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The influence of external factors on children's travel mode: A comparison of school trips and non-school trips

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ABSTRACT

This study examined travel patterns of pupils from four secondary schools in Austria and Germany. Their mobility behavior was examined using a one-week travel diary in a typical school week. This paper examines objective determinants (in particular settlement pattern and trip characteristics) of mode choice. We used a Bayesian approach for nonlinear Structural Equation Modeling (SEM) of binary response variables to assess the effects of external factors on the choice of travel modes. The focus lies on the competitiveness between car and transit. The results indicate that children's modal choices are influenced by trip length and the service quality of motorized modes. A key finding is that school trips and non-school trips are very different. School trips are quite affine to transit even in rural areas, given a sufficient service quality, which can easily be provided by a school bus system. Long school trips increase the frequency of transit use. Non-school trips, however, are much more affine to car ridership, if trip length exceeds the range for walking and cycling.

1. Introduction

The causalities between the built environment and mobility behavior are a recurrent topic in urban and transportation planning. A wide range of studies examined the effects of different attributes of the built environment on travel behavior. They were systematically reviewed and summarized by several authors. They found that a dense and diverse urban form with good accessibility to local destinations leads to less car use, more transit use, and also more use of the active modes walking and cycling (Badoe and Miller, 2000; Ewing and Cervero, 2001; Ewing and Cervero, 2010; Stead and Marshall, 2001; Whalen et al., 2013). A lot of these studies refer to adults. However, the travel decision making process and framework of children differs fundamentally from the adults' perspective. Children have limited scope of when, where and how they travel, and they are more dependent on adults giving them a lift (e.g. Mackett, 2013; Yarlagadda and Srinivasan, 2008). Nevertheless, during the phase of childhood individual preferences for a certain mode of transport are already developing. For example, a pro-car orientation seems to be acquired from the age of 12 (Flade and Limbourg, 1997). When growing up they get more control over their choices of transport options (Mitra, 2013). The age group in this paper (7th school grade) represents a "transition phase" between childhood and late adolescence: They are much more independent in their mobility decisions than younger children are, but their travel behavior is still influenced by their parents' travel decisions. This is evidenced among other things by the fact that our target group made 49% of the travel decisions by themselves; only 5% were other directed (46% joint decisions).

It is very important to better understand influencing factors on mode choice in this young age group, because the experiences at young age influence travel decisions at adulthood (Mackett, 2001). The last decade has indeed shown an increasing interest in the mobility behavior and mobility needs of children; most of them examined school trips with focus on active modes. Fewer studies took non-school-trips into account (*reference blended*; Fyhri and Hjorthol, 2009; Hjorthol and Fyhri, 2009; Broberg et al., 2013; Villanueva et al., 2012). Several surveys found that the distance between home and school is a key influencing factor on mode choice (Fyhri and Hjorthol, 2009; Ewing et al., 2004; McDonald, 2008; McMillan, 2007; Mitra and Buliung, 2012; Schlossberg et al., 2005; Schlossberg et al., 2006; Wilson et al., 2007; Yarlagadda and Srinivasan, 2008). This is also confirmed by Müller et al. (2008), who revealed that the mode choice of young people aged between 10 and 19 in Germany is most influenced by distance, car availability, and weather conditions. In view of the

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growing public health concerns such as obesity and inadequate physical maturation, medical researchers also put an emphasis on the mobility at a young age, primarily with a focus on active travel modes such as walking and cycling (D'Haese et al., 2011; Larsen et al., 2009; Panter et al., 2008; Pont et al., 2009; Timperio et al., 2006; Van Dyck et al., 2010).

