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Travel attitudes or behaviours: Which one changes when they conflict?

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Abstract

In recent years, there has been a resurgence of interest in the ‘disagreement’ or dissonance between travel attitudes and behaviours. This has shown that when people experience travel-related dissonance they are less satisfied with their travel experience. However, what remains unclear is whether people experiencing dissonance are more likely to change their travel attitude or their behaviour, so that they are more closely aligned. Moreover, it is unclear whether and how life events, such as having a child, interact with creating or reducing travel-related dissonance.

Using data from a large and well-designed longitudinal study, this paper addresses these two gaps in the literature on travel-related cognitive dissonance through an exploratory study. The findings suggest that dissonant travellers are more likely to change their segment membership than consonant travellers. Furthermore, in line with the theory of cognitive dissonance, people may adjust either their attitudes or behaviours to achieve a state of consonance. This suggests that policymakers should not only focus on subtle nudges aimed at changing attitudes (and subsequently behaviours) in desirable directions but also implementing policies aimed at directly influencing behaviours, assuming that attitudes will follow.

1. Introduction

Transportation researchers have long been interested in the relationship between attitudes and travel behaviour. Most of this research focuses on the congruent relationship between attitudes and behaviour, showing that positive mode-specific attitudes predict the use of that mode (Kroesen and Chorus 2018) or conversely that travel behaviours shape attitudes (Tardiff 1977, Dobson et al. 1978, Kroesen et al. 2017). More recently, researchers have become interested in the state of ‘disagreement’ between attitudes and behaviours. When actions and attitudes do not match, people experience an unpleasant psychological state. In psychology, this state is referred to as cognitive dissonance and it has been a subject of research since the 1950s (Festinger 1957). When people experience cognitive dissonance, they tend to change either their attitude or their behaviour so that the two are more closely aligned.

In recent years transportation researchers have found that when people experience travel-related dissonance they are less satisfied with their travel experience (De Vos 2018). However, a recent review highlighted that to date no studies have been able to examine whether people change their travel behaviour to reduce travel-related dissonance (De Vos and Singleton 2020).

Furthermore, to date, no studies on travel-related dissonance have examined the role that life events might play in inducing (or reducing) a state of cognitive dissonance. The mobility biographies approach highlights the important role of life events, such as moving houses or changing jobs, in triggering travel behaviour change (Clark et al. 2016a, de Haas et al. 2018). For instance, moving house may allow an individual with negative attitudes towards the car but frequent car-use to move to a less car-dependent location. However, if the choice of home location is constrained, it may also induce dissonance, for example, if an individual who prefers transit must move to a car-dependent area for work (see for example the ‘reverse causality hypothesis’ between the built environment and travel, (van Wee et al. 2019)).

This paper attempts to address these two gaps in the literature on travel-related cognitive dissonance through an exploratory study. It does this through three research questions:

1. Over time, how stable is the state of travel-related cognitive dissonance?
2. Are people who experience travel-related cognitive dissonance more likely to change their travel behaviour or attitudes?
3. What is the impact of life events on inducing or reducing travel-related cognitive dissonance?

We explore these research questions using longitudinal panel data to examine whether mode-dissonant or mode-consonant individuals are more likely to remain in the same category in subsequent waves. Secondly, we explore whether mode-dissonant travellers are more likely to adapt their behaviour or attitudes to reduce dissonance. Finally, we explore the effect of life events on creating or reducing dissonance between travel attitudes and behaviours. Insights from these research questions may have implications for strategies encouraging travel behaviour change, identifying potential segments of the population who are more open to changing their travel behaviour.

2. Cognitive dissonance theory and travel behaviour

Cognitive Dissonance Theory (CDT) posits that people have an internal drive to resolve inconsistencies between attitudes and behaviours (Festinger 1957). If an inconsistency exists or arises between a particular attitude and behaviour, people will typically experience some level of

psychological discomfort. In turn, this motivates people to adopt strategies to reduce this discomfort. Festinger (1957) outlined three typical strategies to alleviate the discomfort: changing one of the dissonance conditions or changing the cognition through either acquiring new knowledge that assists to alleviate the dissonance or trivialising the dissonance. For example, a person experiencing dissonance between his/her smoking behaviour and the cognition that smoking is bad for health may alter the behaviour (quit smoking) or the cognition (downplay the negative health effects of smoking). A priori, the theory of cognitive consistency assumes no dominance over which strategy is more likely to occur. Hence, based on this theory, an influence from behaviour towards attitudes is as likely as an influence from attitudes towards behaviour.

