



What can psychology contribute  
to the climate crisis?

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# **Goal for the talk**

Share my vision for what psychology can do

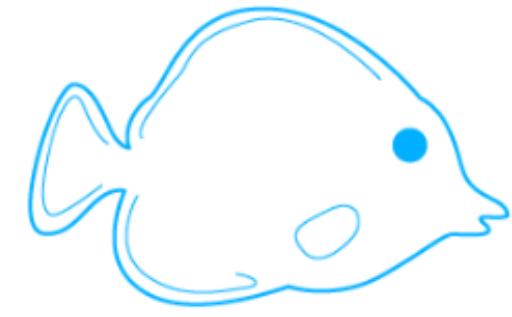
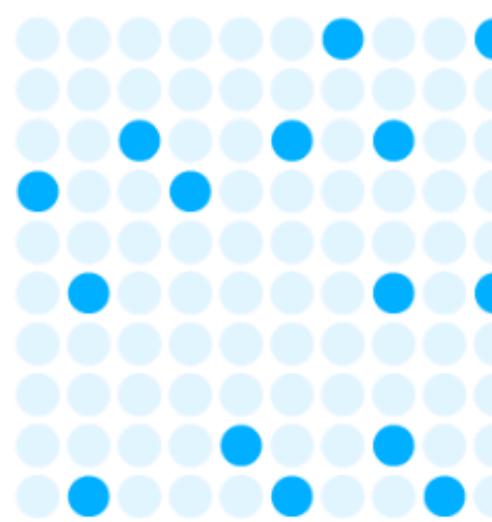
My current work in this direction

My future plans/project ideas

(Might skip few technical details and instead focus more on high-level vision)

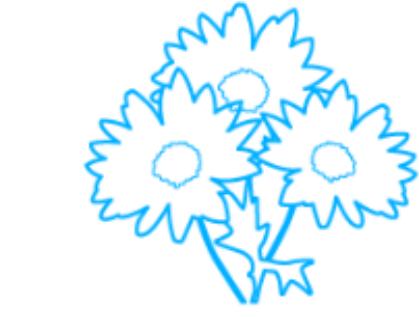
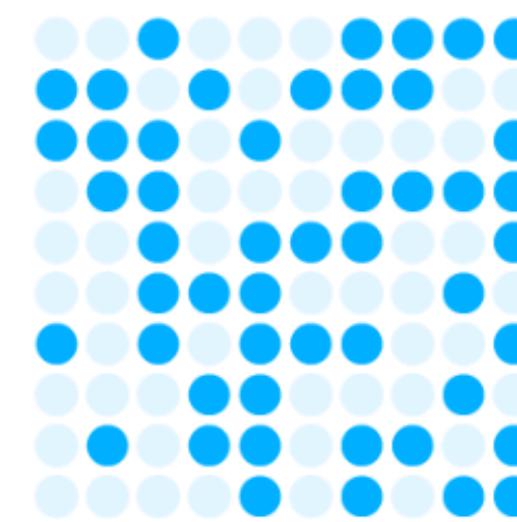
# Species lost since rise of human civilization

15%



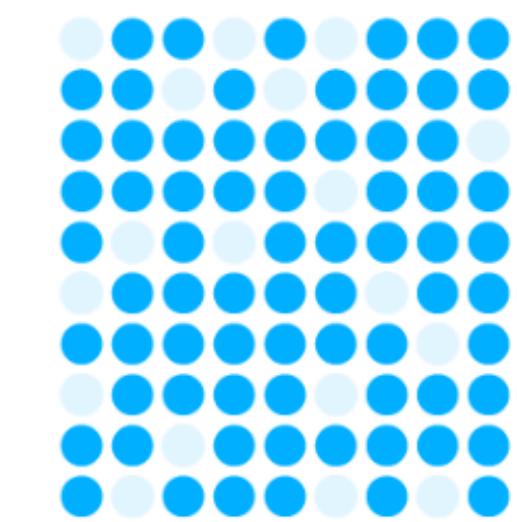
of fish

50%



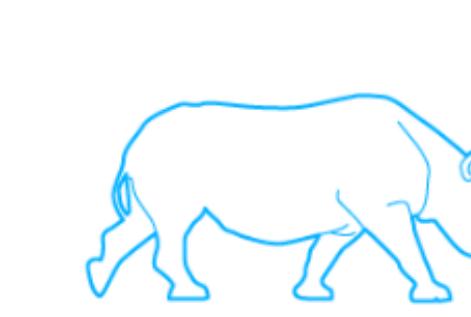
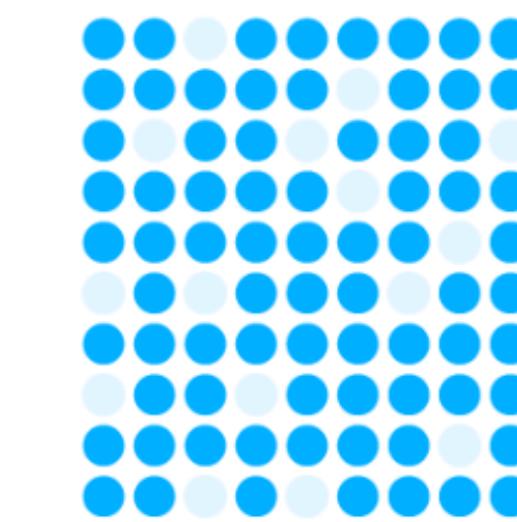
of plants

80%



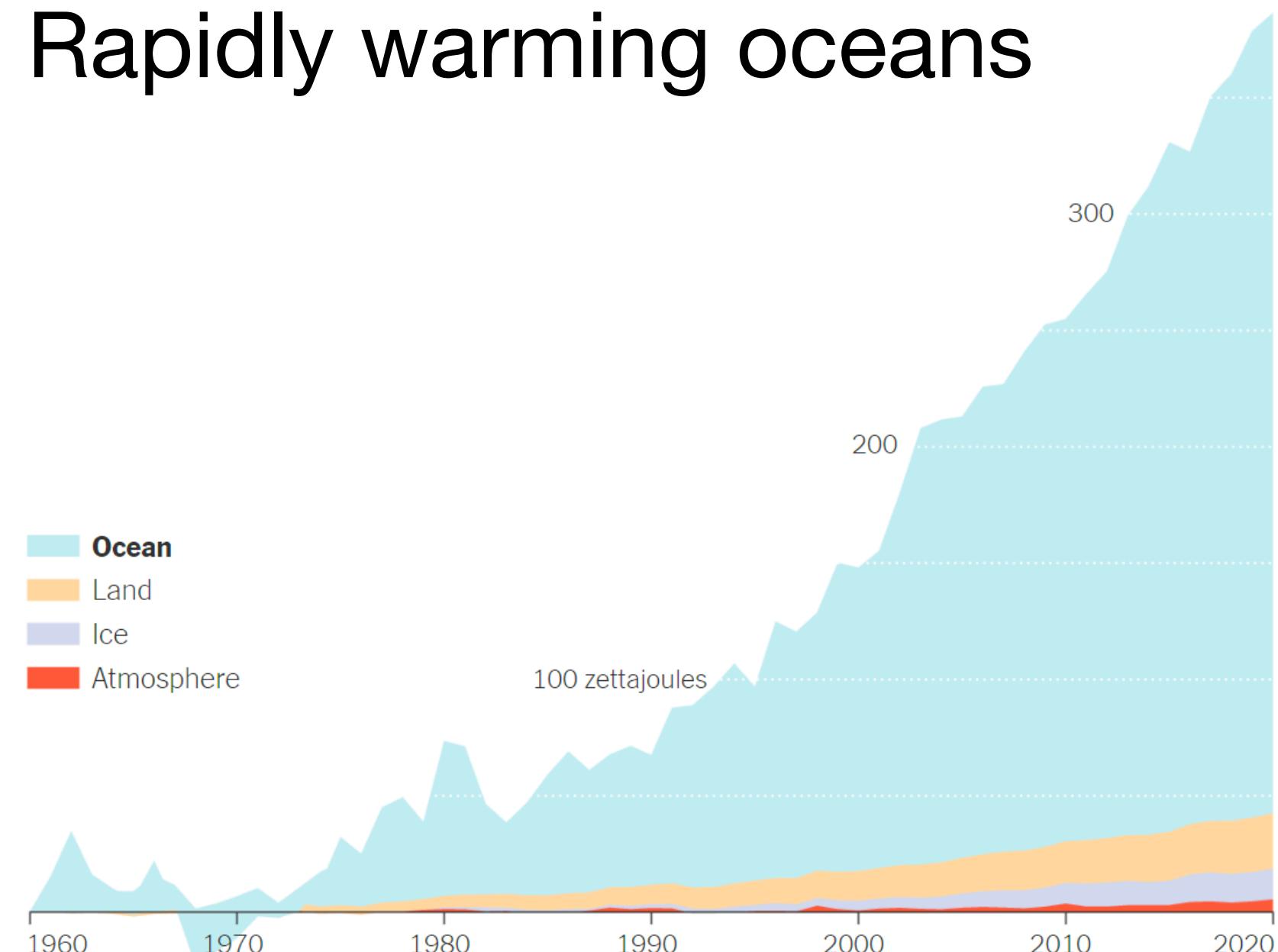
of marine mammals

83%



of wild mammals

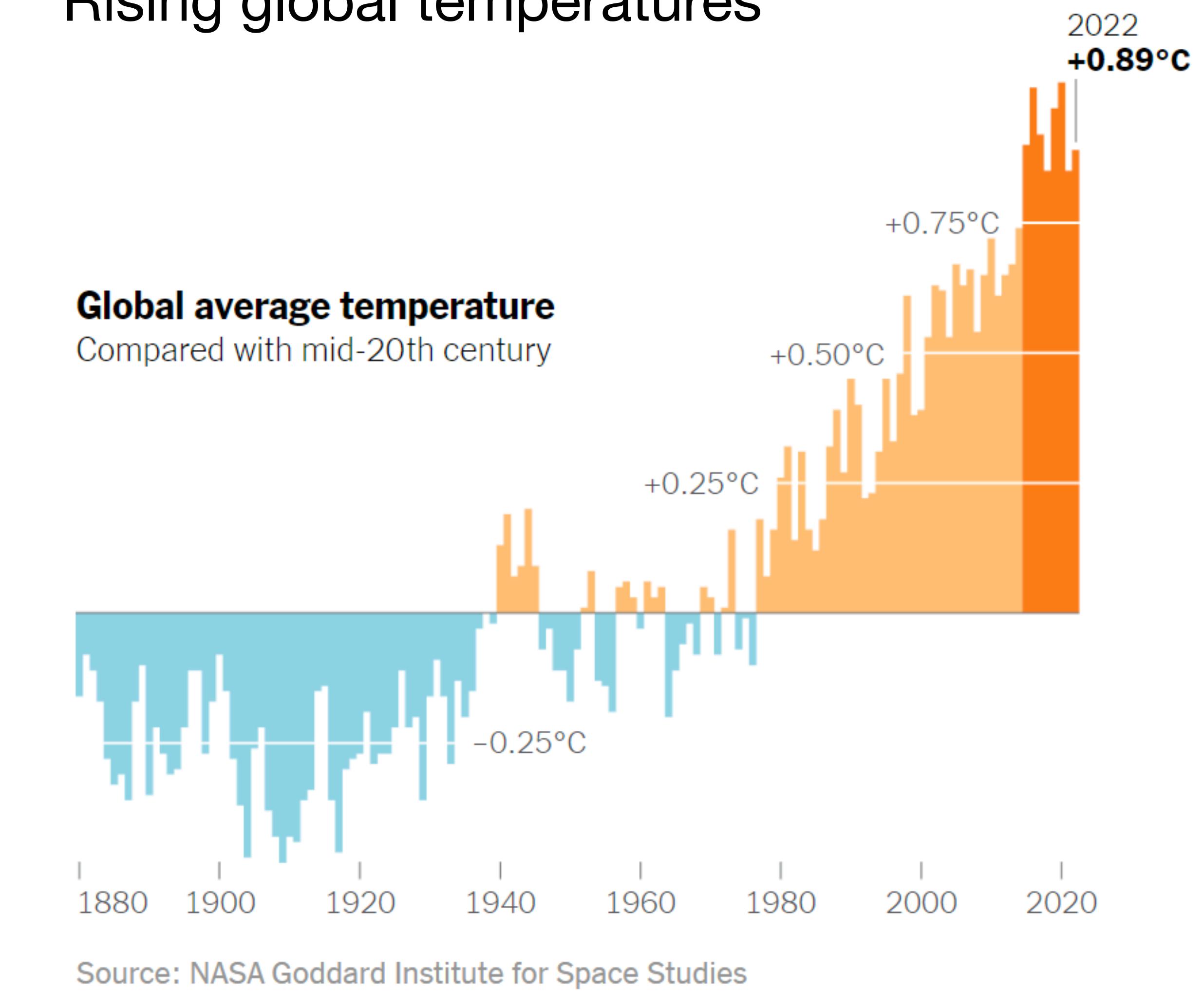
# Rapidly warming oceans



# Rising global temperatures

## Global average temperature

Compared with mid-20th century

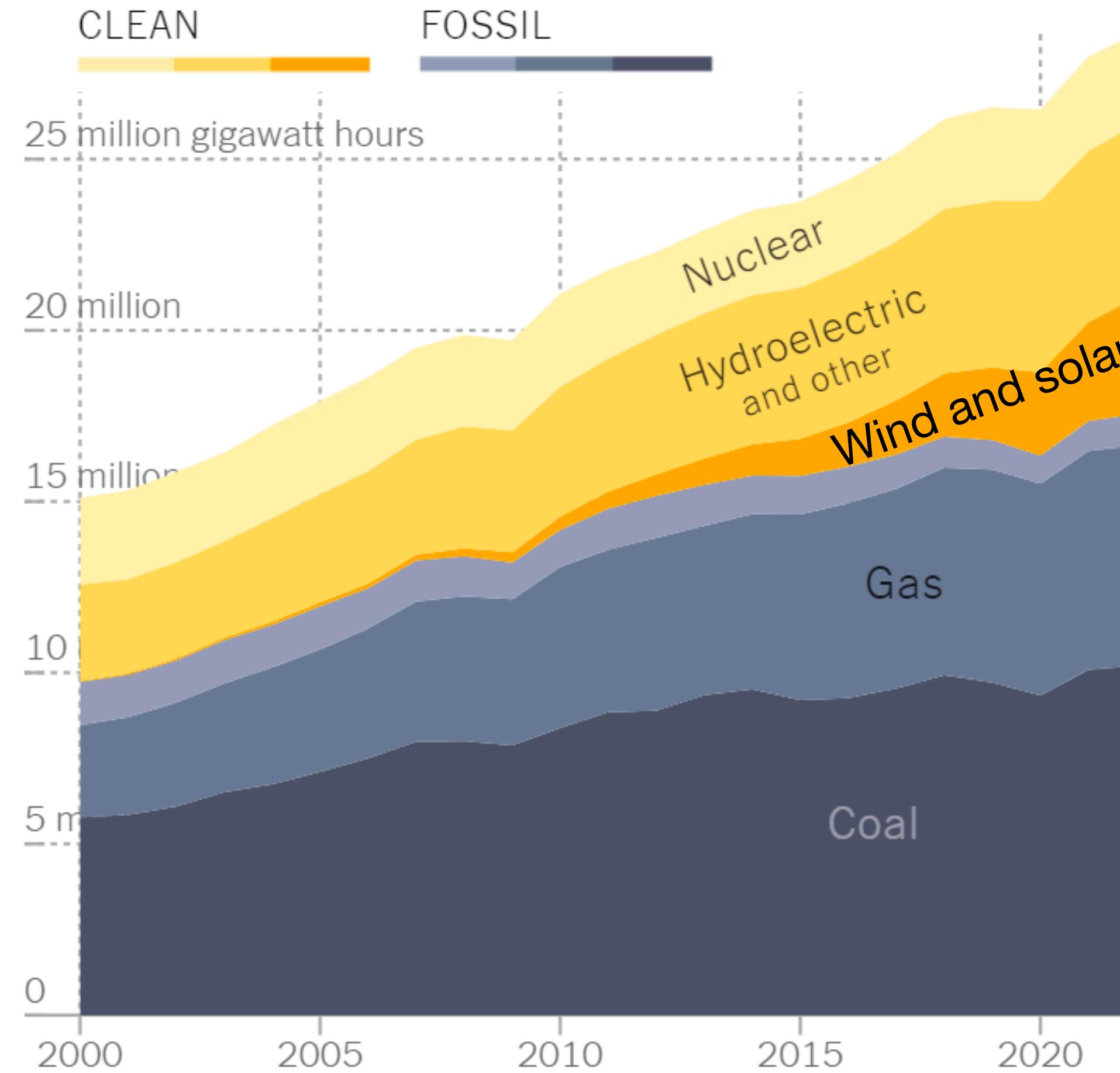


# Humanity's footprint on the planet

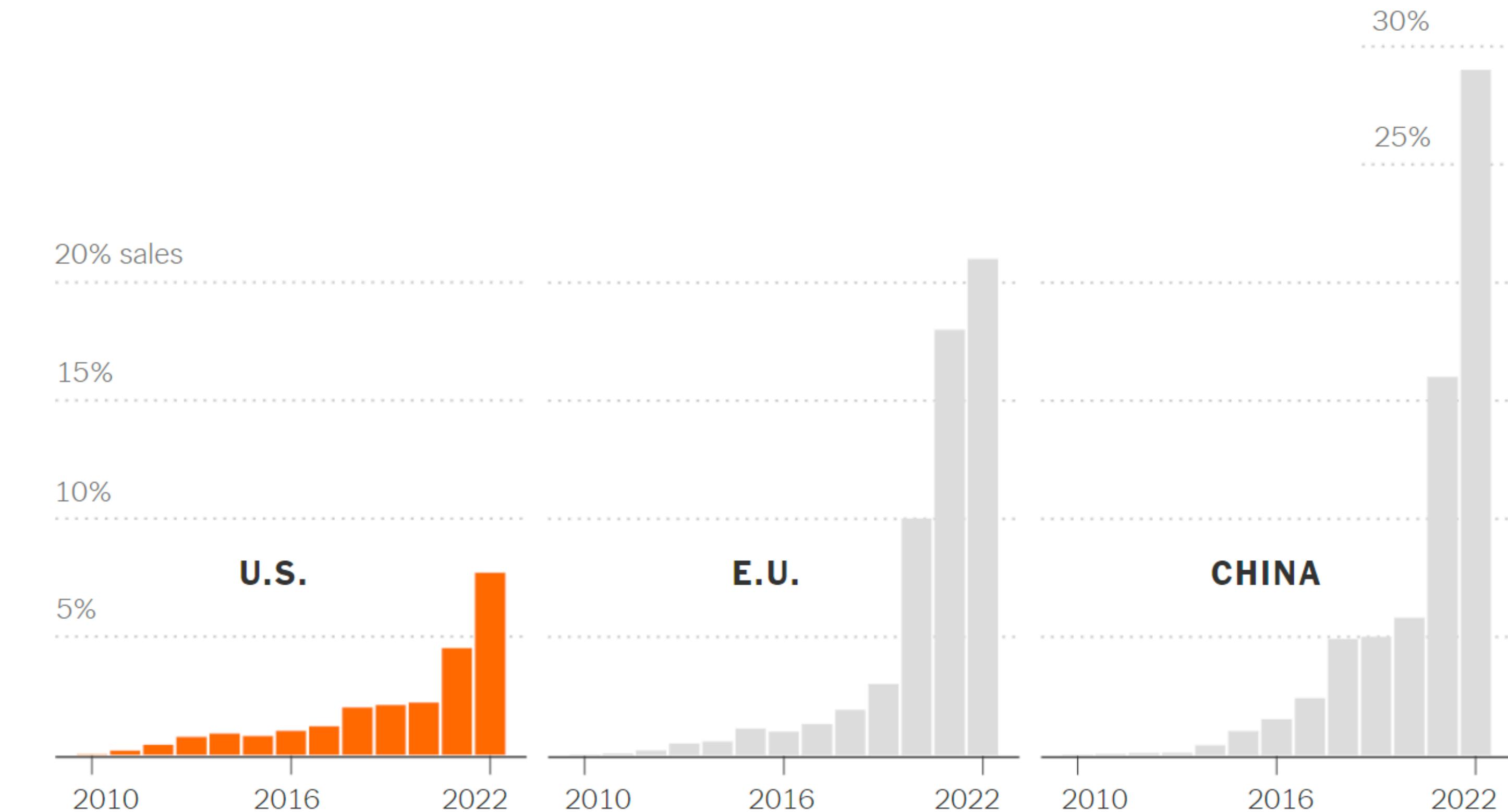
[Wake et al., 2008; Barosky et al., 2011; Ceballos et al., 2017; Ceballos et al., 2020; IPCC 2023]

# Progress on climate action **not** nearly enough

## Increase in cleaner energy

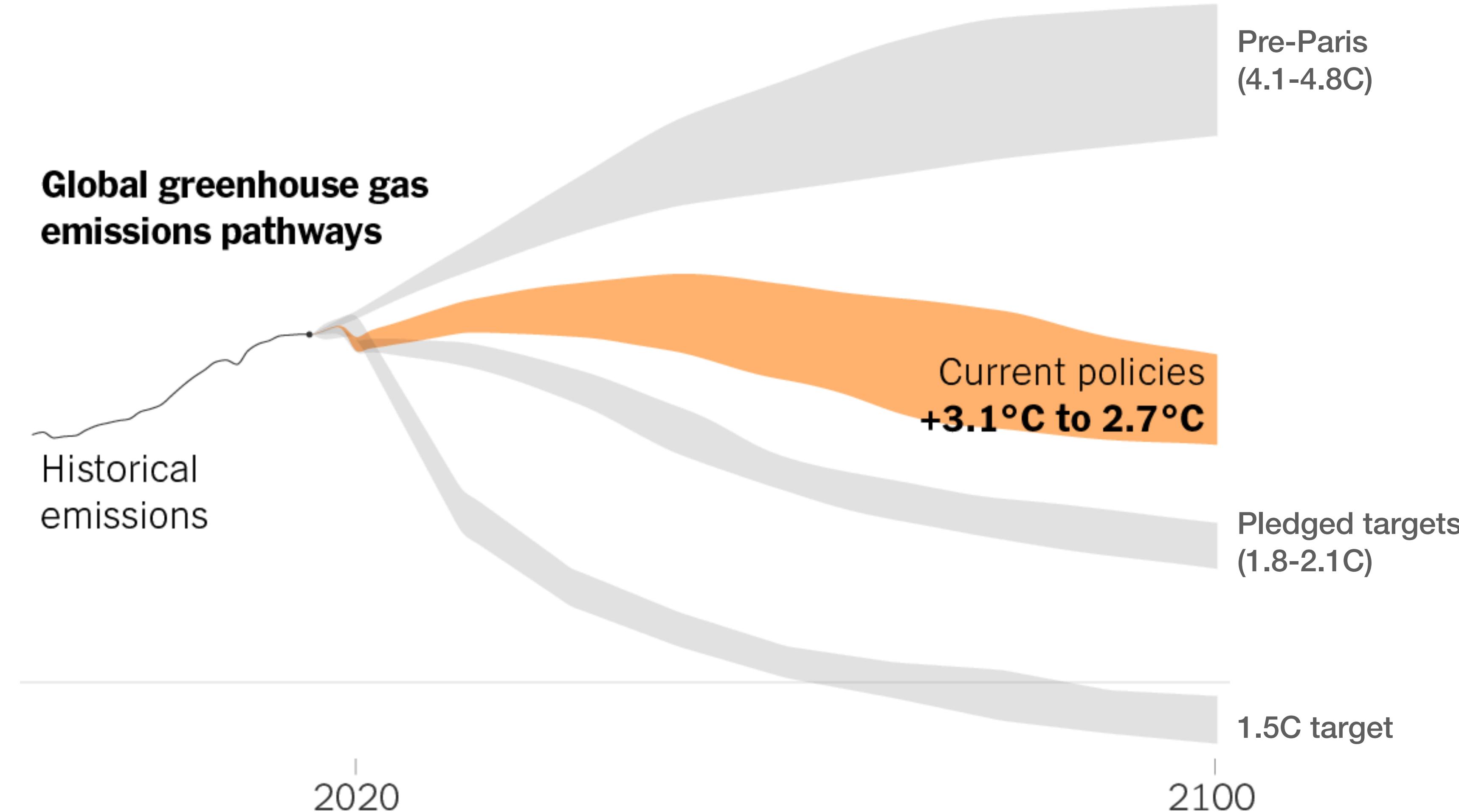


## Electrification of personal vehicles



Source: [International Energy Agency](#) • Note: Sales share of battery electric vehicles excludes plug-in hybrids, electric trucks and buses and other vehicles. • By The New York Times

