Understanding the Communication of Data Stories: A User-Centered Perspective

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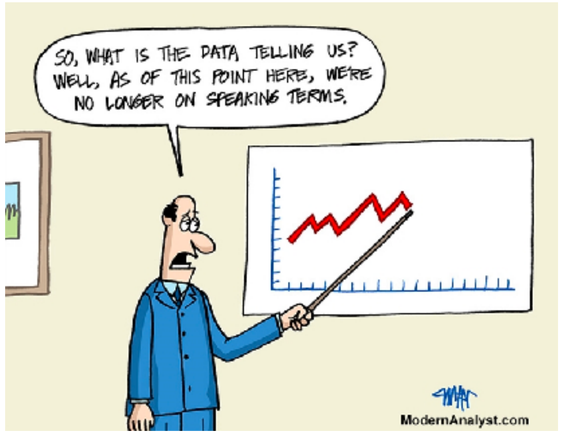
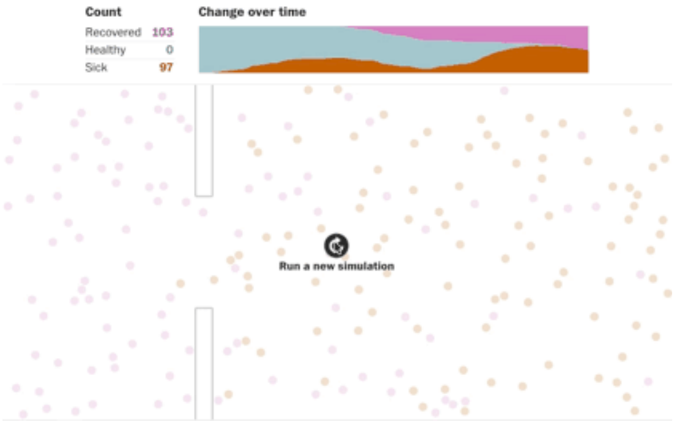
Data Stories

- The growth of data-driven storytelling makes visualization reach a broad audience





- The need of understanding user experience with data stories
  - e.g., How do people read / interact with data stories?
  - e.g., How do people respond to data stories?
  - e.g., What is a good data story?
  - e.g., How to communicate data effectively?

Data Stories

- **The need of understanding user experience with data stories**

Table 1: Definitions of the three user experience goals discussed in this paper.

GOALS	DEFINITION
Memorability	Memorability is a capability of maintaining and retrieving information [13].
Engagement	Emotional, cognitive and behavioural connection that exists, at any point in time and possibly over time, between a user and a resource [2].
Enjoyment	Feeling that causes a person to experience pleasure [16]. Pleasure is recognized with occurrent happiness and excitement, which can be explained in terms of belief, desire, and thought.

Beyond usability and performance: A review of user experience-focused evaluations in Visualization

V = C + E (A, P, I, S), where the value of a data representation derives from:

C—its creativity. In terms of introducing new and original ideas;

E—its ability to engage beyond the raw information content, with respect to distinctions of Perry[15] through;

A—affective (emotional) engagement;

P—physical interaction being invited through touch and movement, real or imagined;

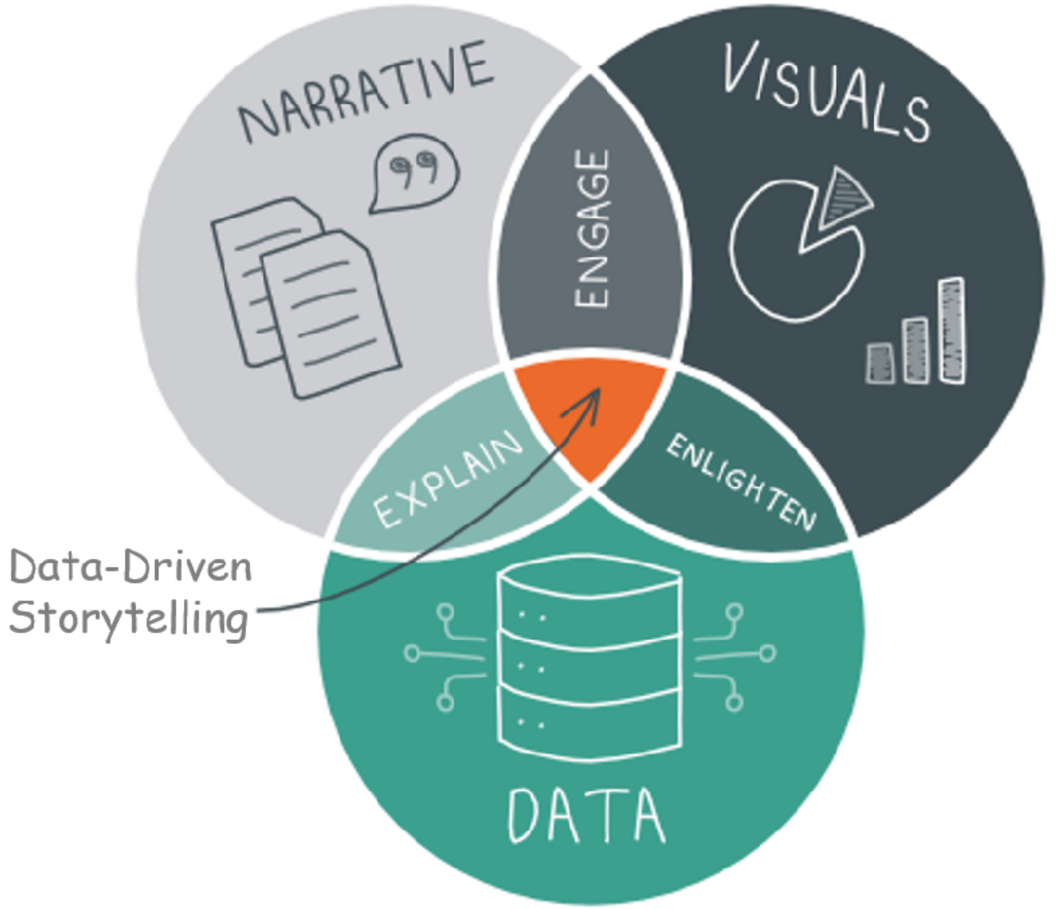
I—intellectual engagement;

S—social engagement.

An Emotional Response to the Value of Visualization

Data Stories

- How people feel data stories?
- How to design data stories that appeal to people's subjective feelings?
- Let's examine these questions from two aspects: visuals and narrative

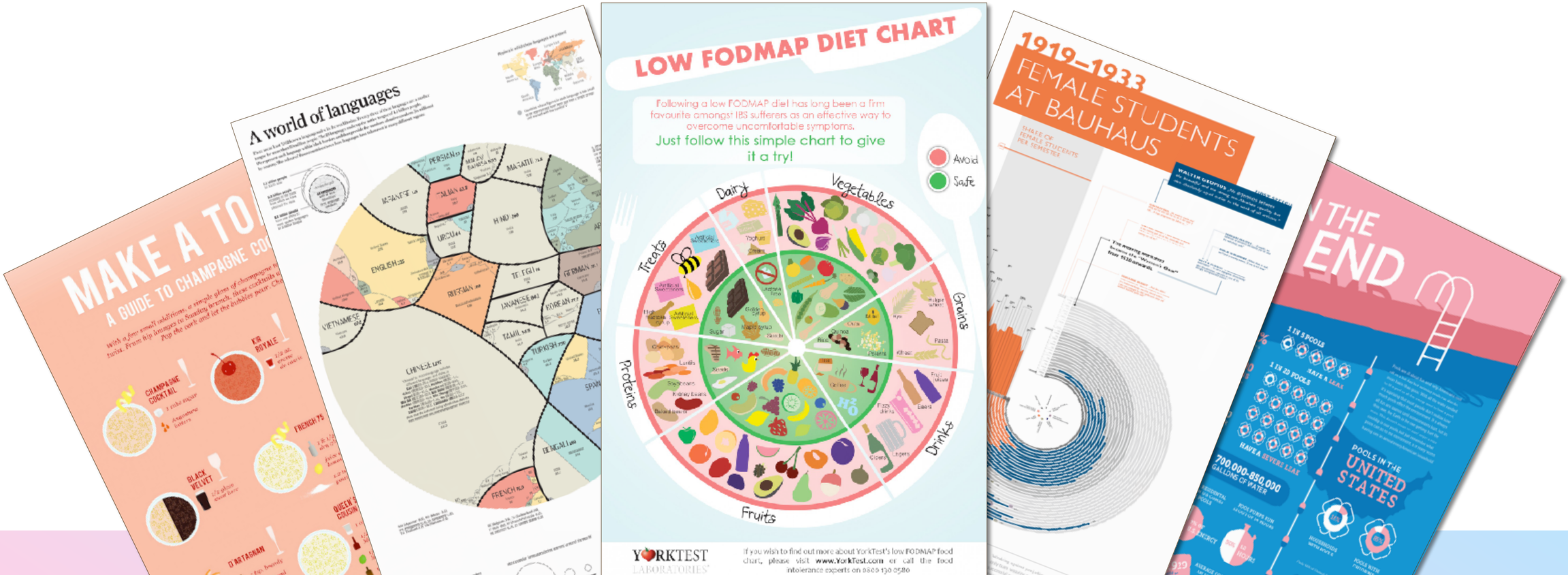


Smile or Scowl? Looking at Infographic Design Through the Affective Lens

Lan, X., Shi, Y., Zhang, Y., & Cao, N. (2021). Smile or Scowl? Looking at Infographic Design Through the Affective Lens. *IEEE Transactions on Visualization and Computer Graphics*, *27*(6), 2796-2807.

Looking at Infographic Design From the Affective Lens

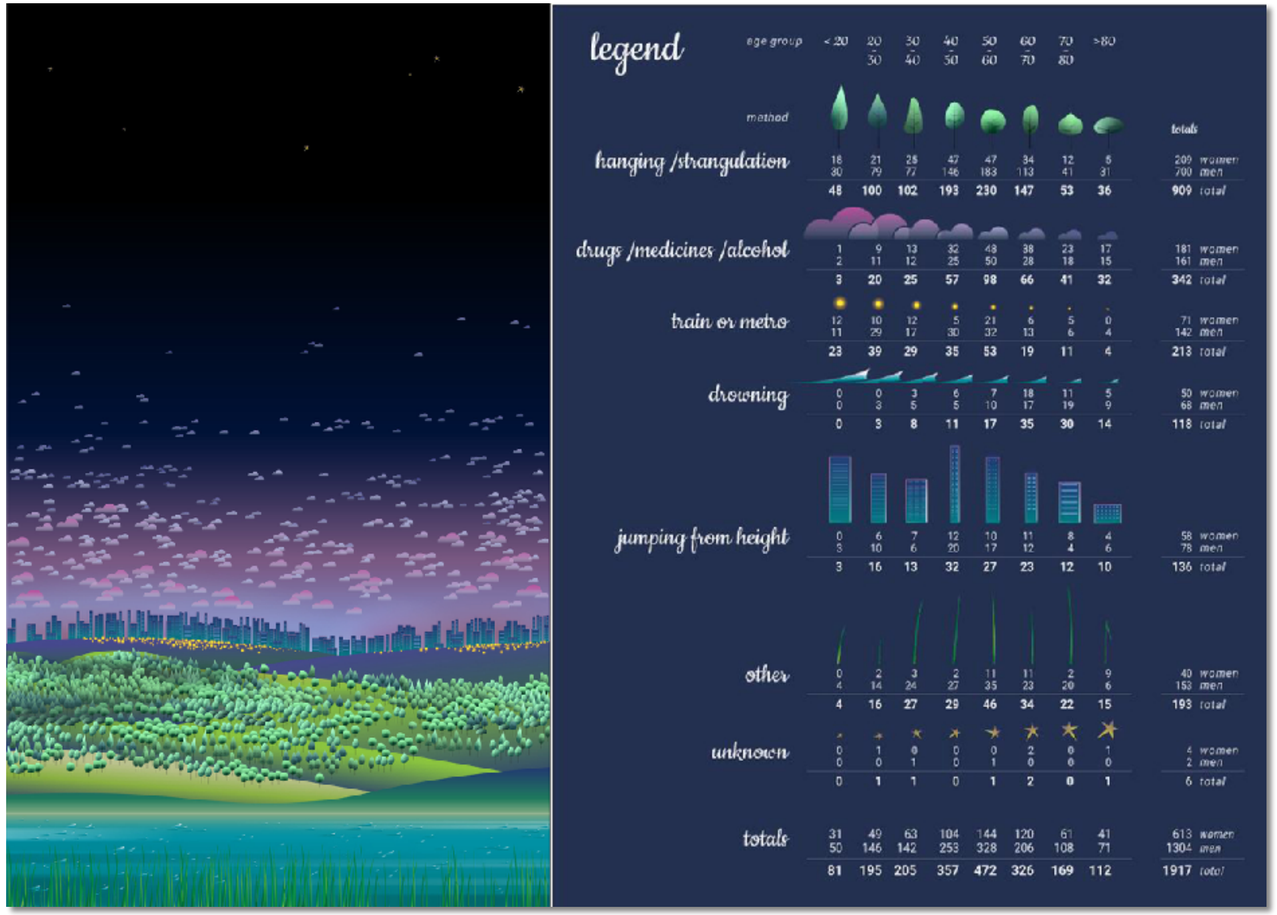
Infographics, as visual communication devices that use visualizations, texts, and embellishment to convey data, knowledge, and insights, have been increasingly applied to various domains to attract, persuade, or educate the audience.



