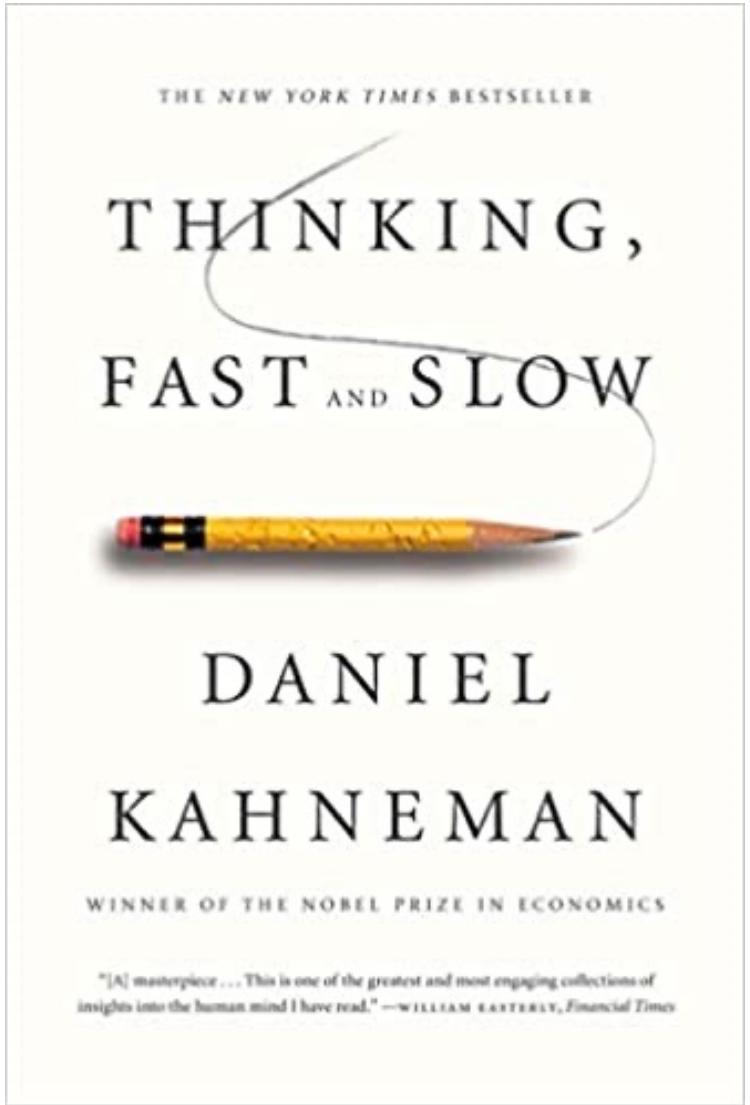
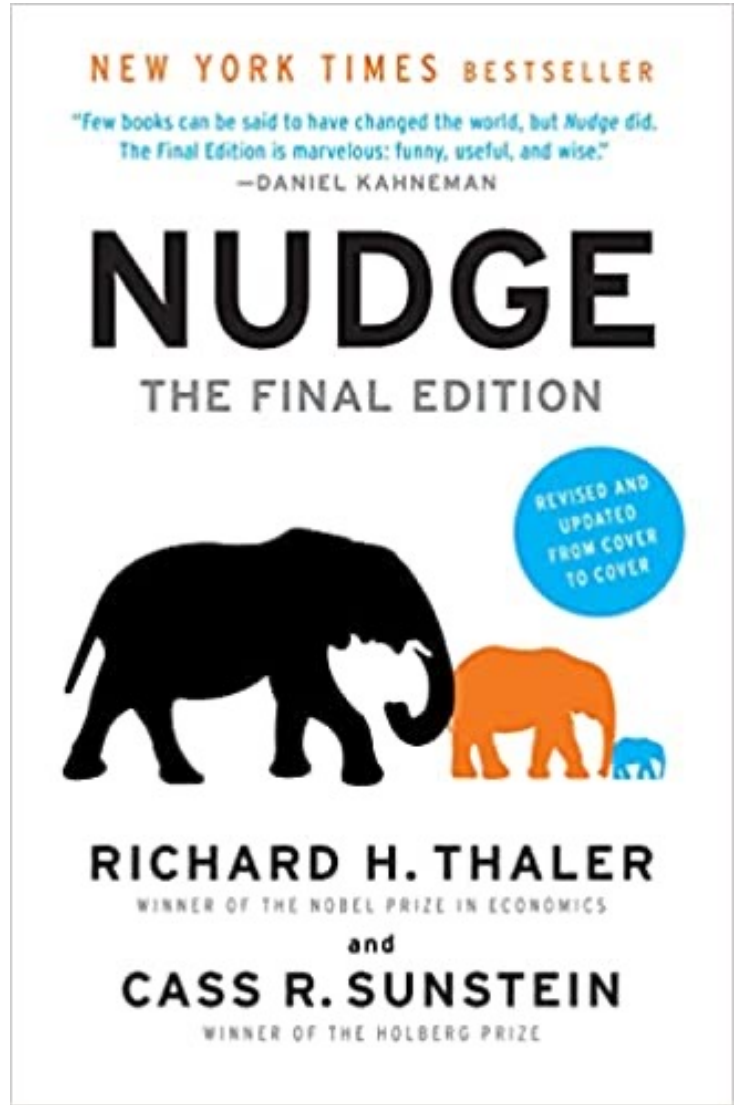
Technology: Tool or Trainer?

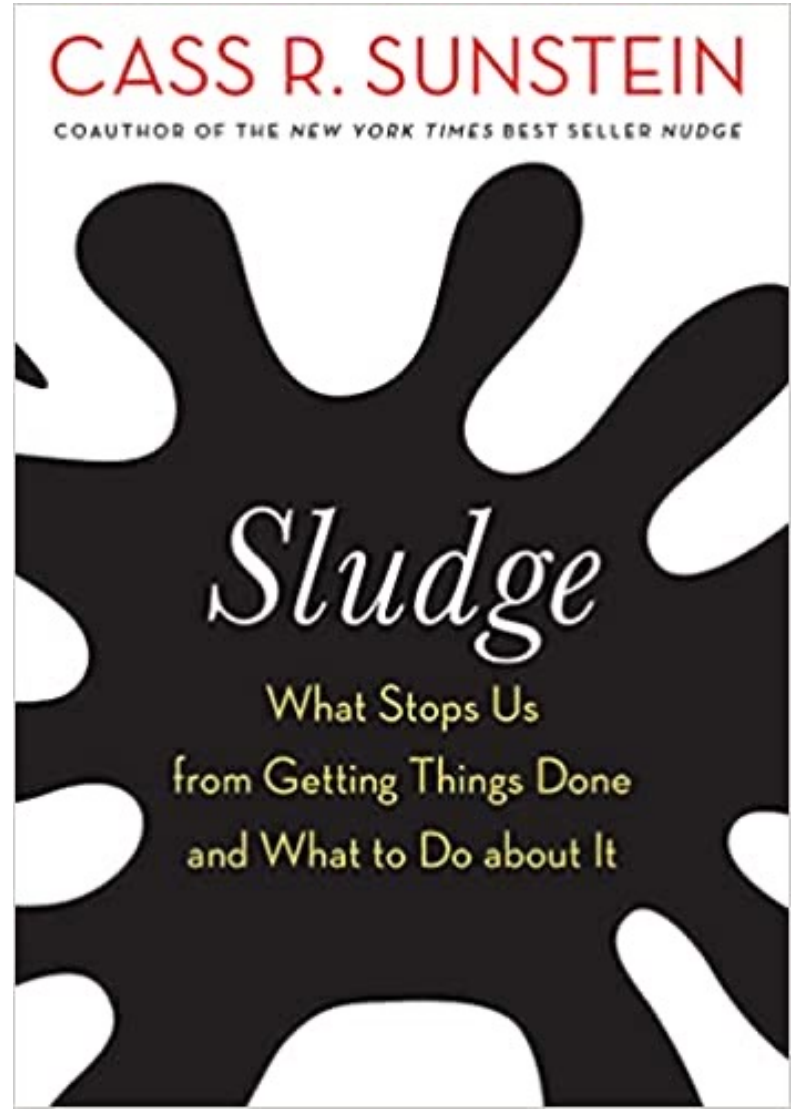
Addressing behavioral and decision-making 'plumbing' in healthcare

Ruth Schmidt, Institute of Design, IIT

May 18, 2022


THE NEW YORK TIMES BESTSELLER
THINKING, FAST AND SLOW
DANIEL KAHNEMAN
WINNER OF THE NOBEL PRIZE IN ECONOMICS
"[A] masterpiece . . . This is one of the greatest and most engaging collections of insights into the human mind I have read." —WILLIAM EASTERLY, Financial Times


NEW YORK TIMES BESTSELLER
"Few books can be said to have changed the world, but Nudge did. The Final Edition is marvelous: funny, useful, and wise."
—DANIEL KAHNEMAN
NUDGE
THE FINAL EDITION
REVISED AND UPDATED FROM COVER TO COVER
RICHARD H. THALER
WINNER OF THE NOBEL PRIZE IN ECONOMICS
and
CASS R. SUNSTEIN
WINNER OF THE HOLBERG PRIZE


CASS R. SUNSTEIN
COAUTHOR OF THE NEW YORK TIMES BEST SELLER NUDGE
Sludge
What Stops Us from Getting Things Done and What to Do about It

Economists would have us believe:

We make decisions based on rational deliberation

We have all the necessary information to make an informed choice

Our decisions and actions reflect our best interests and intent

Whereas in reality...

We're not always "rational"

Cognitive biases get in the way

We often lack the information we need

Yet are also swamped with too much content

We often don't act in our own best interests

Our "best interest" changes based on the context

We dislike the feeling of loss more than we like to win

We remember recent, high, low, and end points more than whole experiences

Ownership makes us value things more

We are social animals, influenced by a sense of kinship or belonging and by social norms

We stick with existing mental models to make decisions, and ignore new information that doesn't fit