# Progress on climate action **not nearly enough**



Climate change is fundamentally an issue of ***human behavior***

# My research

**Central focus:** Understanding human motivation  
and leveraging insights to motivate sustainability

“To be motivated means to *be moved* to do something”  
- *Ryan & Deci (2000)*

## How psychology can help in the long-run

Understand cognitive biases related to climate **inaction**

## How psychology can help in the short-run

Motivate **individuals** to be more sustainable

Help efforts aiming to bring **systemic** changes

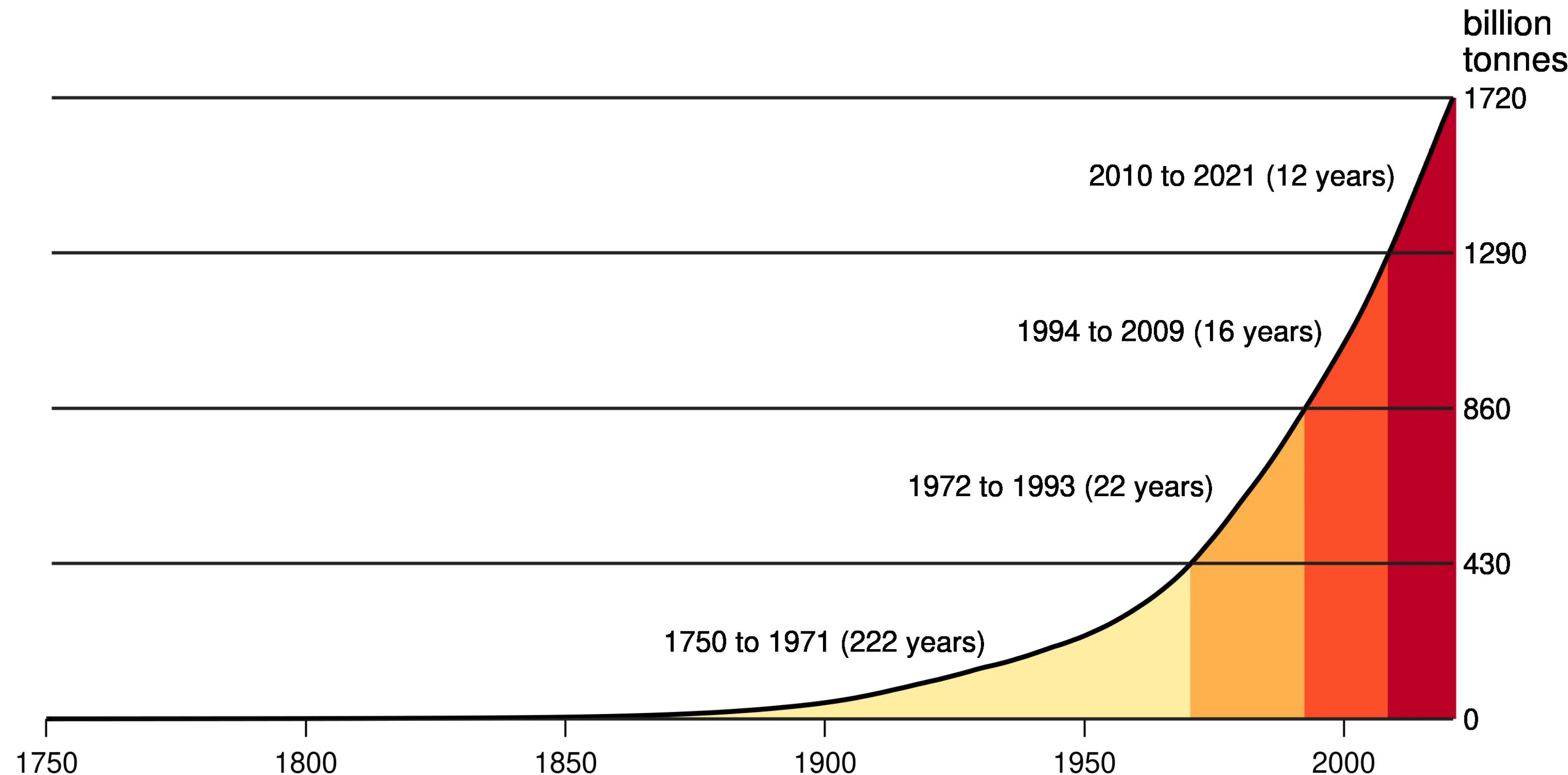
# **Part 1**

How psychology can help in the long-run

1. Understand overconsumption and habituation

# Climate change is fueled by **overconsumption**

**Exponential growth** in emissions!



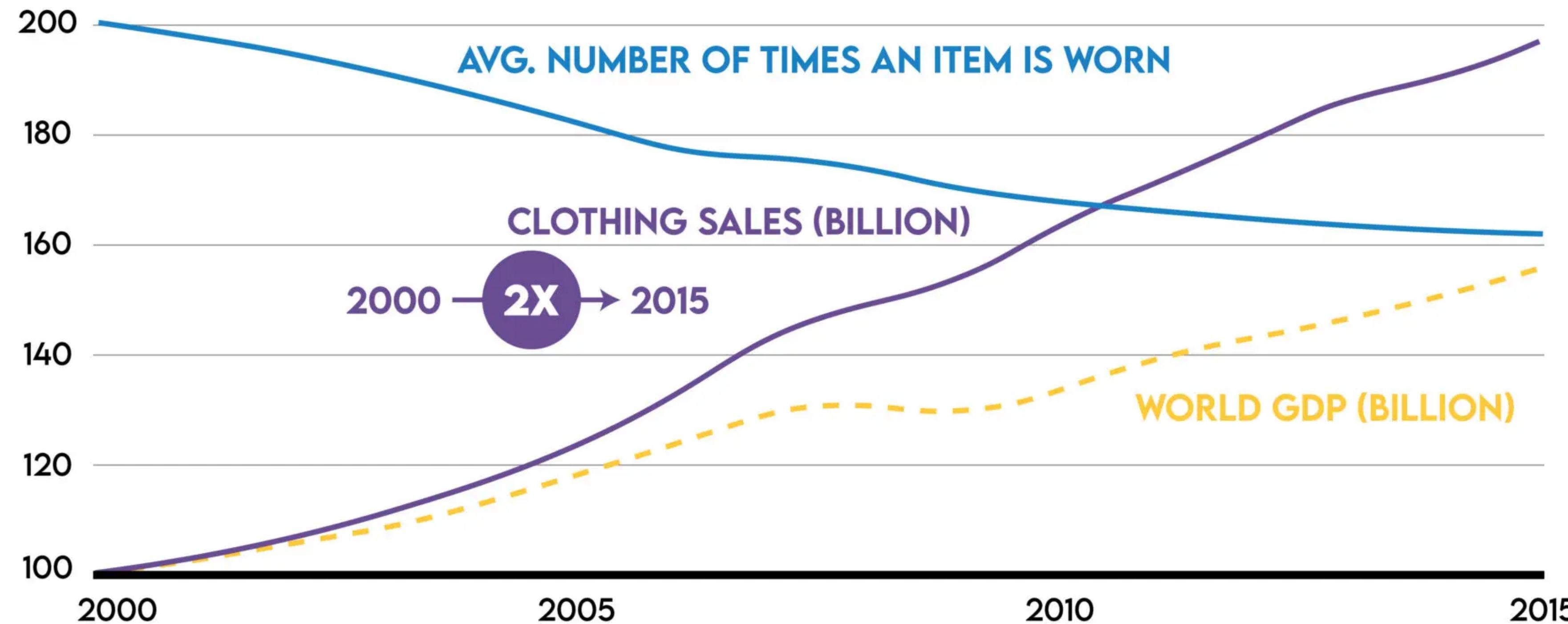
Data source: Friedlingstein et al (2020)  
created by: @neilrkaye

# Climate change is fueled by **overconsumption**

Half the fossil fuels and many  
other resources ever used by  
humans have been consumed in  
*just the past 30 years!*

[Steffen et al., 2015; Rees, 2018]

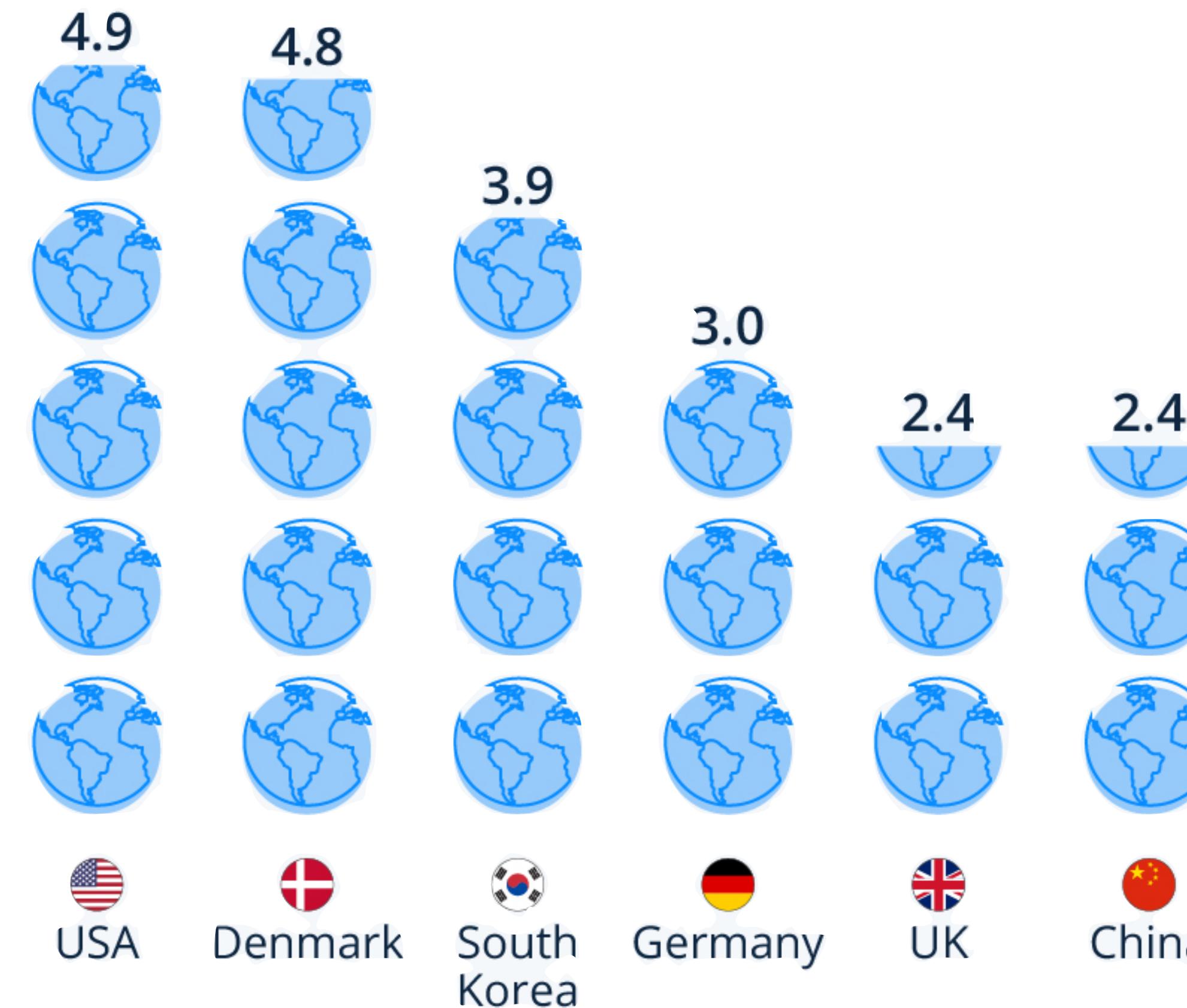
# Growth of **clothing sales** and decline in **clothing utilization** since 2000



SOURCE: ELLEN MACARTHUR FOUNDATION  
GRAPHIC BY: CRYSTAL FANG

# Consumption has grown **exponentially..** but the planet has not

Number of earths/its resources needed if the world's population lived like the following countries:



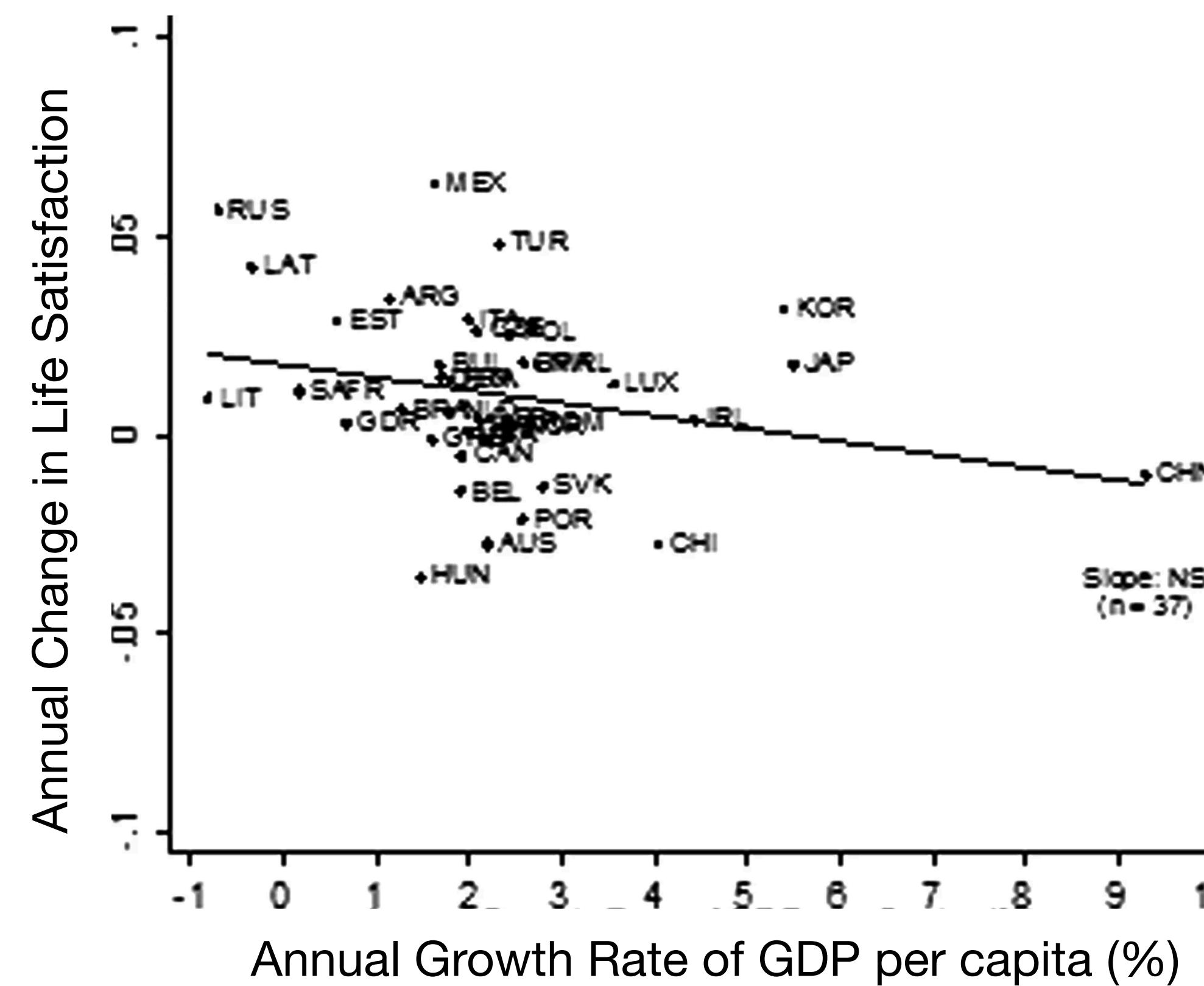
Selected countries. Calculated based on 2022 data estimates

Source: Global Footprint Network

To address environmental issues, it is important to understand **overconsumption**

# Is increased consumption increasing happiness?

Over long-term, happiness does not increase as a country's income rises



Material purchases don't necessarily increase happiness

[Gilovich & Kumar 2015; Kumar et al., 2020]

Materialistic people are less happy

[Chancellor & Lyubomirsky, 2011; Wang et al., 2017]

# Why are we consuming so much then?

Happiness depends on two tragic relativities

**Habituation**

+

**Comparisons**

...can result in depression, materialism, and overconsumption

# My work

Deep dive

How habituation and comparisons influence an  
individual agents' behavior

Dubey, Griffiths, & Dayan (2022). *PLOS Computational Biology*

Ask me during Q&A

How agents should manage multiple needs

Dulberg, Dubey, Berwain, & Cohen (2023). *PNAS*

How multiple agents can solve a resource consumption  
problem in the face of habituation and comparisons

*Work in progress*

## **Research question**

Why do we habituate and compare?

These relative features might have offered evolutionary advantages

[Nesse, 1990; Buss, 2000; Nesse 2004; Kovac, 2012; Euba, 2021]

Habituation and comparisons might be optimal in presence of uncertainty, noise, or costly computation

[Rayo & Becker 2007; Rangel & Clithero 2012; Palminteri & Lebreton, 2021; Hunter & Daw, 2021]

We analyze the costs and benefits of these features by adopting the framework of Reinforcement Learning

Habituation and comparisons could have been favored due to the ***learning*** advantages they confer

# **Study:** Why do we habituate and compare?

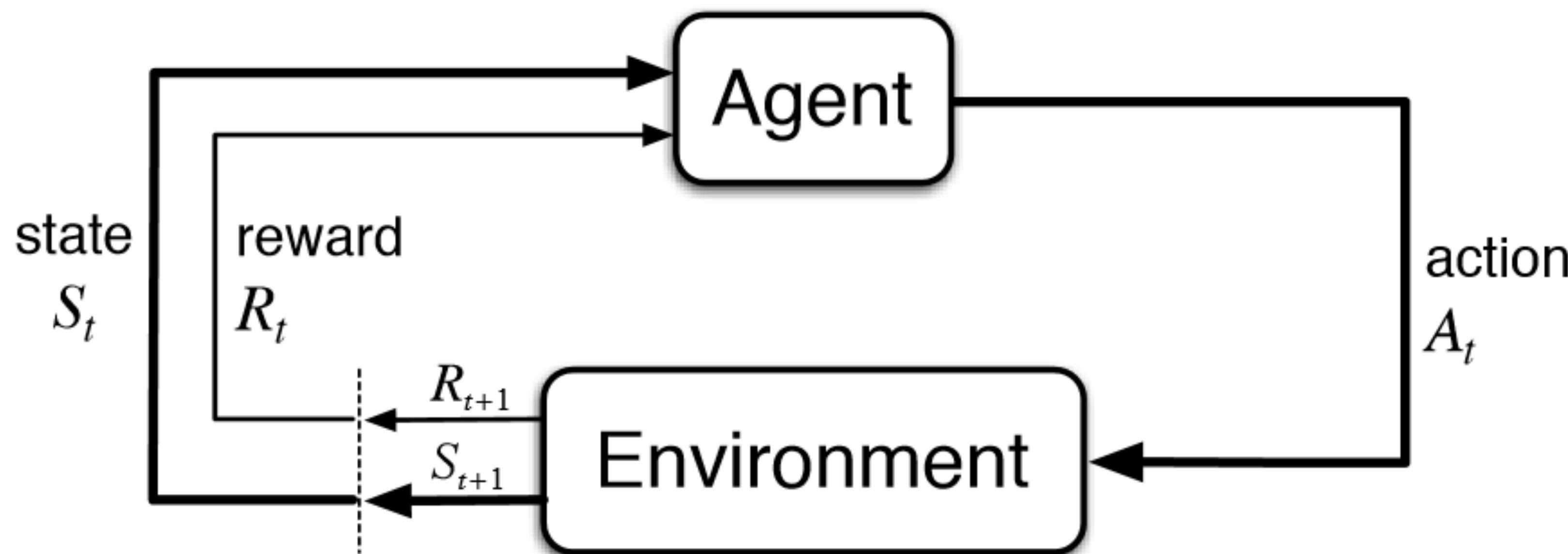
A reinforcement learning perspective on habituation and comparisons

Dubey, Griffiths, & Dayan (2022). *PLOS Computational Biology*

- Background
- Methods
- Results

# Reinforcement Learning

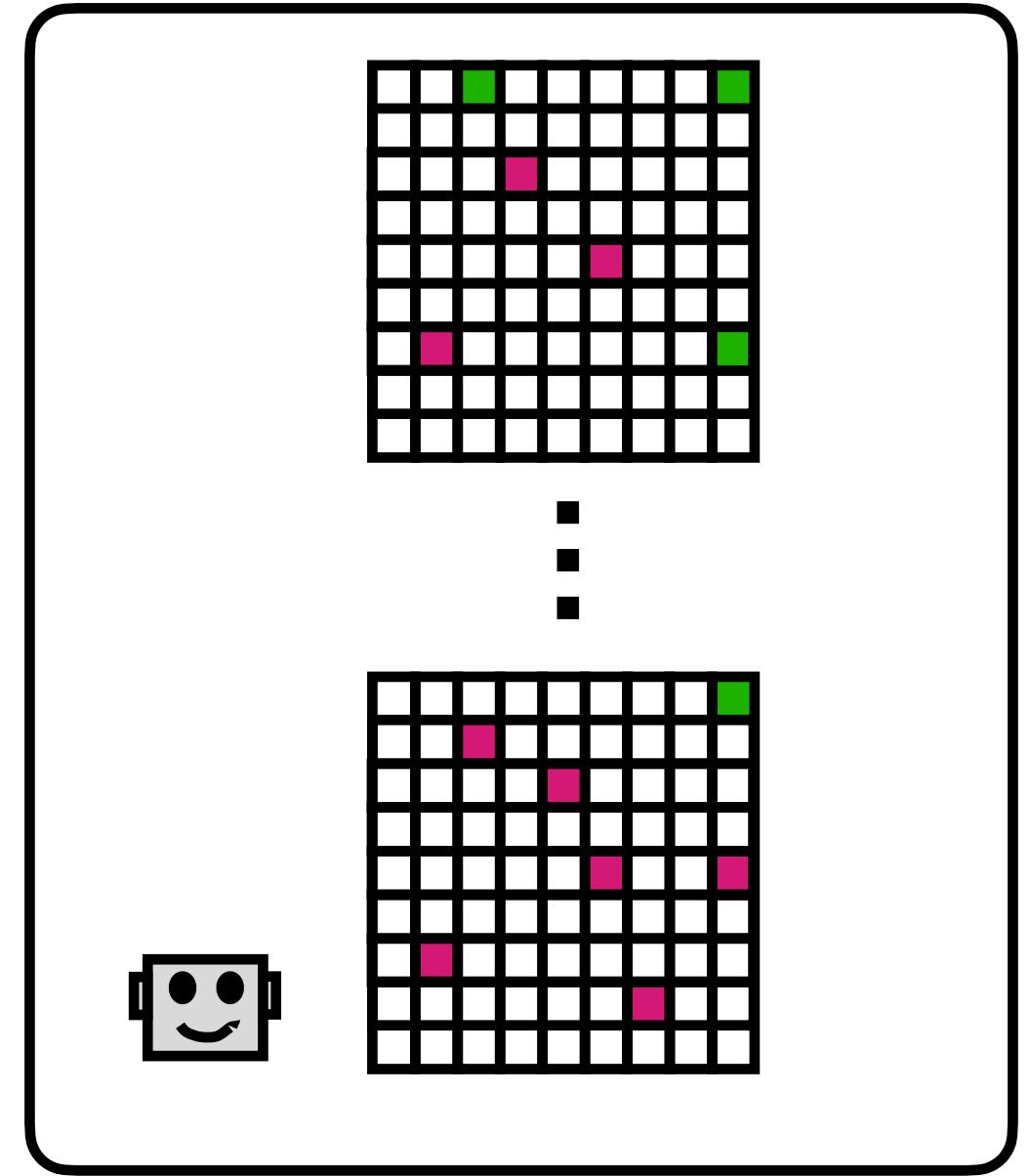
Describes how an agent learns to interact with an environment through *feedback*



# Reinforcement Learning

Describes how an agent learns to interact with an environment through *feedback*





# Reward design

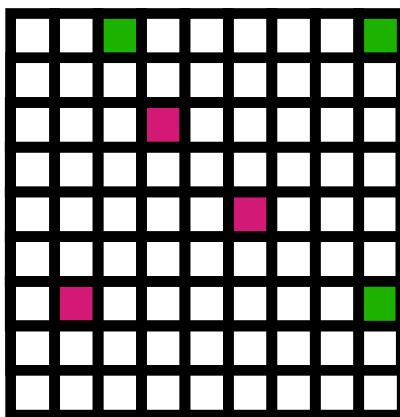
[Ng et al., 1999; Singh et al., 2010; Sorg et al., 2018]



- What reward function should I provide to the agent?

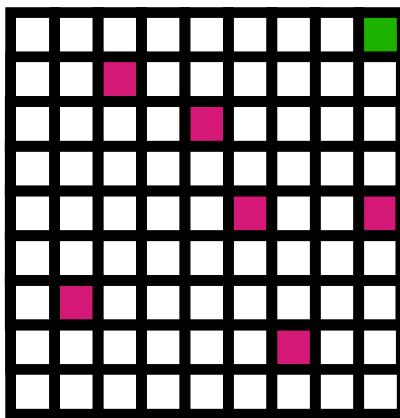
# Optimal Reward Framework [Singh et. al., 2010]

*What should the subjective reward function be in the agent's computation?*



:

**Challenge:** Learning from objective rewards alone is very hard



**Subjective reward function:** Agent's reward, provides useful feedback

**Optimal reward:** Subjective reward that bests achieves the designer's objective

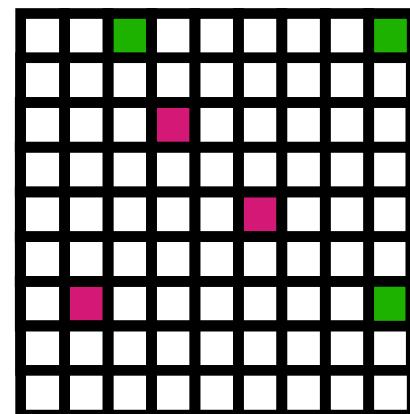
o



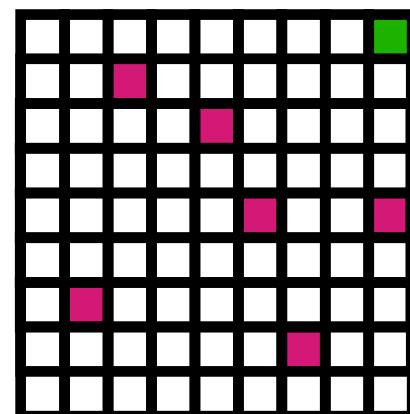
**Objective reward function:** Agent-designer's goal

# Habituation and comparisons as useful reward signals

Environments with  $w_2 \neq 0$  and  $w_3 \neq 0$  can provide insights!



