



The implications of cross-regional differences for the design of In-vehicle Information Systems: A comparison of Australian and Chinese drivers

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ABSTRACT

The increasing global distribution of automobiles necessitates that the design of In-vehicle Information Systems (IVIS) is appropriate for the regions to which they are being exported. Differences between regions such as culture, environment and traffic context can influence the needs, usability and acceptance of IVIS. This paper describes two studies aimed at identifying regional differences in IVIS design needs and preferences across drivers from Australia and China to determine the impact of any differences on IVIS design. Using a questionnaire and interaction clinics, the influence of cultural values and driving patterns on drivers' preferences for, and comprehension of, surface- and interaction-level aspects of IVIS interfaces was explored. Similarities and differences were found between the two regional groups in terms of preferences for IVIS input control types and labels and in the comprehension of IVIS functions. Specifically, Chinese drivers preferred symbols and Chinese characters over English words and were less successful (compared to Australians) at comprehending English abbreviations, particularly for complex IVIS functions. Implications in terms of the current trend to introduce Western-styled interfaces into other regions with little or no adaptation are discussed.

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1. Introduction

The design and functionality of In-vehicle Information Systems (IVIS) is increasingly being seen by automotive manufacturers as providing opportunities for competitive advantage. IVIS systems address secondary aspects of driving by providing information that supports primary driving tasks. Examples include route guidance and weather warning systems. Commonly grouped within the IVIS cluster are in-vehicle visual (i.e., DVD) and auditory entertainment (i.e., radio, CD) systems (Harvey et al., 2011; Mitsopoulos-Rubens et al., 2011; Young et al., 2011). Historically, the design and development of IVIS has largely focused on the needs and preferences of drivers from Western markets; these systems are now being introduced into emerging markets, such as China, virtually unchanged. It is unclear how drivers from these emerging markets, whose culture, language and driving environment differs substantially from Western societies, will respond to IVIS in terms of their comprehension and acceptance of system features. For IVIS to be used successfully and safely in emerging vehicle markets, their design must, at a minimum, meet the needs and preferences of drivers in these target regions.

The importance of cross-regional or cultural issues in the design of in-vehicle systems has been acknowledged (e.g., Lesch et al., 2009; Lindgren et al., 2008). To appreciate how regional differences influence the acceptability and usability of an interface, key differences between regions both in terms of their driving and legislative environments, and their language and cultural values, must be identified and considered. Culture, by its subjective and elusive nature, has many definitions and there are a number of cultural theories that attempt to define those characteristics or dimensions that differentiate the members of one region or culture from another. These cultural theories include the Pyramid Model (Hofstede, 1980), the Iceberg Model (Hofstede, 1996), and the Onion Model (Trompenaars and Hampden-Turner, 1998). Each of these models considers culture to be comprised of at least an outer surface layer (the directly observable aspects of culture) and a deeper, hidden layer (the intrinsic aspects of culture, outside immediate awareness). The current project drew heavily on the Pyramid model and cultural dimensions developed by Hofstede (1980), as this is one of the most widely used and well validated cultural scales, for which a standardised scale is available as well as cultural rankings for various countries, including Australia and China. As defined for this project, culture is the phenomenon that leads a group of people to think, feel and behave in a common manner.

Although relatively few studies have examined the influence of cross-cultural differences on IVIS design, the potential benefits and

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applicability of culturally adaptive IVIS are being explored in a research program by Heimgärtner and colleagues (Heimgärtner, 2005, 2007; Heimgärtner and Holzinger, 2005; Heimgärtner et al., 2007). This research highlighted a range of cultural differences among German and Chinese users in terms of their user preferences, system navigation styles, driving styles and task management styles that are relevant to IVIS system design. For example, it was found that Chinese users are more likely to prefer greater information speed and density and to work on multiple tasks simultaneously than German or English users. Similar results have also been found by Knapp (2007), where in-vehicle navigation systems specifically designed to suit the mental models of a certain culture (e.g. Germany) were found to significantly impact the ability of people from another culture (e.g. China) to successfully interact with the system, as measured by task completion times and number of unnecessary steps taken. At present, however, there is limited understanding of the nature of observed differences, particularly their causes and impact relative to other factors.

