### A Framework for Studying Biases in Visualization Research

André Calero Valdez, Martina Ziefle, Michael SedImair





## **Real Cognitive Scientists!**



#### André Calero Valdez



#### Martina Ziefle



Michael Sedlmair

A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.

# Thanks André!



# **Background story**

- InfoVis 2017 paper:
  - Priming and Anchoring Effects in Visualization [Wed, 8:30, Perception session]
- Geoff told us about DECISIVe
- We have to write a paper!!



Geoff @EuroVA, Barcelona, 2017

rward (Thu & Fri Sess (4:15-5:15 PM) @ 301-D 7:00-9:00 PM

A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.



# Next step: brainstorming

- There are so many biases out there!
- Map by Buster Benson.

**Remember?** 

We favor simple-looking options and complete information over

To avoid mistakes. we aim to preserve autonomy and group status, and avoid irreversible decisions

To get things done, we tend invested time & energy in

Need To Act Fast

DESIGNHACKS.CO · CATEGORIZATION BY BUSTER BENSON · ALGORITHMIC DESIGN BY JOHN MANOOGIAN III (JM3) · DATA BY WIKIPEDIA Commons (1) (2) attribution · share-alike

Michael Sedlmair

#### COGNITIVE BIAS CODEX





# Next step brainstorming ...

- There are so many biases out there!
- Map by Buster Benson.
- (and a more readable, less beautiful version

