Suggested Interactivity: Seeking Perceived Affordances for Information Visualization

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Tony Abbott was prime minister for fewer days than Gillard or Rudd - chart

This graph shows total days in office (including multiple, non-consecutive terms) for all Australian prime ministers, from the longest-serving, Robert Menzies, to the eight days of Francis Forde. Having just been ousted by Malcolm Turnbull, Tony Abbott has had the 10th shortest time in office.

Australism prime ministers: total days in office

<table>
<thead>
<tr>
<th>Prime Minister</th>
<th>Days in Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Menzies</td>
<td>6,735</td>
</tr>
<tr>
<td>John Howard</td>
<td>4,284</td>
</tr>
<tr>
<td>Robert Hawke</td>
<td>3,206</td>
</tr>
<tr>
<td>Malcolm Fraser</td>
<td>2,677</td>
</tr>
<tr>
<td>William Hughes</td>
<td>2,602</td>
</tr>
<tr>
<td>Joseph Lyons</td>
<td>2,448</td>
</tr>
<tr>
<td>Stanley Bruce</td>
<td>2,447</td>
</tr>
<tr>
<td>Alfred Deakin</td>
<td>1,972</td>
</tr>
<tr>
<td>Andrew Fisher</td>
<td>1,735</td>
</tr>
</tbody>
</table>
How can we attract these users’ attention to a visualization and suggest its interactivity through design?
Background

Affordances

- **Real affordances**: the actual physical properties of an artifact that call for action
- **Perceived affordances**: the perception and/or understanding a person has of the actions that can be performed with that artifact

Feedforward: tells users what the result of their action will be
Breakdown

**Study #1:**
Testing Interaction Propensity

**Study #2:**
Design Space for Suggested Interactivity

**Study #3:**
Testing Three SI Cues on Bar Charts

**Analysis and Critique**
Study #1:
Testing Interaction Propensity
Setup

7 simulated articles with text and visualizations


Data and Text: OECD Better Life Index website

Task: simple fact-checking task

• Multiple choice extraction task

• Possible to do task with text and with visualization
Setup

Participants from Amazon Mechanical Turk
  • Native English speakers

Coding
  • Brush interactions
  • Decisive brushes
  • Number of subsequent trials decisive brushes were used
  • Participant’s answers

Analysis
  • Point estimates and 95% CI based on 10 000 percentile bootstrap replicates
Experiment #1:

*Are people inclined to interact with charts to carry out fact-checking tasks?*

**H1.1:** A majority of participants will not know that the charts are interactive, and therefore they will not use them to complete trials.

**H1.2:** A majority of participants who ‘discover’ the interactivity of the charts will use them throughout all subsequent trails.
**Experiment #1: Important Results**

Only used participants with score > 0
- 59 participants

**H1.1 & H1.2 confirmed**

Layout contribution

Charts perceived as efficient

<table>
<thead>
<tr>
<th>Measure</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 1 Brush</td>
<td>42.4%</td>
</tr>
<tr>
<td>&gt;1 Decisive</td>
<td>28.8%</td>
</tr>
<tr>
<td>(Decisive</td>
<td>Brush)</td>
</tr>
<tr>
<td>(Brush in all 7 trials</td>
<td>&gt;1 Brush)</td>
</tr>
<tr>
<td>(Brush in subsequent trials</td>
<td>Brush)</td>
</tr>
<tr>
<td>(Decisive in all 7 trials</td>
<td>&gt;1 Decisive)</td>
</tr>
<tr>
<td>(Decisive in subsequent trials</td>
<td>Decisive)</td>
</tr>
</tbody>
</table>
Experiment #2:  

Are charts more efficient than text?

Trials 3, 4, 5 were replaced with just charts

**H2.1:** all participants will interact with the charts in trials [3-5]  
**H2.2:** majority of participants will use the charts in trials [6-7]  
**H2.3:** there will be good evidence that more participants interact with the charts in trials [6,7] than in [1,2]  
**H2.4:** participants should complete trials [6,7] faster than [1,2]
Experiment #2: Important Results

H2.1 failed: not all participants interacted with charts
  • Visualization literacy
  Needed to get used to charts
H2.2, H2.3, H2.4 confirmed
Charts are more efficient
Conclusion: charts are more efficient
Experiment #3 + Results:

*Is Wikipedia layout choice biasing results?*

Ran experiment #1 again without Wikipedia styling attributes.

