

# How temporally stable are attitudes? It depends

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# Introduction: Context

- Attitudes add explanatory power; it's desirable to include them in regional travel demand forecasting (TDF) models



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Pursuing the impossible (?) dream: Incorporating attitudes into practice-ready travel demand forecasting models

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- However, challenges:

## Measurement

- Intangible
- Not straightforward to measure
- Surveys are already demanding

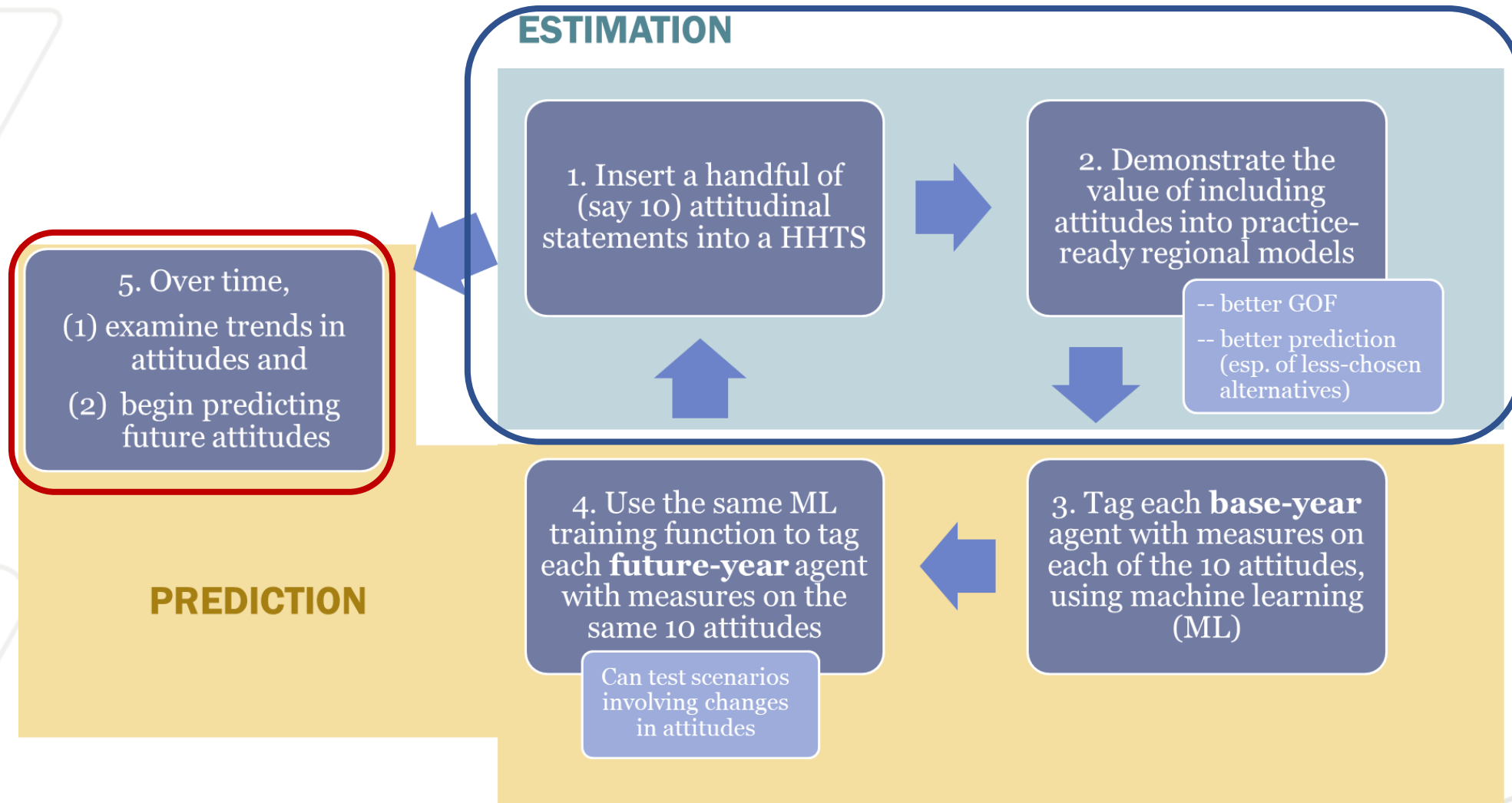
## Forecasting

- Difficult to forecast them

## Integration

- Complexity in incorporating attitudes into existing TDF frameworks
- Potential endogeneity concerns

# Introduction: Context (2)



# Introduction <sup>(3)</sup>: The key question of this talk

- How can we *forecast* what attitudes will be in the future?

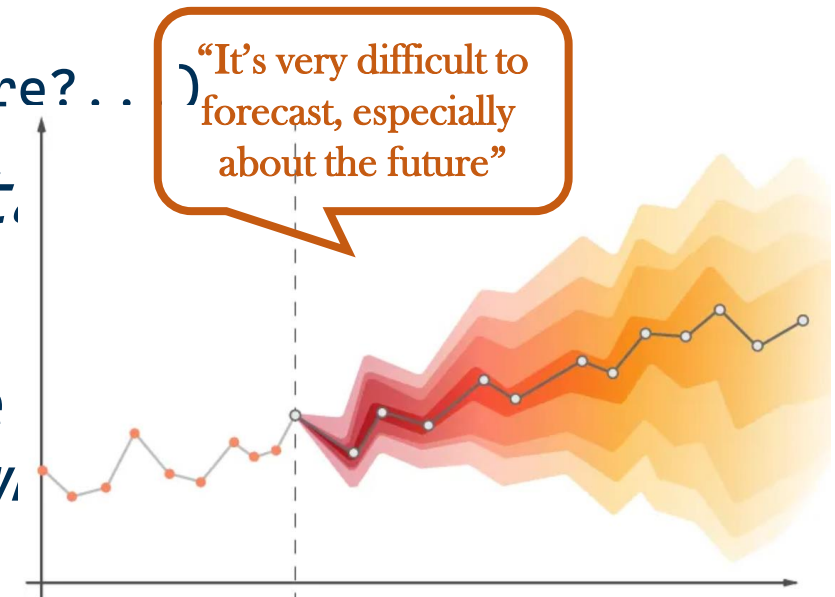
- (How well do we forecast *anything* in the future?.. )

- Let's start with... How *temporally stable* attitudes?

- Are there identifiable *patterns* to the or lack thereof, of attitudes: *under what conditions are they stable?*

- The literature on attitude formation and change/stability ...

- ... is vast
  - ... sprawls over multiple disciplines



# Introduction (4)

**Table 1**

Example attitudes and transportation-related choices/measures potentially influenced by them.

<b>Attitude toward...</b>	<b>Example travel-related choices/measures</b>
Sharing vs. owning	Owning a car versus using car-sharing and/or ridehailing
Multitasking	Value of travel time as a function of activities performed while traveling
Time	Value of travel time
Money	Value of travel time; willingness to pay
Status-seeking	Vehicle type choice; choice of airline passenger class
Materialism	Shopping trip frequency; vehicle type choice; dwelling size
Privacy	Propensity to share rides; choice of dwelling unit type and size; propensity to use autonomous vehicles (given fear of data breaches)
Physical activity	Choice of bicycling or walking over car or transit
The environment	Vehicle ownership and type choice; mode choice; air travel frequency; telework adoption
Types of residential locations	Dwelling size and type; mode choice
Transportation modes	Mode choice; vehicle ownership; residential and/or work location
Self-efficacy	Driver's license possession; adoption of new transportation technologies/services
Need for control	Owning versus sharing a vehicle; driving versus riding
Peer influence	Mode choice; residential location; vehicle type choice; adoption of new technology; social trip generation
Perception of risk	Adoption of autonomous vehicles, or bicycling; bicycle route choice
Risk-taking	Adoption of new technology; driving behavior
Spontaneity	Trip generation; habit persistence
Technology	Adoption of new transportation technologies/services
Family	Commute distance; employment; telework adoption/frequency; trip generation/purpose
Work	Employment status; work hours/days; telework adoption; propensity to work productively while traveling
Leisure	Trip generation/purpose
Government	Support for transportation-related taxes; compliance with regulations

# Introduction (4)

**Table 1**

Dimensions of travel behaviour, impact of attitude changes on those dimensions, and impacts on societally relevant impacts due to behavioural changes.