#### I. Too Much Information II. Not Enough Meaning III. Need to act fast remember?

a. We notice things 2 Attentional Bias	<b>a.</b> We find stories and 1. Contabulation	a. 10 act, we must be 2. Risk compensation	a. we earl and ". Spacing effect
already primed in 3 Illusory truth effect	<i>patterns</i> even in Z Inconsitivity to complexize	<i>confident</i> we can <sup>2</sup> . Kisk compensation	reinforce some 3 False memory
momory or ropostod 4 Mere exposure effect	5. Insensitivity to sample size	make an impact and 4 Trait ascription bias	memories after the 4 (ryntomnesia
5 Centext effect	Sparse uata 4. Neglect of probability	<b>Thake an impact and F.</b> hat ascription bias	r Source confusion
often 6 Cue-dependent forgetting	5. Affectuotat fattacy	feel what we do is hypothesis	fact 6 Misattribution of memory
7 Mood-congruent memory bias	6. Illusion of validity	important 6 Eurodamental attribution error	o. Misattibution of memory
8. Frequency illusion	7. Masked man fallacy	7 Actor observer bias	
0. Frequency Illusion	8. Recency Illusion	7. ACLOI-ODSEIVEI DIAS	
10 Empathy cap	9. Hot-nand fallacy	o. Sett-setving blas	
10. Empathy gap	10. Illusory correlation	9. Lake wobegone effect	<b>b</b> We discard 1 Fading effort him
11. Offission bias	11. Pareidolia	10. Illusory superiority	D. WE UISCALU I. Fading affect blas
12. Base rate ratiacy	12. Anthropomorphism	11. Hard-easy effect	specifics to form <sup>2. Negativity bias</sup>
	<b>b</b> We fill in the	12. Dunning-Kruger effect	aeneralities A Standardia hisa
L D: (C ( 1 Discusso offert	<b>D.</b> We fitt in 1. Group attribution error	13. False consensus effect	4. Stereotypical bias
<b>b.</b> Bizarre/funny/ 1. Bizarreness effect	characteristics from 2. Ultimate attribution error	14. Illusion of control	5. Implicit stereotypes
visually-striking/ Z. Humor effect	stereotypes, <sup>3. Stereotyping</sup>	15. Barnum effect	6. Implicit associations
anthronomorphic A Disk	apparalition and prior, 4. Essentialism	16. Forer effect	
antinopomorphic 4. Picture superiority effect	generatities, and prior 5. Functional fixedness	17. Third-person effect	
hings stick out more	histories 6. Moral credential effect	18. Social desirability bias	c. We reduce events 1. Suffix effect
6. Negativity Effect	7. Just-world hypothesis	19. Optimism bias	and lists to their key 2. Serial position
	8. Argument from fallacy	20. Egocentric bias	3. Recency effect
non-bizarre/unfunny	9. Authority bias	21. Overconfidence effect	elements 4. Primacy effect
things	10. Automation bias		5. Past-list cueing effect
tinngs	11. Bandwagon effect	<b>b</b> To stay focused	6. Memory inhibition
	12. Placebo effect	<b>D.</b> 10 Stay 10cuseu, 1. Identifiable victim effect	7. Modality effect
		we favor the <sup>2. Appeal to novelty</sup>	8. List-length effect
c We notice when	• We impaine things <sup>1. Halo effect</sup>	immediate relatable <sup>3. Hyperbolic discounting</sup>	9. Serial recall effect
1. Anchoring	2. In-group bias		10. Duration neglect
something has 2. Conservatism	and people we're 3. Not invented here	thing in front of us	11. Misinformation effect
changed <sup>3. Contrast effect</sup>	familiar with or fond <sup>4</sup> . Cross-race-effect		12. Leveling and sharpening
4. Distinction bias	5. Cheerleader effect		13. Peak-end rule
5. Focusing effect	OT as Detter 6. Well-traveled road effect		
6. Framing effect	7. Out-group homogeneity bia	s <b>c.</b> To get things done, 1. Backfire effec	
7. Money illusion	8. Reactive devaluation	we tend to complete 2. Endowment effect	
8. Weber-Fechner law	9. Positivity effect	3. Pseudocertainty effect	
	·	things we've 4. Unit bias	<b>d.</b> We store 1. Tip of the tongue phenomenon
	<b>d</b> We simplify 1. Mental accounting	invested time & 5. Disposition effect	memories differently 2. Google effect
	2. Normalcy bias	6. Zero-risk bias	3. Next-in-line effect
<b>d.</b> We are drawn to 1. Confirmation bias	probabilities and 3. Magic number 7 + 2	energy in 7. Generation effect	Dased on now they 4. Testing effect
details that confirm 2. Congruence bias	numbers make them 4. Murphy's law	8. Processing difficulty effect	were <i>experienced</i> 5. Absent-mindedness
3. Post-purchase rationalization	obsign to think about <sup>5</sup> . Subadditivity effect	9. IKEA effect	6. Levels of processing effect
4. Choice-supportive bias	6. Survivorship bias	10. Loss aversion	
<b>beliefs</b> 5. Selective perception	7. Zero sum bias	11. Escalation of commitment	
6. Observer-expectancy effect	8. Denomination effect	12. Irrational escalation	
7. Experimenter's bias	9. Appeal to probability fallac	y 13. Sunk cost fallacy	
8. Observer effect			
9. Ostrich effect	e. We think we know 1.Curse of knowledge	<b>d.</b> To avoid mistakes, 1. Status quo bias	
10. Subjective validation	what other people 2. Illusion of transparency	we're motivated to 2. Social comparison bias	
11. Continued influence effect	3. Spotlight effect	3. Decoy effect	
12. Semmelweis reflex	are thinking 4. Illusion of external agency	preserve our 4. Reverse psychology	
	5. Illusion of asymmetric insid	ht autonomy and status 5. Reactance	The reason <b>why</b> a bias ————————————————————————————————————
- Manation flows in	6. Extrinsic incentive error	in a group and to 6. System justification	occurs is given at the top
e. We notice <i>flaws in 1. Bias blind spot</i>		in a group, and to	and with roman numerals.
others more easily 2. Naive cynicism	<b>f.</b> We <i>project</i> <b>our</b> 1. Self-consistancy bias	avoid irreversible	<b>x.</b> Strategy 1. Bias a
than flaws in <sup>3</sup> . Naive realism	current mindset and 2. Restraint bias	decisions	How humans cope with
		decisions	this reason is given with
ourselves	assumptions onto the 4 Pro-innovation bias		bold letters.
	past and future 5. Time-saving bias	e. We favor 1. Less-is-better effect	
	6. Planning fallacy	simple-looking 2. Occam's razor	The bias name is
	7 Pessimism hias	3. Conjunction fallacy	addressed using arabic
	8 Impact hias	options and 4. Delmore effect	numerals.
	9 Rosy retrospection	complete 5. Law of Triviality	
	10 Telesconing effect	6. Belief bias	
	11 Declinism	Information over 7. Bike-shedding effect	
	12 Moral luck	complex. ambiguous 8 Rhyme as reason effect	Derived from John Manoogian III "Cognitive Bias Codex 2016
	12. Moldi luck	options 9 Information bias	Categorization by Buster Benson - Visualization by ACV
	13. Outcome bias	Options <sup>10</sup> Ambiguity bias	CC-SA BY 4.0
	14. HINUSIYIL DIAS	10. Anolyulty blas	

#### A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.

#### IV. What Should We omnesia rce confusio ttribution of memo ing affect bias ativity bias icit stereotyr

#### p of the tongue phenom ogle effect xt-in-line effect sting effect ent-mindednes els of processing effec



### And now

- Interesting, but not very actionable for VIS
  - Where should we start?
  - What are the important ones for VIS?
  - How does everything connect together?
  - Any methodological considerations we should be aware of?

