Effect of Driving Context On Design Dialogue

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Abstract The automotive sector is currently undergoing dramatic technological and sociological advances which challenge the traditional design process, and which appear to require a more intimate understanding of owner needs and desires. The use of a real-time communication link between designers and the people who are in the automobiles could become a key component of an innovative automobile design process. The research described here consisted of an investigation of the influence of driving context (country road, motorway or city road) on the real-time verbal exchange between a driver and a designer who asked questions about the automobile and driving experience. Twenty university students and staff were recruited for the tests. A psychologically optimized question set was prepared, and was deployed with each participant as the individual drove the simulator on the target road. The research confirmed the dependency on the driving context of both the quantity of exchanged words and their semiotic content.

Keywords: automobile, scenario, co-design, human centred design, innovation

1 Introduction

Like most human habitats the automobile is characterized by multiple perceptions, emotions and social interactions. Drivers and passengers "live" and "socially interact" in their vehicles [1]. Given the sophistication of modern technologies and the complexity of modern social behaviors, it would be simplistic to continue to consider the automobile as an environment characterized mostly by the performance of the driving task [2]. A shift in focus away from "human performance" towards instead "human behavior" therefore appears fundamental to design success [3].

To respond to these challenges the concept of an Automotive Habitat Laboratory (AutoHabLab) has emerged [4]. It is a design environment which involves the real-time application of human centered design methods on the road during actual driving [5]. It provides a “virtual design workshop” between the people in the auto-mobile and the designer working from a control room. Ideally, the discussion can be automat-

ically recorded and transcribed, with the resulting linguistic and numerical information providing a helpful database of design feedback and concepts.

The real-time nature permits direct customer interactions which do not suffer the biasing effects of time-from-event and difference-in-context [6]. Memory obstacles to the accurate evaluation of customer emotion such as the well-known "fading affect bias" or "event horizon bias" are thus minimized. The real-time nature permits the evaluation of experiences from short-term memory, rather than attempting to recall the events and feelings from long-term memory. The ability to speak with people during actual driving rather than afterwards may prove to be highly advantageous towards optimizing the automotive experience.

The resulting database of automatically recorded and transcribed information can be used in various manners, with one of the most obvious approaches being to perform a preliminary Discourse Analysis [7] or Content Analysis [8] on the database. The two approaches provide tools for analyzing and summarizing the interactions between the automobile driver and the designer in terms of semiotic events. In either case, the most obvious first analysis step is to perform a word frequency analysis to ascertain the most frequently used words, and to perform a word correlation analysis to ascertain the most frequently pronounced combinations of words within phrases.

The research hypothesis of the study described here was that the driving context (country road, motorway city road) would strongly influence the numerical quantity and the semantic quality of the dialogue between a designer and a person driving an automobile.

