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Travel socialization within households: A longitudinal analysis

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ABSTRACT

While transport research has shown that individual attitudes and subjective norms affect travel behavior, most studies overlook how household-level travel socialization processes (i.e., how attitudes and behaviors are transmitted between members) affect these patterns over time. The current study examines socialization processes in two household types, two-partner and family households, focusing on how fathers (or male partners), mothers (or female partners), and children influence each other's travel attitudes and behaviors over time. Using a two-wave cross-lagged panel model from the Netherlands Mobility Panel, we test the directionality of these effects. Results indicate that (i) in two-partner households, sustainable modes show more bidirectional effects between partners, though train use remains asymmetrical; (ii) in family households, the socialization process is largely parent-driven, with mothers playing a central role in influencing sustainable travel attitudes/behaviors of both children and partners; (iii) car use shows bidirectional effects between children and parents; and (iv) in both household types, individual travel behaviors are also highly stable over time, indicating the importance of behavioral consistency in addition to socialization processes. Mode-specific strategies targeting influential household members; mothers for cycling, parents for train use, and children for car reduction; can more effectively promote sustainable travel.

1. Introduction

In the travel behavior research, the individual has traditionally been viewed as the main decision-maker of his/her behavior (de Dios Ortúzar and Willumsen, 2024). It has been assumed that attitudes towards modes can influence individuals' travel behavior (i.e., different travel mode use/choice) in cross-sectional studies (e.g., guided by Ajzen's (1991) theory of planned behavior) and it has also been reported a bidirectional effect between attitude and behaviors in longitudinal studies (Chorus and Kroesen, 2014; Kroesen et al., 2017; Mehdizadeh and Kroesen, 2025). However, all these studies about the attitude-behavior relationships have been limited to the individual level. Nevertheless, one important aspect of travel decisions named travel socialization (Baslington, 2008; Haustein et al., 2009; Kroesen, 2015) at the household level has been overlooked. Studies have shown that travel behaviors of individuals can be highly dependent on other household members (Ho and Mulley, 2015; Hu et al., 2023), yet the socialization processes through which, for example, attitude–behavior effects are transmitted among household members remain underexplored.

At individual level in cross-sectional empirical studies, the main assumption driven by psychological (Ajzen, 1991) and economic theories (Walker and Ben-Akiva, 2002) tells us that individuals' attitudes affect travel behavior. Longitudinal studies, however, report a weaker effect but bidirectional, in which, behavior impacts attitudes more than the reverse (Chorus and Kroesen, 2014; Kroesen et al., 2017; Mehdizadeh and Kroesen, 2025; Mehdizadeh et al., 2026). Another psychological element which is also important is social norm referring to the perceived shared expectations or social pressure to behave in a certain way based on what people see others doing around them (descriptive norms) or what they believe others believe they ought to do (injunctive norms) (Cialdini and Trost, 1998). Different approaches have been used to reflect on the role of social norms. One of the most applied methods is driven by the theory of planned behavior (TPB) that attempts to measure individual's subjective norms by requesting agreement with statements like "my partner/parents/child always encourage me to use public transport rather than other travel modes" or "most people think I should do X". However, in some cases social norms are not measured explicitly in injunctive/descriptive terms. Instead, the attitudes or behaviors of others are used as proxies for normative influence. For example, in Baslington's (2008) study, the fact that parents drove regularly was

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treated as a normative influence on children's mobility, even though no explicit social norm items were included. In line with this, the effects of social norms can also be captured indirectly by measuring what others do or what others believe or value (attitudes), without explicitly framing them as norms (Kroesen, 2015). While such proxy measures are not equivalent to direct TPB-style norm items, they nonetheless capture the normative environment in which decisions are made, and attitudes are expressed. It can also be assumed that family members, perhaps particularly those within a household, represent the most significant others of an individual. The importance of intra-household interactions in capturing activity participation and other decisions has been also reported in the transport research in empirical and theoretical frameworks (Hu et al., 2023; Ho and Mulley, 2015).

The current study makes three main theoretical contributions to travel behavior and socialization literature. First, it extends attitude–behavior frameworks beyond the individual level by treating household members' attitudes and behaviors (i.e., mode use heterogeneity) as part of the normative environment in which travel decisions are formed. By modeling intra-household attitude–behavior dynamics across three travel modes (car, bicycle, and train) using longitudinal data, the study conceptualizes socialization as a dynamic and reciprocal process rather than a static or one-way effect. This perspective advances existing applications of the TPB and related approaches by examining how social norms operate through the observed attitudes and behaviors of significant others within the household over time. Second, the study contributes to socialization theory by comparing two theoretically distinct household contexts, namely two-partner households and family households with parents and children. These household types differ in their social influence structures, with partner households characterized by relatively symmetric relationships between adults, and family households characterized by role-based and age-related asymmetries between parents and children (McMillan, 2005; Mehdizadeh et al., 2018). By estimating bidirectional effects among household members in both contexts, the study examines whether and how processes of travel socialization differ between settings of mutual effect and settings where authority and dependency play a stronger role. This comparison helps identify the conditions under which socialization processes are more likely to be bidirectional or more likely to follow hierarchical patterns. Finally, by applying cross-lagged panel models, the study provides insight into the temporal stability and change of travel attitudes and behaviors across different household roles. This analysis identifies which household members show more stable attitudes or behaviors over time, and which are more responsive to influence from others. This longitudinal approach deepens theoretical understanding of how social norms are maintained, negotiated, and reshaped within households, and clarifies how individual agencies and social context jointly affect travel behavior over time.

2. Literature: Travel socialization

The concept of travel socialization, first introduced by Baslington (2008), suggests that travel behaviors (using or choosing a specific travel mode) are shaped socially and passed down culturally. In her qualitative study, she argued that travel routines experienced during childhood, especially those embedded in family life, influence long-term mobility habits. This framing moves beyond the idea of travel behavior as a purely rational choice, instead presenting it as part of a broader social script. This view reflects earlier social learning theories, such as those proposed by Bandura and Walters (1977). Building on this perspective, Klöckner and Matthies (2012) imply that travel socialization is a process through which cognitive and behavioral aspects of travel are transmitted to other agents, such as family members. They found that decisions about car use in adulthood are linked to early life experiences and previously established behavioral patterns. Döring et al. (2014) focused on the importance of taking a life-course approach to travel behavior. Their work points to the intergenerational transfer of travel modes, such as regular car use or reliance on public transport, which often continue into early adulthood, especially when supported by stable household routines.

In a very recent study based in Portland, Oregon, Kim and Dill (2025) examined how parents shape their children's travel behavior. They observed that parents' walking habits and concerns about safety were strong predictors of children's walking patterns, while the influence in the opposite direction was minimal. Similarly, Jafari et al. (2025) conducted a qualitative study in Melbourne, Australia, which showed that parents' concerns about safety, especially risks like harassment or unpredictable encounters with strangers, affected whether they allowed their teenagers to use public transport. Earlier work by Sandqvist and Kristrom (2001) explored the views of adolescents living in car-less households. They found that these young people formed mobility-related identities in dialogue with their parents, often linking car access with independence and social belonging. Haustein et al. (2009) developed a framework to explain car use among young adults, identifying the influence of early family habits, symbolic meanings tied to driving, and peer expectations. Their findings support the idea that while early experiences lay the foundation for travel preferences, these preferences continue to shift through adolescence and early adulthood. This idea is supported by Waygood et al. (2017), whose qualitative work found that enjoyable travel experiences shared with peers or family during adolescence contribute to greater satisfaction with sustainable transport later in life.

Longitudinal and retrospective studies (e.g., Kroesen, 2014; Döring et al., 2014) also suggest that travel decisions in early adulthood are shaped not only by financial considerations but also by earlier travel socializations. Kroesen (2015) studied two-partner households using latent transition modeling and found that travel behaviors within couples are often interconnected. Over time, a change in one partner's travel behavior often led to changes in the other's, even after accounting for factors such as car ownership and access to other transport options. This pattern suggests that travel decisions within households may evolve through mutual effect rather than being made independently (Timmermans and Zhang, 2009). Guan and Wang (2019a,b) also showed that individuals adapt their travel behavior in response to their partner's behavior. Anggraini (2009) also examined how household-level factors affect travel behavior. Their simulation-based models focused on how resources like shared cars and the division of daily tasks shape decisions.

Although the field has progressed, several gaps remain. Most existing research focuses on one-way effects, particularly from parents to children or from dominant to less dominant household members. Few studies compare different types of households, such as couples versus families with children. No study to date has explored changes in both attitudes and behaviors over time in multi-person households. Additionally, researchers tend to rely more on subjective perceptions of social norms than on socialization processes among household members. While cross-sectional research has helped identify patterns of intra-household travel behavior, it cannot capture how these patterns develop over time or how individual household members affect each other's attitudes and behaviors. There is still a lack of understanding about how these effects operate dynamically. A systematic review by Hu et al. (2023) called for more longitudinal work to examine how social norms are passed on and how changes in travel attitudes and behaviors are connected across different life stages.