Looking at Infographic Design From the Affective Lens

When designing infographics, designers often seek to trigger ***affective responses*** (people's emotion, mood, or feeling) from viewers.

An affect-inducing infographic is felt more interesting, attractive, and thought-provoking, and can catalyze learning and actions.



Sonja Kuijpers, A view on despair

Looking at Infographic Design From the Affective Lens

To facilitate the creation of affective infographics, we still lack knowledge on:

(1) ***what*** affective responses can be triggered by infographics,
(2) ***why*** they occur.

Given such motivations, this work makes an initial attempt to understand the affects elicited by infographics and the design-relevant factors that contribute to such affects.

We collected a corpus of 976 infographics, based on which two crowdsourcing studies were conducted:

Looking at Infographic Design From the Affective Lens

Experiment I: Identifying Affective Responses

Experiment I was used to identify the typical affective responses to infographics.

Procedure:

We recruited 245 native English speakers from AMT. Each participant viewed 10 infographics randomly and wrote down words that best described their feelings freely.

	Primary affect	Affective words	Percentage
Positive	happy	happy, amused, joyful, cheerful, enjoyment, delighted, satisfied, entranced, fulfilled, gratified, elated	16.26%
	surprised	surprised, amazed, astonished	10.52%
	excited	excited, enthusiastic, thrilled	3.43%
	content	content, pleased	3.03%
	awestruck	awestruck	1.95%
	hopeful	hopeful, optimistic, anticipating	1.75%
Negative	sad	sad, depressed, unhappy, despair, hopeless, melancholy, miserable, sorrowful, grief, despondent	9.80%
	concerned	concerned, worried, anxious, upset, nervous, disturbed, uneasy, apprehensive, troubled, dread, distressed	7.75%
	shocked	shocked, fearful, scared, alarmed, frightened, horrified, terrified, appalled, aghast, afraid	6.79%
	overwhelmed	overwhelmed	6.66%
	bored	bored	6.56%
	annoyed	annoyed, irritated, aggravated, agitated, grouchy, mad	5.74%

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Experiment II: Infographic-Response Mappings

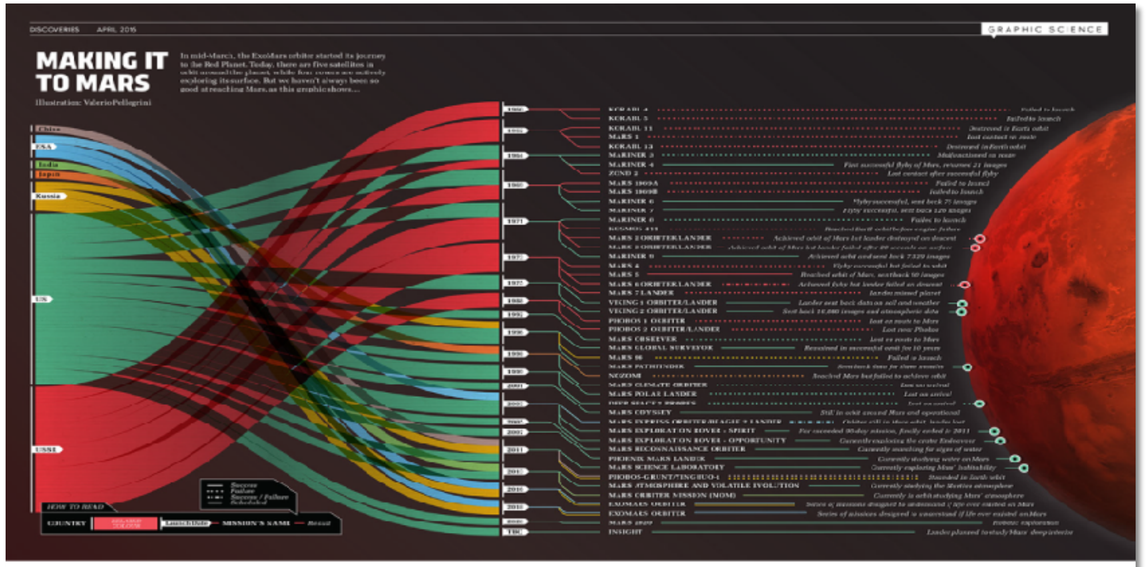
Experiment II was used to map the identified affects to infographics and collect user feedback explaining why the identified affects were triggered.

Procedure:

We recruited 490 native English speakers from AMT. Each participant viewed 10 infographics randomly and rated the infographics using the 12 identified affects.

Analysis:

(1) Can people form consistent judgment on affective responses?
(2) How is the distribution of affective responses?
(3) How affective responses relate to design?



	not at all aware	slightly aware	somewhat aware	moderatly aware	extremely aware		not at all aware	slightly aware	somewhat aware	moderatly aware	extremely aware
Happy	1	2	3	4	5	Sad	1	2	3	4	5
Surprised	1	2	3	4	5	Concerned	1	2	3	4	5
Excited	1	2	3	4	5	Shocked	1	2	3	4	5
Content	1	2	3	4	5	Overwhelmed	1	2	3	4	5
Awestruck	1	2	3	4	5	Bored	1	2	3	4	5
Hopeful	1	2	3	4	5	Annoyed	1	2	3	4	5

Reasons:

Next

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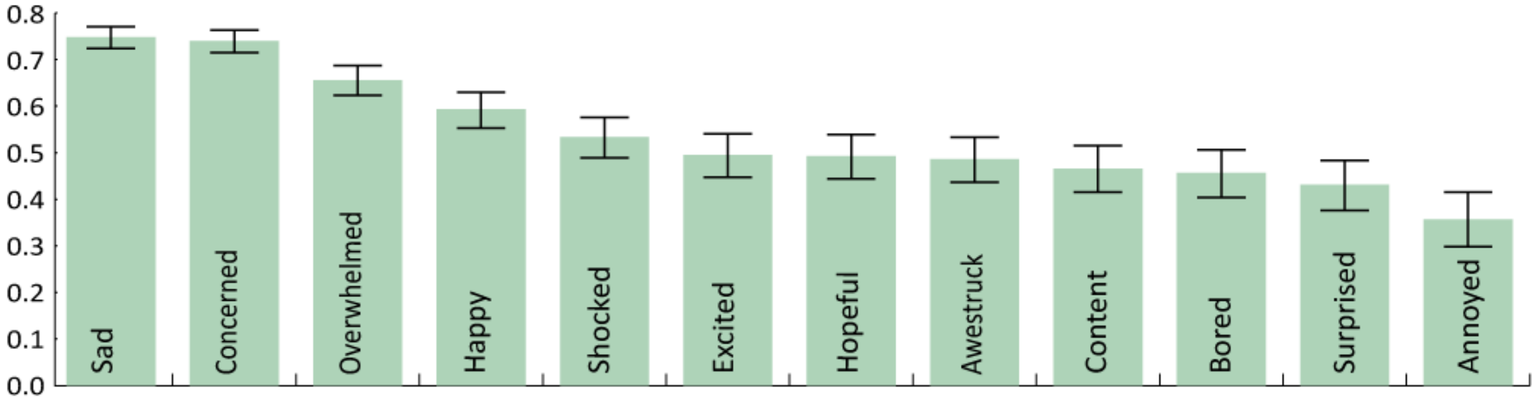
(1) Can people form consistent judgment on affective responses?

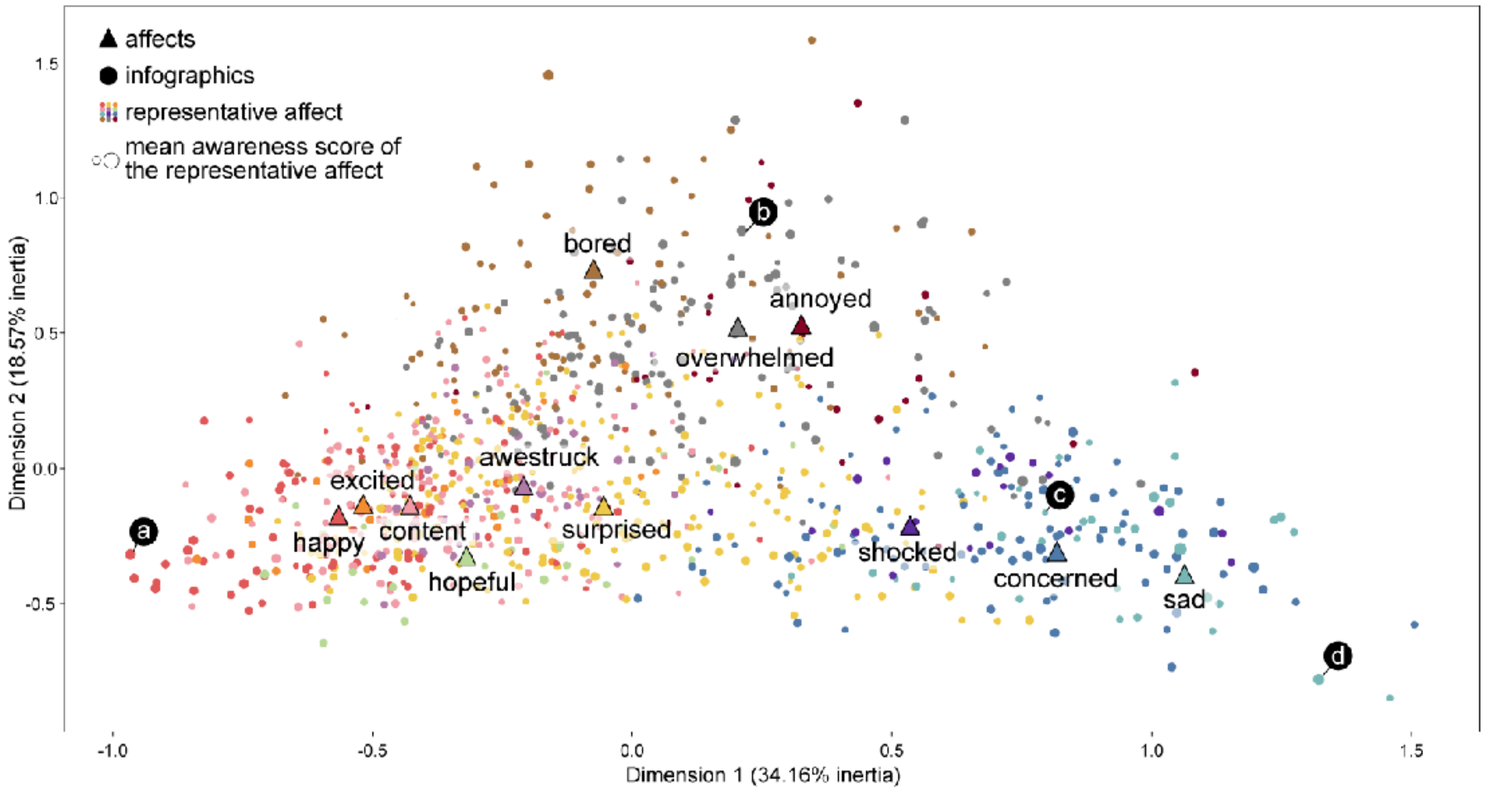
We used intra class coefficients (ICC) to assess the consistency in ratings. In general, there is a good agreement in ratings on the affective responses.