2 Scenarios selection

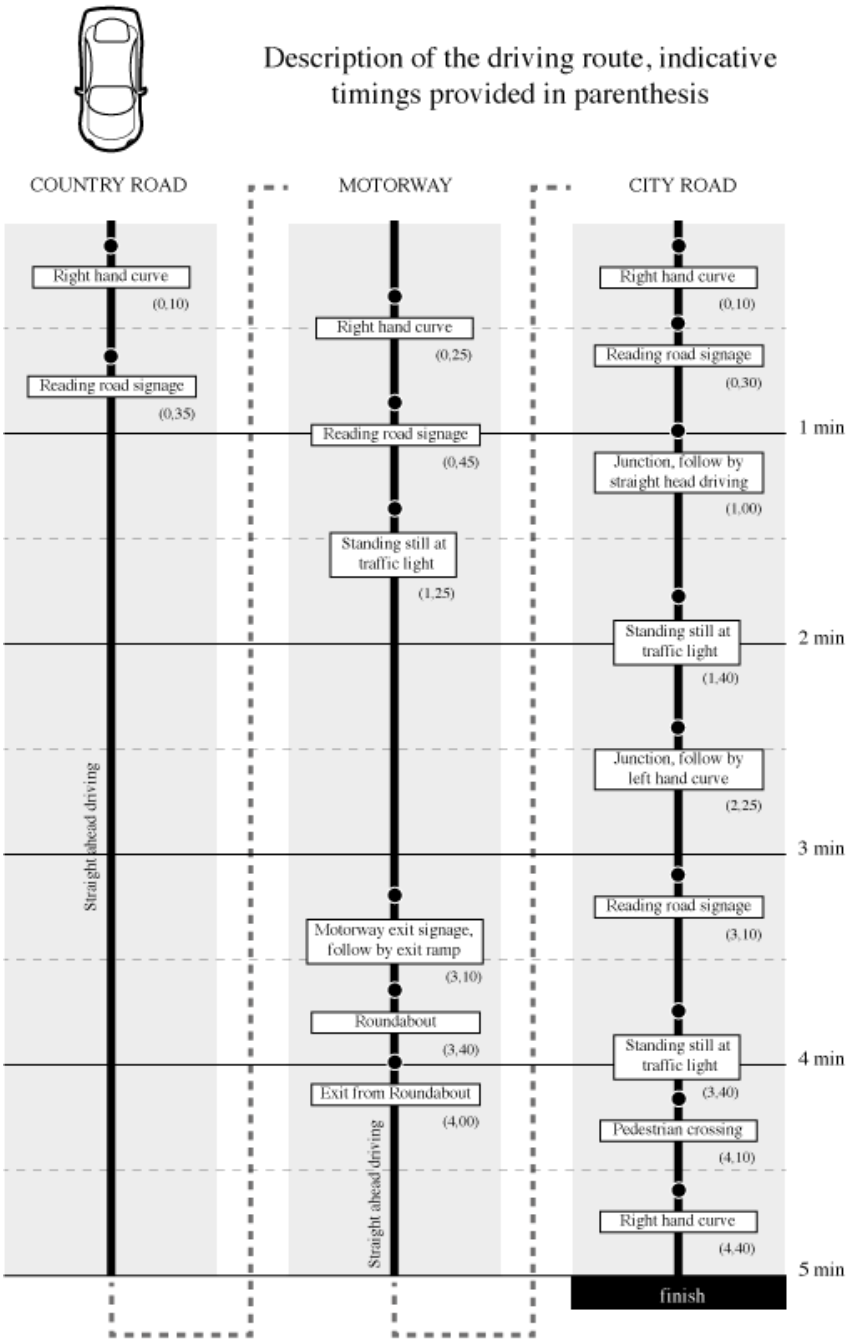
Following traditional automotive industry practice [9] the three most frequently encountered driving conditions of country driving, motorway driving, and city driving were selected as the basis for the study.

For each driving condition a driving scenario was developed which consisted of a series of events involving navigation, route following, traffic lights and automobile control around curves and roundabouts. Each of the three scenarios was developed into a single video sequence of five minutes in length which could be projected within the Brunel University Driving Simulator.

The sequence for each test participant was that of the country road video, followed by the motorway video, followed by the city road video. The video storytelling recounted a hypothetical automobile journey from the country to the city center. The idea behind the storytelling was to increase the test participant engagement and imagination. Figure 1 below presents a representative single frame from each video while Figure 2 provides a schematic description of the "logical structure" or "event structure" of the scenario.

Figure 1. Example driver's view for each of the three driving scenarios.

Figure 2. Driving events for each of the three driving scenarios.



