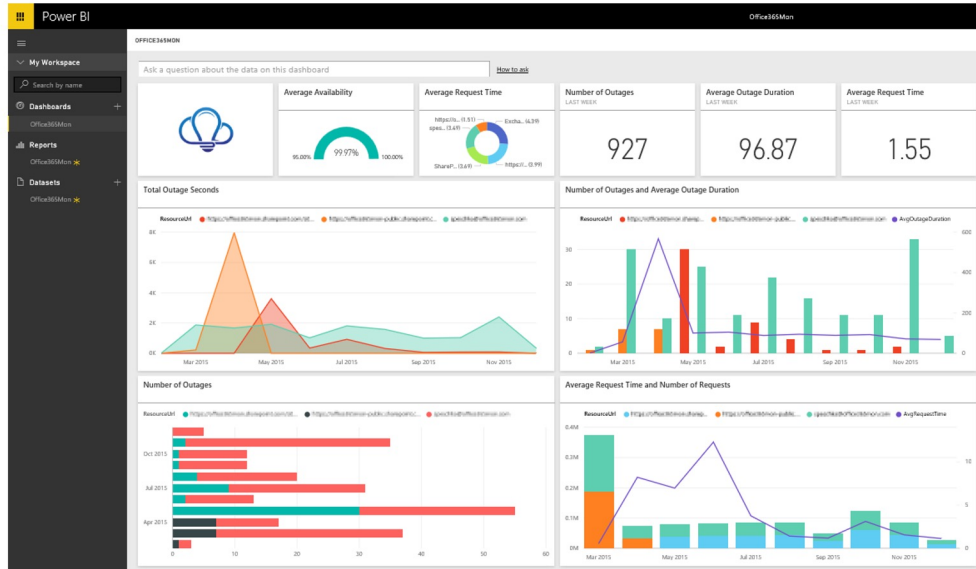


1977 - 2015

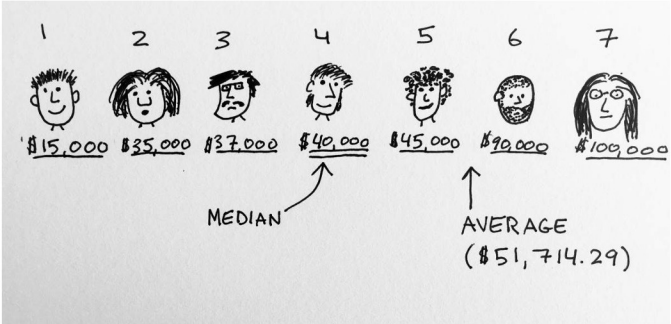
Nationwide Fiscal & Programmatic Trends

Financial Self-Advocacy & Determination

Tableau / Power BI



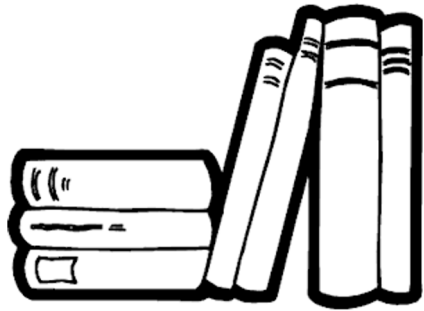
Paper-based Sketch



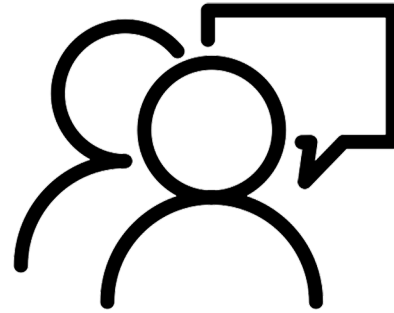


**How do People with
Intellectual and Developmental Disabilities
Interpret Data Differently?**





Literature Review



Informal Interview

Three Hypotheses

Three Hypotheses

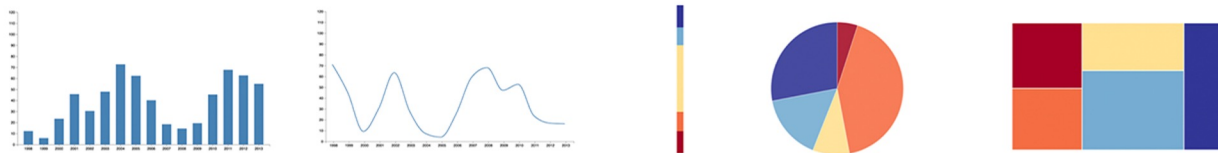
H1: The best chart type for a given task will differ between people with and without IDD.

