



Determining optimal carbon display properties

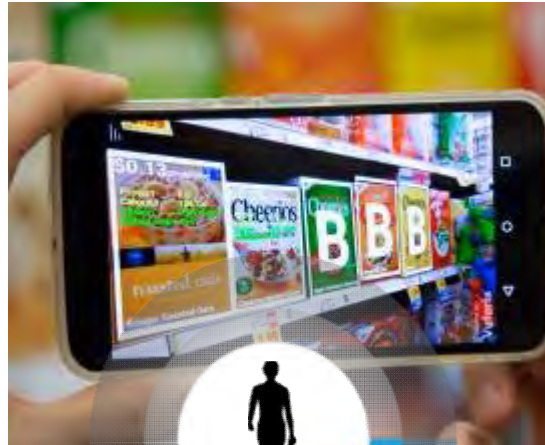
Steven Isley

BECC – October 2016

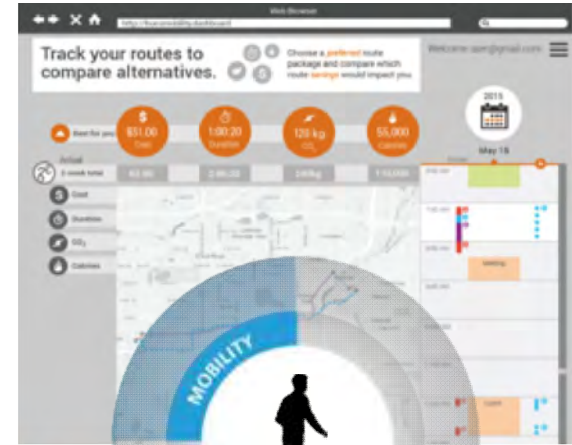
Behavioral Research At NREL



C-Suite



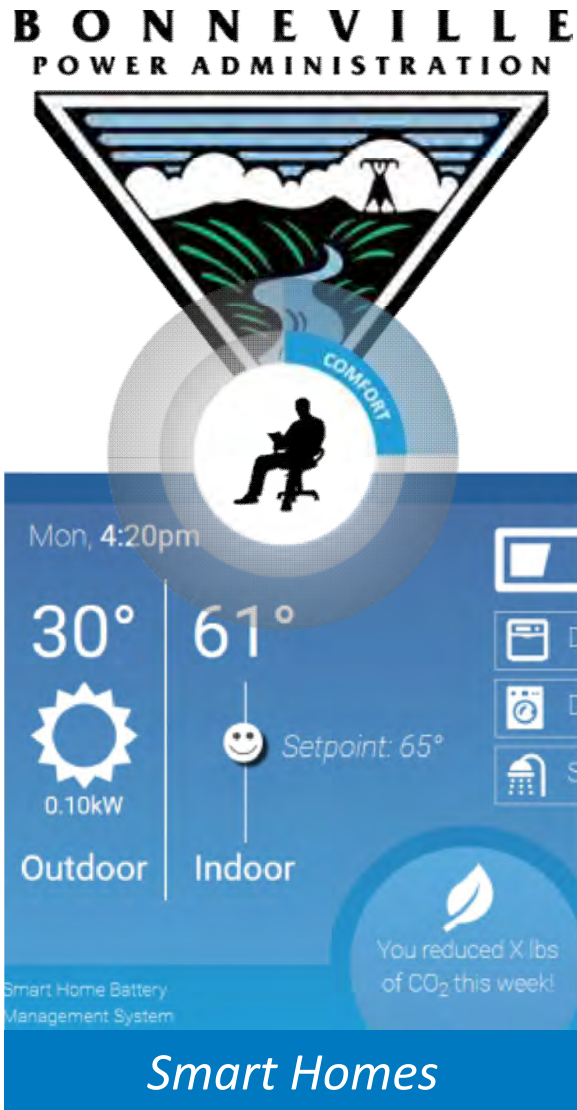
Augmented Reality



TriOP

Behavioral Research At NREL

B O N N E V I L L E
POWER ADMINISTRATION



The image shows a smart home energy management interface. At the top is the Bonneville Power Administration logo. Below it is a circular icon with a person sitting at a desk, labeled 'COMFORT'. The main interface displays the time 'Mon, 4:20pm', outdoor temperature '30°' with a sun icon and '0.10kW', and indoor temperature '61°' with a smiley face icon. A slider is set to 'Setpoint: 65°'. A green leaf icon indicates 'You reduced X lbs of CO₂ this week!'. The bottom of the interface is labeled 'Smart Home Battery Management System'.

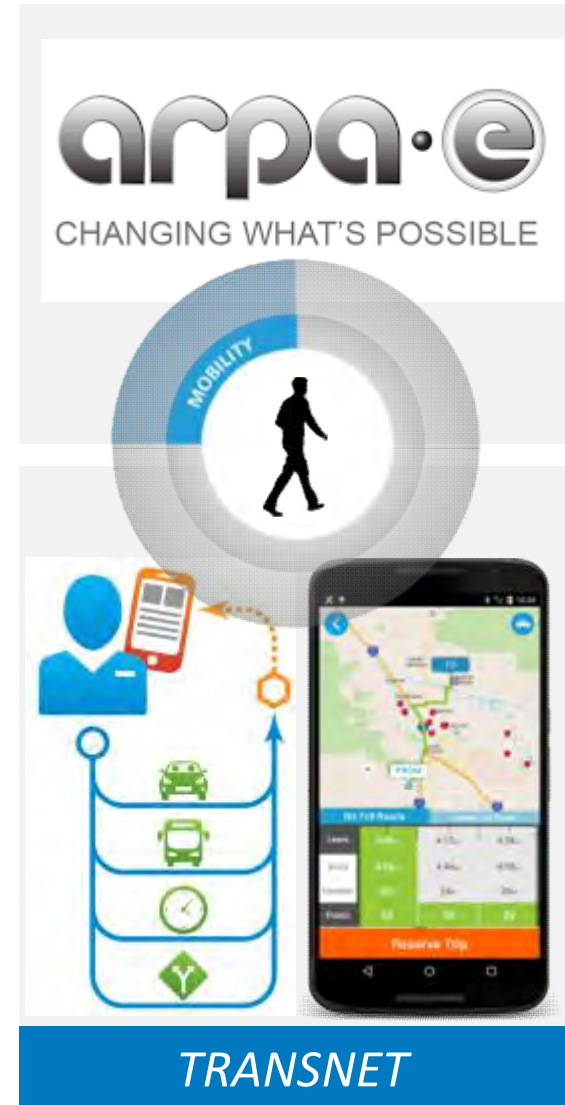
Smart Homes



The image shows a virtual reality research setup. At the top is a VR headset. Below it is a circular icon with a person sitting at a desk, labeled 'COMFORT'. A black sign with white text reads: 'Green Line points to Trigger Button. Pull Trigger Button to submit surveys and grab slider buttons.' A green laser line points from the sign to a black trigger button.