3. Research objectives and conceptual model

This research proposes a longitudinal study using panel data to explore how travel (mode) attitudes and behavior (mode use pattern) among household members evolves and influences each other over time. Due to the complexity of household-level modeling, separate models are estimated for the three modes (i.e., car, cycling, and train) to ensure parsimonious and reliable estimation. Specifically, this study aims to:

- Examine the transfer (and stability) of travel attitudes and behaviors among household members over time for each travel mode.
- Explore the bidirectional relationship between travel attitudes and intra-household travel decisions.
- Identify which members play a greater role in shaping travel behavior and attitudes in different household types.

A panel model can capture the directionality and temporal effects of travel elements between household members. According to data availability and research aims, as illustrated in Fig. 1, a two-wave cross-lagged panel model is employed. According to this modeling approach, the stability and cross-lagged effects of travel behavior and attitudes across different household types (with different structure and size) are tested. Two household types are considered: (A) two-partner households and (B) family households (two partners and at least one child). In the latter, the presence of children can influence the structure of travel-related socialization, while in the former, the absence of children may lead to different socialization patterns between adult partners. To control for potential confounding effects in the attitude–behavior relationship, we also consider mean age of household heads, income level, rurality/urbanity level of residential location and number of children under 12 years old as covariates of all attitudinal and behavioral elements for both waves in the modeling framework. For family households, age and gender of child are also considered covariates of child's travel attitudes and behaviors. Of note, for the sake of parsimony, these covariates are not shown in Fig. 1.

4. Method

4.1. Sample

This study employs longitudinal research design using panel data to capture the dynamic interactions within households. Data from the Netherlands Mobility Panel (MPN) are used for the analysis. The MPN began data collection in 2013, surveying individuals aged 12 and above. This age criterion means that children younger than 12 are not surveyed. Consequently, changes in household composition due to births between the two survey waves, while potentially affecting household size, do not alter the set of surveyed participants or the household classification used in this study. Participants were asked to complete a three-day travel diary documenting their mobility behaviour. The data collection has been conducted annually using the same survey and participants. To ensure the analysis is not affected by the disruptions caused by the COVID-19 pandemic, this study focuses on the pre-COVID period. Specifically, the years 2014 and 2016 were selected as the two waves of analysis, as these years included detailed measures of attitudes toward various travel modes.

Not all data from the MPN were included in this study. First, only households with completed travel diaries and accompanying questionnaires for both waves were retained. Single-person households were excluded, as this study focuses on socialization effects between at least two household members rather than individual decision-making. Among couple households, only those with two household heads were considered. These criteria reduced the sample size from 2,500 to 779 couple households. For the second household type, only households with one male and one female household head and at least one child[1] were included, further reducing the sample to 337 family households. In the case of family households with multiple children, one child was randomly selected to represent the household's children's attitudes and behaviors, in order to maintain model parsimony and interpretability. This approach may overlook the impact of children of different ages within the same household. Including multiple children, however, would require a different CLPM structure than a family model with only one child and would further reduce the effective sample and compromise model reliability. While this approach does not fully capture interactions among multiple children in larger households, randomly selecting one child provides a reasonable approximation. For example, in four-member households with one child under 18 and one aged 18 or older, the selected child may differ across households, allowing the model to reflect heterogeneity. Single-parent households and same-sex couple households were not included in our analysis because their sample sizes were too small. Four variables were included as covariates of all members in family households: average partners' age, rurality (urbanity) level of the residential location,[2] number of children under 12 years old, and gross household income, in addition to child's gender and age as covariates of child's travel attitudes/behaviors. For two-partner households, all covariates except children-related variables were included. These covariates control for the age of household heads, household income levels, and residential location, which are important for accounting for potential confounding effects in the attitude–behavior relationship. Covariates were selected based on theoretical relevance and parsimony. Urban/rural residential context captures broad differences in transport accessibility; therefore, for example, more detailed transit accessibility measures were excluded due to collinearity. Car ownership was also excluded because it was partly correlated with household income and is likely endogenous to travel attitudes and behaviors. Sensitivity checks also showed that including or excluding these covariates did not meaningfully affect the main cross-lagged or stability effects.

For two-partner households, the average age of partners is 49.48 years (SD = 15.94). In the sample, the minimum reported mean age of couples is 20.5 years, and the maximum is 89.5 years. In terms of gross household income,[3] 21.6 % of respondents reported earning within the benchmark range (€26,200–<€38,800), while 32.9 % reported an income between twice the average and just below twice the modal income (€65,000–<€77,500). The remaining respondents fell into other income categories. Regarding the level of rurality/urbanity of residential areas, 10.1 % of respondents lived in non-urban areas, 23 % in low-urban areas, and 22.7 % in moderately urban areas. Additionally, 28.9 % lived in highly urban areas, while the rest resided in very highly urbanized regions.

On average, partners (parents) in family households are 46.49 years old (SD = 7.62). In the sample, the minimum mean age of parents is 21.5 years, while the maximum is 76.5 years. Among the randomly selected children in these family households, the mean age[4] is 17.12 years (SD = 5.74). Among the surveyed parents, 78 % reported having no children under the age of 12, while 16.6 % had one child, and the remaining respondents had two or more children in this age group. 31.5 % of respondents reported earning between one to two times the average income (€38,800–<€65,000). Additionally, 9.8 % reported an income between two times the average and just below twice the modal income (€65,000–<€77,500), while 13.4 % reported incomes exceeding twice the modal threshold (≥€77,500). A smaller portion (7.1 %) reported earnings below the modal range (€12,500–<€26,200), and the remainder fell within the benchmark range (€26,200–<€38,800). Regarding the level of urbanity of residential areas, 11.9 % of

[1] "By 'child,' we refer to individuals aged at least 12 years, as children younger than 12 were not part of the MPN participants.

[2] Residential location was coded on a five-point scale from 1 = very strongly urban to 5 = non-urban (rural). Higher values indicate greater rurality.

[3] Measured relative to the national benchmark income in 2014 (€26,200–€38,800).

[4] Child age was modeled as a continuous variable. Although younger children may not yet have independent travel perceptions and adult children may make more autonomous decisions, we also tested a binary specification for age (<18 = 0; ≥18 = 1). These alternative produced results similar to the continuous model. We also did not estimate a multi-group CLPM by age, as splitting the family sample would yield insufficient subgroup sizes for reliable estimation.