3 Questions selection

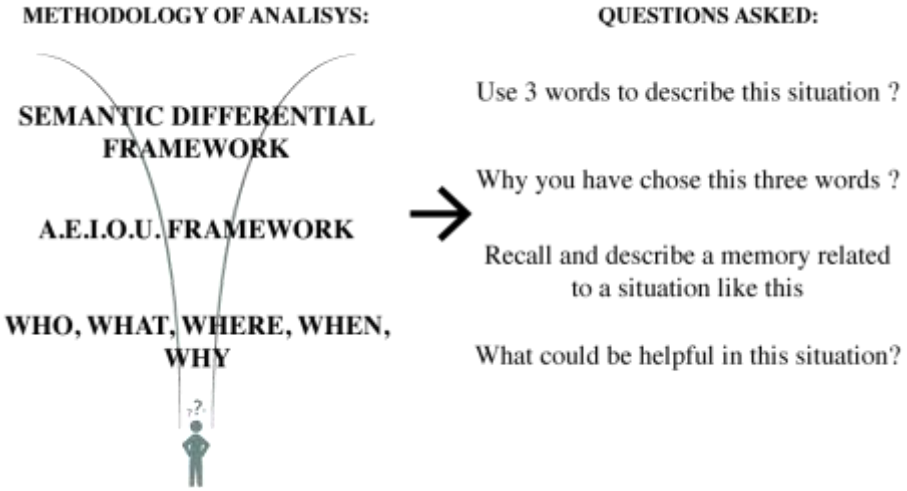
A set of standardized questions was selected for use in the current study by the designer when speaking with the test participant who was driving the simulator. The questions were intended to be representative of the variety of issues which might emerge during an open and creative conversation between an expert in design, marketing or branding and an owner of an automobile who is driving.

A preliminary list of questions was developed and was refined based on a set of criteria which could help towards widening and deepening the conversation. In design ethnography [10] a number of criteria can be applied when evaluating whether a question will help towards providing a balanced and unbiased view of the matter under investigation. Question frameworks that are frequently applied to question selection in design ethnography include:

- Semantic Differential Framework [11];
- A.E.I.O.U. Framework [12];
- Who, What, Where, When, Why [13];

Each of the above frameworks was deployed during question generation and question selection, leading to the final set of reasonably generic questions presented below in Figure 3.

Figure 3. Questions asked to the driver while driving in each scenario.



4 Participants selection

Review of the ergonomic, psychological and sociological literature has suggested that researchers have concluded that the use of 10 participants can frequently be considered sufficient for purposes of qualitative analysis [14]. Given the exploratory nature of the current investigation, it was decided to involve 20 participants.

A total of 20 University staff and students (10 male and 10 female) were selected. Participant age ranged from 21 to 40 years with a mean value of 27.8.

Efforts were made to achieve an equal distribution in terms of the demographic descriptors of gender and age. A constraint which was paced on the recruitment process was the holding of a drivers' license by the participant

The recruitment of participants was conducted internally at Brunel University London. All phases of the recruitment process and of the tests themselves were performed in compliance with the university's ethics policy and with the terms of the specific ethics approval granted by the university for the study.

5 Test facility

The tests were performed in the Brunel University Driving Simulator which consists of a Jaguar S-type body shell and a Toshiba TDP-T95 projection system with 1024 by 768 pixel resolution and 60 Hz refresh rate. The driving simulator uses three screens of 2.4m x 1.8 m with a 105 degree horizontal and 45 degree vertical field of view. Acoustic speakers reproduce the environmental sound (Creative Inspire 5800 sound reproduction system with 40 Hz to 20,000 Hz bandwidth).

The AutoHabLab Control Room is composed of a separate room from the driving simulator itself, and is currently connected to the Jaguar S-type interior by means of microphones. The control room has space to comfortably accommodate up to 6 designers and will eventually be equipped with an extensive set of vehicle dynamic monitoring workstations and driver and passenger emotion monitoring workstations.

6 Test procedure

Upon arriving in the Brunel University Driving Simulator each participant was issued an information and consent form and was provided an explanation of the experimental methods and of the laboratory safety features. Gender, age and driving expe-

rience data were then collected, and the participant was requested to state whether he or she had any physical or mental condition which might affect driving performance or driving opinion.

Before commencing, each participant was asked to remove any articles of heavy clothing such as coats. He or she was then asked to adjust the seat so as to achieve a driving posture that was as similar as possible to the one normally adopted in their own automobile. He or she was next asked to grip the steering wheel using both hands. Room temperature was from 18 to 22° C for all tests.

Considering all activities performed from the moment the participant entered the laboratory the total time to perform a complete experiment was less than 25 minutes. The time spent driving and answering questions by each participant added up to a total of less than 16 minutes, which was considered appropriate in terms of minimizing bias from learning and fatigue effects. For each of the three driving scenarios (country road, motorway and city road) there was a setup time of approximately 30 seconds followed by a driving time of 5 minutes on average for each participant.