In the early days of social-psychological research, CDT was among the most heavily researched theories in the field. Literally hundreds of experiments have been conducted (Aronson 1992). Interestingly, however, little efforts have been made to operationalise the theory in a field setting. With respect to a particular target behaviour, one may simply identify four groups, two consonant ones and two dissonant ones, as depicted in Table 1 below. This approach to classifying people into categories of dissonant vs consonant has been used in studies of travel behaviour and residential location choice (Kroesen et al. 2017, Kamruzzaman et al. 2021). By assessing how membership of these four groups evolves, the main premise of CDT may already be tested in an observational setting, namely the notion that members of consonant groups are more likely to stay in their respective groups compared to members of the dissonant groups, who may be expected to either change their behaviour or their attitude towards the behaviour or adjust their circumstances. This approach assumes the adjustment of attitudes or behaviours is the only mechanism adopted to alleviate dissonance. Moreover, it does not account for the scale or variations in other background factors that may influence the extent and type of reduction strategies adopted. Nonetheless, this simplified approach allows for a fundamental concept of CDT to be tested in a field setting.

Table 1: Four attitude/behaviour profiles

Attitude towards behaviour	Behavioural frequency	
	Low	High
Negative	Consonant	Dissonant
Positive	Dissonant	Consonant

In this paper, we aim to return to the exploration of changes in attitude-behaviour inconsistencies overtime, focusing on travel behaviour in particular. A few recent studies have explored this topic. Kroesen et al. (2017) used latent class analysis to identify groups of consonant and dissonant travellers and found, in line with CDT, that consonant travellers were less likely to change travel behaviour over time than dissonant travellers. De Vos (2018) also identified groups of consonant/dissonant travellers for different modes, revealing sizeable groups of dissonant travellers, especially regarding the use of the bicycle. The contribution of this study rests in the link that was made with travel satisfaction. In line with expectations, respondents travelling with their preferred travel mode (i.e., consonant travellers) seemed to experience their trip more positively compared to people travelling with a non-preferred travel mode (i.e., dissonant travellers). This result is well in line with CDT, in which inconsistency is assumed to create a state of stress/arousal, which can also be regarded as a state of dissatisfaction.

The present study also begins by classifying and describing consonant/dissonant travellers. However, this study extends the analysis to a second point in time to assess how stable these states are over time, and whether people are more likely to change their attitude or their behaviour to

reduce dissonance. Given this is a major gap in the field, (identified in a recent review of CDT research (De Vos and Singleton 2020)), it represents the first contribution of this paper.

3. Life events and cognitive dissonance

The second contribution of this paper is to explore the relationship between life events and travel-related dissonance. The mobility biographies approach, first introduced by Lanzendorf (2003), provides a framework for understanding travel behaviour changes throughout the life course. The framework introduces the theory of multiple life domains and recognises that a change in one domain or area will have ramifications for other areas (Lanzendorf 2003). As comprehensive reviews of the state of the field and the development of the theoretical framework have recently been conducted (see Müggenburg et al. (2015) and (Scheiner 2018)), we will instead focus this discussion on aspects of the framework relevant to our study.

A key concept emerging from the mobility biographies approach is the notion of stability and change in travel behaviour throughout the life course. Drawing on the role of habit as an important determinant of travel mode choice (Banister 1978, Aarts et al. 1997), the approach posits that life events, such as moving house or changing jobs, can disrupt stable travel routines. A life event can prompt changes to circumstances or context, which, in turn, requires an individual to switch from habitual to reflective thinking about their travel mode choices. It is these periods, in which travel routines are disrupted and habits are weakened, that provide a valuable opportunity to intervene and encourage the adoption of more sustainable travel choices (Verplanken et al. 2008).

Studies in this field have tended to focus on how *behaviour*, specifically mode use, changes following (or in anticipation of) a life event. Life events associated with an increase in car-based mobility include childbirth (Oakil et al. 2016, de Haas et al. 2018) and entering the workforce for the first time (Busch-Geertsema and Lanzendorf 2017). In contrast, life events associated with a decrease in car-based mobility are often associated with changes resulting in a reduction of income or change in activity patterns, such as unemployment or retirement (Oakil et al. 2014).

Overall, research in this field has shown that individuals are more likely to change their travel behaviour as a result of a life event than during stable circumstances (Clark et al. 2016b). A 'dissonant' life event may induce an inconsistency between the frequency of using a travel mode and the attitudes towards that travel mode. For instance, in the case of childbirth, cycling frequency may reduce but positive attitudes towards cycling may remain. Conversely, a dissonant reducing life event may create an opportunity for an individual to align their travel mode use with their attitudes to that travel mode. For instance, an individual with positive attitudes towards public transport moving house from a car-dependent location to a transit orientated location. It should be noted here that there are differing views regarding the hypothesized role of life events and inconsistencies between travel attitudes and behaviours. While (Verplanken et al. 2008) posits that life events can prompt self-activation, enabling an individual actively reflect on their optimal travel choices, applying cognitive dissonance theory, we are proposing that the life event may provide an opportunity to reconcile mismatches between travel attitudes and behaviours (rather than the self).

Using the four profiles of dissonant/consonant travellers, we explore whether respondents who have experienced a life event between the two waves are more likely to transition into a different profile in the second wave. This analysis, which forms the second contribution of this paper, is largely exploratory.

