User-Rated Comfort and Preference of Separated Bike Lane Intersection Designs

Chris Monsere, Professor and Chair
Department of Civil and Environmental Engineering
Portland State University
Nathan McNeil, Portland State University
Rebecca Sanders, Arizona State University

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TOOLE DESIGN

NITC NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

Background

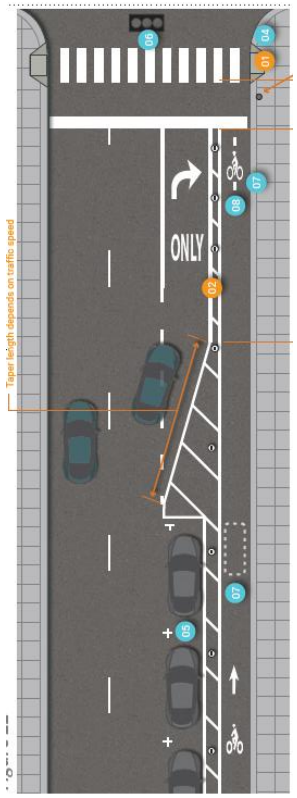
- Perception of safety and comfort is an important consideration in decision to cycle *Winters et al. (2011), Dill and McNeil (2016), Sanders (2016)*
- Separated / protected bike lanes preferred, especially by potential cyclists and women *Sanders and Judelman (2016), McNeil et al. (2015) Dill and McNeil (2016), Clark et al. (2019) Foster et al. (2015)*
- In general, separated / protected bike lanes are associated with increased safety *(Marshall and Ferenchak 2019; Harris et al. 2013; Teschke et al., 2012; Lusk et al. 2013)*
- Intersections are the weak link for both actual safety (reported crashes and observed conflicts) and perceived safety (comfort)

Measuring Comfort

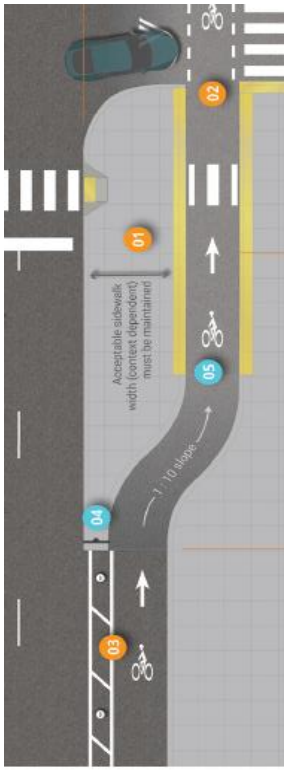
- How to measure?
  - Hypothetical/imagined photos or video, in-person or online
  - Simulated environments
  - Naturalistic (i.e. people bicycling)
- What to measure?
  - Survey answers of stated comfort
  - Bio-physiological parameters
- Some evidence of bias
  - Imagined environments less comfortable compared to actual experience (*Fitch and Handy, 2018*)
- Important to consider sample demographics, cycling experience, attitudes and other variables

Designs Considered

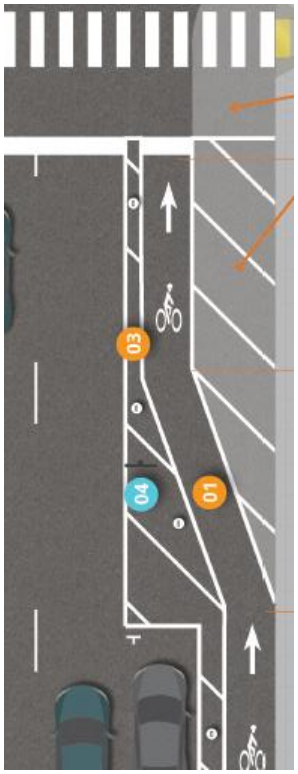
Bike Signal*



Protected / Bend-out *



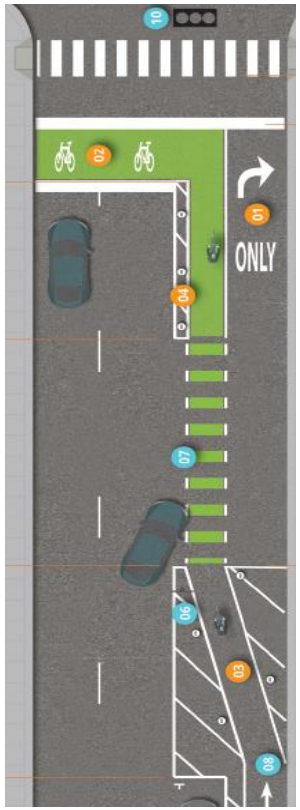
Bend In *



Maintain Path

Mixing Zone *

Lateral Shift *



* ***FHWA Separated Bike Lane Planning and Design Guide (2015)***

Scope: One-way configurations and focus on the right-turning interaction with cars

Collecting and Curating Sample Clips

10 locations from:

- Denver, CO
- Portland, OR
- Salt Lake City, UT
- Seattle, WA

Mixing Zones

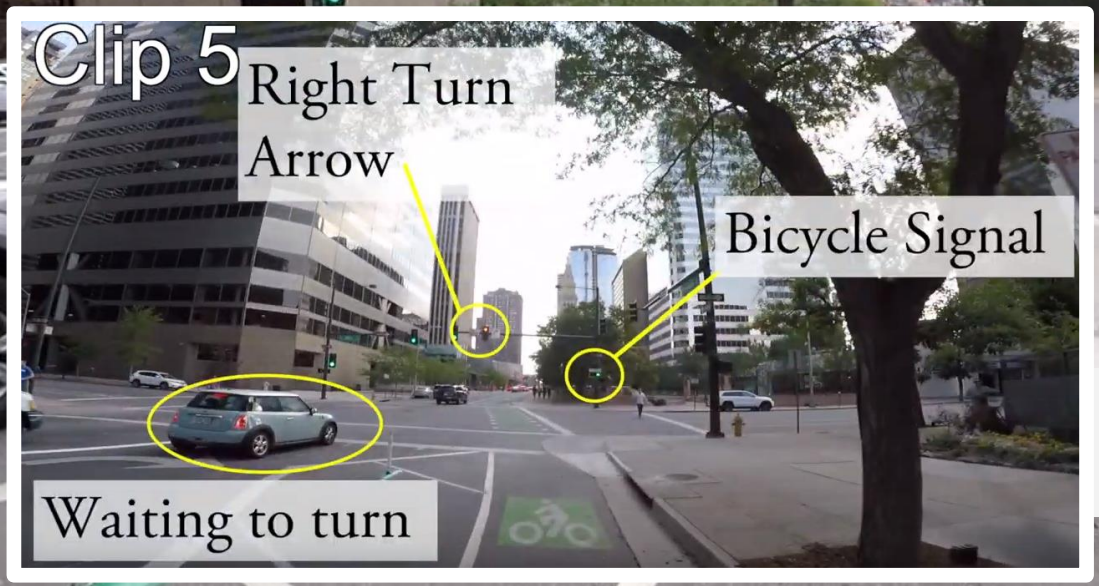
Salt Lake City
300S at 200E

Portland
NE Multnomah

Mixing Zone

Seattle
Dexter at Harrison

Bicycle Signal



Denver
Arapahoe at 18th

Lateral Shift

Denver
Lawrence and 19th

Seattle
Roosevelt NE at 50th

Bend In

Salt Lake City
300S at 300E EB

Denver
W 14th Ave at Delaware

Protected / Bend Out

Salt Lake City
200W at 300S

Maintain

Portland
Multnomah and 11th

Controls:
Off Street Path

Springwater Corridor Trail,
Portland, OR