⋮



Each possible ***subjective*** reward function takes the form:

$$f = w_1 \cdot \text{Objective} + w_2 \cdot \text{Habituate} + w_3 \cdot \text{Compare}$$

$$\text{Objective} = r_t$$

$$\text{Habituate} = r_t - Q(s_t, a_t)$$

$$\text{Compare} = r_t - \text{aspiration}$$

Derive optimal reward by performing dense grid search over  $w_i$  [0 to 1; 0.1]

Also searched aspiration,  $\epsilon$ , and  $\alpha$

○



**Designer's objective:** maximize expected return  $J_t = \sum_{t=t}^T r_t$

# **Study:** Why do we habituate and compare?

A reinforcement learning perspective on habituation and comparisons

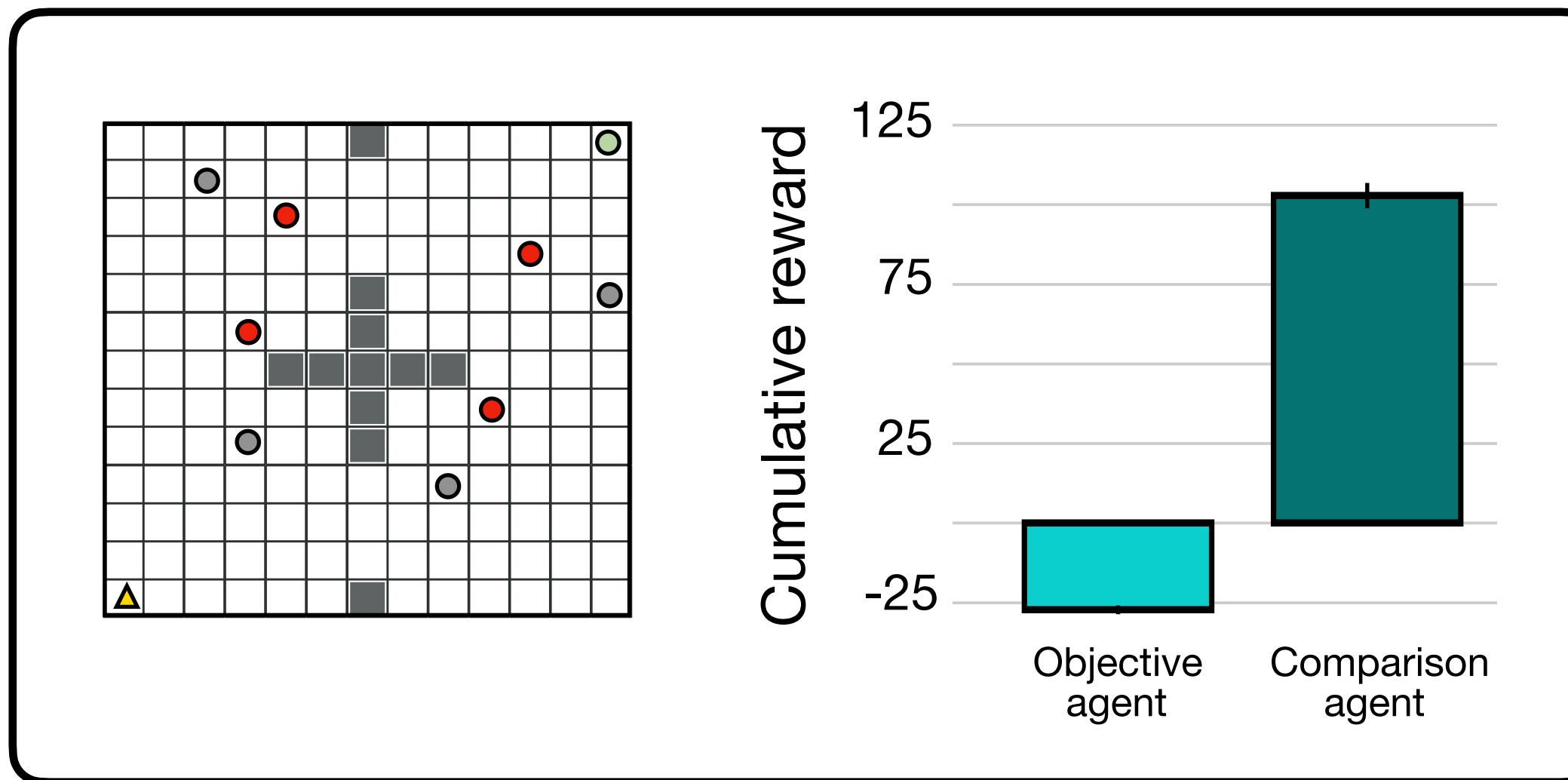
Dubey, Griffiths, & Dayan (2022). *PLOS Computational Biology*

- Background
- Methods
- Results

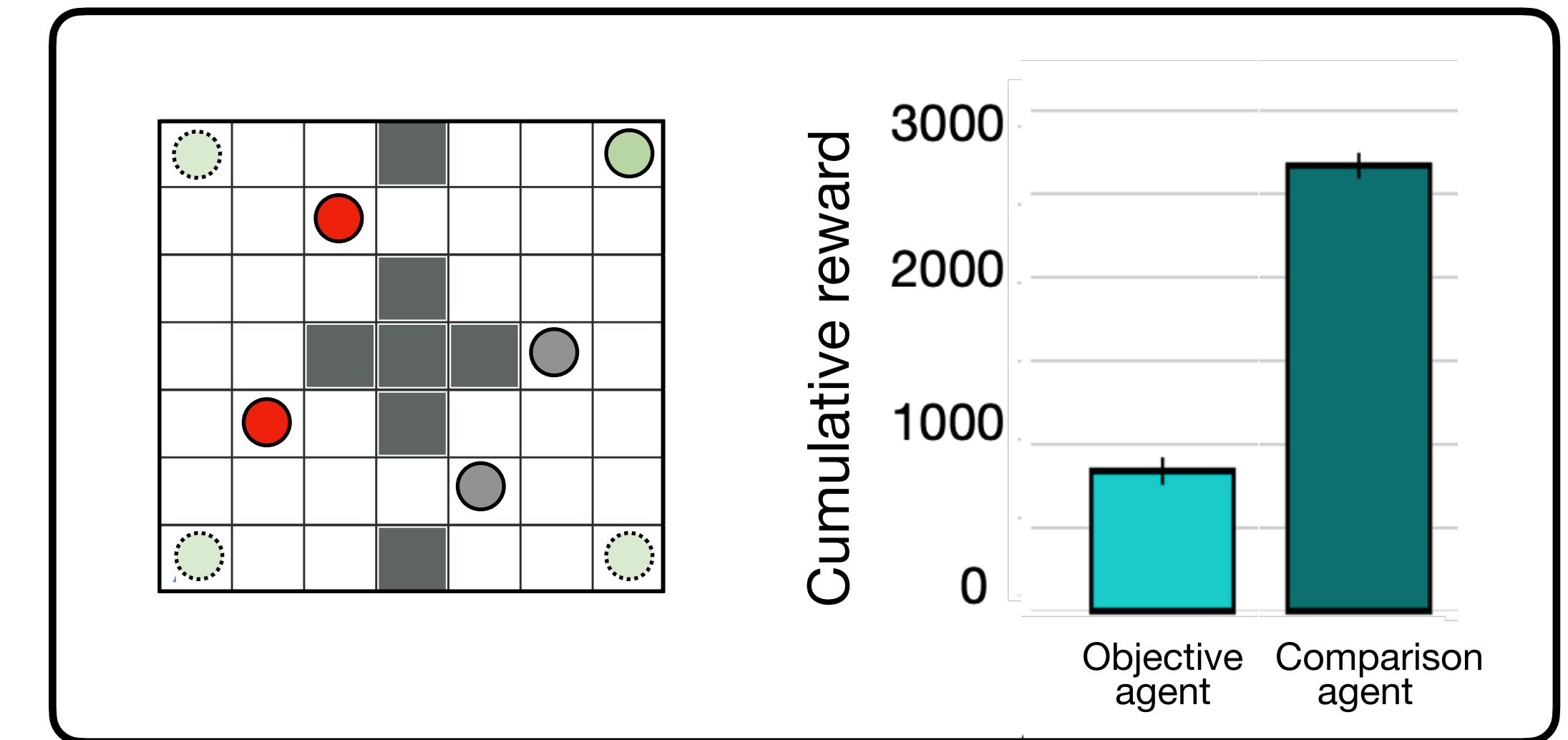
# Finding 1:

Comparisons significantly speed learning in all environments

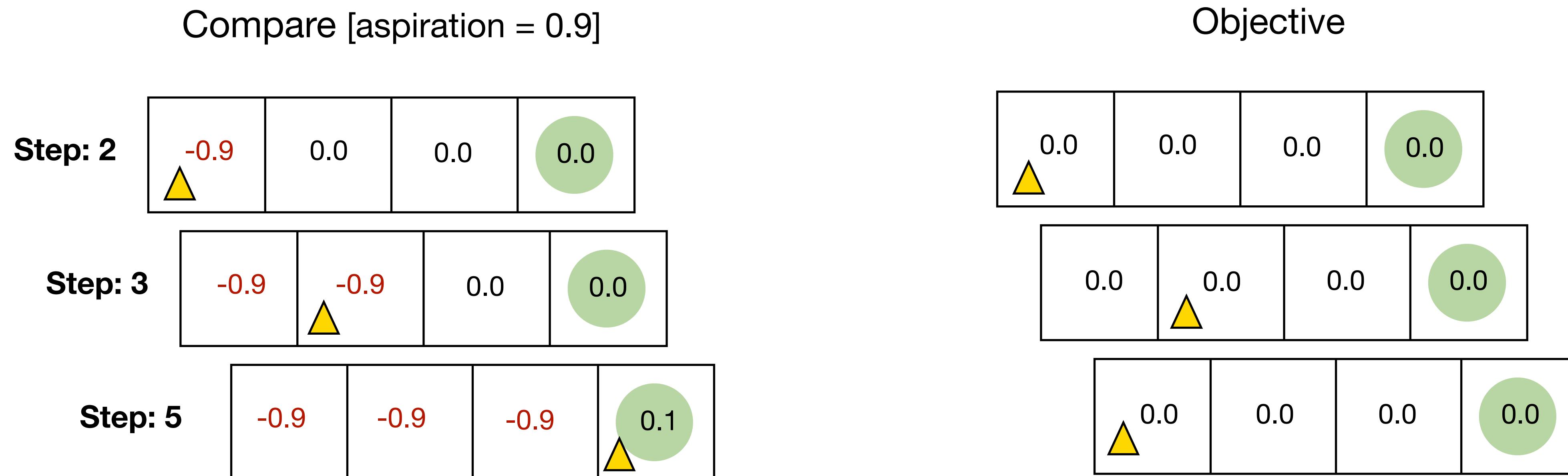
Sparse environments



Non-stationary environments



# Comparison provides an *exploration* incentive



Note: number in grid represents value of state

## **Finding 2:**

Exploration induced by comparisons is more efficient than exploration induced by optimistic initialization

Comparisons encourage exploration by inducing ***pessimism***

**Alternative:** Encourage exploration via ***optimistic*** initialization

[Sutton 1991; Dayan & Sejnowski, 1996]

Objective agent

0.0	0.0	0.0	0.0
▲			

0.0	0.0	0.0	0.0
▲			

Optimistic initialization

1.0	1.0	1.0	1.0
▲			

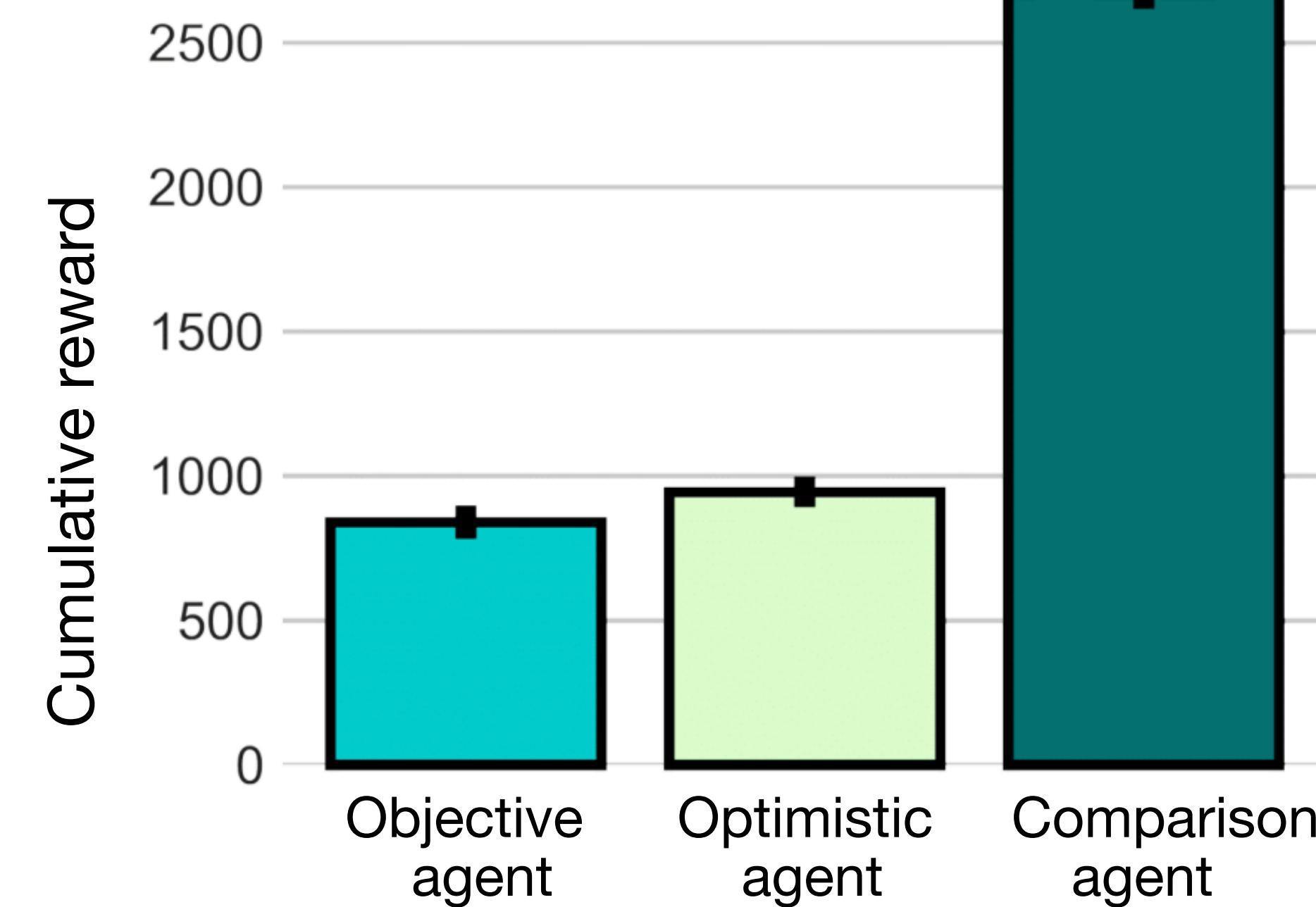
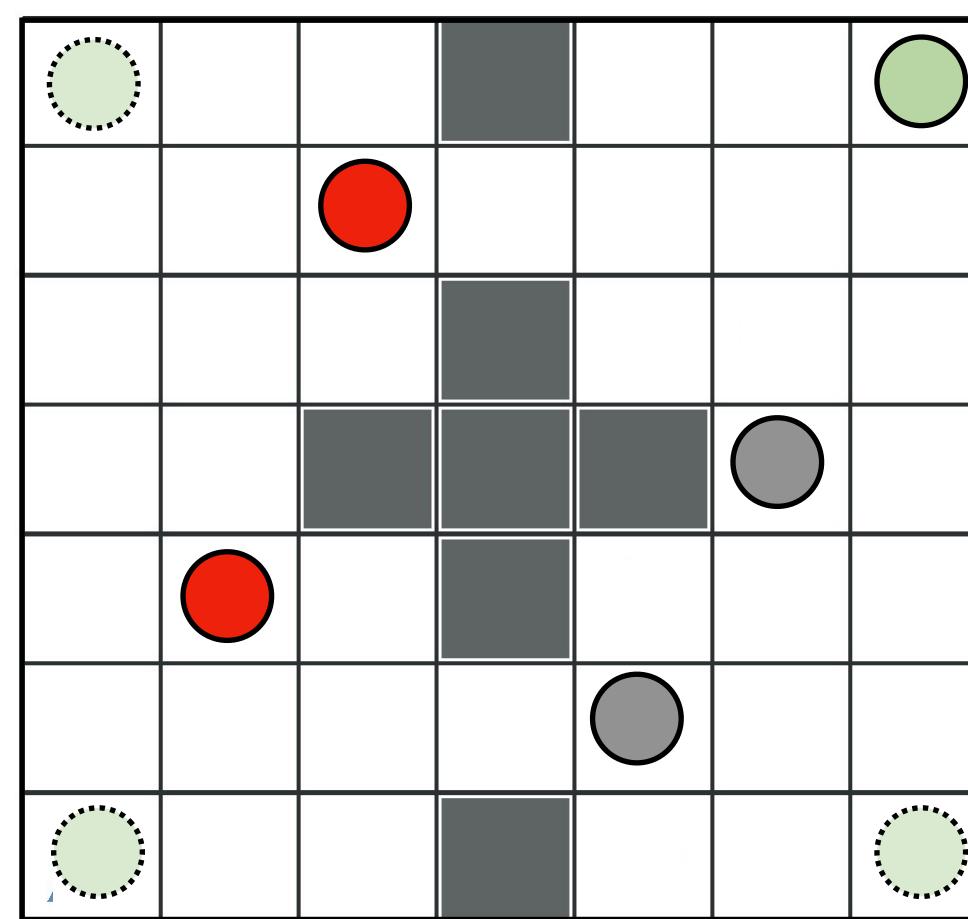
0.0	1.0	1.0	1.0
▲			

# Optimism vs. pessimism

Comparison agents perform better than optimistic agents in non-stationary settings

**Optimistic initialization is temporary; comparisons are forever**

Non-stationary environments

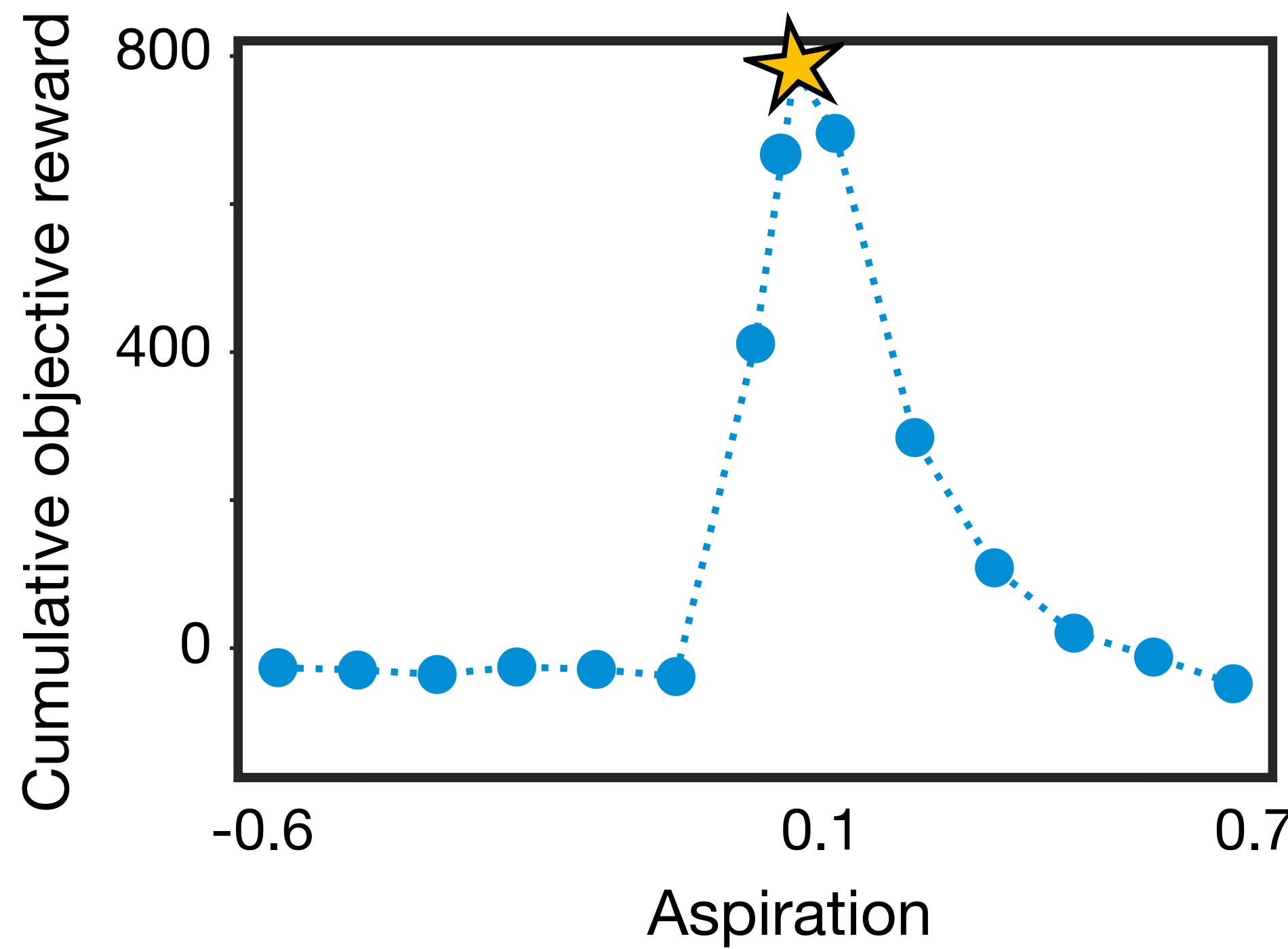


## **Finding 3:**

When and why comparisons become *maladaptive*

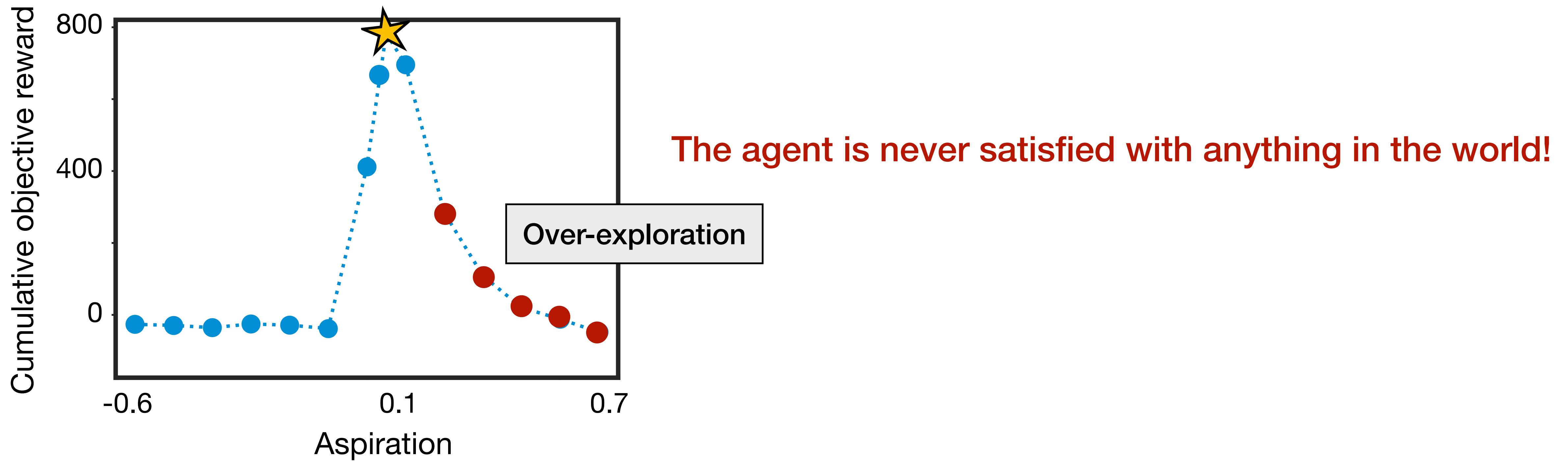
# Maladaptive comparisons

Comparisons are only useful when  
aspiration is set properly!



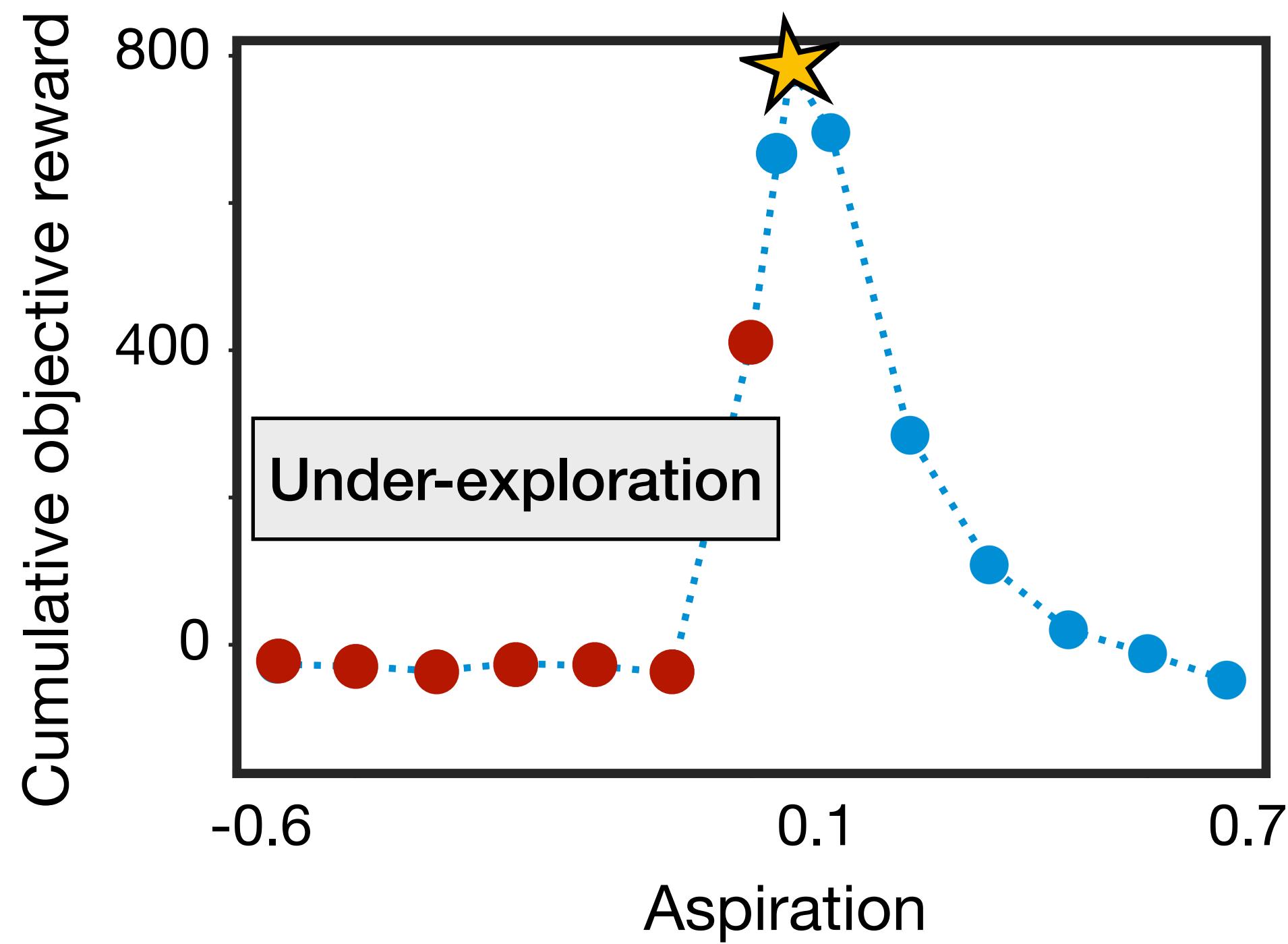
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# Maladaptive comparisons

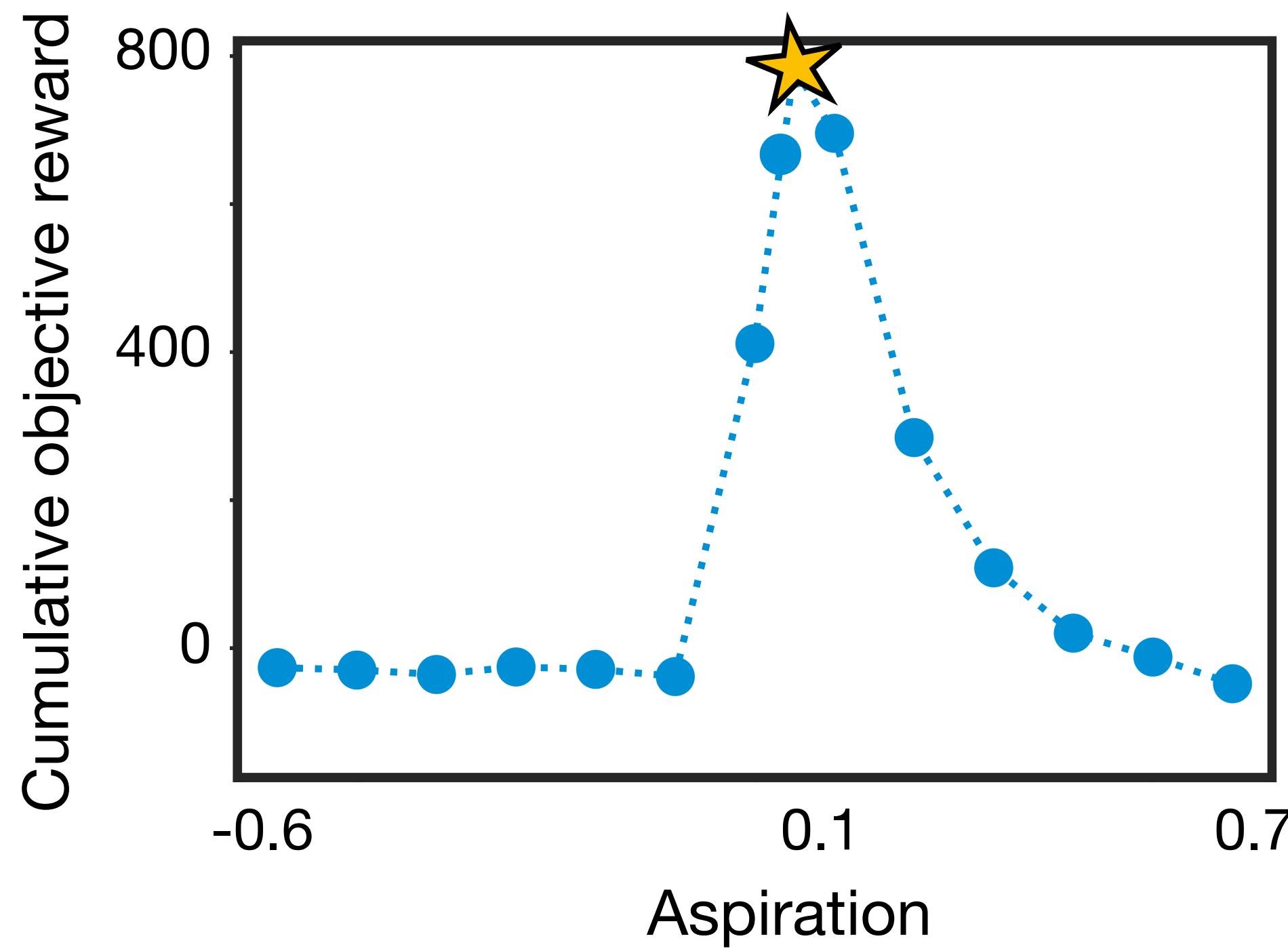
Comparisons are only useful when aspiration is set properly!