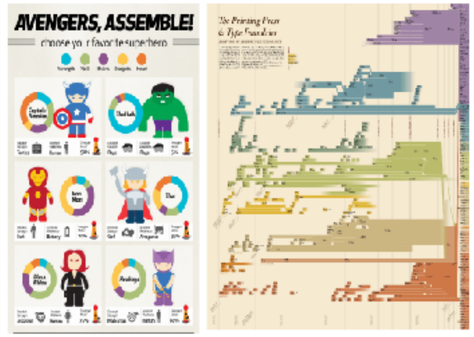


Looking at Infographic Design From the Affective Lens

(2) How is the distribution of affective responses? https://affectiveinfographics.idvxlab.com

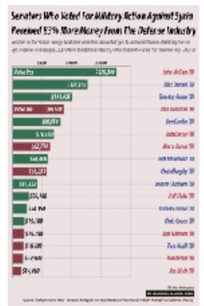
We analyzed the distribution of affects using Correspondence Analysis (CA).



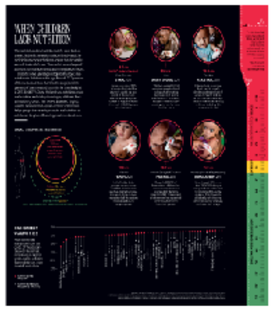


a happy (μ=4.1)

b overwhelmed(μ=3.9)



c sad (μ=2.2)



d sad (μ=4.3)

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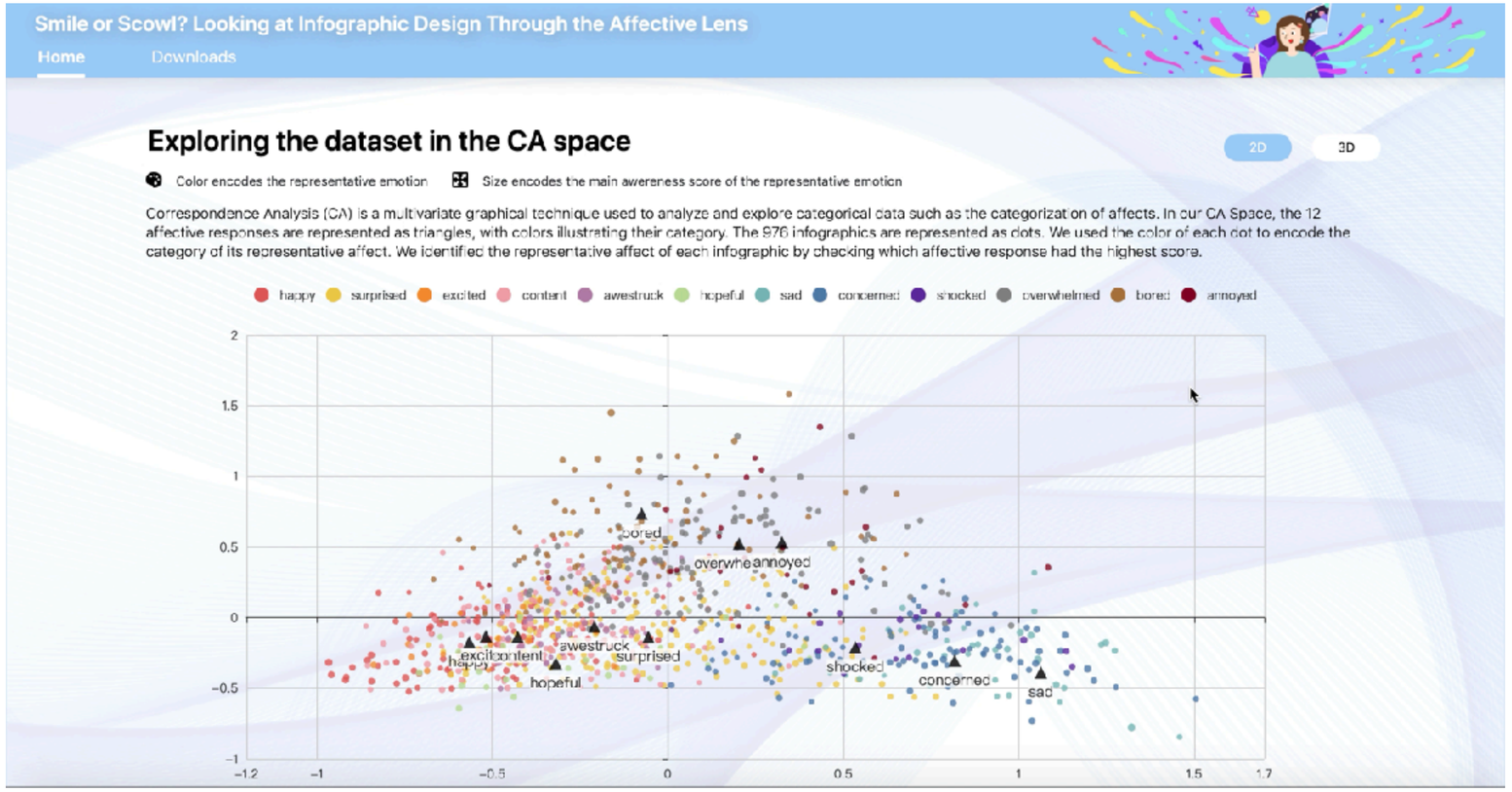


Looking at Infographic Design From the Affective Lens

(3) How affective responses relate to design?

We collected more than 9,000 pieces of user comments explaining what triggered affective responses in the infographics from Experiment II.

We found that affective responses can be triggered by many reasons.

We then distilled user comments about design and coded the comments using iterative random sampling.

Looking at Infographic Design From the Affective Lens

Developing Design Heuristics

Finally, we built a taxonomy of design heuristics that exemplifies the affect-related design factors in infographics.

Design heuristics are a series of design guidelines that help designers ideate or assess their work systematically and efficiently.

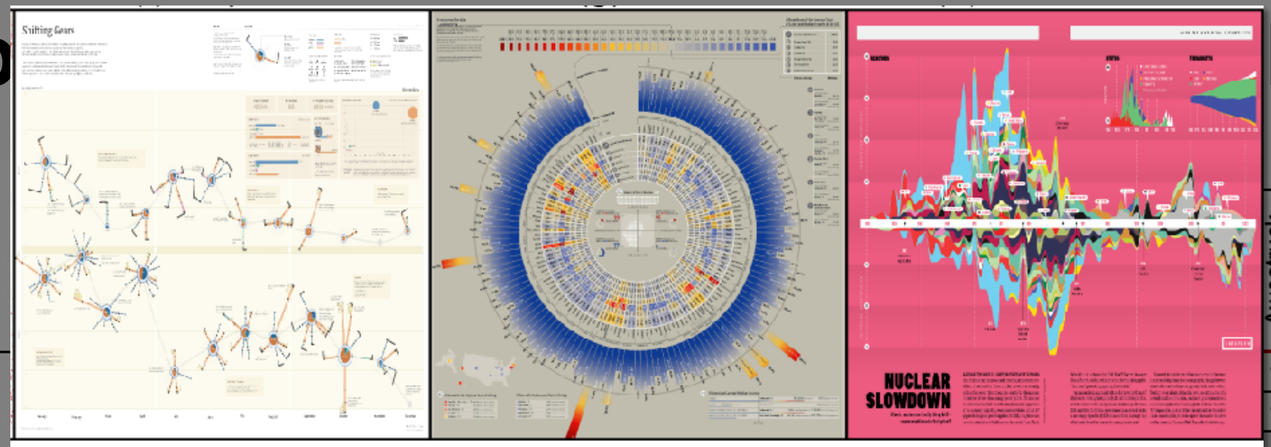
H1 Usability	**H1-1** Accessibility	**H1-1-1** The infographic uses comprehensible data encodings
		H1-1-2 The infographic provides an appropriate amount of information
		H1-1-3 The infographic provides a clear reading path
	H1-2 Readability	**H1-2-1** The infographic uses readable font size
		H1-2-2 The infographic's graphics and texts stand out from the background
		H1-2-3 The infographic has no spelling or grammar errors
	H1-3 Messaging	**H1-3-1** The infographic provides clear labels and legends for data visualization
		H1-3-2 The infographic provides contextual information for data visualization
		H1-3-3 The infographic provides a detailed explanation for data visualization
	H1-4 Credibility	**H1-4-1** The infographic presents information in an impartial way
		H1-4-2 The infographic uses data that is valid and clearly collated
H2 Expressivess	**H2-1** Embodiment	**H2-1-1** The infographic incorporates topic-relevant imagery into visualization
		H2-1-2 The infographic uses topic-relevant imagery as embellishment
		H2-1-3 The infographic uses bright/dark color for positive/negative tone
		H2-1-4 The infographic uses warm/cold color for positive/negative tone
		H2-1-5 The infographic is of high/low colorfulness for positive/negative tone
		H2-1-6 The infographic uses semantically-resonate colors
	H2-2 Narrative	**H2-2-1** The infographic emphasizes key data facts
		H2-2-2 The infographic addresses the audience directly
		H2-2-3 The infographic uses powerful wording
	H2-3 Uniqueness	**H2-3-1** The infographic uses novel data visualization
		H2-3-2 The infographic has a salient style or personality

Looking at Infographic Design From the Affective Lens

The heat map indicates the empirically observed distribution of the design heuristics among the 12 identified affects.