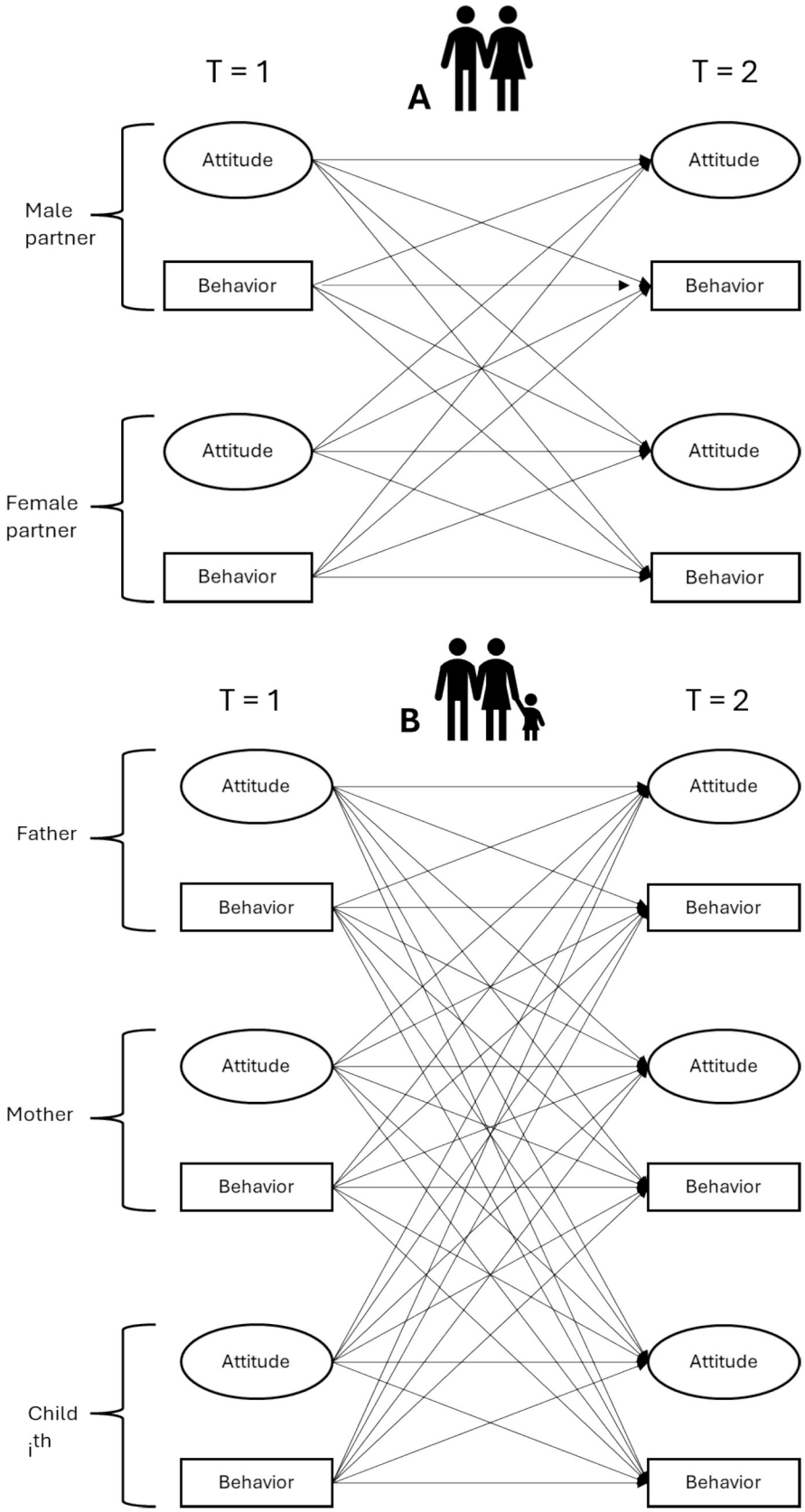

Fig. 1. The conceptual modeling framework (A: two-partner households, B: family households).

respondents lived in non-urban areas (fewer than 500 inhabitants per km^2), 21.7 % in lowly urban areas (500–1,000 inhabitants/km^2), and 30 % in moderately urban areas (1,000–1,500 inhabitants/km^2). Additionally, 25.5 % lived in highly urban areas (1,500–2,500 inhabitants/km^2), while 9.8 % resided in very highly urbanized regions (2,500 or more inhabitants/km^2). Also, 49 % of the selected children in the model were boys.

4.2. Measures

As for travel behavior, we considered the use of the car, bicycle and train. These modes were selected because they capture the largest shares in terms of the total distanced travelled in the Netherlands; the car accounting for 69.1 % (129 billion kilometres), bicycle for 9.5 % (17,9 billion kilometres) and train for 8.8 % (16.5 million kilometres) of all travelled kilometres (187 billion kilometres in total) (KIM, 2025)). The frequency of using these mods was measured in both waves on a seven-point Likert scale ranging from (1) never, (2) less than 1 day per year, (3) 1 to 5 days per year, (4) 6 to 11 days per year, (5) 1 to 3 days per month, (6) 1 to 3 days per week, and (7) 4 or more days per week. Notably, the "car" category in the data excludes taxis, and car use frequency refers to instances of travel as either a driver or a passenger.

Following the guidance of Ajzen and Fishbein (1977), attitudes in the MPN survey were measured to align directly with the specific travel behaviors under investigation. Respondents' attitudes toward car use, cycling, and train travel were assessed individually. For each travel mode, six items [I find traveling by X comfortable; I find traveling by X relaxing; Traveling by X saves me time; Travelling by X is safe; I find traveling by X flexible; Travelling by X is enjoyable] were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). These items were designed to capture key motivations behind mode use, reflecting both instrumental (practical) and affective (emotional) dimensions, as suggested by Anable and Gatersleben (2005). It is worth noting that prior validation of this instrument via factor analysis showed that the six items for each mode reliably loaded onto a single latent factor representing the overall attitude toward that specific mode (Kroesen and Chorus, 2020). Composite attitude scores were calculated by summing the six items per mode, producing scales with possible values ranging from 6 to 30. Each scale indicated strong internal consistency, with Cronbach's alpha values exceeding 0.80.

4.3. Modeling approach

To investigate the temporal relationships between travel attitudes and behaviors across different travel modes and household members, we employed a two-wave cross-lagged panel model (CLPM) using structural equation modeling (SEM). Of note, estimating a random intercept model (RI-CLPM), which separates stable differences between-person from within-person changes, would be preferable. However, RI-CLPMs require a minimum of three waves to be identifiable. Because including a third wave would substantially reduce the available sample size, we therefore opted to use a standard CLPM for our two-wave data. Given the two-wave design, synchronous (within-wave) effects could not be estimated alongside lagged effects without making the model underidentified; therefore, only lagged paths were included, as they satisfy the temporal precedence criterion of causality. Separate models were estimated for each travel mode: car, bicycle, and train, with corresponding attitudinal and behavioral indicators for each individual within the household, including male and female partners in couple households, and father, mother, and (randomly selected) child in family households. For each mode and person, Wave 2 attitudes and behaviors were regressed on their respective Wave 1 values (autoregressive effects), as well as on the other construct at Wave 1 (cross-lagged effects). Crucially, the model also incorporated cross-member effects, allowing us to examine whether, for instance, a father's car use at Wave 1 predicts the child's car attitude at Wave 2. The equations for each person i and mode m are specified as:

$$Attitude_{m,i,wave2} = \beta_1 \times Attitude_{m,i,wave1} + \beta_2 \times Behavior_{m,i,wave1} + \gamma \times Covariates_{m,i,wave1} + error_{Attitude,m,i}$$

$$Behavior_{m,i,wave2} = \beta_3 \times Behavior_{m,i,wave1} + \beta_4 \times Attitude_{m,i,wave1} + \gamma \times Covariates_{m,i,wave1} + error_{Behavior,m,i}$$

where m denotes the mode (car, bike, train), and i indicates the household member (e.g., father, mother, child). Covariates (exogenous variables) were included for each individual and element and assumed time-invariant factors. We also allowed for residual correlations between attitudes and behaviors at waves and correlated disturbances between individuals (e.g., residual correlations between partners or between parents and children). Model fit was evaluated using the Comparative Fit Index (CFI $\geq$ 0.90), Root Mean Square Error of Approximation (RMSEA $\leq$ 0.08), and Tucker-Lewis Index (TLI $\geq$ 0.90), following Kline (2023) and Hu and Bentler's (1999) guidelines. Estimation was conducted using maximum likelihood.

5. Results

5.1. Descriptives

Table 1 summarizes travel attitudes and behaviors among male and female partners in two-partner households. Overall, both partners reported relatively high car attitudes, with male partners consistently showing slightly more favorable views than female partners in both Wave 1 (M = 24.65 vs. 24.03) and Wave 2 (M = 24.85 vs. 24.16).

Table 1
Descriptives of travel attitudes and behavior among *two-partner* households (n = 779).

Item	Role in household	Wave 1		Wave 2	
		Mean	Std. Deviation	Mean	Std. Deviation
Car attitudes*	Male partner	24.65	3.552	24.85	3.505
	Female partner	24.03	3.511	24.16	3.672
Bicycle attitudes	Male partner	22.66	4.091	22.81	4.106
	Female partner	22.98	4.001	22.99	4.073
Train attitudes	Male partner	18.68	4.379	18.78	4.483
	Female partner	18.80	4.116	18.81	4.172
Car use (behavior**)	Male partner	6.33	1.040	6.30	1.090
	Female partner	6.13	1.144	6.15	1.074
Bicycle use (behavior)	Male partner	5.54	1.679	5.47	1.742
	Female partner	5.82	1.641	5.67	1.742
Train use (behavior)	Male partner	2.68	1.642	2.62	1.635
	Female partner	2.78	1.516	2.72	1.535

* Ranged from 6 to 30, calculated by summing the six attitudinal items for each mode.
** Ranged from 1 to 7.

Attitudes toward bicycles were moderately positive and remained stable across waves, with female partners expressing slightly higher bicycle attitudes than male partners. Similarly, train attitudes were the least favorable mode among both partners but remained relatively stable between waves. In terms of behavior, car use was highest among both partners, with only minimal changes over time. Bicycle use was moderate, with a small decline observed in both male and female partners across waves. Female partners used bicycles slightly more than male partners overall. Lastly, train use was the lowest across all travel modes, with both male and female partners showing a slight decrease in use from Wave 1 to Wave 2.