Avg. Rating = 4.77

Separated / Protected Bike Lane Segment

NE Multnomah Protected Lane,
Portland, OR
Avg. Rating = 4.54

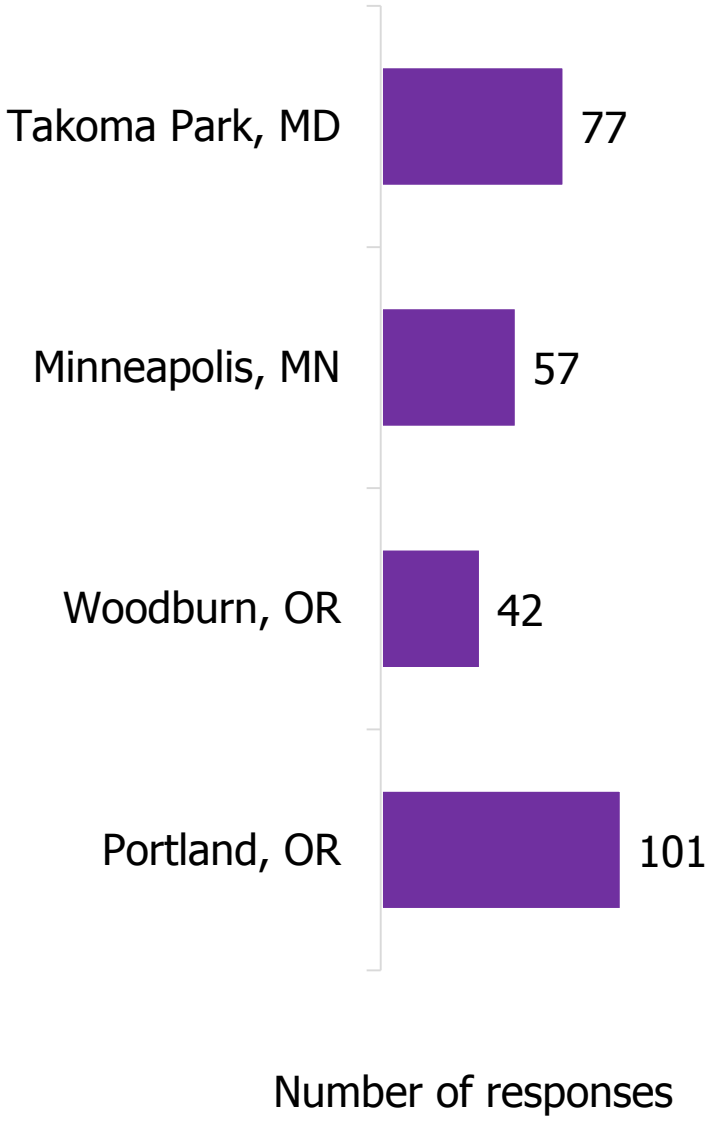
Example clip - Interaction

https://youtu.be/VrFGqoBrgaA

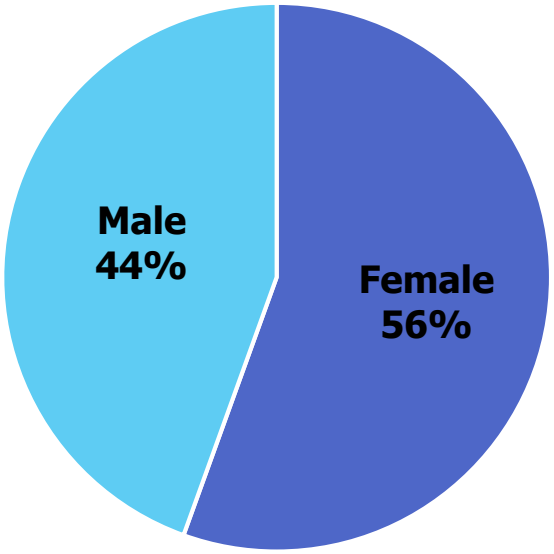
Example clip – Turn Visible

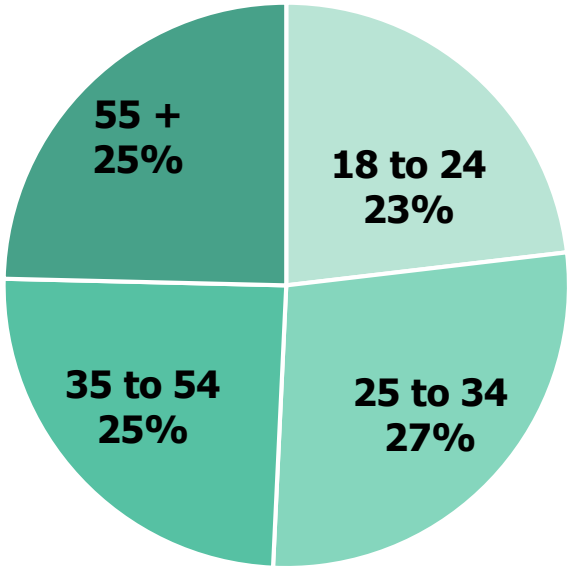
In Person Survey

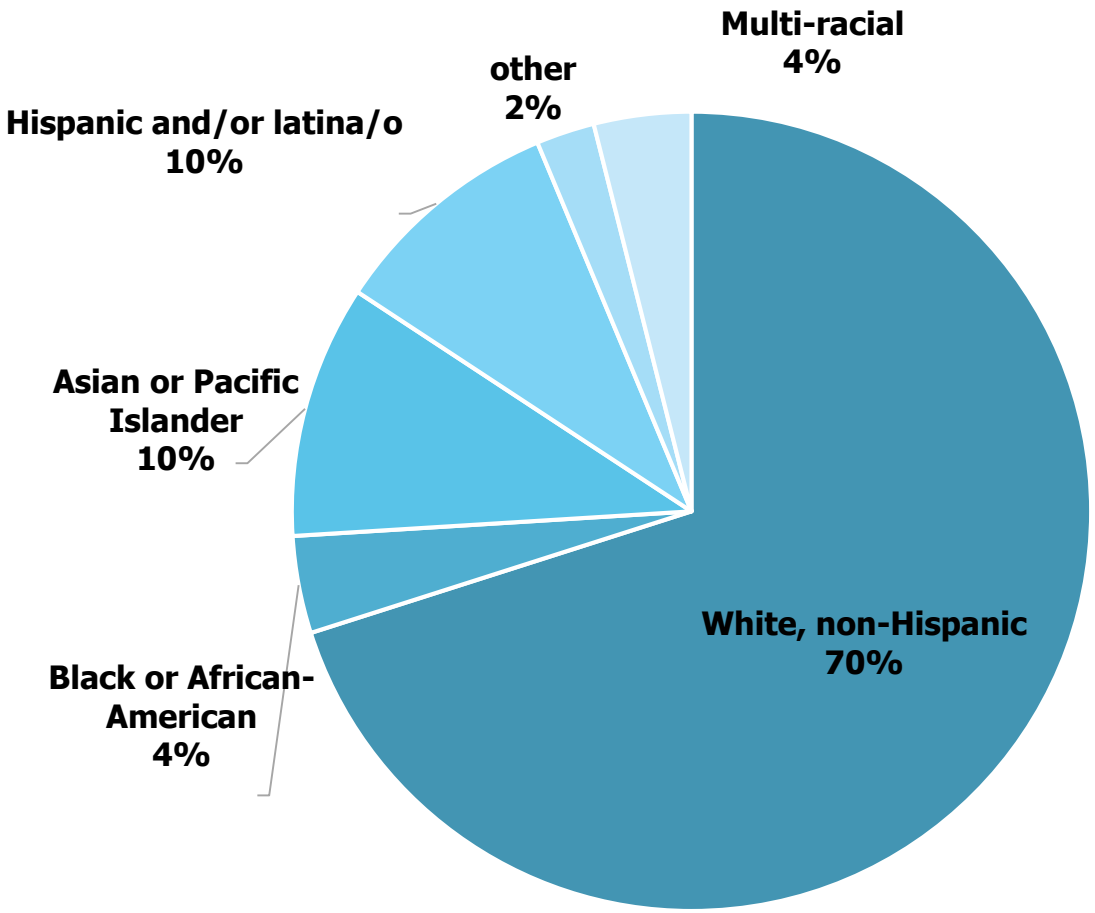
- 277 individuals
- 26 clips rating each on a 1-5 comfort scale (including neither) some on riding with children
- 7,166 total ratings



Who took the survey?