4. Methods

4.1 Data source

The Netherlands Mobility Panel (known as the MPN) is an annual household panel survey that was set up to study the short-run and long-run dynamics in the travel behaviour of Dutch individuals and households, and to determine how changes in personal- and household characteristics, and in other travel-related factors, correlate with changes in travel behaviour (Hoogendoorn-Lanser et al. 2015). The first wave of data collection started in 2013 and the panel consists of approximately 2,000 complete households. Respondents are recruited by means of a screening questionnaire in which an adult household member is asked whether the whole household wants to participate in the MPN for several years. Yearly, after entering the panel, the same adult household member fills out a household questionnaire to gather basic information about the household. Furthermore, all household members of 12 years and older are asked to fill out an individual questionnaire and complete a three-day online travel diary. The individual questionnaire consists largely of questions that are repeated yearly. This includes questions regarding any life events that respondents have experienced in the previous 12 months. However, a special topic is repeated bi-annually. In the second and fourth waves of the MPN the special topic focused on attitudes and perceptions with regard to various modes of transportation. Therefore, the second (2014) and fourth (2016) waves of the MPN are used in this study.

In order to account for attrition and to maintain a representative sample, additional households are recruited yearly. In the second wave, additional focus was placed on recruiting certain groups (such as young and low educated people) since they were somewhat underrepresented in the first wave and had higher nonresponse levels. Due to attrition and recruitment of new households, there are some slight variations between waves in terms of sample composition. However, based on the so-called Gold Standard (which reflects the composition of the Dutch population on several personal- and household characteristics) it can be concluded that the sample is fairly representative for the Dutch population. The largest deviation is found on educational level, with an underrepresentation of low-educated people and an overrepresentation of high-educated people.

Table 2: Descriptive statistics (N=3851 wave pairs)

	Variable	Category	%	N
Demographics (2014)	Gender	Male	45	1785
		Female	54	2066
	Age	29 years and younger	20	771
		30 to 59 years	56	2171
		60 years and older	24	909
	Employment status	Employed	59	2233
		Job seeking / Incapacitated	9	339
Retired or early retirement		16	609	
Student		8	308	
Housewife / husband		8	312	
Urbanisation level	Highly or very urbanized (1500 or more inhabitants/km ²)	46	1757	
	Moderately urbanized (1000 to 1500 inhabitants/km ²)	24	927	
	Non-urbanized area (Less than 1000 inhabitants/km ²)	30	1136	
Life events (2016)	Respondents experiencing a life event	Child born in household	3	98
		Partnership dissolution	1	48
		Partnership formation	1	55
		Started or changed education programme	4	139
		Started working	2	66
		Stopped working	3	116
		New job	9	354

4.2 Defining segment membership

Table 3 presents the two measures used to determine segment membership: a composite measure of mode specific attitudes and frequency of mode use. The measures derived from two sets of questions in the MPN survey. The MPN asks about attitudes towards travel by car, cycling and public transit. Six items are asked (Comfort/Relaxing/Saves time/Safe/Flexible/Pleasurable) measured on a five-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”. Cronbach’s Alpha for all modes exceeded 0.8 (Table 3), indicating a sufficient level of internal consistency to allow for a composite score to be generated. Scores for each of the six items were combined, creating a scale ranging from 6 to 30. An average of the six items was then generated and rounded to the nearest integer, providing a value of between 1 and 5. The measure regarding mode use frequency derives from a question asking about frequency of car, public transport and bicycle use over the previous year. Responses were recoded to a five-point scale to align with the attitude measure.

The attitudinal measure does not directly align with more common psychological literature typically operationalising dissonance as an unpleasant feeling or tension. Nonetheless, cognitive dissonance theory explicitly states that people attempt to align their attitudes with behaviour. As such, the attitudinal measure we use in our study is still largely aligned with what CDT posits.

Table 3: Respondents' mode use and attitudes (N=3851 wave pairs)

		Car		Bicycle		Public Transport	
		Wave 1	Wave 2	Wave 1	Wave 2	Wave 1	Wave 2
<i>Mode use [5 point scale]</i>	Less than 1 day per year / never (1)	3.1	3.1	9	11.5	32.3	26.2
	1 to 11 days per year (2)	4.5	4.5	8.6	8.2	34	31.6
	1 to 3 days per month (3)	10.8	10.5	12.2	13.1	15.1	20
	1 to 3 days per week (4)	36	36.3	25.8	26	9.7	12.4
	4 or more days per week (5)	45.6	45.7	44.4	41.1	8.9	9.8
<i>Attitude towards mode</i>	Sum	25.4	24.7	22.8	22.9	17.8	17.9
	Standard deviation	3.5	3.6	4.1	4.2	4.2	4.3
	Cronbach's Alpha	0.888	0.866	0.884	0.866	0.949	0.922
<i>Composite attitude variable [5 point scale]</i>	Strongly disagree (1)	0.1	0.1	0.9	0.9	3.2	3.4
	Disagree (2)	0.7	0.5	2.5	3	17.4	17.9
	Neutral (3)	10.4	10.6	20.3	19.3	55.4	54.5
	Agree (4)	59.5	57	59.2	58	22.6	22.2
	Strongly Agree (5)	29.3	31.7	17.1	18.9	1.3	2

We used the two measures to categorise respondents into four groups based on their behaviour (frequent or infrequent) and attitudes (negative or positive). Each respondent was categorised into one of the four groups (Frequent-Positive; Frequent-Negative; Infrequent-Positive; Infrequent-Negative) for each mode (car, cycling and public transport). Respondents were categorised as "Infrequent" if they used the travel mode three days per month or less and "Frequent" if they used the travel mode at least weekly.