			Happy (2)	Surprised	Excited	Content	Awestruck	hopeful	Sad	Concerned	Shocked	Bored (1)	Overwhelmed	Annoyed
H1 Usability	H1-1 Accessibility	**H1-1-1** The infographic uses comprehensible data encodings	3		1	8	1					-2	-8	-3
		H1-1-2 The infographic provides an appropriate amount of information	1			2	1	1				-11	-31	-4
		H1-1-3 The infographic provides a clear reading path	8	1	1	6						-3	-5	-4
	H1-2 Readability	**H1-2-1** The infographic uses readable font size	1									-4	-7	-6
		H1-2-2 The infographic's graphics and texts stand out from the background	1			2						-1		
		H1-2-3 The infographic has no spelling or grammar errors										-1		-2
	H1-3 Messaging	**H1-3-1** The infographic provides clear labels and legends for data visualization	2									-1	-1	-1
		H1-3-2 The infographic provides contextual information for data visualization										-5	-2	-1
		H1-3-3 The infographic provides a detailed explanation for data visualization	5		1	4			-1			-2	-3	
	H1-4 Credibility	**H1-4-1** The infographic presents information in an impartial way												-2
		H1-4-2 The infographic uses data that is valid and clearly collated	1											-2
H2 Expressivess	H2-1 Embodiment	**H2-1-1** The infographic incorporates topic-relevant imagery into visualization	4	1		2	2		1	2	3	-1		
		H2-1-2 The infographic uses topic-relevant imagery as embellishment	7	1	1	3		1	1	3	1		-1	
		H2-1-3 The infographic uses bright/dark color for positive/negative tone	2					1	1	1				
		H2-1-4 The infographic uses warm/cold color for positive/negative tone	2						1	1				
		H2-1-5 The infographic is of high/low colorfulness for positive/negative tone	6		3	2		1				-4	-2	
		H2-1-6 The infographic uses semantically-resonate colors	2	1		1			1		2			-1
	H2-2 Narrative	**H2-2-1** The infographic emphasizes key data facts	2	11	1	1	2	1	7	4	3		1	1
		H2-2-2 The infographic addresses the audience directly	1	1								-1		-1
		H2-2-3 The infographic uses powerful wording	2			1				1	1			1
	H2-3 Uniqueness	**H2-3-1** The infographic uses novel data visualization	7			1	4					-2		
		H2-3-2 The infographic has a salient style or personality	1		1	1								

Looking at Infograp Lens



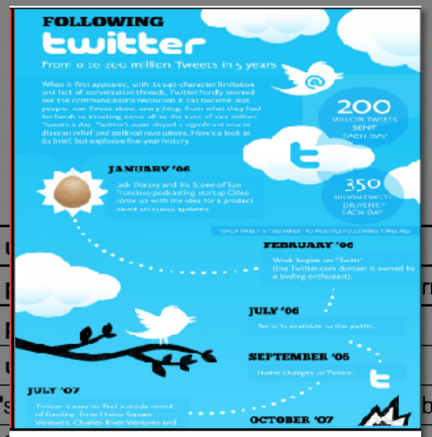
(j) Bored (k) Overwhelmed (l) Annoyed

The heat map indicates the empirically observed distribution of the design heuristics among the 12 identified affects.

			Awestruck	hopeful	Sad	Concerned	Shocked	Bored	Overwhelmed	Annoyed
H1 Usability	**H1-2** Readability	**H1-2-1** The infographic uses readable font size	1					-2	-8	-3
		H1-2-2 The infographic's graphics and texts stand out from the background	1	1				-11	-31	-4
		H1-2-3 The infographic has no spelling or grammar errors						-3	-5	-4
	H1-3 Messaging	**H1-3-1** The infographic provides clear labels and legends for data visualization						-4	-7	-6
		H1-3-2 The infographic provides contextual information for data visualization	1					-1		
		H1-3-3 The infographic provides a detailed explanation for data visualization	2					-1		-2
	H1-4 Credibility	**H1-4-1** The infographic presents information in an impartial way	2					-1	-1	-1
		H1-4-2 The infographic uses data that is valid and clearly collated						-5	-2	-1
H2 Expressivess	**H2-1** Embodiment	**H2-1-1** The infographic incorporates topic-relevant imagery into visualization	5		1	4		-1		-2	-3	
		H2-1-2 The infographic uses topic-relevant imagery as embellishment								-2
		H2-1-3 The infographic uses bright/dark color for positive/negative tone	1							-2
		H2-1-4 The infographic uses warm/cold color for positive/negative tone	4	1		2	2		1	2	3	-1		
		H2-1-5 The infographic is of high/low colorfulness for positive/negative tone	7	1	1	3		1	1	3	1		-1	
		H2-1-6 The infographic uses semantically-resonate colors	2					1	1					
	H2-2 Narrative	**H2-2-1** The infographic emphasizes key data facts	6		3	2		1				-4	-2	
		H2-2-2 The infographic addresses the audience directly	2	1		1				2				-1
		H2-2-3 The infographic uses powerful wording	2	11	1	1	2	1	7	4	3		1	1
	H2-3 Uniqueness	**H2-3-1** The infographic uses novel data visualization	1	1								-1		-1
		H2-3-2 The infographic has a salient style or personality	2			1				1	1			1
			7			1	4					-2		
			1		1	1								

Looking at Infographic Design From the Affective Lens

The heat map indicates the empirically observed distribution of the design heuristics among the 12 identified affects.



(d) Content

			Happy	Surprised	Excited	Content	Awestruck	hopeful	Sad	Concerned	Shocked	Bored	Overwhelmed	Annoyed
			2									1		
H1 Usability	H1-1 Accessibility	H1-1-1 The infographic	3		1	8	1					-2	-8	-3
		H1-1-2 The infographic …rmation	1			2	1	1				-11	-31	-4
		H1-1-3 The infographic	8	1	1	6						-3	-5	-4
	H1-2 Readability	H1-2-1 The infographic	1									-4	-7	-6
		H1-2-2 The infographic's …backg…nd	1			2						-1		
		H1-2-3 The infographic										-1		-2
	H1-3 Messaging	H1-3-1 The infographic provides clear labels and legends for data visualizat…n	2									-1	-1	-1
		H1-3-2 The infographic provides contextual information for data visualization										-5	-2	-1
		H1-3-3 The infographic provides a detailed explanation for data visualization	5		1	4			-1			-2	-3	
	H1-4 Credibility	H1-4-1 The infographic presents information in an impartial way												-2
		H1-4-2 The infographic uses data that is valid and clearly collated	1											-2
H2 Expressivess	H2-1 Embodiment	H2-1-1 The infographic incorporates topic-relevant imagery into visualization	4	1		2	2		1	2	3	-1		
		H2-1-2 The infographic uses topic-relevant imagery as embellishment	7	1	1	3		1	1	3	1		-1	
		H2-1-3 The infographic uses bright/dark color for positive/negative tone	2					1	1	1				
		H2-1-4 The infographic uses warm/cold color for positive/negative tone	2						1	1				
		H2-1-5 The infographic is of high/low colorfulness for positive/negative tone	6		3	2		1				-4	-2	
		H2-1-6 The infographic uses semantically-resonate colors	2	1		1			1		2			-1
	H2-2 Narrative	H2-2-1 The infographic emphasizes key data facts	2	11	1	1	2	1	7	4	3		1	1
		H2-2-2 The infographic addresses the audience directly	1	1								-1		-1
		H2-2-3 The infographic uses powerful wording	2			1				1	1			1
	H2-3 Uniqueness	H2-3-1 The infographic uses novel data visualization	7			1	4					-2		
		H2-3-2 The infographic has a salient style or personality	1		1	1								

Looking at Infograp e Affective Lens

The heat map indicates the empirically observed distribution of the design heuristics among the 12 identified affects.

(a) Happy

(c) Excited

(g) Sad

(h) Concerned

			Happy 2	Surprised	Excited	Content	Awestruck	hopeful	Sad	Concerned	Shocked	Bored 1	Overwhelmed	Annoyed
H1 Usability														
		ings	3		1	8	1					-2	-8	-3
		f information	1			2	1	1				-11	-31	-4
			8	1	1	6						-3	-5	-4
			1									-4	-7	-6
		m the background	1			2						-1		
		s										-1		-2
		s for data visualization	2									-1	-1	-1
		or data visualization										-5	-2	-1
		or data visualization	5		1	4			-1			-2	-3	
		ial way												-2
		collate	1											-2
H2 Expressivess		ery into visualization	4	1		2	2		1	2	3	-1		
		mbellishment	7	1	1	3		1	1	3	1		-1	
		/negative tone	2					1	1	1				
		negative tone	2						1	1				
		H2-1-5 The infographic is of high/low colorfulness for positive/negative tone	6		3	2		1				-4	-2	
		H2-1-6 The infographic uses semantically-resonate colors	2	1		1			1		2			-1
	H2-2 Narrative	**H2-2-1** The infographic emphasizes key data facts	2	11	1	1	2	1	7	4	3		1	1
		H2-2-2 The infographic addresses the audience directly	1	1								-1		-1
		H2-2-3 The infographic uses powerful wording	2			1				1	1			1
	H2-3 Uniqueness	**H2-3-1** The infographic uses novel data visualization	7			1	4					-2		
		H2-3-2 The infographic has a salient style or personality	1		1	1								

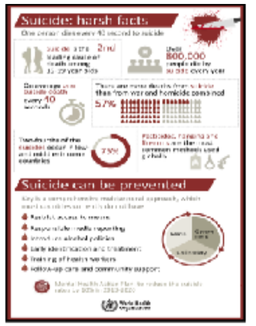
Looking at Infographic Design From the Affective Lens

Evaluation

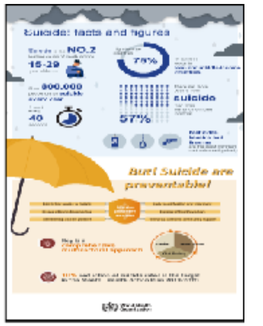
Last, we conducted an online workshop with 15 designers where the participants used the design heuristics to redesign the infographics to augment intended affect(s).

The results indicated that our design heuristics can support assessing affective design in infographics and inspire the creation of infographics that elicit affective responses.

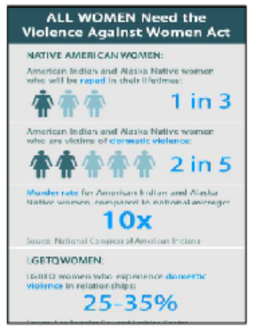
(O1)



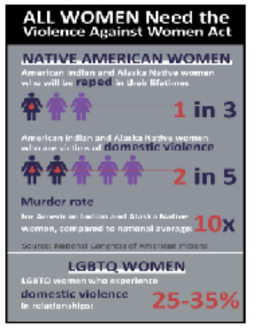
(R1) Shocked



(R2) Concerned+Hopeful

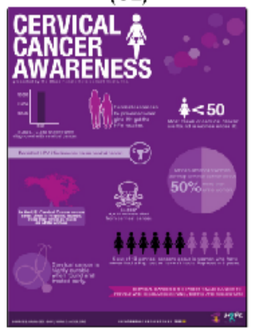


(O2)

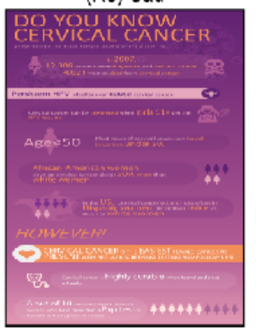


(R3) Sad

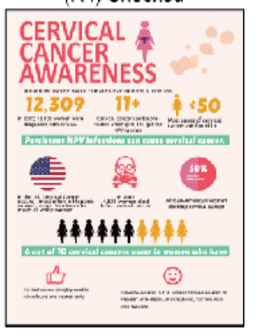
(R4) Shocked



(O3)



(R5) Hopeful



(R6) Happy

Looking at Infographic Design From the Affective Lens

Discussion & Future work

- We see measuring affective responses to visualization as a promising research direction;
- Measuring affective responses is still challenging; to capture affective responses more precisely, building more standardized measurements / instruments is desired.
- Visual communication is a vital skill in affective design; how to achieve a balance between usability and expressiveness is worthy of investigation.
- More controlled experiments should be done to quantify the relationships between certain design factors and affective responses.

Understanding Narrative Linearity for Telling Expressive Time-Oriented Stories

Lan, X., Xu, X., & Cao, N. (2021). Understanding Narrative Linearity for Telling Expressive Time-Oriented Stories. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-13).

Exploring Narrative Linearity in Time-Oriented Stories

Background & Motivation

- What is Narrative Linearity?

“时间总是按照线性流逝的，但故事不一定”

Exploring Narrative Linearity in Time-Oriented Stories

Background & Motivation

- What is Narrative Linearity?

According to narratologist Gérard Genette, every story has two orders: the natural order of the story (which is always chronological) and the order in which it is narrated.

The narrative can either follow the linear order of story events **(chronology)**,
or deviate from linearity **(anachronies)**.

