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# Dynamic modelling of travellers' social interactions and social learning

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ABSTRACT

Social interaction and social learning are likely to be influential factors in the travel choices made by individuals and the dynamics of these choices. This study aims to understand the influence these social aspects have on travellers' decision making and behaviour. Furthermore, this research seeks to find out the possibility of utilising this understanding to enhance policies on behavioural change. Social interactions, which may due to an interdependent situation between travellers, social information about other travellers' behaviour and communication between travellers enable social learning and social influence processes between travellers. Social psychology theories have been used to provide the underlying framework for the study as well as the methods for analysing the data using the individual and social learning models. This study utilises a laboratory experiment to capture the role of social interactions and social learning in the dynamics of travellers' decision making over time. A major finding of the laboratory experiment is that social interaction and social learning influence individuals' behaviour. However providing more social information makes people behave in a less cooperative way and be more unstable in making choices. It also influences more people to make *contrarian* than *direct* responses. Analyses reveal that people learn individually from their previous experience and socially from other people. It is revealed that *confirmation* (keeping previous behaviour when observed individuals also chose the same choice) and *conformity* (following the choice of the majority) are exhibited whenever individuals have access to social information, and therefore could be incorporated into models of travel choice. These findings elicit some behavioural, policy and methodological insights.



## 1. Introduction

Travellers' decision making and behaviour can be considered as dynamic processes, since individuals can and do change their behaviours over time. The understanding of how travel behaviour develops and changes over time is important in order to improve dynamic models of travel choice, and to identify possibilities for influencing behaviour. A traveller's decision to change behaviour may be due to new information gained from their own experience and/or information and influence from the experience and behaviour of others.

Kitamura et al. (1999) raised the issue of the need when analysing individual behaviour to assess the effects on them of other travellers who also respond to demand management measures. Jones and Sloman (2003) stated that there is some evidence that behavioural changes may be very slow at first, but then accelerate as people observe their colleagues and neighbours changing their travel behaviour. These and other studies indicate that social interaction and social learning may influence travellers' change of behaviour.

Social interaction is likely to influence individuals' behaviour inside a group, or in a wider scope, a society. It also contributes to changes of the broader environment. In his theory of social process, Douglas (1974) stated that the social environment is constantly changing due to the contribution of individuals and groups engaged in social interactions. Social interaction always exists whenever an individual is in an interdependence situation that involves other individuals where their actions affect each other. The scale of interactions may depend on the size of group (or society). In a group, actions of a group member achieve more influence than that within a population, since inside a group there exists a feeling of belonging and responsibility as a group member. In a population, these feelings may not strongly exist.

An individual may expect that other individuals will contribute to a collective action so that she does not need to contribute anything. Olson's (1965) experiment found two factors that can promote cooperation: repeated *social interactions* and *communication*

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among the participants. In a travel choice context, more people might car share to work if they are aware of what others do and this can take place only if some kind of interaction and communication occur between them. A way of communicating through *word-of-mouth* has been identified to allow an efficient social learning process. For example, Taniguchi and Fujii (2007), in their study of promoting a community bus service, found that word-of-mouth advertising through recommendations to friends and family plays an important role in promoting bus use.

There are three levels of social interaction which may influence travellers' behaviour. The first level of social interaction is due to an *interdependent* situation where none of the individuals engaged in a collective action can be excluded from enjoying the benefits/costs of the sum of the individual decisions (e.g. a social dilemma of public road users, where the decision of each user affects not only herself but also the state of the system, hence affects other users). The second type of social interaction happens through *observation* by a traveller of others' choices. This type of social interaction is more direct than the first type but it is one-way and does not involve communication or exchange of information with other travellers. The third type of social interaction is the most direct interaction which happens through *communication* or exchange of information between travellers regarding their travel experience (choices and their outcomes) and/or intentions. The communication in this context covers all possible communicating media, including face-to-face, telephone, video and text messaging. Both the second and third levels of social interaction may be due to the fact that individuals are not indifferent to the outcomes received by others (Messick, 1985) since travellers sometimes take into account and are concerned about choices by other travellers (Van Lange et al., 2000). This study focuses on the first and second levels of social interaction (see Sunitiyoso et al., 2011a for a study involving the third level of social interaction, communication).

Travel behaviour can be seen as a dynamic process that occurs over time and may involve a learning process. Kimble (1961) defines learning as a relatively permanent change in behavioural potentiality that occurs as a result of reinforced practice. Learning is more likely to happen when there is a change in the situational context (or behavioural goal), when deliberation is prompted by information or when the situation is uncertain due to its nature or due to interdependence between people.