Dimension of Travel behaviour	Possible impacts of attitude changes on the dimension of travel behaviour	Societal relevant impacts
Number of trips, total and by mode	Changing preferences for travel in general, and by specific modes	Emissions, noise, safety, well-being, health
Number of kilometres travelled, total and by mode	„	Emissions, noise, safety, well-being, health
Residential location choices	Changing preferences for types of residential areas	Additional to overall levels of emissions, noise, safety, well-being: local environmental impacts (noise, concentrations of pollutants, nuisance of driving and parked vehicles)
Destination choices	Changing preferences for activities at certain places, changing travel preferences	Additional to overall levels of emissions, noise, safety, well-being: local environmental impacts (noise, concentrations of pollutants, nuisance of driving and parked vehicles)
Route choice	A changing preference for more attractive or safer routes	Noise nuisance, concentrations of pollutants, health
Total travel time	Changing (dis)like for spending time on travel	Emissions, noise, safety, well-being
Time of day of travel	Changing attitudes towards congestion	Congestion levels, travel times, travel time reliability
Way of using vehicles	Changing preferences for driving styles	Emissions, noise, safety
Vehicle type choice	Changing preferences for specific vehicle types	Emissions, noise, safety of vehicle users and other road users
Interactions between dimensions above	Many combinations of the above changes are possible	All impacts listed above

# What do we mean by stability, anyway? (1)

## Aggregate level

- Longitudinal surveys like WVS, GSS, and ISSP track societal attitudes over decades
  - E.g., cultural values, policies, race, income inequality, and environmental issues... etc.
- These studies often rely on repeated cross-sectional surveys
  - To identify broad societal patterns and measure the persistence or evolution of attitudes in response to external events or generational changes.
- We need such long-term surveys

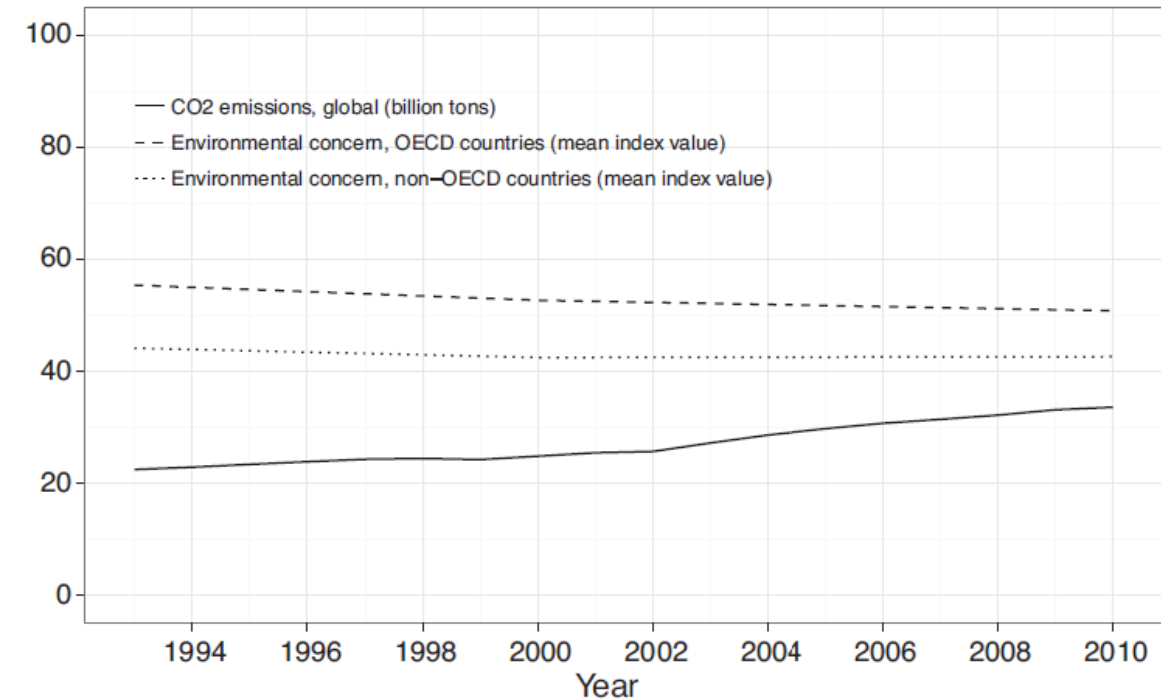


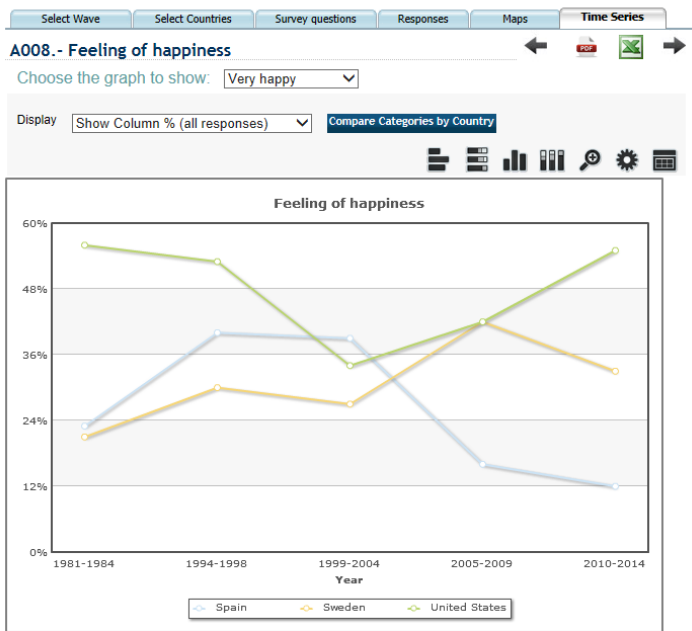
Fig. 1. CO<sub>2</sub> emissions and environmental concern.

Franzen & Vogl (2013)

# Inglehart et al.

(2014)

World Values Survey Wave - Time Series



# Firebaugh and Davis

(1988)

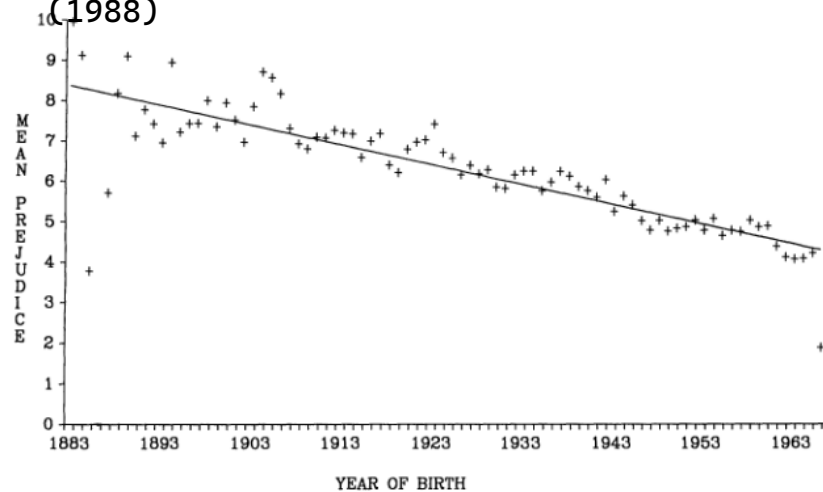


FIG. 2.—Prejudice by birth year. Means for the pre-1895 and post-1963 cohorts are based on fewer than 20 cases and thus are less reliable (the first three means are based on two cases each, and the final mean is based on a single case).

# Franzen and Vogl

(2013)

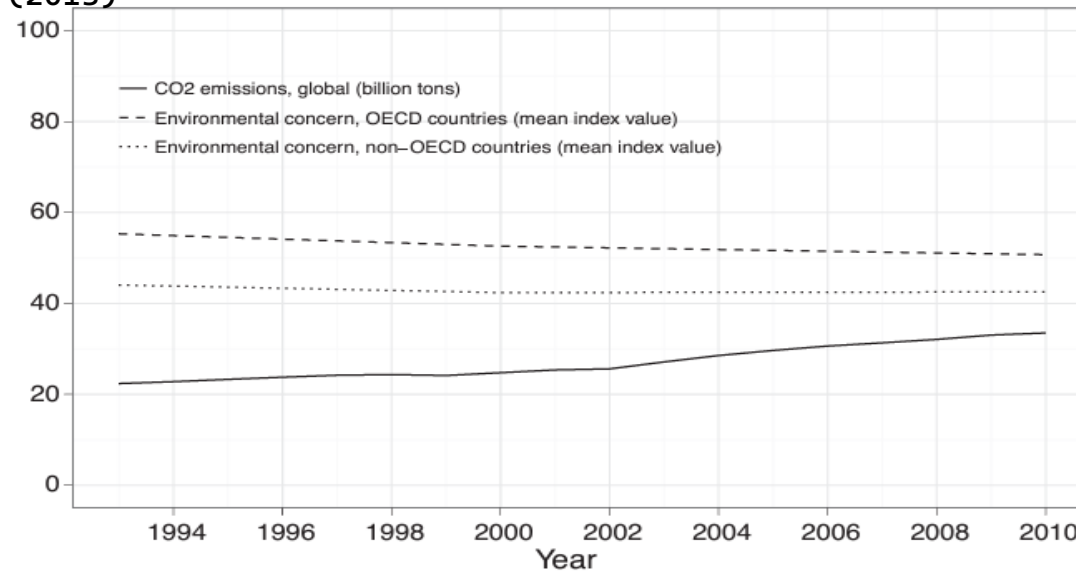


Fig. 1. CO<sub>2</sub> emissions and environmental concern.

