Parental perceptions of transport mode choice for educational trips: A case study of Vallensbæk, Denmark

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SHORT SUMMARY

This study examines children's school travel mode choice and independent travel in Vallensbæk Municipality, Denmark. Previous research has mainly focused on objective determinants, while giving less attention to parental perceptions as behavioural drivers. Three discrete choice models were estimated based on parental survey data of three primary schools in 2024 and 2025: a Multinomial Logit model for travel mode choice, a Binary Logit model for independent travel, and an Integrated Choice and Latent Variable (ICLV) model, incorporating parental perception of children's cycling skills as a latent variable. Distance and grade are the strongest predictors of mode choice and independent travel. The ICLV reveals that latent parental perception of cycling skills enables both cycling and walking, a finding the standard MNL does not detect, and that parental confidence improved between 2024 and 2025, coinciding with the Green Mobility Shift interventions. These results highlight parental behavioural perspectives in school travel research.

Keywords: active school travel, cycling skill, discrete choice modelling, mode choice, parental perception, school travel behaviour

1 INTRODUCTION

The journey between home and school is one of the most common daily travel activities for children, providing not only an important opportunity for regular physical activity, but also contributing to environmental sustainability (Broberg & Sarjala (2015)). However, researchers have documented a dramatic decline in active school travel (AST), such as walking and biking, over the last few decades (Vitale et al. (2019)).
The literature reveals significant geographical differences in how students commute. Most research has been conducted in low bicycle countries, where walking is the only primary active mode. In contrast, countries with a strong cycling culture, such as Denmark, demonstrate high bicycle use, with cycling often serving as the most common mode of school travel (Kaplan et al. (2016)).
Therefore, understanding the preferences and perspectives of children is a critical component of encouraging these sustainable modes, as travel behaviour and mode preferences developed during childhood play a foundational role in shaping travel habits in adulthood (Kaplan et al. (2016)).
It is also worth noting that mode choice is a complex decision driven by a combination of different factors. In this regard, distance is consistently identified as the most critical determinant, with the probability of active travel decreasing sharply as travel distance increases (McDonald (2008)). In general, older children are more likely to use active travel or public transport (Ermagun & Samimi (2015)). Similarly, gender effects on mode choice are context-dependent and are often negligible in places with strong cycling cultures, where boys and girls tend to travel similarly (Wallimann & Balthasar (2026)).
At the same time, parents play a central role in shaping children's mobility. Concerns about traffic danger and personal safety are among the most frequently reported barriers to active school travel, often outweighing the influence of supportive physical environments (Wallimann & Balthasar (2026)). Parents' views of their child's maturity, traffic awareness and cycling ability may therefore be critical in determining whether a child is allowed to walk or cycle to school independently (Scheiner et al. (2019)).
Despite these insights, objective determinants, such as distance, age and the built environment continue to be the primary focus of the literature, whereas subjective parental perceptions remain comparatively underexplored, particularly within discrete choice models. Specifically, little is known about how parental perception of children's cycling competence relates not only to school travel mode choice, but also to children's independent mobility. This is an important gap, because parents act as gatekeepers whose perceptions may directly shape whether children are driven or allowed to travel alone.
To fill this gap, this study examines two related outcomes: children's school travel mode choice and independent travel, with parental perception of cycling competence treated as a key behavioural driver. Using

parental survey data collected across three primary schools, the study provides new evidence on how objective trip characteristics and parental perceptions interact in shaping children's school travel behaviour.

2 METHODOLOGY

The survey data used in this study was collected as part of the Green Mobility Shift project, a Danish initiative aimed at strengthening cycling culture in schools through borrowed bicycles and cycling courses across three primary schools in Vallensbæk Municipality.

Vallensbæk is a small suburban municipality in the southwestern part of Greater Copenhagen, with the highest cycle path density in the Capital Region at 4.49 km per km^2. Parental surveys were collected in 2024 and 2025, with 533 and 528 responses respectively, yielding 1,061 responses.