The concept of *individual learning* suggests that an individual learns from her past experience and utilises an adaptive decision making process to cope with uncertainty. In another form of learning, *social learning*, individuals learn from others' experiences or observed behaviours. In travel behaviour modelling, the individual learning concept has often been studied (for a review, see Arentze and Timmermans, 2005), while social learning has not been investigated significantly although evidence from other disciplines (e.g. economics and behavioural sciences) have shown that this kind of learning process is influential and important (e.g. Offerman and Sonnemans, 1998).

The lack of understanding of the potential role of social interaction and social learning in influencing travellers' behaviour encouraged the authors to explore the social aspects using a laboratory experiment. This study also aims at understanding the dynamics of behaviour at both aggregate and individual levels when individuals are provided with social information about other individuals' behaviour. The authors aim to answer the following hypotheses: (H1) whether providing more information will change individuals' behaviours in making choice; (H2) whether it will make individuals choose a more cooperative choice; (H3) whether it will make individuals more decisive in making choice; and (H4) whether it will make individuals make direct responses rather than contrarian responses.

## 2. Laboratory experiment

To the authors' knowledge, the effects of social interaction on travellers' intentions and behaviours have not been much explored directly, i.e. by observations of choices in a laboratory or field environment. In the transport field, laboratory experiments have been used to study travellers' choice behaviours, particularly the dynamics of route choice making (e.g. Mahmassani and Jou, 2000; Selten et al., 2004), departure time choice making (e.g. Ramadurai and Ukkusuri, 2007) and the effects of traveller information services or ITS on travellers' departure time and route choice making (e.g. Mahmassani and Liu, 1999). However, the effects of social interaction and social learning on individuals' choice making and behaviour have not been investigated in the transport context.

The laboratory experiment utilises a human–computer interface developed on Z-tree (Fischbacher, 2007), an experimental economics tool that allows the experimenter to design, develop and carry out experiments with features, including communication between computers, data saving, time display, profit calculation and tools for screen layout, as well as communication features. The laboratory experiment simulates a multi-player repeated decision making environment. The experiment is a part of a major study involving a behavioural survey and a series of laboratory and simulation experiments which have been conducted to understand the influence of social aspects on travellers' behaviour (Sunitiyoso et al., 2009, 2011a,b). The hypothetical choice situation used in the experiment is based on the public goods (social) dilemma game, where each participant is requested to contribute to collective goods in order to obtain benefits for all participants, with limited information (controlled by the researchers) on the actions of other participants and their contribution to the social dilemma payoffs. In this experiment, the social dilemma is put in the context of car-sharing based on a real-life situation relating to car-sharing and car-parking in a university setting. Each participant is asked to choose whether to drive alone (*car-alone*) or to share a car with another person (*car-share*) for a trip to the university. Each individual who chooses to car-share is randomly partnered with another participant who also decides to car-share. If the number of car-sharers is not even then an extra traveller is generated by the computer server. Whenever people travel to the university by car, regardless of their choice of travel (car-alone or car share), they have to park their car at the university car park. The car park capacity is fixed and there may not be enough spaces for all cars. If the car park is full, then they have to wait for a parking space. This costs a £3.00 penalty per traveller, reflecting the value of waiting time. There is no guarantee that participants will get a parking space even if they choose to car-share but the chance is higher (since less cars means less competition for finding a space). The participants are given a briefing on the situation prior to the experiment.

The generalised costs of travel (without penalty) for each individual for a trip from the city centre to the university for each mode are: (a) the total travel cost for driving car alone is £3.50, which consists of walking time cost (£1.40), in-vehicle time cost (£1.30) and vehicle operating cost (£0.80); and (b) the total cost of car-sharing is £4.50, which consists of walking time cost (£1.40), in-vehicle time cost (£1.30), shared vehicle operating cost (£0.80/2 = £0.40), and picking up/waiting time cost (£1.40). These costs are roughly estimated based on the DfT's Transport Analysis Guidance: Values of Time and Operating Costs (DfT, 2004) for a single trip by car from Bristol City Centre (UK) to the University of the West of England (UWE) Frenchay Campus via M32. Participants are asked to select between car-alone and car-share. After all participants have made decisions, they are provided with feedback on the outcomes of their individual decisions (travel cost, penalty, and money left). The cost that a participant has to pay does not