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

Three Hypotheses

Chart Type



Data Continuity

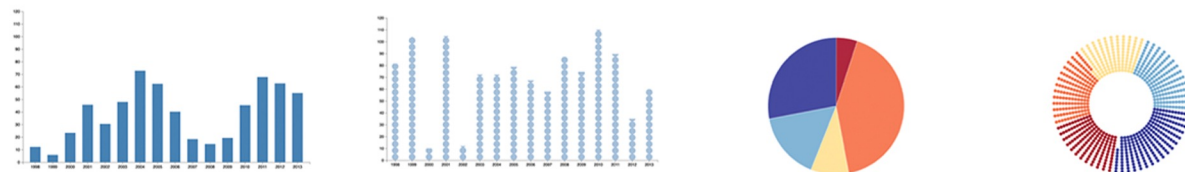
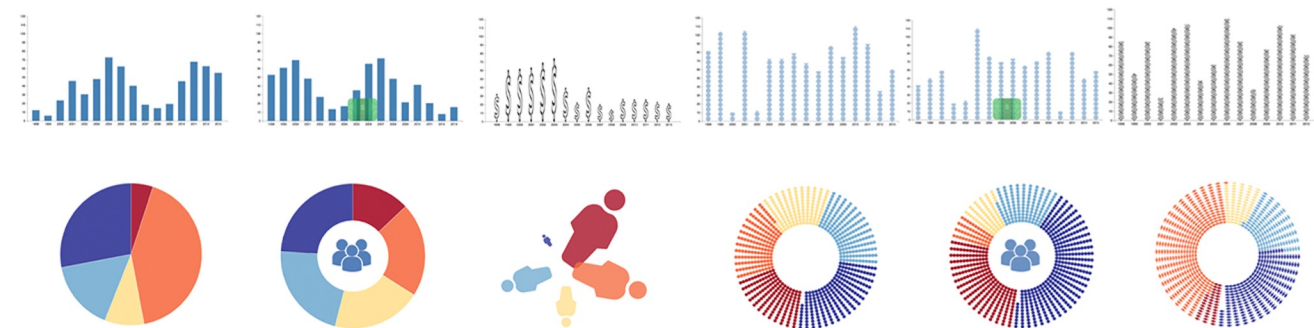


Chart Embellishment



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



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

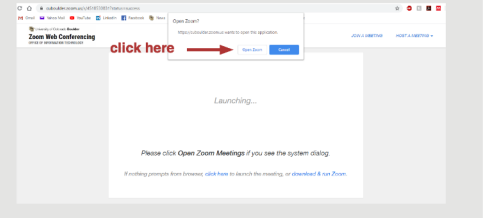
This document will show you step by step how to join a zoom meeting using the link in your email invite and then how to begin the study. You can also watch Zoom's video on how to join a meeting here: <https://support.zoom.us/hc/en-us/articles/201362193-Joining-a-Meeting>.

How to Join a Zoom Meeting With an Email Invite:

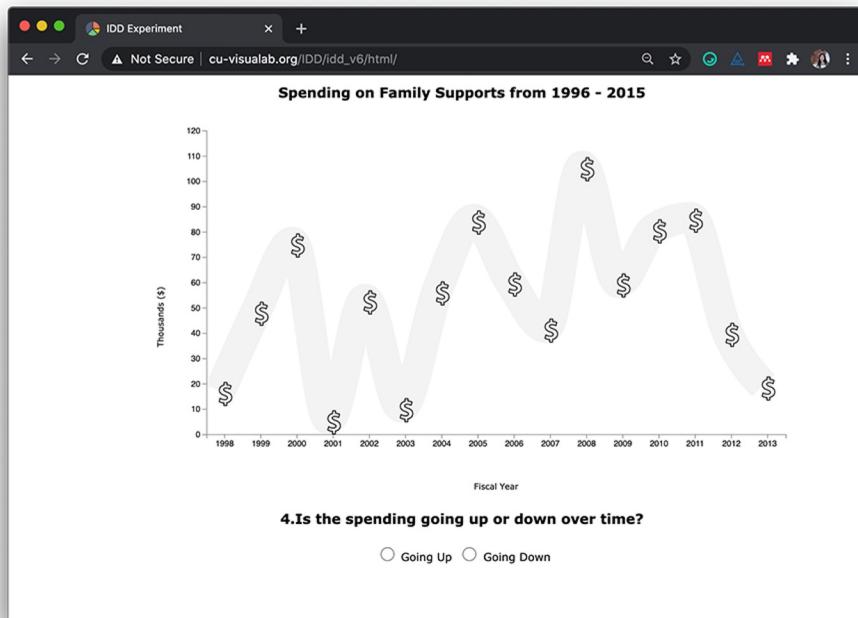
1. Click on the link in the email we sent you. It will be below the text "Join Zoom Meeting", as in the image below.

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).