Virtual Reality

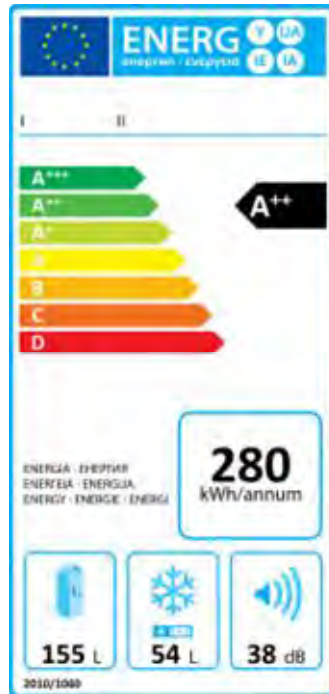
arpa·e
CHANGING WHAT'S POSSIBLE



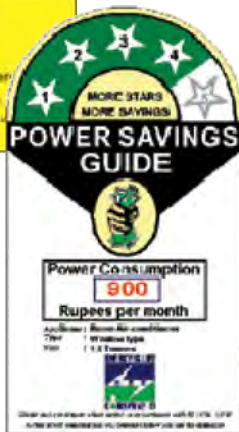
The image shows the TRANSNET mobility app interface. At the top is the arpa·e logo and tagline 'CHANGING WHAT'S POSSIBLE'. Below it is a circular icon with a person walking, labeled 'MOBILITY'. The main interface shows a smartphone displaying a map with a route. Below the map are icons for a car, a bus, a clock, and a leaf. A 'Reserve Trip' button is visible at the bottom of the smartphone screen.

TRANSNET

How Should Environmental Information be Displayed?



working with the Carbon Trust™



Approach

- Define attributes of a display method
- Ask people what they prefer
- Generate hypotheses
- Replicate existing research, then add carbon
- Present at BECC

Methodological Aside #1 (Sorry, there are 2)

amazon mechanicalturk™
Artificial Artificial Intelligence



- A micro-job platform
 - 500k workers
- Results comparable to traditional survey & laboratory experiments

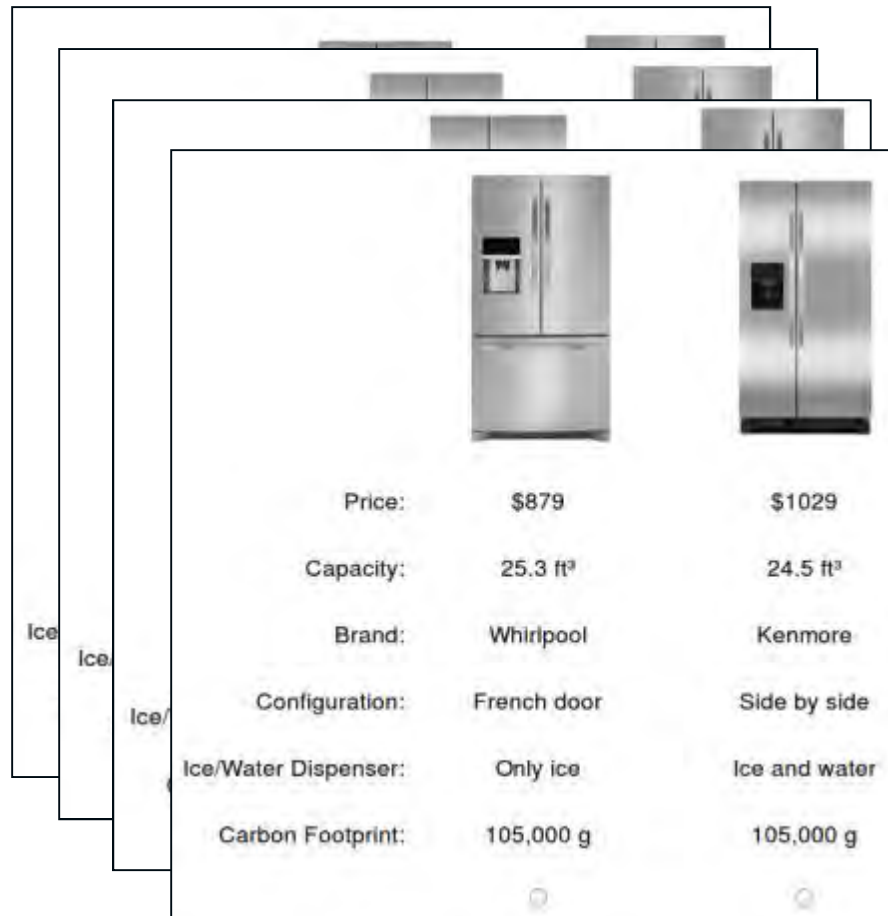
Pros

- Large population
- Fast
- Cheap (~\$1-2)
- Reproducible

Cons

- Not representative
- Cannot watch participants
- When mistakes get cheaper, you buy more