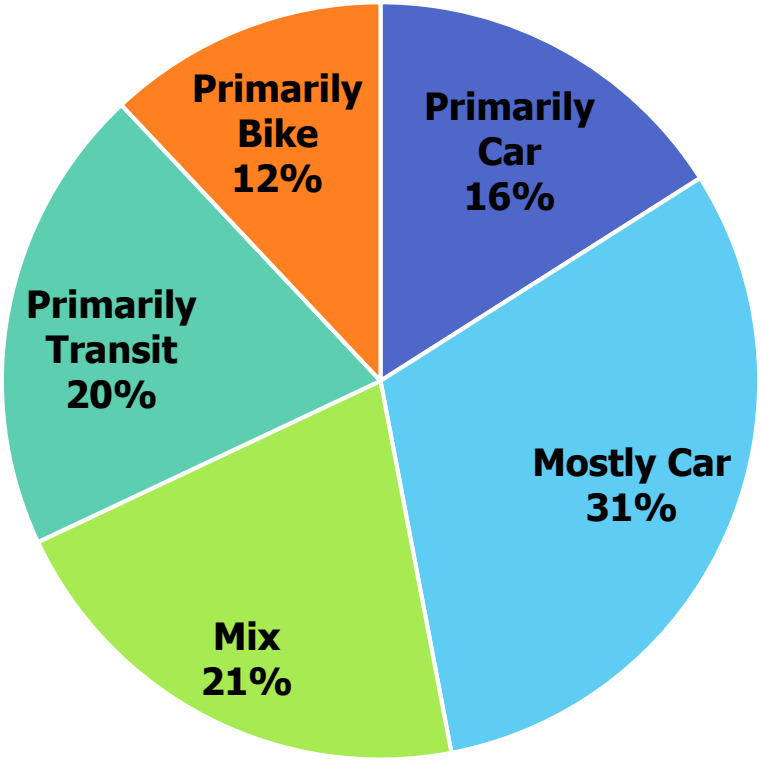




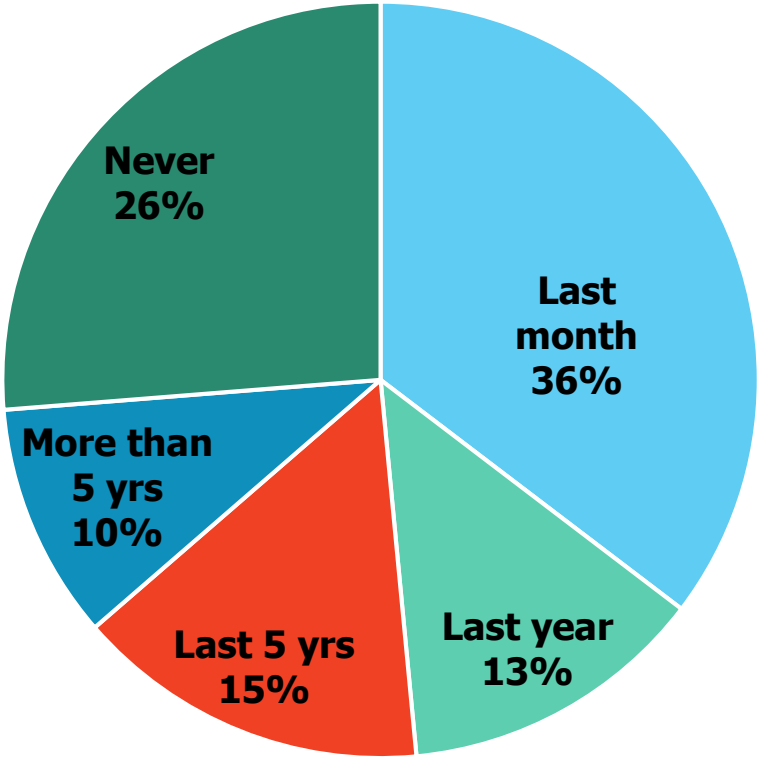


Who took the survey?

90% have driver's license
58% had a working bicycle
45% had a transit pass
57% had a car or truck