Too Much Information	II Not Enough Meaning	III Need to act fast	IV. What Sh
	n. Hot Enough Ficulturg		remem
<ul> <li>a. We notice things already primed in nemory or repeated often</li> <li>b. Availability Heuristic 2. Attentional Bias 3. Illusory truth effect 4. Mere exposure effect 5. Centext effect 6. Cue-dependent forgetting 7. Mood-congruent memory bias 8. Frequency illusion 9. Baader-Meinhof Phenomenon 10. Empathy gap</li> </ul>	<ul> <li>a. We find stories and patterns even in sparse data</li> <li>b. Clustering illusion</li> <li>c. Clustering illusion</li> <li>l. Insensitivity to sample size</li> <li>A. Neglect of probability</li> <li>S. Anecdotal fallacy</li> <li>Clustering illusion</li> <li>Insensitivity to sample size</li> <li>A. Neglect of probability</li> <li>S. Anecdotal fallacy</li> <li>Clustering illusion</li> <li>S. Anecdotal fallacy</li> <li>S. Anecdo</li></ul>	a. To act, we must be confident we can make an impact and feel what we do is important A. Trait ascription bias 5. Defensive attribution hypothesis 6. Fundamental attribution error 7. Actor-observer bias 8. Self-serving bias 9. Lake Wobegone effect	a. We <i>edit</i> and 1. Sp 2. Su 3. Fa <i>memories</i> after the 4. Cr fact 5. So 6. Mi
<ul> <li>11. Omission bias</li> <li>12. Base rate fallacy</li> <li>b. Bizarre/funny/</li> <li>1. Bizarreness effect</li> <li>2. Humor effect</li> <li>3. Von Restorff effect</li> <li>4. Picture superiority effect</li> </ul>	11. Pareidolia 12. Anthropomorphism <b>b.</b> We fill in characteristics from stereotypes, 4. Essentialism peperalities and prior 5. Functional fixedness	10. Illusory superiority 11. Hard-easy effect 12. Dunning-Kruger effect 13. False consensus effect 14. Illusion of control 15. Barnum effect 16. Forer effect 17. Third-person effect	<b>b.</b> We discard 1. Fa specifics to form 2. Ne generalities 4. Ste 5. Im 6. Im
ings stick out more than on-bizarre/unfunny things	histories 6. Moral credential effect 7. Just-world hypothesis 8. Argument from fallacy 9. Authority bias 10. Automation bias 11. Bandwagon effect 12. Placebo effect	<ul> <li>17. Initia person effect</li> <li>18. Social desirability bias</li> <li>19. Optimism bias</li> <li>20. Egocentric bias</li> <li>21. Overconfidence effect</li> </ul> <b>b.</b> To stay focused, 1. Identifiable victim effect	c. We reduce events and lists to their key elements 5. Pa 6. Me 7. Mc
c. We notice when something has changed 3. Contrast effect 4. Distinction bias 5. Focusing effect 6. Framing effect 7. Money illusion	<ul> <li>c. We imagine things and people we're familiar with or fond of as better</li> <li>1. Halo effect</li> <li>2. In-group bias</li> <li>3. Not invented here</li> <li>4. Cross-race-effect</li> <li>5. Cheerleader effect</li> <li>6. Well-traveled road effect</li> <li>7. Out-group homogeneity bias</li> <li>8. Reactive devaluation</li> </ul>	<ul> <li>we favor the 2. Appeal to novelty</li> <li>3. Hyperbolic discounting</li> <li>c. To get things done, 1. Backfire effec</li> <li>2. Endowment effect</li> </ul>	8. LIS 9. Se 10. D 11. M 12. L 13. P
<ul> <li>8. Weber-Fechner law</li> <li>8. Weber-Fechner law</li> <li>d. We are drawn to details that confirm our own existing beliefs</li> <li>2. Congruence bias 3. Post-purchase rationalization 4. Choice-supportive bias 5. Selective perception 6. Observer-expectancy effect 7. Experimenter's bias 8. Observer effect</li> </ul>	<ul> <li>9. Positivity effect</li> <li>9. Positivity effect</li> <li>1. Mental accounting</li> <li>2. Normalcy bias</li> <li>3. Magic number 7 + 2</li> <li>4. Murphy's law</li> <li>5. Subadditivity effect</li> <li>6. Survivorship bias</li> <li>7. Zero sum bias</li> <li>8. Denomination effect</li> <li>9. Positivity effect</li> <li>9. Positivity effect</li> <li>1. Mental accounting</li> <li>2. Normalcy bias</li> <li>3. Magic number 7 + 2</li> <li>4. Murphy's law</li> <li>5. Subadditivity effect</li> <li>6. Survivorship bias</li> <li>7. Zero sum bias</li> <li>8. Denomination effect</li> <li>9. Appeal to probability fallacy</li> </ul>	<ul> <li>3. Pseudocertainty effect</li> <li>4. Unit bias</li> <li>5. Disposition effect</li> <li>6. Zero-risk bias</li> <li>7. Generation effect</li> <li>8. Processing difficulty effect</li> <li>9. IKEA effect</li> <li>10. Loss aversion</li> <li>11. Escalation of commitment</li> <li>12. Irrational escalation</li> <li>13. Sunk cost fallacy</li> </ul>	d. We store 1. Tip memories differently 2. Go 3. Ne based on how they were <i>experienced</i> 5. Ab 6. Le
9. Ostrich effect 10. Subjective validation 11. Continued influence effect 12. Semmelweis reflex e. We notice <i>flaws in</i> 1. Bias blind spot 2. Naive emisism	<ul> <li>e. We think we know</li> <li>what other people are thinking</li> <li>are thinking</li> <li>f. We project our</li> <li>t. Curse of knowledge</li> <li>2. Illusion of transparency</li> <li>3. Spotlight effect</li> <li>4. Illusion of external agency</li> <li>5. Illusion of asymmetric insight</li> <li>6. Extrinsic incentive error</li> </ul>	<ul> <li>d. To avoid mistakes, 1. Status quo bias</li> <li>we're motivated to preserve our</li> <li>autonomy and status in a group, and to avoid irreversible</li> <li>1. Status quo bias</li> <li>2. Social comparison bias</li> <li>3. Decoy effect</li> <li>4. Reverse psychology</li> <li>5. Reactance</li> <li>6. System justification</li> </ul>	Legend The reason why a bias occurs is given at the top and with roman numerals.
than flaws in <sup>3. Naive realism</sup> ourselves	current mindset and assumptions onto the past and future past and future 2. Restraint bias 3. Projection bias 4. Pro-innovation bias 5. Time-saving bias 6. Planning fallacy 7. Pessimism bias 8. Impact bias	e. We favor 1. Less-is-better effect simple-looking 0. Conjunction fallacy options and 4. Delmore effect	How humans cope with this reason is given with bold letters. The bias name is addressed using arabic numerals.
	9. Rosy retrospection 10. Telescoping effect 11. Declinism 12. Moral luck 13. Outcome bias 14. Hindsight bias	complete 5. Law of friviality 6. Belief bias 7. Bike-shedding effect 8. Rhyme as reason effect 9. Information bias 10. Ambiguity bias	Derived from John Manoogian III Categorization by Buster Bens CC-SA BY

