Driving Experience and the Effect of Challenging Interactions in High Traffic Context.

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This paper focuses on exploring the emotional experience of driving and aims to identify some of the aspects that may influence this experience. The research stands on the premise that emotions play a significant role in the human-artefact relationship especially during interaction. Designers should go beyond designing suitable or satisfactory interactions and aim to enhance the overall experience of interaction. To do so, it is suggested that design move towards investigating novel aspects of interaction that relate to context and environment of interaction. This may provide designers with knowledge in analysing, interpreting, and understanding the way artefacts affect, influence and enhance human experience in an emotional sense.

To demonstrate, an exploratory study is presented which focuses on the driver's experience during interaction with the vehicle interface while driving in a natural setting. The study is based on a data triangulation approach including interviews, observation, and think-aloud protocol.

The experiments provide encouraging findings, identifying aspects of design which both enhance and detract from the driving experience. Preliminary analysis suggests that context and situation have a dominant impact on the driving experience. Further analysis has shown that challenges with the interface under particular conditions, in high traffic contexts, can bring about positive emotional experiences for drivers.

The paper concludes with implications of the findings to future design of driving interfaces and outlines further study directions.

Driving experience and the effect of challenging interactions in high traffic context

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Abstract

This paper focuses on exploring the emotional experience of driving and aims to identify some of the aspects that may influence this experience.

The paper presents an exploratory study focusing on the driver's experience during interaction with the vehicle interface while driving. The study is based on a data triangulation approach including interviews, observation, and think-aloud protocol.

Preliminary analysis of the study provided encouraging indicative findings, identifying aspects of design that enhance and/or detract from the driving experience. Previous analysis suggests that context and situation have a dominant impact on the driving experience. Further analysis has shown that challenges with the interface under particular conditions, within high traffic contexts, can bring about positive emotional experiences for drivers.

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Keywords: design and emotion, automotive design, observational analysis, experience design, context

Introduction

The car is part of everyday life and the design of the vehicle interface has a great influence on the driving experience in a variety of ways including physical, cognitive and an emotional sense. Research in car design concentrated mostly on the physical and cognitive aspects of driving. Recently research into the emotional aspects of driving has also been conducted in relation to exterior styling (Desmet, 2002) as well as to the broader social aspects of car design (Pelly, 1996). However, there appears to be an opportunity in investigating the emotional experience between a driver and vehicle interface. This is important to consider as design focus appears to be moving towards enhancing human experience rather than just solving a problem (Fulton, 1993).

The aim of the research is to investigate the emotional experience of driving. The intention is to allow users to engage in appropriate positive emotional experiences. To achieve this, an exploratory study was conducted using fifteen participants. The paper presents the findings and discussion and concludes with future study directions.

Experience Design

Within the field of design the trend to investigate emotions has driven various design approaches concentrating on emotional aspect of the user-artefact relationship. 'Experience Design' is one approach which aims to create appropriate positive experiences before, during and after user-product interaction (Moggridge, 1999; Philips, 2001). The position taken by this approach is that users are interested in experiences rather than the product itself (Overbeeke, Djajadiningrat, Wensveen, and Hummels, 1999). Dealing with issues of experience requires dealing with the functional aspects of products, the usability aspects of products and the emotional aspects of product (Jordan, 2000).

Emotions

Emotions have always been part of design and this has led to the design of many emotional products; however the potential exists to explore the various aspects of emotional experience in design. Emotion may be a difficult subject to comprehend; nevertheless, emotional and affective issues of design can be managed to a degree. The idea is not to control the specific emotion a user is going to feel; instead the intent is to design artefacts and systems that give users the opportunity to engage in experiences that are personal, engaging and enjoyable in different contexts.

To identify emotions within the context of this research it was decided to look at Russell's (2003) model of Core Affect. Russell suggests "that at a single moment the conscious experience of an emotion can be seen as a blend of two dimensions: pleasure – displeasure, a measure of feeling, and activation - deactivation, a measure of energy or mobilization. In addition feelings can be neutral, moderate or extreme" (Gomez, Popovic, and Bucolo, 2004). Furthermore, in the original model, Russell suggested the use of particular labels for the different regions of the model. Words like elated, upset, depressed, calm, serene and comfortable were used as

examples for the emotions represented in the regions. This model was used as a foundation to develop the Emotional Chart (Figure 1) used in this research.