Exploring Narrative Linearity in Time-Oriented Stories

Background & Motivation

- Incorporating Narrative Linearity into Data Stories

Creating expressive data stories often requires choosing a well-planned narrative order.

Does the manipulation of narrative linearity also exists in data stories?

Evidence exists that anachronies in novels and films can enhance story expressiveness.

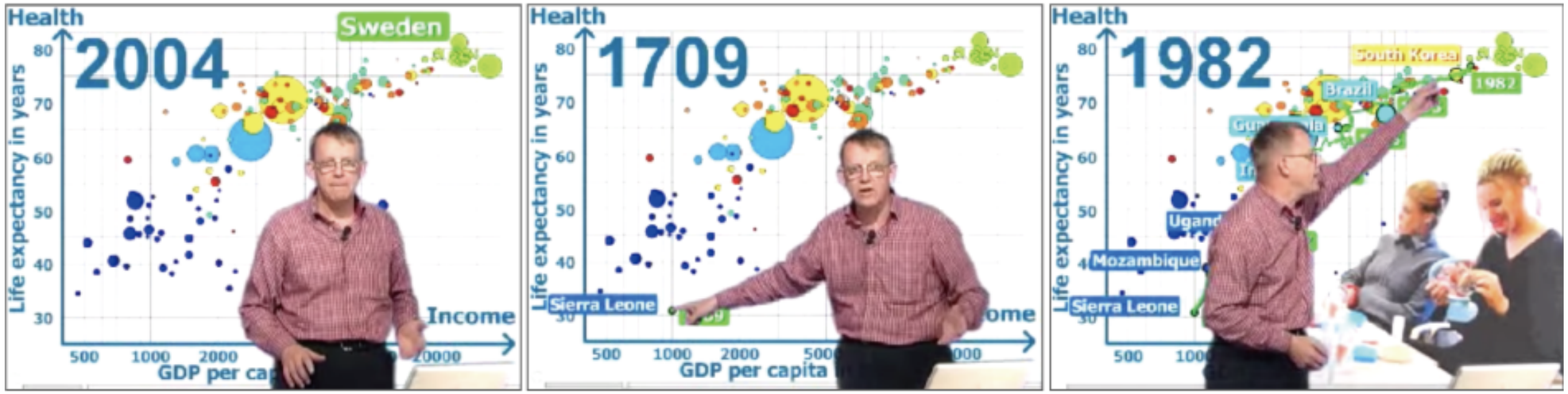
But how can anachronies be incorporated into data stories?

Exploring Narrative Linearity in Time-Oriented Stories

Background & Motivation

- Incorporating Narrative Linearity into Data Stories

Thus, we examine one specific type of narrative visualization, that is **time-oriented stories.**



Exploring Narrative Linearity in Time-Oriented Stories

Background & Motivation

- Incorporating Narrative Linearity into Data Stories

More specifically, we are interested in:

(1) What are the regular patterns of manipulating narrative linearity in time-oriented stories;

(2) Whether different narrative order patterns help improve story expressiveness.

Exploring Narrative Linearity in Time-Oriented Stories

Step I: Preliminary Interviews

First, we conducted preliminary interviews with seven experts to understand the motivations and challenges of manipulating narrative linearity in time-oriented stories.

Motivations	**Mentioned By**
1. Cater to Communicative Intents	E1, E2, E3, E5, E6, E7
2. Manage the Flow of Attention and Emotion	E1, E4, E5, E6, E7
3. Hook the Audience Quickly	E1, E3, E5, E6, E7
4. Consolidate the Memory	E1, E3, E4
5. Create Novelty	E2, E5, E6
6. Adapt to Conventional Thinking	E2, E6
Challenges	**Mentioned By**
1. Balance Expressiveness and Comprehensibility	E1, E2, E4, E6, E7
2. Save Time for Authoring	E1, E5

Exploring Narrative Linearity in Time-Oriented Stories

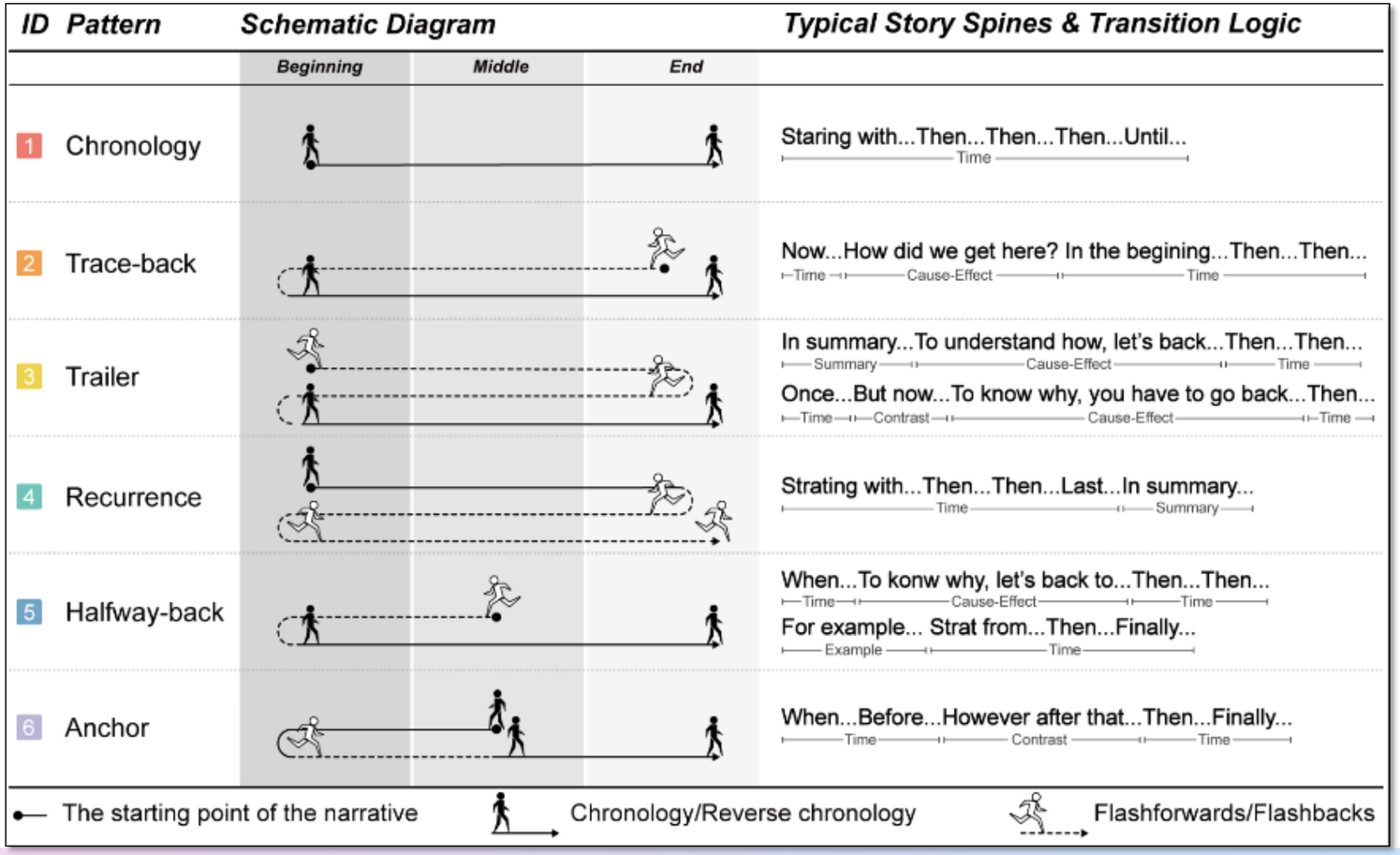
Step II: Corpus Collection & Analysis

Then, we collected a corpus of 80 time-oriented stories.

ID	TITLE	TYPE	YEAR	AUTHOR/CHANNEL	LINK
1	2014 Was the Hottest Year on Record	web	2015	Bloomberg	https://www.bloomberg.com/graphics/2014-hottest-year-on-record/
2	Timeline Of Earth	web	2018	Andy Bergmann	http://timelineofearth.com/
3	The history of Hong Kong, visualized	web	2019	National Geographic	https://www.nationalgeographic.com/culture/topics/reference/hong-kong-history-visualized/
4	How the Virus Got Out	web	2020	The New York Times	https://www.nytimes.com/interactive/2020/03/22/world/coronavirus-spread.html
5	BLACK & BLUE	web	2020	Vince Dixon	https://vincedixonportfolio.com/app/police-brutality/
6	History of the Internet	video	2009	Melih Bilgil	https://vimeo.com/2696386
7	Global fertility rates | The Economist	video	2009	The Economist	https://www.youtube.com/watch?v=rilAlXjunIE
8	Steve Fossett Crash: 3D terrain visualization and crash site overview	video	2010	exosphere3d	https://www.youtube.com/watch?v=29H15fOgEHk
9	Visualizing Empires Decline	video	2010	Pedro M. Cruz	https://vimeo.com/11506746
10	The Oil Spill By The Numbers | TIME	video	2010	TIME	https://www.youtube.com/watch?v= tq91E9WRRY
11	9/11 Timeline: The Attacks on the World Trade Center in New York City | His	video	2011	HISTORY	https://www.youtube.com/watch?v=GmedslmeiUc
12	7 Billion: How Did We Get So Big So Fast? | SKUNK BEAR	video	2011	NPR	https://www.youtube.com/watch?v=VcSX4ytEfcE&t=40s
13	Democrats in the South | The Economist	video	2011	The Economist	https://www.youtube.com/watch?v=TbYAINpRcug
14	Has the world's population passed 7 billion?	video	2013	The Economist	https://www.youtube.com/watch?v=0CNC_VJ11CM
15	200 Countries-200 Years-4minutes	video	2014	BBC	http://www.gapminder.org/videos/200-years-that-changed-the-world-bbc/#.VB3ChfldXts
16	Time History of Atmospheric Carbon Dioxide	video	2014	CIRES/NOAA	http://climatestate.com/2014/07/12/time-history-of-atmospheric-carbon-dioxide/
17	NASA | A Year in the Life of Earth's CO2	video	2014	NASA Goddard	https://www.youtube.com/watch?v=x1SgmFa0r04
18	Humanity's cultural history captured in 5-minute film	video	2014	Nature	https://www.nature.com/news/humanity-s-cultural-history-captured-in-5-minute-film-1.15650
19	World Population by the Billion	video	2014	Population Reference Bureau	https://www.youtube.com/watch?v=BNSC10BksBs
20	Hoover and the Great Depression	video	2014	PragerU	https://www.youtube.com/watch?v=KfeHWnaK7rY&list=WL&index=2
21	2060 and the world population pyramid | The Economist	video	2014	The Economist	https://www.youtube.com/watch?v=QwfH1gYkXTw&t=87s
22	World's biggest economies throughout history | The Economist	video	2014	The Economist	https://www.youtube.com/watch?v=Q_vJfTy1wpw
23	Videographic: How America beefed up financial regulation	video	2014	The Economist	https://www.youtube.com/watch?v= FEZrKO6HEc
24	Live chart: World GDP	video	2014	The Economist	https://www.youtube.com/watch?v=Oeq9PLYG_MY
25	Live chart: How many Americans own guns?	video	2014	The Economist	https://www.youtube.com/watch?v=nB-bGzVI3zc
26	The Evolution of US Girl Names: Bubbled	video	2015	Abacaba	https://www.youtube.com/watch?v=qVh2Qw5KSFg
27	Animated map shows how religion spread around the world	video	2015	Business Insider	https://www.youtube.com/watch?v=AvFI6UBZLv4
28	Trinity	video	2015	Orbital Mechanics	https://vimeo.com/135580602
29	Map Shows How Humans Migrated Across The Globe	video	2015	Science Insider	https://www.youtube.com/watch?v=CJdT6QcSbQ0&t=8s
30	Timeline of Modern Art	video	2015	Tate	http://www.openculture.com/2015/10/the-history-of-modern-art-visualized-in-a-massive-130-foot-timeline.html
31	The rise of ISIS, explained in 6 minutes	video	2015	Vox	https://www.youtube.com/watch?v=pzmO6RWy1v8
32	Human Population Through Time	video	2016	American Museum of Natural History	https://www.youtube.com/watch?v=PUwmA3Q0_OE
33	Animated Map Shows History Of Immigration To The US	video	2016	Business Insider	https://www.youtube.com/watch?v=Fe79i1mu-mc
34	The True Timeline Behind The People vs. O.J. Simpson	video	2016	Instant Checkmate	https://www.youtube.com/watch?v=uCzUeRf6gUo
35	What Happened Before History? Human Origins	video	2016	Kurzgesagt – In a Nutshell	https://www.youtube.com/watch?v=dGiQaubX3_o
36	A New History for Humanity – The Human Era - YouTube	video	2016	Kurzgesagt – In a Nutshell	https://www.youtube.com/watch?v=ezgOWmtGVGs
37	Visualizing the History of World Urbanization, 3700 BC to 2000 AD	video	2016	Metrocosm	https://www.youtube.com/watch?v=cW_cCaybH1.8
38	The Real Story Behind Donald Trump's Wealth	video	2016	Visual Capitalist	https://www.youtube.com/watch?v=Ej1hlQgwXcA&list=UUc3e9XOO_neg3mnb9yDTklg&index=14
39	The racist history of US immigration policy	video	2016	Vox	https://www.youtube.com/watch?v=6yiQAmgI5s4
40	How America became a superpower	video	2016	Vox	https://www.youtube.com/watch?v=BShvYeyMm_Y&t=37s
41	A brief history of America and Cuba	video	2016	Vox	https://www.youtube.com/watch?v=chYBlArm9Ao
42	From white supremacy to Barack Obama: The history of the Democratic Party	video	2016	Vox	https://www.youtube.com/watch?v=Z6R0NvVr164&t=236s

