



Influence of built environment on pedestrian's crossing decision



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ABSTRACT

The objective of this experimental study is to identify the differentiation made by pedestrians, in their crossing decision, between various urban environments, notably in terms of perception of walking pleasantness and safety. This experiment further aims to identify the environmental features that pedestrians take into account and the inferences they develop and use to explain their road crossing decision. Sets of photographs presenting five different environments (city center, inner suburbs, public housing in the outskirts, commercial zone in the outskirts and countryside) were presented to 77 participants divided up into three age groups (pre-adolescents, young and middle adults). Their decision to cross or not, their perception of pleasantness and safety, and the elements they take into account to make a decision were collected for each environment presented. The quantitative results show the pedestrians' perceptions of the pleasantness and safety of public spaces, in terms of walking, largely vary with urban environments. Moreover, the crossing decision significantly varies according to the environment. Pedestrians were significantly more inclined to take the decision to cross in city center than in the other sites presented. The qualitative analysis of the interviews shows that the presence and function of the buildings, the quality of the sidewalks and the marked parking spaces are key factors to explain their crossing decision, by enabling them to infer the density of pedestrians and traffic and the vehicle speed.

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1. Introduction

Providing urban spaces that benefit to all users is a major challenge for urban designers and planners. This concern requires to deal with roadway, roadside and road environment. Such approaches need knowledge on the influence of environment characteristics on users' trips.

Concerning pedestrians, the relation between built environments (street network, land use) and walking or pedestrian flow has been widely studied (Baranes et al., 2005; Marshall and Garrick, 2010; Mitra et al., 2010; Shay et al., 2006). It has also been established that the frequency and seriousness of pedestrians accidents vary with urban density, the function of the zone (residential, business activities), presence of shops, or location in the city (city center, suburbs) (Clifton et al., 2009; Dissanayake et al., 2009; Graham and Glaister, 2003; Wedagama et al., 2006). Of course, these differences come in part from the influences of the environment on important parameters such as the speed of vehicles, that increases the risk

and seriousness of accidents (Aarts and Van Schagen, 2006; Davis, 2001; Pitt et al., 1990; Rosén et al., 2011).

The differentiated effects of urban spaces on pedestrian accidents may also, at least in part, be due to pedestrians' perception and interpretation of the environment and their influence on crossing decisions. Thus, the design and layout of the public space of some built environments (in terms of road accessibility, roadway width, salience of the car in a public space, which is notably influenced by the organization of parking) may poorly match the pedestrians' uses and perceptions of this space (high pedestrian mobility, strong sense of ownership of public space by the inhabitants, very young population). Such a mismatch can lead to a lack of safety for pedestrians (Millot, 2008).

Pedestrians' perceptions of the road environment have been studied by psychologists, with a view to improving risk evaluation (Cho et al., 2009; Mullan, 2003; Underwood et al., 2007), and by urban planners, architects and geographers, with a view to make this environment more favorable to pedestrian (Foltête and Piombini, 2007; Hine, 1996; Livi Smith, 2009) in terms of the feeling of comfort, safety and security. Some of these studies, such as the one by Ewing et al. (2006) dealt with the "walkability" or "walking potential" of public space – i.e. the way individuals

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perceive and assess the street as a walking space. This study looked into the physical elements in the environment that determine the qualities of the urban design (recognizable, readable, open, on a human scale, transparent, unified, rich, coherent and in good upkeep) and can influence perceptions and subjective reactions of pedestrians (feeling of safety or comfort, level of interest). All these studies provide a better understanding of the environmental determinants of pedestrian mobility.

However, the way in which the built environment influences (or does not influence) pedestrian behavior in interaction with other types of users, notably when crossing a street, is not taken into account for now. To the best of our knowledge, no research has yet been carried out to explore the influence of context – and especially road scenes and their representation by the pedestrian – on the pedestrians' expectations and decision making of, as it has already been done for drivers (Fleury et al., 1991). Thus, the previous studies on pedestrians do not enable to determine whether perception and interpretation of urban environments by pedestrians lead them to develop expectations on how the current situation will evolve (notably in terms of foreseeing driver behavior) so as to be able to take faster, better suited decisions when they are faced with a crossing task. Recent work suggests that the environment influences the crossing task through its topographical, infrastructural and regulatory aspects (Bergeron et al., 2008; Chu et al., 2004; Li et al., 2010). Other physical elements in the environment, however, such as the nature and spatial distribution of buildings, pedestrian and traffic density, could influence the gathering of information on the crossing situation and its interpretation, notably concerning inferences on driver behavior (Foot et al., 2006), as well as decision-making when crossing. Empirical evidence on these subjects is likewise limited and a better grasp of the “crossability” of urban environments is needed, in order to act more effectively in terms of prevention, but also of road engineering.

