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Make this detour and be unselfish! Influencing urban route choice by explaining traffic management

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ABSTRACT

Traffic management policies aim to improve traffic flow by influencing the route choice of drivers, therefore preventing traffic jams in crowded cities. With respect to a system-optimum of the traffic network, drivers might have to make small-scale detours. The aim of this article is to encourage unselfish route choice behaviour in an urban context by informing drivers in advance about the objectives of traffic management. Two studies were conducted: (1) an online survey ($N = 244$) and (2) a driving simulation study ($N = 48$). The first study focussed on the general effect of recommendations for routes with longer travel times (system-optimal routes) when traffic management is explained. Other route choice attributes (travel time, red-light duration, time pressure) were analysed as well. Drivers were randomly confronted with 35 route choice scenarios consisting of a main route with certain red-light duration and an alternative route without. Results showed that the compliance with system-optimal routes is increased by around 10 percentage points when comparing the group with recommendation to the group without. This effect occurred independently of the variation of other route choice attributes. The second study aimed to determine if the compliance can be increased even more if drivers receive in-depth information about traffic management and experience 'good' as well as 'bad' recommendations in a driving simulator. Results showed no further effect of these manipulations on route choice. Only decision-making times and subjective evaluation were influenced by in-depth information compared to basic information. Altruism was partly correlated with decision-making. This article shows a novel approach to encouraging drivers to select routes with longer travel times for the benefit of the common good. Drivers' knowledge gap regarding traffic management needs to be closed in order to enhance their understanding of traffic regulations. Finally, results of this research should be transferred to driver models within traffic simulations to estimate the effects on traffic networks.

1. Introduction

Traffic jams in crowded cities result in billions in economic and environmental costs (Centre for Economics, 2014). However, as traffic is still increasing in urban areas, traffic management policies aim to improve traffic flow by influencing drivers' route and mode choice. Although a change of transport modes towards public transport or ride sharing would be the

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best solution, the choice of routes is relevant for drivers who depend on their car. With the assistance of advanced traveller information systems (ATIS), drivers receive travel information and route advice. To improve overall traffic flow towards a system optimal state of the network, single drivers may receive recommendations from traffic management which demand a short detour in the urban street network. Navigation system manufacturers are already giving route suggestions that differ by a few minutes and require small-scale detours. Additionally, in the future, traffic management should also be able to provide alternative routes within a range of minutes through car-2-infrastructure communication and smart traffic lights. In this case, drivers could be selfish with respect to travel time and choose user-optimal, shorter routes instead of recommended system-optimal, longer routes. Introduced by Wardrop and Whitehead (1952), the user equilibrium represents a scenario in which drivers act selfish and minimise their individual travel time. In contrast, the system optimum describes a state of the traffic network where the averaged travel time over all traffic participants is minimized and therefore the capacity of the network is higher. So if the traffic is distributed more efficiently and the degradation of network performance (price of anarchy; Youn, Gastner, & Jeong, 2008) is reduced, overall shorter travel times would benefit all traffic participants. At an individual level, the question arises as to whether unselfish route choice behaviour can be encouraged if the drivers are informed about those mechanisms and the aims of traffic management.

To approach this question, we provide in the following a concise overview of research on route choice and on the impact of ATIS on compliance with route recommendations. Route choice as a navigational task is associated with active decision-making at a conscious level and refers to the level of knowledge-based behaviour when driving (Donges, 1999). Accordingly, this knowledge-based behaviour is dependent on information regarding eligible routes. Besides the influence of classical route choice attributes (Bovy & Stern, 1990), the provision of travel information has a huge impact on route choice. Ben-Elia and Avineri (2015) distinguish between experiential, descriptive and prescriptive travel information. While experiential information about the route characteristics is gained by the driver themselves, descriptive and prescriptive information is offered by traffic management authorities or private providers. ATIS is an example of the latter and aims to inform (descriptive) or redirect (prescriptive) drivers via in-vehicle information systems (e.g., smartphone applications) or public information systems (e.g., variable message signs) and require a free decision. In the case of system-optimal route recommendations, the driver receives prescriptive travel information.

Research on the impact of ATIS has been widely done via questionnaires, computer-based experiments, driving simulators and field implementation (Ben-Elia & Avineri, 2015; Chorus, Molin, & van Wee, 2006a, 2006b). Abdel-Aty and Abdalla (2004) showed that, compared to a situation without travel information, participants in a travel simulator study deviated more often from the normal route when receiving information or route advice. This effect was not very large, with about 5% of the drivers changing their route. Erke, Sagberg, and Hagman (2007) found that about one fifth of the drivers changed to the recommended route if variable message signs were available. In line with this, Peeta and Ramos (2006) demonstrated that, based on roadside, online and mail-back surveys, drivers are highly likely to follow route advice from variable message signs. In addition, compliance with ATIS is highly dependent on the design of travel information (Chorus et al., 2006a). The impact of ATIS is limited by increased familiarity with the routes (Adler, 2001; Ardeshiri, Jeihani, & Peeta, 2015; Shiftan, Bekhor, & Albert, 2011). In addition, Ardeshiri et al. (2015) as well as Abdel-Aty and Abdalla (2004) showed that the probability of choosing the advised route decreases as the travel time of the recommended route increases. Thus, in the case of system-optimal recommendations for routes that require a short detour, it is questionable whether compliance is still high.

Referring to the aforementioned relevance of unselfish behaviour, strategies are needed that influence route choices in situations without clear travel time benefit. Avineri (2009) gave an overview of how to 'nudge' drivers to make decisions corresponding to the aims of traffic management. According to that article, system-optimal routes could be set as defaults and the findings of prospect theory can be used to design travel information. In addition, the presentation of other people's (system-optimal) choices can trigger social learning. A further important aspect is the quality and variety of travel information. Chen, Srinivasan, and Mahmassani (1999) showed that the highest compliance is achieved if the quality of real-time information is high and travellers receive prescriptive travel information. Also, Peeta and Ramos (2006) showed that the highest willingness to divert was achieved if variable message signs presented all information about accidents, expected delays and best detour strategies (independently of onsite-, mail back- or internet-based survey). Furthermore, van Essen, Thomas, van Berkum, and Chorus (2016) concluded in their review that individual-specific travel information should be used as people differ in regard to levels of altruism, loss aversion and sense of equity, for example. We also see the importance of inter-individual differences (especially altruism) and social norms when dealing with unselfish route choice behaviour.

Nevertheless, to promote prosocial route choice behaviour in the long run, we assume that drivers might be convinced to make 'better choices' by understanding the non-commercial and useful work of traffic management. This can be accomplished through theoretical instructions and practical experiences. From a psychological perspective, such an approach aims to enhance the knowledge of drivers, similar to driver education and health prevention. In addition, social norms and altruistic behaviour may be unconscientiously activated if instructions focus on travel time benefits of all traffic participants. This concept of giving theoretical instructions of traffic management was tested in a stated choice study by Kerkman, Arentze, Borgers, and Kemperman (2012). They analysed how drivers' route choice is influenced by being told that the traffic advice is either given by traffic management (focus on system optimum) or a navigation system (focus on user optimum). In addition, the advice should be based either on individual preferences or generic preferences. Results showed that traffic management advice based on personal preferences led to the highest compliance rates.

Besides the main approach of informing drivers about mechanisms of traffic management, this article addresses the special situation of route choice in urban traffic. In cities, traffic lights are important route choice attributes (Abdel-Aty &