Methodological Aside #2 – Discrete Choice Experiments





- Break product into attributes
- Ask people to make a choice among alternatives
- Ask them again
- And again
- ...
- Use choices to estimate coefficients in a utility function


$$U = \beta_p Price + \beta_{cap} Capacity + \dots + \beta_c Carbon + \epsilon$$

$$Willingness to Pay for Carbon Reductions = -\beta_c / \beta_p$$

Display Attributes

Scale Categorical  > Continuous 500 g > Nominal 

Familiar Yes 1.2 miles driven > No 500 g

Comparable Yes  > No 500 g

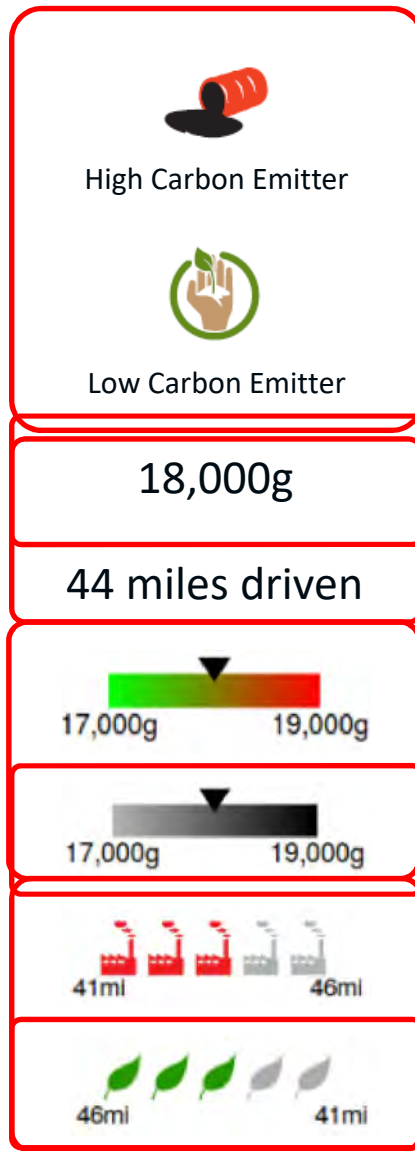
Framing Gain 500 g saved > Average 500 g less than average > Loss 500 g

Color Color  > Grey Scale 

Style Both  > Visual  > Textual 500 g

Displays

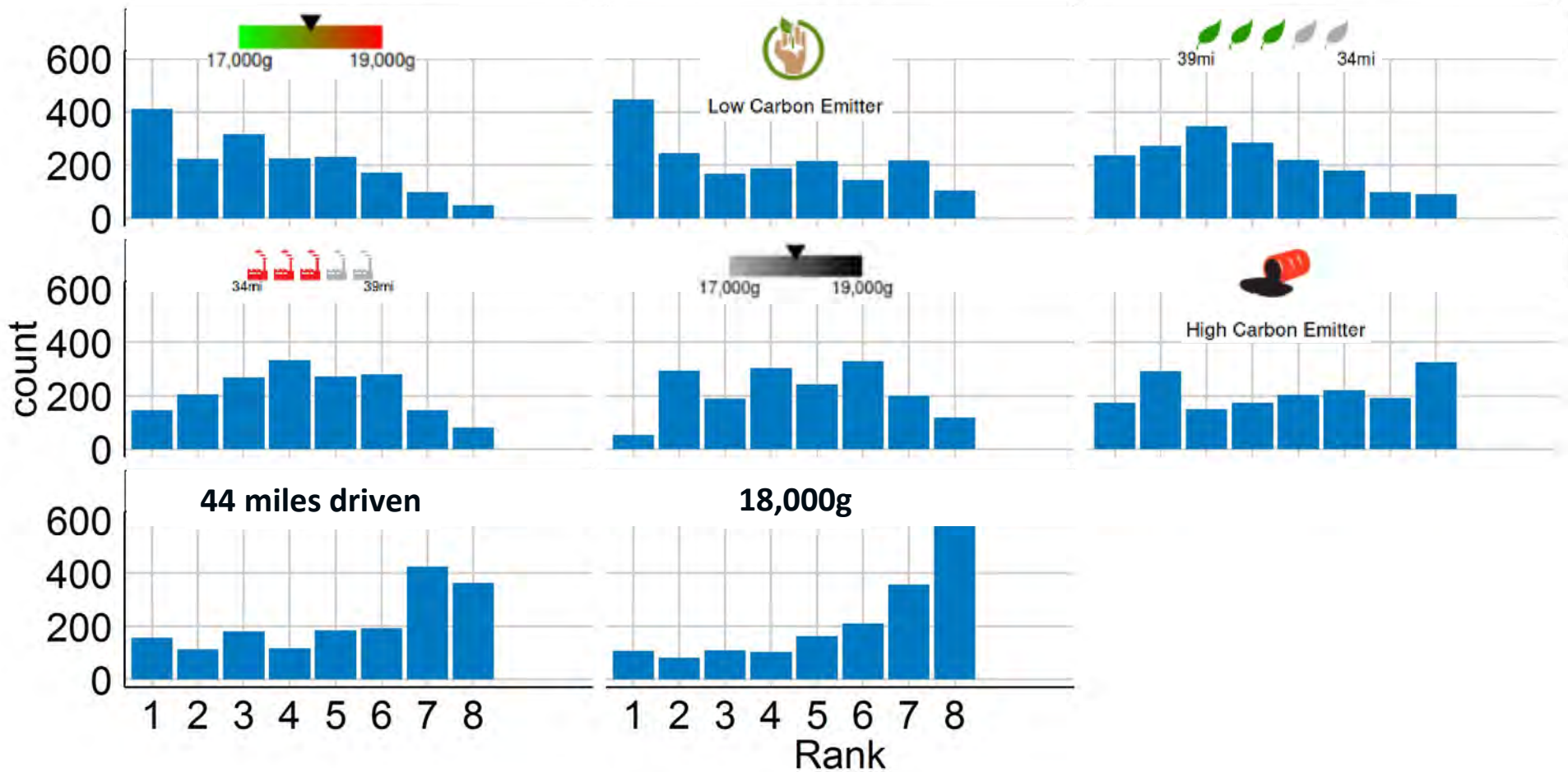
Hypotheses



1. The most effective display will be categorical, verbal & visual, gains framing, in color
2. People respond more to gains framing than loss framing
3. Color, all by itself, makes a display more effective
4. Familiar units are more effective than unfamiliar units
5. Comparable displays are more effective than incomparable ones