Figure 1. Emotional Chart (after Russell, 2003)

Figure 1 illustrates the modified version of Russell's model. The model represented consists of two hemispheres where positive emotions are situated on the right and negative emotions on the left. For example, to articulate the emotion *annoyed*, it would be somewhere between 'neutral' and 'unhappy excited', depending how strong the feeling was. The Emotional Chart was used in the study and formed part of the questions asked in the interviews. The labels were used in the coding system during the analysis stage (Table 1).

Experience Framework

It has been argued that studies relating to the human – artefact relationship have been based on cognitive psychology (Hoff, Øritsland, and Bjørkli, 2002; Nardi, 1996). This approach has been challenged for being too systematic where human aspects and the context of interactivity were overlooked (Nardi, 1996). To design appropriate interfaces for interactive products, consideration must be paid to broader issues of context and emotions (Frascara, 1999).

In this research, activity theory has been considered to support a better understanding of interaction during use. This stands on the premise that interactions occur within a context and artefacts act as mediators of human experience. Several ideas of activity theory are taken into account (Kuutti, 1996):

- Focus on use/activity through time
- Use/activity occur within a context
- People have motives/intentions/emotions

Thus when considering human experience, it is not solely about looking at what happens between user and product, instead it is about what happens between human, product and overall activity within a context (Figure 2).

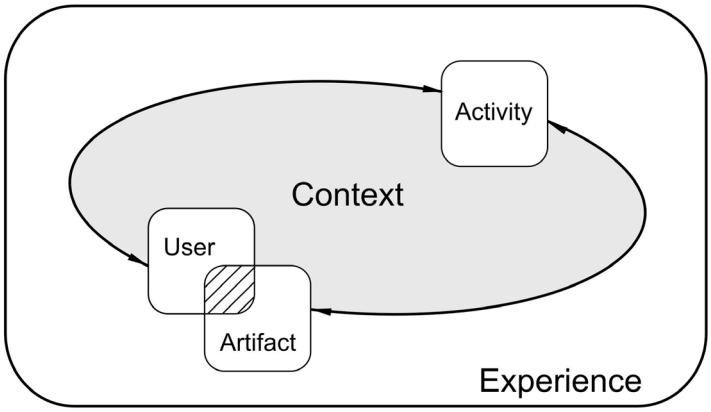

Figure 2. User – Artefact – Activity within context forms experience.

Figure 2 is a graphical representation of experience. It illustrates how (i) a human-artefact interaction does not exist in isolation but takes place within a surrounding context (ii) an artefact is a mediator between the users and their activities. The artefact in this instance is not the ultimate concern; it is merely an agent used to perform an activity (Gomez et al., 2004).

Exploratory Study

An exploratory study was conducted to investigate the driver's emotional experience with a vehicle interface in a driving situation. The objective was to identify aspects that influence the emotional experience.

Participants

Fifteen participants (seven females and eight males) were part of the study. All of them were full-time staff members of Queensland University of Technology (QUT). Every participant was screened to make sure they held a legal Australian driver's licence.

Equipment

The experiments used a Toyota Corolla vehicle to keep the interface consistent. A mini DV camera and tripod located on the back seat recorded the participant's activities in the vehicle as well as audio. In addition, a web-cam was located on the dashboard, which was attached to a laptop positioned on the passenger seat. This camera was used to videotape the participant's facial expressions (Gomez et al., 2004).

Procedure

The study was based on a methodological triangulation (Denzin, 1989) approach consisting of interviews, observation and think-aloud protocol. The advantage of

using a triangulation approach was that each event could be verified from three different avenues; the observation, interview and think-aloud protocol.

Prior to testing, participants were given an information package describing the test, how it would be performed and the purpose of the study. To keep the study consistent, all tests were performed between 11:00am and 2:00pm and followed a similar route around the central business district of Brisbane, made up of a low traffic zone, a medium traffic zone and a high traffic zone. The journey took approximately twenty minutes. The study was set up in three steps consisting of an initial interview followed by the drive itself and finally the retrospective interview.

1. Initial interviews
These semi-structured interviews were primarily aimed at recording the participant's emotional state before the drive (Figure 3). This was done by asking the participants to record how they felt using the emotional chart (Figure 1).