Table 2 presents the descriptive statistics for travel attitudes and behaviors among family household members across two waves. Overall, car attitudes were the most favorable mode among all household members, with fathers reporting the highest mean scores in both waves (M = 25.20, SD = 3.43 in Wave 1; M = 25.61, SD = 3.31 in Wave 2). Mothers and children showed slightly lower but comparable levels of positive car attitudes. Attitudes toward bicycles were moderately positive, with fathers' scores increasing slightly across waves, while children's attitudes remained stable. In contrast, train attitudes were the least favorable among all three members, particularly for fathers, although children consistently reported slightly more favorable train attitudes than their parents. Regarding behavior, car use was highest among parents and remained relatively stable over time, while children reported lower car use with a slight increase from Wave 1 (M = 5.51) to Wave 2 (M = 5.58). Children showed the highest bicycle use across waves, although their use slightly declined in Wave 2. Finally, train use was generally low among parents but notably higher among children, with a noticeable increase from Wave 1 (M = 3.50) to Wave 2 (M = 3.87).

The *cross-sectional* correlation analyses presented in the supplementary material file (Tables A.1–A.4) reveal several patterns in the relationships between travel attitudes and behaviors in both household types across Wave 1 and Wave 2. The correlation matrices for two-partner households (Tables A.1 and A.2) reveal consistent patterns across both waves. Notably, there is a strong positive association between male and female partners' attitudes toward the same travel modes, especially for car attitudes (e.g., r = 0.357 in Wave 1, r = 0.437 in Wave 2). For example, car attitudes are positively linked to car use for both partners across waves (e.g., male partner: r = 0.305 in Wave 1, r = 0.299 in Wave 2), while being negatively associated with both train and bicycle use, suggesting a tendency for car-oriented individuals to use alternative modes less frequently. In contrast, bicycle attitudes are strongly correlated with bicycle use, especially for male partners (e.g., r = 0.515 in Wave 1, r = 0.514 in Wave 2).

Across both waves, among family households, there is strong attitudinal alignment among members toward the same travel modes, particularly for car and bicycle attitudes. For instance, in both waves, car attitudes among fathers, mothers, and children were significantly and positively correlated, indicating shared attitudes within households. A consistent and notable trend is the strong association between bicycle attitudes and bicycle use, especially among parents. Fathers and mothers who held more favorable attitudes toward cycling were significantly more likely to use bicycles themselves (e.g., r = 0.628 and 0.542, respectively, in Wave 1), and these strong correlations persisted in Wave 2. Car attitudes also showed expected positive associations with car use and negative correlations with train and bicycle use, particularly among parents. Children showed a more multimodal profile. Their attitudes toward trains and bicycles were positively associated with corresponding behaviors, indicating a greater openness to using diverse travel modes.

Table 2
Descriptives of travel attitudes and behavior among *family* households (n = 337).

Item	Role in household	Wave 1		Wave 2	
		Mean	Std. Deviation	Mean	Std. Deviation
Car attitudes*	Father	25.20	3.431	25.61	3.308
	Mother	24.43	3.607	24.65	3.607
	Child	24.44	4.035	24.70	3.707
Bicycle attitudes	Father	22.32	4.151	23.00	4.122
	Mother	22.82	4.382	22.97	4.545
	Child	21.67	4.239	21.66	4.188
Train attitudes	Father	18.25	4.178	18.31	4.467
	Mother	18.49	3.973	18.81	4.517
	Child	19.57	4.031	19.24	4.055
Car use (behavior**)	Father	6.51	0.823	6.47	0.942
	Mother	6.28	0.937	6.26	0.925
	Child	5.51	1.395	5.58	1.460
Bicycle use (behavior)	Father	5.37	1.812	5.41	1.872
	Mother	5.92	1.658	5.87	1.742
	Child	6.48	1.195	6.17	1.544
Train use (behavior)	Father	2.52	1.625	2.50	1.597
	Mother	2.65	1.379	2.72	1.524
	Child	3.50	2.090	3.87	2.073

* Ranged from 6 to 30, calculated by summing the six attitudinal items for each mode.
** Ranged from 1 to 7.

5.2. CLPM results for two-partner households

According to the likelihood ratio test, RMSEA, TLI/CFI indices, and equation-level goodness of fit, all (unsaturated) models showed good overall fit. The standardized effects of statistically significant cross-lagged effects and stability coefficients at 5 % significance levels for different models are reported in the corresponding Figure results. The insignificant coefficients (arrows) are not shown in Figures. In addition, the coefficients of covariances are not shown in these figures. Since the discussion around the effects of exogenous covariates is beyond the scope of this study, the estimations result of only statistically significant effects are provided in figures in grey color. The signs of the covariate effects are generally in line with results from previous studies. Fig. 2 shows the results of the CLPM examining the relationship between car attitudes and car (use) behavior in two-partner households. All stability effects are significant and strong. The male partner's car use shows the highest stability (β = 0.56). Car attitudes also remain relatively stable for both partners over time. Among the 12 possible cross-lagged effects, four are significant. There is no directional attitude-behavior effect within male partners. The male partner's car attitude only influences his female partner's car attitude (β = 0.14). His car use also contributes to an increase in his partner's car use (β = 0.15). For female partners, the relationship between attitude and behavior is unidirectional (from attitude to behavior) (β = 0.09). Additionally, the female partner's car attitude influences the male partner's car attitude (β = 0.15), but do not significantly affect their male partner's car use. Overall, it seems that male partners show slightly more impact on their female partners' car use than the other way around.

Fig. 3 presents the results of the CLPM for the relationship between cycling attitudes and bicycle behavior in two-partner households. All stability effects are significant and large. The female partner's bicycle use shows the strongest stability (β = 0.61). Bicycle attitudes also indicate consistency over time. Seven cross-lagged effects are found to be significant. For both male and female partners, themselves, the relationship between cycling attitudes and behavior is bidirectional, though the influence of actual cycling behavior on affecting attitudes appears to be roughly twice as strong as the reverse effect. Additionally,

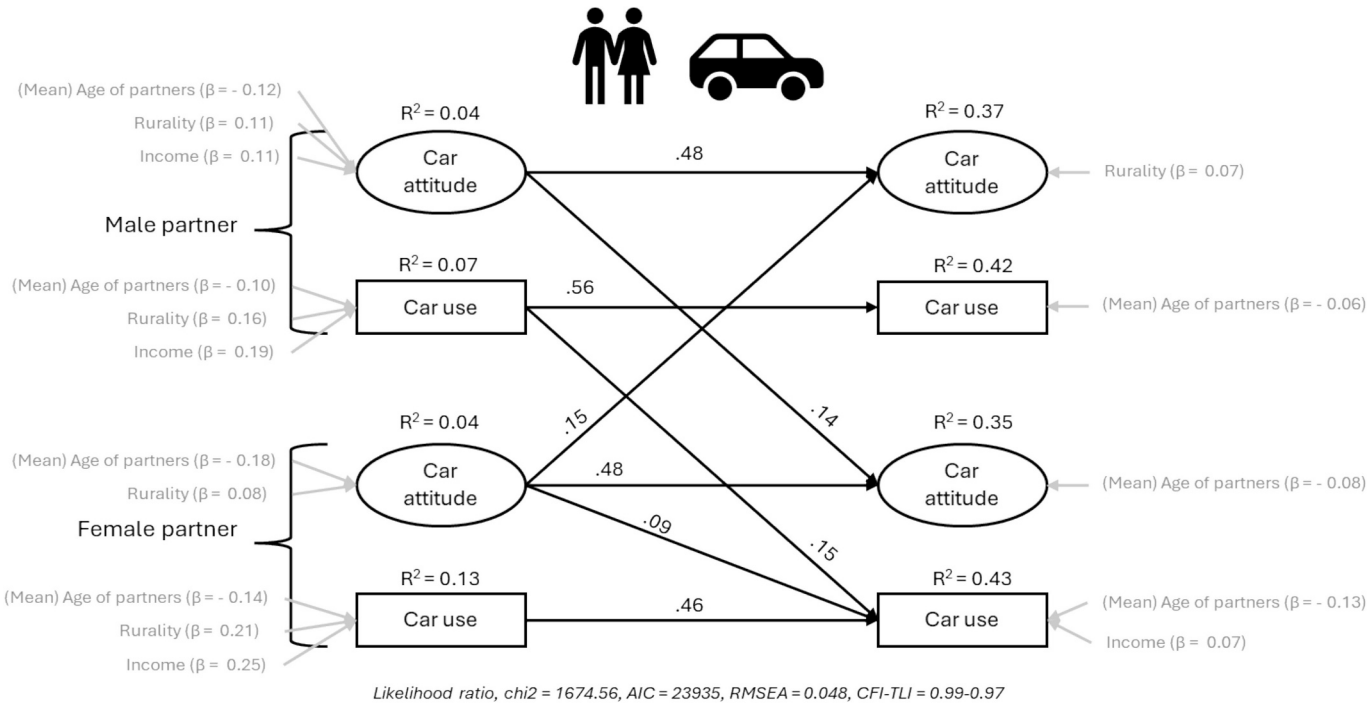

Fig. 2. Standardized effects of CLPM on the car attitude-behavior relationship for two-partner households. *Note: only significant effects (arrows) are shown.* Note: Rurality was measured as follows: (1) very strongly urban, and (5) non-urban.