# Diener and Tay

(2015)

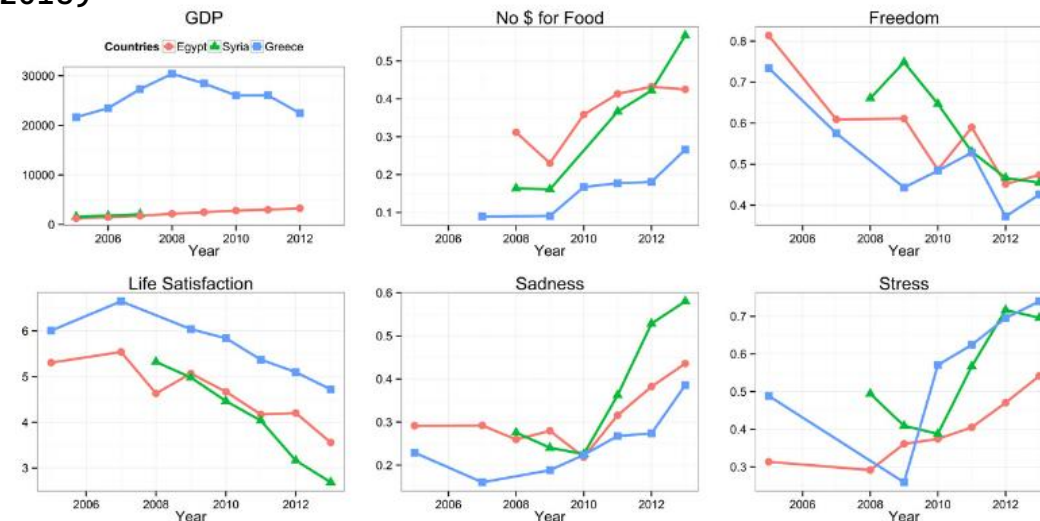


Figure 1. Declining well-being over time in three nations.



# What do we mean by stability, anyway? (2)

## Disaggregate level

- In contrast, research on attitude stability in the transportation domain tends to focus on *disaggregate* data, probably due to...
  - ... the limited availability of long series of data on transportation-related attitudes, and
  - the tendency to focus on individual-level analysis in travel behavior research/transportation planning models
- We'll focus on the disaggregate level, and explore
  - Mechanisms of attitude change
  - Data sources and methodologies
  - Examples of studies and (a few) key findings

# What do we mean by stability, anyway? (3)

Stability at *neither* level implies stability at the other

- *Aggregate* stability can mask considerable *instability* – or at least *variability* – at the *disaggregate* level

(travel time budgets, Mokhtarian & Chen, 2004)

- And conversely, cohort-level attitudes may be fairly stable, but as

TONIGHT: ARE MILLENNIALS KILLING THE JOINT REPLACEMENT INDUSTRY?