#### A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.

#### nould We nber? ce confusio tribution of me ng affect bias tivity bias

prmation effe

of the tongue phenor gle effect -in-line effec ng effect nt-mindedne ls of processing effect



### **Our contribution:** Let's try a first attempt to structure that space for VIS!



#### **A Framework**

Michael Sedlmair



# Let's try a first attempt to structure that space for VIS!

How: use Norman's venerable UX action loop!

Michael Sedlmair





### Action Loop

### **Action biases** e.g., Ostrich effect



<u>vww.slideshare.net/agkrish/garbage-ostrich-effe</u>

Michael Sedlmair



### **Motor-sensory Loop**

### **Perceptual biases** e.g., Clustering illusion



<u> https://meetinmontauk.com/2014/08/03/song-of-the-day-2203-say-it-right-nelly-furtado/</u>

Michael Sedlmair





# Bounded

### **Social biases**



http://study.com/academy/lesson/ingroup-vs-outgroup-definition-and-explanation.htm

A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.

### Framework

- cross-talk
- structures the space
- guides to different biases
- pinpoints different methodological considerations on different levels

build on lower levels

#### methodological challenges



Daniel Kahneman

good starting point

#### established methods





## Discussion

- What we think
  - theoretical discussion needed -
  - our framework might be a first starting point
- What we do \*not\* think
  - our framework is the holy grail
- Goal: spark \*VIS-specific\* discussions
  - proper theoretical underpinnings? -
  - methodological challenges? —
  - should we **counteract** biases? —
  - counteract on perceptual, action, and social levels? -

A Framework for Studying Biases in Visualization Research. IEEE VIS Decisive Workshop: Phoenix, AZ, USA. Oct 2nd, 2017.

### Thanks!

### A Framework for Studying Biases in Visualization Research

André Calero Valdez, Martina Ziefle, Michael SedImair







michael.sedlmair@univie.ac.at