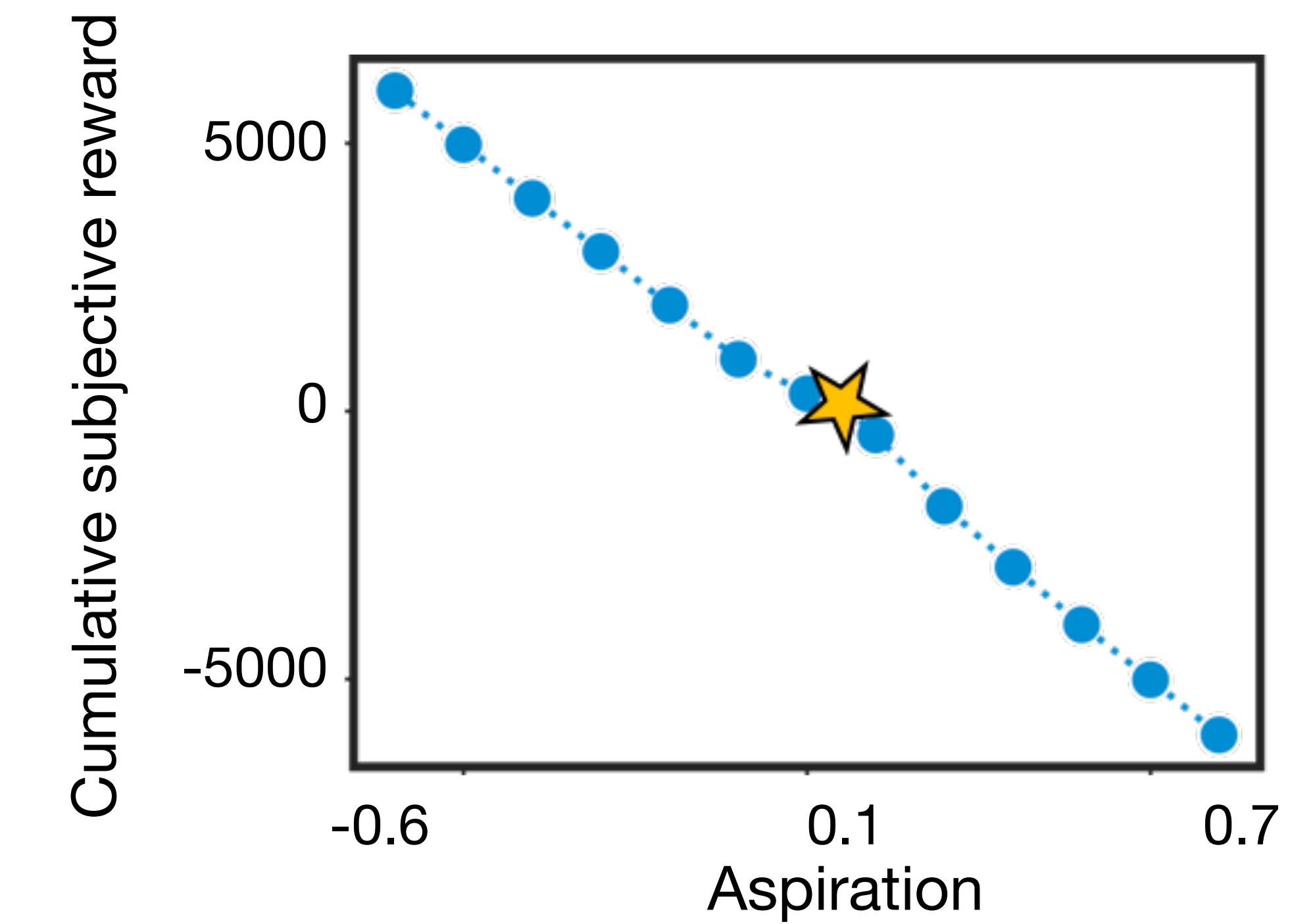
The agent is satisfied too easily!

# Maladaptive comparisons

Comparisons are only useful when aspiration is set properly!



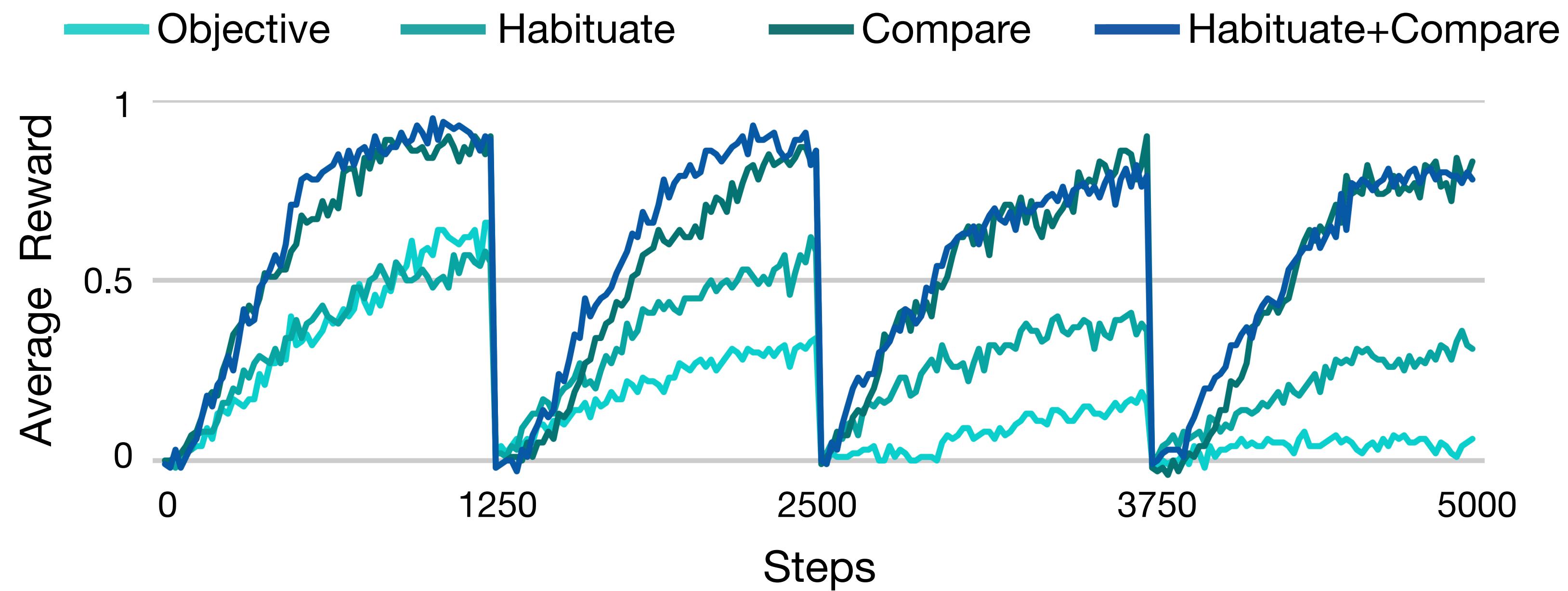
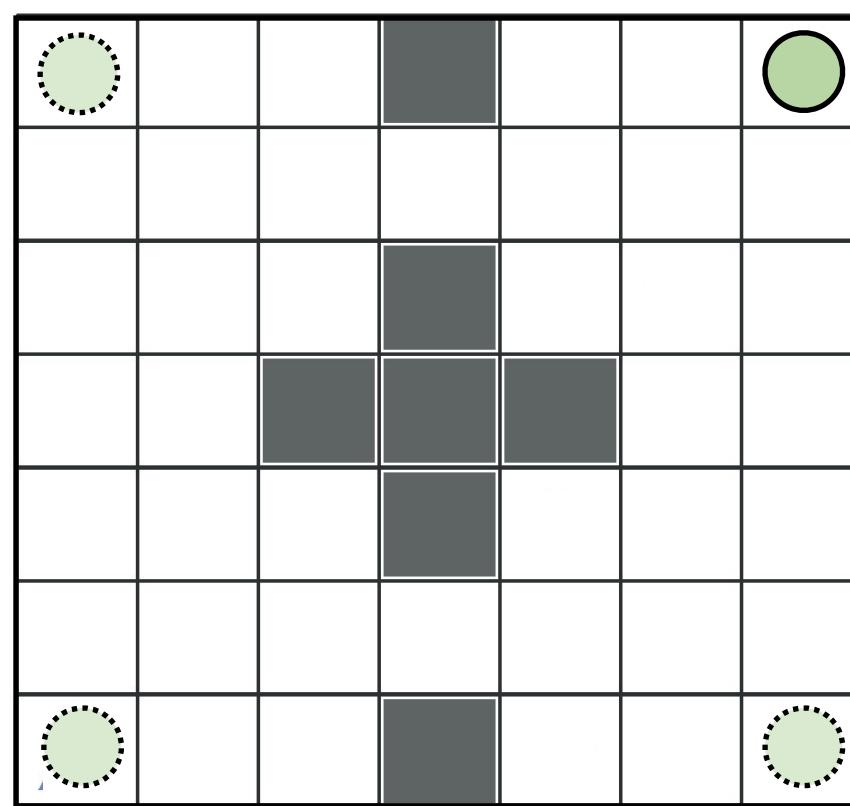
Trade-off between objective and subjective reward



## **Finding 4:**

### When and why habituation helps an agent

# Habituation improves learning in *non-stationary* environments



# **Study:** Why do we habituate and compare?

A reinforcement learning perspective on habituation and comparisons

Dubey, Griffiths, & Dayan (2022). *PLOS Computational Biology*

- Background
- Methods
- Results
- Takeaways

## **When and why do habituation and comparisons help us?**

These presumed “flaws” play an important role in promoting adaptive behavior

They facilitate learning when rewards are infrequent and help adapt to environmental changes

## **When do they become maladaptive?**

They can quickly become maladaptive in many modern-day situations, where we are constantly bombarded with new luxuries

# Implications

From a computational viewpoint, it might be *optimal* to design agents that always want more

*Computational perspective: Overconsumption might be a deeply rooted bias*



Requires fundamental investigation on how to manage these biases of the human mind

# How psychology can help in the long-run

## 1. Understand overconsumption and habituation

Future directions

### **Computational underpinnings of overconsumption** (aka how to be happy with less)

People are willing to pay more for “rare” products [Snyder, 1992; Stephens et al., 2007]

**Research question:** Why do we cherish rare rewards?

We don’t appreciate things when they are widely available [Rothenhoefer et al., 2021]

**Research question:** Why does abundance cause value-depreciation?

# **How psychology can help in the long-run**

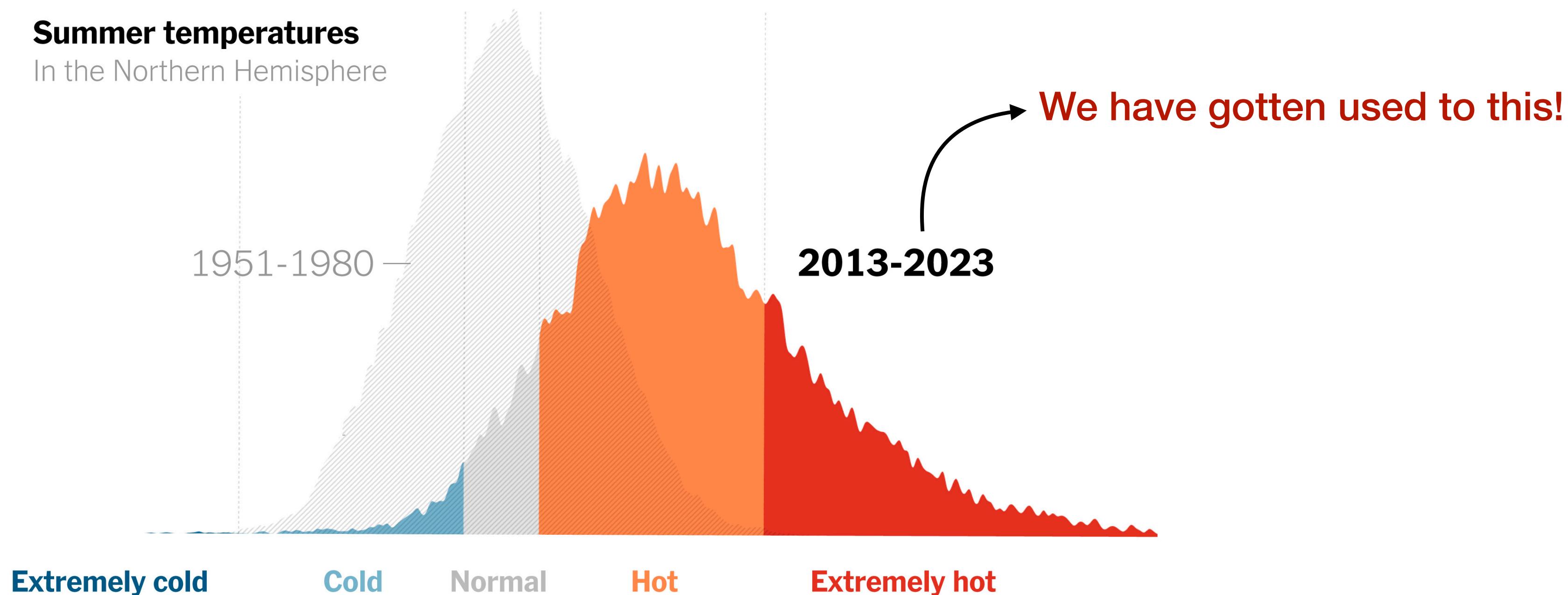
1. Understand overconsumption and habituation
2. Understand habituation to worsening events

**Previously:** How people adapt and get used to **good** things

Dubey, Griffiths, & Dayan (2022). *PLOS Computational Biology*

.. But people also adapt to **bad** events

Especially problematic in the context of climate change!



# The “Boiling Frog” effect

Humans get used to extreme weather disturbingly fast

RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES | ✓

f t in e Check for updates

## Rapidly declining remarkable temperature anomalies may obscure public perception of climate change

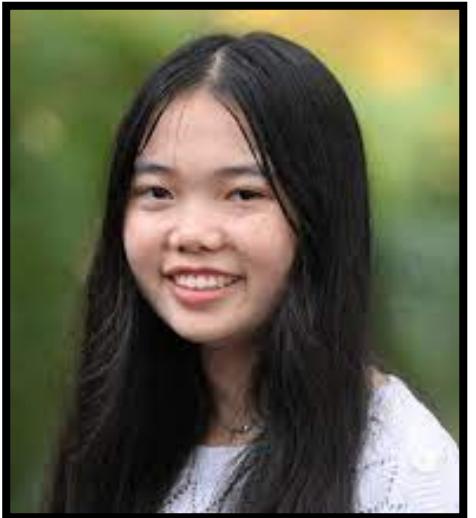
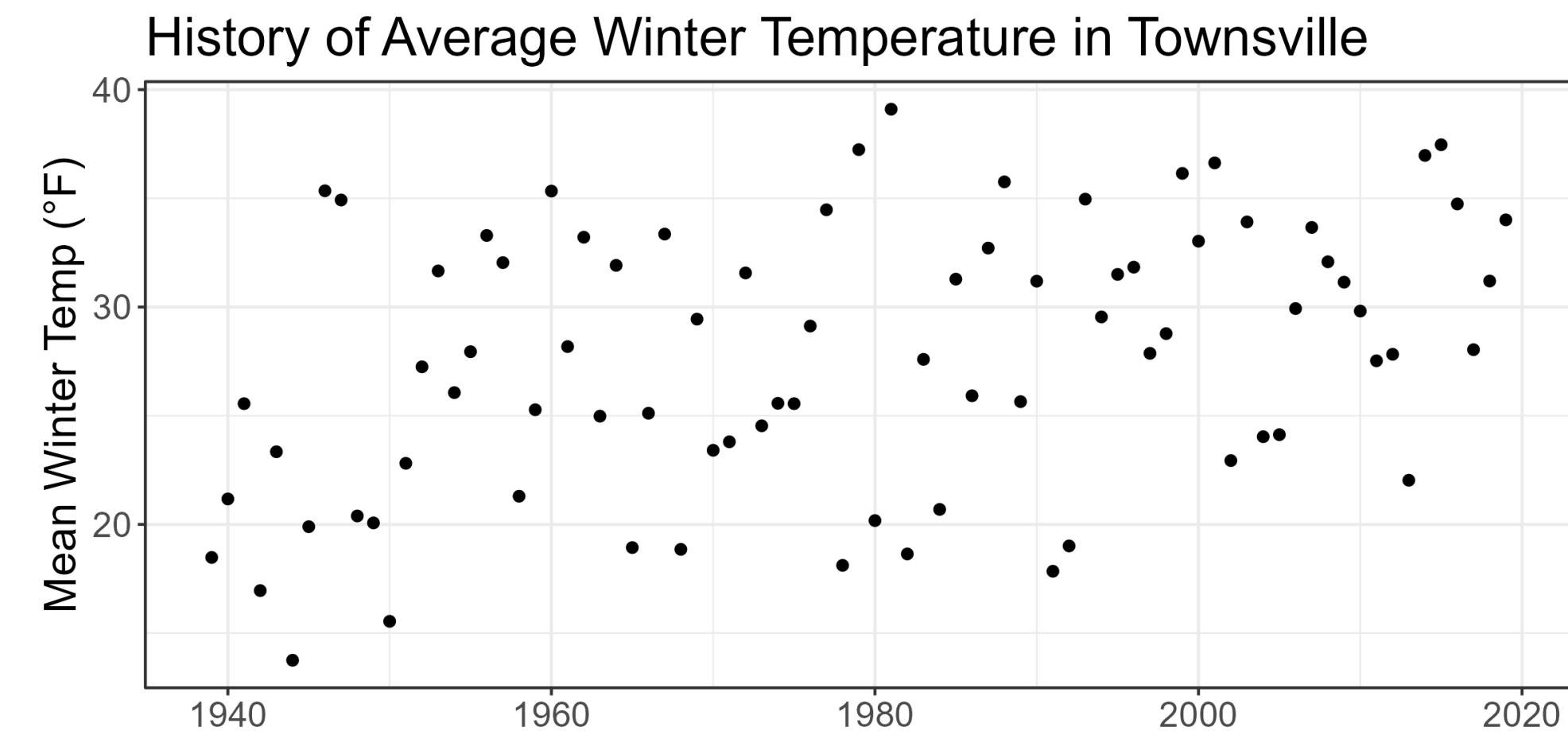
Frances C. Moore , Nick Obradovich , Flavio Lehner, and Patrick Baylis [Authors Info & Affiliations](#)

CLIMATE POLITICS SCIENCE

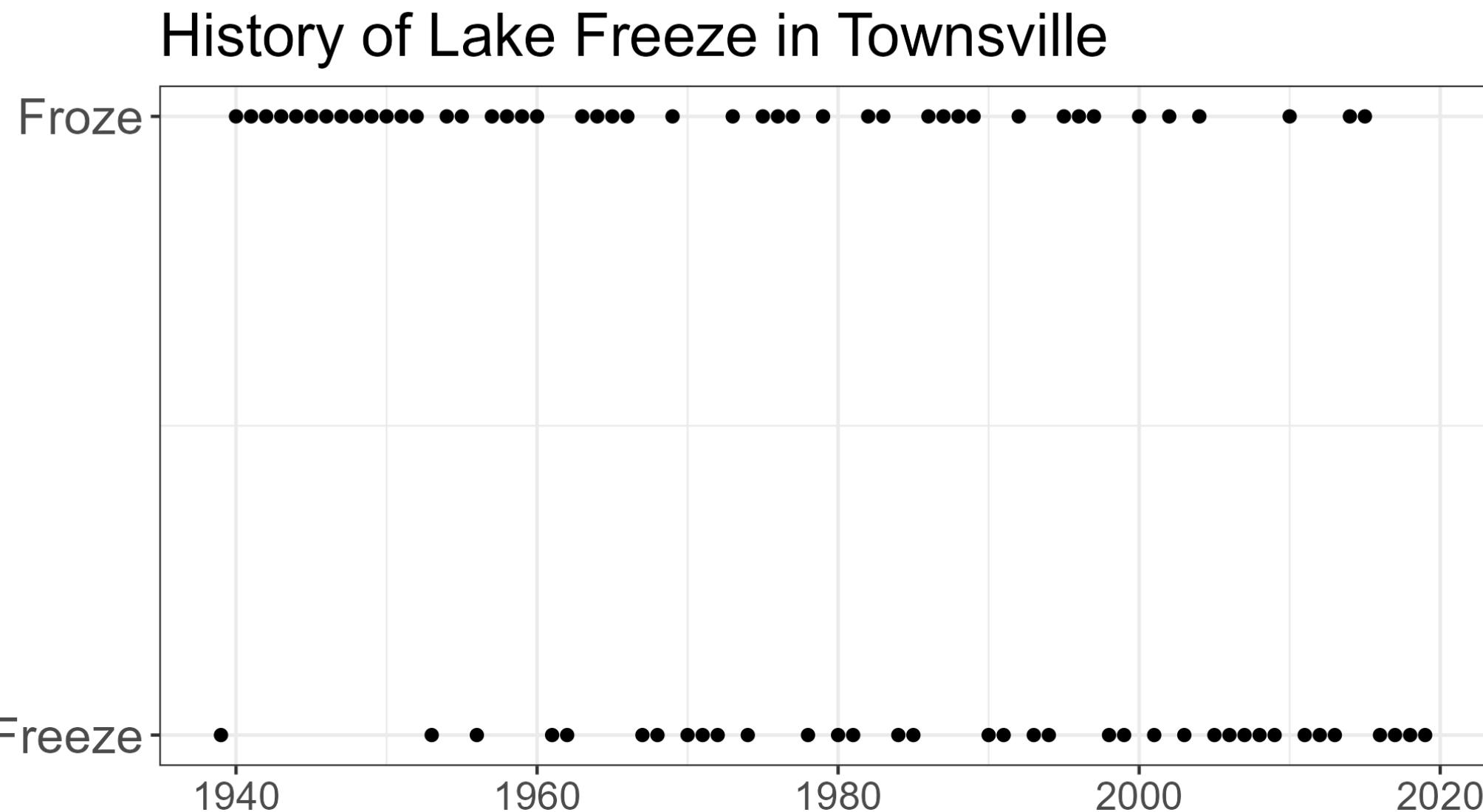
## Wildfire smoke reminded people about climate change. How soon will they forget?

Extreme weather and climate-linked disasters don't always lead to changes in public opinion.

# Ongoing work: Countering the boiling frog effect

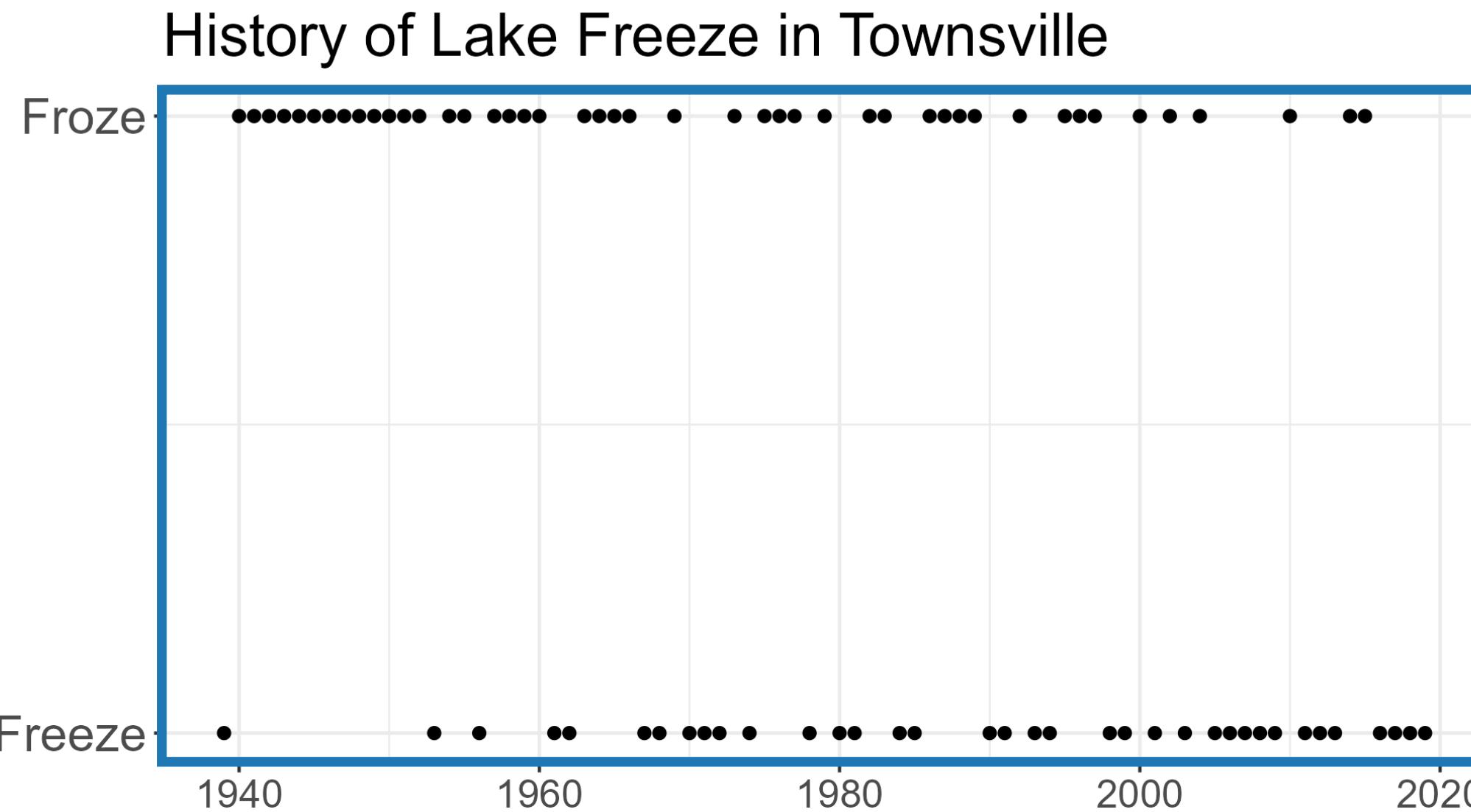
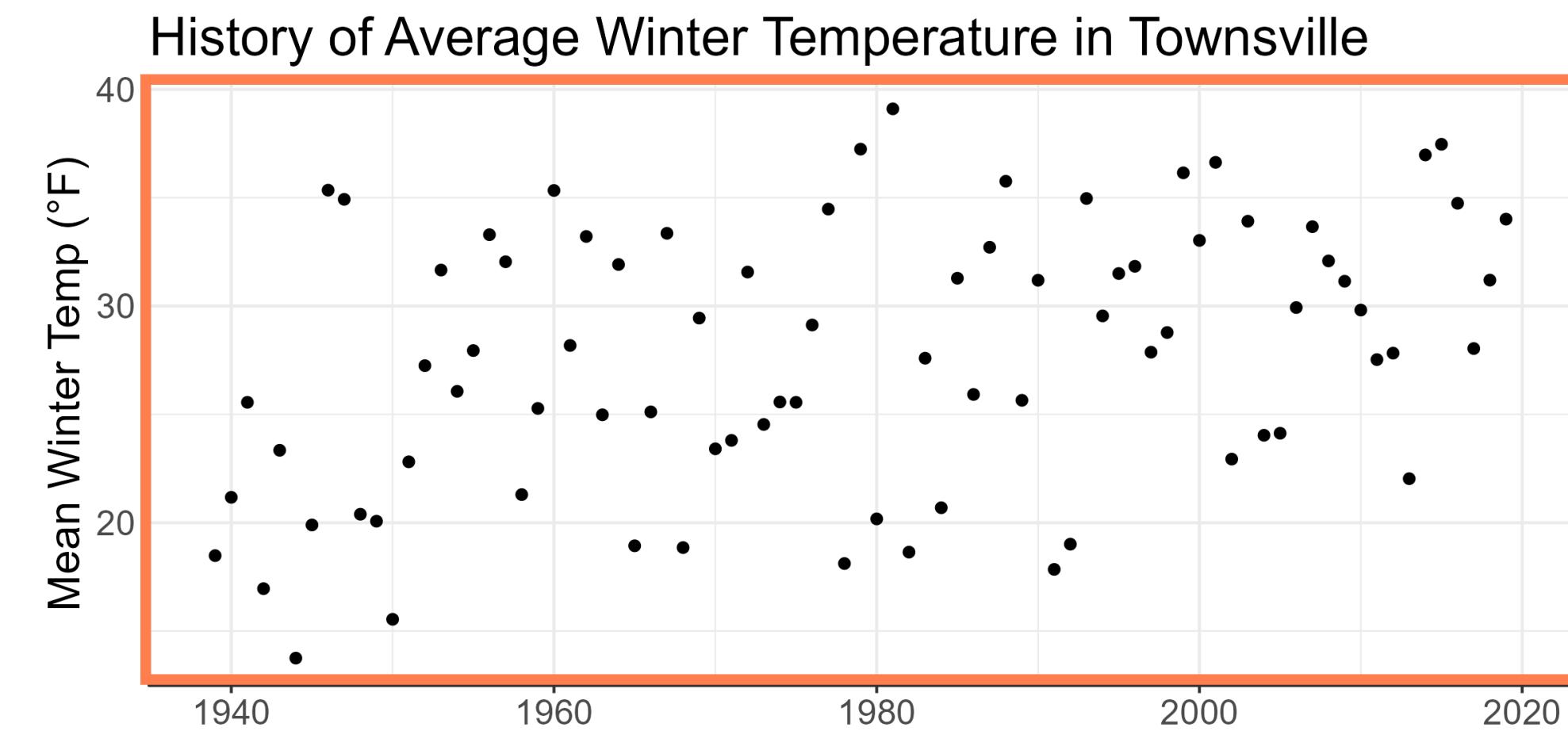