To allow a more equitable distribution of the four categories, respondents whose attitude towards a particular mode was a value of between 1 and 3 were classified as "Negative" and 4 or 5 as "Positive". Classifying respondents with neutral attitudes towards cycling and car in either the positive or negative category had a minimal bearing on the results. However, as a large number of respondents held neutral attitudes towards public transport, changing whether they were grouped in the positive or negative category lead to a significant change in the size of the consonant and dissonant segments for this mode. However, if "neutral" attitudes were re-classified as "positive" for public transport use, this resulted in multiple segments with very few respondents. Therefore we continued the analysis with all "neutral" responses coded as negative. While this approach is imperfect, and the public transport results must be treated with some caution, it ensures all segments are of a sufficient size to allow for meaningful analysis.

Table 4 shows the size of each segment and the percentage of respondents in each behaviour or attitudinal category. Overall, the largest segments among each of the three modes are consonant. Given the considerably lower frequency of public transport use compared with cycling and car use among respondents, the largest segment size in the Car and Cycle mode is Frequent-Positive, whereas among the Public Transport mode it is the Infrequent-Negative group. The Car model has the largest share of consonant respondents (81%), followed by Cycling (76%) and Public Transport (68%).

Table 4: Indicators used to determine segment membership

Consonance Name Size	Model 1: Car				Model 2: Cycling				Model 3: Public Transport			
	C	D	D	C	C	D	D	C	C	D	D	C
	FP	IP	FN	IN	FP	IP	FN	IN	FP	IP	FN	IN
	76%	13%	7%	5%	61%	15%	9%	15%	7%	19%	13%	61%
Mode use (Time 1)												
1 day/year or less (1)	-	11	-	20	-	15	-	41	-	19	-	32
1-11 days/year (2)	-	21	-	34	-	25	-	32	-	42	-	43
1-3 days/month (3)	-	69	-	46	-	60	-	28	-	40	-	25
1-3 days/week (4)	42	-	62	-	36	-	54	-	58	-	55	-
4+ days/week (5)	58	-	38	-	64	-	46	-	42	-	45	-
Attitudes (Time 1)												
Strongly disagree (1)	-	-	0	3	-	-	0	6	-	-	3	5
Disagree (2)	-	-	2	8	-	-	4	18	-	-	16	26
Neutral (3)	-	-	98	90	-	-	96	76	-	-	82	69
Agree (4)	62	80	-	-	71	91	-	-	91	92	-	-
Strongly agree (5)	38	20	-	-	29	9	-	-	9	8	-	-

Note: Values within the table are percentages read down a given column. FP = Frequent use and positive attitude; IP = Infrequent use and positive attitude; FN = Frequent use and negative attitude; IN = Infrequent use and negative attitude; C = consonant; D = dissonant.

Once the travellers were classified into consonant and dissonant groups, we conducted a logistic regression model that included initial segment membership for each of the modes. Seven life events were included and four exogenous variables (gender, employment status, age and location) as active covariates. The seven life events included: childbirth, partnership formation and dissolution, starting an education course, starting or stopping working and changing employment.

5. Results

5.1 Segment profiles

Table 5 outlines the demographic characteristics of each of the twelve groups. As the characteristics of each segment is not the focus of this paper, these will not be discussed in detail. However, the profile of each segment is plausible. For example, those travellers typically comprising 'captive' transport markets, such as students (who are entitled to free public transit in The Netherlands), are underrepresented in the Frequent-Positive Car group but overrepresented in the Frequent-Negative Cycling and Public Transport Groups. This suggests that while members of these groups have a preference for car-based mobility, their current financial circumstances make car ownership unattainable and instead use public transport or cycle. Similarly, Frequent Public Transport users, both negative and positive, are overrepresented in the highly or urbanised location and underrepresented in the rural location, likely reflecting the different level of public transport service in the respective locations.