Overall, when compared to walking or cycling, the circumstances of transit choice among children and young adolescents are less known. However, when children get older, their action radius increases (Daschütz, 2006). In this context, it has to be considered that above a certain trip length the use of non-motorized modes is not an option anymore. For this age group also the allowances of parents play an important role. Parents may be especially concerned about cycling because of traffic safety. It should be noted, that the use of transit for longer trips is preferable to escorted trips by car - mainly for environmental reasons, but also because (i) it encourages independent (unsupervised) mobility and (ii) transit trips almost always include at least short stages of walking trips. In this context, the service quality of transit is a critical factor for children's mode choice and also interesting from the planning point of view. Ewing and Cervero (2010) consider the distance to transit as one of six main criteria describing the quality of the built environment relevant to mobility (along with density, diversity, design, accessibility, and parking management). But, the service quality of transit is difficult to measure. The literature suggests several approaches for indirect measurement. Dense population structures are often associated with good transit supply. van Goeverden and de Boer (2013) draw this conclusion, but cannot prove it empirically. Yarlagadda and Srinivasan (2008) found that children living in areas with high employment rates use transit more often and conclude that these areas have better transit services. A more disaggregate indicator is the distance from home to the next transit station, the transit route density, the distance between transit stops, or the number of stations per unit area (Ewing and Cervero, 2010). However, none of these approaches considers the service quality for particular trips. The existence of a transit stop near home does not necessarily mean that one can reach the desired destination at the required time in a convenient way. On the other hand, a properly scheduled school bus can provide a very good service for school trips in an otherwise poorly served area. In response to this problem, we calculated the door-to-door speed for each reported trip using a route planning web application. It yields an indicator for the service quality at the level of single trips.

The research reported here is part of a study which explored (changes of) attitudes and the mobility behavior of pupils over a period of two years. This paper explores how external factors like settlement pattern, trip purposes in terms of school trips and non-school trips, trip length, and service quality of motorized modes influence mode choice and how they affect each other. In the models we controlled for gender and household characteristics in order to remove possible confounding effects with these variables.

In particular, this analysis hypothesizes that

- School trips and non-school trips (mainly leisure trips) of children's everyday mobility follow different rules; as a result, the determining factors of mode choice are also different.
- The trip length has an influence on the used mode of transportation; a longer trip increases the need of motorized means of transport.
- The trip specific service quality of private car use and transit use (or the ratio between the two) influences the decision as to which of the two motorized modes is chosen.
- The settlement pattern influences both aforementioned factors; urban areas have a shorter average trip length, a better service quality of transit, and a worse service quality of private car use.
- Trip length and service quality of motorized modes capture only a part of the variability of mode choice between different locations, because a location stands for many more differences that may influence children's mode choice.

Our interest in the interdependencies between different exogenous factors suggests using the approach of structural equation modelling (SEM), which allows analyzing the causes and effects in a networked sense.

The paper is structured as follows. In Section 2 we describe the sample, data collection as well as the methodology. Section 3 presents the descriptive data analysis and structural equation models examining the relationship between the exogenous variables as predictors and the outcome variables (mode choice). This section also describes detailed analyses e.g. with regard to home-school and school-home relations and with regard to accompaniment. The model results are discussed in context to the research hypotheses. The paper closes with conclusions on the study methodology and results (Section 4).

2. Data and methods

2.1. Sample

Our sample includes 186 children in the 7th grade (average age 13.1) of eight classes, coming from four different secondary schools of a comparable type. The schools were selected along a gradient from central-urban to rural areas (Table 1): School A is located in the densely built city center of Vienna; it is very well accessible with metro, tram and bus. School B at the edge of Vienna is less accessible with metro, but some central tram lines are in short distance; the neighborhood is affluent and less densely built. Regular transit can be used for both school trips and non-school trips. School C is in Tulln, a small town in Lower Austria of 15,000 inhabitants, but with a large catchment area; the school is located about one kilometer from the railway station and is accessible with a very few school bus connections. In the city of Tulln a city bus serves the area (mainly weekday), single regional bus lines serve the wider area. School D is located in Itzehoe, North Germany, a city of 32,000 inhabitants; the school is comparable with Tulln, the catchment area also covers neighboring rural municipalities within a radius of about 20 kilometers. At School D, there are very few bus connections and the next railway station is about 1.5 kilometers away. The region is socially and culturally similar to Austria. With a view to the schools' catchment areas there are no major differences in terms of altitude profiles. One difference with regard to mobility is that the bicycle plays an important role as an everyday means of transport.

It should be noted that there are no explicit 'school busses', although

Table 1
Spatial characteristics of the studied schools.

School	A	B	C	D
Country	Austria	Austria	Austria	Germany
Location	Center of town (Vienna)	Edge of town (Vienna)	Small town in rural area (Tulln)	Small town in rural area rural area (Itzehoe)
Density [inhabitants/km^2]	4983 (urban district)	1361 (urban district)	107 (district)	126 (district)
Accessibility with transit	Very good connections (metro, tram, bus)	Good connections (metro, tram)	Very few connections (busses)	Very few connections (busses)