Student lead  
Grace Liu

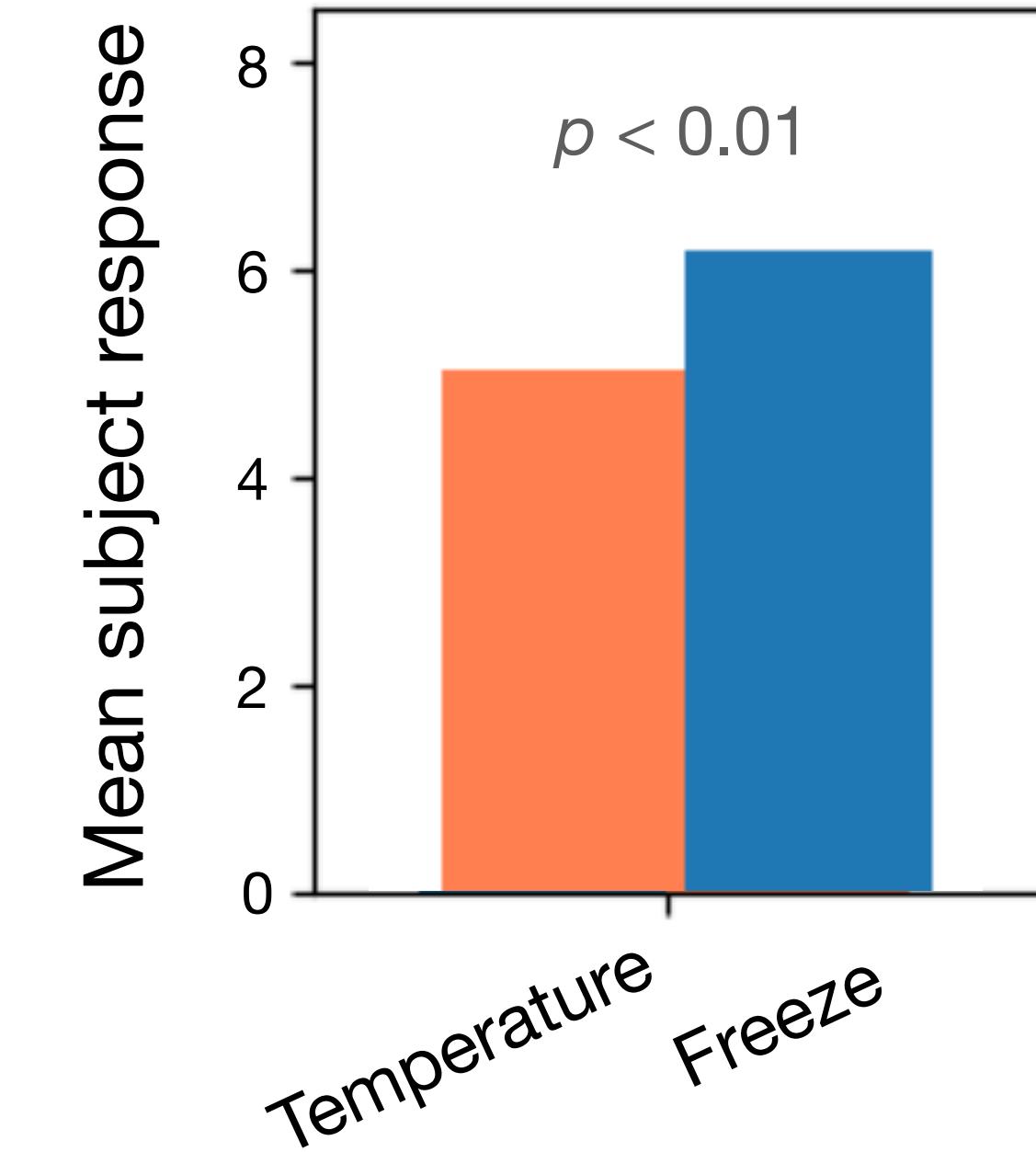


Both graphs have the **same** correlation

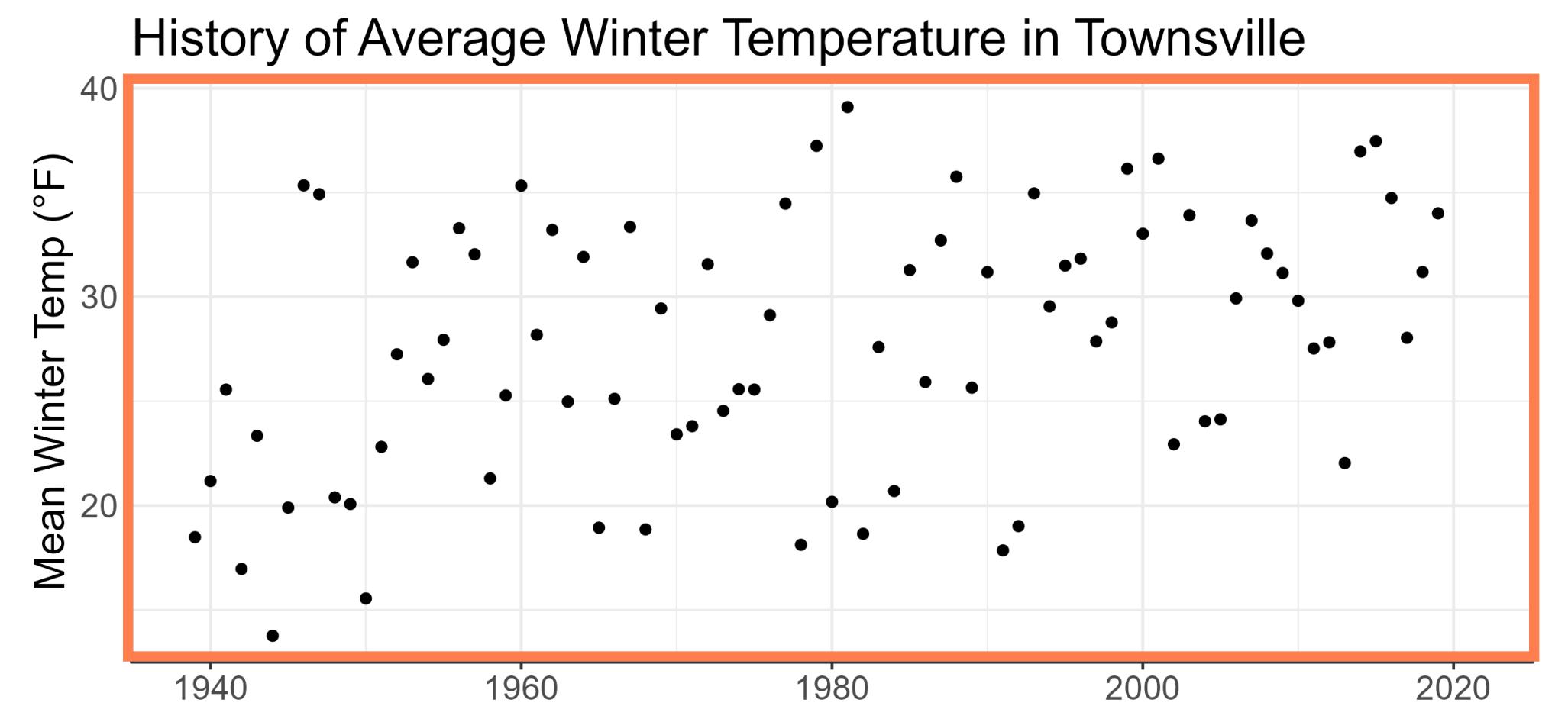
# Ongoing work: Countering the boiling frog effect



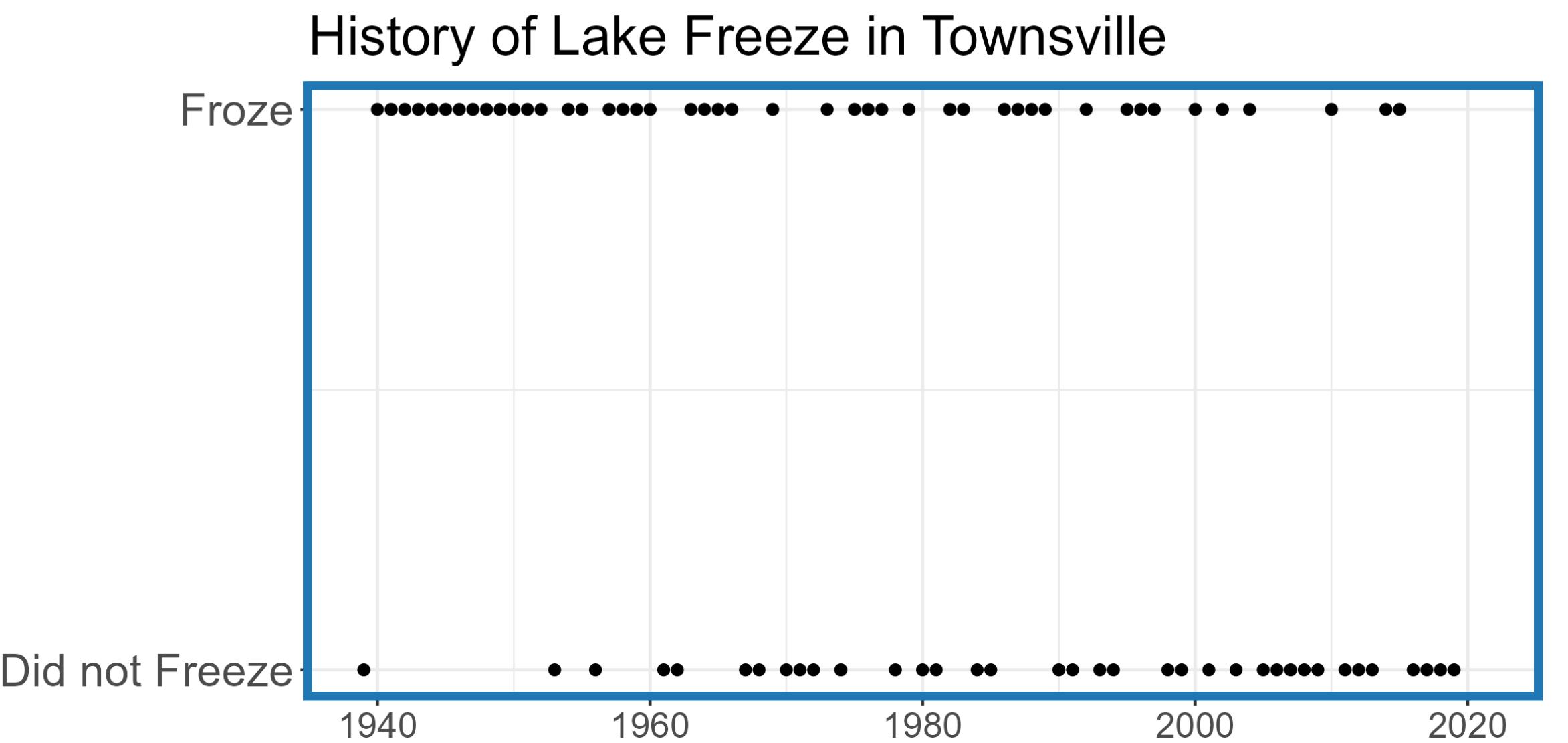
## Perceived change in climate



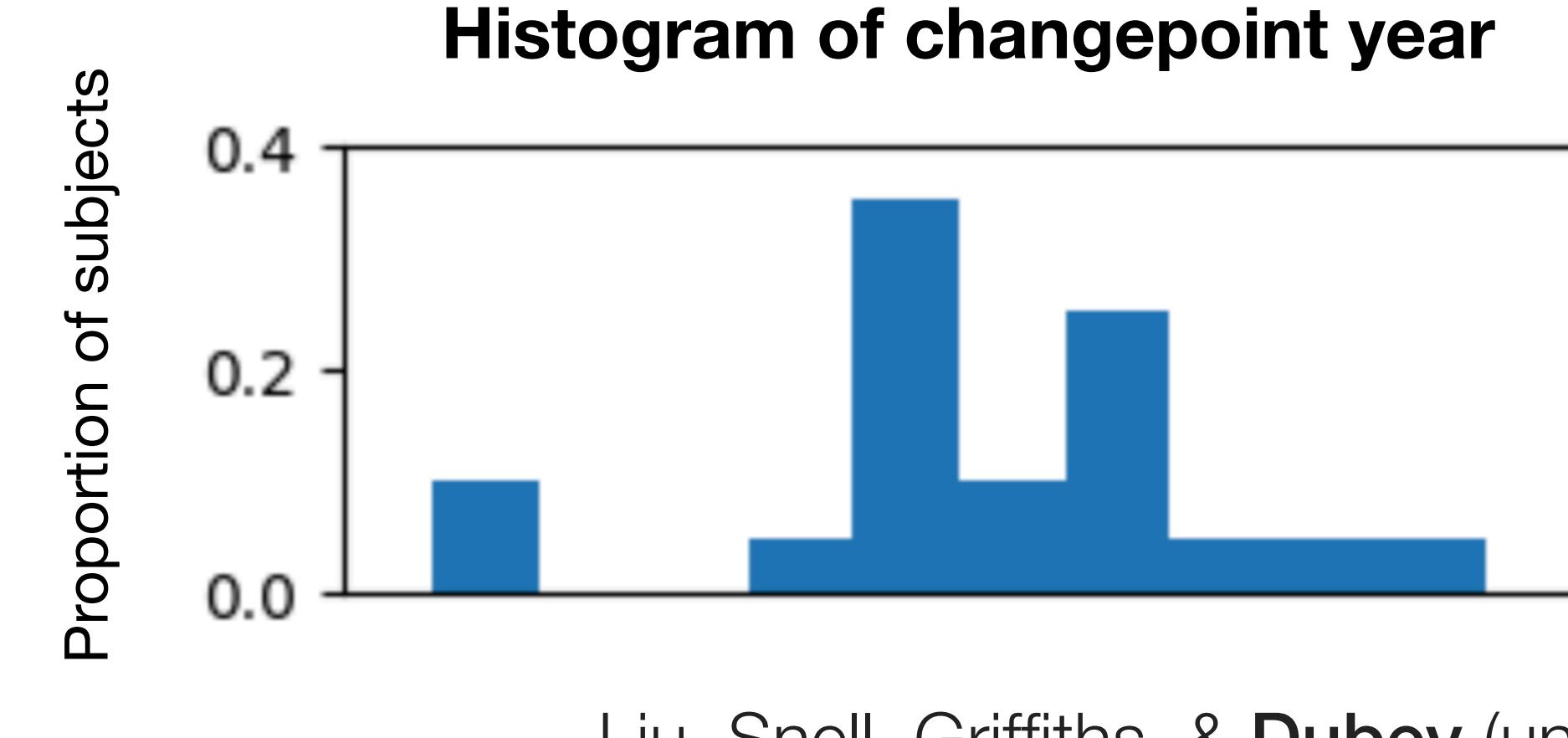
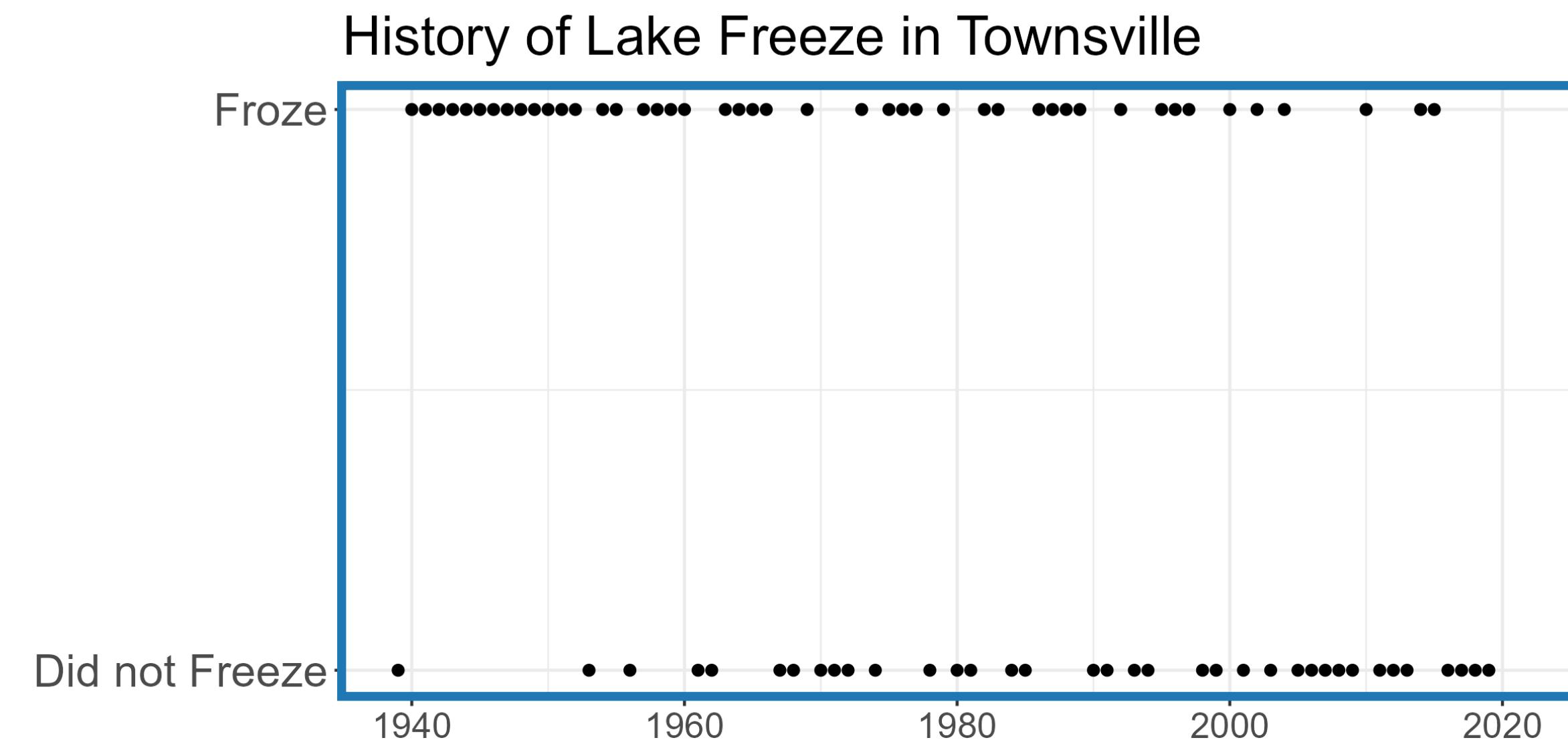
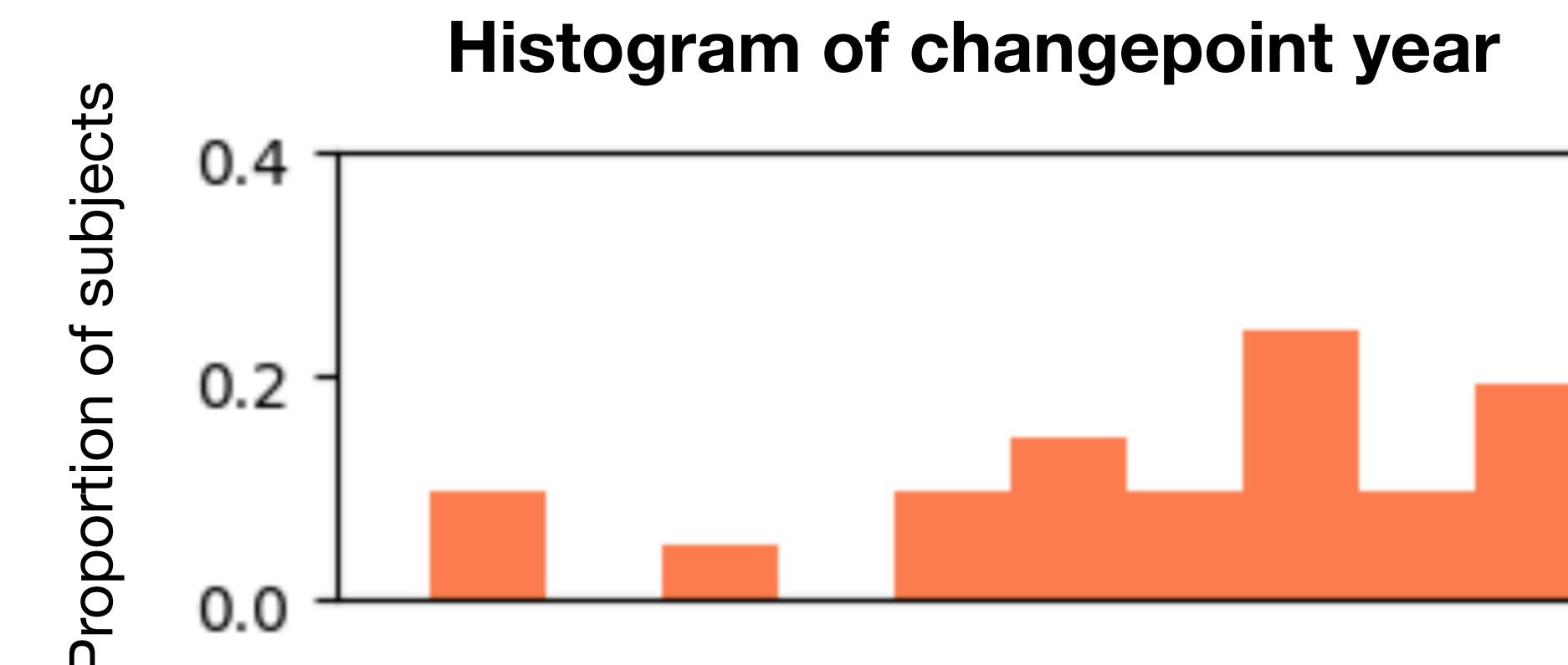
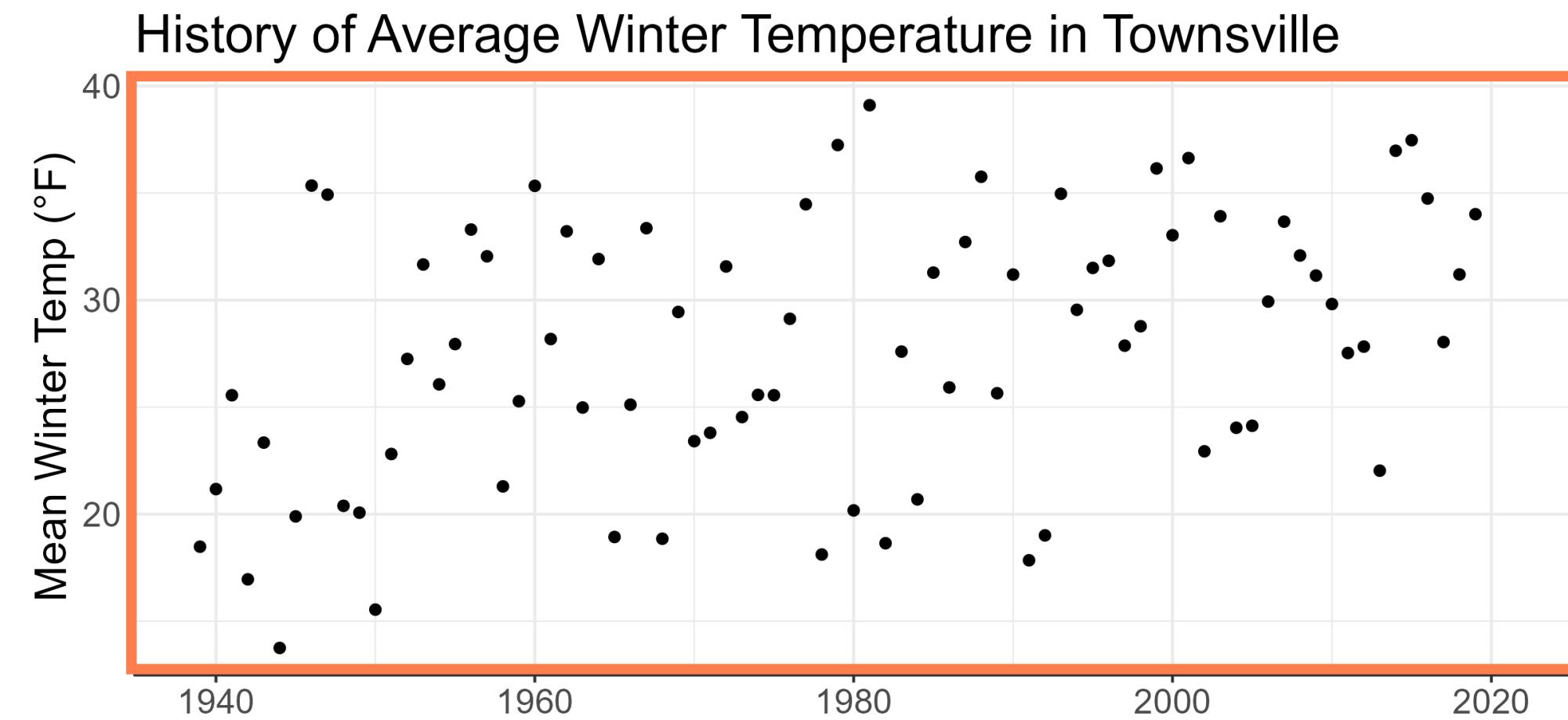
Student lead  
Grace Liu