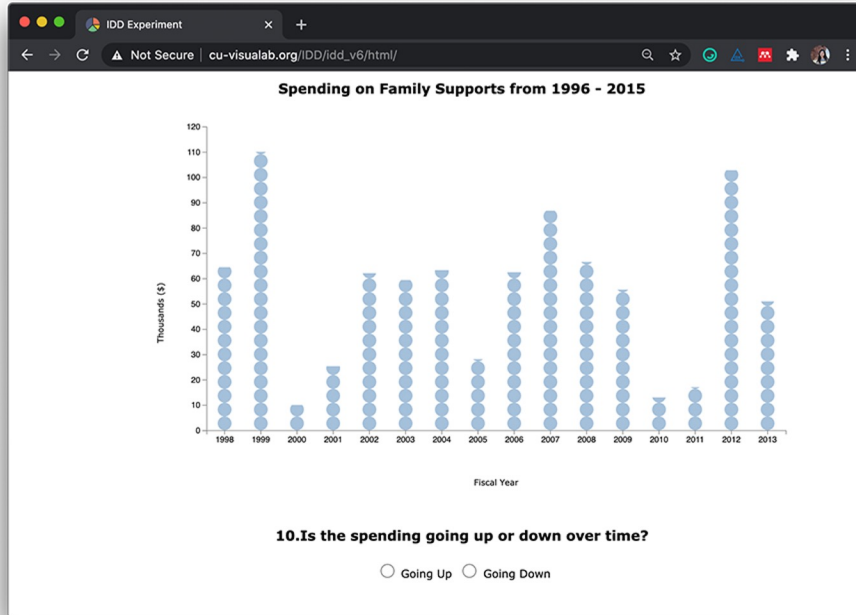


Mixed-Methods Experiment



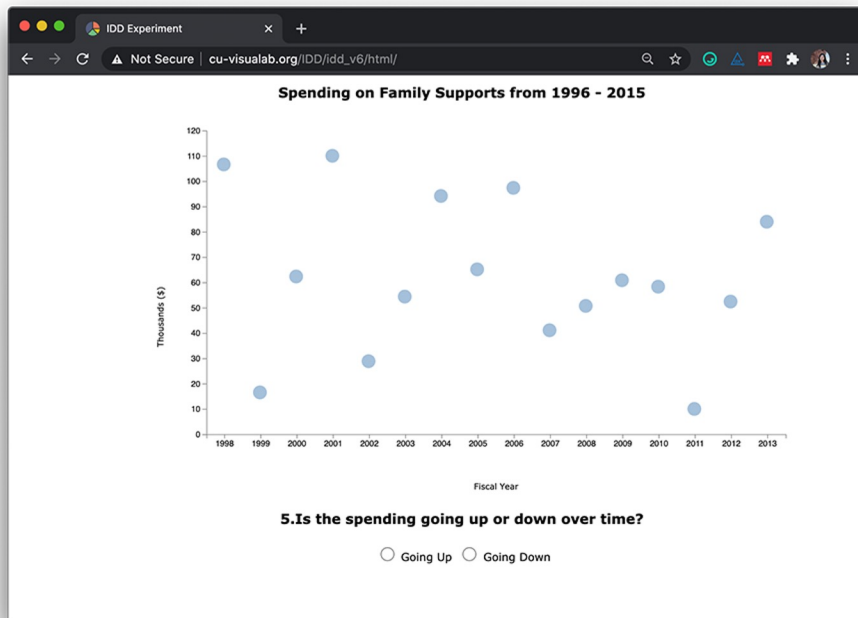
34 Participants
with and without IDD

Mixed-Methods Experiment



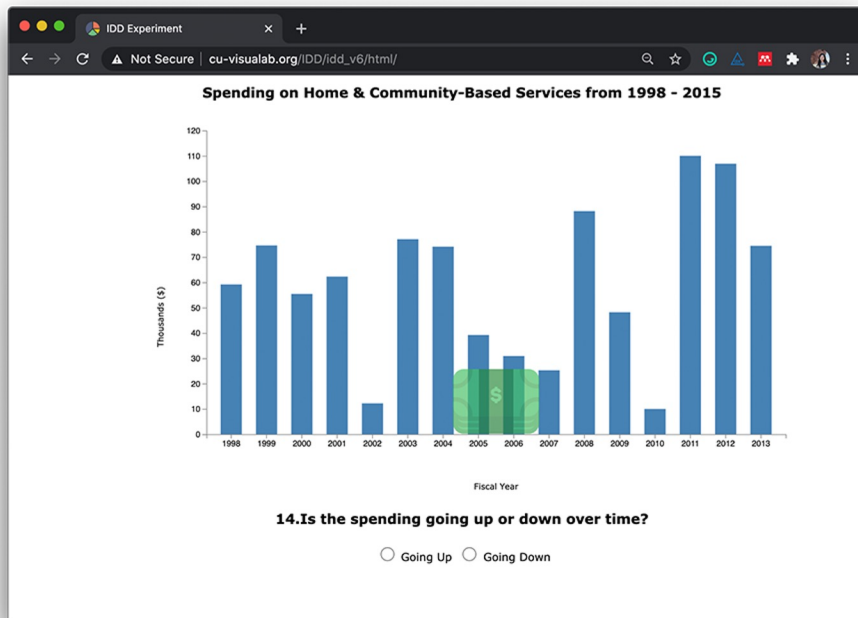
**34 Participants
with and without IDD**