Table 5: Demographic characteristics respondents, Wave 1 (2014)

	Car				Cycling				Public Transit				Sample
Segment	FP	IP	FN	IN	FP	IP	FN	IN	FP	IP	FN	IN	-
Consonant	C	D	D	C	C	D	D	C	C	D	D	C	-
Size	76%	13%	7%	5%	61%	15%	9%	15%	7%	19%	13%	61%	100%
Gender													
Male	49	35	39	41	44	53	43	53	50	46	42	47	45
Female	51	65	61	59	56	47	57	47	50	54	58	53	54
Age													
Under 30	17	39	11	27	20	15	33	17	42	12	55	15	20
30 to 59	61	40	52	49	55	65	51	64	41	51	37	65	56
60 years +	22	21	37	24	25	19	16	19	17	37	08	20	24
Location													
High urban	41	65	51	66	47	41	46	45	65	48	59	44	59
Med urban	26	20	18	21	25	23	25	22	19	23	23	24	09
Non-urban	34	15	31	13	28	36	29	34	16	29	18	32	16
Employment													
Employed	64	44	50	47	58	71	48	67	54	51	47	67	08
Unemployed	08	14	07	16	08	10	12	08	08	08	08	10	08
Retired	15	14	26	17	16	14	10	13	11	28	05	13	46
Studying	06	19	06	13	09	02	21	05	24	04	37	03	24
Homemaker	08	09	11	08	09	04	08	07	03	09	03	08	30

Note: Values within the table are percentages read down a given column. FP = Frequent use and positive attitude; IP = Infrequent use and positive attitude; FN = Frequent use and negative attitude; IN = Infrequent use and negative attitude; C = consonant; D = dissonant.

5.2 Stability of travel-related cognitive dissonance

Table 6 shows the movements between groups between Wave 1 (2014) and 2 (2016) for car, cycling and public transit modes respectively. Given earlier research (Kroesen et al. 2017), we would expect the consonant segments to be the most stable (and have the highest probability of remaining in the same segment in the second wave) and the dissonant segments to be the least stable. This is the case for the largest consonant segments within each mode. Approximately 89% of the FP Car segment remained in the same segment in Wave 2 with similar proportions for the FP Cycling (83%) and IN Public Transit segments (74%). However, the smallest consonant segments (IN Car, IN Cycling and FP Public Transit) were less likely to remain in the same segment in the second wave. This is likely due to forming a much smaller proportion of the sample (5% car; 15% cycling; 7% PT) and, as such, slight changes (which may in part be random, e.g. when resulting from random from measurement errors) may appear more pronounced.

Interestingly, across all modes, dissonant travellers were more likely to remain in the Infrequent-Positive segment between waves than their counterparts in the Frequent-Negative dissonant segment. For instance, approximately half of the 2014 IP segment for car (53%), cycling (51%) and public transport (48%) remained in this state in 2016. In contrast, the proportion of respondents remaining in the Frequent-Negative segments between waves was 34% (car), 32% (cycling) and 42% (public transport). This suggests infrequent use and positive attitudes are perhaps less of a motivator to reduce dissonance than frequent use and negative attitudes.

These findings address the first research question of this paper. The next section explores whether people who experience travel-related cognitive dissonance are more likely to change their travel behaviour or their attitudes.

Table 6: Movements between segments (Waves 1 and 2)

		Car (%)				Cycling (%)				Public Transport (%)					
		2014 (Wave 1)				2014 (Wave 1)				2014 (Wave 1)					
Size (%)		76%	13%	7%	5%	61%	15%	9%	15%	7%	19%	13%	61%		
		FP	<i>IP</i>	<i>FN</i>	IN	FP	<i>IP</i>	<i>FN</i>	IN	FP	<i>IP</i>	<i>FN</i>	IN		
2016 (Wave 2)	FP	89	35	53	15	FP	83	25	43	12	FP	38	12	10	2
	<i>IP</i>	6	53	5	28	<i>IP</i>	8	51	8	22	<i>IP</i>	30	48	7	11
	<i>FN</i>	5	4	34	14	<i>FN</i>	6	4	32	8	<i>FN</i>	16	7	42	13
	IN	1	8	8	43	IN	3	21	18	58	IN	16	32	41	74

Note: Values within the table are percentages read down a given column. **Bold** indicates consonant segment, *italics* indicate dissonant segment.

5.3 Change in behaviour and attitudes among formerly dissonant travellers

A core aim of this paper was to explore whether respondents experiencing travel-related cognitive dissonance more likely to change their travel behaviour or attitudes. To explore this, we assessed the movements between segments, between waves. Respondents in one of the dissonant segments in 2014 (either 'Frequent-Negative' or 'Infrequent-Positive') could transition into a consonant segment in 2016 by adjusting either their attitudes or their behaviour.

We would expect Frequent Negative travellers, to be travelling against their attitudes due to external factors, such as infrastructure or conceivably time, income or family commitments. As such, we would expect an adjustment in attitudes in order to move to a consonant group (FP). Interestingly, however, whether respondents in a dissonant segment changed their attitude or behaviour varied depending on the mode and their original segment.

For both car travel and cycling, people who were IP in 2014 were more likely to change their behaviour than their attitude to become consonant travellers. Over 80% of IP drivers in 2014 who became consonant in 2016 did so because they drove more in 2016; 54% of IP cyclists did the same. In contrast, FN drivers and cyclists in 2014 who became consonant in 2016 were more likely to change their attitudes; 87% of FN drivers and 70% of cyclists who changed classification did so because they had a more positive attitude to the respective modes in 2016.