Both graphs have no underlying changepoint



# An illusion of a changepoint in binary data...

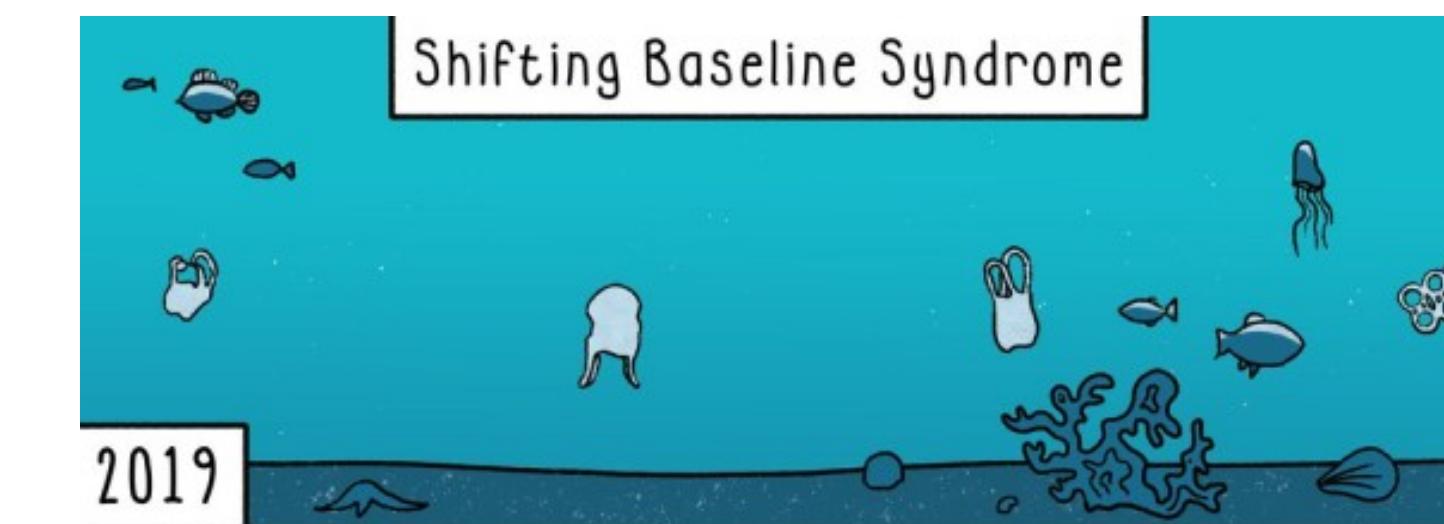
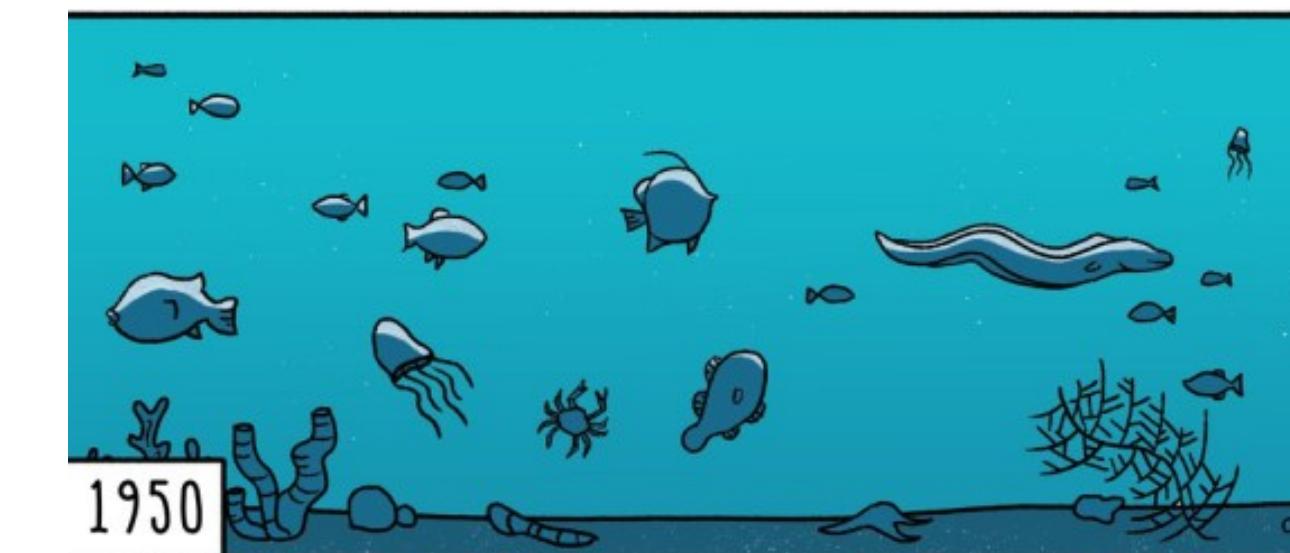
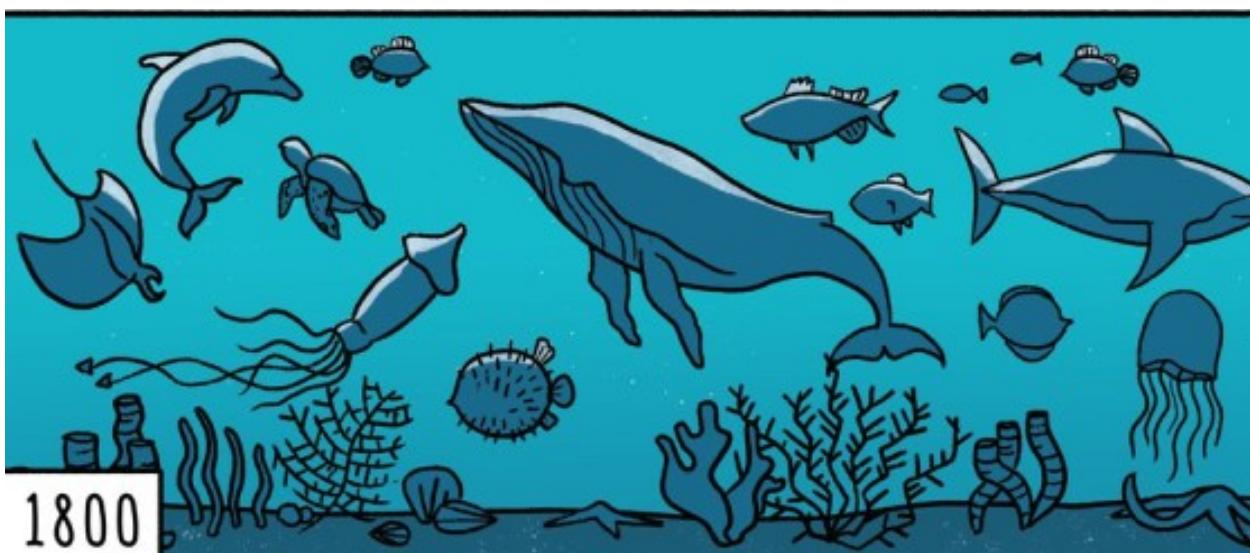


# How psychology can help in the long-run

1. Understand overconsumption and habituation
2. Understand habituation to worsening events

Future directions

**Shifting baseline syndrome** (aka boiling frog among generations)



# **How psychology can help in the long-run**

1. Understand overconsumption and habituation
2. Understand habituation to worsening events
3. Understand imagination in the context of climate change

■  
■  
■

# Part 2

How psychology can help in the short-run

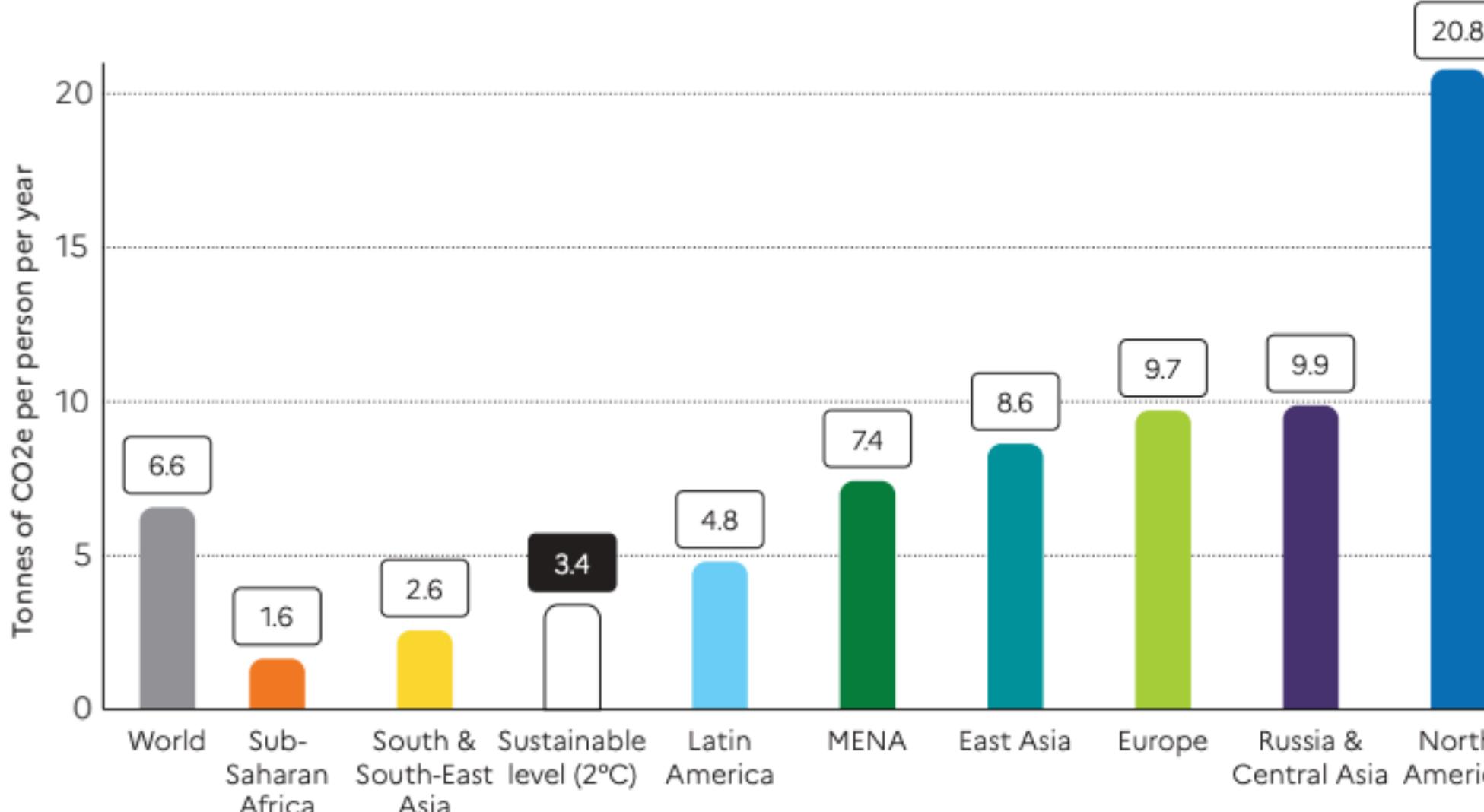
1. Motivate individuals to be more sustainable

# Which individuals to target?

Shifting the focus from the average individual to the **super-rich** is important

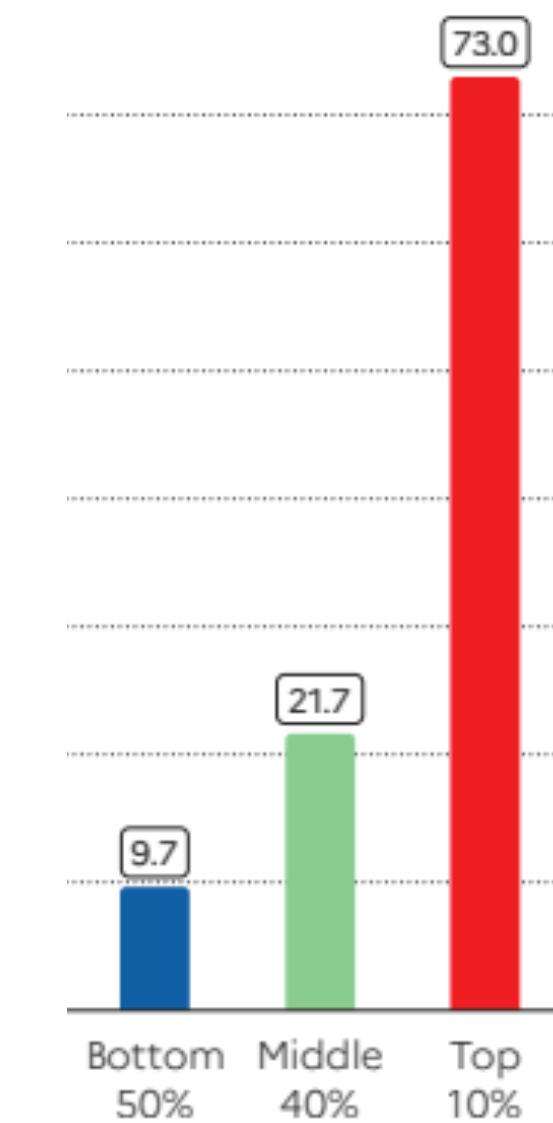
[Chancel, 2022; World Inequality Report, 2022]

**First glance:** reducing emissions of rich countries is important..

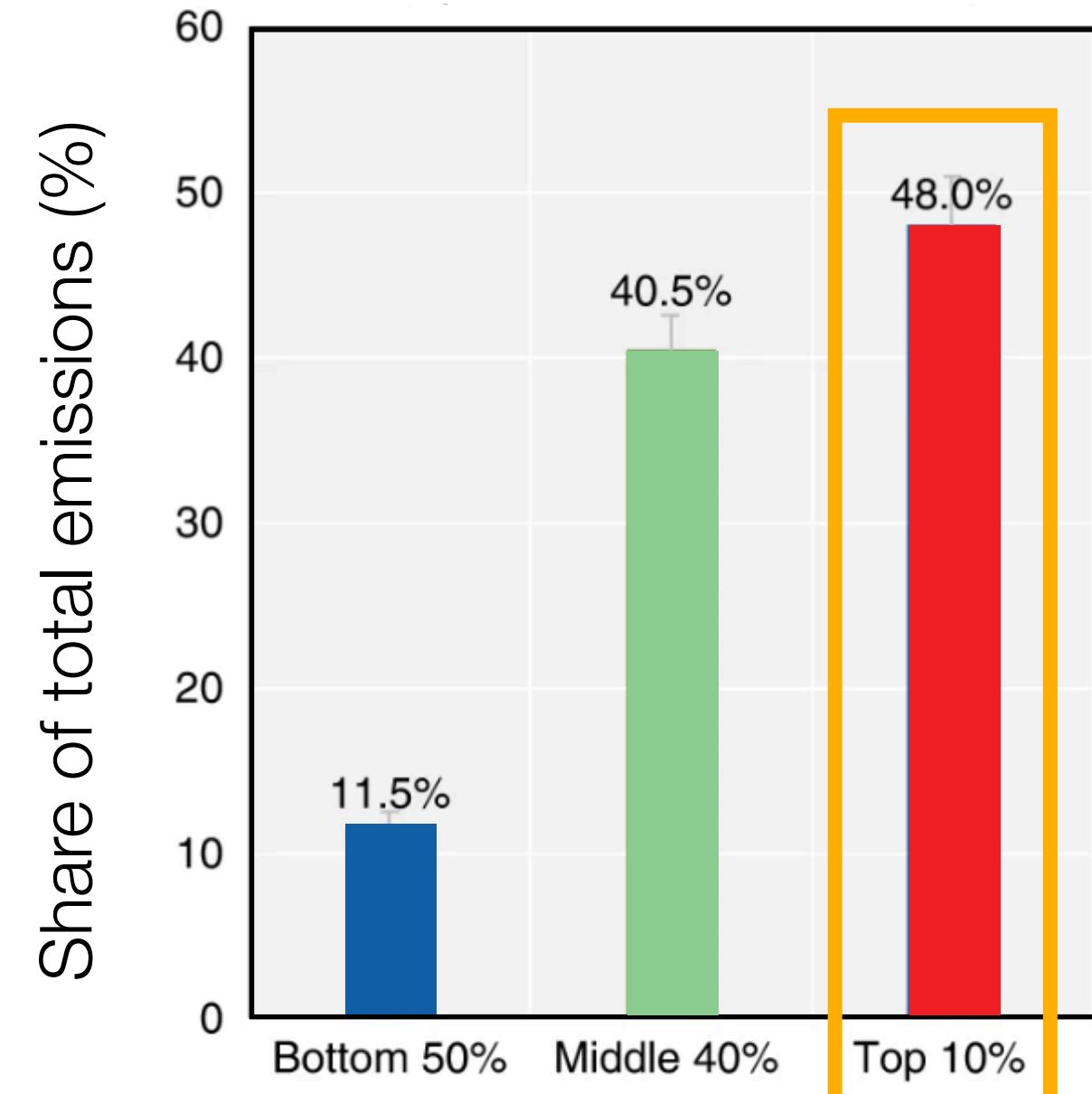


But this is driven primarily by **wealthy** individuals

This is the case in North America



And the rest of the world...



**Challenge:** Wealthy are unresponsive to traditional economic incentives

# Motivating the wealthy to reduce consumption

*co-lead:*

Gordon Kraft-Todd



People have “prosocial motivations”

[Fehr & Fischbacher, 2003; Zaki & Mitchell, 2011]

In economic games, framing public goods interactions in language emphasizing terms like “community” and “cooperation” leads to greater prosocial behavior

[Libermann et al., 2004; Engel & Rand, 2014]

Appeals to “prosocial” motives are more effective than “financial” self-interested appeals

[Betsch et al., 2017; Jordan et al., 2020]

## **Research question**

Are wealthy more responsive to sustainability messages that emphasize prosocial benefits compared to financial benefits?

# We focus on reducing water consumption

Urban water shortages are expected to worsen worldwide [Rodell et al., 2018]

Urban water crises are often triggered by the elite & upper-middle class [Savelli et al., 2023]

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nature sustainability



Article

<https://doi.org/10.1038/s41893-023-01100-0>

## **Urban water crises driven by elites' unsustainable consumption**

[Elisa Savelli](#) [Maurizio Mazzoleni](#), [Giuliano Di Baldassarre](#), [Hannah Cloke](#) & [Maria Rusca](#)

# Motivating the wealthy to reduce consumption

**Study 1:** Field experiment of home mailer campaign to  $N=10,500$  high-income households in Connecticut, Aug 2017-April 2018



**Study 2:** Three field experiments (one pre-registered) of Facebook ads across 6 states in New England; 313,764 impressions, 96,892 unique users



# Motivating the wealthy to reduce consumption

**Study 1:** Field experiment of home mailer campaign to  $N=10,500$  high-income households in Connecticut, Aug 2017-April 2018



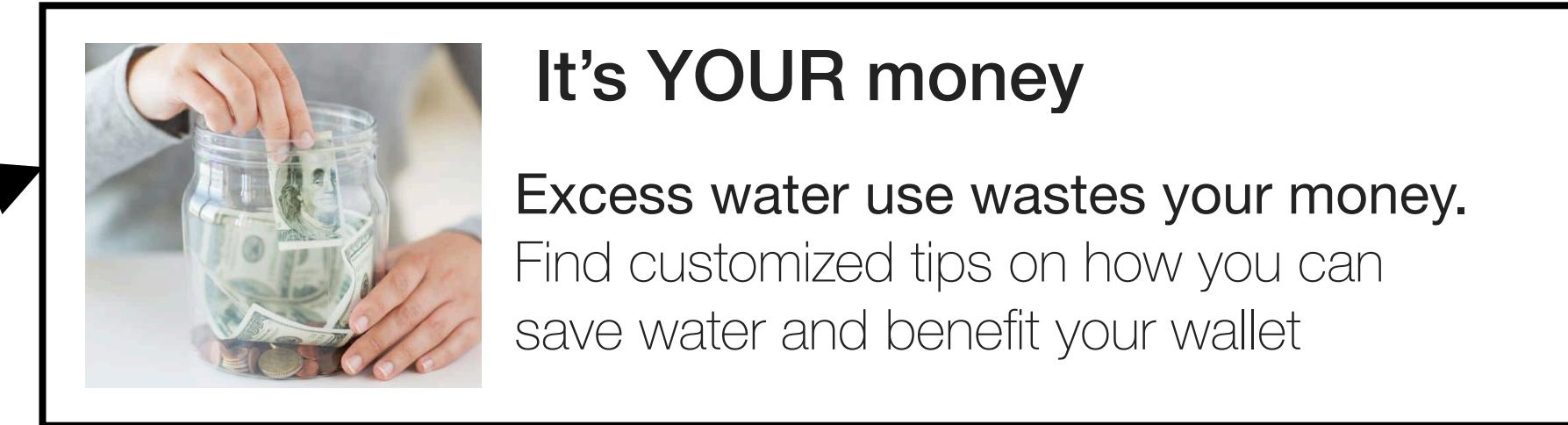
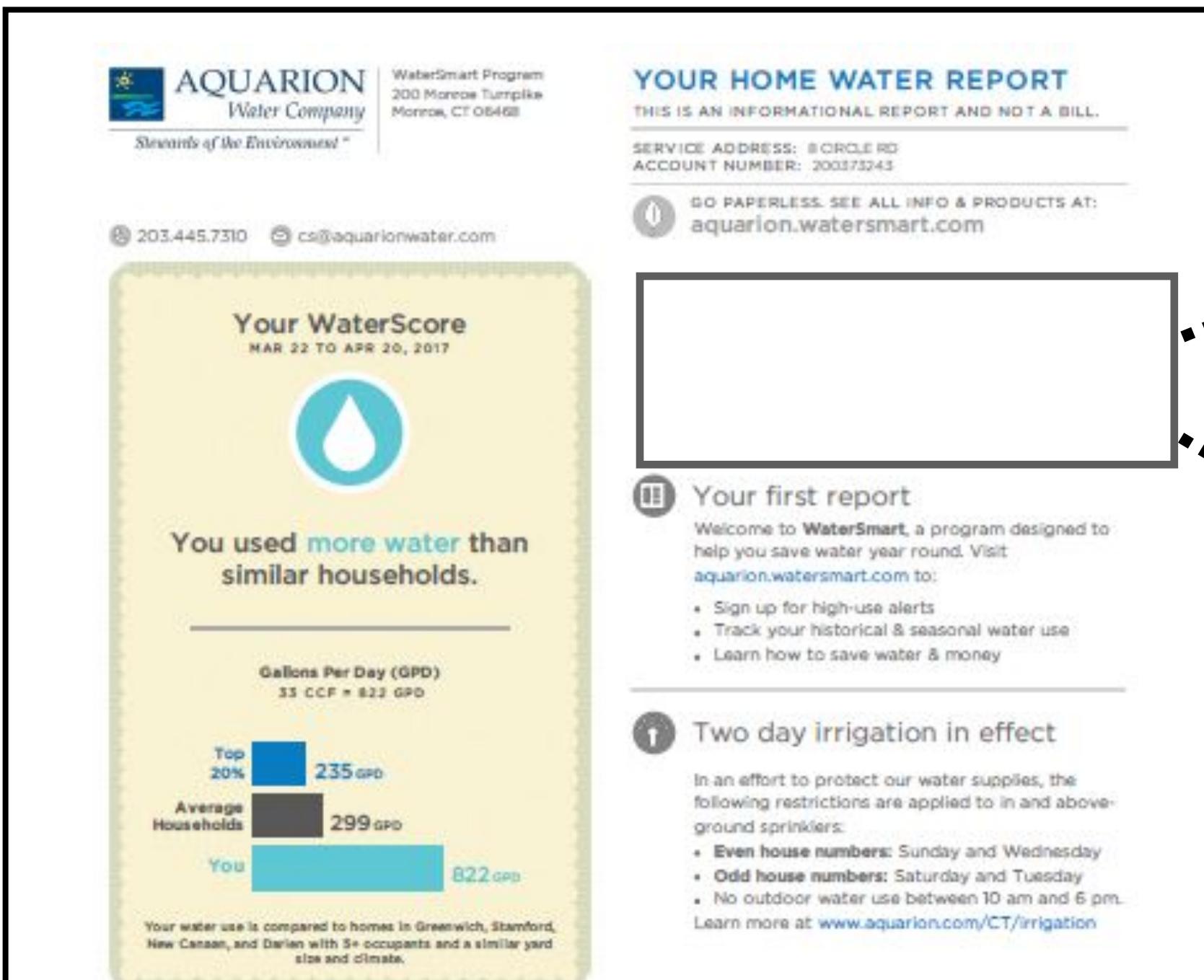
## Study details

9-month field study, in which households received a Home Water Report every 2 months

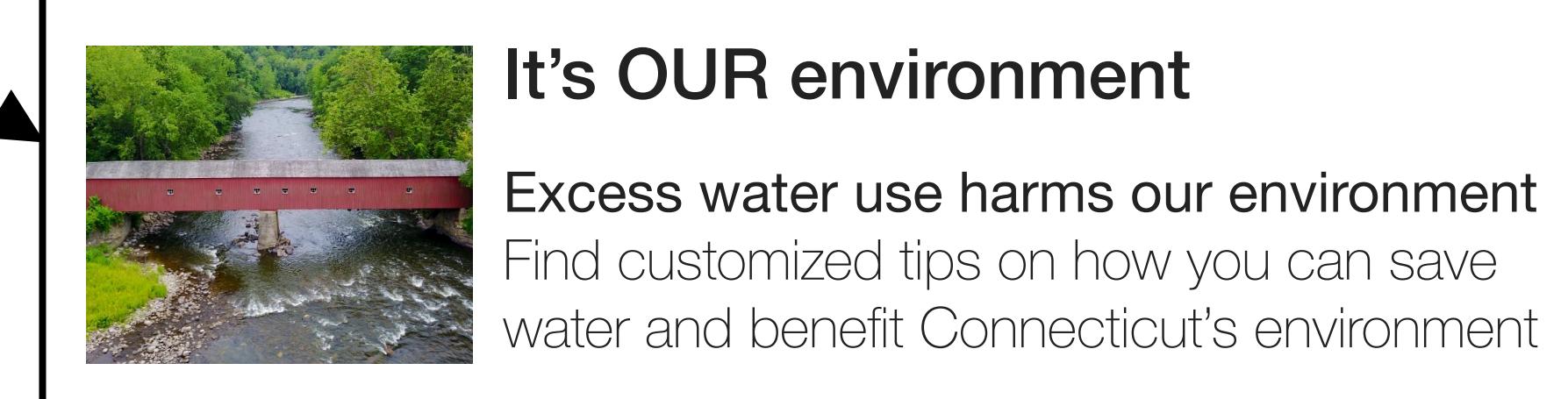
1. Control group ( $N= 2,525$ ); no communications
2. “Economic framing” treatment ( $N=3,908$ )
3. “Prosocial framing” treatment ( $N=3,967$ )