We get overwhelmed by options and can be paralyzed by too much choice

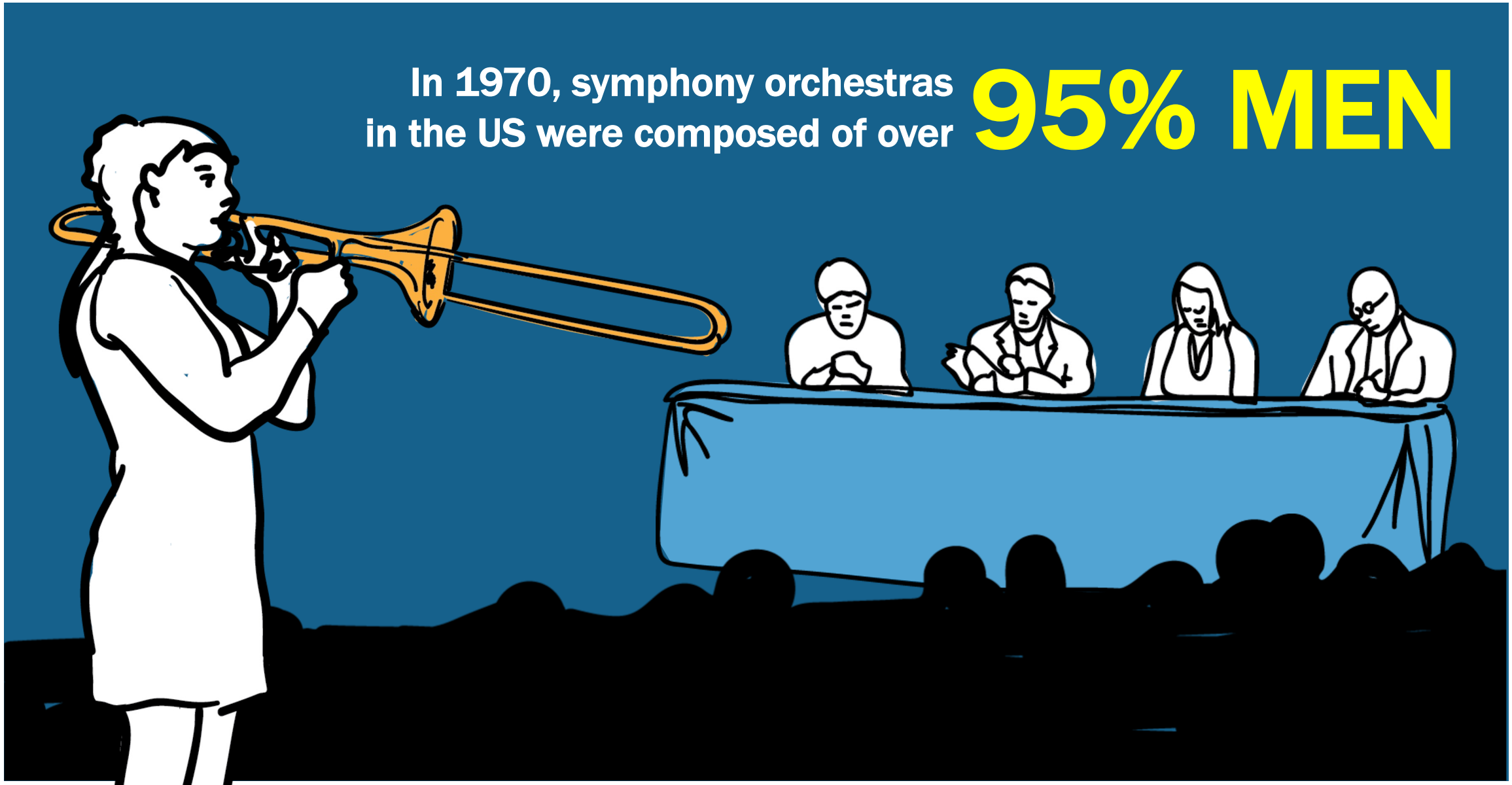
Small barriers can cause us to derail more than large or systemic ones

The order, source, and framing of options impacts what we choose

We judge options and outcomes relatively, not absolutely

Blunt instruments for behavior

Behavioral design introduced the idea of *choice architecture*: targeting "last mile" behavior change by shaping the immediate environment at the moment of decision-making


In 1970, symphony orchestras
in the US were composed of over
95% MEN

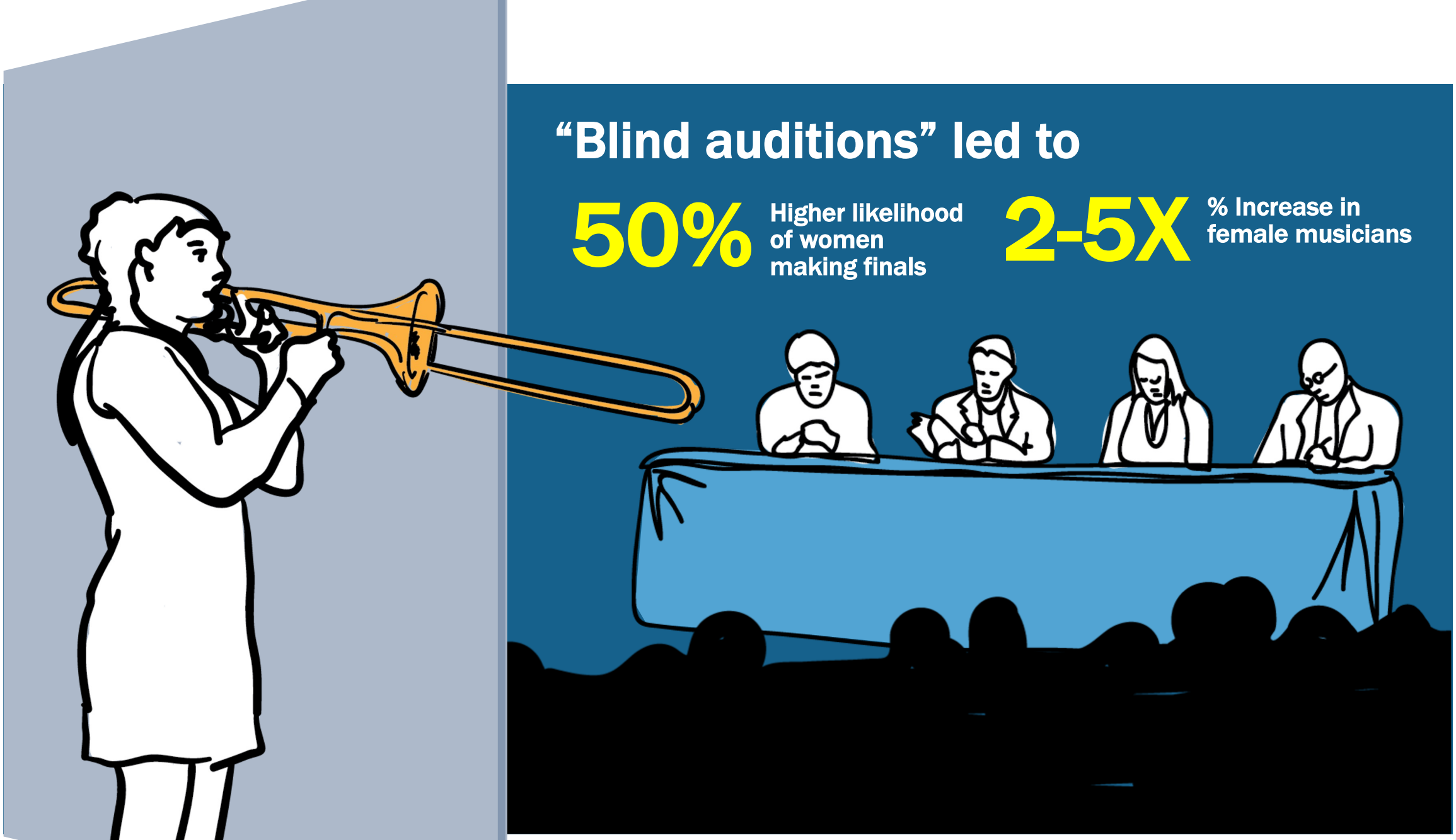
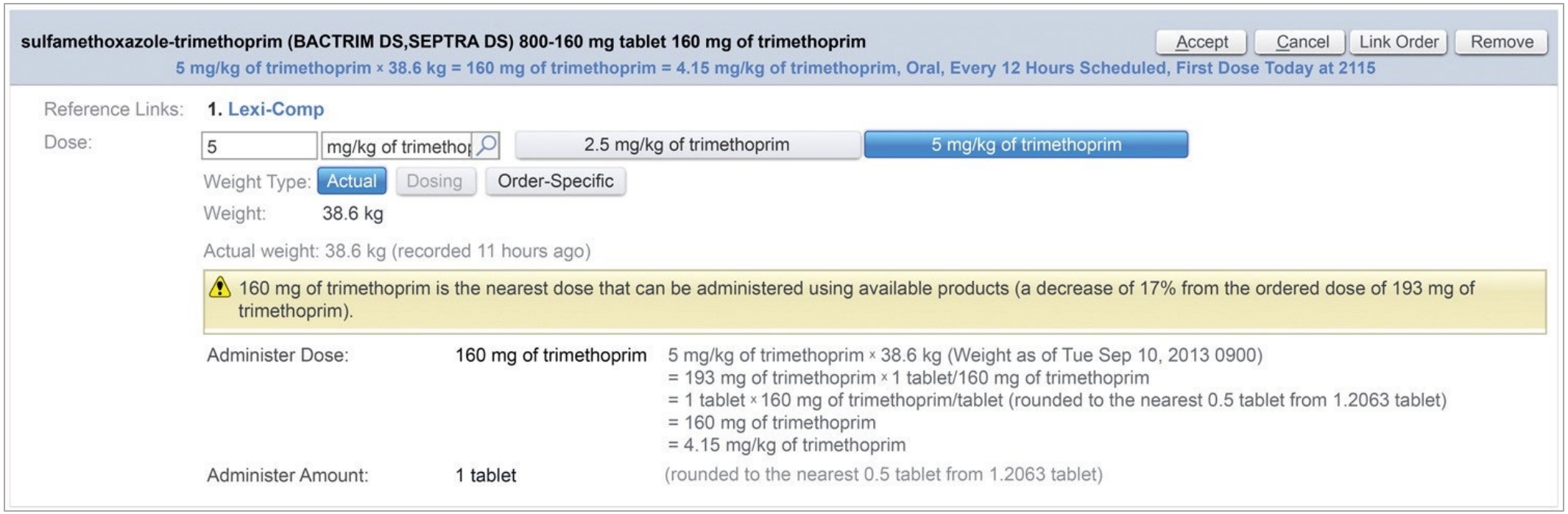

“Blind auditions” led to
50%
Higher likelihood of women making finals
2-5X
% Increase in female musicians