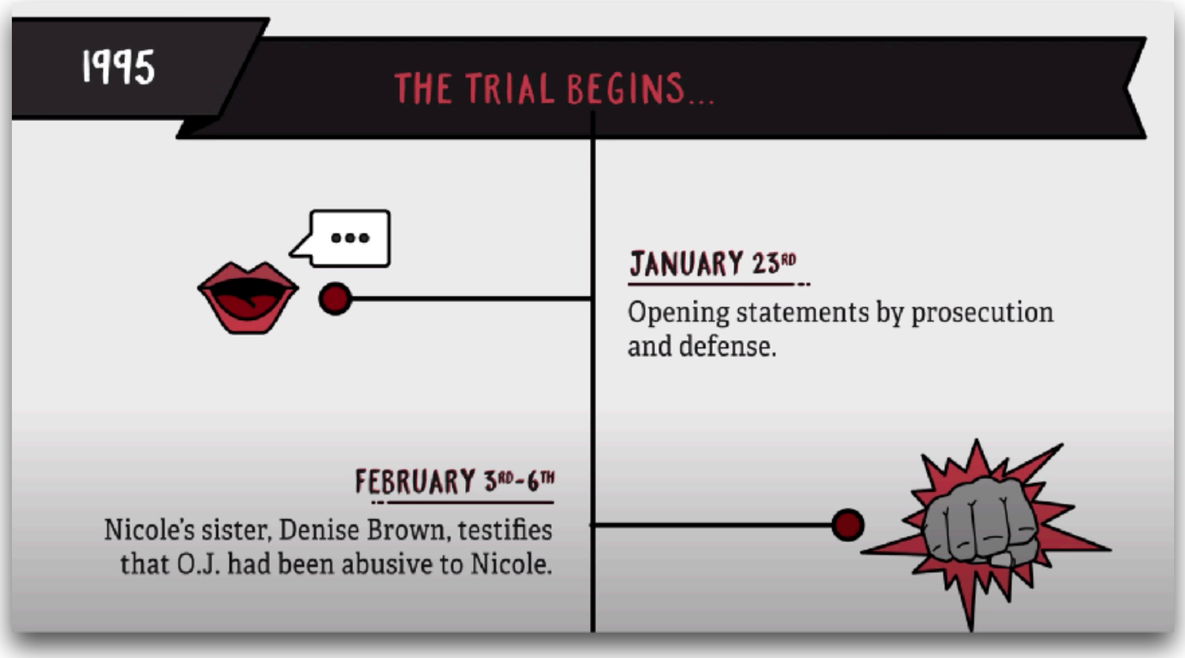
Exploring Narrative Linearity in Time-Oriented Stories

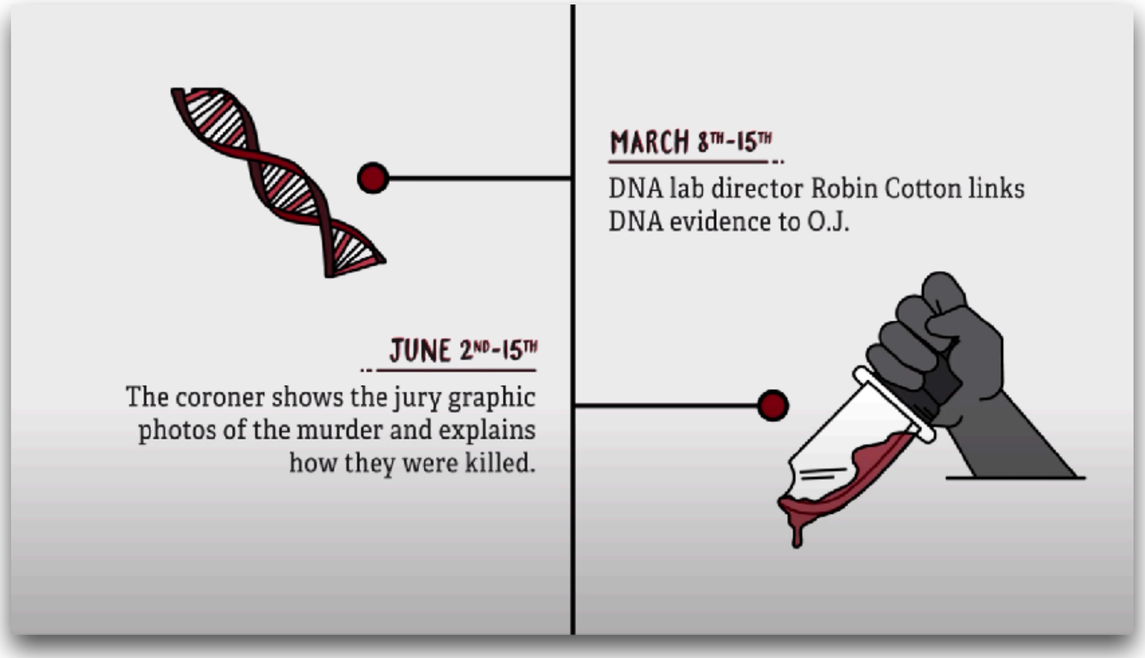
By coding the 80 stories, we identified six most salient patterns of narrative orders, including chronology and 5 anachronies.



Exploring Narrative Linearity in Time-Oriented Stories

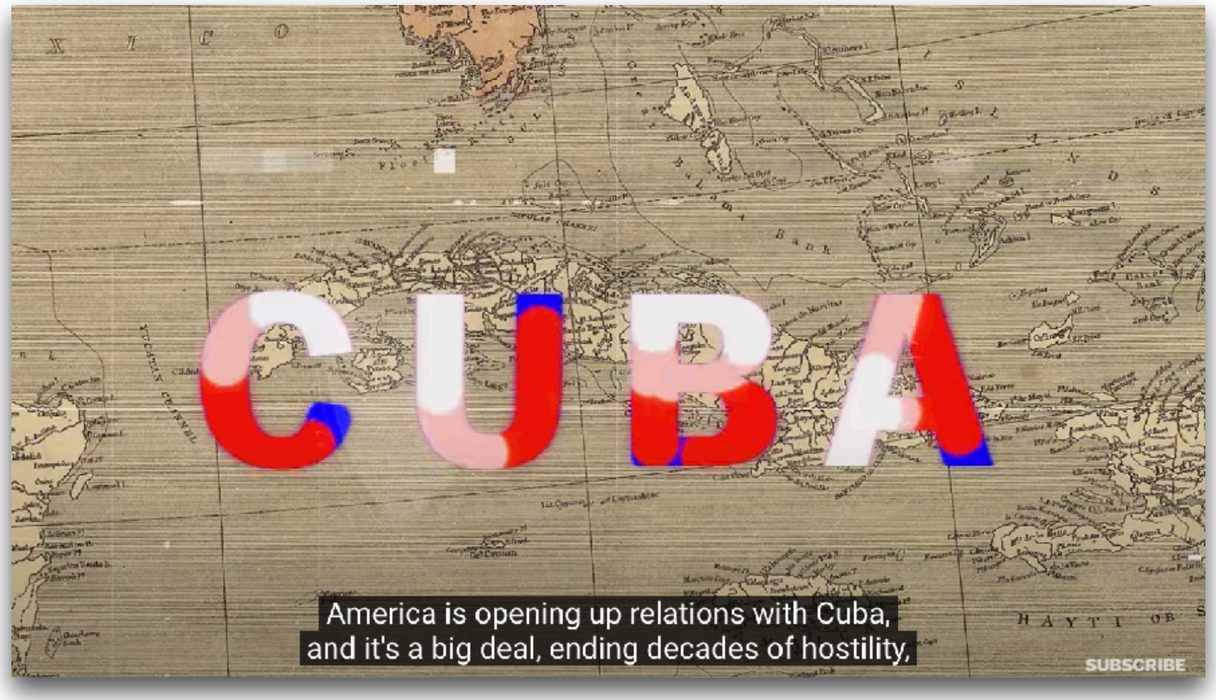
1 Chronology





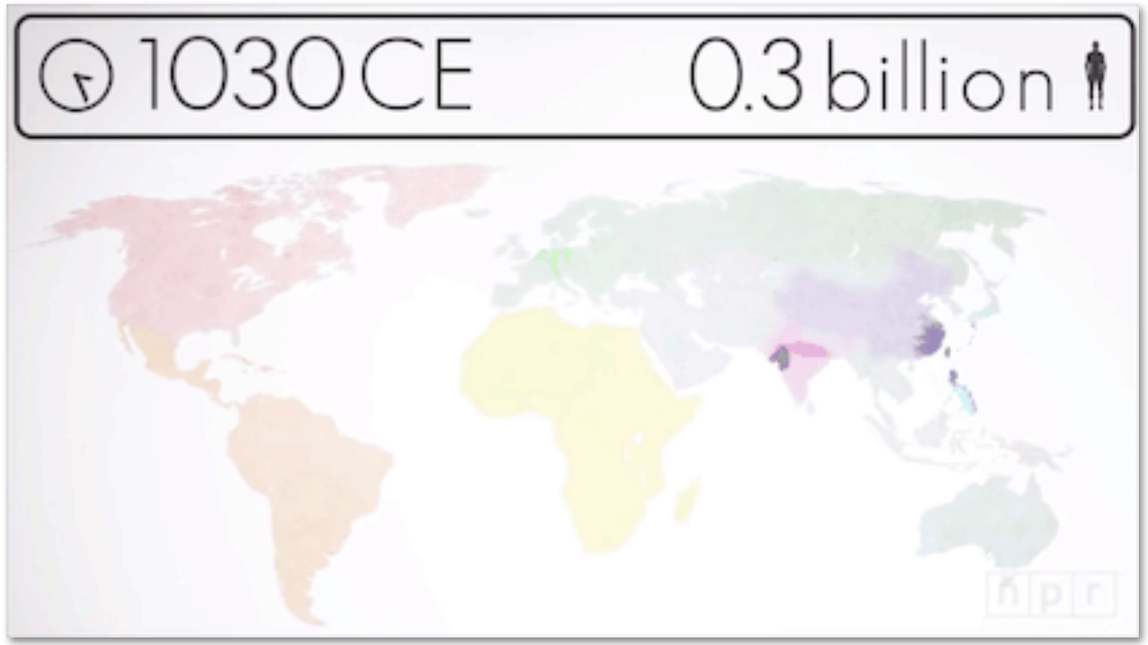
Exploring Narrative Linearity in Time-Oriented Stories