The goal of the present study is to explore the nature of perceptions of the built environment of crossing – both in terms of general feeling (pleasantness, feeling of safety) and in terms of road potentiality to be crossed – and their mobilization by the pedestrians when crossing. The hypothesis is that the presence of a number of elements in the environment – and their type – will influence the information taken in the situation of crossing and the crossing decision-making. It is furthermore assumed that taking into account the elements of the environment requires a conceptual organization (Dubois et al., 1993) in the pedestrian and that it is built by the displacement activity, social interaction, and regular perception of road scenes in the various activities of travel (Van Elslande, 2001). Thus, this conceptual organization depends on the level of experience of the individual concerning the road and its functioning, both as a pedestrian and as a driver.

Given that this field is still little investigated, this research aims: (i) to study the differentiation made by pedestrians between various urban environments, notably in terms of perception of pleasantness and safety (for walking); (ii) to explore the influence of the environment of the crossing site on the crossing decisions of pedestrians, and further to identify the environmental features that pedestrians take into account and the inferences they develop and use when they explain their road crossing decision; and (iii) to examine the effects of the pedestrian experience of participants, but also of their driving practice, on such perceptions and decisions. This study is a first investigation of the role of the environment in the pedestrian's decision to cross in general. The pedestrians aged over 65 were not included, despite their greater risk of accidents (ONISR, 2011), due to the particularities of this age group, particularly in terms of functional limitations (Dommes et al., 2013).

2. Method

2.1. Material

In a preliminary focus group study, 20 photographs of built environments were presented to participants in order to gather their perceptions related to the agreement and convenience of these environments for walking and crossing (Granié et al., 2013). The results of this qualitative study allowed to identify, among these various environments, five main types of urban environments, contrasted in terms of perceptions and inferences made by the participants. The following features were used by the participants of the preliminary study to characterize these types of environments:

- city center environment: wide sidewalks, narrow roadway, demarcation between the sidewalk and the road, commercial activities generating walking but also sojourning of pedestrians, presence of trees;
- inner suburb environment: heterogeneous but continuous buildings, straight alignment of the sidewalk, old and recent housing, some commercial activities;
- public housing environment in the outskirts: parking at the bottom of the buildings, high multi-dwelling buildings, no building continuity, homogeneity of the frame, unclear demarcation between public space and private areas, wide road and wide field of view;
- commercial zone in the outskirts: recent business buildings on the outskirts of the town, wide road, narrow sidewalks, parking spaces;
- countryside environment: few houses, presence of through-traffic, no commercial activity, no sidewalk, abundant vegetation.

For the present experiment, five sites meeting the above-mentioned criteria were selected in different urban regions of the South East of France and were chosen to be unfamiliar to the participants. The experimental material used five sets of five photographs, each of these sets presenting one of these environments (see an example in Fig. 1). Each set, presented on a 297 mm × 420 mm (11.69 in. × 16.54 in.) page, showed left-hand, right-hand and central views of a site, thus providing a 180° view of a street. These photographs were taken from the pedestrian's point of view (height of the view and position on the sidewalk in a pre-crossing position). The photos were taken under normal and daily conditions of use, during working hours but outside rush hours, in order to control the situation presented and avoid overloaded situations that would overly focus the participants' attention (oncoming vehicles located right next to the viewer, for example) and may influence their perception more than the environment.

The situations of crossing in each presented environment were similar: a two-lane infrastructure environment (one lane in each direction), no visible marked crosswalk within 50 m. In French law, pedestrians are required to cross the road on a marked crosswalk when there is one less than 50 m (54.68 yd) from them. In the other cases, they can cross the road while taking into account the visibility, the distance and speed of the vehicles. According to the French law, driver must yield to pedestrians starting to cross or indicating their intention to cross. Thus, crossing the road requires interactions with drivers in any cases. As there was no marked crosswalk less than 50 m from the crossing sites studied, the participants had not to refer to the rules related to such a marking when they decided to cross or not.

On each left-hand view and in all cases, an approaching vehicle was visible, the same one at the same distance from the pedestrian's point of view. The legal speed limit was 50 kph on all urban sites, and 90 kph on the site in countryside environment (this information was not given to the participants). However, as the experiment

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