Illustration by Lisk Feng


sulfamethoxazole-trimethoprim (BACTRIM DS,SEPTRA DS) 800-160 mg tablet 160 mg of trimethoprim
Accept
Cancel
Link Order
Remove
5 mg/kg of trimethoprim × 38.6 kg = 160 mg of trimethoprim = 4.15 mg/kg of trimethoprim, Oral, Every 12 Hours Scheduled, First Dose Today at 2115
Reference Links: 1. Lexi-Comp
Dose: 5 mg/kg of trimetho
2.5 mg/kg of trimethoprim
5 mg/kg of trimethoprim
Weight Type: Actual Dosing Order-Specific
Weight: 38.6 kg
Actual weight: 38.6 kg (recorded 11 hours ago)
160 mg of trimethoprim is the nearest dose that can be administered using available products (a decrease of 17% from the ordered dose of 193 mg of trimethoprim).
Administer Dose: 160 mg of trimethoprim
5 mg/kg of trimethoprim × 38.6 kg (Weight as of Tue Sep 10, 2013 0900)
= 193 mg of trimethoprim × 1 tablet/160 mg of trimethoprim
= 1 tablet × 160 mg of trimethoprim/tablet (rounded to the nearest 0.5 tablet from 1.2063 tablet)
= 160 mg of trimethoprim
= 4.15 mg/kg of trimethoprim
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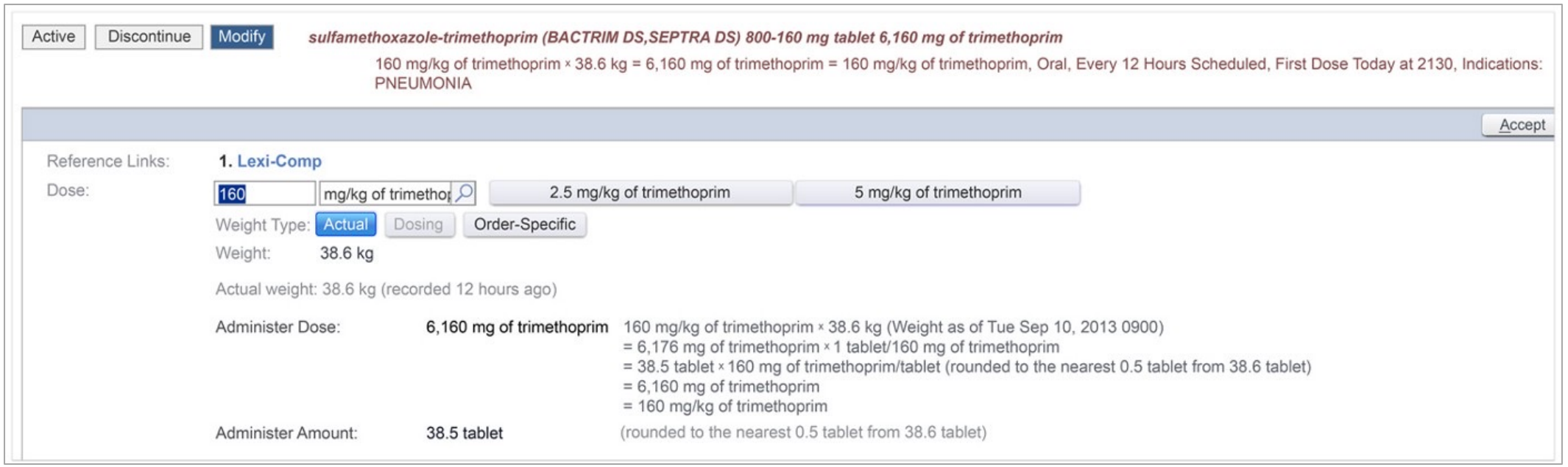
(rounded to the nearest 0.5 tablet from 1.2063 tablet)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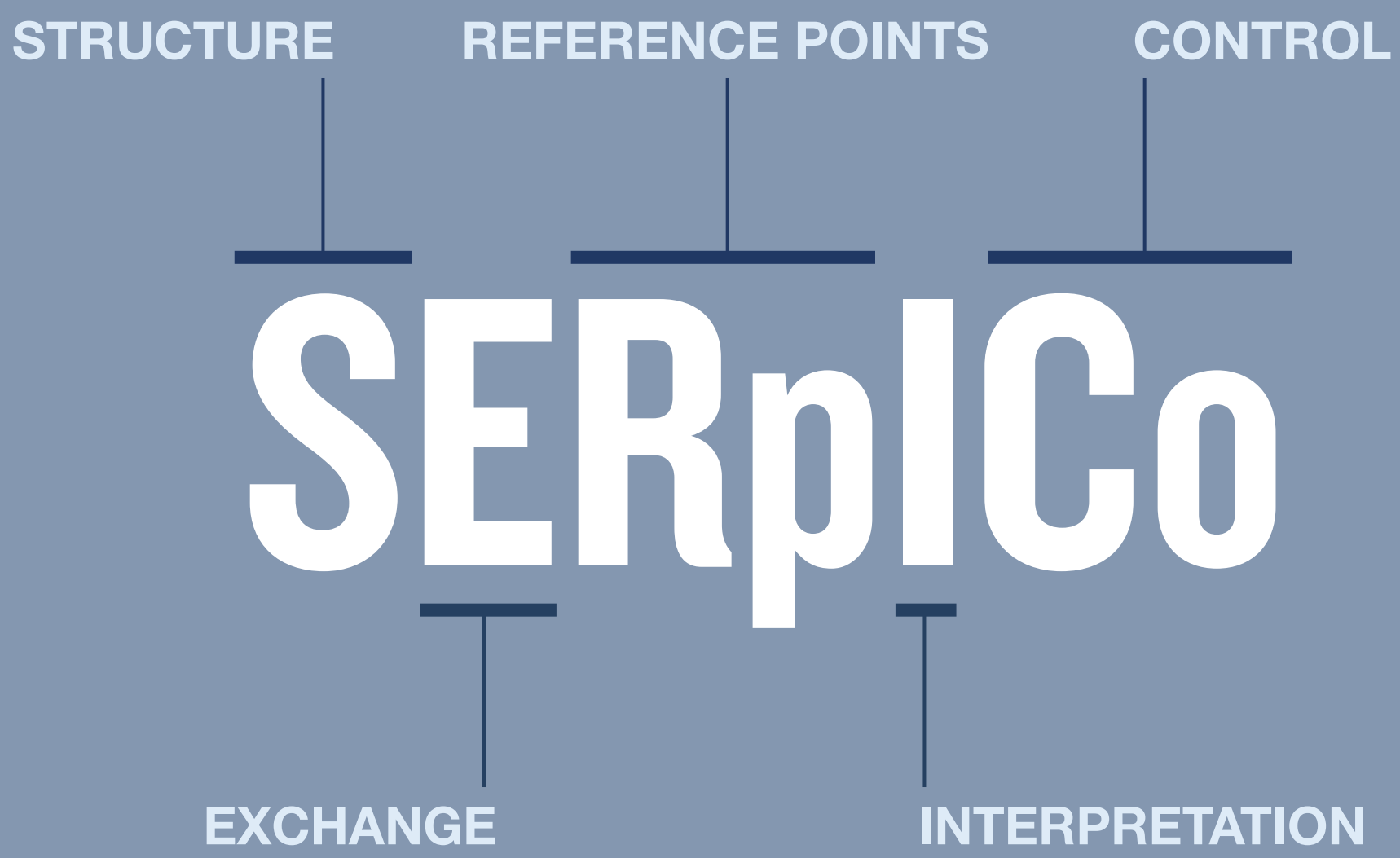
sulfamethoxazole-trimethoprim (BACTRIM DS,SEPTRA DS) 800-160 mg tablet 6,160 mg of trimethoprim
160 mg/kg of trimethoprim × 38.6 kg = 6,160 mg of trimethoprim = 160 mg/kg of trimethoprim, Oral, Every 12 Hours Scheduled, First Dose Today at 2130, Indications: PNEUMONIA
Accept
Reference Links: 1. Lexi-Comp
Dose: 160 mg/kg of trimetho
2.5 mg/kg of trimethoprim
5 mg/kg of trimethoprim
Weight Type: Actual Dosing Order-Specific
Weight: 38.6 kg
Actual weight: 38.6 kg (recorded 12 hours ago)
Administer Dose: 6,160 mg of trimethoprim
160 mg/kg of trimethoprim × 38.6 kg (Weight as of Tue Sep 10, 2013 0900)
= 6,176 mg of trimethoprim × 1 tablet/160 mg of trimethoprim
= 38.5 tablet × 160 mg of trimethoprim/tablet (rounded to the nearest 0.5 tablet from 38.6 tablet)
= 6,160 mg of trimethoprim
= 160 mg/kg of trimethoprim
Administer Amount: 38.5 tablet
(rounded to the nearest 0.5 tablet from 38.6 tablet)

What went wrong from a behavioral standpoint?

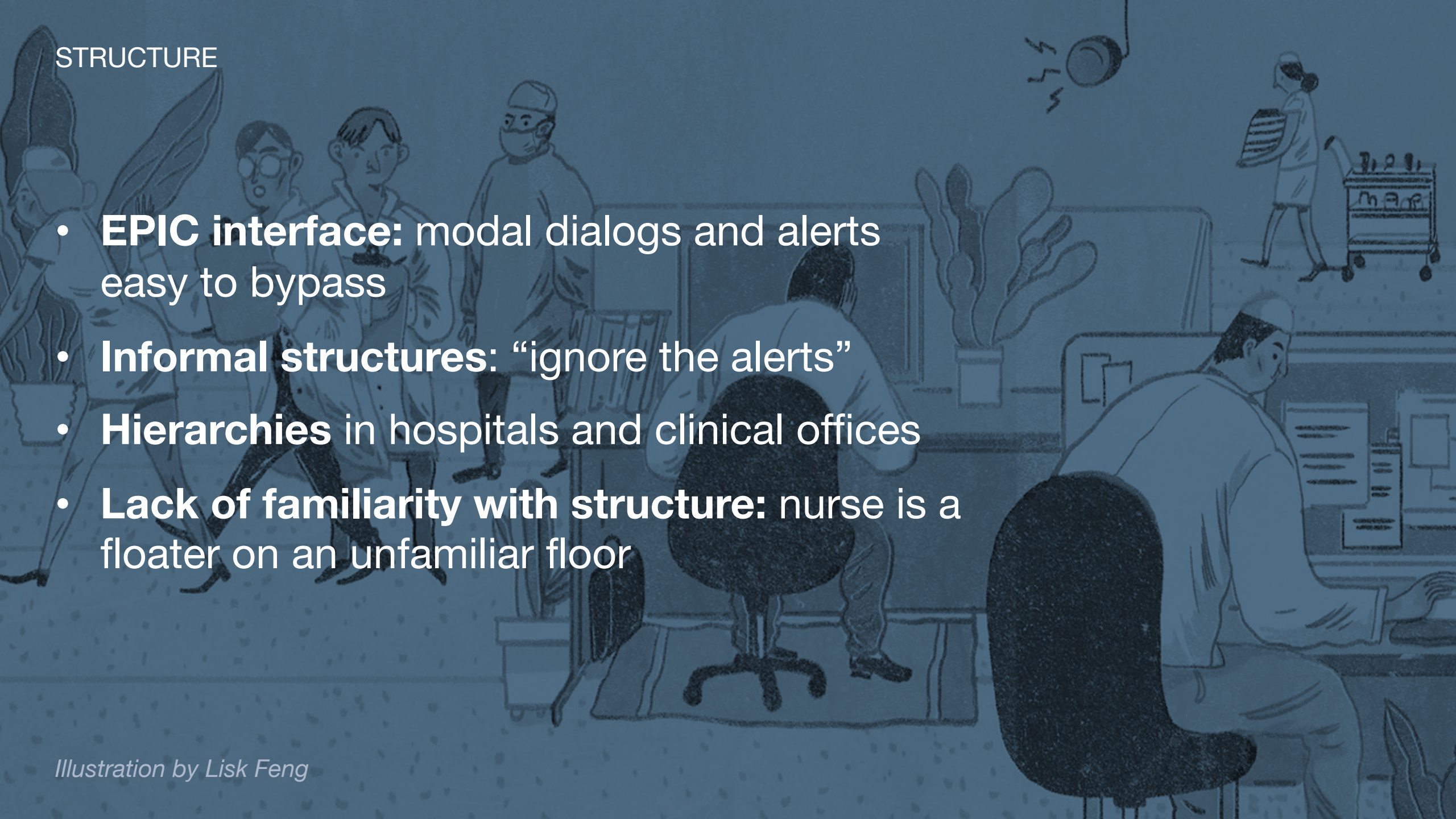
Illustration by Lisk Feng


STRUCTURE
REFERENCE POINTS
CONTROL
SERpICo
EXCHANGE
INTERPRETATION

Principles of structure

- We think in terms of **parts, not wholes**
- We crave **categorization** and will create it if it's not provided
- **Mental models** help us function, but can also constrain what we consider possible
- The **units** that are used frame what and how we value things (mental accounting)

STRUCTURE



- **EPIC interface:** modal dialogs and alerts easy to bypass
- **Informal structures**: “ignore the alerts”
- **Hierarchies** in hospitals and clinical offices
- **Lack of familiarity with structure:** nurse is a floater on an unfamiliar floor

Illustration by Lisk Feng

Principles of exchange

- We frequently make **tradeoffs** based on limited knowledge
- **Value is relative** and often intangible, situational, and personal
- **Losing** hurts more than gain feels good (prospect theory)
- **Present-tense value** > future value (e.g. spending now v. saving for later)