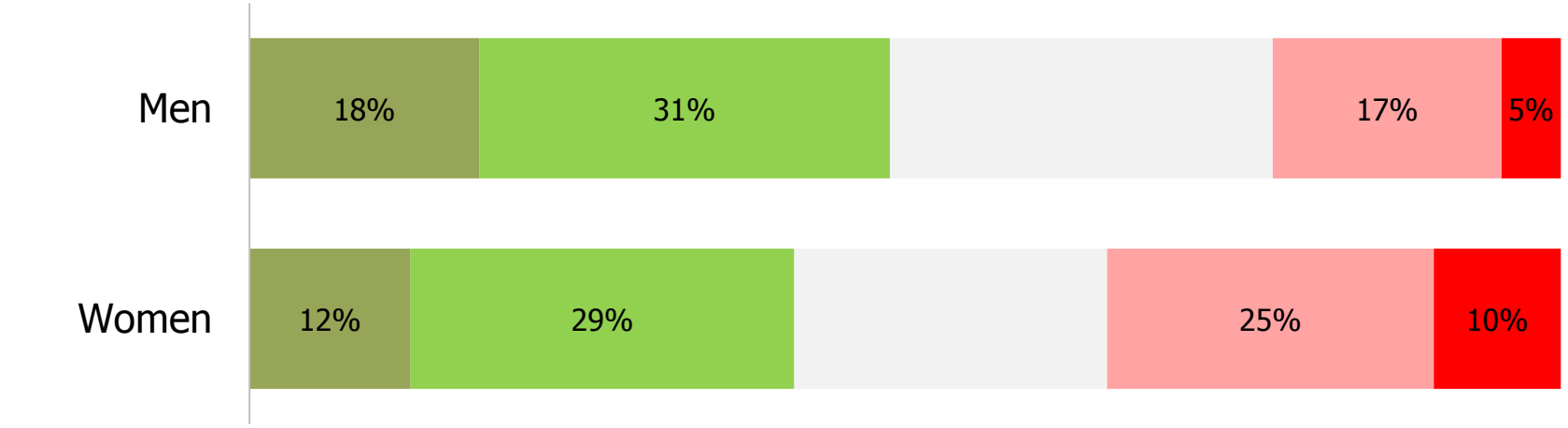
Travel behavior categories



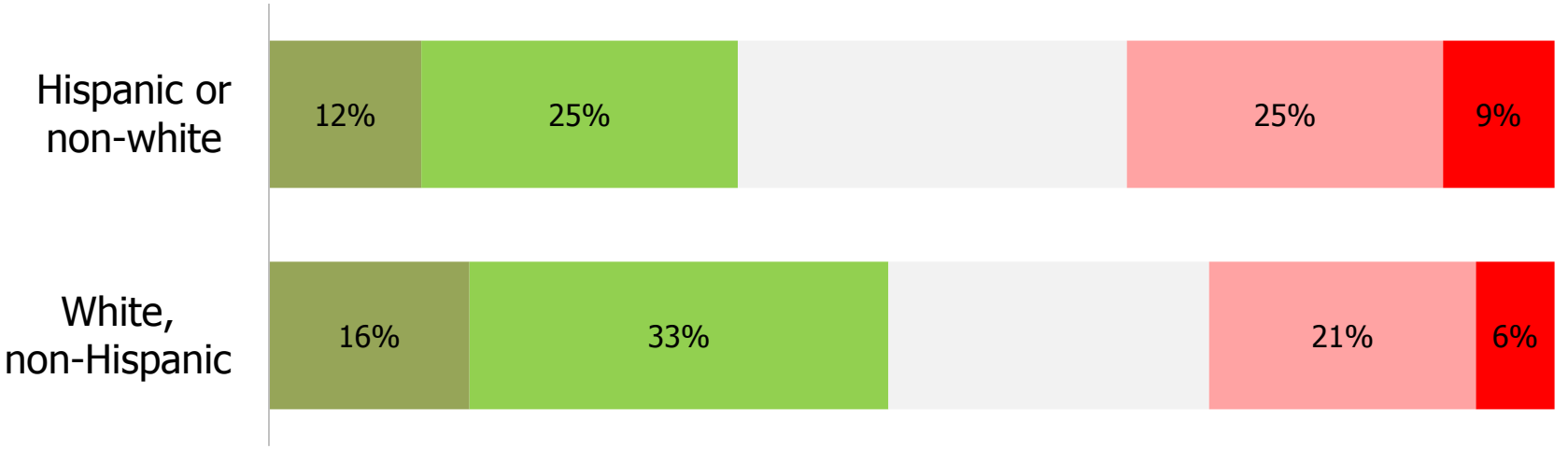
Most recent biking for transportation

Results

COMFORT BY GENDER IDENTITY

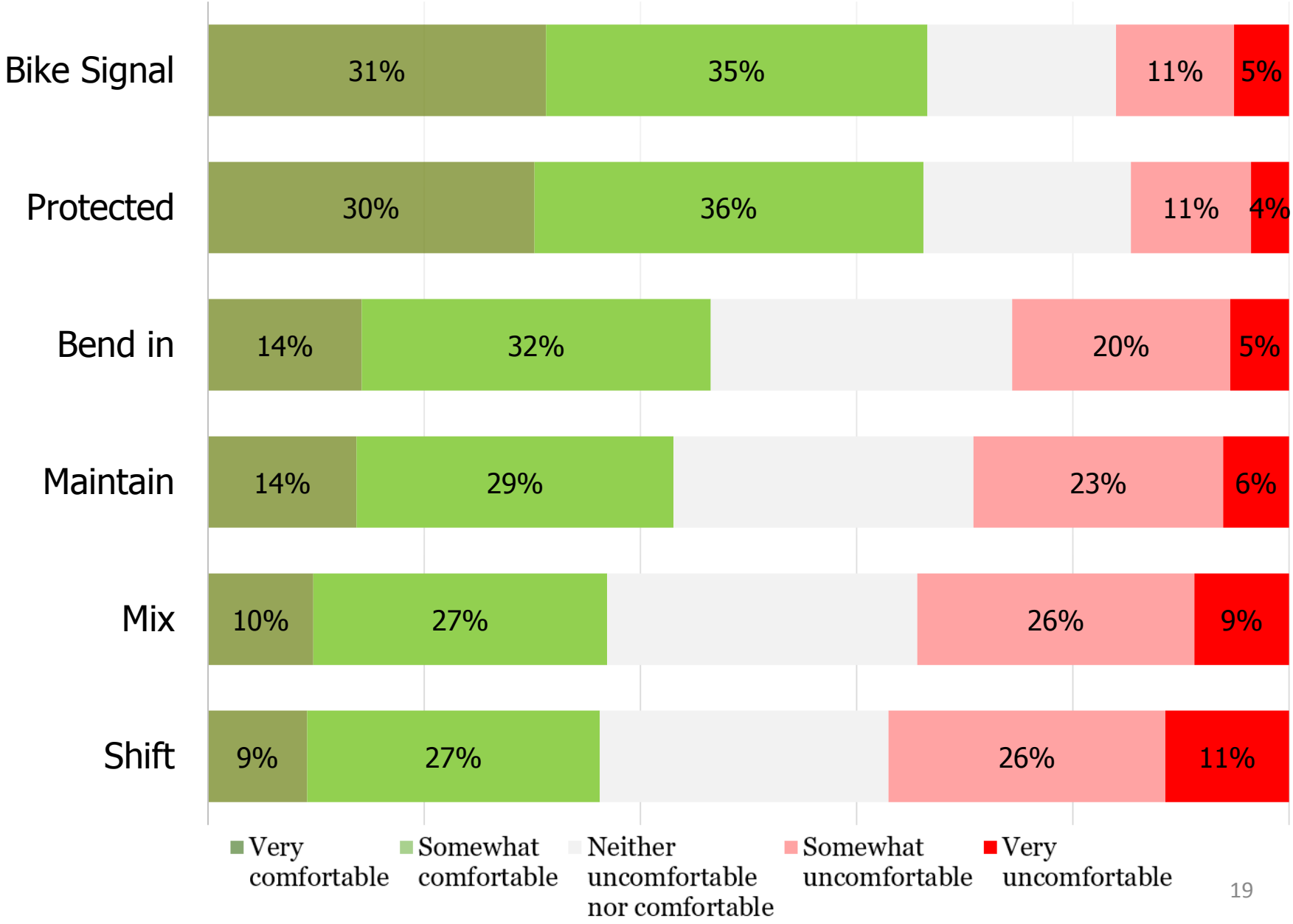