Figure 3. Initial interview prior to driving

2. Observation and think - aloud protocol
During the journey, participants were asked to perform specific tasks, which they could perform in any order at any time (Figure 4). The tasks were:

- Turning on the radio
- Tuning to a specific radio station
- Inserting a compact disk
- Playing song number 10 on the compact disk
- Turning on the air-conditioning
- Adjusting the air-conditioning
- Washing the front windscreen with wipers and water, and
- Washing the back windscreen with water-jet and wipers

The observation component of the study required the participants to carry out a think - aloud protocol during the drive. This involved the participants verbally expressing how they felt about performing each of the tasks. The experimenter was seated on the back seat of the vehicle to help the participants with directions or to prompt them if necessary.

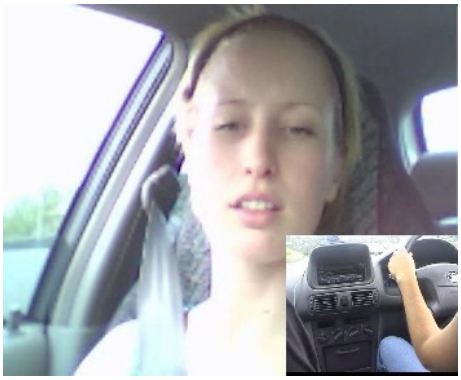

Figure 4. Video still of the drive

3. Retrospective interviews
Following the drive a retrospective interview was conducted (Figure 5). The questions were aimed at gauging the participant's emotional state after the drive and a brief explanation of the reasons. Questions about how they felt regarding each of the activities were also asked.

Figure 5. Retrospective interview after driving

Analysis

The experiments were set-up to measure the emotional response by analysing the participant's bodily expressions in conjunction with their verbal descriptions of their feelings. The observation was used as the main source of information because the affective and emotional system can control human's facial and bodily behaviour, providing clues about the emotional state of the user (Frijda, 1986; Norman, 2004; Picard, 1997). The interviews and think - aloud protocol were used to verify the observations. The coding of the observations was supported by a behavioural analysis computer software program -*The Observer* (v.5).

Since the purpose was to investigate emotional aspects of the experience the coding system used was split into three categories called *Behavioural Classes*; Context, Activities and Emotions. Each *Behavioural Class* contained *Behaviours*, which are used to define each category into more detail. The *Behavioural Classes* and their *Behaviours* are shown on Table 1 (Gomez et al., 2004).

Behavioural Class	*Behaviours*
Context	Low Traffic Medium Traffic High Traffic
Activities	Correct interaction Incorrect interaction Visual interaction (looking at interface) Driving
Emotions	Neutral excited (Concentrated) Happy excited Happy Happy calm Neutral calm (Calm) Unhappy calm Unhappy Unhappy excited

Table 1. Behavioural Classes and their corresponding Behaviours

For example, consider an instance where a participant is driving in a high context area, they turn the radio on and a few seconds later they smile contently as they hear the music coming through the speakers. Figure 6 illustrates a sequence showing an example of the coding used.

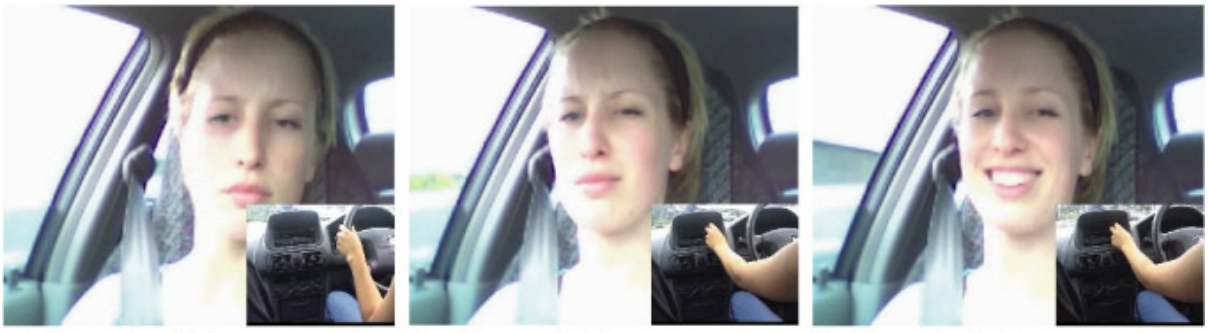

Figure 6. Example of coding sequence.