EXCHANGE

- **Tradeoffs:** Speed in the service of efficiency v. deep attention
- **Risk aversion:** Following gut instincts would rankle colleagues
- **Give up control** for robotic precision

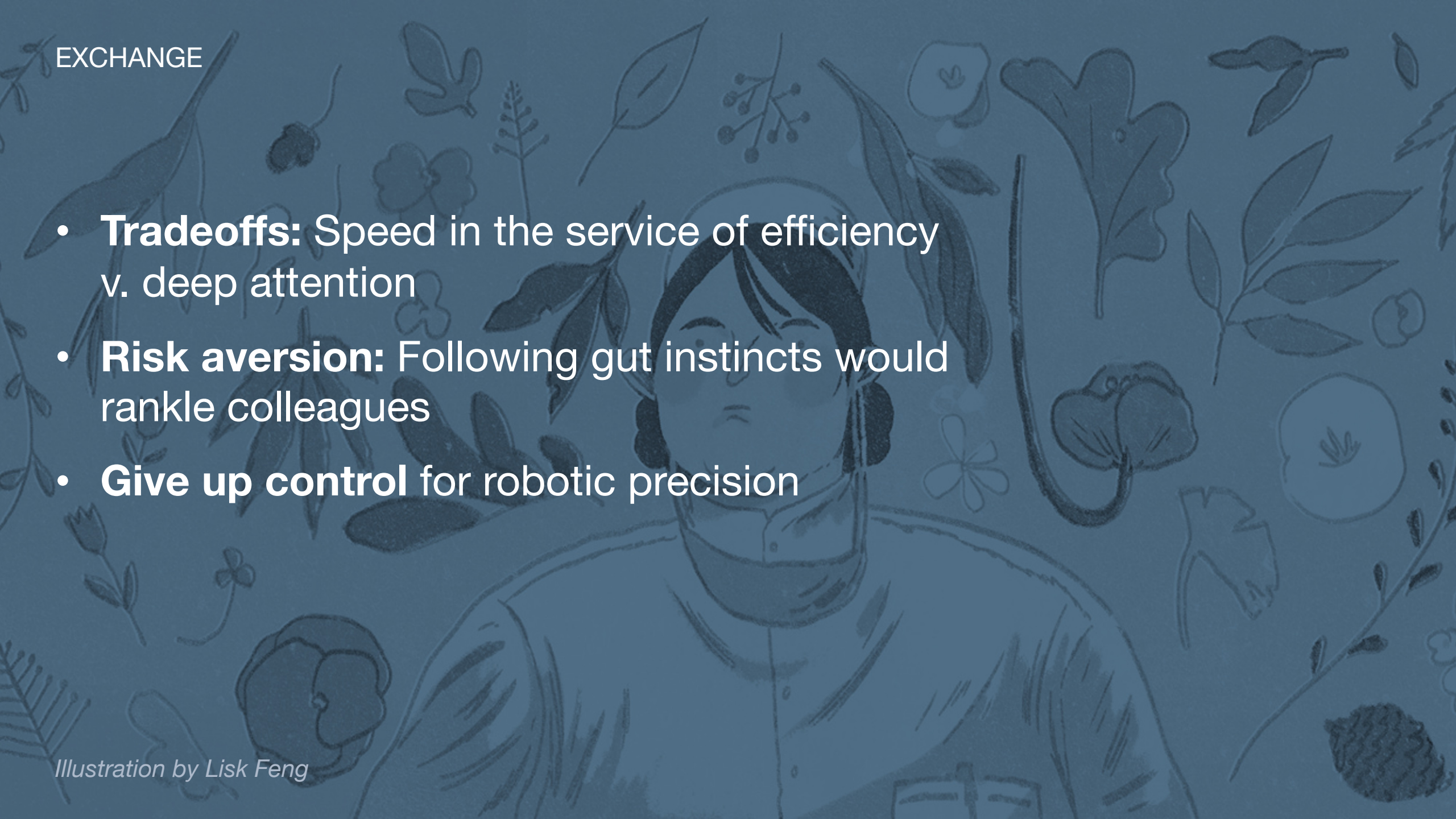
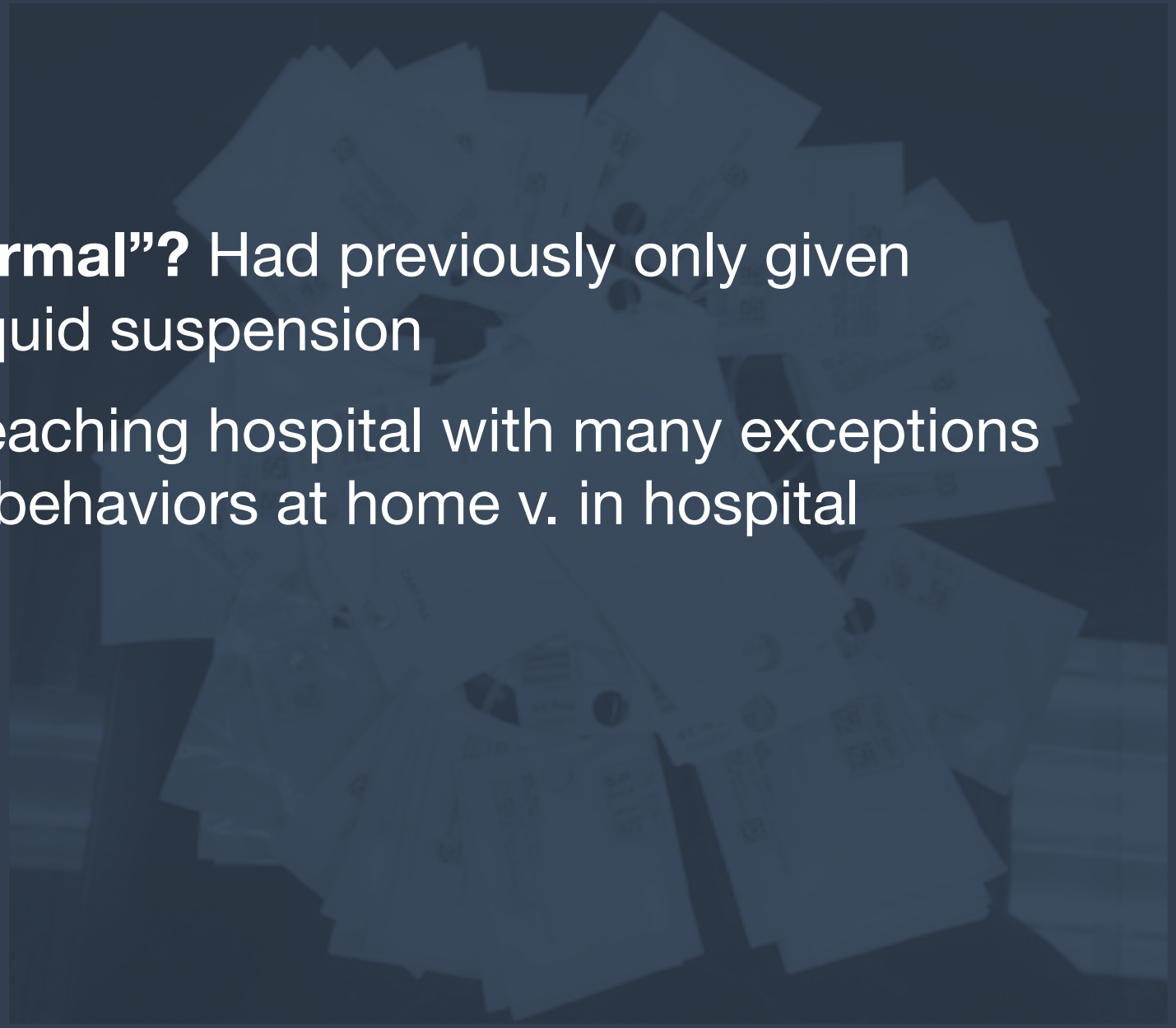


Illustration by Lisk Feng

Principles of reference points

- Evaluation of outcomes is judged on **relative, not absolute value** (anchoring)
- We know where we stand based on **difference** (rivalry, podium effects)
- **Modeling** often demonstrates what “good” looks like (social norms)

REFERENCE POINTS

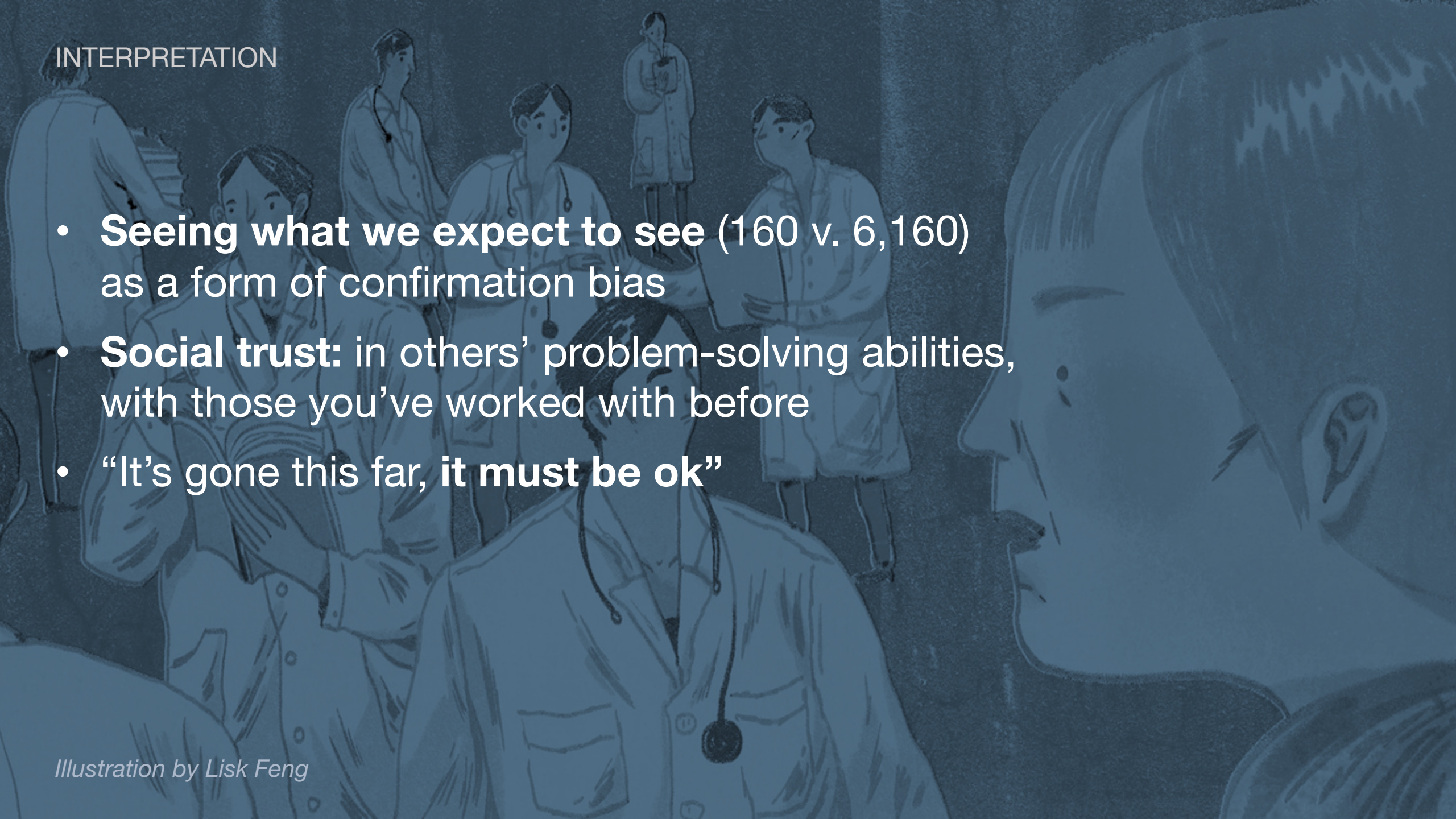


- **What's "normal"?** Had previously only given Septra in liquid suspension
- **Context:** Teaching hospital with many exceptions to the rule; behaviors at home v. in hospital