OPERATION RATE PER 100,000		
	KNEE	HIP
BABY BOOMERS	720	390
MILLENNIALS	1	3

STATS PET PEEVE: PEOPLE MIXING UP COHORT EFFECTS AND AGE EFFECTS

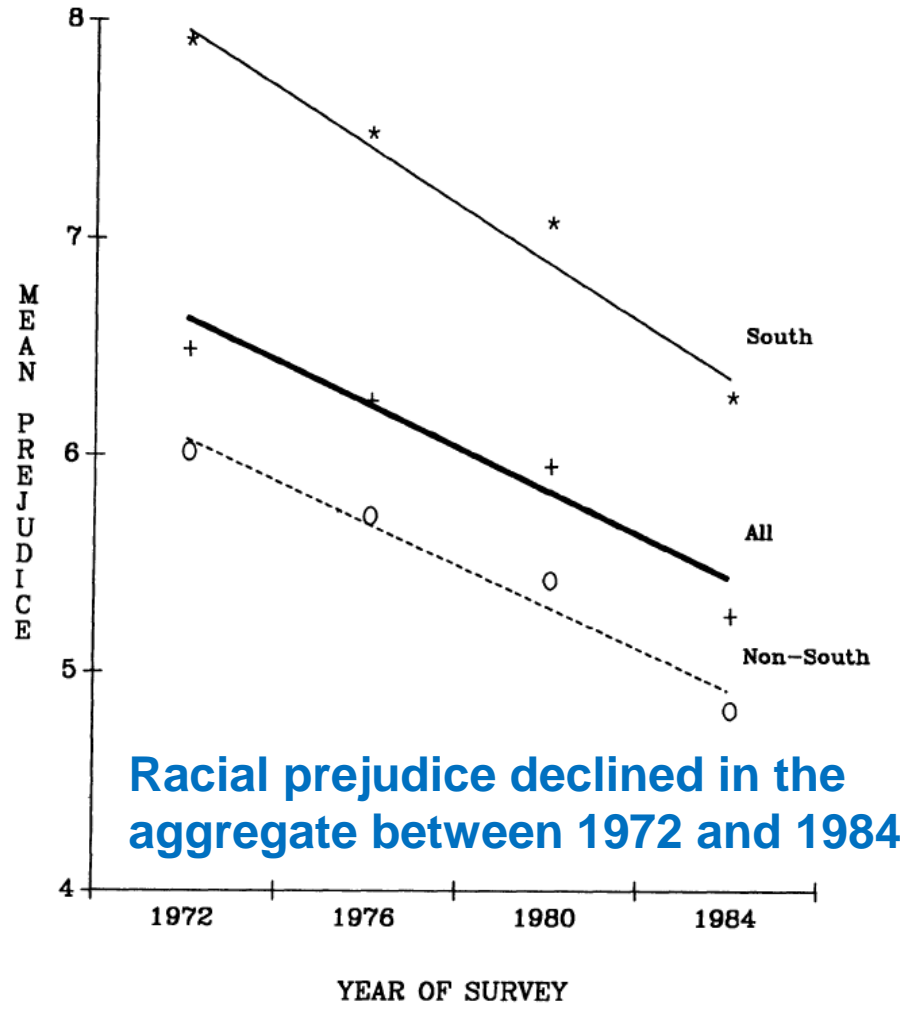


FIG. 1.—Prejudice by year for all respondents and prejudice by year by region

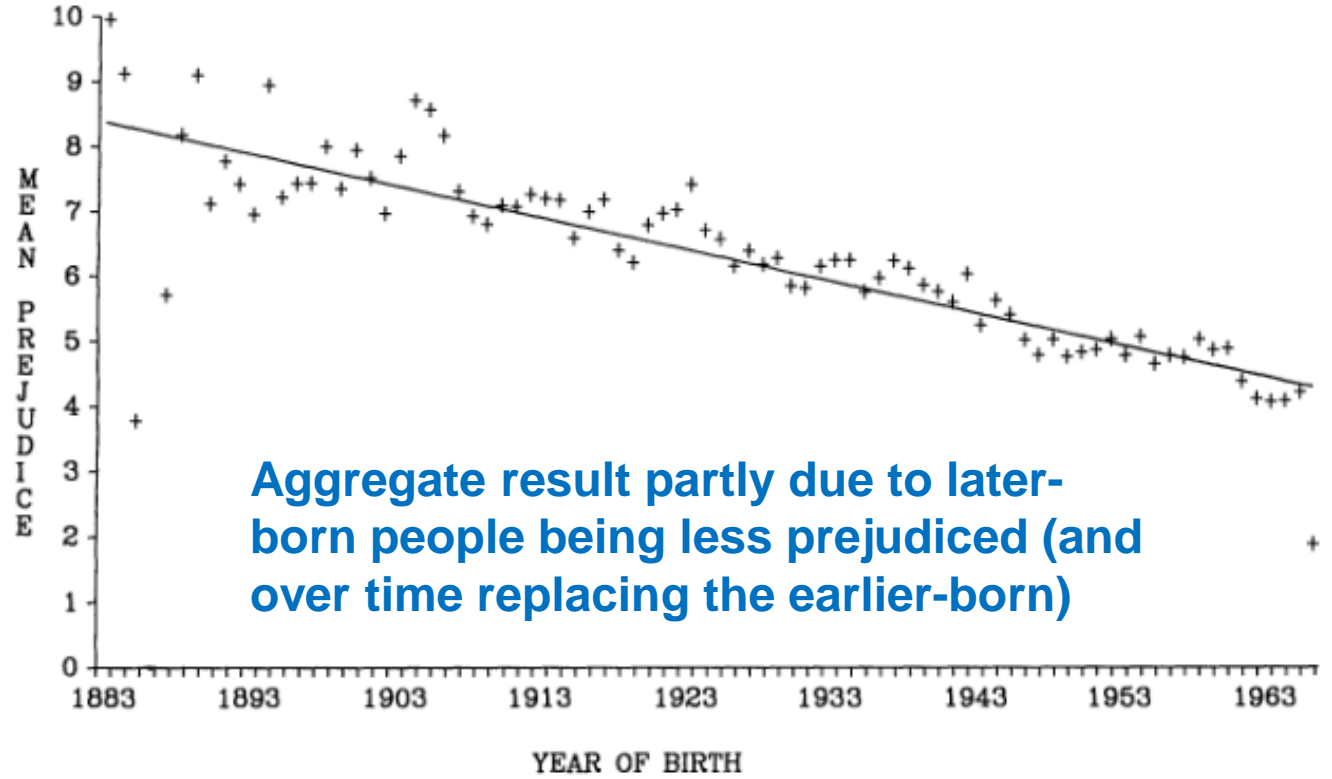
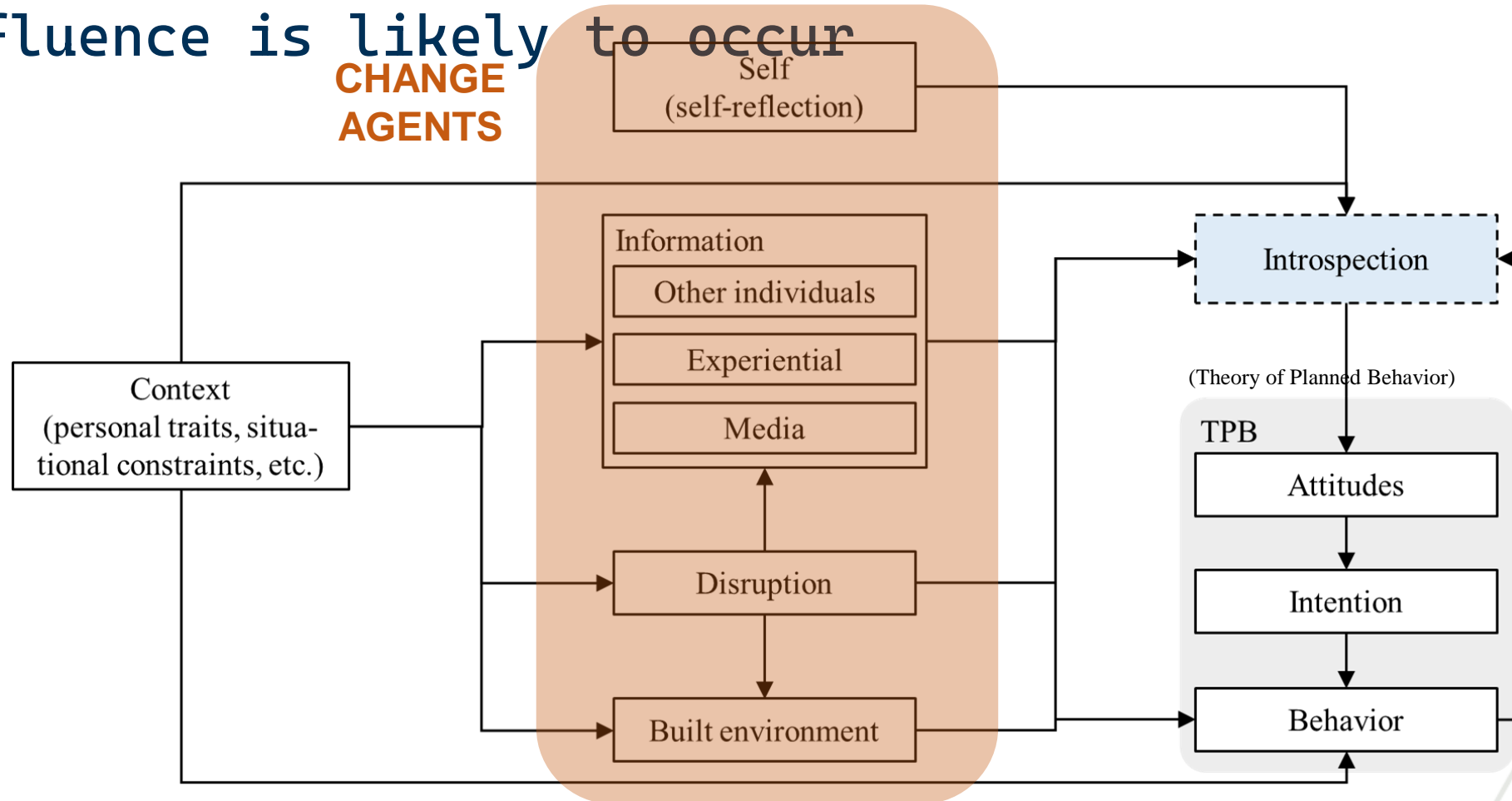


FIG. 2.—Prejudice by birth year. Means for the pre-1895 and post-1963 cohorts are based on fewer than 20 cases and thus are less reliable (the first three means are based on two cases each, and the final mean is based on a single case).

# Mechanisms of (dis)aggregate attitude change

- We have identified a number of factors that (we believe) influence attitude change, and pathways by which that influence is likely to occur



# Mechanisms of (dis)aggregate attitude change

## 1 Context influences...

### A. Attitudes

- E.g., income influences individuals' support for redistributive policies (Choi, 2021); desire to work while traveling depends on trip purpose

### B. Information

- E.g., those living in rural areas with limited internet access may have less up-to-date news