Mixed-Methods Experiment



**34 Participants
with and without IDD**

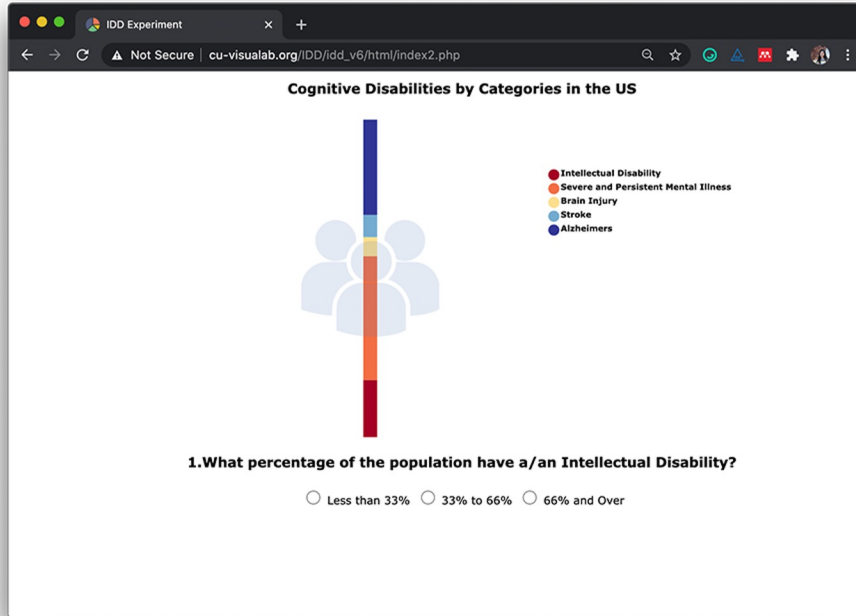
Mixed-Methods Experiment



34 Participants
with and without IDD

Time Series &
Proportion Data

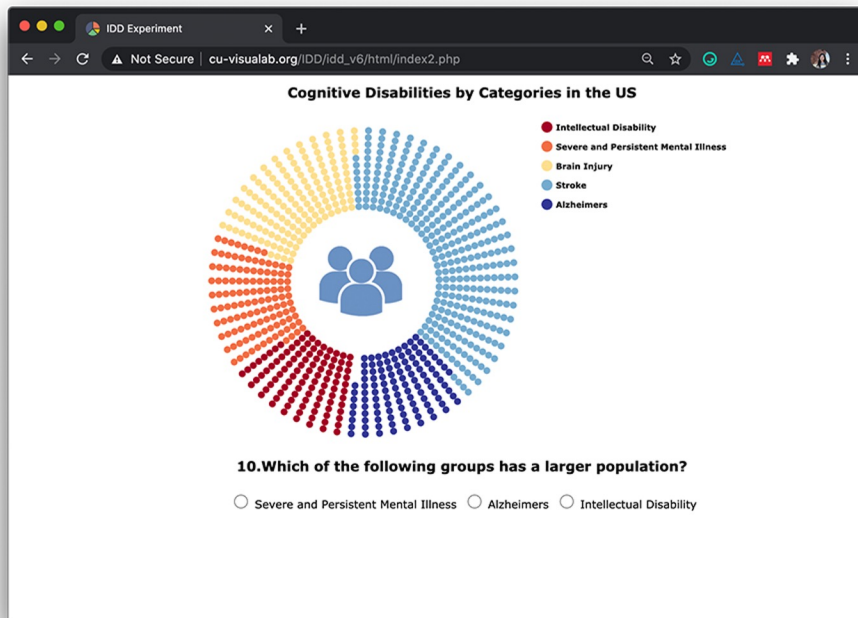
Mixed-Methods Experiment



34 Participants
with and without IDD

Time Series &
Proportion Data

Mixed-Methods Experiment

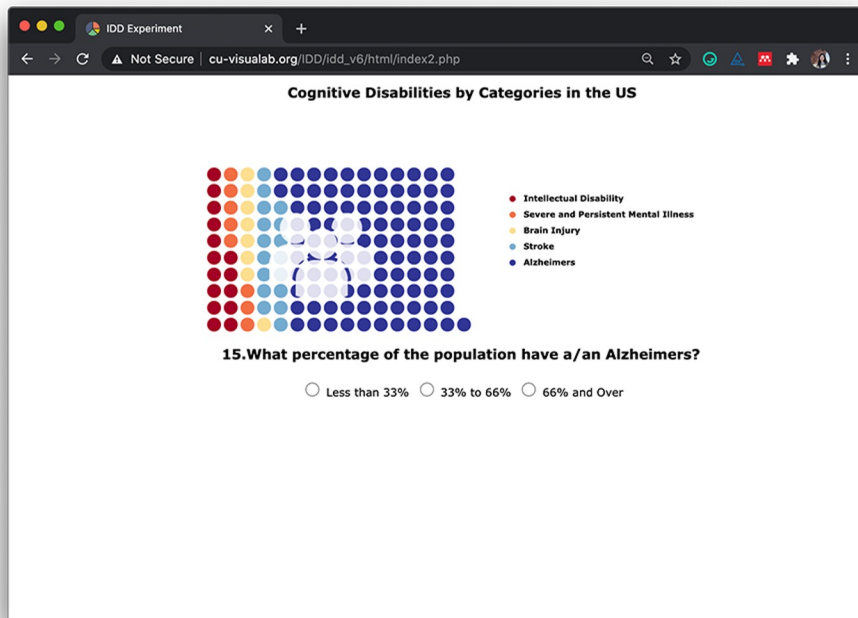


34 Participants
with and without IDD

Time Series &
Proportion Data