The pattern was reversed for public transport. Here, 73% of IP transit users who became consonant between 2014 and 2016 did this by *reducing* their attitude to public transport, becoming IN users. Among the FN public transport riders who became consonant in 2016, 80% did this by reducing their ridership (becoming IN).

These contrasting patterns may be explained by the baseline attitudes toward the three modes and considerably lower use of public transport among the sample. Overall attitudes toward cars and bicycles are more positive than public transport and only 20% of respondents are categorised as 'frequent' public transport users compared with 83% of car travellers and 70% of cyclists.

Table 7: Change in behaviour vs. attitude for people who moved from dissonant to consonant segment between Waves 1 and 2

2014 dissonant segment	Mode	% of respondents	
		changing behaviour	changing attitude
Infrequent positive	Car	81	19
	Cycling	54	46
	Public transport	27	73
Frequent negative	Car	13	87
	Cycling	30	70
	Public transport	80	20

The final section of the findings addresses the third research question, exploring whether life events induce or reduce travel-related cognitive dissonance.

5.4 Life events and changes in dissonance

Table 8 presents the results of paired sample t-tests showing the changes in mean attitudes and behaviour between 2014 and 2016. The changes are presented overall and by respondents who have experienced a life event. It should be noted that these are derived from ordinal scales and no correction was made for multiple comparisons; however these initial results provide an indication of the direction of change between survey waves. Among the overall sample, there are marginally significant declines in cycling and increases in public transit use. There were no significant changes to attitudes towards each mode between the survey years. Interestingly, among the life events examined, only behaviour changes are significant suggesting that when experiencing a life event, behavioural rather than attitudinal changes create dissonance. However, as we are examining the aggregate changes this may mask changes apparent within individual groups.

Most life events analysed were associated with some behaviour change between the two survey years. Echoing findings from previous studies examining the effects of different life events on travel mode use, childbirth is associated with a slight decline in cycling (de Haas et al. 2018). Of note, partnership formation is associated with an increase in car-use and decrease in cycling. This is likely attributed to the new partner owning a vehicle and, as a result, more joint trips being conducted by car rather than cycling. An alternative interpretation could also be, however, that it is more cost-efficient to own a vehicle as couple, and, as a result respondents may have been more likely to purchase a vehicle in the intervening two years between the survey waves. Starting and stopping working is associated with an increase and decrease in car use, respectively. Stopping working is also associated with an increase in public transit use. These mode changes are likely a result of income or time-budget changes, as a result of changing employment status.

Starting an education course is associated with a decrease in cycling. This may reflect the local context, as in The Netherlands students can travel for free on public transport to and from their education institution. Finally, changing jobs (but *not* changing job location) is associated with an increase in car use and decrease in public transport use. This could reflect gaining a promotion and a subsequent increase in salary or obtaining a company car.

Table 8: Change in average attitudes and behaviour between 2014 and 2016 by life event

Life event	Car				Cycling				Public transport			
	Behaviour		Attitude		Behaviour		Attitude		Behaviour		Attitude	
	2014	2016	2014	2016	2014	2016	2014	2016	2014	2016	2014	2016
Overall sample	4.17	4.17	4.18	4.20	3.88	3.77	3.91	3.92	2.29	2.48	3.03	3.03
Child born	4.43	4.55	4.19	4.23	3.81	3.42	3.95	3.93	2.11	2.38	2.81	2.75
Partner moves out	3.98	3.75	4.26	4.23	3.79	3.67	3.67	3.69	2.79	2.71	3.03	3.14
Partner moves in	4.02	4.31	4.26	4.28	4.04	3.71	4.13	4.02	3.00	2.64	3.07	3.02
Started edu course	3.88	3.97	4.20	4.17	4.34	4.16	3.90	3.95	3.08	3.13	2.98	3.09
Started working	3.70	4.00	4.23	4.20	4.44	4.41	4.03	3.94	3.33	3.18	3.02	3.06
Stopped working	4.16	3.97	4.22	4.24	3.84	3.77	3.90	4.00	2.13	2.36	3.01	3.09
Changed job	4.08	4.24	4.25	4.29	4.08	3.90	3.89	3.87	2.79	2.77	2.99	2.95

Note: Bold and shaded values are significant at $p < 0.05$ using paired-samples t-tests

Table 9 presents the results of a logistic regression model that included initial segment membership for each of the modes and shows the probabilities of changing segments between 2014 and 2016 by type of life event. The results have been presented in this format rather than logit parameters for easier interpretation. Statistically significant movements between segments were evident among respondents who have experienced childbirth, partnership formation and dissolution, starting an education course and changing employment or employment location. However, across all life events and modes, respondents were *equally* likely to become either more consonant or more dissonant following a life event.

Of note, childbirth was associated with a greater likelihood of forming part of the IP Cycling segment and a lower likelihood of forming part of the FP Cycling segment. This reflects the decline in cycling evident in Table 6 and echoes previous research demonstrating showing new parenthood is associated with a decline in cycling (Scheiner and Holz-Rau 2013, de Haas et al. 2018). Interestingly, childbirth is also associated with an increasing likelihood of forming part of the IN Public Transit segment. As public transit is commonly used for commuting, this may reflect the changes in activity patterns as result of taking parental leave and reduced use of this mode for work travel.