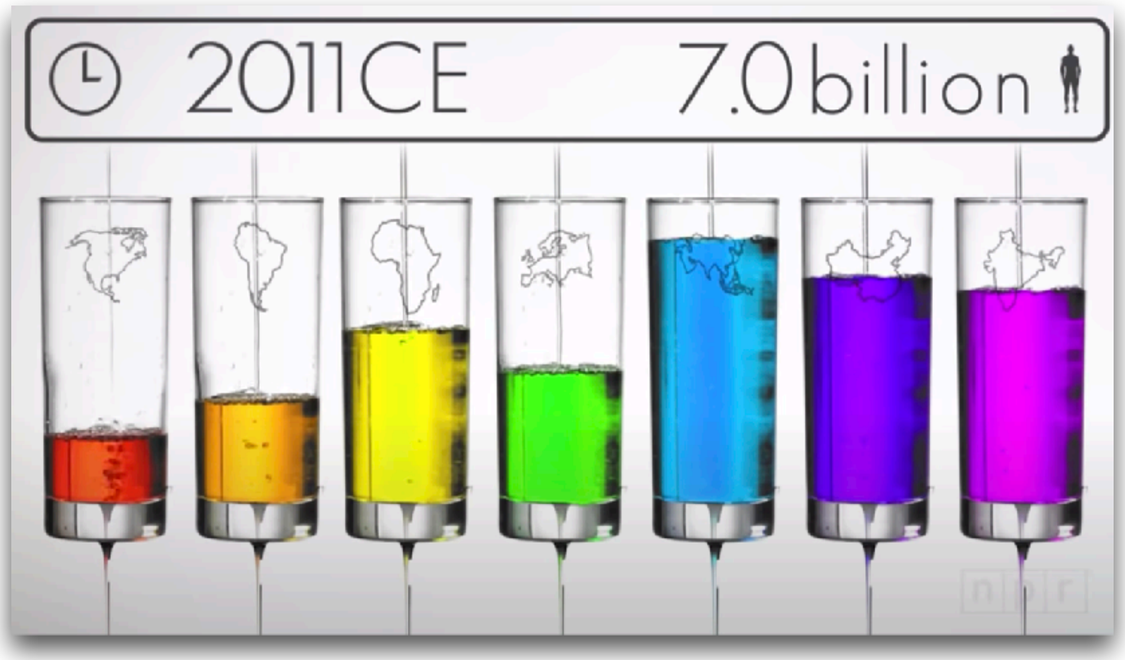
2 Trace-back



Exploring Narrative Linearity in Time-Oriented Stories

3 Trailer



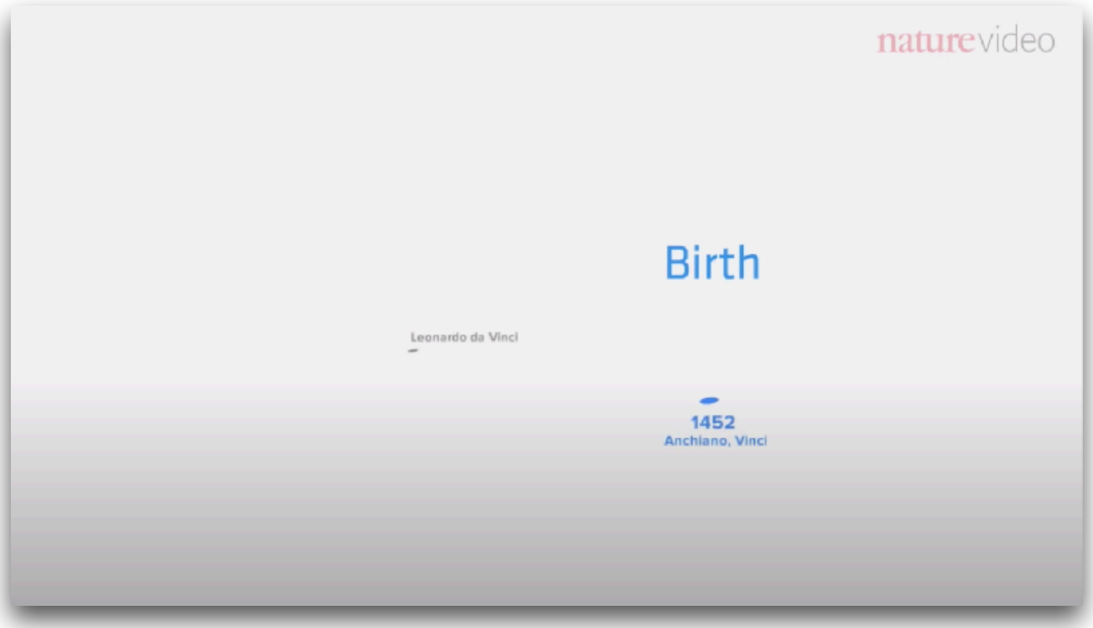


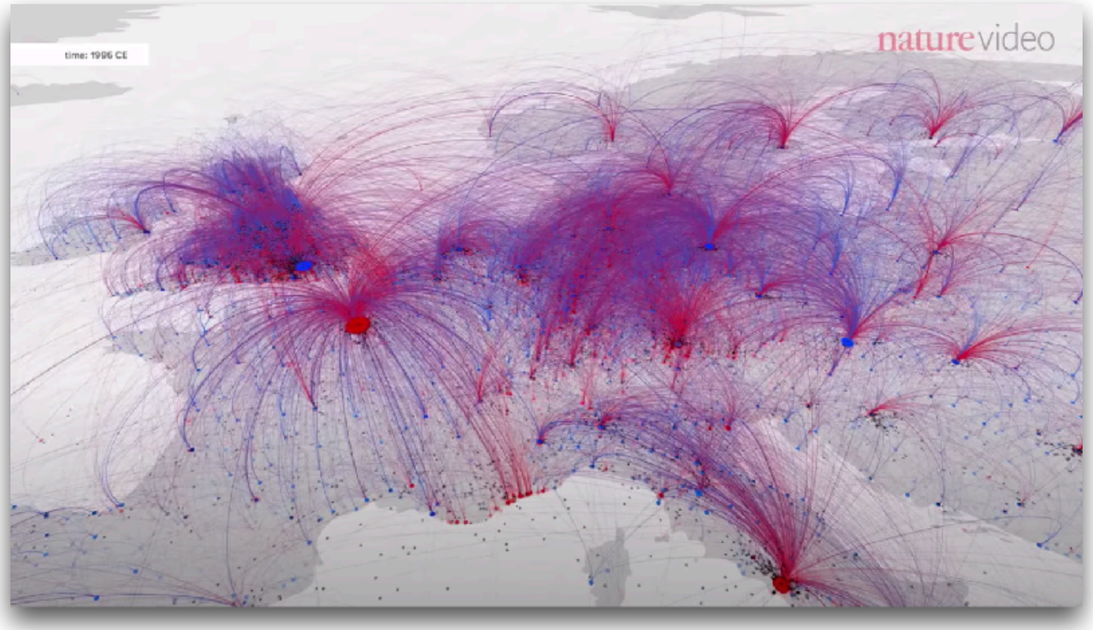
Exploring Narrative Linearity in Time-Oriented Stories

4 Recurrence

Exploring Narrative Linearity in Time-Oriented Stories

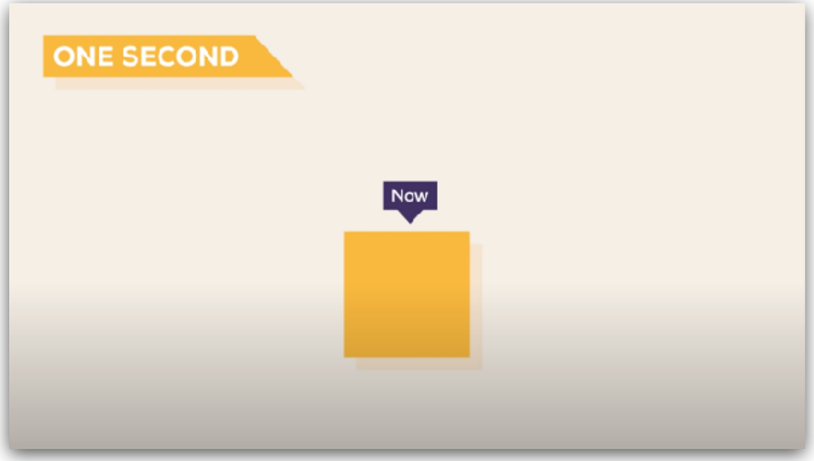
5 Halfway-back

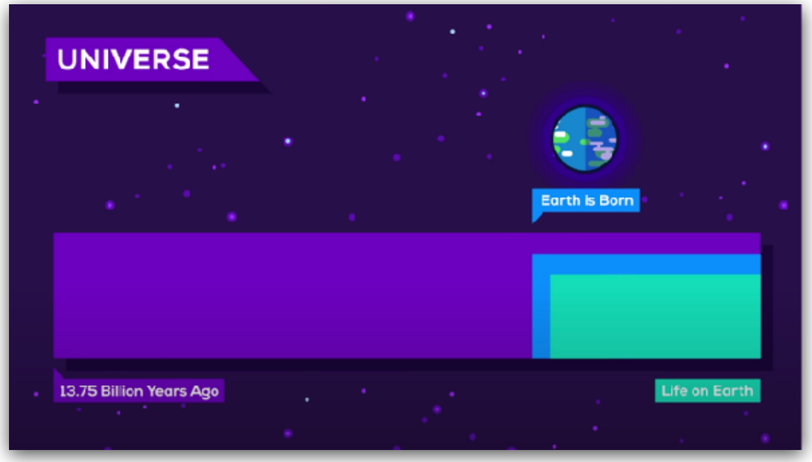


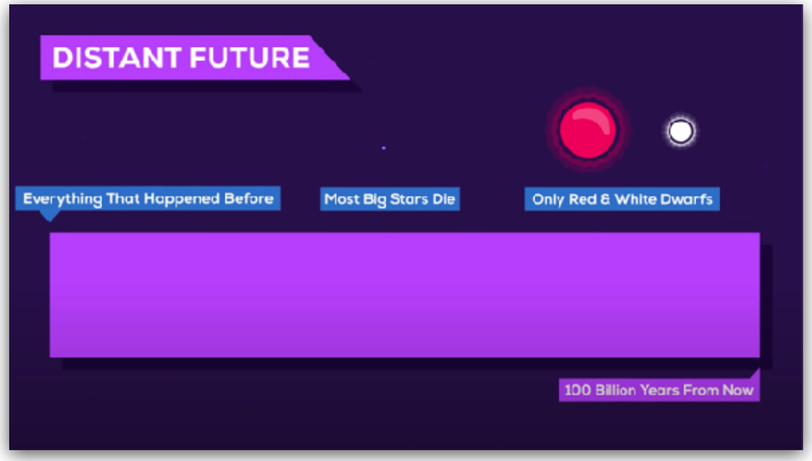


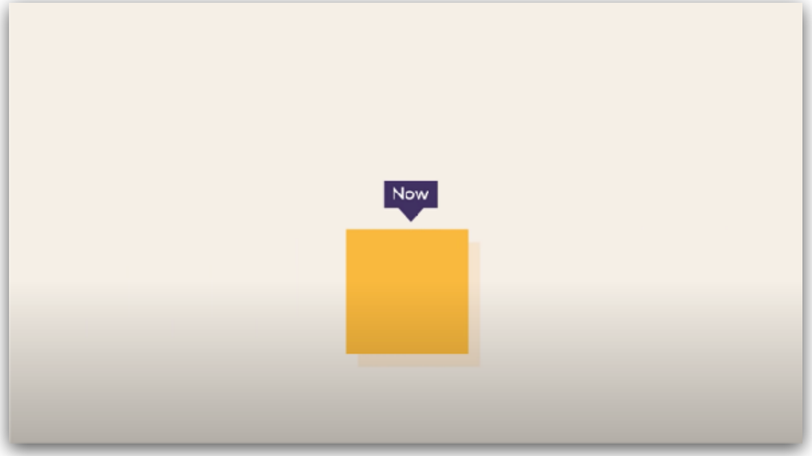
Exploring Narrative Linearity in Time-Oriented Stories

6 Anchor









Exploring Narrative Linearity in Time-Oriented Stories

Step III: Evaluation

Next, we conducted a crowdsourcing study with 221 participants to evaluate and compare the six patterns.