A 29 year old male designer asked the four interview questions from the control room in the English language

7 Data Analysis

All voice exchanges between the driver and the designer in the control room were audio recorded, and later fully transcribed. The NVivo software [15] was used as the test database technology and as the analysis engine. NVivo supports quantitative, qualitative and mixed methods research by means of a variety of statistical algorithms and logical tools. Of particular relevance to the current study, NVivo provides algorithms, for performing word counts and between-words correlations. It also provides a number of visualization tools such a Word Clouds.

For the complete experiment the NVivo software was used to perform a full word count analysis and a full between-words correlation analysis across the complete data set consisting of all the conversations with all participants over all the scenarios.

For each individual driving scenario the NVivo software was also used to perform a full word count analysis and a full between-words correlation analysis across all conversations recorded with all the participants in that scenario.

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While not presented here, a multidisciplinary team of four individuals composed of psychologists, ergonomists, and designers also coded the individual statements and performed a standard thematic analysis [16] of the information.

8 Results

Figure 4 below presents the total number of words for each driving scenario recorded for all 20 participants in response to the four questions asked by the designer. The number provided in the figure is the sum obtained by adding all the words expressed in response to each question, for all the questions and for all participants. It can be noted that the city road driving scenario produced the greatest number of words in response to the designer's questions, with the motorway providing six percent less words and the country road providing nineteen percent less words. A two-tailed normally distributed ANOVA performed across the data set suggested that the differences were statistically significant at a 93% confidence level.

Figure 4. Total number of words used by all the drivers for each driving scenario in response to the four questions asked by the designer.

Figure 5 below presents the Word Cloud representation of word usage frequency for each driving scenario recorded for all 20 participants in response to the specific question "What could be helpful in this situation?" which was asked by the designer. It can be noted that the semantic nature of the words changed substantially across the three driving scenarios, with the country road leading to numerous words related to entertainment, the motorway leading to numerous words related to driver assistance and the city road leading to numerous words related to navigation and travel organization.

Figure 5. Word Cloud representation of word usage frequency for all the drivers for each driving scenario in response to the to the specific question "What could be helpful in this situation?".

9 Discussion

The research hypothesis of the study was that the driving context (country road, motorway or city road) would strongly influence the numerical quantity and the semantic quality of the dialogue between a designer and a person driving an automobile. The results of the simulator based study would appear to indicate support for this hypothesis.

With statistically significant differences of up to nineteen percent in the number of words used by the drivers from one driving scenario to another, the driving context would appear to have important effects on the conversation which can be held with drivers in relation to the automobile. This suggests the importance of scenario definition when designing studies to investigate automobile design under real world driving conditions.

Based on the data obtained in the current study it would appear reasonable to speculate that certain driver needs or desires may not be identifiable outside the specific driving scenario which leads to people thinking and talking about those concepts. Knowledge of the workings of the human memory systems [17] suggests their parallel-distributed nature, leading to their responding to simultaneous stimuli from multiple perceptual and cognitive areas. A trivial reading of the current results suggests the need to stimulate contextual cues of relevance to the on-board system which is being designed, if useful customer feedback and suggestions are to be obtained. Co-design and co-creation of automotive products appear to be heavily contextually dependent despite the customer potentially having many years of previous driving experience.

10 Future research

The current research study has not investigated the possible effects of driver cognitive loading or driver emotional state on the linguistic and numerical information which can be obtained via ethnographic interviewing by designers during actual driving. These human conditions would be expected to have a noticeable effect on the quantity and quality of the exchanges between the driver and the designer, and are thus highly worthy of investigation.

The current research study has also not investigated the linguistic and numerical information which can be obtained when operating an automobile under non-steady-state conditions. Transient maneuvers such as parking, stopping at a junction or departing from a junction might be expected to lead substantial variations in word usage frequency and word semantics. Further, non-traditional operational scenarios such as infotainment system usage while the vehicle is stationary might also be expected to lead to substantial variations in word usage frequency and word semantics.

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