Ranking Results

We asked people to rank the 8 displays and this is the result



Baseline Studies – Meat, Fridge, T-Shirt, Travel



	Route 1	Route 2
Toll:	\$2	\$2
Time:	80 minutes	100 minutes
Variation of time:	12 minutes	12 minutes
Safety:	1	3
Carbon Footprint:	17,000g	17,000g



Price:	\$929	\$979
Capacity:	25.8 ft ³	23.7 ft ³
Brand:	GE	Kenmore
Configuration:	Side by side	French door
Ice/Water Dispenser:	Ice and water	Only ice
Carbon Footprint:	115,000 g	95,000 g



Price:	\$15	\$18
Organic Content:	70 %	70 %
Processing Method:	Organic	Eco friendly
Social Label:	\$1 Donated to Cancer Research	Fair trade
Carbon Footprint:	17ml	17ml



Price:	\$11.99	\$8.99
Agriculture Label:	Local	Organic
Certification:	Third Party	USDA
Carbon Footprint:	34mi	34mi

T-shirt: By Camisetas (Camisetas) [CC BY-SA 3.0 (<http://creativecommons.org/licenses/by-sa/3.0/>)], via Wikimedia Commons

Steak: By Maggie Osterberg (Transferred from en.wikipedia to Commons.) [CC BY-SA 2.5 (<http://creativecommons.org/licenses/by-sa/2.5/>)], via Wikimedia Commons

Fridge: By Goedeker's [CC BY-SA 2.0 (<https://creativecommons.org/licenses/by/2.0/>)], via <https://www.flickr.com/photos/goedekers/12640052475>

Travel: public domain, <https://commons.wikimedia.org/wiki/File:Trafficjam.jpg>

Hypothesis #1

The most effective display will be categorical, verbal & visual, gains framing, in color



44 miles driven

18,000g



Low Carbon Emitter

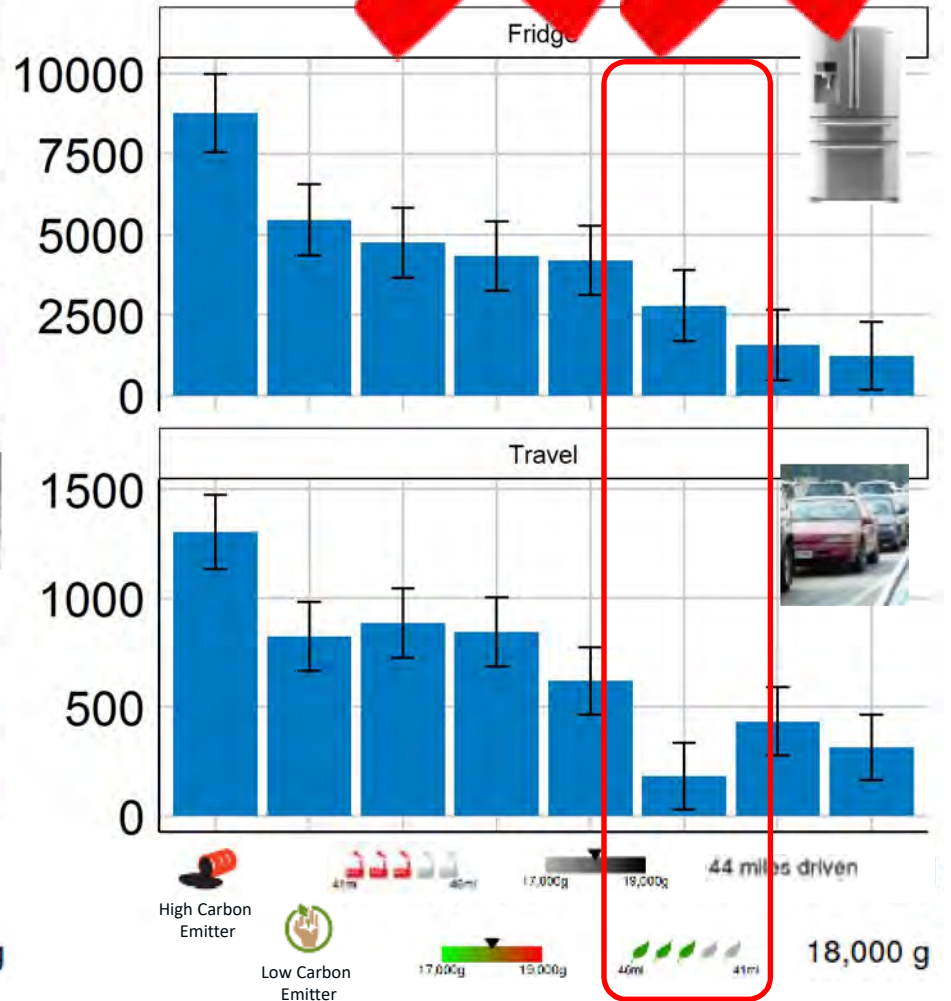
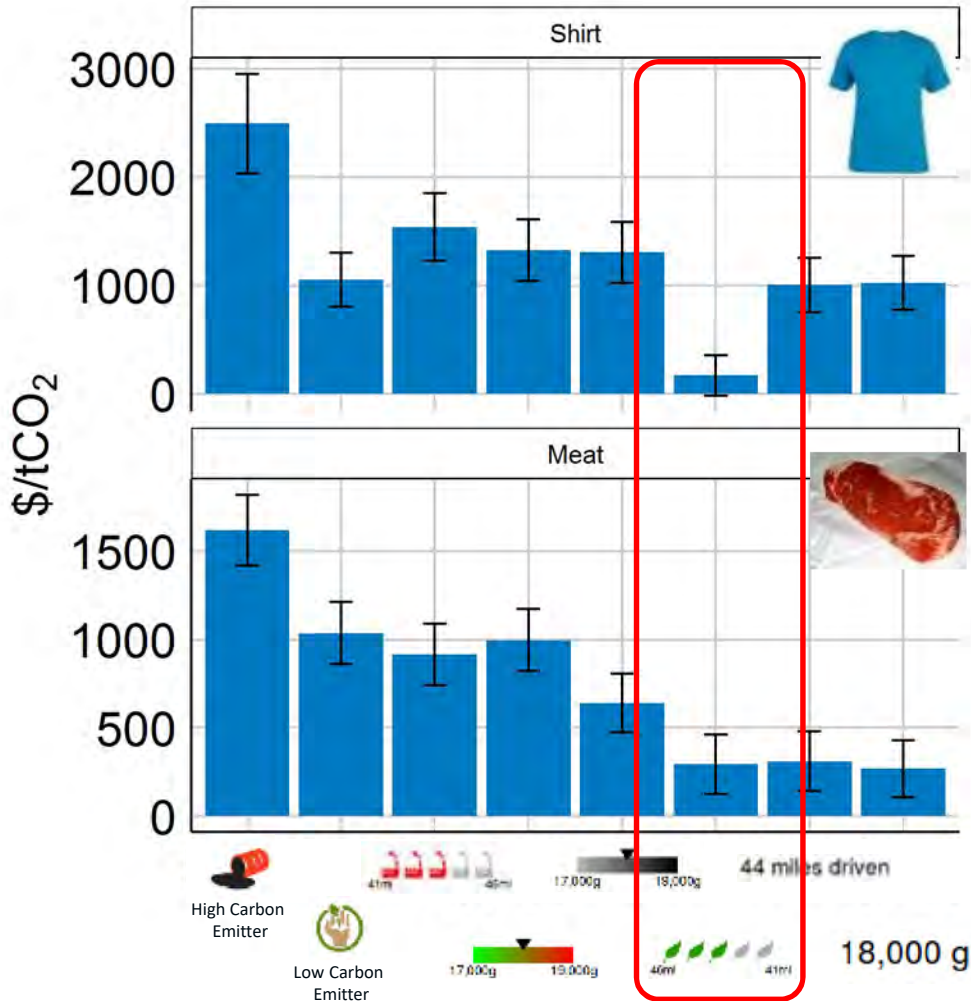