Principles of interpretation

- We **overweight our personal status** and ability (expertise bias)
- **‘Time optimism’** feeds tendencies toward procrastination and over-committing
- We’re **bad with gauging likelihood** (e.g., lotteries and insurance)
- **‘Availability’** of vivid, anecdotal stories makes them sticky and stand out

INTERPRETATION



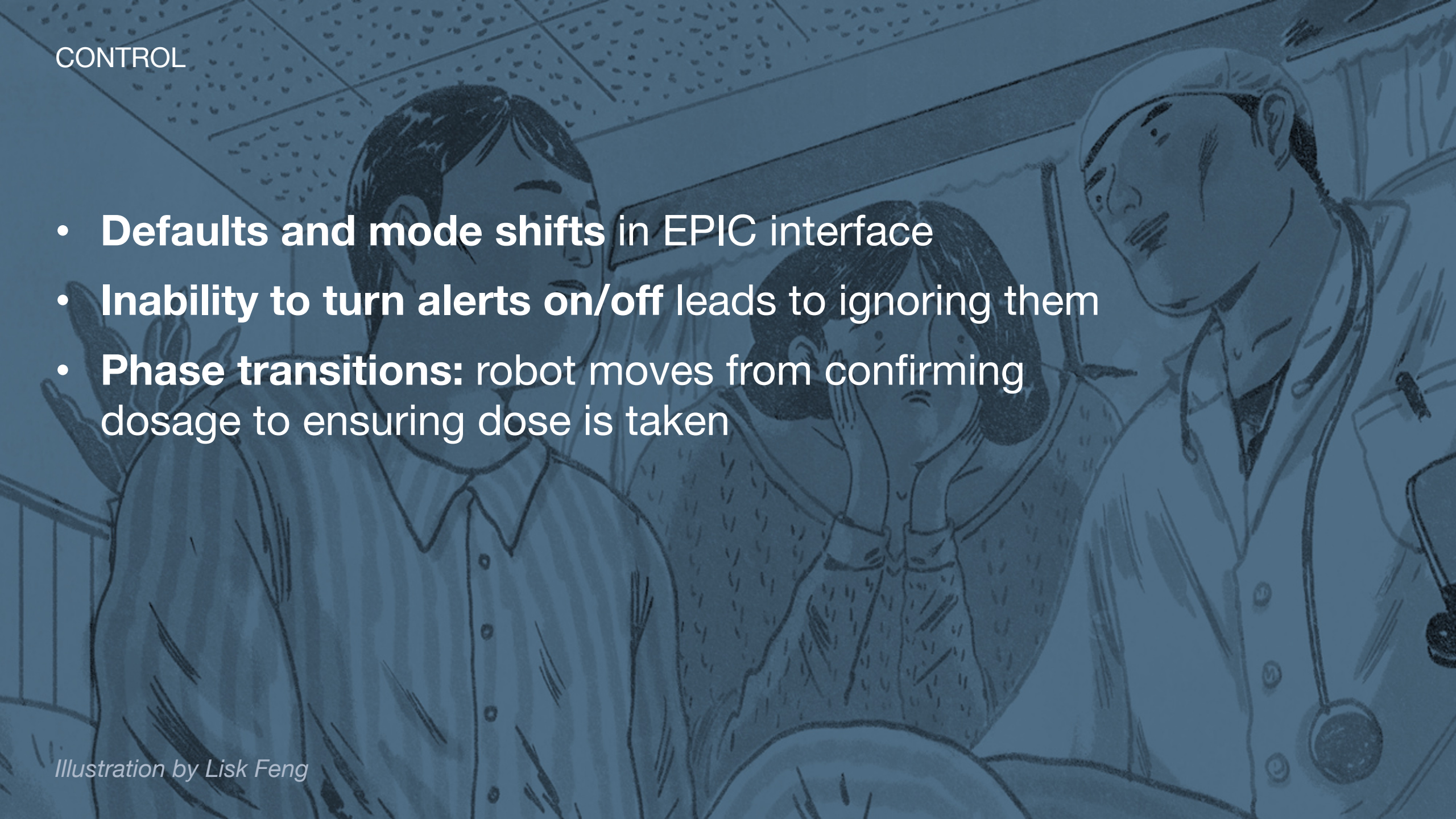
- **Seeing what we expect to see** (160 v. 6,160) as a form of confirmation bias
- **Social trust:** in others' problem-solving abilities, with those you've worked with before
- "It's gone this far, **it must be ok**"

Illustration by Lisk Feng

Principles of control

- **Self control:** ‘Hot’ state impulses battle with ‘cold’ state planning and reflection
- **Defaults:** it’s always easier to do nothing (status quo bias)
- **Ownership** or engagement increases commitment (endowment effect; sunk costs)

CONTROL

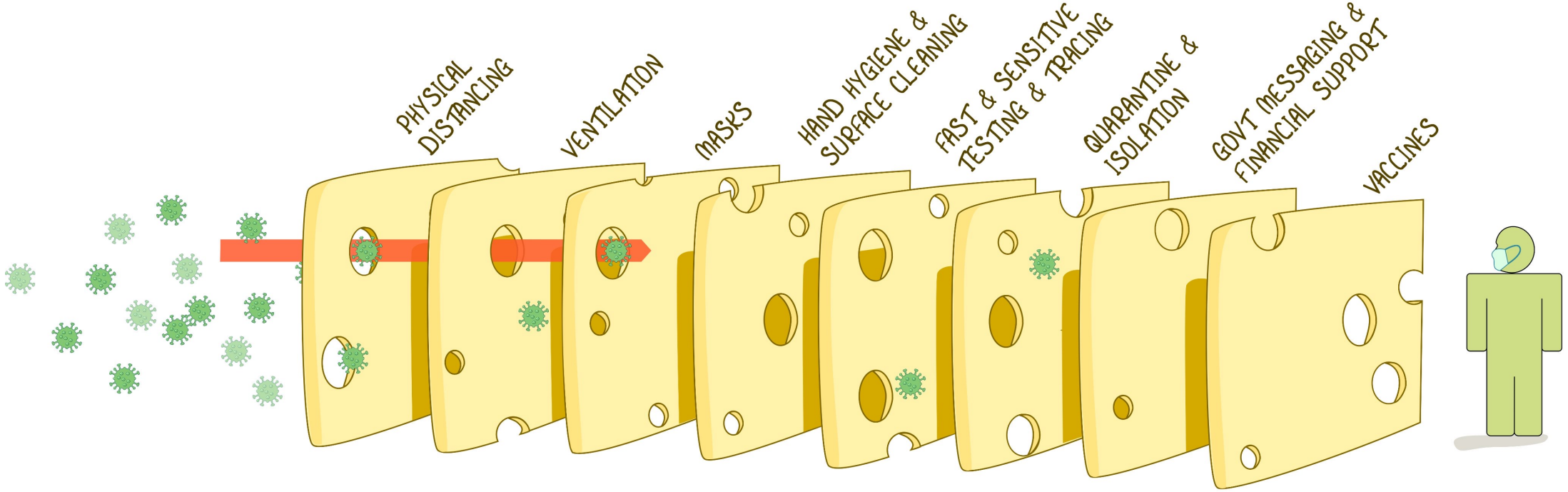


- **Defaults and mode shifts** in EPIC interface
- **Inability to turn alerts on/off** leads to ignoring them
- **Phase transitions:** robot moves from confirming dosage to ensuring dose is taken

Illustration by Lisk Feng

The Swiss Cheese Respiratory Virus Pandemic Defence

Recognising that no single intervention is perfect at preventing spread



Each intervention (layer) has imperfections (holes).
Multiple layers improve success.

Ian M Mackay
virologydownunder.com

Based on the Swiss cheese model of accident causation, by James T Reason, 1990

version 2
update: 15oct2020

But in addition to designing choice environments to ‘fix’ behavior *(choice architecture)…*

…we can also design the system conditions that support these interventions *(choice infrastructure)*


Choice
architecture
Choice
infrastructure

‘Plumbing design’ and intervention effectiveness

Duflo, E. (2017), ‘The economist as plumber’, American Economic Review, 107(5): 1–26. doi:10.1257/aer.p20171153.

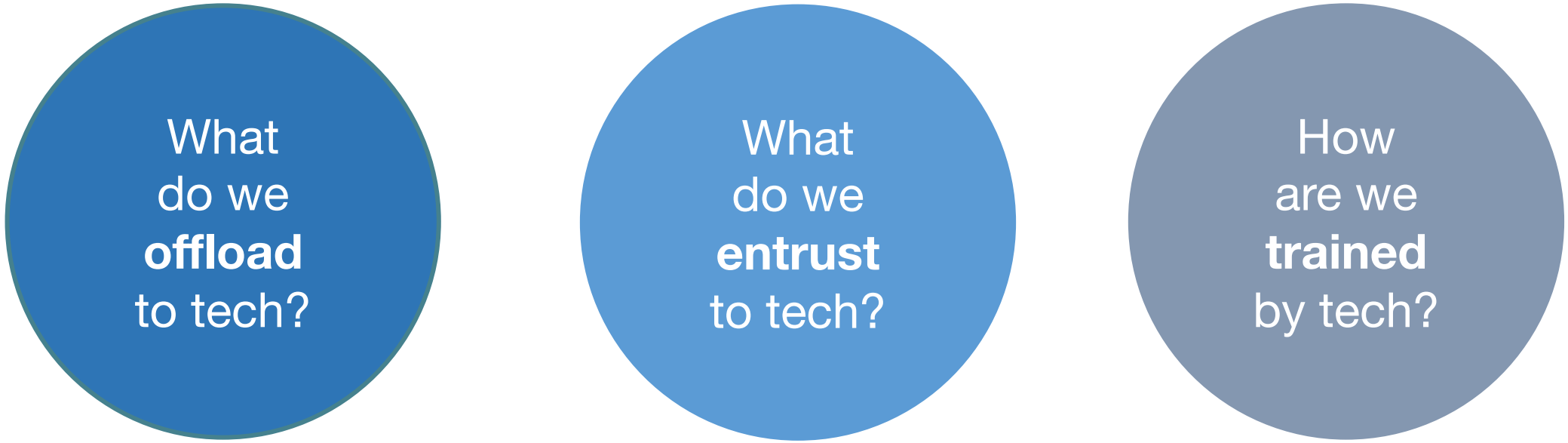
“…any particular set of rules will, advertently or inadvertently, affect the ability and willingness of the frontline workers to implement the policy. **Any policy will necessarily take place in an organization that has power structures, and a culture that has large impacts on how the policy will play out.”**

Esther Duflo

Choice infrastructure ‘plumbing’ comes in different forms, both tangible and intangible:

Technological	• Devices used for communication/information • EPIC system platform and interface
Socio-cultural	• Hierarchies within clinical environments • Expectations of responsiveness • Social norms and relationships between colleagues
Procedural/policies	• RVUs and financial incentives • Do not disturb/‘ignore the alerts’ • Patient rooming and check-in/check out processes

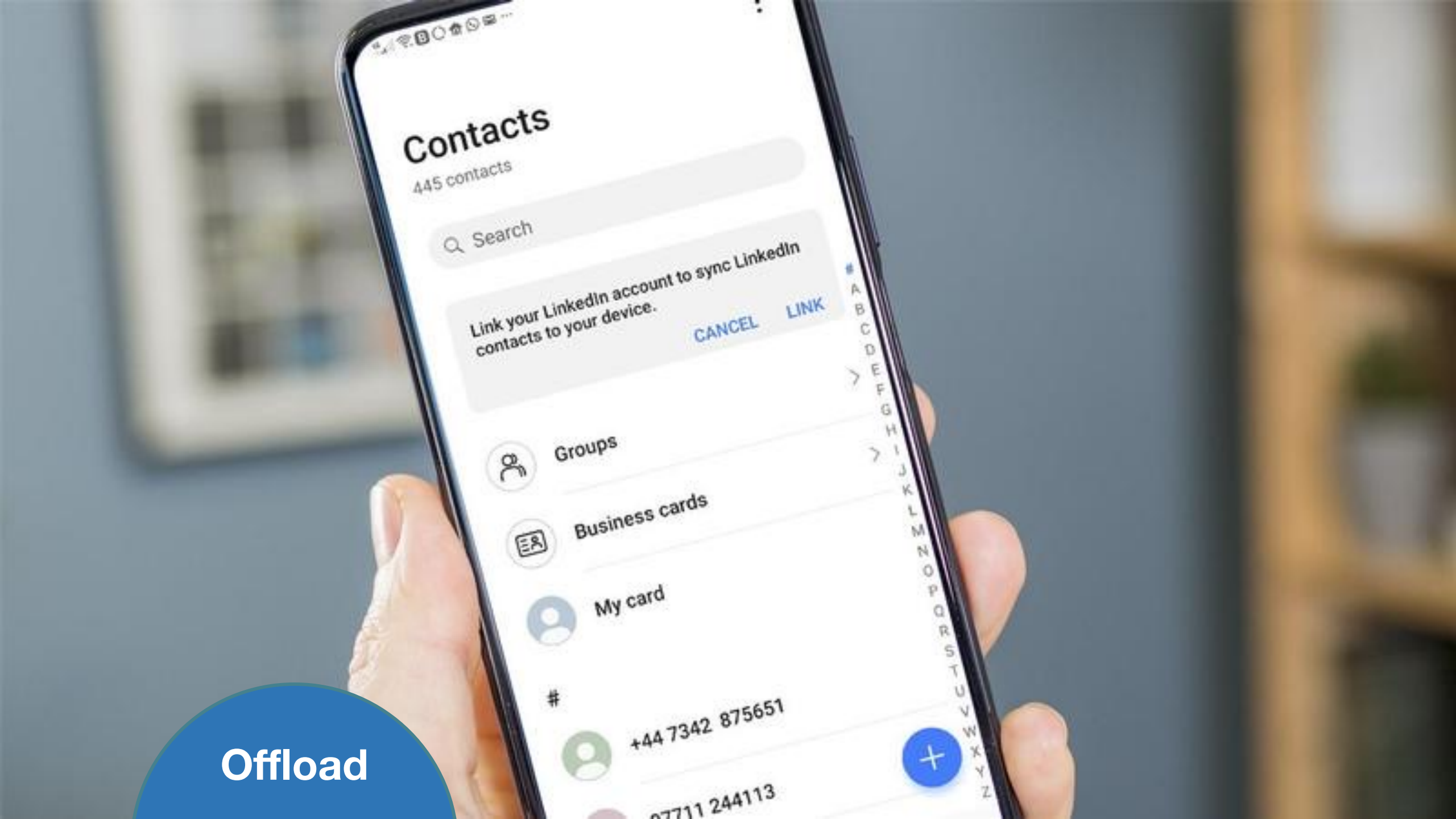
Technology as a form of *choice infrastructure*



Outsourcing work to technology *reduces cognitive load*

Level of trust impacts ***how/if we engage*** *with technology*

Technology shapes our behaviors and *habits*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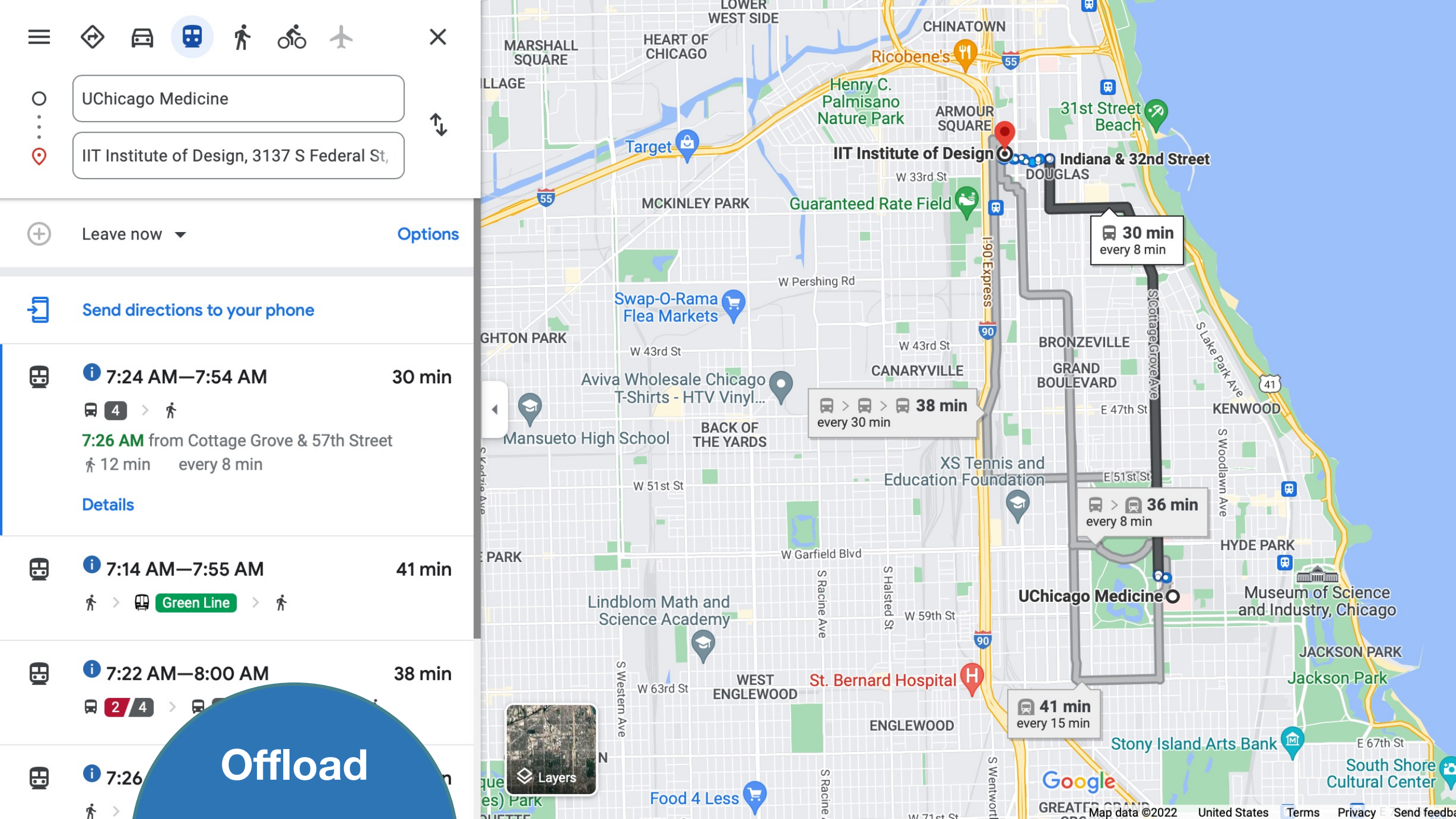
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Mansueto High School
XS Tennis and Education Foundation
Lindblom Math and Science Academy
St. Bernard Hospital
Museum of Science and Industry, Chicago
Jackson Park
Stony Island Arts Bank
South Shore Cultural Center
Food 4 Less
MARSHALL SQUARE
HEART OF CHICAGO
CHINATOWN
ARMOUR SQUARE
DOUGLAS
MCKINLEY PARK
BRONZEVILLE
GRAND BOULEVARD
KENWOOD
CANARYVILLE
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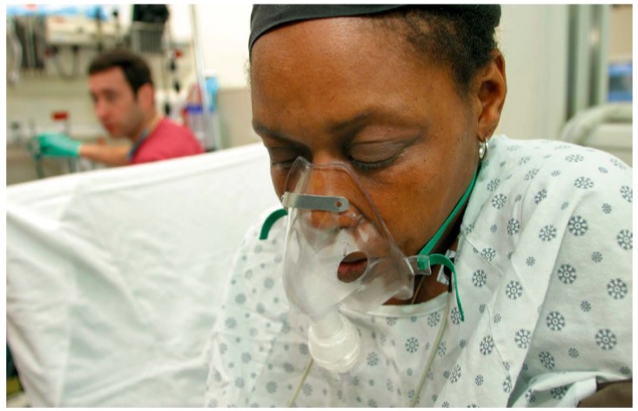


Black people were less likely than white people to be sent for personalized care, a study found.

ED KASHI/VII/REDUX/EYEVINE

MILLIONS AFFECTED BY RACIAL BIAS IN HEALTH-CARE ALGORITHM

Study reveals widespread racism in decision-making software used by US hospitals.

By Heidi Ledford

An algorithm widely used in US hospitals to allocate health care to patients has been systematically discriminating against black people, a sweeping analysis has found.

The study, published in *Science* on 24 October, concluded that the algorithm was less likely to refer black people than white people who were equally sick to programmes that aim to improve care for patients with complex medical needs (Z. Obermeyer *et al*. *Science* **366**, 447–453; 2019). Hospitals and insurers use the algorithm and others like it to help to manage care for about 200 million people in the United States each year.

This type of study is rare, because researchers often cannot gain access to proprietary algorithms and the reams of sensitive health data needed to fully test them, says Milena Gianfrancesco, an epidemiologist at the University of California, San Francisco, who has studied sources of bias in electronic medical records. But smaller studies and anecdo… reports have documented unfair and … decision-making by algorithms … everything from criminal justice … and health care.

"It is alarming," says Gi…

the latest study. "At the same time, it's not surprising."

Ziad Obermeyer, who studies machine learning and health-care management at the University of California, Berkeley, and his team stumbled across the problem while examining the impact of programmes that provide additional resources and closer medical supervision for people with multiple, sometimes overlapping, health problems.

When Obermeyer and his colleagues ran routine statistical checks on data they received from a large hospital, they were surprised to find that people who self-identified as black were generally assigned lower risk scores than equally sick white people. As a result, the black people were less likely to be referred to the programmes that provide more-personalized care.

The researchers found that the algorithm assigned risk scores to patients on the basis of total health-care costs accrued in one year. They say that this assumption might have seemed… …higher health-… …greater … …the

a greater prevalence of conditions such as diabetes, anaemia, kidney failure and high blood pressure. Taken together, the data showed that the care provided to black people cost an average of US$1,800 less per year than the care given to white people with the same number of chronic health problems.