Task Performance &
Chart Preference

Mixed-Methods Experiment

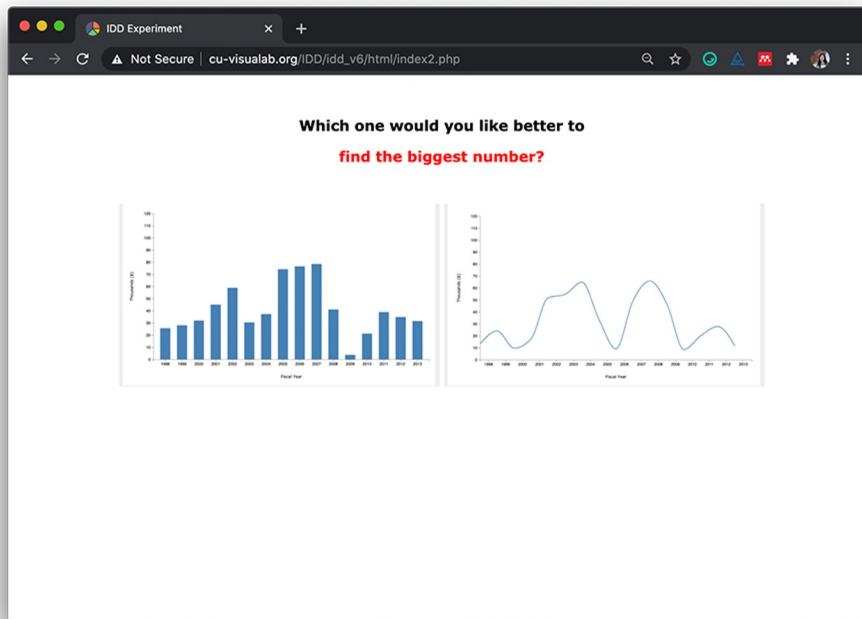


34 Participants
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Time Series &
Proportion Data

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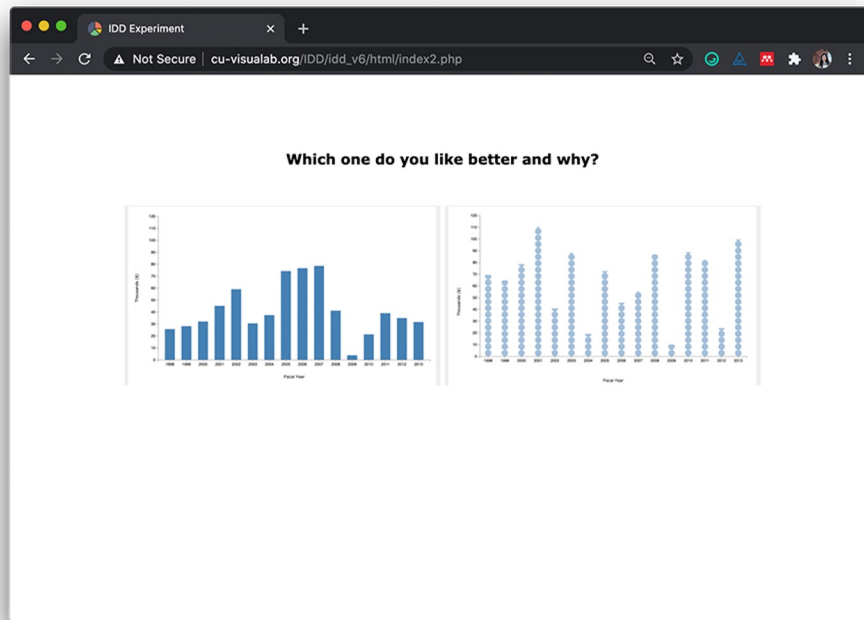


34 Participants
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Time Series &
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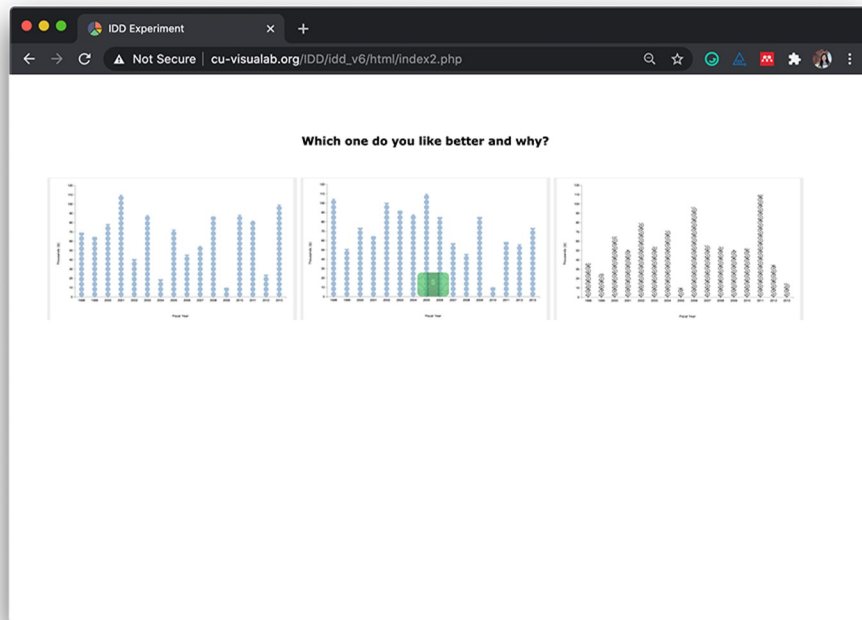