The survey collected information on the child's school, class grade, gender, perceived cycling skill, distance from home to school, travel mode for the most recent trip to and from school and whether the child travelled independently. Each survey response covers two trips (to and from school), yielding up to 2,122 trip observations, of which 1,897 habitual trips are retained for modelling, resulting in a final estimation sample of 1,876 observations across bicycle, walking and car trips.

Several variable coding decisions were made prior to modelling. Class grades are grouped into five age groups: grades 0–1 (ages 6–8), grades 2–3 (ages 8–10), grades 4–5 (ages 10–12), grades 6–7 (ages 12–14) and grades 8–9 (ages 14–16). Parents were asked to rate their child's cycling ability by selecting one of six options: *Cannot cycle*, *Balance bike/training wheels*, *Closed areas only*, *With adult*, *With peer* and *Independently*. The two lowest categories were combined into a single *Pre-cyclist* category due to small sample sizes ($N = 7$ and $N = 8$), resulting in five levels used in the analysis. Similarly, distance from home to school was reported in five categories: less than 1 km, 1–2 km, 2–3 km, 4–5 km and more than 5 km. The two longest categories were merged into a single 4 km+ category due to small sample sizes ($N = 36$ and $N = 19$).

A Multinomial Logit (MNL) model is estimated for travel mode choice, with bicycle, walking and car as outcome categories and car as the reference, following the random utility maximisation theory. A Binary Logit model is also estimated for independent travel, where the outcome is whether a child travels independently or accompanied, based on the survey question asking parents whether their child travelled to or from school alone.

An Integrated Choice and Latent Variable (ICLV) model is additionally estimated for mode choice, treating parental perception of cycling competence as a latent variable jointly estimated with mode choice via maximum simulated likelihood with 500 quasi-Monte Carlo Halton draws. The model consists of three equations estimated jointly. The structural equation models the latent cycling competence score LV_n as a linear function of observed characteristics plus a normally distributed error term:

$$LV_n = \alpha \mathbf{X}_n + \omega_n, \quad \omega_n \sim N(0,1) \tag{1}$$

where $\mathbf{X}_n$ is the vector of determinants and α the corresponding coefficient vector. The measurement equation links LV_n to the observed cycling skill rating $y_n \in \{1, \ldots, 5\}$ via ordered normal CDF probabilities with four estimable thresholds $\tau_1 < \tau_2 < \tau_3 < \tau_4$. The choice equation follows the MNL structure, with LV_n entering each utility function via factor loadings λ_j for $j \in \{\text{bike, walk}\}$ and $V_{\text{car}} = 0$. The three equations are estimated jointly by maximising the simulated log-likelihood:

$$SLL = \sum_{n=1}^{N} \log \left(\frac{1}{R} \sum_{r=1}^{R} P(j_n \mid LV_n^r) \cdot P(y_n \mid LV_n^r) \right) \tag{2}$$

where $LV_n^r = \alpha \mathbf{X}_n + \omega_n^r$. ω_n^r are $R = 500$ quasi-Monte Carlo Halton draws from $N(0,1)$, $P(j_n \mid LV_n^r)$ is the MNL probability of the observed mode and $P(y_n \mid LV_n^r)$ is the measurement probability of the observed cycling skill rating.

3 RESULTS AND DISCUSSION

The results are presented for the best model specification of mode choice and independent travel. The MNL identifies which characteristics drive mode choice and the Binary Logit examines what determines whether a child travels alone. Independent travel is excluded from the MNL due to endogeneity, as among car users 100% travel accompanied, while 79% of cyclists and 75% of walkers travel independently. An ICLV model is further estimated to address the concern arising from treating parental perception of cycling competence as a directly observed variable in the MNL.

Table 1 presents the odds ratios from the MNL model, where values above 1 indicate a higher likelihood of choosing that mode relative to car and values below 1 indicate a lower likelihood.