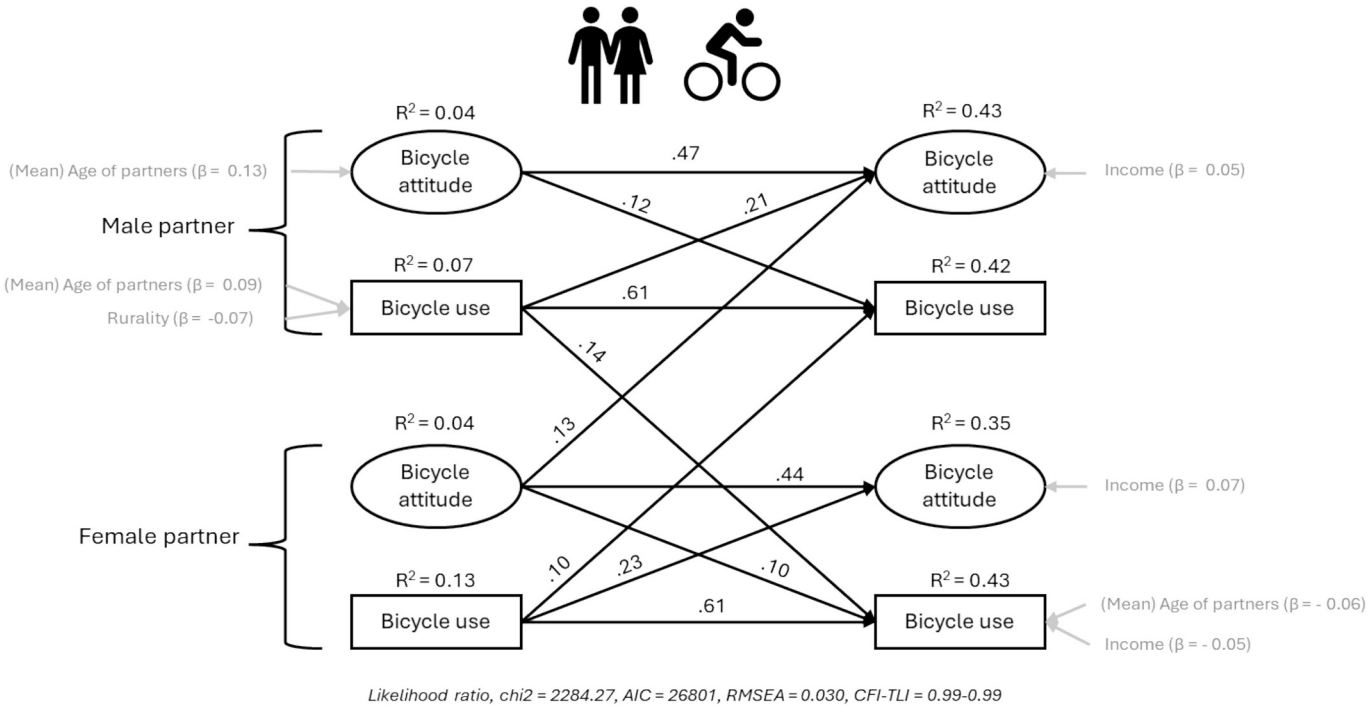

Fig. 3. Standardized effects of CLPM on the cycling attitude-behavior relationship for two-partner households. *Note: only significant effects (arrows) are shown.*

each partner's behavior influences the other's (cycling) behavior. The strength of these effects is relatively similar between men and women. However, only females' attitudes influence males' attitudes, while the reverse is not observed.

Fig. 4 presents the results of the CLPM for the relationship between train attitudes and train behavior in two-partner households. All stability effects are significant and strong. Both partners show high stability in train use (β = 0.63–0.69), along with strong consistency in attitudes over time. Male partners' train use positively affects their own attitudes (β = 0.09), while the reverse effect is not significant. Male train use increases their partners' train use (β = 0.08). For female partners, the relationship between train attitudes and behavior is bidirectional, with behavior showing a stronger impact on attitudes. Additionally, female partners' attitudes and behaviors influence their partners' attitudes (β = 0.09) and train use (β = 0.13), respectively. In general, bidirectional socialization occurs with respect to train use and attitudes.

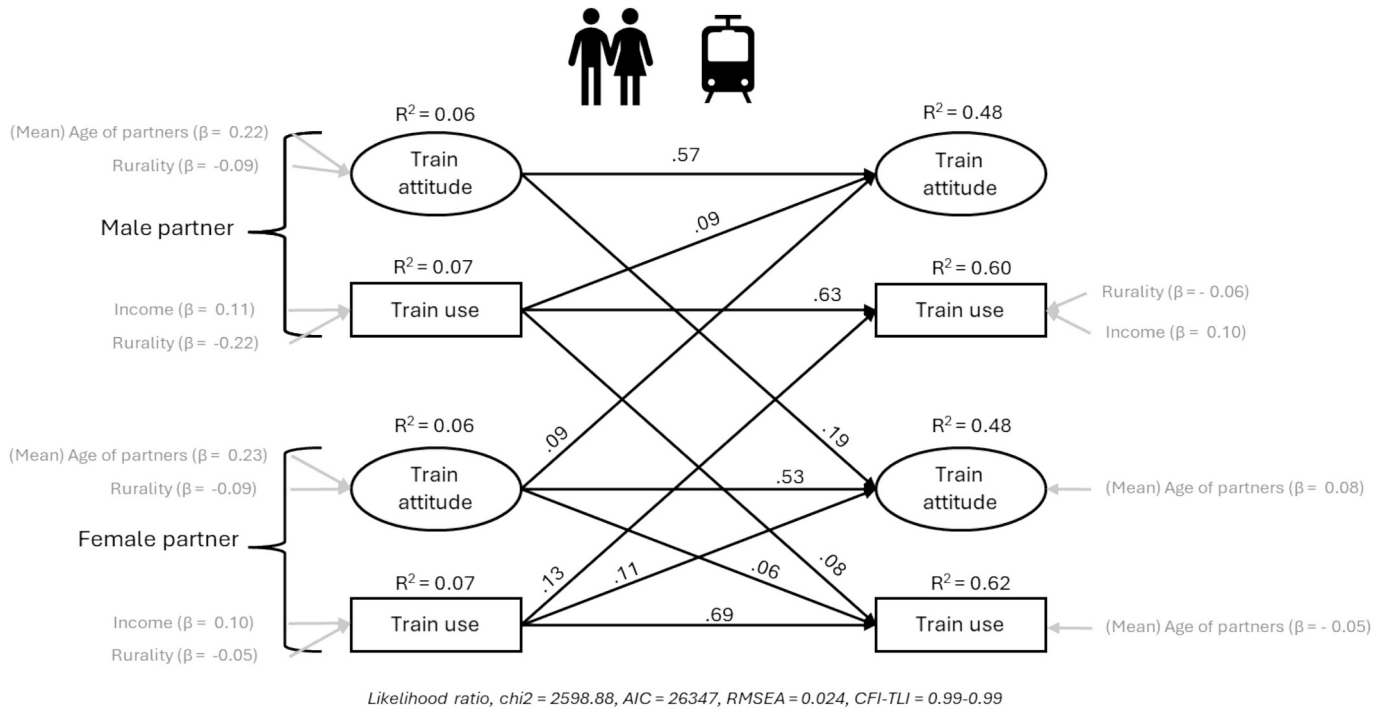

Fig. 4. Standardized effects of CLPM on the train attitude-behavior relationship for two-partner households. *Note: only significant effects (arrows) are shown.*

5.3. CLPM results for family households

According to the likelihood ratio test, RMSEA, TLI/CFI indices, and equation-level goodness of fit, all (unsaturated) models showed good overall fit. Fig. 5 presents the results of the CLPM for the relationship between car attitudes and car (use) behavior in households consisting of parents (father and mother) and a random child. All stability effect sizes are strong and significant. Mothers' car use shows the strongest stability effect (β = 0.61), followed by fathers (β = 0.54) and children (β = 0.39). Car attitudes also show considerable consistency over time, with fathers showing the highest stability (β = 0.51), followed by mothers (β = 0.47) and children (β = 0.35). Among the 30 possible cross-lagged effects, eight are significant. Fathers' car attitudes positively influence their child's car attitude (β = 0.17). Mothers' car attitudes and car use (behavior) affect their child's car attitude (β = -0.14) and car use (β = 0.12). While favorable attitudes towards car among mothers reduce their child's car use over time, mothers' actual car use increases their child's car use. This suggests that, in general, favorable mothers' attitudes are not a trigger of children's actual car use; however, mothers' car use may lead to increased car use among children, possibly due to joint trips, as the reverse effect, where children's car use increases mothers' car use, also holds true. Overall, children's car use is influenced more by their mothers than by their fathers. On the other hand, children impact on their parents consistently. Regarding cars, children's attitude and car use significantly affect their mothers' and fathers' car attitudes and use. When comparing the mutual effects between children and fathers, it is evident that children's car attitudes significantly impact their fathers' car attitudes (β = 0.20) and car use (β = 0.13). Children's car attitudes increase their mothers' car attitudes (β = 0.14), suggesting that children encourage their mothers to adopt a more car-positive mindset. Also, children's car use increase mothers' car attitude (β = 0.12) and car use (β = 0.09). Furthermore, for each household member, an interesting pattern emerges: there is no significant attitude-behavior effect over time for individuals, yet household members influence each other's attitudes and behaviors over time.