34 Participants
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Time Series &
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Task Performance &
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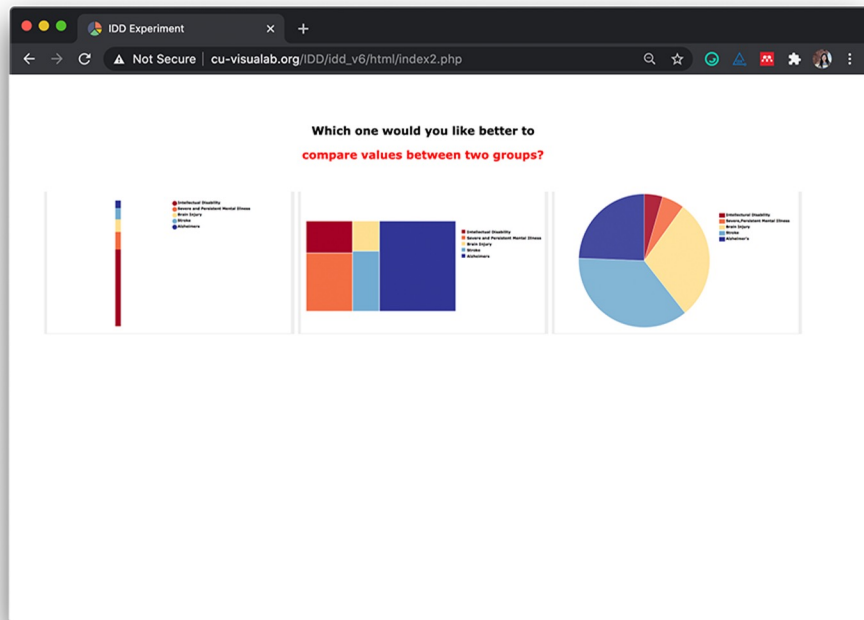


34 Participants
with and without IDD

Time Series &
Proportion Data

Task Performance &
Chart Preference

Mixed-Methods Experiment

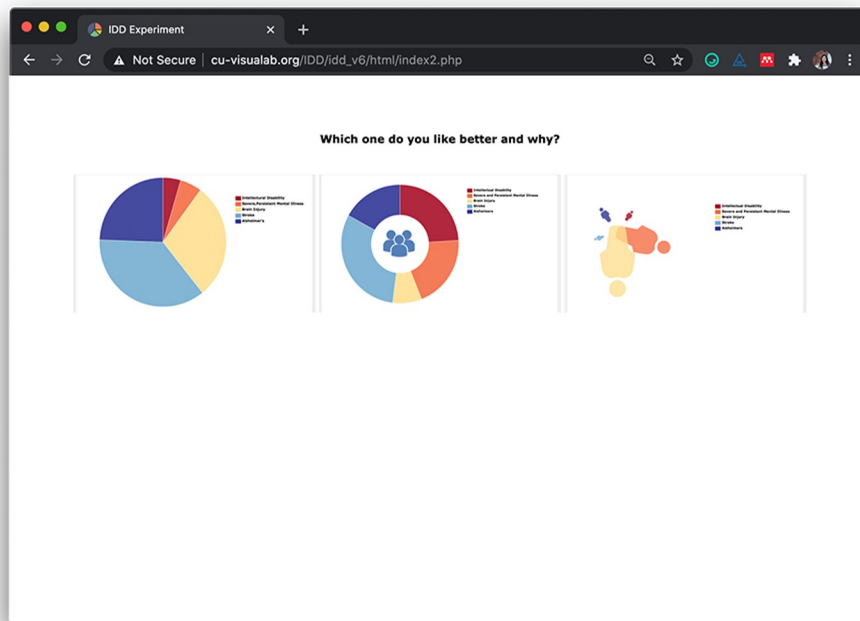


34 Participants
with and without IDD

Time Series &
Proportion Data

Task Performance &
Chart Preference

Mixed-Methods Experiment



34 Participants
with and without IDD

Time Series &
Proportion Data

Task Performance &
Chart Preference

Four Design Guidelines

Design Guidelines

Avoid pie charts

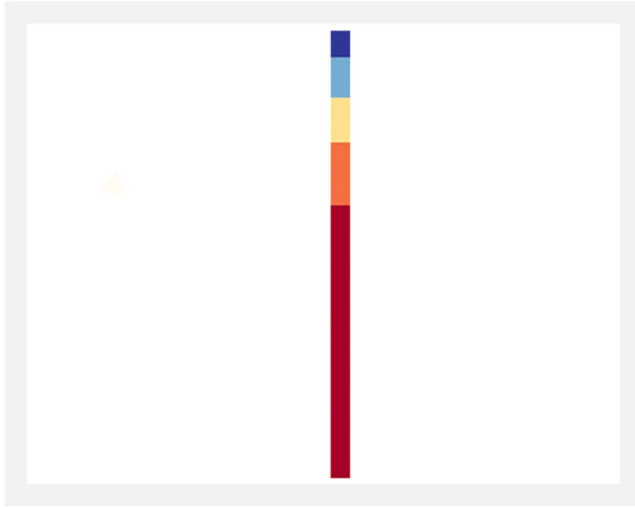
Use familiar metaphors

Manage visual complexity

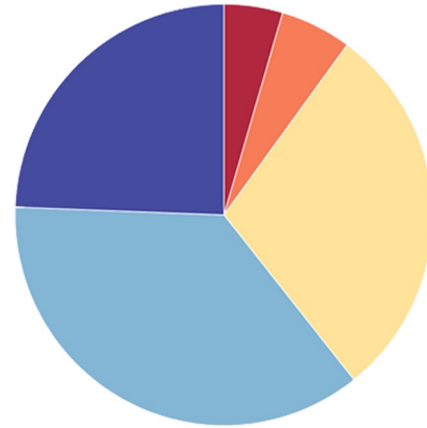
Use discrete encodings for axis-aligned representations