COMFORT BY RACE/ETHNICITY

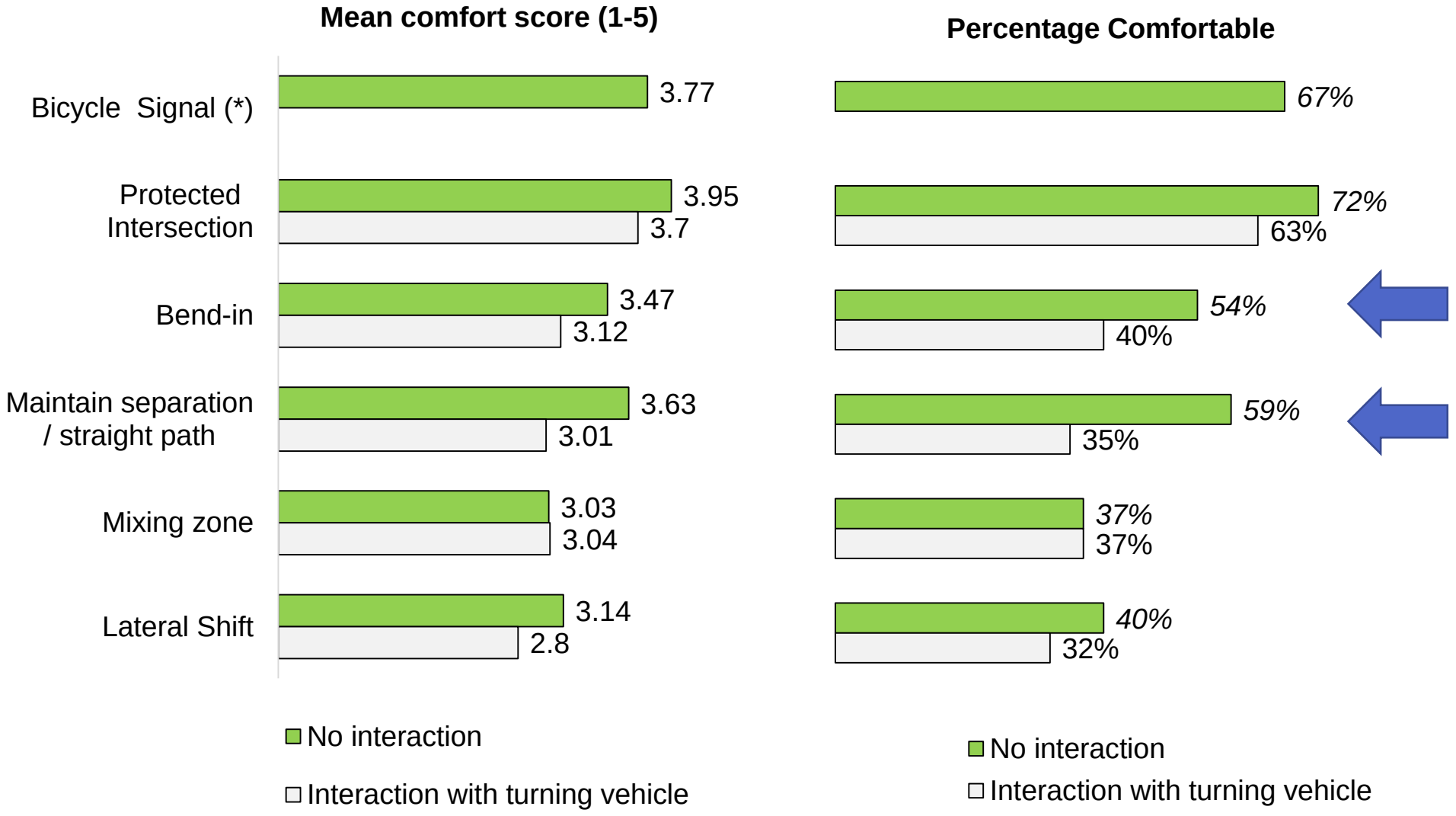


Very comfortable | Somewhat comfortable | Neither uncomfortable nor comfortable | Somewhat uncomfortable | Very uncomfortable