High Carbon Emitter



Hypothesis #1

The most effective display will be categorical, verbal & visual, gains framing, in color



Hypothesis #2

People respond more to gains framing than loss framing



Low Carbon Emitter

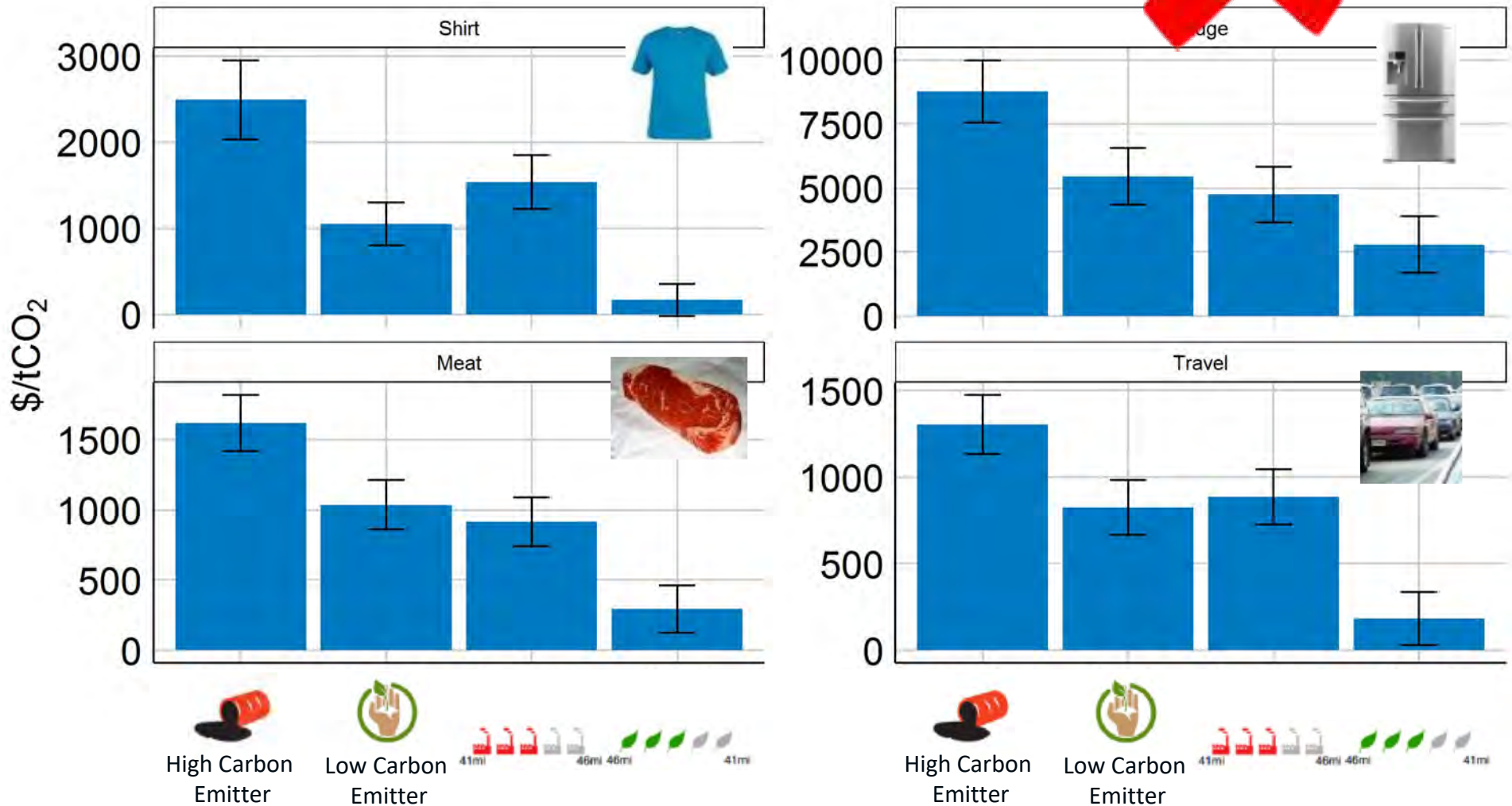