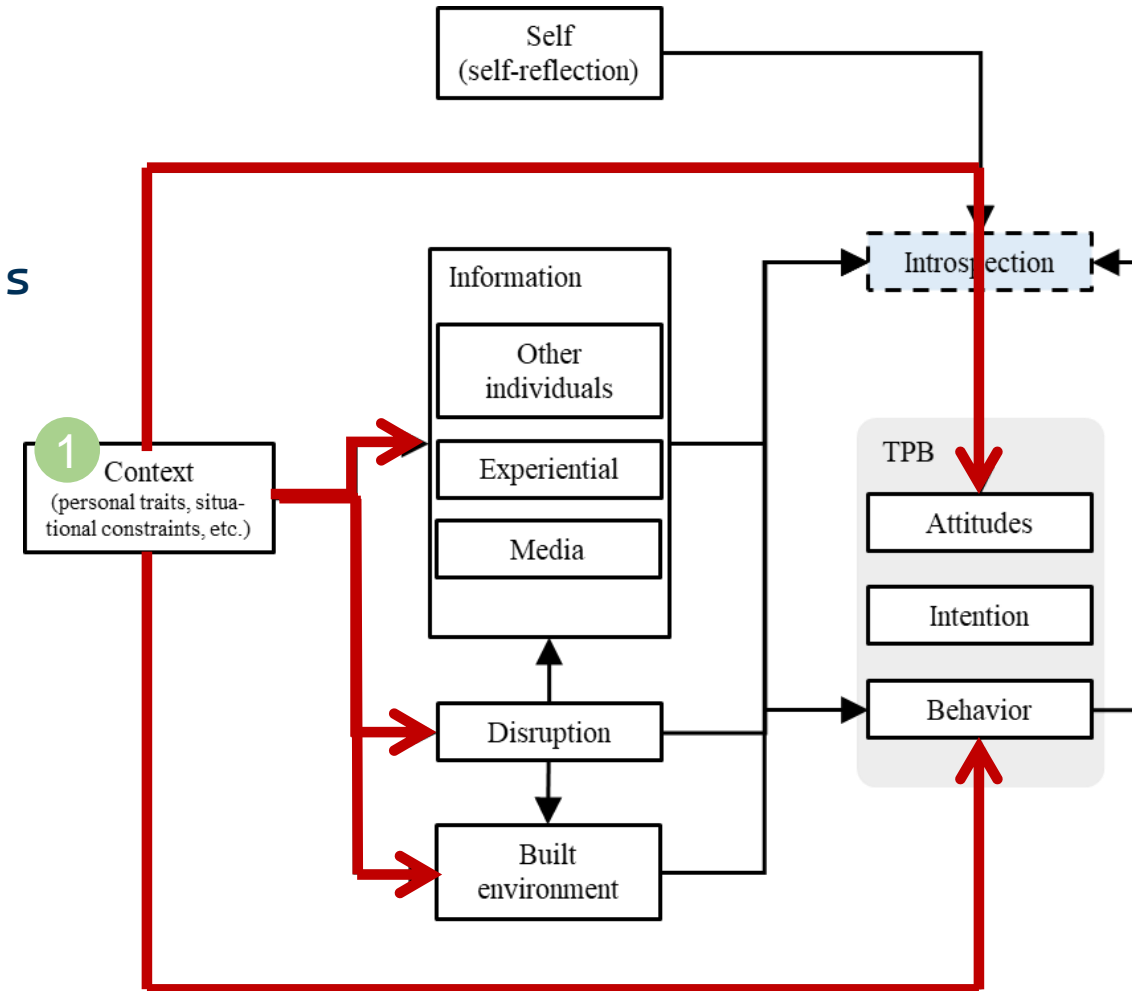
### C. Disruption

- E.g., occupation influenced exposure to/disruption of COVID-19

### D. Built environment

- E.g., income may limit one's residential and job location choices

### E. Behavior



# Mechanisms of (dis)aggregate attitude change

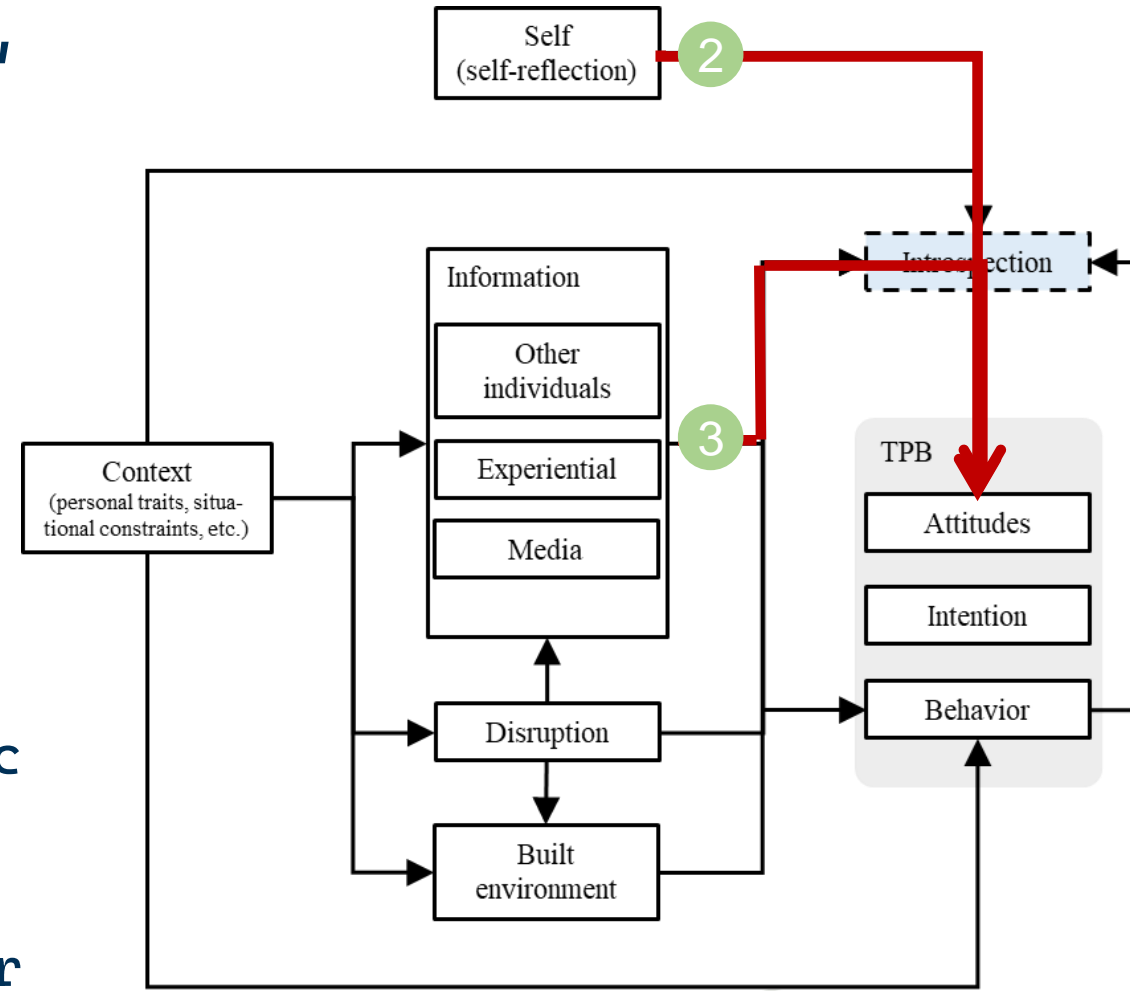
2 Individual's connection to values, goals, language, emotions, and human development can influence attitude formation and change

3 (Albarracin and Shavitt, 2018)

• Exposure to new facts or perspectives that challenge existing attitudes can influence attitude change

(Albarracin and Shavitt, 2018; Hepler and Albarracin, 2013)

- Persuasive messages or peer influence  
(Albarracin and Shavitt, 2018; de Klepper et al., 2010)
- Education on the mechanisms of a topic can shift attitudes, such as learning about climate change  
(Ranney and Clark, 2016)
- Individuals experiencing maturation or idiosyncratic events, much observed in early and late adulthood, are more susceptible to attitude change than in



# Mechanisms of (dis)aggregate attitude change

4 Disruptions, such as societal shifts, historical events, extreme events, or life changes can change attitudes (Ingwersen et al., 2023)

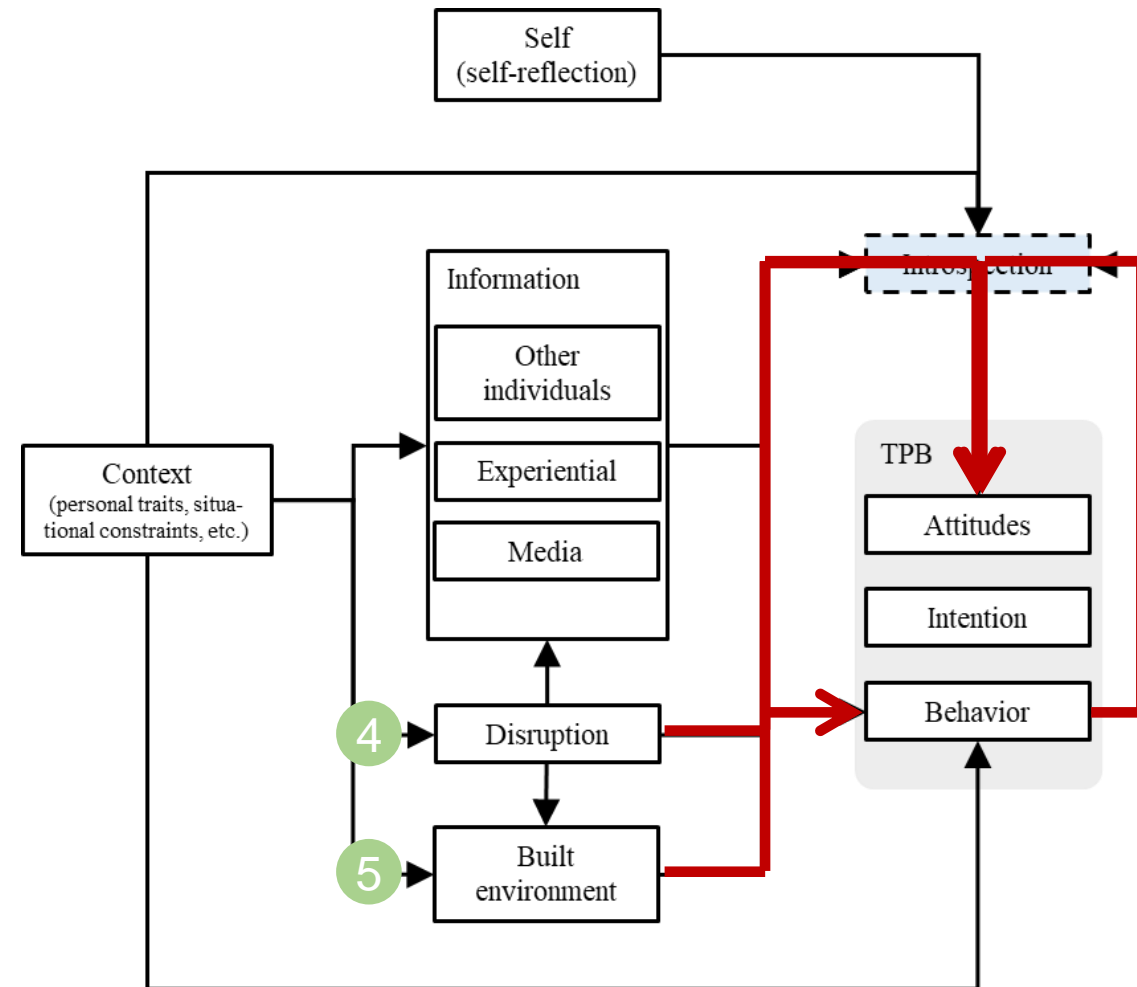
- Extreme events, especially when reported in the media, can impact public attitudes quickly and on a large scale (Petty et al., 1997)

5 • Civil rights movement, Watergate scandal, COVID-19 pandemic, etc.

• Changes to the built environment can both directly and indirectly influence attitudes

(van Wee and Kroesen, 2019 & 2022; Rahman and Sciara, 2022)