Partnership formation and dissolution were associated with slight movements between the segments. Partnership dissolution was associated with an increased likelihood of forming part of the IP Car and IP PT segment. In contrast, partnership formation increased the likelihood of forming part of the IN Cycling and PT segments. These changes could be attributed to the new partner bringing a car to the household (or, in the case of dissolution, taking away a car). Among respondents who experienced a partnership formation, vehicle ownership *increased* from 0.8 vehicles per household to 1.0 vehicles per household (compared to a slight decline in vehicle ownership across the entire survey sample). This suggests the new partner may bring a vehicle to the relationship or they may be more likely to purchase a new vehicle as a couple, with subsequent implications for the respondents' daily travel behaviour.

Starting an education course is associated with a decreased likelihood of forming part of the Infrequent-Negative PT segment and increased likelihood of forming part of either Frequent Positive or Frequent Negative PT segment (although the latter two changes are not significant). This likely reflects the growth of public transit use during tertiary study and provision of reduced fares available to students.

Finally, the two employment life events were associated with only marginal movements between segments. Changing job was associated with a greater likelihood of forming part of the FP Car segment while changing job location was associated with a greater likelihood of forming part of the IN PT segment and a less likely to form part of the FP PT segment.

For some life events the results are difficult to interpret. Perhaps this is because the life event is not captured at a sufficiently granular level. For instance, life events resulting in location changes (such as moving house, changing jobs or changing job locations) will likely have varying effects depending on the spatial and temporal context of the change. Surprisingly, no significant effects were evident for starting or stopping employment.

Table 9: Life events and movement between segments

Name	Model 1: Car				Model 2: Cycling				Model 3: Public Transport			
	FP	IP	FN	IN	FP	IP	FN	IN	FP	IP	FN	IN
Consonant	C	D	D	C	C	D	D	C	C	D	D	C
Size	76%	13%	7%	5%	61%	15%	9%	15%	7%	19%	13%	61%
Child born	0.28	-0.16	0.12	-0.24	-0.31	0.32	-0.05	0.03	-0.50	-0.05	0.21	0.35
Partner moves out	-0.26	0.45	-0.56	0.37	-0.12	-0.03	-0.03	0.17	-0.18	0.40	-0.19	-0.02
Partner moves in	0.08	-0.35	0.17	0.10	-0.19	0.17	-0.37	0.39	-0.14	0.07	-0.17	0.24
Started edu course	0.02	-0.17	-0.14	0.28	0.14	0.06	-0.01	-0.20	0.15	-0.03	0.08	-0.19
Started working	-0.04	-0.22	0.31	-0.05	0.24	-0.34	0.26	-0.16	0.08	-0.10	0.12	-0.10
Stopped working	-0.13	0.10	0.06	-0.03	0.11	-0.02	-0.05	-0.04	0.05	-0.02	-0.06	0.03
Changed job	0.18	0.00	-0.14	-0.04	0.04	-0.04	-0.07	0.06	-0.20	0.13	-0.04	0.10

Notes: Values show the probability of changing membership between waves; values in bold and shaded are significant at $p < 0.05$; FP = Frequent use and positive attitude; IP = Infrequent use and positive attitude; FN = Frequent use and negative attitude; IN = Infrequent use and negative attitude.

6. Discussion and conclusion

This paper explored stability among dissonant and consonant travellers and whether dissonant travellers are more likely to adjust their behaviour or attitudes to reach a state of consonance. Moreover, it explored the role of life events in creating or creating or reducing dissonance between travel attitudes and behaviours. Differences between travel attitudes and behaviour were explored by public transit, cycling and car use, using panel data. It should be noted there are limitations regarding the measure we used to assess dissonance and the dissonance strategies we tested (only behaviour or attitude change). The psychology literature has identified a range of other mechanisms to reduce dissonance, such as self-forgiving, denial of responsibility or forgetting about the dissonance (Kruglanski et al. 2018), that depend on the intensity of negative feeling and familiarity of the situation (Cancino-Montecinos et al. 2020). In a travel behaviour context, it is plausible people could adopt a range of these and other strategies to reduce dissonance. The implications of this limitation are discussed below.

Addressing our first research question, consistent with earlier research (Kroesen et al. 2017), between the survey years, dissonant travellers were more likely to change their segment membership than consonant travellers. Interestingly, dissonant travellers were more likely to remain in the Infrequent-Positive segment between waves than travellers in the Frequent-Negative segment. This suggests that infrequent use and positive attitudes are perhaps less cognitively distressing than frequent use and negative attitudes. This may be evidence that people are practicing a range of mental mechanisms to reduce this dissonance, such as self-forgiving or denial of responsibility (e.g. 'I'd love to cycle but it's not my fault it isn't safe') (Kruglanski et al. 2018).