Design Guidelines

Avoid Pie Chart



Accessible



Not Accessible

Design Guidelines

Avoid pie charts

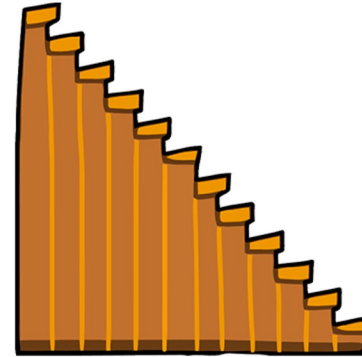
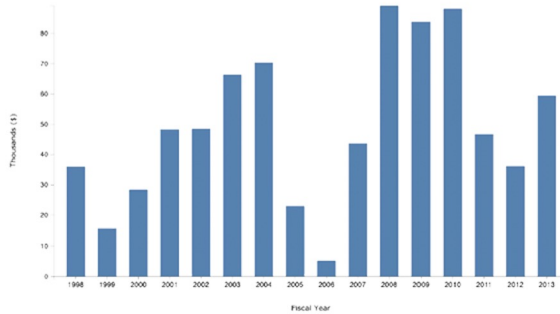
Use familiar metaphors

Manage visual complexity

Use discrete encodings for axis-aligned representations

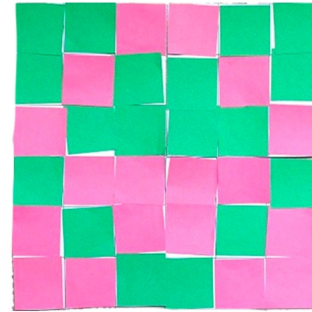
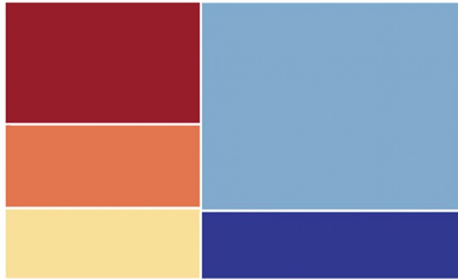
Design Guidelines

Use Familiar Metaphors



Design Guidelines

Use Familiar Metaphors



Design Guidelines

Avoid pie charts

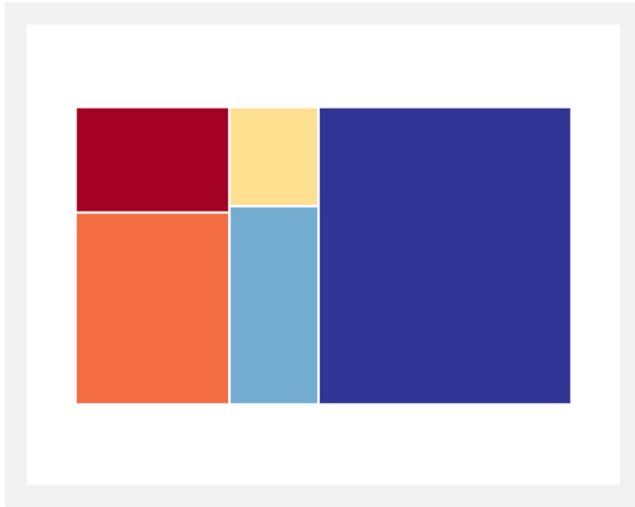
Use familiar metaphors

Manage visual complexity

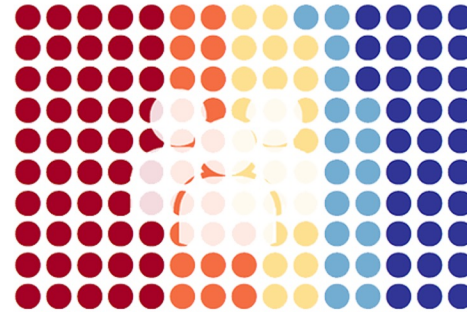
Use discrete encodings for axis-aligned representations