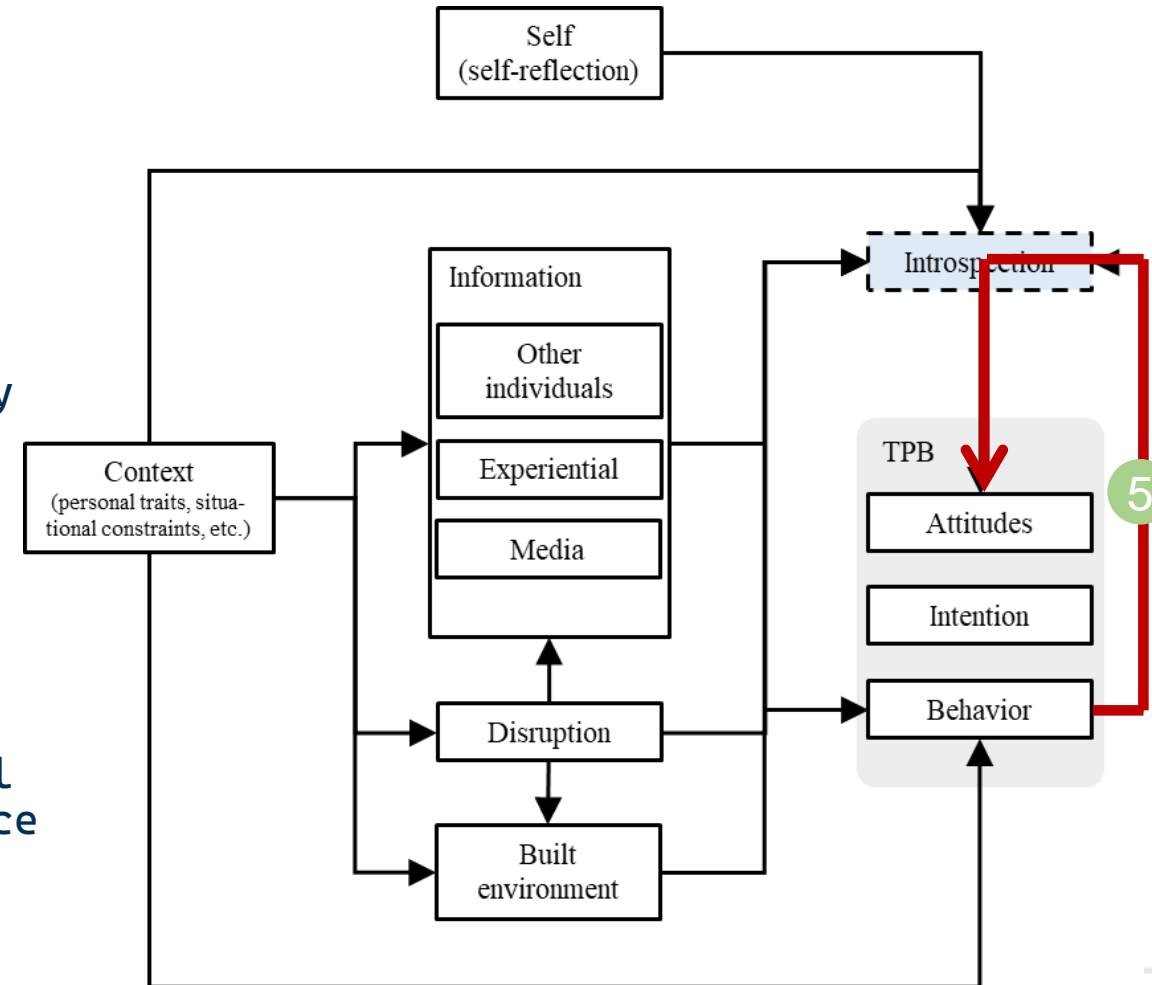
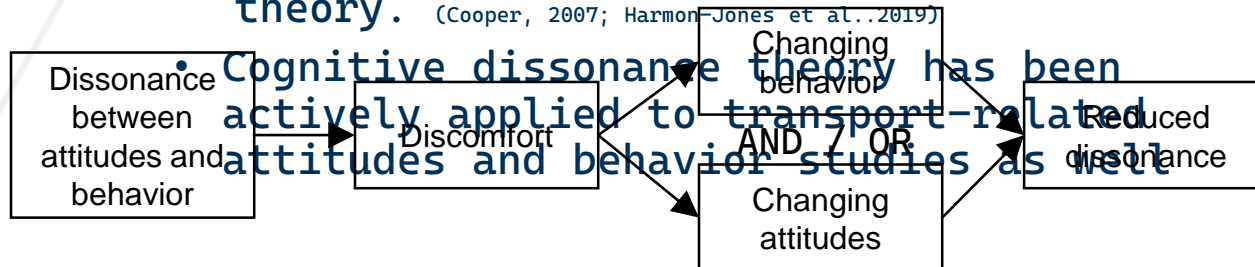
- E.g., relocation can modify travel-related attitudes, such as pro-transit preferences and awareness of



# Mechanisms of (dis)aggregated attitude change

## 5 Behavior can bring about change in attitudes

- Repeated behaviors can solidify attitudes  
(Verplanken et al., 1999)
- Cognitive dissonance
  - Introduced by Festinger (1957), the theory explains the discomfort from conflicting attitudes or behaviors and strategies to reduce it. (Festinger, 1957)
  - It faced challenges during the 1970s, including criticism and the rise of alternative theories such as self-perception theory. However, additional research has provided further experimental evidence that is consistent with dissonance theory. (Cooper, 2007; Harmon-Jones et al., 2019)





# So, how stable are attitudes?

It depends on...

- The individual
  - Personality traits, resistance to change, emotional regulation
  - Between-individuals vs. within-individuals
- Congruence with behavior
- External events
- Social relationships
- The attitude
  - Attitude strength and conviction help explain why certain attitudes endure longer than others.  
(Petty and Cacioppo, 1981; Erber et al., 2014)
- The time frame
  - *“Given the inherent uncertainty in forecasting over such long periods, forecasts beyond 150 years are best interpreted as attitude stability.”* (Charlesworth et al., 2019)
- The content and precision of measurement
- Etc

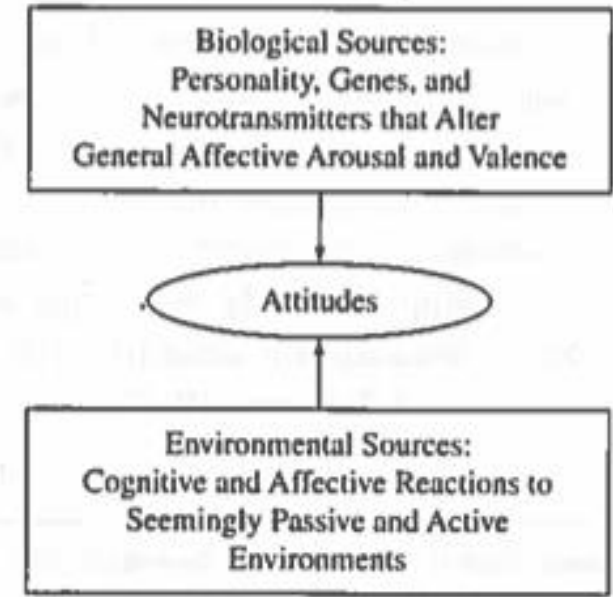


Figure 11.1 Sources of attitudes.

Albarracin and Shavitt  
(2018)

# Data sources

- Large-scale social science surveys
  - World Value Survey (WVS)
  - General Social Survey (GSS), European Values Survey (EVS), British Social Survey (BSS), New Zealand Attitudes and Values Study
  - International Social Survey Programme (ISSP)
  - etc.
  - Question: How many of these have directly relevant transportation attitudes?
- Subjective well-being (SWB) studies
- Household travel surveys
  - US National Household Travel Survey
  - Puget Sound Region Household Travel Survey
- Others

# Methodologies

\* Most or all methodologies appropriate for repeated cross-sectional data can also be applied to panel data.

		Type of data	
		<i>Repeated cross-sections; longitudinal</i>	<i>Panel*</i>
<b>Methodology</b>	<i>Aggregate</i>	<ul style="list-style-type: none"> <li>• Visual inspection</li> <li>• Differences in means</li> <li>• Markov Chain</li> </ul>	<ul style="list-style-type: none"> <li>• Time series analysis (ARIMA)</li> </ul>
	<i>Disaggregate</i>	<ul style="list-style-type: none"> <li>• Blinder-Oaxaca approach to decompose differences in mean factor <i>scores</i></li> <li>• Regression models with time dummy variables</li> <li>• Multi-level linear models (nesting individuals within country and year)</li> <li>• Measurement invariance in structural equations (differences in factor <i>structure</i>)</li> <li>• Pseudo-time series for temporal analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Cross-lagged panel analysis (e.g., random-intercept RI-CLPM)</li> <li>• Structural equation modeling (SEM)</li> <li>• Karlson-Holm-Breen (KHB) method</li> </ul>

# Transportation studies

## Repeated cross-sectional data

Dynamic Analysis of Traveler Attitudes and Perceptions Using Panel Data. (Sunkanapalli et al., 2000)

Exploring stability in travel attitudes: Evidence from a repeated cross-sectional study in Sydney, Australia. (van Acker and Mulley, 2023)

What drives the gap? Applying the Blinder – Oaxaca decomposition method to examine generational differences in transportation-related attitudes. (Etezady et al., 2021)

How public interest and concerns about autonomous vehicles change over time: A study of repeated cross-sectional travel survey data of the Puget Sound Region in the Northwest United States. (Xiao and Goulias, 2021)

Do changes in travellers' attitudes towards car use and ownership over time affect travel mode choice? A latent transition approach in the Netherlands. (Kalter et al., 2020)

How are life satisfaction, concern towards the use of public transport and other underlying attitudes affecting mode choice for commuting trips? A case study in Sydney from 2020 to 2022. (Balbontin et al., 2023)

How stable are transport-related attitudes over time? (Mirtich et al., 2024)

**Aggregate**

**Disaggregate**

## Panel data

Investigating changes in within-person effects between attitudes and travel behaviour during the COVID-19 pandemic. (Faber et al., 2024)

Effects of life events and attitudes on vehicle transactions: A dynamic Bayesian network approach. (Yang et al., 2023)

Residential relocation and travel behavior change: Investigating the effects of changes in the built environment, activity space dispersion, car and bike ownership, and travel attitudes. (Ramezani et al., 2021)

Road users' attitudes towards electric vehicle incentives: Empirical evidence from Oslo in 2014–2020. (Aasness and Odeck, 2023)

Attitudes, mode switching behavior, and the built environment: A longitudinal study in the Puget Sound Region. (Wang and Chen, 2012)