Fig. 6 presents the results of the CLPM for the relationship between bicycle attitudes and bicycle behavior in family households. All stability effects are significant and strong. Parents' bicycle use shows the strongest stability effect (β = 0.67–0.68), followed by children (β = 0.47). Bicycle attitudes also show considerable consistency over time. Mothers' attitudes show the highest stability (β = 0.59), followed by fathers (β = 0.46) and children (β = 0.45). About one third of the cross-lagged effects are significant. Fathers' cycling behavior strongly influences their own cycling attitudes over time (β = 0.30), while the reverse relationship is weaker (β = 0.10). However, fathers' bicycle attitudes positively influence their partners' attitudes (β = 0.12). Mothers in the household play the most influential role in affecting the cycling attitudes and behaviors of other members. Firstly, for mothers themselves, the effects of cycling attitude and behavior are bidirectional and similar in magnitude. Additionally, mothers' cycling attitudes positively influence the cycling attitudes of other household members. Within households, although mothers' cycling behavior has a positive effect on fathers' cycling behavior, it reduces fathers' cycling attitudes. This may be due to safety concerns among male partners regarding their female partners' cycling experiences. On the other hand, children's cycling attitudes and behaviors do not influence their parents. Instead, their attitudes and cycling behavior are primarily influenced by their mothers. Mothers' attitudes encourage children's attitudes toward cycling, and mothers' cycling behavior increases children's cycling behavior. Finally, children's cycling attitudes unidirectionally affect their own cycling behavior over time.

Fig. 7 describes the results of the CLPM for the relationship between train attitudes and train behavior in family households. All stability effects are significant and strong. Fathers' train use shows the strongest stability effect (β = 0.82), followed by mothers (β = 0.58) and children (β = 0.46). Eight out of 30 cross-lagged effects are significant. Fathers' train use affects their own train attitudes over time (β = 0.13), while the reverse relationship does not hold. However, fathers' favorable attitudes towards trains positively influence their partners' attitudes (β = 0.17) and children's attitudes towards trains (β = 0.17). Fathers' train use also positively affects their partners' train use. The effects between train attitude and train use do not function for mothers themselves; however, mothers' attitudes towards trains positively influence the attitudes of other household members. Mothers' train use also increases children's

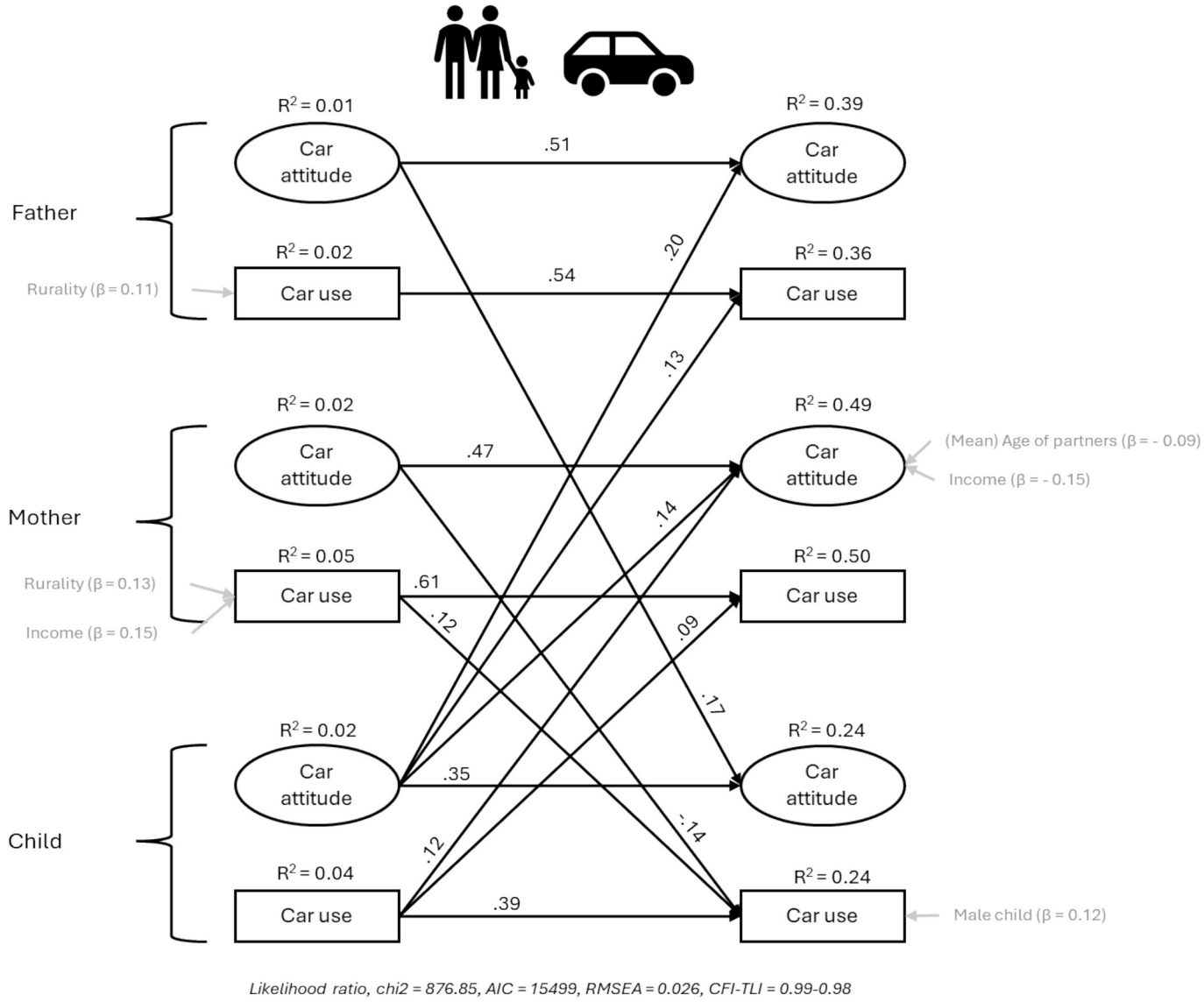

Fig. 5. Standardized effects of CLPM on the car attitude-behavior relationship for family households. *Note: only significant effects (arrows) are shown.*

train use, possibly indicating joint trips, as the reverse effect is also present. Children have little impact on their parents regarding train attitudes and use (except for the impact of the child's train use on mothers), as their attitudes and behavior are largely influenced by their parents in relation to this mode.

6. Discussion

This study provides new insights into how travel attitudes and behaviors develop and influence household members over time. The results indicate the existence of socialization processes within households in addition to consistency in individual behaviors. Within-household interactions do emerge, revealing distinct patterns of effects depending on the travel mode and household member. By considering the direction/strength of these effects, a clearer picture of how travel socialization functions in different contexts becomes evident.

6.1. Findings in two-partner households

In the car domain, both partners show relatively stable car attitudes/behavior over time. The cross-lagged effects highlight a degree of asymmetry in influence. Male partners play a more dominant role: their car use not only affect their own car use but also influence their female partners' car use. Interestingly, females influence on their male partners is limited to affecting attitudes, without significantly affecting male car use. This suggests that while women may contribute to the cognitive framing of car-related views in the two-partner households, their effect on actual car use decisions remains more constrained.