Should this indeed be true, then a straightforward implication for policy would be that positive attitudes, e.g. towards bicycle use, are not enough to increase the uptake of cycling. Instead, policies that negatively influence the attitudes towards alternative modes (e.g. the car) may potentially be more effective. Similarly, encouraging an increase in behavioural frequency for certain modes (e.g. encouraging infrequent-negative cyclists to cycle more frequently), may lead to more positive attitudes towards this mode.

In addition, from a scientific perspective, it would be interesting to explore whether dissonance resulting from infrequent use and positive attitudes is indeed less distressing than dissonance resulting from frequent use and negative attitudes. As shown by De Vos (2018) dissonance between the chosen and preferred mode also translates itself into travel dissatisfaction. This concept could be used to assess whether those belonging to the segment “frequent use and negative attitudes” are (even) more dissatisfied with their travel behaviour than those belonging to the segment “infrequent use and positive attitudes”.

Our second research question explored whether dissonant travellers were more likely to adjust their behaviour or attitudes. The results depended on the mode and their original class. A similar pattern was evident between car and cycling modes. Infrequent car travellers and cyclists with positive attitudes were more likely to increase their use than adjust their attitudes to reach a state of consonance in the following wave. Conversely, among frequent car-users and cyclists with negative attitudes, their attitudes were likely to become more favourable in the following wave. The reverse picture was evident for public transport; this is likely to be attributed to the baseline use and attitudes towards this mode being considerably lower than for car and cycling.

A general take-away from the results above is that, in line with the theory of cognitive dissonance, people may adjust both their attitudes and behaviours to achieve a state of consonance. From a policy perspective, this means that policymakers should not only focus on subtle nudges aimed at changing attitudes (and subsequently behaviours) in desirable directions but may also implement policies that aim to directly influence behaviours, e.g. by setting rules or pricing policies, assuming that attitudes will follow.

Finally, we explored whether life events induced or reduced dissonance. Nearly all of the life events included in the analysis were associated with changing levels of cognitive dissonance across at least one travel mode. However, across all life events participants were equally likely to become more or less consonant following a life event. And while certain life events were associated with *behavioural* changes between the two survey years, no life events were associated with *attitudinal* changes towards the travel mode. This suggests that following life events, *behavioural* rather than *attitudinal* changes tend to create dissonance. Future analysis, using data from subsequent waves, could explore whether there is a lag in attitude change following the behavioural change.

Life events associated with an increase in car-based mobility (either as a result of increasing car-use or decreasing use of cycling or public transit) included: childbirth, moving in with a partner, starting work and changing jobs. An increase in car-use, overtime, is likely to contribute to the adoption for more favourable attitudes towards car-use. This, in turn, makes it less likely individuals will return to their former sustainable travel patterns, if, or when, their circumstances change. The adoption of more favourable attitudes towards car-use poses problems for transportation planners and policymakers seeking to encourage more sustainable travel modes. Further qualitative research may assist in unpicking the processes by which travel attitudes are adjusted (or not) to align with new travel behaviours. This would provide important insights to contribute to policies tasked at curbing the adoption of car-based mobility associated with certain life events.

Although the panel data provides a rich and detailed source of life events, several limitations exist. Due to the small number of respondents experiencing certain life events, some of the results were difficult to interpret. Furthermore, the classification of life events, especially those that instigated a relocation of work or home location, could be analysed at a more granular level. As data from future years becomes available, and more participants experience these life events, this will assist with

interpreting the changing levels of cognitive dissonance associated with experiencing less common life events.

Further limitations regard the measures and classification process we adopted. As this was an exploratory analysis, we conducted an a priori classification. However, future analyses could adopt a post-hoc classification process which may yield more nuanced segments of behavioural and attitudinal adjustments made by dissonant travellers. Moreover, we assumed travellers were only to reach a consonant state through adjusting their attitudes or behaviours where we have acknowledged that multiple strategies (such as forgetting or trivialising) may also be adopted (Kruglanski et al. 2018). In addition, we did not account for the magnitude of the dissonance or familiarity of the situation in influencing the dissonance reduction strategy adopted (Cancino-Montecinos et al. 2020). As this was an exploratory study, aiming to test fundamental concepts of CDT, these topics are proposed for future research.

The panel data used in this analysis was conducted before the COVID-19 pandemic. Given the anticipated structural changes to employment practices prompted by the pandemic, it may provide an opportunity for respondents to reconcile disparities between their travel attitudes and behaviour. For instance, respondents in the 'Frequent-Negative' categories for car or public transport may have the opportunity to work from home, reducing the need for commuting. Initial analysis of MPN respondents suggests that, of those respondents working at home during the pandemic, over a quarter expect to work from home more in the future (de Haas et al. 2020). Data from future waves will reveal the extent that this has transpired into changing travel practices and the subsequent impact this may have on reducing travel related cognitive dissonance.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Author contribution statement

Laura McCarthy: Research conception, research design, data analysis, results interpretation, lead paper writing

Alexa Delbosc: Research design, results interpretation, paper writing

Maarten Kroesen: Research design, results interpretation, paper writing

Mathijs de Haas: Data analysis, paper writing

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