# Study 1: Methods

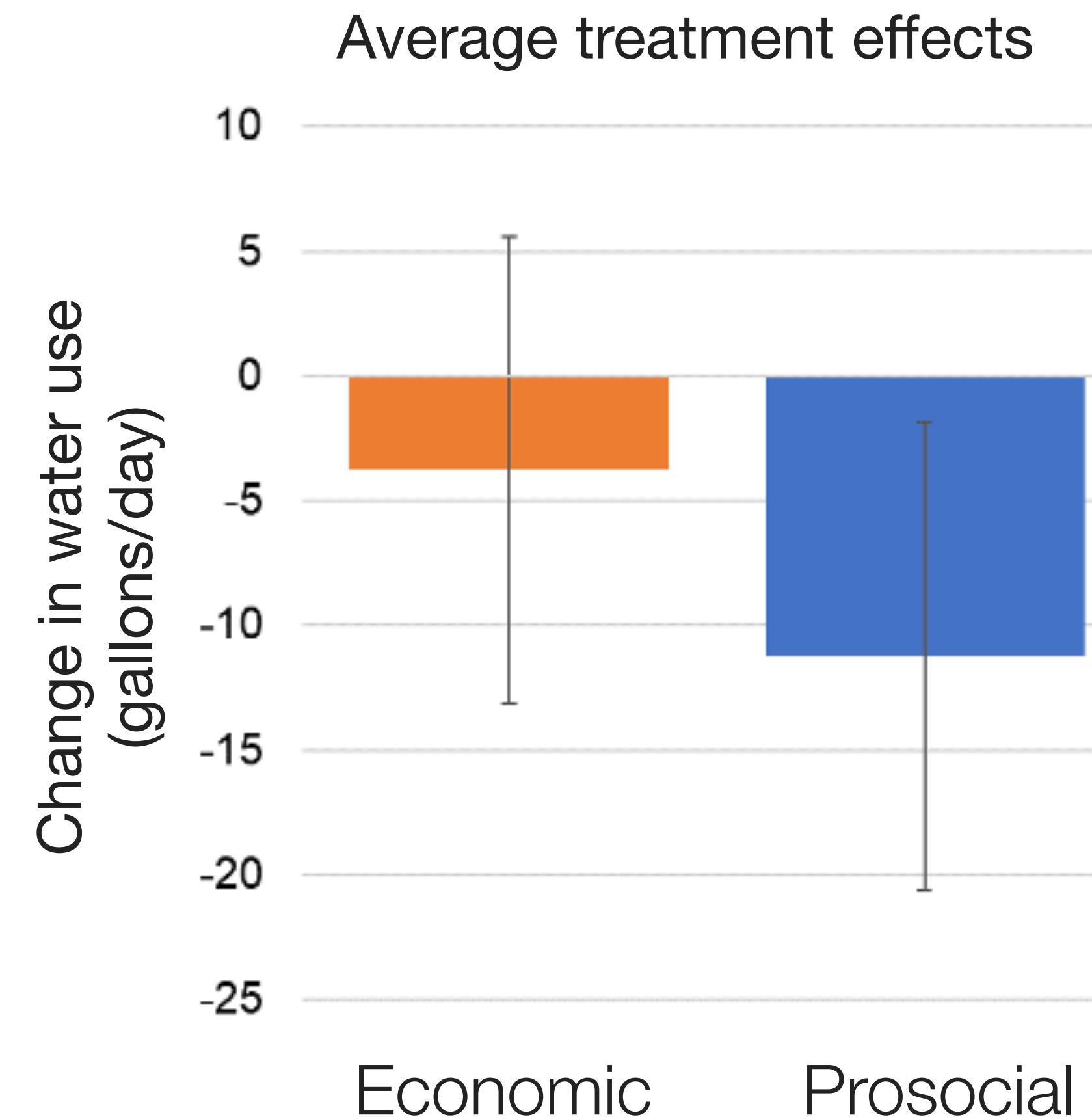
## Economic framing



## Prosocial framing



# Study 1: Results



Economic → Control:  
coeff=.61,  $p=.960$

Prosocial → Control:  
coeff =-28.24,  $p=.018$

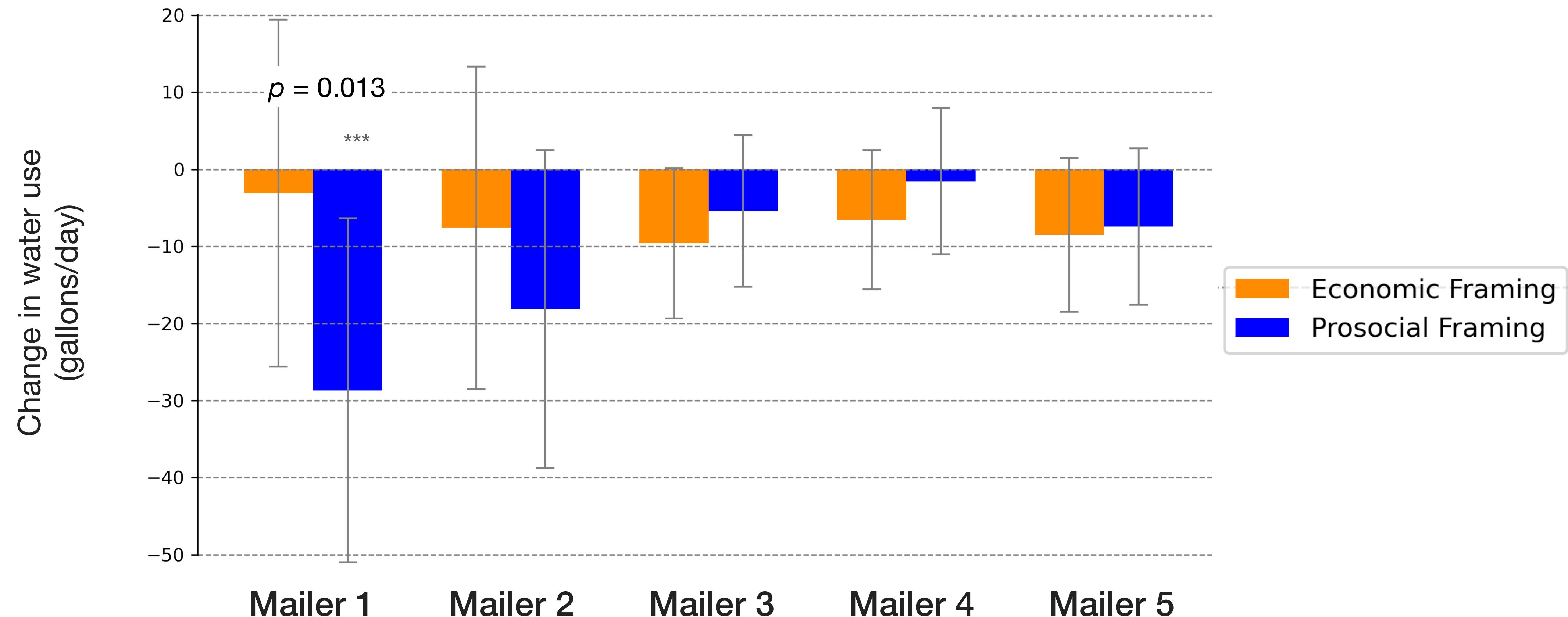
Prosocial → Economic:  
 $p=.07$

*Error bars represent 95% CI of the mean*

# Study 1: Results

The impact of messaging treatments over time

Useful for cases when **urgent** behavior change is needed (e.g., drought)



# Motivating the wealthy to reduce consumption

**Study 2:** Three field experiments (one pre-registered) of Facebook ads across 6 states in New England; 313,764 impressions, 96,892 unique users



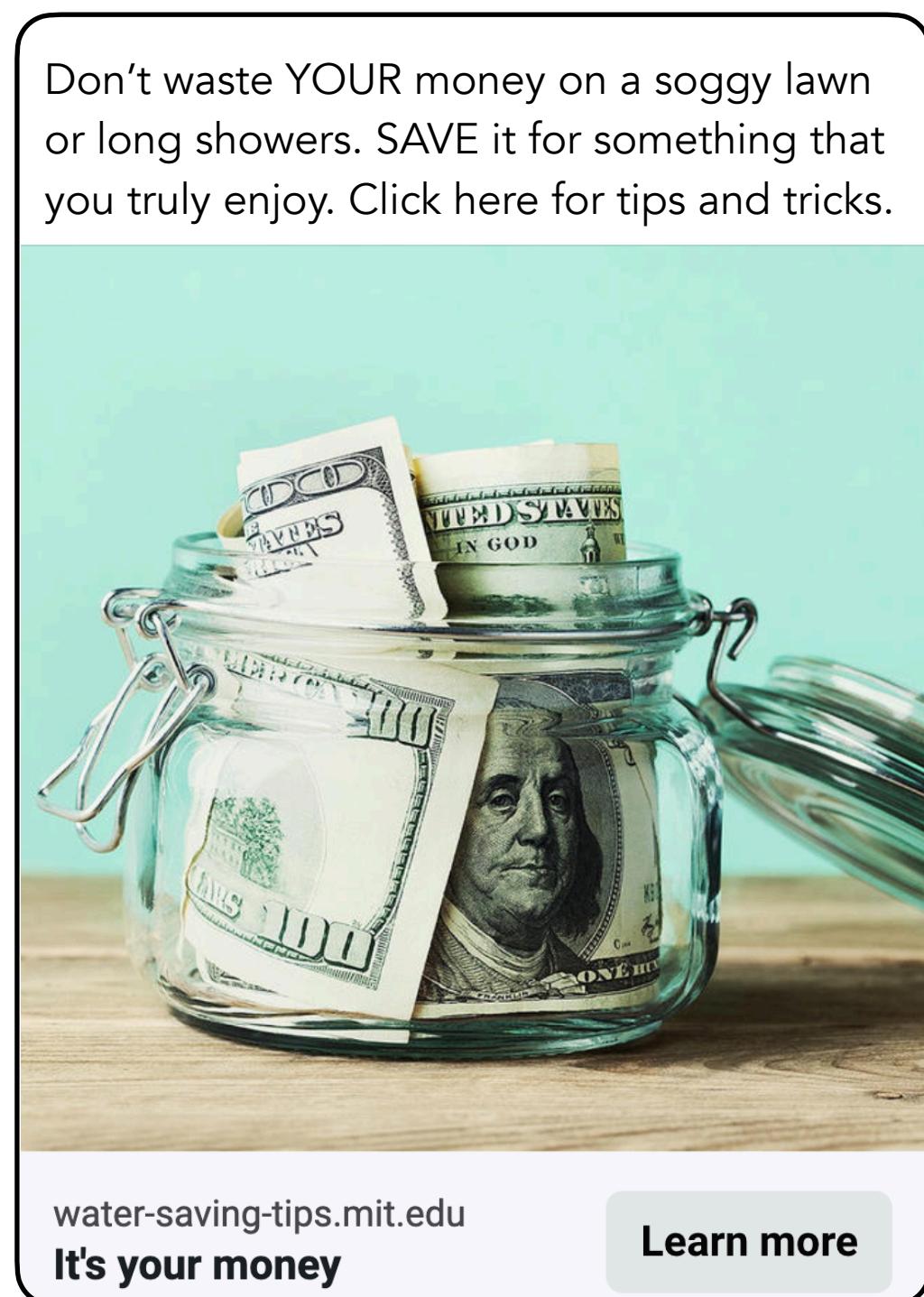
## Study details

Pre-registered conceptual replication using Facebook's ad platform

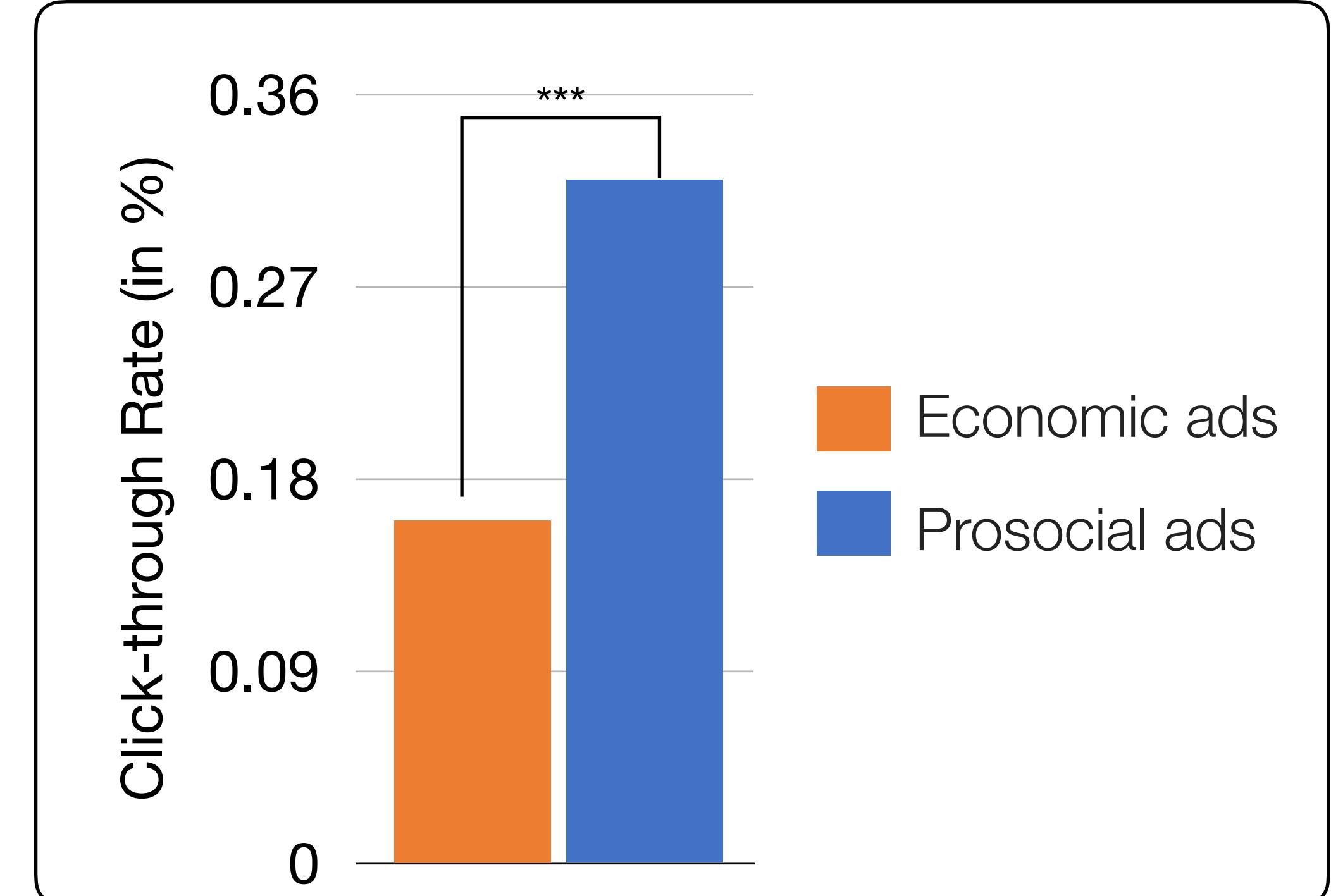
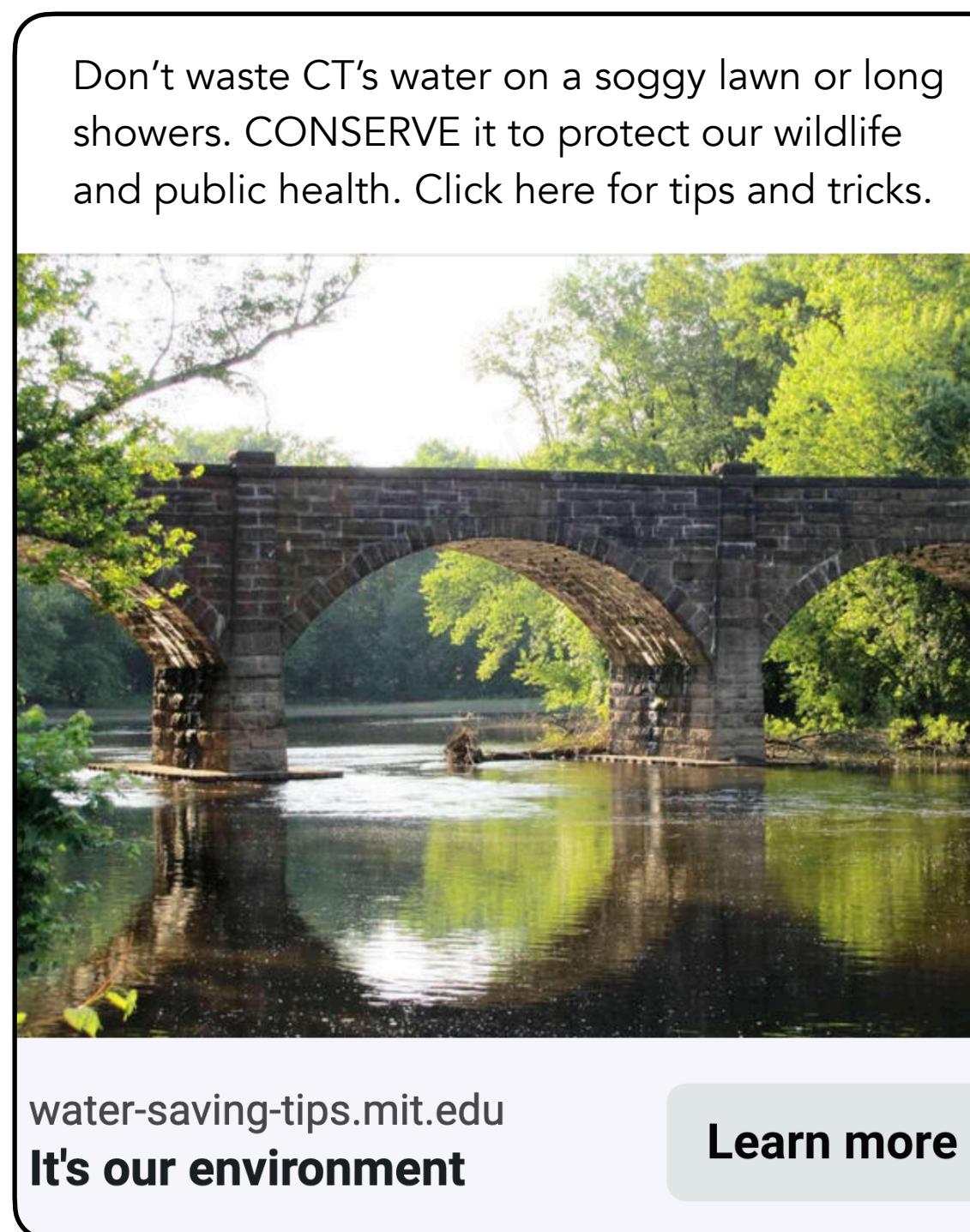
Targeted users whose income was top 10% within the six states of New England

# Study 2: Results

Economic framing ad



Prosocial framing ad



## **Implications for motivating the wealthy**

Messages that tap into *intrinsic motives* are more powerful than simple economic incentives

**11.1 million gallons** of water saved

**Equivalent to 444,000 showers** (10 minutes per shower)



Water drank by  
**181,000**  
People in a year

# How psychology can help in the short-run

Motivate **wealthy** individuals to be more sustainable

Future directions

## 1. Psychology of the rich

Perceptions and concerns about climate change among the wealthy

Decision-making under risk when wealth isn't a concern

## 2. Driving climate action among the wealthy

Focus on people who *already* believe in climate change

Large-scale field studies testing multiple interventions at once

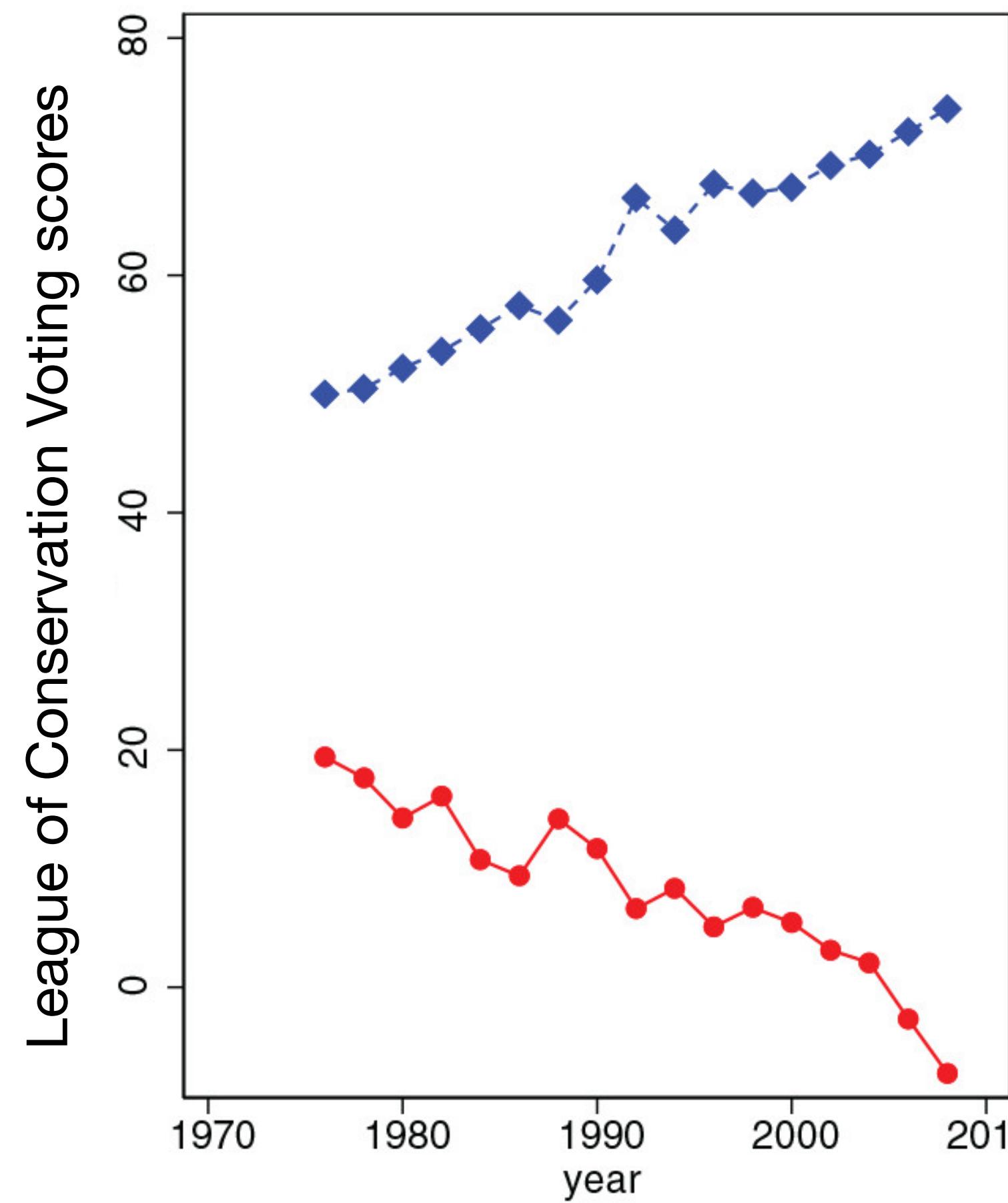
# How psychology can help in the short-run

Motivate **wealthy** individuals to be more sustainable

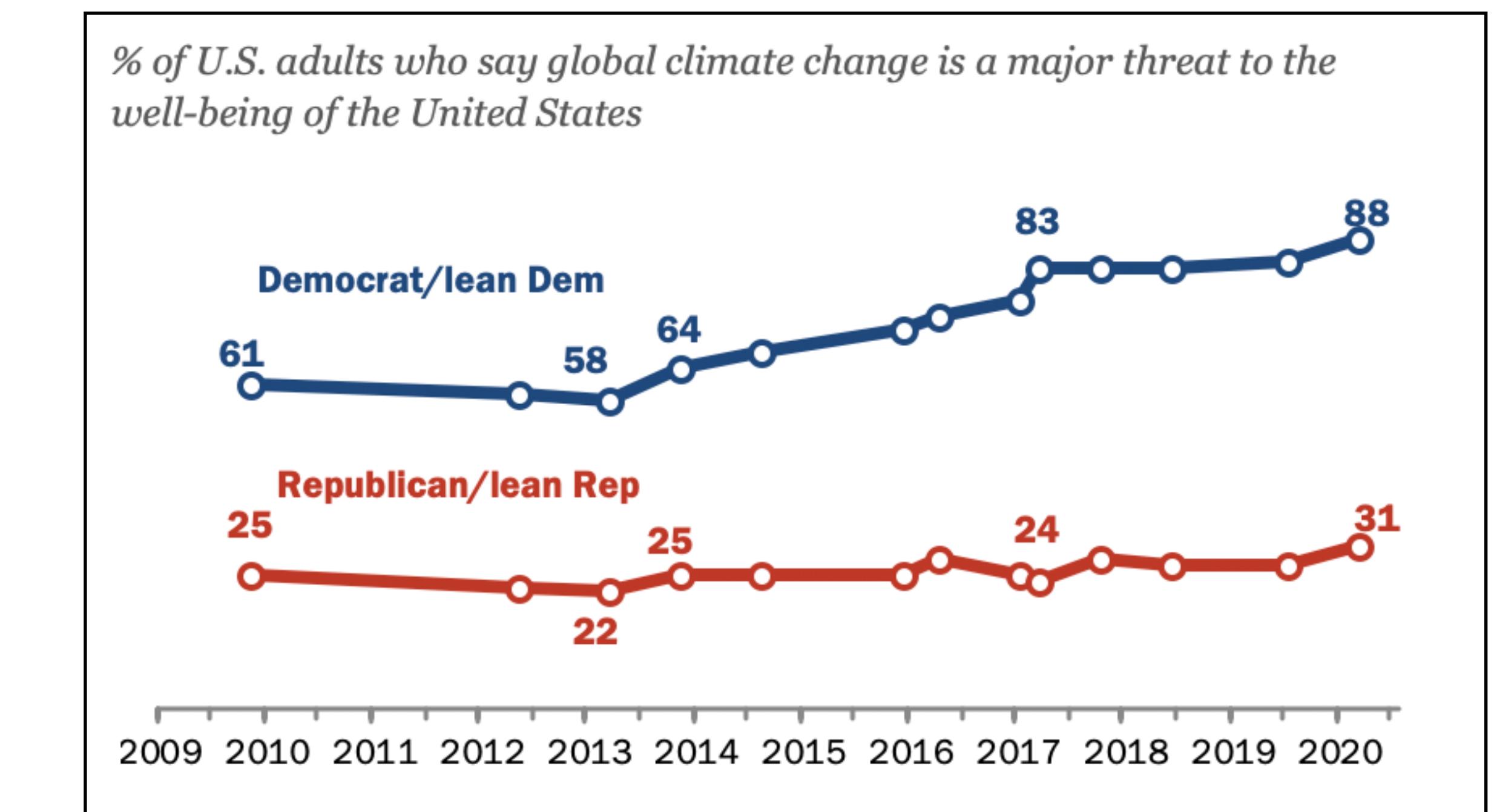
Help policies aiming to bring **systemic** changes