In contrast to car use, cycling behavior reveals a more balanced and reciprocal relationship between partners. Both male and female partners influence one another in behavior (Kroesen, 2015), and they also show bidirectional relationships within themselves. However, an important pattern is observed: cycling behavior more strongly affects attitudes than vice versa. This is especially significant given that both partners indicate higher stability in both cycling behaviors, possibly reflecting stronger cycling routines or deeper internalization of cycling as a lifestyle in the Netherlands. The mutual reinforcement observed in cycling may reflect shared values or joint participation in cycling activities, suggesting that this mode facilitates greater alignment and co-adaptation between two-partner households over time.

Train use and attitudes continue to show high temporal consistency, with strong stability effects for both partners across time. For male partners, train use significantly enhances their own attitudes toward train travel, although the reverse remains non-significant. Male train use

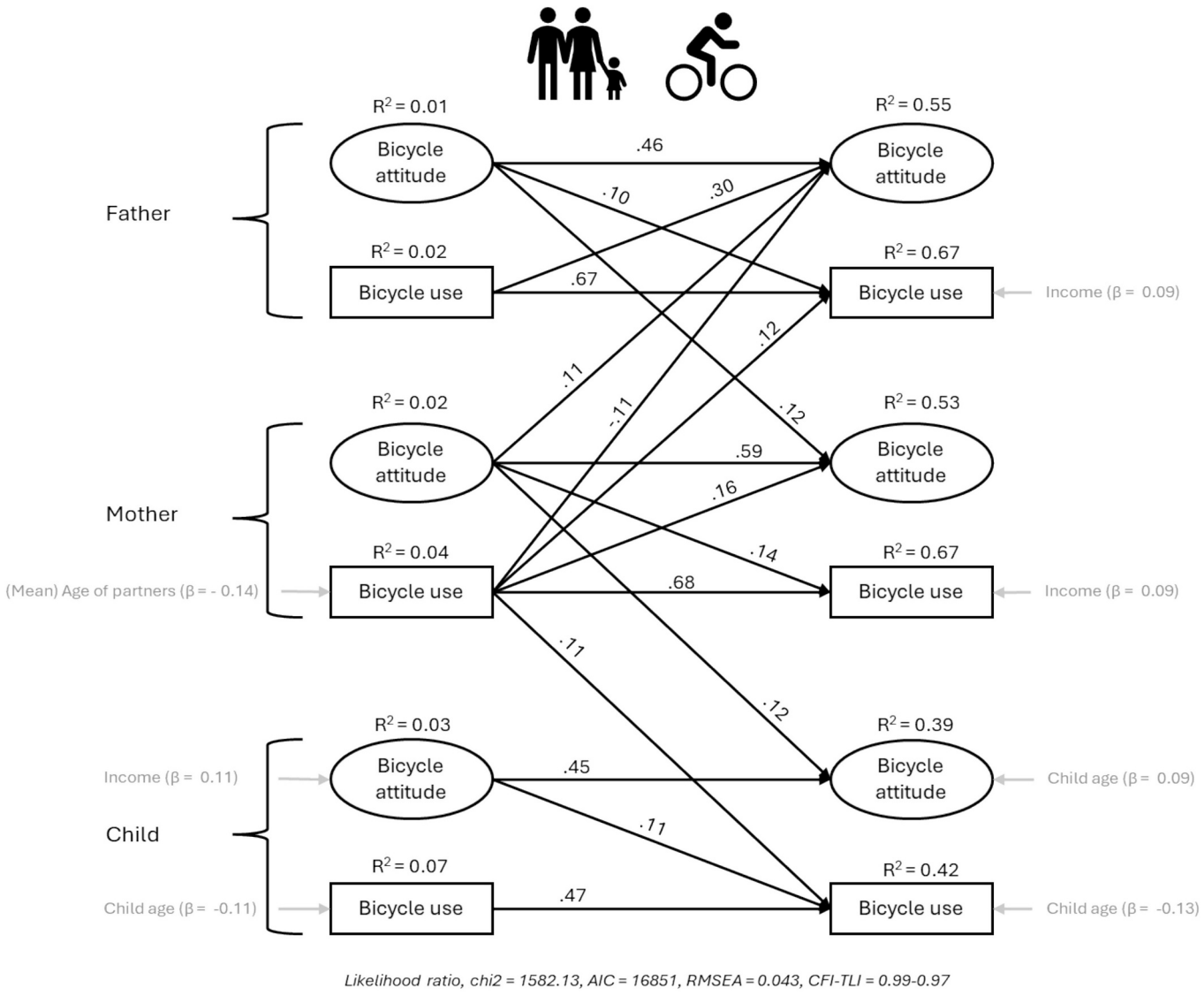

Fig. 6. Standardized effects of CLPM on the bicycle attitude-behavior relationship for family households. *Note: only significant effects (arrows) are shown.*

also positively influences their female partners' train use, suggesting a behavioral spillover effect. For female partners, the relationship between train attitudes and behavior is clearly bidirectional, with behavior having a somewhat stronger effect on attitudes. Moreover, female partners' effects are beyond their own trajectories: their train attitudes shape their male partners' attitudes, and their behavior positively affects male partners' train use. This highlights the central role of female partners in influencing both attitudinal and behavioral dynamics with regard to train. Overall, the findings indicate a pattern of bidirectional socialization between partners regarding train use and attitudes, though asymmetries remain.

Across all three travel modes, a consistent pattern is that attitudes and behaviors are more stable than they are flexible, with cross-lagged effects typically weaker than stability effects. However, the role of behavior in influencing attitudes is particularly notable in cycling and train use, where real-world experiences appear to challenge or reinforce pre-existing views. This supports the idea that habitual or experiential learning may be more influential in some contexts than attitudinal planning, contrasting with traditional models that assume attitudes precede behavior. In terms of interpersonal effect, male partners generally show stronger behavioral effects in car-related domains, while female partners appear more influential in sustainable modes such as cycling and train travel. This points to mode-specific socialization processes, where the balance of power or persuasion shifts depending on the travel context.

6.2. Findings in family households

A key finding is that mothers play an important role in influencing their children's travel behavior across all modes. The strength of their effect depends on whether they are affecting attitudes or behaviors, and the travel mode involved. Regarding cars, mothers' attitudes and behaviors affect their children in opposite directions. While mothers' attitudes towards cars tend to discourage car use of children, mothers' actual driving patterns reinforce their children's car use. A factor worth considering is the role of child gender in this pattern. Male children, in particular, are more likely to increase their car use in the second wave of data, raising the possibility that the conflicting effects of mothers' attitudes and behaviors on car use may differ between boys and girls. In contrast, for cycling and train, both attitudes and behaviors of mothers positively reinforce cycling/train attitudes and behavior in their children. This highlights that for sustainable modes, participation and role modeling of mothers play a much stronger (consonant) role than for cars. Use of trains/bicycles by mothers increases their children's train/bicycle use. However, mothers' attitudes towards trains/cycling do not influence children's train/bicycle use in the same way, indicating that