High Carbon Emitter



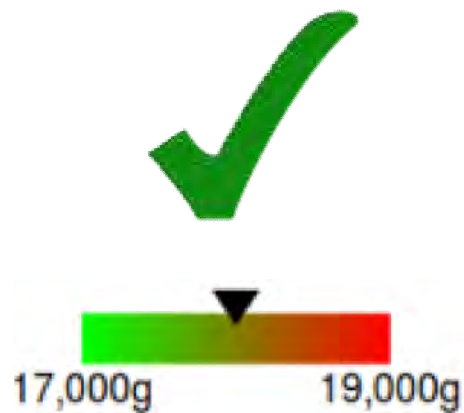
Hypothesis #2

People respond more to gains framing than loss framing



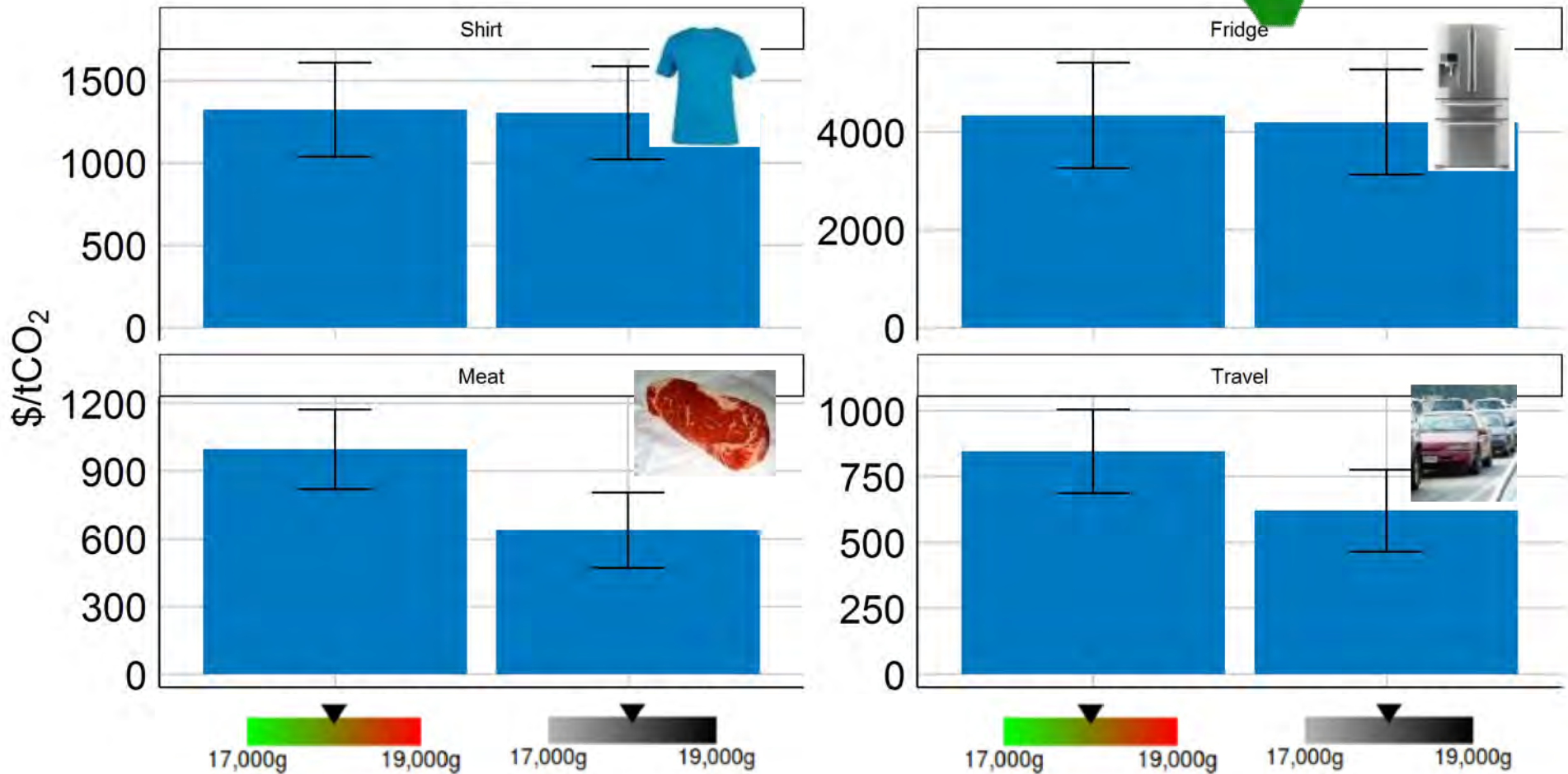
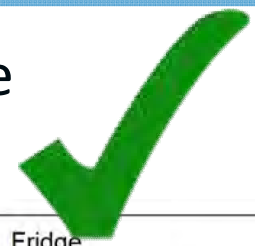
Hypothesis #3