Hypotheses:

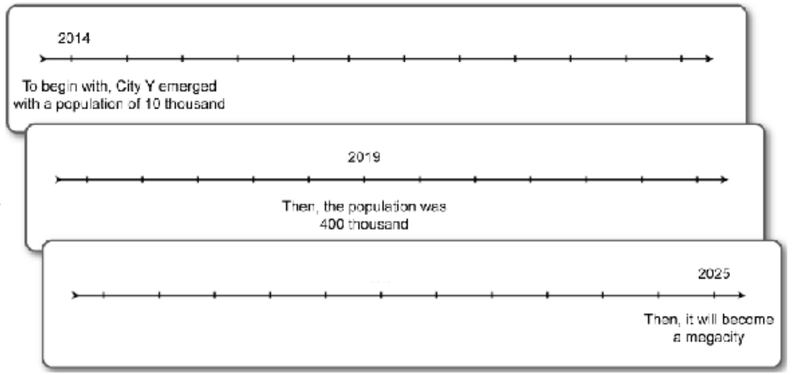
H1: We will observe substantial differences in the learning outcome between the six narrative order patterns.

H2: We will observe substantial differences in user engagement between the six narrative order patterns.

H3: We will observe substantial differences in the tension between expressiveness and comprehensibility between the six narrative order patterns.

Stimuli:

3 time-oriented stories visualized with timelines ✕ 6 narrative order patterns



Exploring Narrative Linearity in Time-Oriented Stories

H1: We will observe substantial differences in the learning outcome between the six narrative order patterns.

Measurement:

Immediate recall

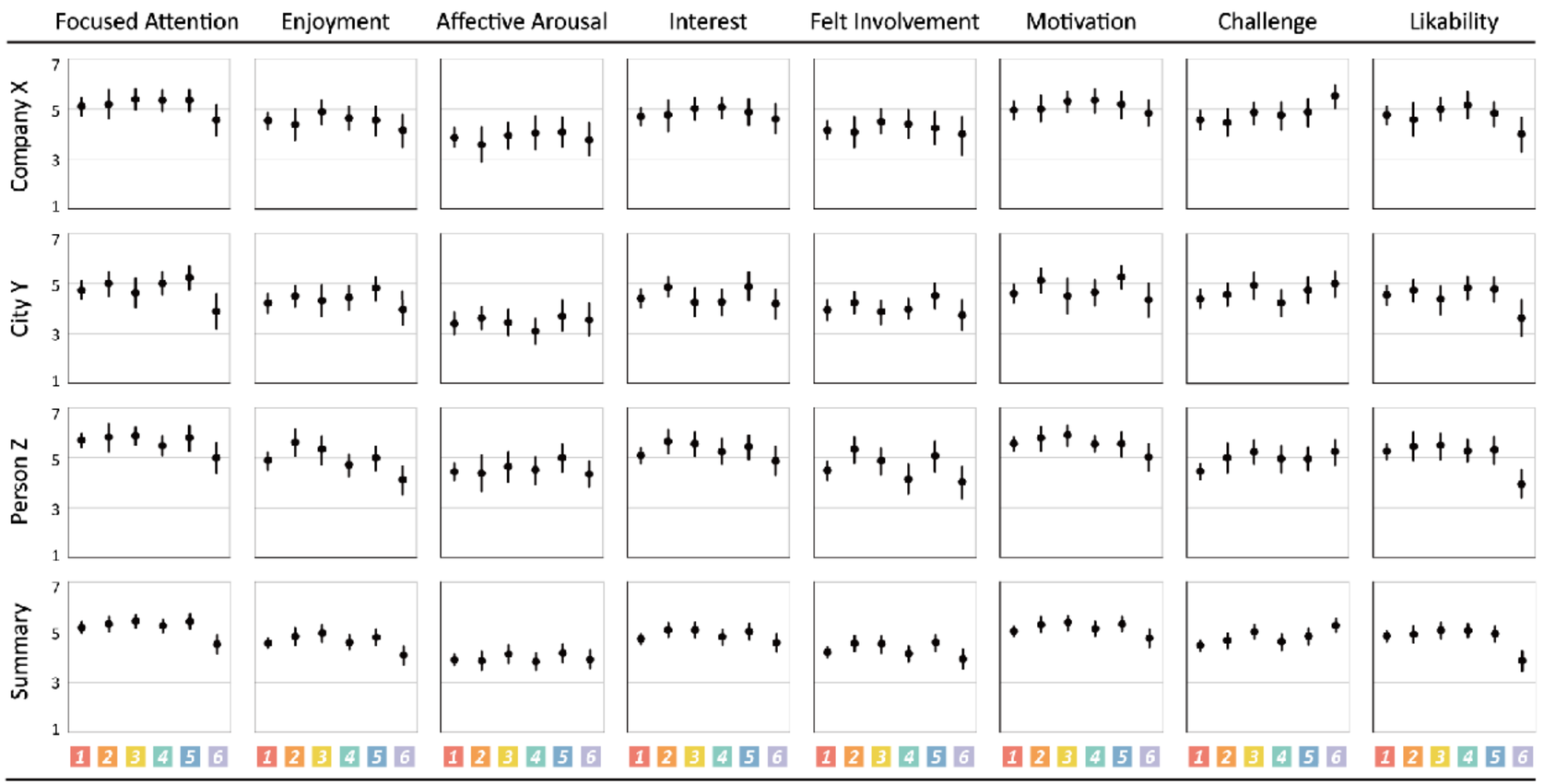
Result:

No significant difference in recall was found between chronology and anachronies or between the six patterns.

Exploring Narrative Linearity in Time-Oriented Stories

H2: We will observe substantial differences in user engagement between the six narrative order patterns.

Measurement: 7 metrics of user engagement (7-point Likert scale)



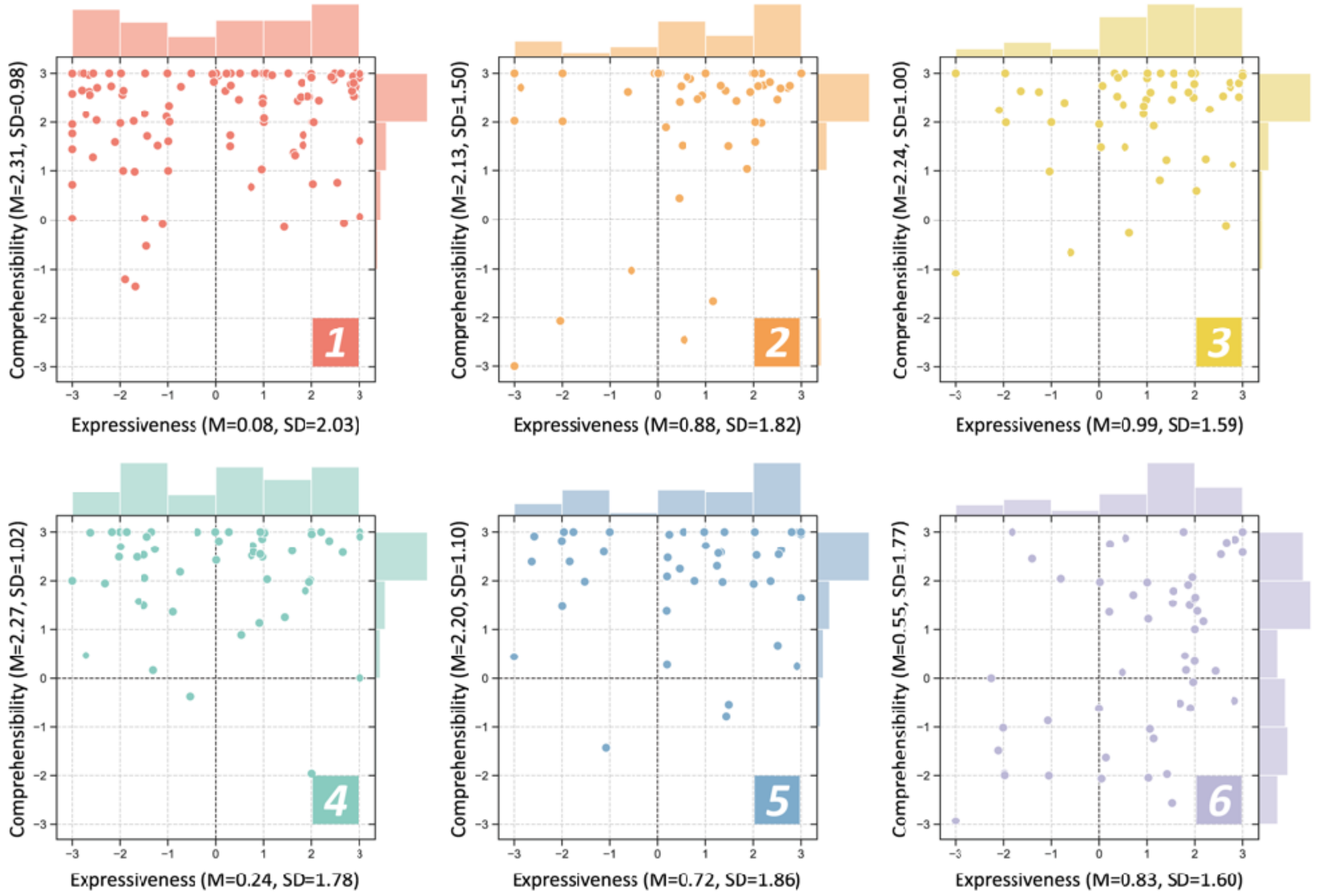
Exploring Narrative Linearity in Time-Oriented Stories

H3: We will observe substantial differences in the tension between expressiveness and comprehensibility between the six narrative order patterns.

Measurement:

Grid evaluation

Overall, the results indicated that anachronies have the potential to make time-oriented stories more expressive without hindering comprehensibility.



Exploring Narrative Linearity in Time-Oriented Stories

Takeaways & Future Work

- We found that manipulating narrative linearity is common in time-oriented data storytelling.
- To increase story expressiveness, people may intentionally add extra turns or jumps (i.e., bigger transition cost) to the narrative order to inject a climax or tension into a data story.
- Our evaluation suggested that anachronies (*trace-back, trailer,* and *halfway-back*, especially) have the potential to increase user engagement and lead to expressive storytelling.
- Our work have shed light on some archetypal structures of time-oriented stories. Such story templates have opened up the potential for generating expressive narrative visualization automatically or semi-automatically.

Thanks :)

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