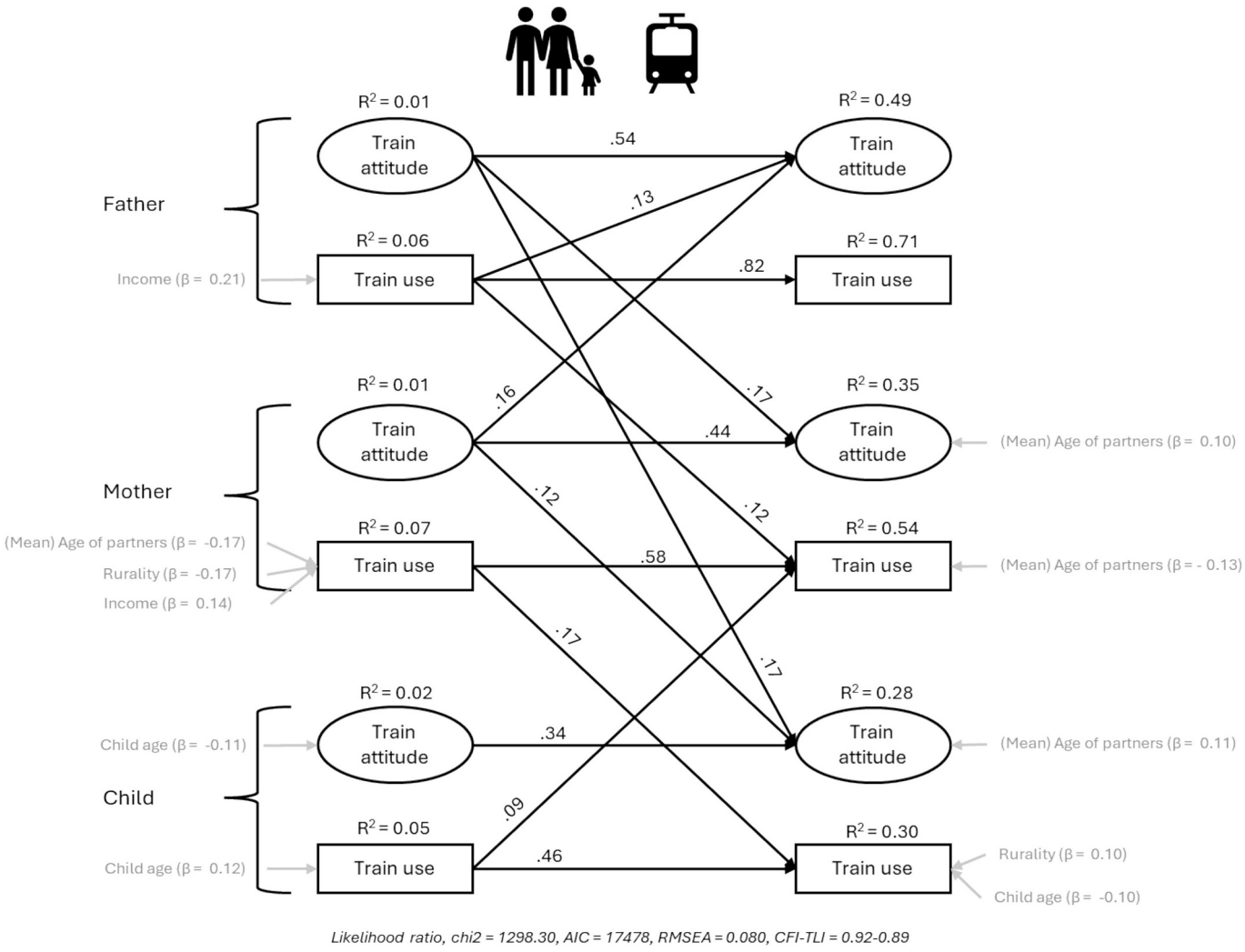

Fig. 7. Standardized effects of CLPM on the train attitude-behavior relationship for family households. *Note: only significant effects (arrows) are shown.*

exposure to sustainable modes in daily routines might be more influential than expressed opinions. Beyond their influence on children, mothers also partly affect the travel behaviors of their partners in family households. Their role is particularly evident in cycling, where their cycling behavior encourages their partners (i.e., fathers in the family households) to cycle more often. However, this increased cycling participation by mothers does not translate into a stronger attitude towards cycling among fathers in households. This pattern might suggest that practical considerations, such as convenience or family needs, may drive fathers' participation rather than a fundamental shift in their attitudes.

Fathers show strong consistency in both their attitudes and behaviors across all travel modes. However, their influence on other family members is different from that of mothers. Fathers play a stronger role in influencing attitudes within the household rather than directly influencing behavior. Regarding cars, fathers' attitudes contribute to affecting their children's attitudes, reinforcing a positive view of car travel. However, this does not necessarily translate into changes in car use, indicating that the development of car-related attitudes occurs at a conceptual level and fathers' attitudes towards cars do not influence the car use of any household members. For cycling, fathers' attitudes influence their partners' attitudes but have no impact on their children's cycling attitudes/behaviors. Interestingly, fathers are one of the few cases where their cycling behaviors strongly affects their own attitudes towards cycling rather than the other way around. This suggests that for fathers, direct cycling habits/experience plays a stronger role in influencing positive cycling attitudes than pre-existing beliefs. This finding aligns with longitudinal studies (Kroesen et al., 2017; Mehdizadeh and Kroesen, 2025) and challenges the conclusions of many cross-sectional studies that claim improving cycling attitudes is key to increasing cycling behavior. For train use, fathers shape both their partners' and children's attitudes toward train travel. Unlike car use, where children can influence fathers' attitudes/behaviors greatly, this pattern is not present for train travel. This might suggest that attitudes toward public transport are largely shaped by parental influence rather than by socialization (interactions) with children.

In general, children are more influenced by their parents than the other way around. This result is in line with findings reported by Kim and Dill (2025) and Jafari et al. (2025) showing that children are more a function of their parents regarding use of active and public transport. However, the extent of this effect varies depending on the travel mode. For cars, there are bidirectional socialization effects between children and parents. Children's car attitudes increase their fathers' car attitudes and use, while children's car use increase their mothers' car attitudes and use. This is one of the few cases where children's attitudes influence parental behavior, suggesting that fathers may be more open to adjusting their travel behaviors based on their children's views. However, children's attitudes towards car do not influence their mothers' car use, reinforcing the idea that mothers maintain stronger control over their own travel choices. Of note, the main

difference in the effects from children to their parents lies in the source of effect. For fathers, the socialization effect begins with the children's attitudes, whereas for mothers, it originates from the children's actual car use. For cycling and train use, children's behaviors and attitudes are primarily shaped by their mothers. Unlike car use, children do not significantly influence their parents' cycling or train use. This suggests that while children may adopt their parents' habits, they have limited ability to change the travel decisions of adults when it comes to active and public transport. An important pattern emerges in cycling, where children's own attitudes influence their behavior over time. This suggests that cycling is more self-motivated than other travel modes for children. Unlike car or train use, which often depend on parental decisions, cycling may be seen as a more personal and independent choice for children, specifically in a context like in the Netherlands. Improving children's cycling attitudes can positively increase children's cycling behaviors.

When comparing across different travel modes in family households, three key patterns emerge. First, parents-children socialization around car use is more bidirectional. While fathers influence their children's attitudes, mothers affect their children's car use. In reverse, children also influence their fathers' and mothers' car attitudes and behaviors. Second, cycling socialization is more strongly affected by mothers than by fathers. Mothers influence both children and their partners, reinforcing the idea that role modeling and active participation are key drivers of cycling behavior. The relationship between attitudes and behaviors for each member is also different from car use. While attitudes toward car travel do not strongly predict actual driving, cycling attitudes and behaviors are more closely connected, particularly for mothers. Third, train socialization follows a structured pattern where parents' (both fathers and mothers) attitudes influence attitudes of children while fathers' train use affect mothers' train use and mothers' train use affect children's train use. It is mothers who influence actual train use in children. Unlike car use and to some extent similar to cycling, children do not play an active role in shaping parents' train travel choices, suggesting that sustainable mode choices are largely determined by parents.

7. Conclusion

The findings reveal significant socialization processes in how travel attitudes and behaviors evolve across two-partner and family households. Differences emerge in the structure of socialization. In two-partner households, sustainable travel modes show more reciprocal influence between partners, though train use remains asymmetrical, with female partners having broader effects. Car use in these households reflects a more traditional pattern, with male partners driving behavioral outcomes and female partners influencing attitudes. A commonality is that behavior often influences attitudes, especially in cycling and train travel, supporting the idea that engaging in a mode can increase positive perceptions through experiential learning. In family households, influence is largely parent-driven, with mothers playing a central role in affecting both children's and partners' sustainable travel behaviors, while fathers tend to affect attitudes more than behavior. Children show notable effect only in car use, where parent–child effects are bidirectional. Another feature is the stability of individual travel behavior over time: past behavior, particularly in car, cycling, and train use, is also a strong predictor of future behavior. This highlights the importance of behavioral consistency (persistence of established habits) in addition to socialization processes.

For policy and intervention efforts, these findings suggest that programs aimed at changing travel behaviors should target different family members depending on the travel mode. Reducing car utilities among schoolchildren through nudging strategies at schools and increasing use and attitudes of parents towards sustainable modes can efficiently improve sustainable travel mode use among households. Initiatives promoting cycling might be most effective when engaging mothers, as they are the strongest influencers of cycling behaviors in both children and partners. Efforts to encourage train use should focus on shaping attitudes among mothers/fathers, as they play a key role in determining household perceptions of public transport. Recognizing that different family members play different roles in travel socialization can help design policies that align with real-world behavioral dynamics. Future studies could build on this work by using larger sample sizes and including other household types, such as one-parent households or same-sex couples, or by evaluating how socialization processes occur for other psychological constructs. Including multiple children from households with four or more members also allows for better capture of interactions across different child age groups. Incorporating additional waves in panel studies or extending the time gaps between them could provide new insights into the time-sensitivity of socialization. Beyond the household, it would also be valuable to examine socialization among peers, classmates, colleagues, and within broader social networks, including how friends and social media influencers shape travel attitudes and behaviors. A limitation of the study is that travel behavior is not distinguished by trip purpose, which prevents the analysis from examining whether intra-household attitude and behavior interactions vary across trip purposes. Future research using purpose-specific travel data could extend this framework to assess how household socialization processes differ across travel contexts.

CRediT authorship contribution statement

Milad Mehdizadeh: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Maarten Kroesen:** Writing – review & editing, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Jillian Anable:** Writing – review & editing, Investigation, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tbs.2026.101368.

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