**H3:** results will be consistent with Experiment #1, meaning Wikipedia styling did not bias participants’ behaviour.

**Results:** consistent with Experiment #1
Study #1: Conclusions

Lack initial propensity to interact with charts embedded with text
Visualization literacy problems
Charts are more efficient
People can be motivated to interact with visualizations if they are shown the possibility
Highlights the need for suggested interactivity
Study #2:
Design Space for Suggested Interactivity
Definitions

**Suggested Interactivity (SI)**: set of methods for indicating that a graphical area can be interacted with by subtly directing a user’s attention so as not to impede too heavily on this person’s focus or on the rest of the interface design.

**SI cues**: specific graphical elements or attributes that are used for suggesting interactivity.
Design Space for Suggested Interactivity

**Attractor:** the object that attracts attention to the interactive area
- Object of interest
- External object

**Animation:** the state of the attractor over time
- Staged: blink
- Interpolation: unique or looped
- dynamic

**Trigger:** the event that initiates the animation
- System event
- User event

**Visual attributes:** the specific visual variables and/or marks the animation is applied to

**Persistence:** the ongoing display or not of the cue once the interaction has been performed
### Sequenced Interaction with Same Object or Area

A sequenced interaction with the same object or area occurs when a user event is performed on the 'whole-page' level.

<table>
<thead>
<tr>
<th>Attractor</th>
<th>Object of interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Staged</td>
<td>Blink</td>
</tr>
<tr>
<td></td>
<td>Unique</td>
</tr>
<tr>
<td></td>
<td>Looped</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Interpolated</td>
</tr>
<tr>
<td></td>
<td>Unique</td>
</tr>
<tr>
<td></td>
<td>Looped</td>
</tr>
</tbody>
</table>

### Animation

Animation can be staged or dynamic.

- **Staged**: Blink, Interpolated
- **Dynamic**

### Trigger (Event)

The trigger can be initiated by the user or a variable.

- **User**
  - Pageload/update
  - Mousemove
  - Mouseover
  - Click
  - Drag
  - Mousewheel

- **Variable**

### Visual Attribute

Visual attributes can be extra mark or non-textual.

- **Extra mark**
  - Non-textual
  - Textual

### Persistence

Persistence options include mouseover, click, drag, and mousewheel.

### Intended Interaction

Intended interactions include mouseover, click, drag, and mousewheel.

### Feedforward

Feedforward options are not specified in the provided table.

Additional Resources:

- [Study](http://peopleviz.gforge.inria.fr/trunk/Sl_cues/)
Study #2: Results and Observations

SI cues are mostly applied to object of interest

Animation is determined by what triggers it
  • Staged animation -> system events
  • Dynamic animation -> user-events

Combinations: interest attractor and external object attractor
  • Feedforward

Dimensions useful for analyzing current visualizations but too complex when it comes to creating new ones
Design Considerations

Visualisations as attractors
- Already depend on visual marks
- Should not play with free visual attributes
- Required animation:
  - staged: organic motion: heart beat
  - dynamic: attractive motion: orienting, squeezing, stretching depending on how far mouse is

Icons as attractors
- Focal icon
- Identifier icon
- Demonstrator icon
Study #3:
Testing Three SI Cues on Bar Charts
Suggested Interactivity #1

**Attractor:** visualization

**Animation:** staged, looped
  - organic motion - heartbeat

**Trigger:** page-load

**Persistent:** no
Suggested Interactivity #2

**Attractor:** focal icon

**Animation:** no

**Trigger:** page-load

**Persistent:** yes

- Visible when out of focus
Suggested Interactivity #3

**Attractor:** visualization and demonstrator icon

**Animation:** looped staged

**Visual mark:** text label

**Trigger:** page-load

**Persistent:** no
Follow up study results

Conducted follow-up study on AMT

Reproduced **Experiment #1** three times applying each SI
between subjects design

**H4:** more participants will perform brush interactions and decisive brushes when an SI cue is applied to the charts

**Results:** H4 failed

- No evidence that SI1 or SI2 had any effect
- SI3 had an effect
Analysis and Critique
**Analysis: What, Why, How**

<table>
<thead>
<tr>
<th>What</th>
<th>Any Visualization embedded in text</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Why</strong></td>
<td>Suggested Interactivity</td>
</tr>
<tr>
<td><strong>How</strong></td>
<td>SI1</td>
</tr>
<tr>
<td></td>
<td>SI2</td>
</tr>
<tr>
<td></td>
<td>SI3</td>
</tr>
</tbody>
</table>
Critique

• Small scope
  • Only visualizations embedded in text
  • Only considered 3 SI options
  • Specific task
• Only focused on hovering on bar charts
• Didn’t consider age or experience of users
• Only a transition phase
Overall Conclusion

Lack initial propensity to interact with charts
Low interaction literacy
Suggested Interactivity is necessary
Subtle cues are not effective
Feedforward is crucial
Questions?