Color, all by itself, makes a display more effective



Hypothesis #3

Color, all by itself, makes a display more effective



Hypothesis #4

Familiar units are more effective than unfamiliar units

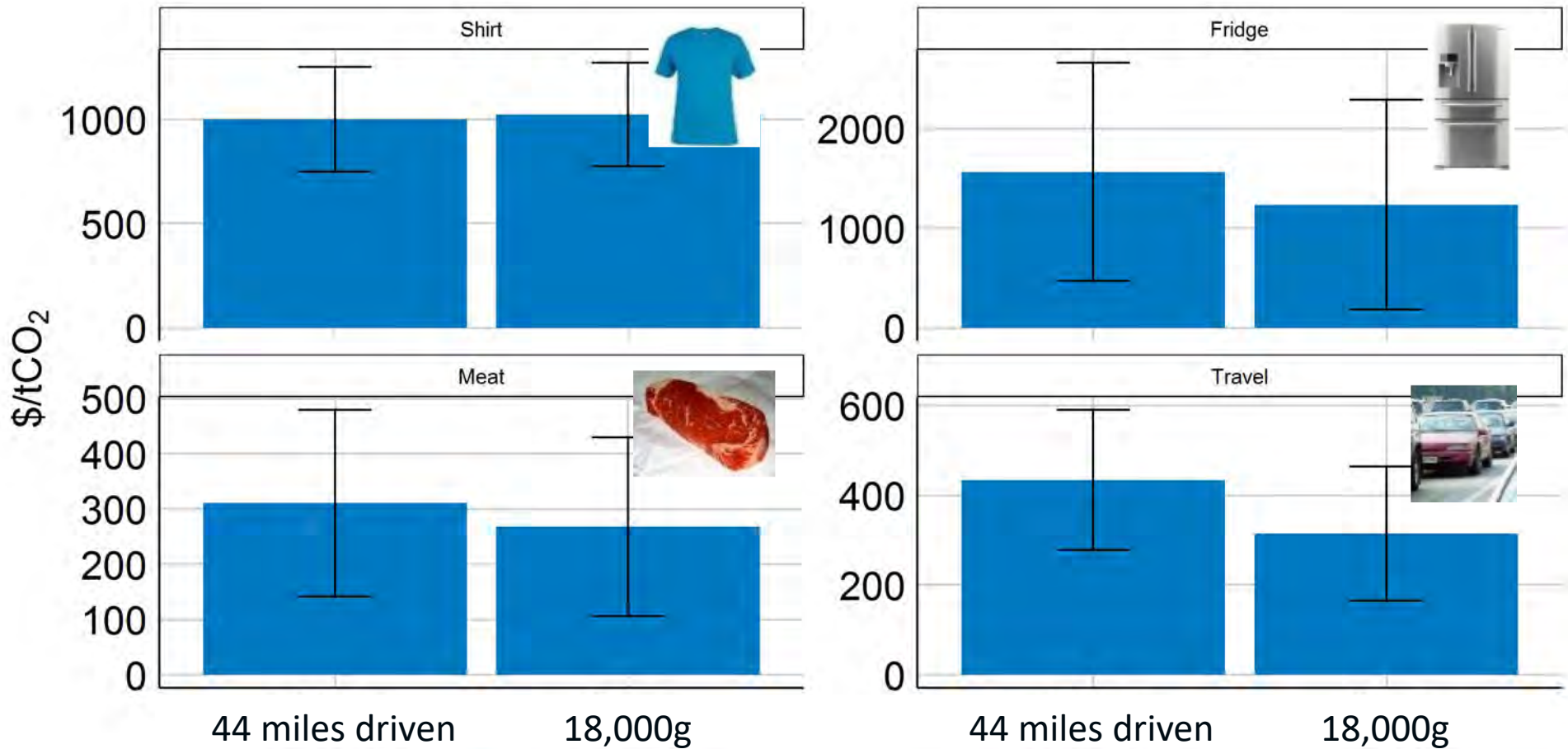


44 miles driven

18,000g

Hypothesis #4

Familiar units are more effective than unfamiliar units



Hypothesis #5

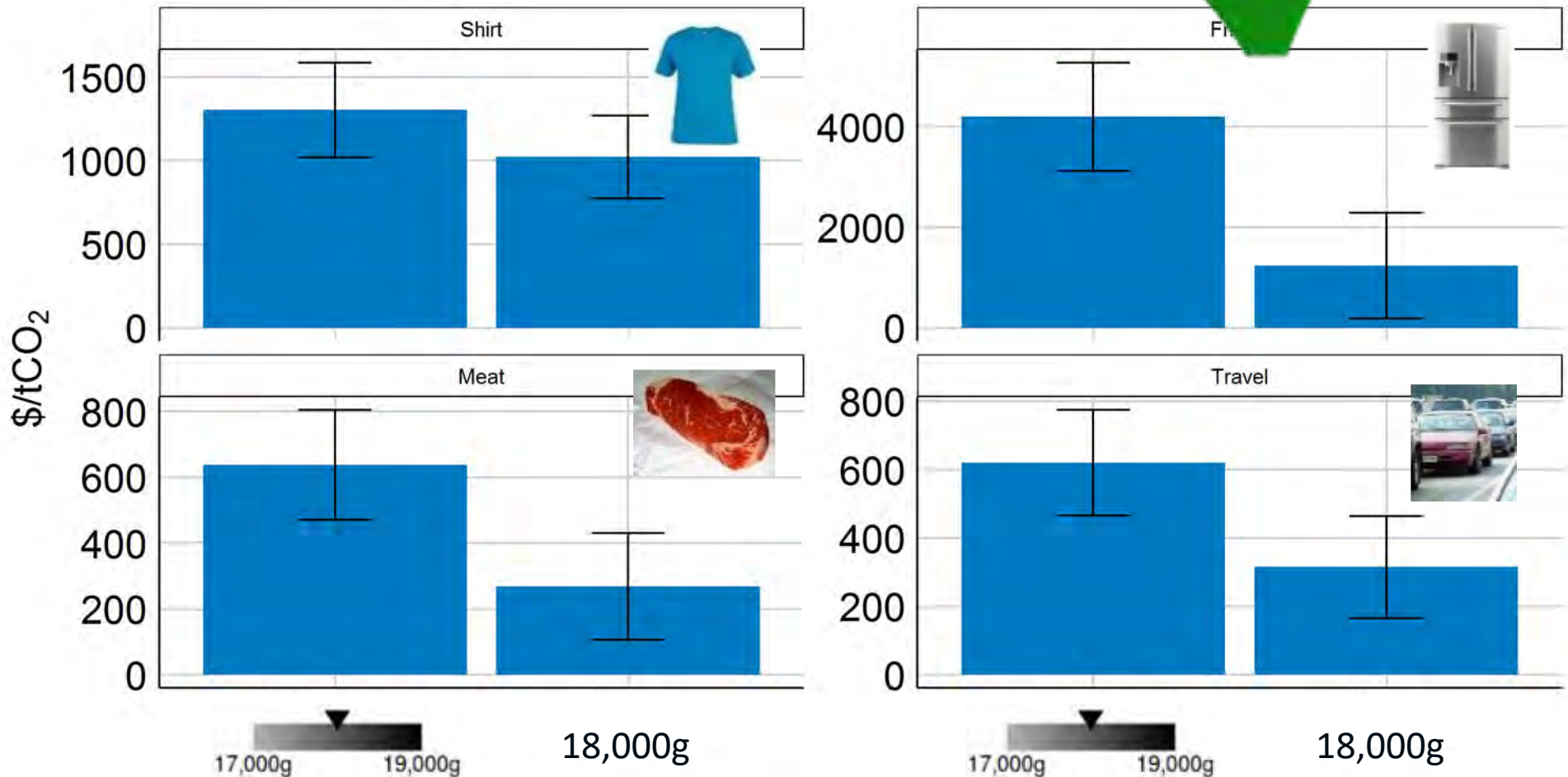
Comparable displays are more effective than incomparable ones