# Important to enact ambitious green policies to implement systemic changes

Polarization about climate policies  
in the congress

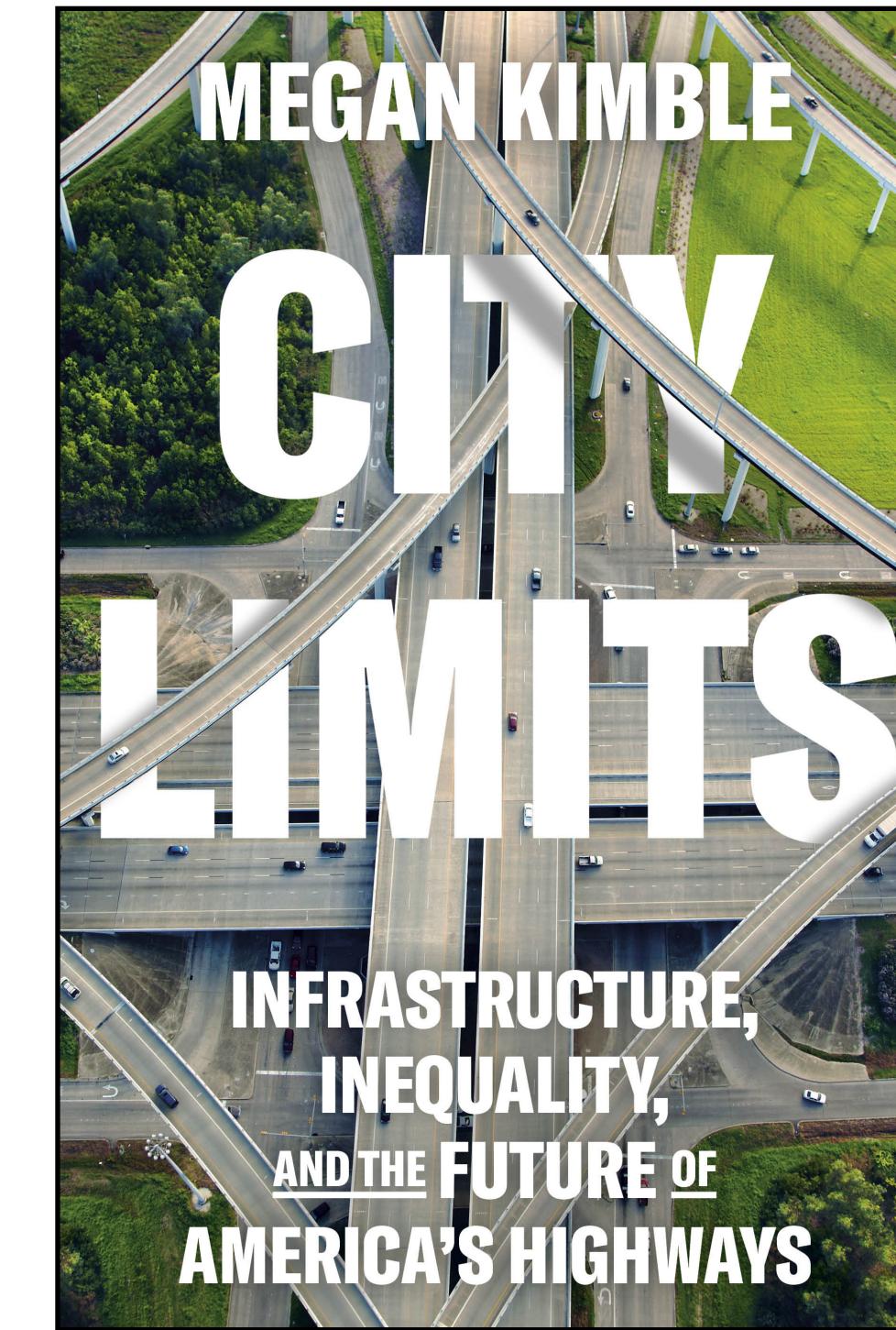
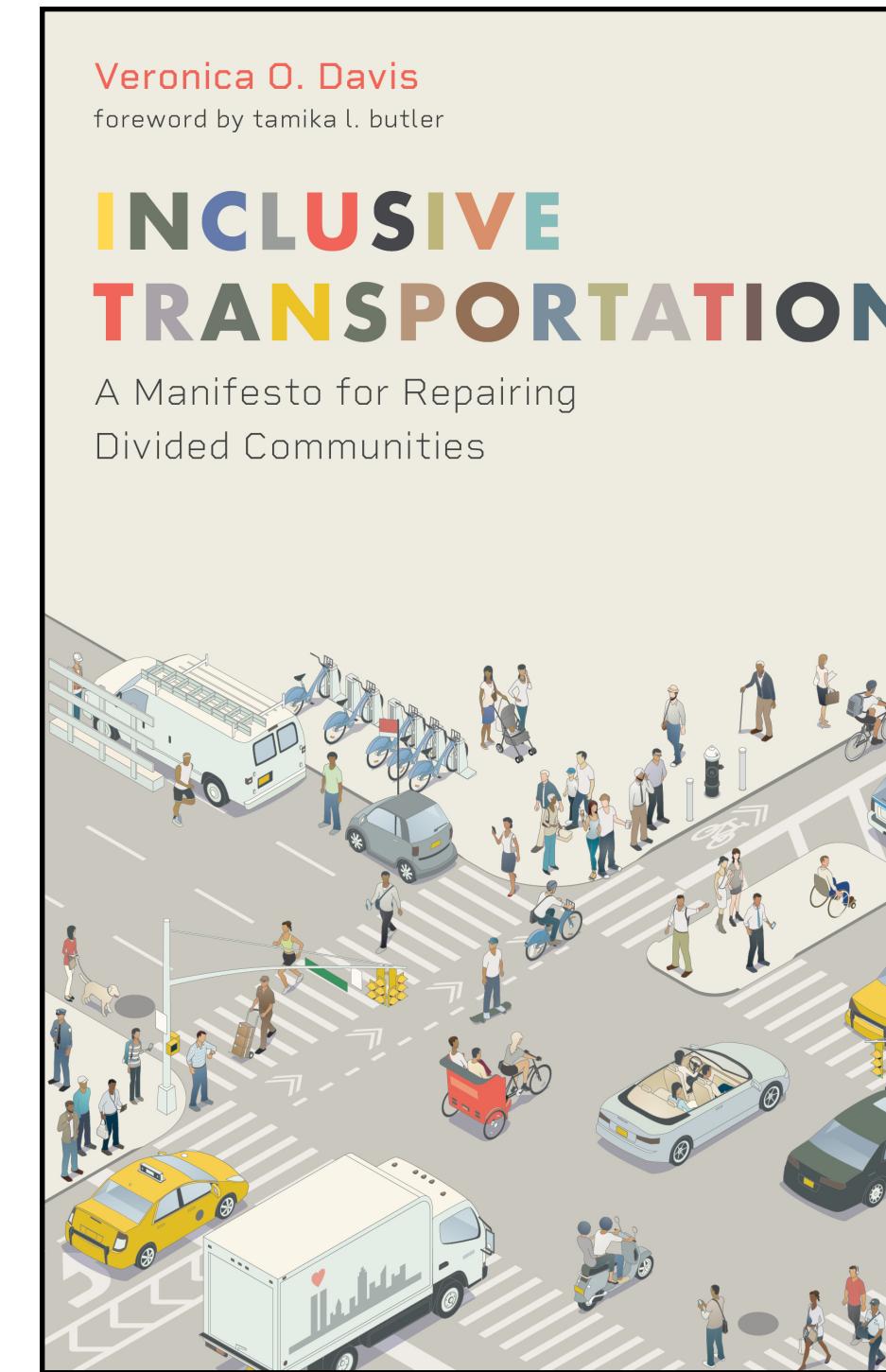
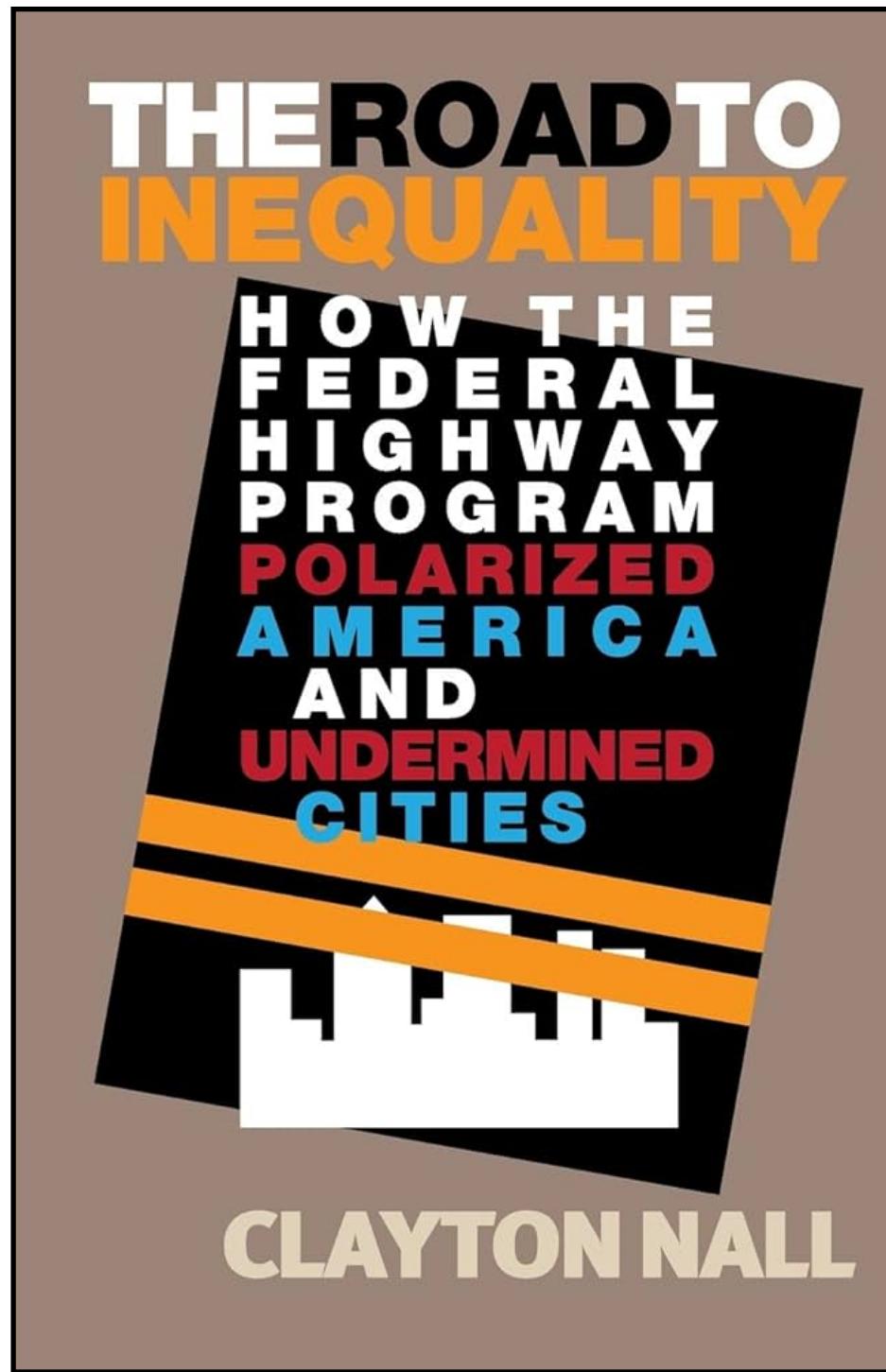


Polarization about climate change  
within the American public



# Case study: Sustainable transport policies

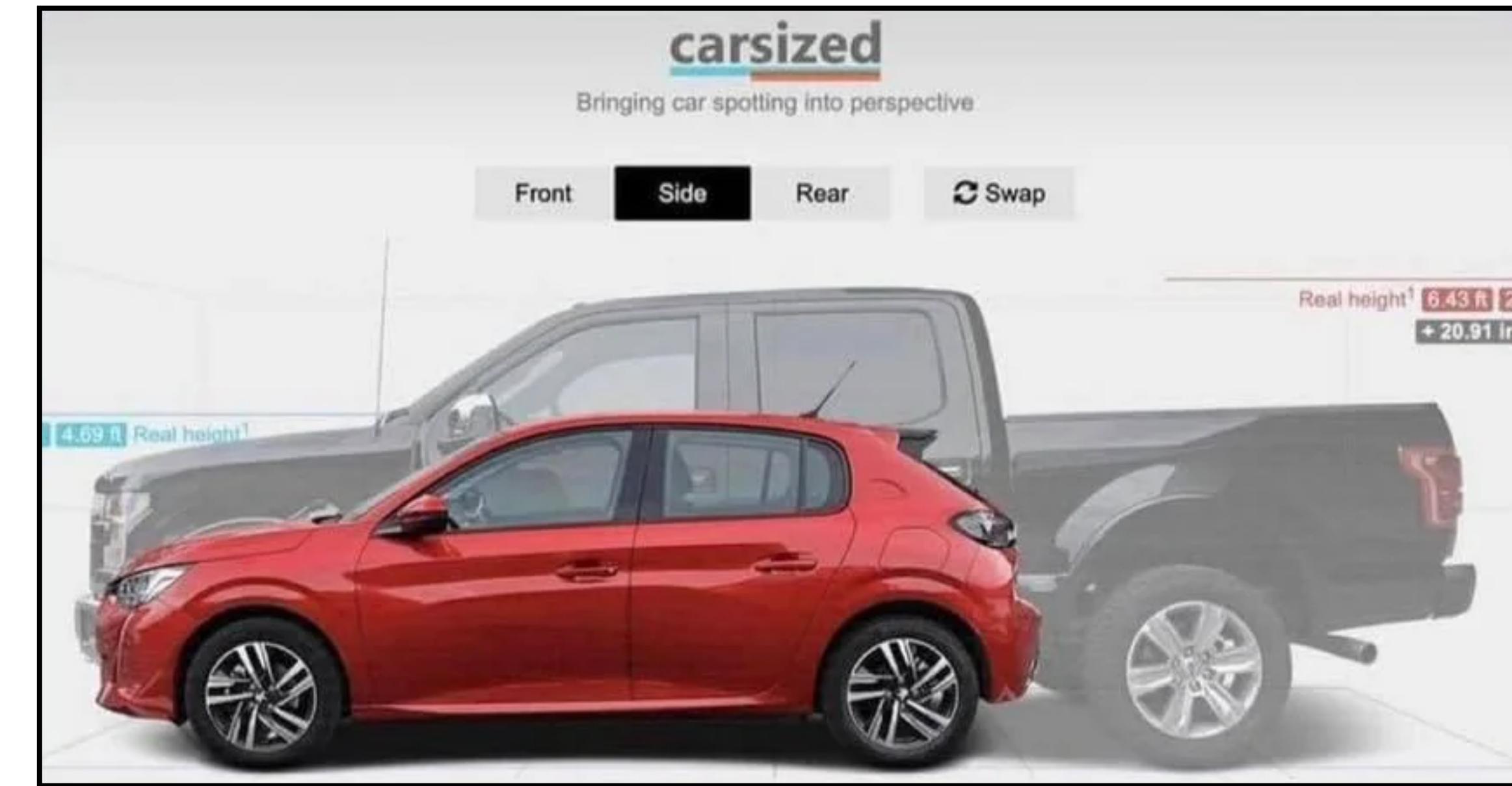
Transforming America's car-centric infrastructure is crucial for reducing emissions and addressing social & economic inequality



A common sight in America...



Average European car size vs.  
American car size



**Challenge:** Americans are polarized about public transportation and are reluctant to support sustainable transport policies

[Nall, 2018; Neves and Brand, 2019]

# Building a less car-dependent America

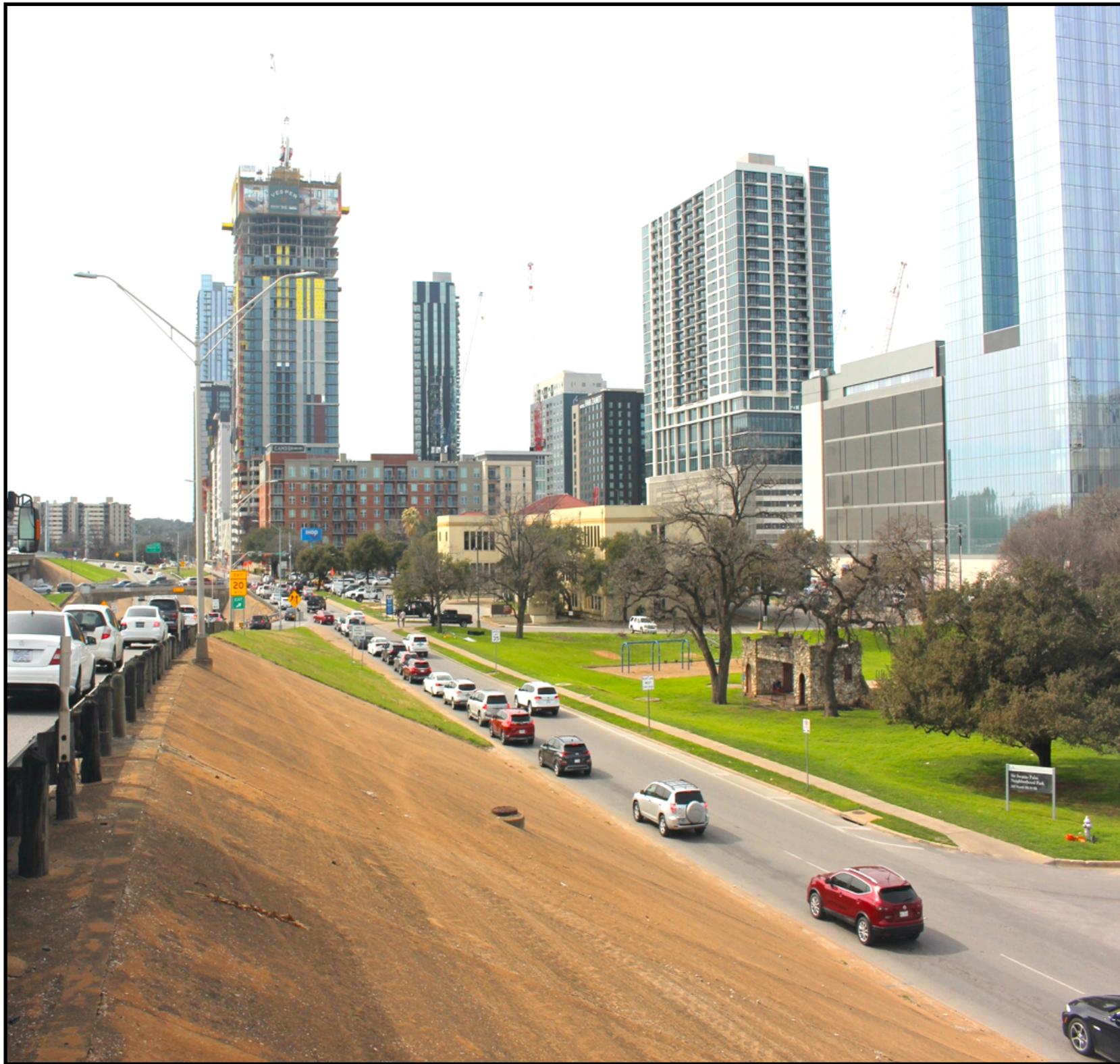
Evoking the **imagination**  
as a strategy of influence

[Escalas, 2004; Petrova & Cialdini, 2018]

# Building a less car-dependent America

## Our cities today

Car dependent, congested, & polluted



## How they can be in future

Walkable, greener, & public transport



Generated using AI

**Main Goal:** Highlight importance of helping people *imagine* outcomes of sustainable policies

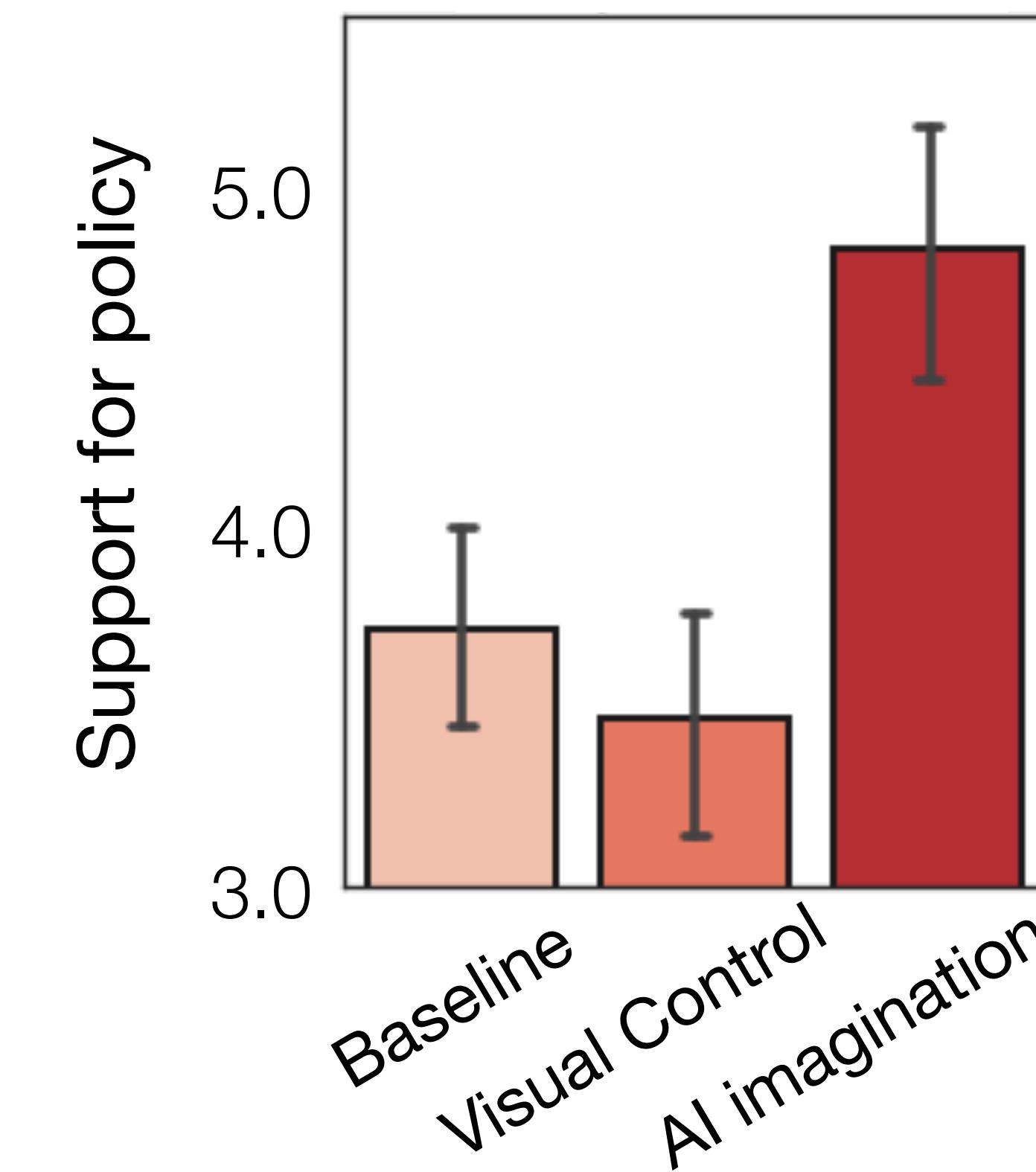
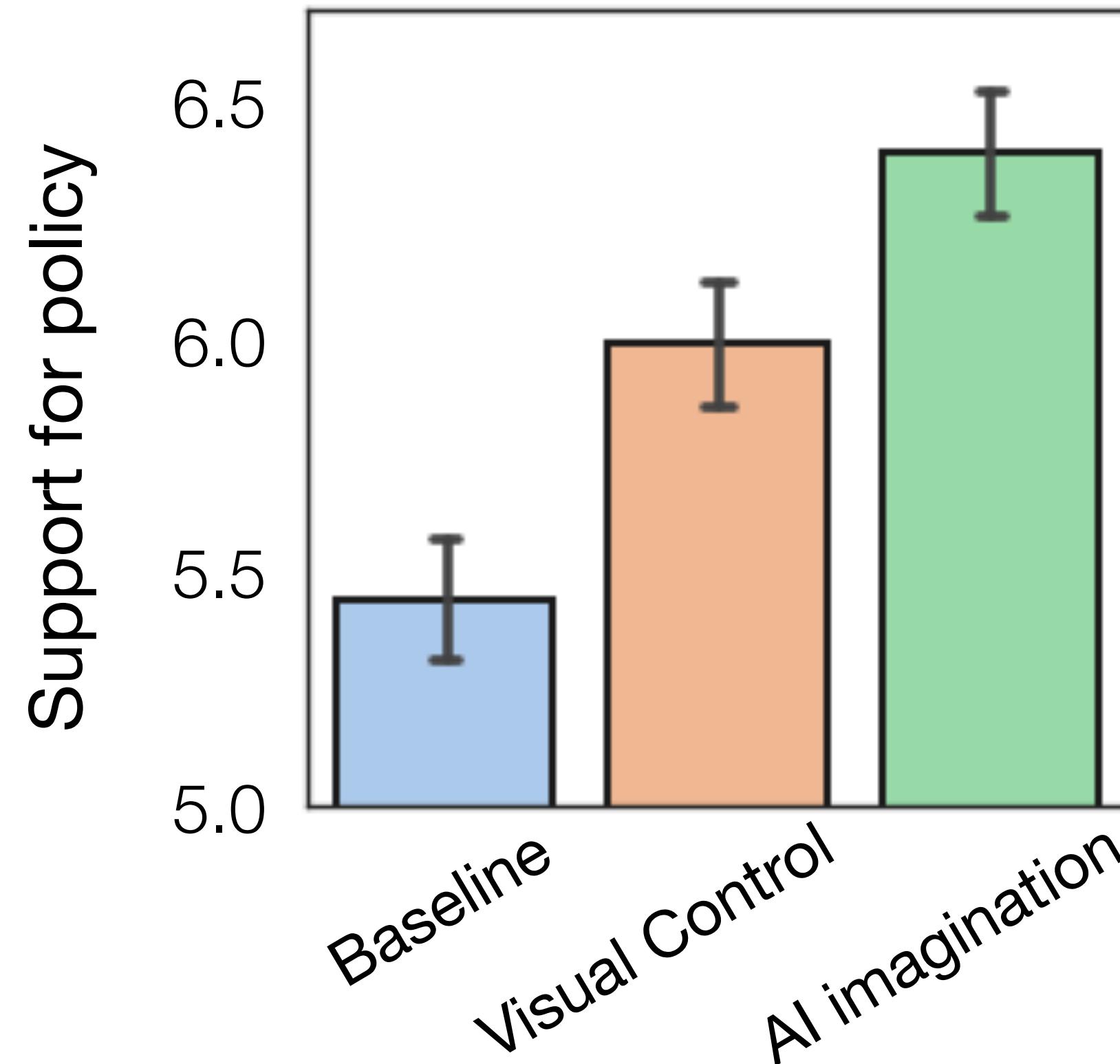
AI merely serves as a *tool* to generate realistic and personalized images

# Building a less car-dependent America

[N=1529]

Increased support for the transport policy  
that proposed to make US less car-reliant

Our intervention is particularly effective  
at shifting opinion of Republicans



## **My philosophy**

Psychology can help get green policies passed at the local & national level

## **My approach**

- Improve public opinion and support for policies
- Avoid focusing on “climate denial” and intervening on those beliefs
- Understand people’s intrinsic motives and desires

# How psychology can help current efforts

Motivate **wealthy** individuals to be more sustainable

Help efforts aiming to bring **systemic** changes

Future directions

## 1. Reduce polarization about green policies

Richer generative AI as a *tool* to supplement people's imagination

## 2. Imagination in the context of climate change

How do prior experiences shape what we can and *cannot* imagine?

Imagining a 40 degree day vs 50 degree day

Climate change is fundamentally an issue of  
***human behavior***

## How psychology can help in the long-run

Understand cognitive biases related to climate **inaction**

## How psychology can help in the short-run

Motivate **wealthy individuals** to be more sustainable

Help **policies** aiming to bring **systemic** changes

# Epilogue: My pessimistic-optimistic vision for the future

Psychology has a **lot** to offer for climate change research

But we can't probably do much right now... (i.e., climate change isn't going to be solved with my bite-sized research so far..)

## **My hope and goal**

*Help make psychology make an integral part of climate policy-making 10-15 years down the line*

**If we want to make an impact 10-15 years from now, we need to start now**