Currently, limited information is available to inform IVIS design for different cultures. With the popularity and functionality of IVIS expanding, further research is clearly needed to explore cross-regional requirements for IVIS design in greater depth and across a broad range of cultures and IVIS features. The inclusion of underlying cultural factors should lead to a better understanding of the origin and extent of regional differences that impact upon IVIS usability and acceptability. To this end, an innovative, multi-study research program was undertaken to identify regional differences in IVIS human–machine interaction (HMI) design requirements and preferences across two target cultures: Australia and China. Study 1 employed a questionnaire to investigate the surface-level aspects of IVIS HMI, including recognition, aesthetic preferences, and comprehension of symbols, labels, input controls, and objects on the interface. Study 2 involved a series of interaction clinics to explore the interaction-level aspects of HMI that may be relevant to regional design requirements. These interaction-level aspects included: input control preferences, information and control layout, and perceived ease of use.

The studies were designed to investigate *regional* differences in HMI design preferences, not only *cultural* differences. Regional differences refer to factors that differ across countries, but that are not necessarily related to cultural values (although they may stem from them). In addition to cultural values, the regional differences considered in the current program included driving environment, travel patterns, and language. Based on previous work (e.g., Hofstede, 2009), it was expected that significant differences between Australia and China would be found in terms of underlying cultural, language and driving characteristics, and that these differences would, in turn, have a significant impact on IVIS design preferences and comprehension.

2. Study 1

A questionnaire was developed to quantitatively measure users' IVIS design needs and preferences, with a particular focus on the surface-level features of the IVIS. Factors that are theoretically relevant to cultural differences in HMI design preferences, including demographics, driving patterns and cultural dimensions, were also assessed, so that any observed group differences could be interpreted in terms of these potential contributing factors. To assess the impact of these factors on user design needs and preferences, a number of surface-level aspects of IVIS HMI were examined, such as the recognition and comprehension of symbols, labels, input controls and functions, aesthetic appeal and control layout preferences. These surface-level aspects of HMI are tangible

and visible, and are therefore appropriate for measurement using a questionnaire format.

2.1. Methods

2.1.1. Participants

Participants were required to be either an Australian or Chinese citizen aged 18 years or over, hold a valid driver licence, live in the Melbourne or Shanghai metropolitan regions, and own, or be intending to purchase, a car in the near future. Participants were divided into those that owned or were intending to purchase one of five vehicle classes (as determined using the Used Car Safety Ratings Vehicle Classification System): light, small, mid-size, large, or luxury. A total of 620 participants completed the questionnaire (300 in Shanghai and 320 in Melbourne).

2.1.2. Materials

The questionnaires used in the two regions were identical, apart from the language used (English vs. Chinese). The questionnaire contained four main sections: 1) Participant demographics; 2) Vehicle ownership and driving patterns; 3) Cultural values; and 4) User design preferences and comprehension.

Given that culture has a range of influences on the way in which people interact with technology and develop expectations and preferences for new systems, cultural values were formally examined in Section 3 of the questionnaire using three standard cultural scales. The Values Survey Module 2008 (VSM 08; Hofstede, 2008) is a measure of Hofstede's seven cultural dimensions, although only the five original dimensions were used in the current study: Power Distance; Individualism; Masculinity; Uncertainty Avoidance; and Long-term Orientation. The two new dimensions (Indulgence vs. Restraint and Monumentalism vs. Self-Effacement) were not included in the current survey because, at the time of the study, they were still experimental and rankings for different countries did not exist for either dimension. The VSM 08 consists of 28 items, measured on a 5-point Likert scale, from 1 = "utmost importance" to 5 = "of very little or no importance". Index scores for each of the dimensions are calculated by tallying the scores of all respondents on a given item and producing a mean (average). The Polychronic Attitude Index (PAI; Kaufman et al., 1991) was used as a measure of individuals' attitudes towards time – specifically their orientation toward polychronicity, which is the degree to which people prefer to do many things at the same time. This scale was included as an individual's attitude toward time can influence preferences for the amount and type of information presented on IVIS interfaces and to what degree they value efficacy in system interactions. The PAI consists of 4 items, each measured on a 5-point Likert scale from 1 = "strongly agree" to 5 = "strongly disagree". Low scores indicate a favourable attitude toward polychronicity. Finally, a 10-item measure of Locus of Control (McDonald et al., 2004) was used. Locus of control relates to assumptions regarding responsibility for positive and negative events, and was used as a proxy measure of the cultural dimension *perception of the environment*. This scale used a 5-point Likert scale from 1 = "strongly agree" to 5 = "strongly disagree". Scores were then tallied to produce an overall locus of control score, with high scores indicating an internal locus of control.

Section 4 of the questionnaire investigated the preferences and expectations of respondents with regard to the surface-level aspects of IVIS HMIs. Surface-level features are those aspects of the interface that are tangible and directly observable (e.g. the physical appearance of the interface). This section contained three sub-sections:

2.1.2.1. Function-matching. The function-matching task was designed to measure respondents' ability to recognise and

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