The scientists speculate that this reduced access to care is due to the effects of systemic racism, ranging from distrust of the health-care system to direct racial discrimination by health-care providers.

And because the algorithm assigned people to high-risk categories on the basis of costs, those biases were passed on in its results: black people had to be sicker than white people before being referred for additional help. Only 17.7% of patients that the algorithm assigned to receive extra care were black. The researchers calculate that the proportion would have been 46.5% if the algorithm was unbiased.

When Obermeyer and his team reported their findings to the algorithm's developers — Optum of Eden Prairie, Minnesota — the company repeated their analysis and got the same results. Obermeyer is working with the firm without salary to improve the algorithm.

He and his team collaborated with the company to find variables other than health-care costs that could be used to calculate a person's medical needs, and repeated their analysis after tweaking the algorithm accordingly. They found that making these changes reduced bias by 84%.

"We appreciate the researchers' work," Optum said in a statement. But the company added that it considered the study's conclusion to be "misleading". "The cost model is just one of many data elements intended to be used to select patients for clinical engagement programs."

Obermeyer says that using cost prediction to make decisions about patient engagement is a pervasive issue. "This is not a problem with one algorithm, or one company — it's a problem with how our entire system approaches this problem," he says.

Examining assumptions

Correcting bias in algorithms is not straightforward, Obermeyer adds. "Those solutions are easy in a software-engineering sense: you just rerun the algorithm with another variable," he says. "But the hard part is: what is that other variable? How do you work around the bias and injustice that is inherent in that society?"

This is in part because of a lack of diversity among algorithm designers, and a lack of training about the social and historical context of their work, says Ruha Benjamin, author of *Race After Technology* (2019) and a sociologist at Princeton University in New Jersey.

"We can't rely on the people who currently … these systems to fully anticipate or … all the harms associated with

Offload

" …the algorithm assigned risk scores to patients on the basis of total health-care costs accrued in one year…

Only 17.7% of patients that the algorithm assigned to receive extra care were black. The researchers calculate that the proportion would have been 46.5% if the algorithm was unbiased."

Ledford, Heidi (2019) Millions of black people affected by racial bias in health-care algorithms. *Nature* **574**, 608-609 (2019) *doi: https://doi.org/10.1038/d41586-019-03228-6*

An overview of clinical decision support systems

- **Alert fatigue — tendency to distrust and dismiss alerts**
- **Negative impact on user skills — reliance on and excessive trust in system accuracy**
- Financial challenges — expensive to set up and maintain
- System and content maintenance — keeping systems up to date
- **User distrust of CDSS — distrust of automated guidelines over clinician judgment**
- Transportability/interoperability — dysfunction across hospital systems
- Dependency on computer literacy — requires new technical proficiencies
- Inaccurate and poor-quality data/documentation — cross-system synch issues
- Disrupted/fragmented workflow — additional steps/workarounds

Sutton, RT et al. (2020) An overview of clinical decision support systems: benefits, risks, and strategies for success. npj Digital Medicine. 3:17; https://doi.org/10.1038/s41746-020-0221-y

PsyArXiv Preprints

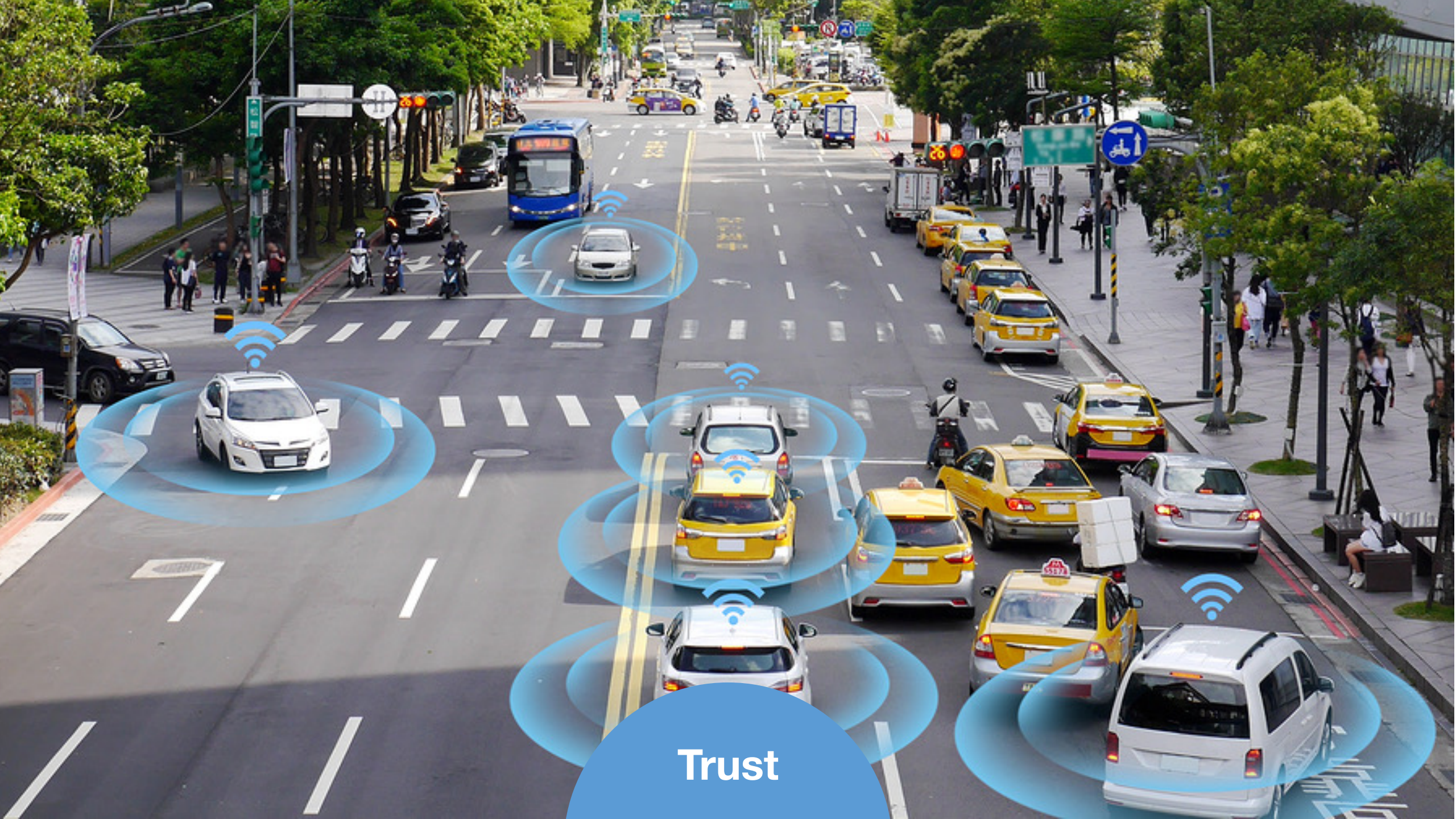
Fooled by beautiful data: Visualization aesthetics bias trust in science, news, and social media

AUTHORS
Chujun Lin, Mark Allen Thornton

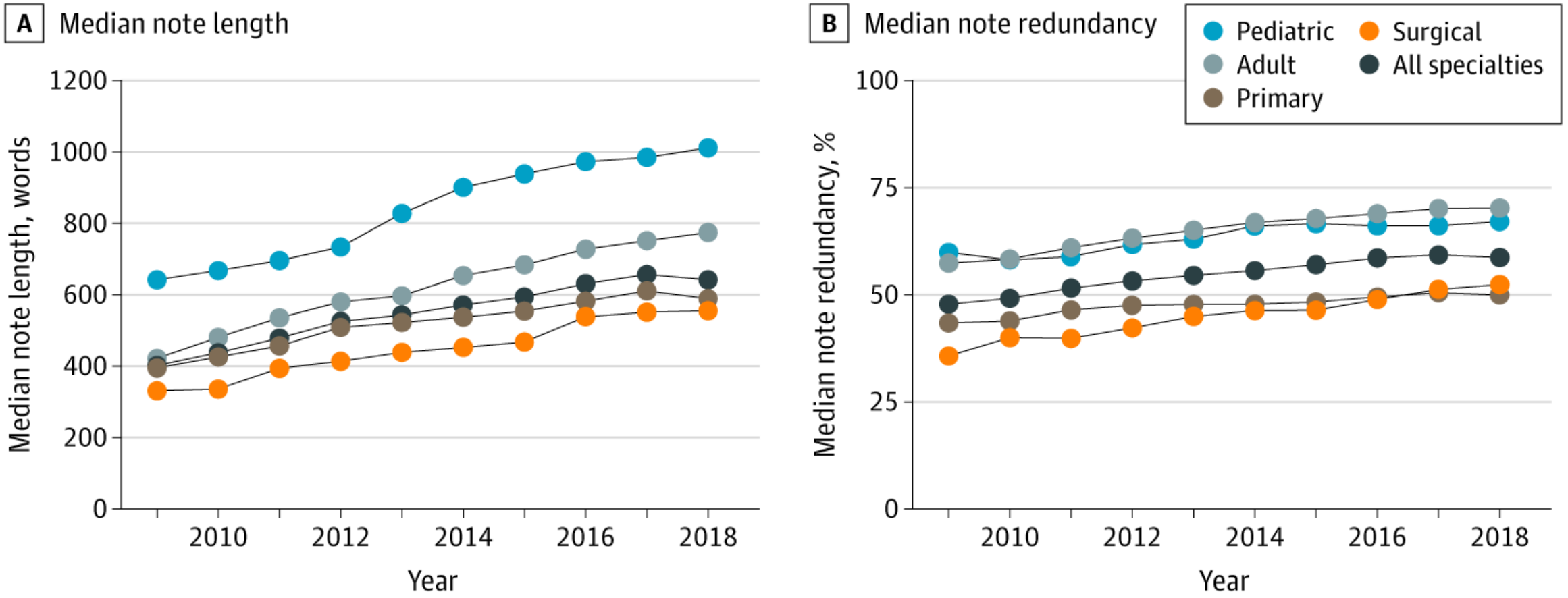
“ **We found that beauty, but not actual misleadingness, causally affected trust.** These findings reveal a source of bias in the interpretation of quantitative data and indicate the importance of promoting data literacy in education.”

Lin, C., & Thornton, M. A. (2021, December 17). Fooled by beautiful data: Visualization aesthetics bias trust in science, news, and social media. https://doi.org/10.31234/osf.id/dnr9s

Trust


Trust

Managing note bloat



Rule A, Bedrick S, Chiang MF, Hribar MR. Length and Redundancy of Outpatient Progress Notes Across a Decade at an Academic Medical Center. *JAMA Netw Open*. 2021;4(7):e2115334. doi:10.1001/jamanetworkopen.2021.15334

Training

Tuesday
25 Apr 2006

No More More Pages?

by **Aza Raskin** 27 Voices

REDESIGN

Google's good. But it could be better. Chances are that you've done a search where you haven't found what you're looking for on the first page. If so, then you've had to click on the unhelpfully numbered more-result pages:

Google's aging links to get more search results.

There's no semantic meaning in these numbers; there's no telling what's lurking behind a representing numeral's bland exterior. If I find something good on the fourth page, I'll be unlikely to find it again without aimlessly clicking on random number after random number. Normally, if I don't find what I want on the first page, I'll usually just give up.