Design Guidelines

Manage Visual Complexity



Accessible



Not Accessible

Design Guidelines

Avoid pie charts

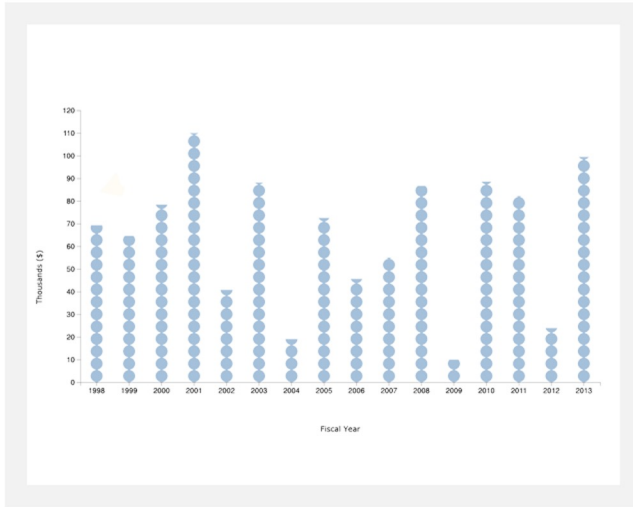
Use familiar metaphors

Manage visual complexity

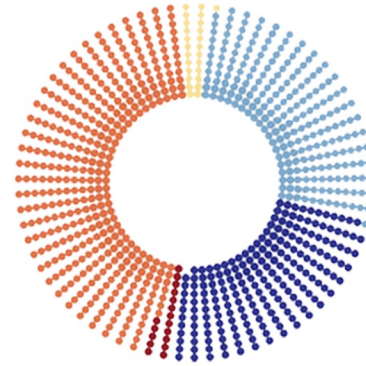
Use discrete encodings for axis-aligned representations

Design Guidelines

Use Discrete Encodings for Axis-aligned Representations



Accessible



Not Accessible



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

Variation is the Norm.



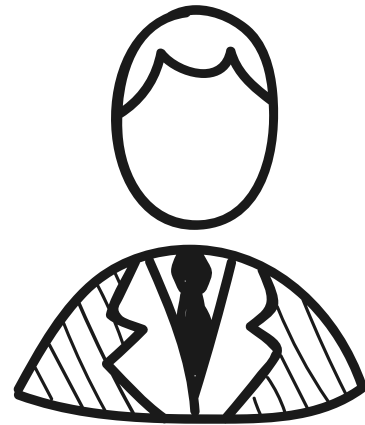
Creativity is a Spectrum!



What's Next?



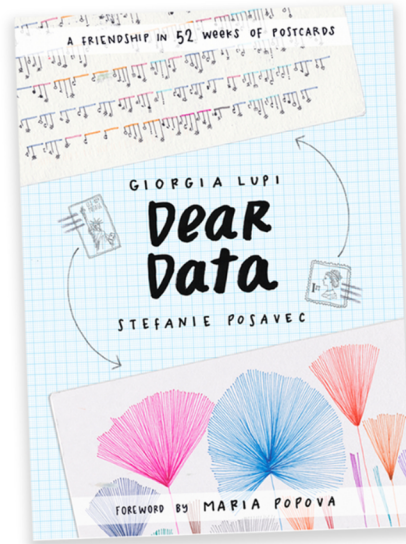
“Nothing About
Us Without Us!”



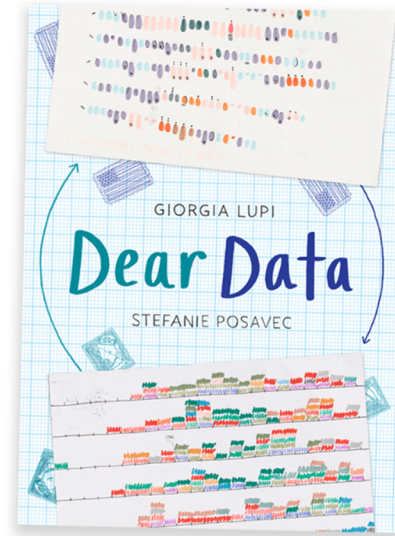
—SOMEONE FAMOUS

Participatory Design Workshop

PUBLISHED IN
NORTH AMERICA BY



COVER BY GEORGIA

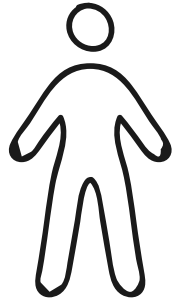


COVER BY STEFANIE

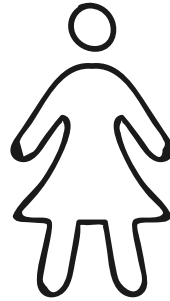
PUBLISHED IN
THE UK BY



Participatory Design Workshop



Data-Pal



Role-Playing

Participatory Design Workshop

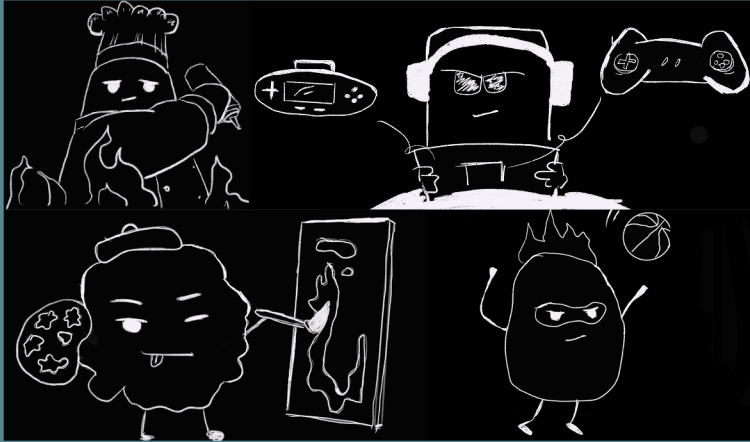
Aliens from the **VisuaLand**

The Circle Story

Participatory Design Workshop 2021

Participatory Design Workshop

Pick Your Favorite!



Who's your favorite alien?

Foodie Alien

Gamer Alien

Artist Alien

Athlete Alien

How do individuals with IDD
approach data & build visualizations?



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