The software allows the researcher to code the time at which an activity occurred, the *Behavioural Class* (context, activity and emotion) and its corresponding *Behaviour*. The coding for each participant was completed employing the method explained above. This resulted in information that was both detailed and comprehensive. With this type of information the software was able to construct a *time-event table*, which represents the coded information in a table format. Table 2 is a characteristic example of a time-event analysis where the duration of the particular context is seven minutes and the activities and emotions occur within this context.

Start Time (hh:mm:ss)	Participant Code	Behavioural Class	Behaviour	End Time (hh:mm:ss)	Duration (hh:mm:ss)
00:05:35	2	Context	Low traffic	00:06:14	00:00:39
00:05:49	2	Activity	Indirect	00:05:59	00:00:10
00:05:59	2	Activity	Driving	00:06:05	00:00:06
00:06:05	2	Activity	Indirect	00:06:12	00:00:07
00:06:12	2	Activity	Driving	00:06:16	00:00:04
00:06:10	2	Emotion	Unhappy Excited	00:06:14	00:00:04

Table 2. Example of Time-Event Table

The *time-event table* (Table 2) shows the start time of a coded behaviour, the participant, the *Behavioural Class*, the corresponding *Behaviour*, the end time of the specific behaviour and the overall duration of the behaviour.

Findings

The findings presented are early indicators only as the analysis is still in progress. Nevertheless, the findings emphasise the notion that context is critical when considering the overall emotional driving experience. The experiments appeared to highlight two levels of interaction: (i) the micro level, representing the direct interactions between the driver and interface and (ii) the macro level, representing the interaction between the user and interface within a specific context.

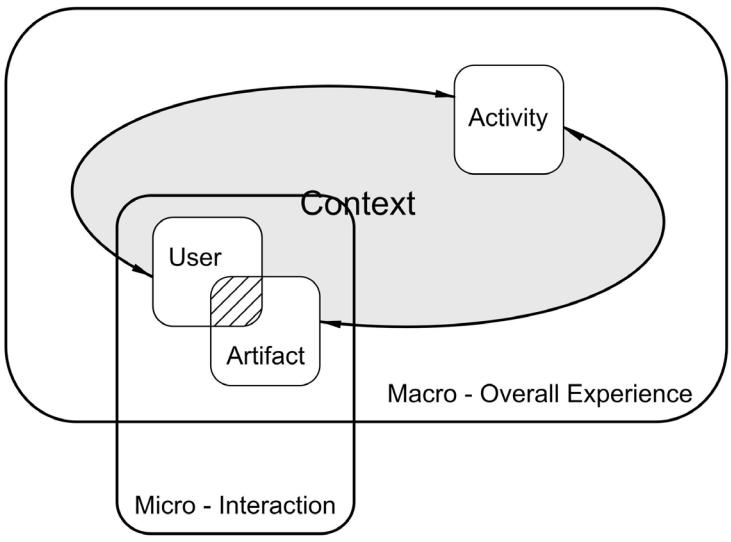

Figure 7. Macro and Micro levels of emotional experience

The macro level is important when considering the driving experience. Emotions occurring at the micro-level are in constant flux; however they do not appear to determine the overall experience. Context is the determining factor on the way the participant perceives and remembers the experience (Gomez et al., 2004).

Further analysis suggests the emotional condition before driving impacted the perceived experience. Results show that females feeling unhappy before driving tend to perceive the experience as positive if they are able to overcome challenging interactions with the interface in high traffic contexts. The female drivers mentioned in the retrospective interview that the experience was like a challenge, which they were able to accomplish. Following are two examples of what some participants stated:

> "…nervous excitement at the start… good that its over…was a challenge…"
>
> "…I get worried about driving so good to do it…"
> (referring to being able to do tasks)

Even though they were annoyed with the interface while driving (micro-level) they perceived the overall experience as positive because they were able to overcome challenges with the interface in high traffic situations (macro-level). The same did not apply to male drivers. These outcomes are based on the analysis of fifteen participants involved in the exploratory study.

For males:

- Regardless how they felt before driving, when they performed few or no incorrect interactions in high traffic contexts, the overall experience was perceived as **neutral**.
- Regardless how they felt before driving, when they performed incorrect interactions in high traffic contexts, the overall experience was perceived as **negative**.