Causal effects of built environment characteristics on travel behaviour: a longitudinal approach. (van de Coevering et al., 2016)

Causes and effects between attitudes, the built environment and car kilometres: A longitudinal analysis. (van de Coevering et al., 2021)

# Studies in transportation

**Differences in means**  
**Blinder-Oaxaca approach to decompose differences in mean factor scores**  
**Regression models with time dummy variables**  
**Cross-lagged panel analysis (e.g., random-intercept RI-CLPM)**  
**Structural equation modeling (SEM)**

Authors	Year	Title	Type of data	Methodology	Attitude	Findings
Sunkanapalli, Pendyala, and Kuppam	2000	Dynamic Analysis of Traveler Attitudes and Perceptions Using Panel Data	1990, 1991, 1993	ANOVA	importance ratings (weather, safety, cost, flexibility); SOV performance ratings (stops, change in vehicle, stress, safety, pollution); Bus performance ratings (time, stops, change in vehicle, safety); agreement ratings	<ul style="list-style-type: none"> <li>- showing attitudinal shift away from alternative modes of transportation.</li> <li>- increasingly tolerant of traffic congestion and pollution</li> <li>- decreasing trend in performance of SOV (increase in 1991, decrease in 1993)</li> </ul>
Van Acker, Veronique and Corinne Mulley	2023	Exploring stability in travel attitudes: Evidence from a repeated cross-sectional study in Sydney, Australia	Cross-sectional; 2016 and 2020	ANOVA	travel attitudes	<p>Even with a big external event like COVID-19, there is still stability in some of the travel attitudes. Both the 'anti-travel' and 'pro-car' attitudes reappeared over time, and more importantly, with more or less the same set of attitudinal statements. COVID-19 also seemed to have stimulated new attitudes, in this case a 'pro-bike' attitude.</p> <ul style="list-style-type: none"> <li>- Millennials tend to be more environmentally conscious, and it is unlikely that convergence of their life-stage variable shares to those of the Gen Xers will significantly impact this tendency</li> <li>- changes in life-stage variables may decrease the stronger tendencies of the younger generation toward urban living in the present time frame</li> <li>- long-term pro-urban tendencies, the generational differences appear less clear</li> <li>- The greater tendency of younger Millennials toward long-term urban living may be reversed as they get married and start to have children</li> <li>- the pro-car ownership attitude among Millennials, currently lower than for Gen Xers, would diminish the gap by 32% if the younger generation were married and had college degrees to the same extent as their older counterparts</li> </ul>
Etezady, Ali, F. Atiyya Shaw, Patricia L. Mokhtarian, and Giovanni Circella	2021	What drives the gap? Applying the Blinder – Oaxaca decomposition method to examine generational differences in transportation-related attitudes.	Cross-sections; 2015; Millennial and Gen X cohorts	Blinder-Oaxaca approach	Currently pro-urban, long-term pro-urban, pro-car ownership, pro-environment	<ul style="list-style-type: none"> <li>- Travelers' attitudes towards car use and ownership are very stable over time.</li> <li>- In most cases, changing car attitudes do not directly affect car use.</li> <li>- most participants remained in the same class between 2014 and 2016</li> <li>- "only when younger adults face life events, such as moving, starting a job or becoming parents, transitioning to more car-oriented profiles appears more likely"</li> </ul>
Kalter, Marie-José Olde, Lissy La Paix Puello, and Karst T. Geurs	2020	Do changes in travellers' attitudes towards car use and ownership over time affect travel mode choice? A latent transition approach in the Netherlands.	Panel data; 2014 and 2016	Latent transition model	Car use and ownership (Cost-sensitive, car-minded, environmentally aware, social-conscious travelers)	<ul style="list-style-type: none"> <li>- gradual growth of public interest in AVs</li> <li>- rising concern of AVs</li> <li>- individuals' interest in AVs have not changed (excluding those who didn't know of AVs)</li> <li>- individuals' concerns about AVs have grown</li> </ul>
Xiao, Jingyi, and Konstadinos G. Goulias	2021	How public interest and concerns about autonomous vehicles change over time: A study of repeated cross-sectional travel survey data of the Puget Sound Region in the Northwest United States.	Repeated cross-sections; 2015, 2017, 2019; aggregate	Visual inspection; combination of binary logit model and partial proportional odds model (time dummy variable observed)	Interest and concerns about AVs	<ul style="list-style-type: none"> <li>- Life satisfaction and positive attitude toward social meetings has increased since 2020.</li> <li>- Concern toward the use of public transport has decreased since 2020.</li> </ul>
Balbontin, Camila, David A. Hensher, and Matthew J. Beck	2023	How are life satisfaction, concern towards the use of public transport and other underlying attitudes affecting mode choice for commuting trips? A case study in Sydney from 2020 to 2022.	Repeated cross-sections; 2020, 2021, 2022	Hybrid choice model (ordered probit model and a mixed MNL model)	Life satisfaction, social meetings, concerns about public transport	<ul style="list-style-type: none"> <li>- transport-related attitudes are fairly stable over four to eleven months and that factors are more stable than questions based on ICCs.</li> <li>- notably younger people, residents of rural areas, and those surveyed early in the pandemic—demonstrate lower attitudinal stability, all groups still show at least moderate stability (ICC) for all attitudinal factors.</li> <li>- "even in this atypical time, attitudes are quite stable"</li> <li>- We also find that respondents recruited through a Qualtrics opinion panel have higher stability than those recruited through direct email or from a convenience sample, possibly because they are regular survey-takers with developed skills in accurate self-assessment and resistance to survey fatigue.</li> </ul>
Mirtich, Laura, Matthew Wigginton Conway, Deborah Salon, Peter Kedron, Rishabh Singh Chauhan, Sybil Derrible, Sara Khoeni, Abolfazl (Kouros) Mohammadian, Ehsan Rahimi, Ram Pendyala	2024	How stable are transport-related attitudes over time?	Repeated cross-sections; 2020 and 2021	Regression	Covid-19 concerned, pro-videoconferencing, environmentalist city lover, anti-in-person-shopping, anti-working from home, home-oriented	<ul style="list-style-type: none"> <li>- Positive within-person estimate for car attitudes on itself (above expected value car attitudes means the next years' car attitude is also likely to be above its expected value)</li> <li>- Relationship between attitudes and behaviour was weakened as a result of the COVID-19 pandemic.</li> <li>- Stable, trait-like differences between persons exist, and the correlations are strong and significant. For example, people with more favourable bicycle attitudes tend to use the bike more often and tend to have more favourable public transport attitudes.</li> <li>- Within-person effects do exist, but that they are much weaker than one would expect based on cross-sectional data due to endogeneity and that parts of the relationship depends on between-person differences rather than within-person effects..</li> </ul>
Faber, R. M., M. C. de Haas, E. J. E. Molin, and M. Kroesen	2024	Investigating changes in within-person effects between attitudes and travel behaviour during the COVID-19 pandemic.	Panel data; 2014 2016 2018 2020 2021	RI-CLPM	Attitude by mode (car, PT, bike, walk; comfortable, relaxing, saves time, safe, flexible, satisfying)	<ul style="list-style-type: none"> <li>- behavioral changes largely results from change in attitudes</li> <li>- An increase in the number of the employed discourages switching and an increase in the access to personal vehicles encourages switching. Increases in either population density at home TAZ or employment density at work TAZ discourages switching.</li> </ul>
Wang, Tingting, Chen, Cynthia	2012	Attitudes, mode switching behavior, and the built environment: A longitudinal study in the Puget Sound Region	Panel data; 1990 1993 1996	SEM	Perceived difficulty of carpool, feelings of carpool	<ul style="list-style-type: none"> <li>- the stability of travel-related attitudes is noticeably higher than stability of travel behaviour; the car attitude is most stable.</li> </ul>
van de Coevering, Maat, and Wee	2016	Causal effects of built environment characteristics on travel behaviour: a longitudinal approach	Cross-sectional and longitudinal; 2005 and 2012	Cross-Lagged Panel Model (CLPM) within a framework of structural equation modelling (SEM)	travel-related attitudes (car attitude, public transport attitude, bicycle attitude)	<ul style="list-style-type: none"> <li>- transport-related attitudes are fairly stable</li> <li>- living further away from a railway station lead to weaker public transport attitudes and stronger car attitudes over time</li> <li>- living in denser neighbourhoods leads to stronger public transport attitudes over time</li> <li>- people do not self-select themselves in more car-oriented areas because they want to, but because they feel they have to</li> </ul>
van de Coevering, Maat, and Wee	2021	Causes and effects between attitudes, the built environment and car kilometres: A longitudinal analysis	Cross-sectional and longitudinal; 2005 and 2012	SEM	travel-related attitudes (car attitude, public transport attitude, bicycle attitude)	<ul style="list-style-type: none"> <li>- the built environment can modify and change travel related attitude and influence activity space dispersion, which in turn affects travel behavior.</li> <li>- influence of changes in the built environment of the residential environment on travel attitudes was higher than that of other sets of factors such as changes in sociodemographics</li> <li>- Lifestyles and attitudes must therefore be considered dynamic rather than static and given (van Acker and Witlox, 2016)</li> </ul>
Ramezani, Samira, Kamyar Hasanzadeh, Tiina Rinne, Anna Kajosaari, and Marketta Kyttä.	2021	Residential relocation and travel behavior change: Investigating the effects of changes in the built environment, activity space dispersion, car and bike ownership, and travel attitudes.	Panel data; 2017 and 2018 (however, just asked in 2018 about 2017)	Structural equation modeling process (SEM)	pro-transit, pro-active travel, susceptible to peer pressure, time sensitive, car safety perception, confident in transit schedule awareness, cost sensitive, environmentally aware	<ul style="list-style-type: none"> <li>- Does include attitude over time in the model, however, doesn't focus on related findings) Incorporating the dynamic attitude in the decision to purchase a car, as an integrated part of the DBN, revealed its noticeable associations with the purchase decision, fuel type, and age of the purchased cars.+</li> </ul>
Yang, Yajie, Soora Rasouli, and Feixiong Liao	2023	Effects of life events and attitudes on vehicle transactions: A dynamic Bayesian network approach.	Panel data; 2013 to 2018	Dynamic Bayesian network (DBN), Levenshtein distance (LD)	car ownership, car use	<ul style="list-style-type: none"> <li>- The older respondents are, the more likely they are to have a negative attitude towards the BEV incentives studied. This is the case for all years, but attitudes are also more likely to become negative over time.</li> <li>- A person is almost 40 percentage points more likely to disagree with toll exemptions in 2020 than in 2014, with all other variables held constant.</li> <li>- A person is approximately 33 percentage points more likely in 2018–2020 to disagree with access to transit lanes without passengers for BEV users than in 2014, with all other variables held constant.</li> <li>- Similar trends are also found for free public parking.</li> <li>- Those who have children from 0 to 6 years old are approximately 4–7 percentage points less likely to disagree with the three incentives investigated here (p &lt; 0.1) than those who do not have children in that age range, with everything else held constant.</li> </ul>
Aasness, Marie Aarestrup, and James Odeck	2023	Road users' attitudes towards electric vehicle incentives: Empirical evidence from Oslo in 2014–2020	Panel data; 2013 to 2018	GSEM	Attitudes towards battery electric vehicle (BEV) incentives	<ul style="list-style-type: none"> <li>- The older respondents are, the more likely they are to have a negative attitude towards the BEV incentives studied. This is the case for all years, but attitudes are also more likely to become negative over time.</li> <li>- A person is almost 40 percentage points more likely to disagree with toll exemptions in 2020 than in 2014, with all other variables held constant.</li> <li>- A person is approximately 33 percentage points more likely in 2018–2020 to disagree with access to transit lanes without passengers for BEV users than in 2014, with all other variables held constant.</li> <li>- Similar trends are also found for free public parking.</li> <li>- Those who have children from 0 to 6 years old are approximately 4–7 percentage points less likely to disagree with the three incentives investigated here (p &lt; 0.1) than those who do not have children in that age range, with everything else held constant.</li> </ul>

