



## Environmental invitingness for transport-related cycling in middle-aged adults: A proof of concept study using photographs



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### ABSTRACT

**Introduction:** Current evidence on associations between modifiable environmental characteristics and transport-related cycling remains inconsistent. Most studies on these associations used questionnaires to determine environmental perceptions, but such tools may be subject to bias due to unreliable recall. Moreover, questionnaires only measure separate environmental characteristics, while real environments are a combination of different characteristics. To overcome these limitations, the present proof of concept study used panoramic photographs of cycling environments to capture direct responses to the physical environment. We examined which depicted environmental characteristics were associated to environments' invitingness for transportation cycling. Furthermore, interactions with gender and participants' cycling behavior were examined.

**Methods:** Fifty-nine middle-aged adults were recruited through purposeful convenience sampling. During a home visit, participants took part in a structured interview assessing demographics and PA during the preceding seven days, followed by an intuitive choice task and a (cognitive) rating task, which both measured 40 photographed environments' invitingness to cycle along. Multi-level cross-classified analyses were conducted using MLwiN 2.26.

**Results:** Both tasks' multivariate results showed that presence of vegetation was identified as the most important environmental characteristic to invite people for engaging in transportation cycling, even when the amount of vegetation was relatively small. In the bivariate analyzes, some differences between results of the cognitive rating task and the intuitive choice task were found, showing that invitingness measured by the rating task was associated with environmental maintenance and cycling infrastructure, whereas invitingness determined by the choice task was associated with more traffic-oriented characteristics. Moreover, only for the choice task's results, moderating effects of gender and participants' cycling behavior in the preceding week were observed.

**Conclusion:** The present study provides proof of concept that capturing people's less cognitive, more intuitive responses to an environment's invitingness for transport-related

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cycling may be important for revealing environment-behavior associations. If replicated in future studies using larger samples, results of our innovative measurements with photographs, especially those on vegetation, can complete the existing knowledge on which environmental characteristics are important for transportation cycling in adults and could form a basis to inform health promoters and local policy makers. However, future studies replicating our study method in larger samples and other population subgroups are highly encouraged. Moreover, causal relationships should be explored.

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## 1. Introduction

Engaging in transport-related cycling for short trips offers a cheap and non-polluting alternative to the private car (Rabl and de Nazelle, 2012) and may partly solve traffic congestion problems. Furthermore, from a public health perspective, cycling may contribute to preventing several acute and chronic diseases in all age groups (Lubans et al., 2011; Matthews et al., 2007; Oja et al., 2011). As transport-related cycling is easy to integrate into daily routine, it is an ideal target behavior to promote in adults living in the city and suburbs. Designing cycle-friendly environments may thus be beneficial for both transportation and health-related purposes, and collaboration between both research domains is desirable (Badland and Schofield, 2005; Sallis et al., 2004). Increasing transport-related cycling such as biking to work has been incorporated in cross-national and local policies on mobility and health (Pucher and Buehler, 2012; United Nations Economic Commission for Europe, 2002; Vlaams Agentschap Zorg en Gezondheid, 2009). Nevertheless, to inform policy makers and health promoters on how to create supportive physical environments for transport-related cycling, knowledge of its correlates is required. Socio-ecological models state that together with individual attributes, the role of the physical environment is of great importance (McLeroy et al., 1988; Richard et al., 2011; Sallis et al., 2006).

Recent research has demonstrated associations between various characteristics of the physical environment and adults' transport-related cycling. A review on European studies (Van Holle et al., 2012) found that transport-related cycling was positively associated with proximity of destinations (e.g., shops; workplace), as well as with aspects of urban design (e.g., degree of urbanization; walkability components such as connectivity of the street network). Moreover, these findings were in accordance with non-European review evidence (Panter and Jones, 2011; Saelens et al., 2003). However, such characteristics are less useful from a health promotion and policy perspective, as they are intrinsic features of the physical environment and therefore difficult to change. Hence, increasing the knowledge of modifiable physical environmental characteristics correlates of transport-related cycling is desirable.

A first modifiable environmental characteristic that has been studied in recent research is cycling infrastructure. Several studies have emphasized that provision of and proximity to cycling infrastructure (such as off-road cycle paths and on-road cycle lanes) are important correlates of transport-related cycling (Buehler and Pucher, 2012; Dill and Carr, 2003; Lee and Moudon, 2008; Parkin et al., 2008; John Pucher and Buehler, 2008; Titze et al., 2008). Moreover, it has been shown that cyclists have a preference for infrastructure that is clearly separated from motorized traffic (Akar and Clifton, 2009; Buehler and Pucher, 2012; Winters and Teschke, 2010). However, other researchers were unable to find significant associations between cycling infrastructure and cycling to work (de Geus et al., 2008; Evenson et al., 2005). A second modifiable environmental characteristic is safety from traffic. Similar to the inconsistent evidence found for cycling infrastructure, the literature on traffic-related correlates of transportation cycling shows conflicting outcomes. Specifically, positive associations were observed between cycling for transportation and various traffic-related measures, such as lower accident risk for cyclists (Vandenbulcke, 2011; Vandenbulcke et al., 2009); lower road traffic volumes (Foster et al., 2011) and presence of traffic calming elements (Titze et al., 2010). However, other studies did not find associations between transport-related cycling and safety from traffic (de Geus et al., 2008; Ishii et al., 2010; Parkin et al., 2008; Van Dyck et al., 2011). In contrast, a number of studies demonstrated inverse associations, indicating that more commuter cycling was associated with higher volumes of motorized traffic (Titze et al., 2007; Vandenbulcke, 2011). A third modifiable environmental characteristic that has been studied as a correlate of transportation cycling is the aesthetic value of the physical environment. Aesthetics may include aspects of pleasantness, interesting architecture, environmental upkeep, pollution, natural elements, etc. Unfortunately, current evidence on the association of aesthetics with cycling for transportation is also inconsistent. While some studies have found positive associations of transportation cycling with more greenery (Lee and Moudon, 2008; Van Dyck et al., 2012; Wendel-Vos et al., 2004; Zlot and Schmid, 2005) and less traffic noise (van Lenthe et al., 2005), other studies were unable to identify significant associations with aesthetic-related features (De Bourdeaudhuij et al., 2005; Kondo et al., 2009; Van Dyck et al., 2012).

A possible explanation for the aforementioned inconsistencies may be the way in which environmental characteristics are generally measured. In specific, questionnaires are most often used to assess the perceived environment. Although some questionnaires may be valid and reliable tools to assess participants' perceptions of the physical environment, some limitations regarding this measurement method should be acknowledged. Firstly, in questionnaires the environment is evaluated through a series of single items. As a consequence, only separate characteristics (e.g., presence of a cycle path; availability of

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