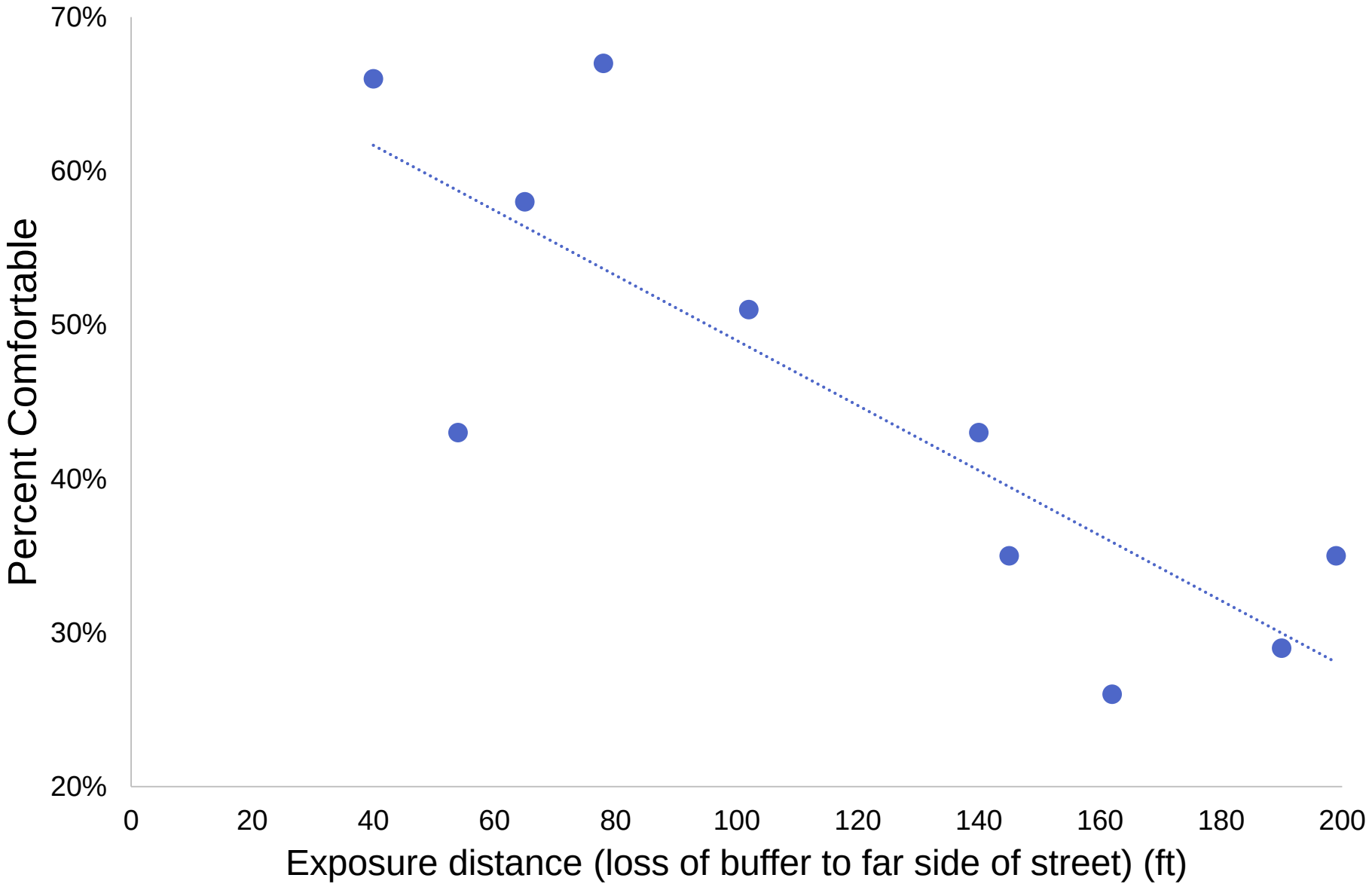
COMFORT BY DESIGN TYPE

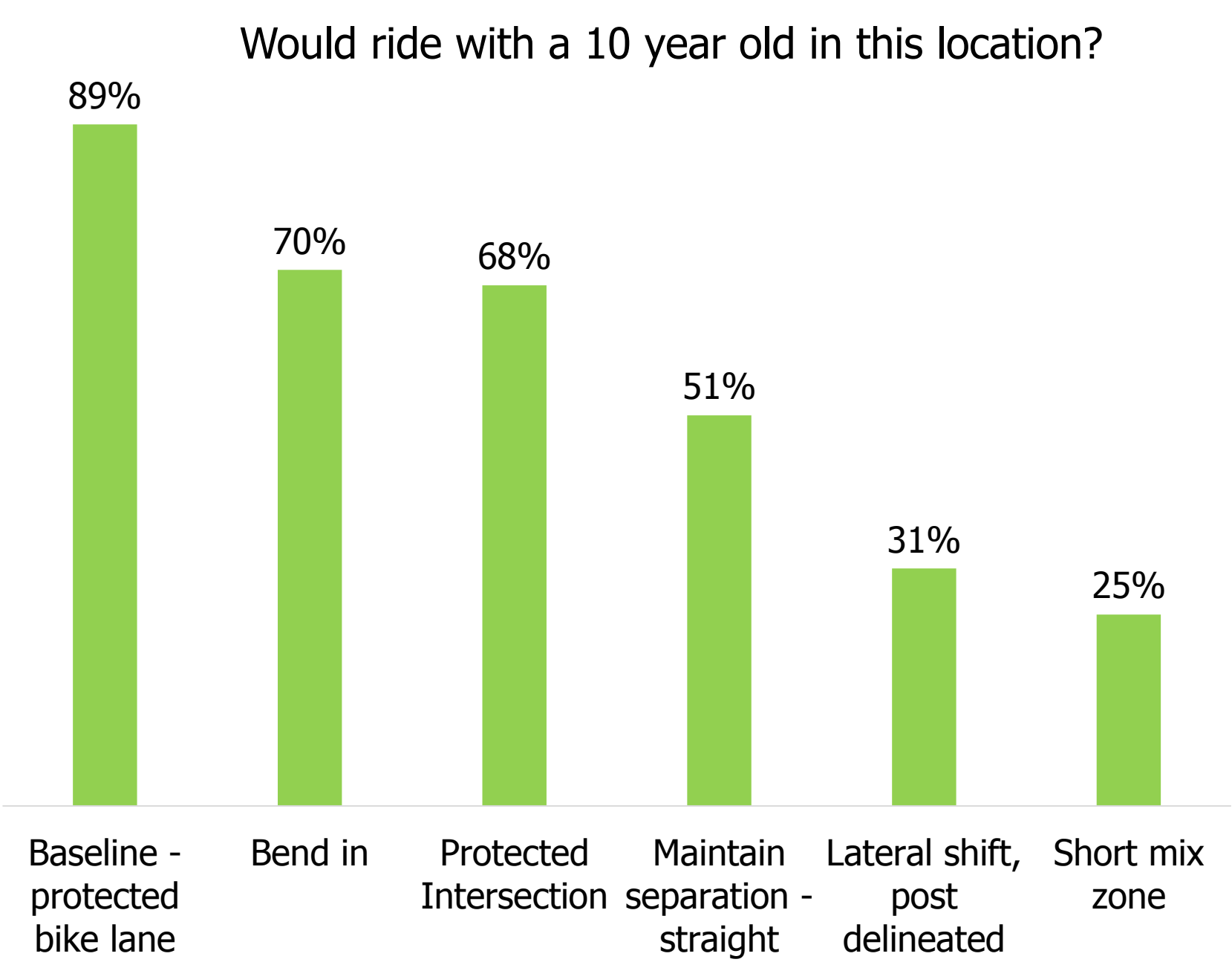


Mean comfort score with and without turning interactions



Percent comfortable by exposure distance




Would ride with a 10 year old in this location?
89%
70%
68%
51%
31%
25%
Baseline - protected bike lane
Bend in
Protected Intersection
Maintain separation - straight
Lateral shift, post delineated
Short mix zone

Would you prefer to ride through intersection A or B on a bicycle?

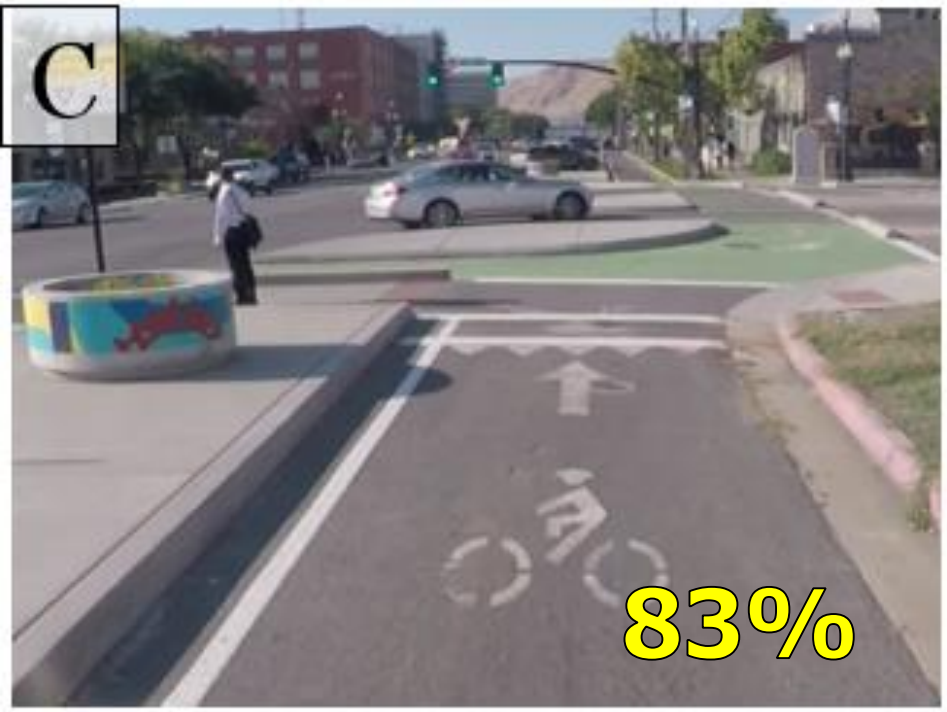
Of those who chose A, reasons include*:

- Preferred the yield sign/markings (19%)
- Not having to cross a car lane (18%)
- Being able to stay to the right (10%)

Of those who chose B, reasons include*:

- Liking the separation from vehicles (35%)
- Clear lane marking (31%)
- Like the green color (21%)

Would you prefer to ride through intersection C or D on a bicycle?