Table 1: Multinomial Logit Model Results: Mode choice

	Bicycle		**Walk**	
Variable	**OR**	**p**	**OR**	**p**
Grade 0–1	**0.387**	0.049	**0.104**	0.000
Grade 2–3	0.711	0.278	0.536	0.113
Grade 6–7	**2.617**	0.031	**4.164**	0.004
Grade 8–9	**4.434**	0.006	**14.195**	0.000
Gender (boy)	0.849	0.577	0.633	0.183
Distance 1–2 km	**0.461**	0.003	**0.095**	0.000
Distance 2–3 km	**0.178**	0.000	**0.012**	0.000
Distance 4+ km	**0.042**	0.000	**<0.001**	0.000
Cycling skill	**2.491**	0.000	1.096	0.568
Pilehaveskolen	1.654	0.057	1.756	0.149
Egholmskolen	0.960	0.877	1.630	0.203
Year 2025	1.238	0.331	1.273	0.353
Direction	**1.648**	0.002	**1.707**	0.004
Grade 0–1 × Boy	1.692	0.270	**3.856**	0.019
Boy × Direction	**0.594**	0.005	**0.576**	0.013
N = 1,876 Adj.Rho-square = 0.213				
Bold indicates significance at $\alpha = 0.05$.				

Mode choice is best predicted by distance, consistent with previous literature (Ermagun et al., 2015). As distance increases, the probability of cycling and walking compared to car declines sharply, with the effect more pronounced for walking than cycling. Grade is also a significant predictor. Children in grades 0–1 are much less likely to use active modes, while those in grades 8–9 are more than four times more likely to cycle and 14 times more likely to walk than to drive. Gender has no significant effect, consistent with high cycling culture expectations (Wallimann & Balthasar, 2026). Parental perception of cycling skill significantly enables cycling but not walking. School location and survey year have no significant effect. Children are more likely to use active modes on the return trip from school, as found by Scheiner et al. (2019).

The two interaction terms reveal important gender differences not captured by the main effects. Boys in grades 0–1 are significantly more likely to walk than girls of the same age (OR = 3.856), but show no difference in cycling. Boys are also less likely to use active modes on the return trip for both cycling (OR = 0.594) and walking (OR = 0.576), meaning boys are more likely to be driven home after school compared to girls.

The results of the Binary Logit model on independent travel are given in Table 2, where the outcome is whether a child travels independently or accompanied.

Table 2: Binary Logit model: Predictors of Independent School Travel

Variable	OR	p
Grade 0–1	**0.044**	0.000
Grade 2–3	**0.468**	0.001
Grade 6–7	**3.103**	0.000
Grade 8–9	**4.661**	0.001
Gender (boy)	1.033	0.853
Distance 1–2 km	**0.536**	0.002
Distance 2–3 km	**0.287**	0.000
Distance 4+ km	**0.077**	0.000
Cycling skill	**2.171**	0.000
Pilehaveskolen	1.346	0.220
Egholmskolen	0.885	0.618
Year 2025	1.261	0.194
Direction	**2.035**	0.000
N = 1,876	Adj.Rho-square = 0.423	
Bold indicates significance at $\alpha = 0.05$.		

The strongest predictors of independent travel are grade, distance and parental perception of cycling skill. Children in grades 0–1 are 96% less likely to travel independently than children in grades 4–5 (OR = 0.044), while those in grades 8–9 are nearly five times more likely to do so. As distance increases, the likelihood of independent travel decreases and children who live over 4 km to school are 13 times less likely to travel alone. The positive influence of perceived cycling skill (OR = 2.171) also confirms that the parental perception of cycling competence is strongly connected with the choice to allow independent travel. Gender shows no significant difference, consistent with the MNL results. Children are more likely to travel alone on the return trip (OR = 2.035) and school location has no significant effect.