18,000g

Hypothesis #5

Comparable displays are more effective than incomparable ones



Hypotheses Review



High Carbon Emitter



Low Carbon Emitter

18,000g

44 miles driven



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Summary

- Do...
 - Use color if you can
 - Keep it simple, but provide context
 - Frame things as losses
 - **Pilot test your display**
- Don't...
 - Use grams, it's hard to do worse (unless you try really hard)



-----> **MOST IMPORTANT SLIDE** <-----

**We've made the source code
freely available!**

<https://github.com/scisley/dce-psiturk>

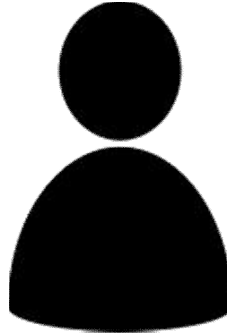
You can pilot test your own displays

Questions? steve.c.isley@gmail.com



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Specialist



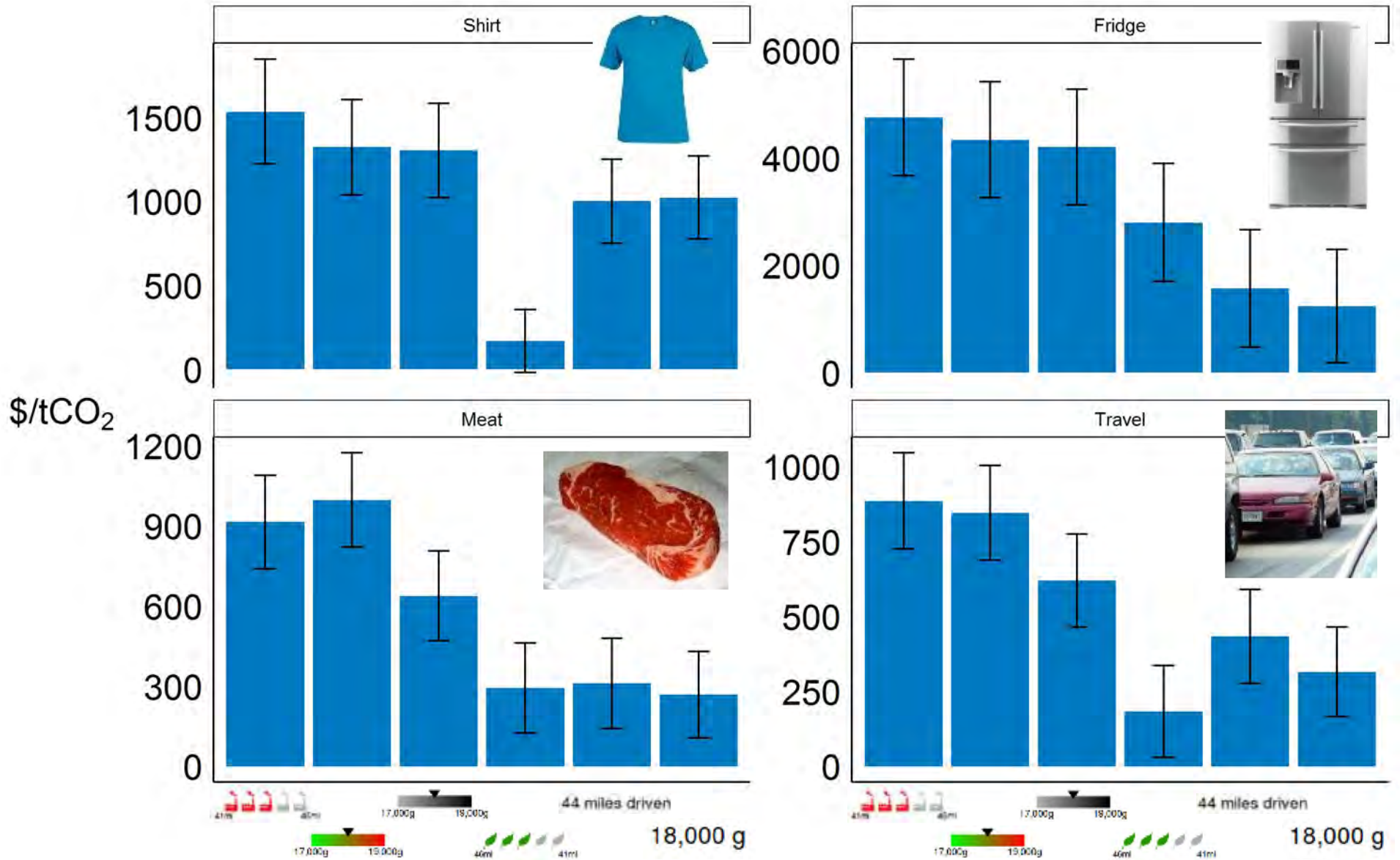
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What did people actually respond to?



Where are our Participants From?



Consumers and policy makers are demanding more information about the environmental impact associated with different goods and services with the idea that more information will lead to better, more informed choices. However, the way in which that information is conveyed to individuals can have a dramatic effect on the weight individuals give greenhouse gas reductions. Surprisingly little research exists on how best to display carbon footprint information in various decision contexts, such as purchasing products in a grocery store or informing individuals about the carbon impact of their commute. Our preliminary results indicate that a properly designed display method can increase the average willingness-to-pay for carbon reductions by a factor of three. We use insights from behavioral psychology to decompose display methods into attributes such as familiar vs. unfamiliar units, scaling method (nominal, ordinal, interval, and ratio), visual vs. verbal imagery, positive vs. negative framing, and the presence or absence of contextual information. Display methods spanning this attribute space were developed and tested using online survey tools across a range of goods and services. For each good or service, a discrete choice experiment was conducted to quantify the willingness to pay for carbon reductions. We present experimental results, offer a set of general recommendations about how to display carbon information across a wide range of decision contexts, and provide the underlying code to quickly determine the appropriate display method for contexts not covered by our analysis.

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