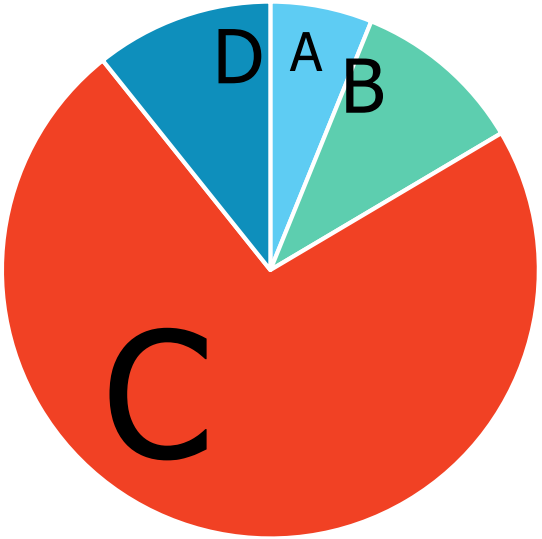
Of those who chose C, reasons include*:

- Protection and separation from vehicles (43%)
- Improved visibility and turning angle (34%)
- Clear markings (17%)
- Slows down drivers, time to react (13%)

Of those who chose D, reasons include*:

- Less confusing design (34%)
- Better visibility and alertness (16%)

Now, compare your preference from A/B to your preference from C/D. Which would you prefer to ride through on a bicycle?



A (Mixing zone design): 6%

B (Lateral shift design): 10%

C (Protected intersection design): 73%

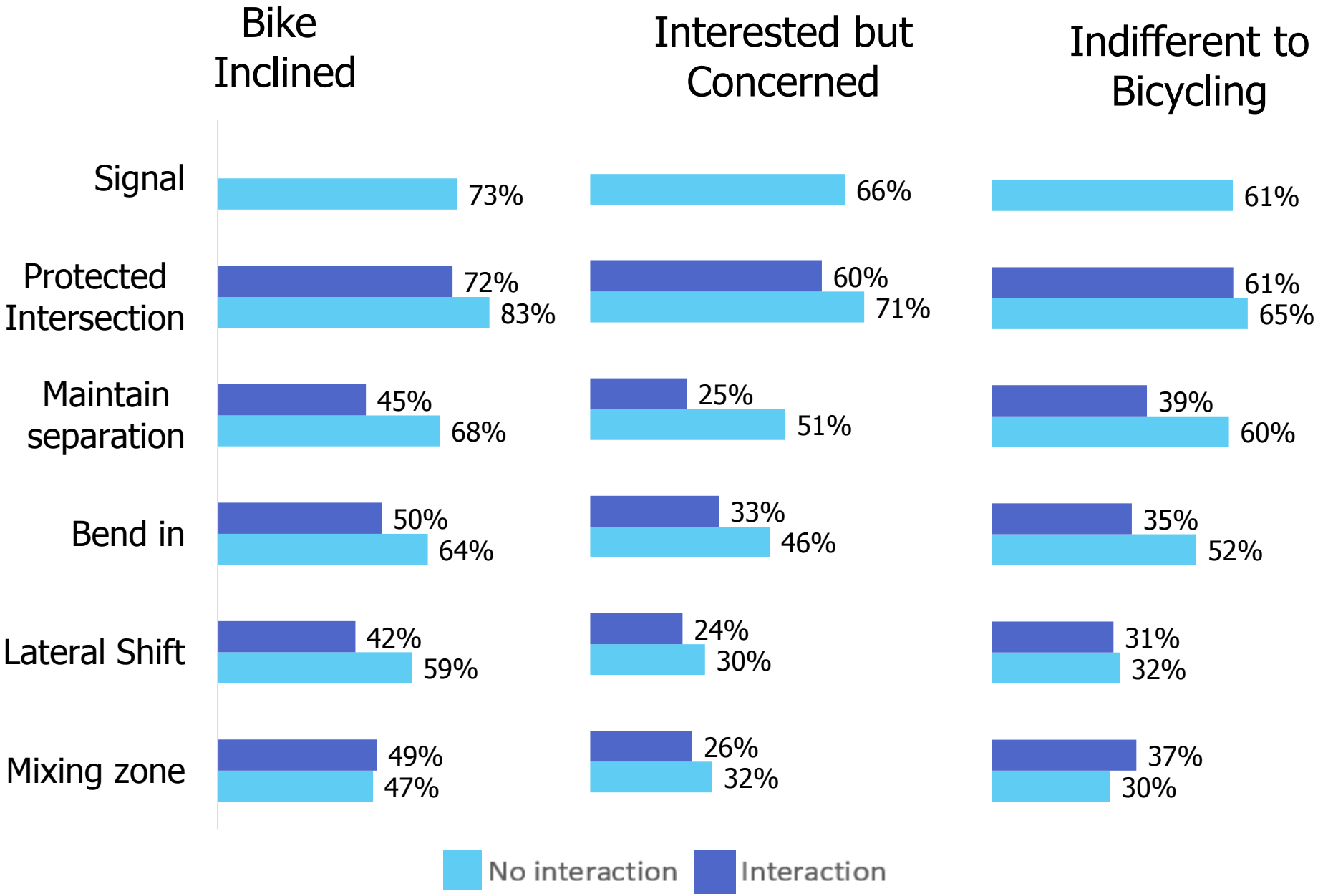
D (Bend-in design) 11%

Cluster Groupings
Exploring "types of cyclists"

K-Means Cluster Analysis, based on attitudes and perceptions toward bicycling

"Bike Inclined"	"Interested but Concerned"	"Indifferent to Bicycling"
• Feel that destinations were within bikeable distances • Not deterred by traffic • Saw people like them riding in their neighborhoods • Most likely to bike for transport	• Interested in biking more • Traffic keeps them from riding more • More likely to be female	• Less interested in bicycling • Don't view destinations as bikeable • Don't see people like themselves riding in their neighborhood. • Least likely to have ridden a bike for transport or have a transit pass • Most likely to take most trips by car.

Percentage Comfortable by Design Type



Conclusions (1)

- Separation matters:
  - Protected intersections / bend out and bike signal were found to provide the best expected rider comfort.
  - Designs that keep a separate bike lane (bend-in, straight-path) were rated as comfortable by more than half of all respondents but were sensitive to the presence of turning vehicles.
  - Designs that move bicyclists and motor vehicles into shared space (mixing zones or lateral shifts) were viewed as least comfortable.
- Exposure distance is a significant predictor of comfort. Shortening exposure distance is a good design objective.

Conclusions (2)

- "Interested but Concerned"
  - As found in past research finding, this group tends to be the most responsive to changes in the design environments.
  - Less than 30% of would feel comfortable with any form of mixing before the intersection.
  - However, about 67% would feel comfortable at a bike signal and protected intersection.
- "Riding with children"
  - Responses provide valuable insights but should be interpreted with caution as they are each based on a single video clip, without any interaction with a turning vehicle.

Acknowledgements

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