But it's not just Google. Alta Vista, Yahoo, Lycos, and all the major search engines conform to the same frustrating way of doing things. Why? Because it was the best solution at the time. A lot of today's web technologies weren't around in the mid-1990's, so designers were forced to place search results on separate pages. But as technology has progressed, no one has thought to go back and redesign.

[...] Here, you discover how to build XML data sources for Ajax, req then dynamically create and animate HTML elements with that XML

(Read More... | 166 of 233 comments | developers.slashdot.org)

< Today's News | April 24 | April 22 >

Slashdot's frustrating links for browsing history.

Of course, this page-chunking phenomenon isn't limited to search sites. It's used everywhere from blogs to forums, from e-commerce sites to e-mail programs. And it's surprising how often one finds oneself just giving up and going somewhere else when one has reached the end of a page.The problem is that every time a user is required to click to the next page, they are pulled from the world of content to the world of navigation: they are no longer thinking about what they are reading, but about about how to get more to read. Because it breaks their **train of thought** and

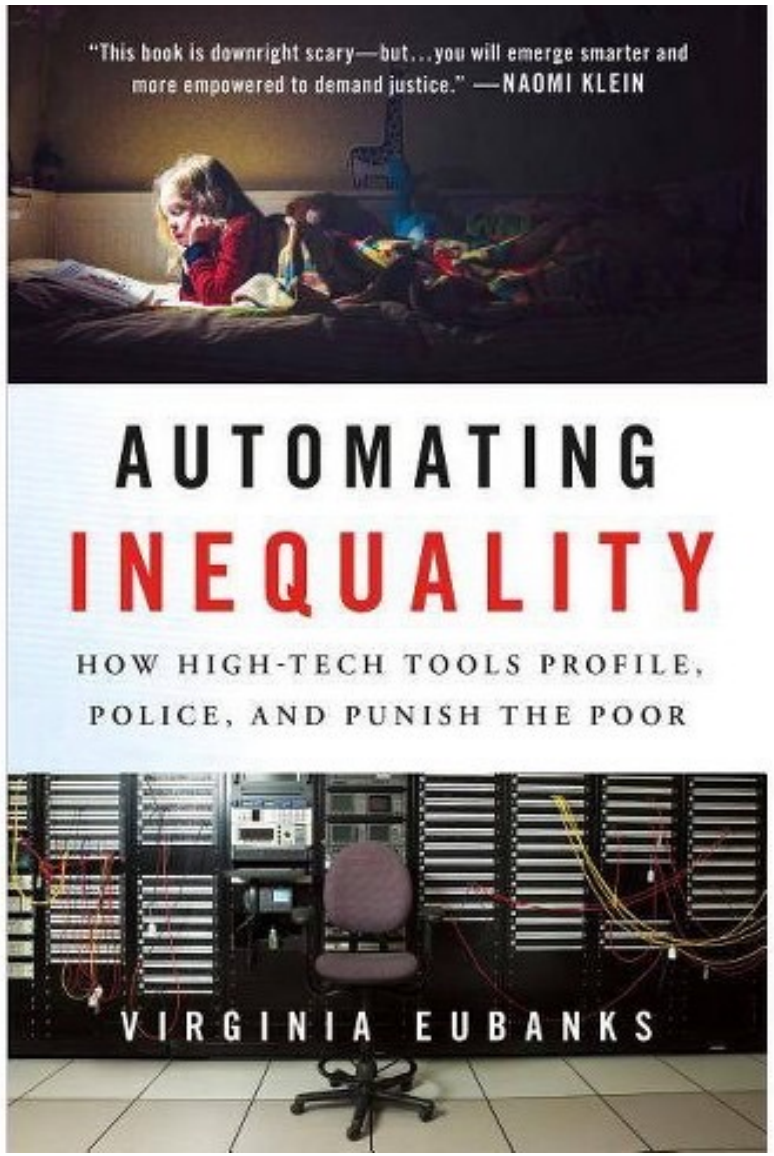
What's measured, matters

" …designers were driven to create addictive app features by the business models of the big companies that employed them.

…when you put that much pressure on that one number, you're going to start trying to invent new ways of getting people to stay hooked."

Andersson, Hilary (2018) Social media apps are 'deliberately' addictive to users. *BBC Panorama*, 4 July 2018. https://www.bbc.com/news/technology-44640959

Training



Second-guessing human judgment

" …[*if*] *you run the score and your research doesn't match the score, typically there's something you're missing. You have to back-piece the puzzle.'*

" We all tend to defer to machines, which can seem more neutral, more objective. **But it is troubling that managers believe that if the intake screener and the computer's assessments conflict, the human should learn from the model."**

Eubanks, Virginia, (2018) *Automating Inequality: How High-tech Tools Profile, Police, and Punish the Poor*. New York, NY: St. Martin's Press.

Training

What does this mean for behavioral design?

Social + technological infrastructure

“ …physician and nursing education, coupled with changes to the EHR, led to a significant reduction of orders for overnight vital signs… however, the virtues of a sleep-friendly environment **depend on the unit-based nurses championing the cause.**”

Arora, Vineet & Mochado, N. & Anderson, Samantha & Desai, Nimit & Marsack, William & Blossomgame, Stephenie & Tuvilleja, Ambrosio & Ramos, Jacqueline & Francisco, Mary & Lafond, Cynthia & Leung, Edward & Valencia, Andres & Martin, Shannon & Meltzer, David & Farnan, Jeanne & Balachandran, Jay & Knutson, Kristen & Mokhlesi, Babak. (2019). Effectiveness of SIESTA on Objective and Subjective Metrics of Nighttime Hospital Sleep Disruptors. Journal of hospital medicine. 14. 38-41. 10.12788/jhm.3091.

Reinforcement

Journal of Hospital Medicine
shm Society of Hospital Medicine

Brief Report

Effectiveness of SIESTA on Objective and Subjective Metrics of Nighttime Hospital Sleep Disruptors

Vineet M Arora MD MAPP, Nolan Machado BA, Samantha L. Anderson BA, Nimit Desai MD, William Marsack MSN, Stephenie Blossomgame MSN, Ambrosio Tuvilleja RN ... See all authors

First published: 01 January 2019 | https://doi.org/10.12788/jhm.3091 | Citations: 23

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Abstract

We created Sleep for Inpatients: Empowering Staff to Act (SIESTA), which combines electronic “nudges” to forgo nocturnal vitals and medications with interprofessional education on improving patient sleep. In one “SIESTA-enhanced unit,” nurses received coaching and integrated SIESTA into daily huddles; a standard unit did not. Six months pre- and post-SIESTA, sleep-friendly orders rose in both units (foregoing vital signs: SIESTA unit, 4% to 34%; standard, 3% to 22%, $P < .001$ both; sleep-promoting VTE prophylaxis: SIESTA, 15% to 42%; standard, 12% to 28%, $P < .001$ both). In the SIESTA-enhanced unit, nighttime room entries dropped by 44% (-6.3 disruptions/room, $P < .001$), and patients were more likely to report no disruptions for nighttime vital signs (70% vs 41%, $P = .05$) or medications (84% vs 57%, $P = .031$) than those in the standard unit. The standard unit was not changed. Although sleep-friendly orders were adopted in both units, a unit-based nursing empowerment approach was associated with fewer nighttime room entries and improved patient experience.

Real v. virtual interactions

“ I asked Chan what would have happened if the tech had received a label with instructions to tear out 38½ individual Septra tablets from a large serrated sheet of individually wrapped pills. Partway through the tearing, he told me, “My tech would have said, ‘Hey, this doesn’t look right.’” I don’t doubt this: **there is something about a physical act, whether it is tearing off 39 pills from a sheet or writing out an order with a pen, that can jog a mind out of numb complacency.**”

“ **Previous research has shown that disfluency—the subjective experience of difficulty associated with cognitive operations—leads to deeper processing.** Two studies explore the extent to which this deeper processing engendered by disfluency interventions can lead to improved memory performance. The results suggest that superficial changes to learning materials could yield significant improvements in educational outcomes.”

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Diemand-Yauman, C., et al. Fortune favors the Bold (and the Italicised): Effects of disfluency on educational outcomes. *Cognition* (2010), doi:10.1016/j.cognition.2010.09.012

Positive friction

Representation

Humans rely more on algorithms than social influence as a task becomes more difficult

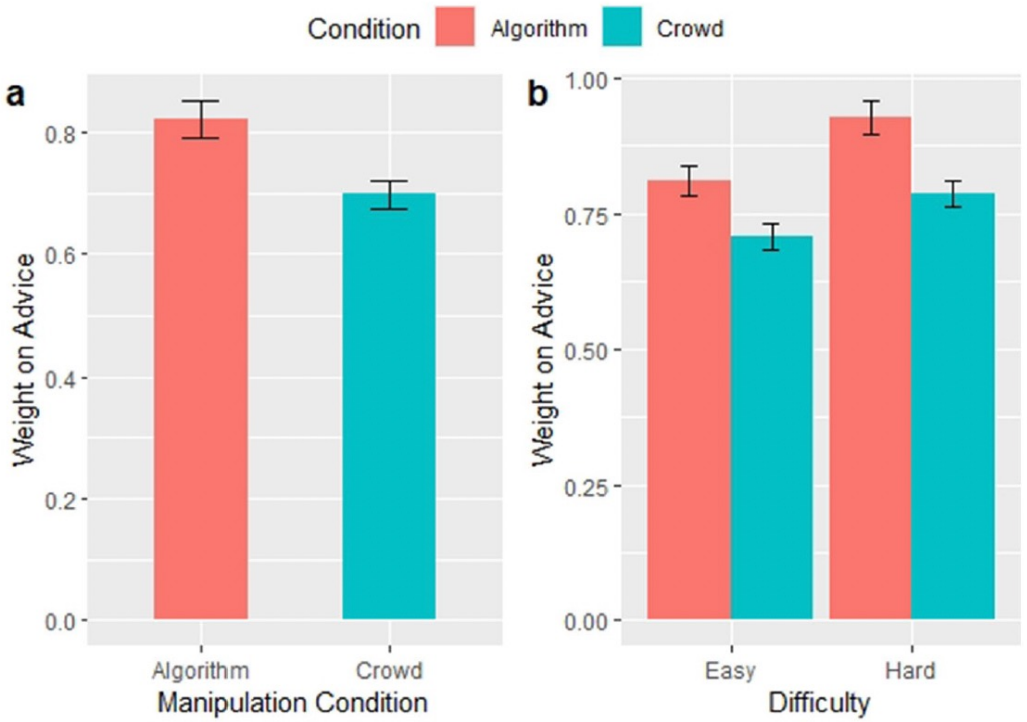

Figure 1. Source of advice affects subject weight on advice (Experiment 1). Each bar chart depicts results of the mixed effects regression model on N = 5083 observations. All models include accuracy as a control. Error bars correspond to the standard error of the estimated effect. (**a**) shows the main effect of advice source on WOA; the difference across conditions is significant ($p < 0.001$). (**b**) shows the effect of advice source on WOA across levels of difficulty; all differences a… Panel A shows the effects using Model 1 from Table S2, Panel B shows the effec…

Unintended consequence

“ All three experiments focused on an intellective task **with a correct answer** and found that subjects relied more on algorithmic advice as difficulty increased.”

Bogert, Eric, Aaron Schecter and Richard T. Watson (2021) Humans rely more on algorithms than social influence as a task becomes more difficult. Nature Scientific Reports 11:8028 | https://doi.org/10.1038/s41598-021-87480-9