# Some findings from recent studies

## • *Car-related attitudes* may be relatively stable over time

### [Difference in means]

#### (1) van Acker and Mulley, 2023

Exploring stability in travel attitudes: Evidence from a repeated cross-sectional study in Sydney, Australia.

- Repeated cross-sectional study
- Survey conducted in Sydney in **2016 and 2020**
- *“The ‘pro-car’ attitude in 2020 is very similar to the results of 2016. It includes largely the same statements in the same order (i.e., ‘I need a car to many things I like to do’, ‘I like driving’, and ‘Getting to work without a car is a hassle’)”*

Same data source

### [Regression models with time dummy variables]

#### (2) Kalter et al., 2020

Do changes in travellers’ attitudes towards car use and ownership over time affect travel mode choice? A latent transition approach in the Netherlands.

- Panel data
- The Netherlands Mobility Panel (MPN): 3-day travel diary (Hoogendoorn-Lanser et al., 2015) collected in **2014 and 2016**
- *“Most of the participants remained in the same class between 2014 and 2016, which suggests that **attitudes towards car use and ownership are stable over time.**” “The share of participants that stayed in the same class was higher than what other studies found in which latent classes were based on the frequency of mode use instead of attitudes”*

### [Cross-lagged panel analysis]

#### (3) Faber et al., 2024

Investigating changes in within-person effects between attitudes and travel behaviour during the COVID-19 pandemic.

- Panel data
- The Netherlands Mobility Panel (MPN): 3-day travel diary (Hoogendoorn-Lanser et al., 2015) collected in **2014, 2016, 2018, 2020, and 2021** (the only years that collected travel mode attitudes)
- *“in Fig. 3, we see a clear blue horizontal line for the car attitudes. This line extends throughout all years (2014 through 2021). This represents a **positive within-person estimate for car attitudes on itself.**” “if a persons’ car attitude is above its expected value, then the next years’ car attitude is also likely to be above its expected value.”*

### [Structural equations modeling (SEM)]

#### (4) van de Coevering et al., 2016 and 2021

(2016) Causal effects of built environment characteristics on travel behaviour: a longitudinal approach.  
(2021) Causes and effects between attitudes, the built environment and car kilometers: A longitudinal analysis.

- Panel data
- Internet questionnaire and GPS tracking in the Netherlands collected in **2005 and 2012.**
- *“it is **apparent that the autoregressive relationships are strong.** The dictum, ‘past behaviour is the best predictor of future behaviour’ seems to apply: higher car use in 2005 has a strong positive effect on car use in 2012 [S1]. The stability of travel-related attitudes is noticeably higher than stability of travel behaviour; **the car attitude is most stable [S2].”***

# Key findings from recent studies

## [Structural equations modeling (SEM)]

### (4) van de Coevering et al., 2016 and 2021

(2016) Causal effects of built environment characteristics on travel behaviour: a longitudinal approach.

(2021) Causes and effects between attitudes, the built environment and car kilometers: A longitudinal analysis.

- Panel data
- Internet questionnaire and GPS tracking in the Netherlands collected in 2005 and 2012.
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- Despite variations in data sources, evidence from these two studies suggests that pro-car attitudes remained stable from 2005 to 2021, even when considering changes in the built environment and external disruptions like the COVID-19 pandemic.
- This observed stability *may* provide a rationale for assuming consistent pro-car attitudes in our models...
- But, will there be a “tipping point” with respect to climate change, ridehailing, shared autonomous vehicles, congestion

# Where do we go from here?

- Challenges remain in understanding and predicting attitudes
- How confident are we in forecasting other variables in the model?
  - E.g., socio-economic and demographic (SED) factors, residential locations
  - Let's not hold attitudes to a *higher* standard than for conventional variables
- Even *current* values of attitudes can provide actionable insights
  - We're better able to predict less-often-chosen alternatives with attitudes (Kim & Mokhtarian, 2025)
  - It can be illuminating to investigate attitudinal differences by SED and geographic population segments
  - Many applications of ABMs are “simply” to test potential scenarios which we can do with attitudes as well



# Next steps... (1)

- Continue reviewing the literature, transportation and otherwise
- Continue demonstrating the value added by including attitudes into practice-ready TDF models (Soria & Mokhtarian, 2024; Kim & Mokhtarian, 2025)

# Next steps... (2)

- The following 7 statements have been/will be inserted into:
  - Georgia add-on to the 2024–25 NextGen National Household Travel Survey (N ≈ 6350, statewide); Atlanta add-on to the 2025–26 NextGen NHTS (N ≈ 6350, ATL regionwide)
  - 2025 Puget Sound Regional Council Household Travel Survey (N = several hundred)
  - 2024 Transportation Heartbeat of America Survey (N ≈ 7500, US-wide)
    - a. I want to own a car.
    - b. I like the idea of public transit as a means of travel for me personally.
    - c. It is important that my job allow me to telework.
    - d. Environmental issues are emphasized too much in this country.
    - e. I try to make as many of my trips as possible by walking or bicycling.



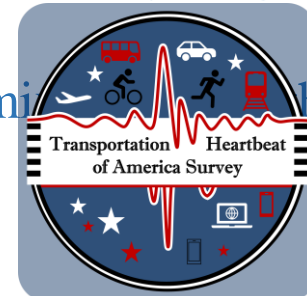
generally enjoy  
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neighborhood



traveling itself.  
, restaurants, and offices mi



Puget Sound Regional Council



the homes in my



## Next steps... (3)

- Work on identifying a small number of attitudes that we think are more critical for travel demand forecasting and focus on those
  - How much value do they add to regional TDF models?
  - Can we start measuring them repeatedly over time, and then begin to analyze their stability?
- Investigate use of the *human development dynamics* approach to incorporate attitudes into agent-based models
  - In the base year, assign attitudes to agents, reflecting a “ground truth” distribution obtained from survey data
  - Evolve attitudes over time, in keeping with rules or diffusion/interaction/change models
  - This approach enables the exploration of attitude change as emergent outcomes of individual behaviors and interactions

(Abdollahian et al., 2013)

## In sum...

- Attitude formation and change is certainly an unwieldy field of study!
  - But, there are many things that can be done in the short and medium term
  - And preliminary investigations suggest that it is worth the effort
  - Like other “moon shots”, there are likely to be spin-offs beyond improving regional TDF models
- We welcome further input!

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