In addition, an ICLV model was estimated jointly with 37 parameters and 500 quasi-Monte Carlo Halton draws. Results are reported in Tables 3 and 4.
Grade is the dominant predictor of parental perception of cycling competence. Younger children (grades 0–1 and 2–3) are perceived as substantially less competent than the grade 4–5 reference group, while older children (grades 6–7 and 8–9) are perceived as more competent. Year 2025 is a significant predictor ($\alpha = 0.223$), suggesting that the Green Mobility Shift initiative raised parental confidence in their children's cycling ability. Gender, distance and school location do not significantly shape parental perception of cycling competence.
In the choice equation, latent cycling competence significantly increases the utility of both cycling ($\lambda_{bike} = 0.897$) and walking ($\lambda_{walk} = 0.905$) relative to car. Grade is excluded from the choice equation as its effect operates through the latent variable. Distance remains a significant factor in mode choice, leading to the same conclusion as in the MNL model. The significant lambda on walking indicates that parental confidence in cycling ability reflects a broader disposition towards active travel, not a mode-specific effect. All remaining predictors in Table 4 are not significant.

Table 3: ICLV model Structural Equation (Latent Cycling Competence)

Variable	**Coef.**	**p**
Grade 0–1	**-2.652**	0.000
Grade 2–3	**-0.969**	0.000
Grade 6–7	**1.363**	0.000
Grade 8–9	**0.775**	0.017
Gender (boy)	-0.060	0.548
Distance 1–2 km	-0.046	0.699
Distance 2–3 km	-0.348	0.083
Distance 4+ km	-0.260	0.283
Pilehaveskolen	0.163	0.222
Egholmskolen	0.163	0.262
Year 2025	**0.223**	0.019
Direction	0.000	0.999
Bold indicates significance at $\alpha = 0.05$.		

Table 4: ICLV model Choice Equation (Mode Choice)

	Bicycle		**Walk**	
Variable	**Coef.**	**p**	**Coef.**	**p**
Gender (boy)	0.132	0.594	-0.067	0.822
Distance 1–2 km	**-0.854**	0.000	**-2.356**	0.000
Distance 2–3 km	**-1.748**	0.000	**-4.156**	0.000
Distance 4+ km	**-3.372**	0.000	**-11.818**	0.000
Pilehaveskolen	0.435	0.060	0.517	0.096
Egholmskolen	-0.154	0.505	0.400	0.198
Year 2025	0.180	0.315	0.190	0.378
Direction	0.503	0.076	0.546	0.093
Boy $\times$ Direction	-0.531	0.134	-0.567	0.172
λ (Latent cycling competence)	**0.897**	0.000	**0.905**	0.000
N = 1,876 Adj.Rho-square = 0.315				
Bold indicates significance at $\alpha = 0.05$.				

4 CONCLUSIONS

This study analysed school travel mode choice among children in three schools in Vallensbæk Municipality, Denmark, using parental survey data from 2024 and 2025. Distance and grade are the strongest predictors of mode choice and active travel declines sharply with distance. Beyond 2–3 km, both cycling and walking become very unlikely relative to car. Younger children in grades 0–1 are significantly less likely to use active modes, while those in grades 8–9 are considerably more likely to cycle or walk than to be driven. There is no significant gender influence in mode choice, as is to be expected in high-cycling societies. Parental perception of cycling skill is a significant predictor of cycling but not walking. An ICLV model further reveals that when cycling competence is treated as a latent variable, it significantly enables both cycling and walking, a finding the standard MNL does not detect, suggesting that parental confidence in active travel extends beyond cycling-specific skill. The ICLV also found that parental confidence in their children's cycling ability increased between 2024 and 2025, which coincided with the Green Mobility Shift initiative. This suggests that targeted cycling programmes, such as bike borrowing schemes and cycling courses in schools, are effective.

At a more general level, this study contributes to the existing active school travel literature by demonstrating that parental perception of cycling competence is a key behavioural dimension. From a policy perspective, the results imply that initiatives designed to facilitate active school travel should focus especially on younger children, as early support for cycling skill development may help establish active and independent travel habits before car-dependent patterns become entrenched. Such interventions should not only improve conditions for active travel, but also strengthen parents' confidence in their children's ability to travel safely. Future studies may build upon this study by adding perspectives of children themselves and more specific measures of the built environment to better understand how skills, perceptions and independent mobility develop over time.

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