For females:

- Regardless how they felt before driving, when they perform few or no incorrect interactions in high traffic contexts, the overall experience was perceived as **neutral**.
- If felling happy or pleasant before driving and they perform incorrect interactions in high traffic contexts, the overall experience was perceived as **negative**.
- If feeling unhappy before driving and perform incorrect interactions in high traffic contexts, and can overcome them, the overall experience was perceived as **positive**.

Table 3 summarises the findings. It shows the conditions that give rise to the different perceived experiences between males and females.

	MALES		FEMALES		
EMOTIONS BEFORE DRIVE	Whichever	Whichever	Whichever	Positive	Negative
ACTIONS IN HIGH TRAFFIC CONTEXT	Few or no incorrect interactions	Incorrect interactions (but tasks achieved)	Few or no incorrect interactions	Incorrect interactions (but tasks achieved)	Incorrect interactions (but tasks achieved)
OVERALL EMOTIONAL EXPERIENCE	 **NEUTRAL**	 **NEGATIVE**	 **NEUTRAL**	 **NEGATIVE**	 **POSITIVE**

Table 3. Differences between males and females overall emotional experience

Discussion

Analysis of the research data provided three important points in respect to the emotional experience of driving:

- Emotions associated with interactions are in constant dynamic change. These specific emotions do not appear to have an impact on the overall experience by themselves.
- Emotions associated with interactions in high traffic contexts appear to have a significant effect on the overall experience.
- Challenges with interface in particular circumstances can give rise to positive overall emotional experiences.

These suggest context plays a critical role in the overall emotional experience of driving. If incorrect interactions are performed in high traffic zones, feelings associated with them are magnified and remembered, having significant impact on the overall driving experience.

Additionally, the emotional state of female drivers prior to driving impacts the perceived driving experience. If female drivers are feeling unhappy before driving and they are faced with challenging interactions in high traffic situations and can overcome them, they perceive the overall driving experience as positive. The same may apply for males, however it is hypothesised that the testing method conducted did not allow for male participants to appropriately express their emotions. The intent in this case is not to create insurmountable problems with the interface, but to understand that interactions which are challenging or require a certain level of effort to accomplish may impact positively on the experience, depending on the emotional state of the driver prior to driving.

The implications for design are that vehicle interfaces should be able to adapt or change according to the context. Furthermore, vehicles should have the ability to asses the driver's emotional state before driving since this will have an impact on the overall experience. At this stage there are three envisaged suggestions:

1. Drivers feeling content before driving: In high traffic situations the interface should adapt to discourage major interaction, since any incorrect interactions will impact negatively on the overall experience.

2. For all drivers: In low or medium traffic situations the interface may encourage interaction, because interactions occurring during low or medium traffic areas has minimal impact on the overall experience.

3. Drivers feeling unhappy before driving: The vehicle should allow for some challenging interactions during high traffic situations, as this promotes feelings of achievement and satisfaction impacting positively on the overall emotional experience.

At this stage the above are just suggestions and need to be tested more rigorously before concrete conclusion can be made.

Conclusion

The research aimed to explore the emotional experience of driving so as to provide possible directions for car interface designs allowing drivers to engage in positive emotional experiences. Analysis of earlier studies, based on eight participants, indicated that context plays a crucial role in determining the emotional experience attained by the driver (Gomez et al., 2004). Furthermore, analysis of an additional seven participants indicates that if females feeling unhappy before driving are faced with challenging interactions in high traffic contexts, and are able to overcome them, they will perceive the experience as positive. The same may apply for males; however, the findings in this experiment did not confirm this.

These initial findings suggest that positive overall experiences can be achieved through experiences that are challenging in particular circumstances, as opposed to the general assumption that positive experiences come about only through straightforward or effortless interaction with a product (Cheng, 2004; Overbeeke et al., 1999). Nonetheless; at this stage more studies need to be conducted to confirm this conclusion.

From these initial findings, the implications for design are that vehicle interfaces should be able to adapt according to the context as well as take into account the emotional condition of drivers prior to driving. This may be done, by designing vehicles with:

- Context aware interfaces
- Interiors that are sensitive to the emotional state of the driver before driving

This study has opened avenues of possibilities for further research in the area of vehicle interface design. Other studies could be performed during night-time or outer city environments. These different conditions would provide additional knowledge relevant to the emotional experience of driving. Another future research opportunity is to test context aware interfaces, or interiors that are sensitive to the drivers emotional state. Furthermore, it would be interesting to investigate if these findings are transferable to other product types that require interactions in a variety of contexts.

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