Affective Scenarios in Automotive Design:

A Human-Centred Approach Towards Understanding of Emotional Experience

A thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

The automotive industry is facing a period of significant transformation due to the arrival of many new digital technologies. As the focus of automotive engineering has shifted from hardware to software, the conventional processes of making, buying and owning an automobile have changed. Peoples' desires for new automotive experiences are increasing; they demand more sophisticated approaches to the automotive experience beyond merely improving functional requirements for advanced automation systems, interfaces and connectivity. Thus, it is essential to understand human experience in order to help people deal with the high degree of complexity in the driving environment and to help them to cope with unanticipated driving events that involve emotional, psychological or sociological issues.

This research takes a human-centred approach to investigating real-life scenarios in which people emotionally engage with automobiles with the aim of developing a relevant set of scenarios for this context. An extensive literature review was conducted of human emotion, memory systems, emotional memory characteristics, scenarios, and scenarios with emotional aspects, followed by a discussion defining scenario development process and affective scenarios.

This research provides a methodology for in-depth qualitative studies that develop affective design scenarios with automobiles. As a triangulation approach, two independent studies in different settings explored affective scenario themes in automotive contexts of people's real-life car stories that made them respond emotionally. The themes that were revealed from both studies were consolidated, and exemplary scenarios of 13 consolidated main themes were formulated to illustrate a set of affective scenarios in automotive contexts. This research leads to an enhanced understanding of a set of critical contexts that automotive practitioners should take into account for future automotive design. Suggestions with possible questions based on the research outcome provide opportunities for them to agilely cope with unanticipated future events, whereby highly complex driving environment by connected and autonomous vehicles. This methodology used here can be replicated for future affective scenario studies focusing on specific products, sub-systems or services such as navigation systems or car-sharing services. The results, which have been validated through a triangulation approach, can bolster the automobile design process by addressing potential issues and challenges in automotive experience by facilitating idea generation, enhancing a shared understanding of critical contexts and by assisting decision-making among

stakeholders from different departments.

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1 Introduction

1.1 Historical Trends in Automotive Design

Automotive design originated from the human desire for mobility in the early 20th century (Damiani, Deregibus and Andreone, 2009; Spinney, Reimer and Pinch, 2017; Figure 1.1). The increasing demands of mobility accelerated development of affordable automobile through the assembly line production that introduced the Ford Model T in 1908 (Eckermann, 2001). With the mass production of automobiles, automotive design as an independent discipline has evolved alongside interplay between the disciplines of automobile engineering, vehicle performance and form from the late 1920s onwards (Sparke, 2002). From the 1950s, new attention was given to the exterior of automobiles, drawing from the perception of automobiles as symbolic icons for expression of upper-class status (Inserra, 2016). Continuous experimentation with multi-coloured exteriors reflected the shift in human needs from basic mobility to an elegant exterior, styling and aesthetics. New concerns with safety and fuel efficiency led to developments in interior design and ergonomics from the 1960s to the 1980s (Inserra, 2016). As a result of the increased focus on interior design and ergonomics, various functions were added to automobile design that related to driver comfort, focus and performance, which then became competitive requirements for manufacturers of all new automobiles (Spinney, Reimer and Pinch, 2017). At the beginning of the 21st century, the proliferation of the Internet and mobile technology (Digital Preservation Management, 2015) boosted the development and integration of digital features in automobiles. Accompanying the expansion of capabilities for communication, entertainment and information access, the focus of automotive design moved towards driver experience (Sheller, 2004; Damiani, Deregibus and Andreone, 2009).

1.2 New Digital Technologies and Trends

In the early 21st century, new digital technologies rapidly transformed the automotive industry with

the introduction of the concept of in-car connectivity (Barra, 2016). A variety of features for conversation, entertainment and information enabled by Internet and mobile technologies began to be available in automobiles, such as voice-activated entry and ignition, Bluetooth and digital music systems (Sheller, 2004). Indeed, with the benefit of GPS technologies, GM's OnStar system introduced safety services with sensors embedded into the automobile (Grabianowski, 2009). By automatically sending the vehicle's location to call centres in emergency situations, the OnStar system opened up a new driving experience that connected information streams and services to the automobile (Nobel, 2013).

By the mid-2000s, the rapid growth of smartphones expanded the capabilities of connectivity, introducing infotainment applications within the car (Massy, 2007). As driver's 'brought-in' their personal phone to the car, this enabled them to access any entertainment content on-the-go (Microsoft News Center, 2012). Furthermore, Internet-connected automobiles can now communicate and share data, not only with smart devices, but also with infrastructure in which multiple sensors are embedded (Ninan et al., 2015). McKinsey (2013) has forecasted that the number of Internet-connected automobiles will rise on average by 30 per cent a year until 2020, while the number of traditional automobiles will only increase on average four per cent a year in the same period. One in five automobiles will be wirelessly connected to the network by 2020 (Davidson, 2015), making various network-based services, such as Internet radio, information, entertainment and driver-assistance apps available within automobiles.

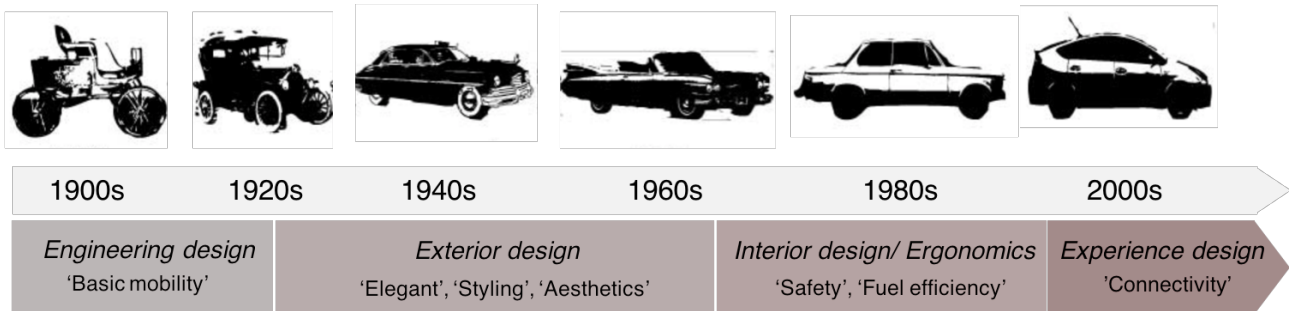


Figure 1.1 Automotive design evolution (adapted from Damiani, Deregibus and Andreone, 2009; Hilke, 2011).

Automated driving is considered to be one of the major potential shifts in the automotive industry due to its estimated huge impact on the economy and society (Milakis, Arem and Wee, 2017). The

annual economic and social benefits of connected and autonomous vehicles (CAVs) could be approximately £51 billion, generating over 30,000 jobs by 2030 (KPMG, 2015) (Figure 1.2). It could impact on growth in the GDP and prevent serious accidents in the UK. It is estimated that the market for CAVs in the UK will be worth £28bn by 2035, capturing 3 per cent of the £907bn global market (Transport Systems Catapult, 2017). Recent forecasting has estimated that, by 2027, all UK produced vehicles will have at least conditional automated technologies known as Level 3 automation, and this is estimated to progressively reach 25 per cent penetration of full automation known as Level 5 automation by 2030 (KPMG, 2015).

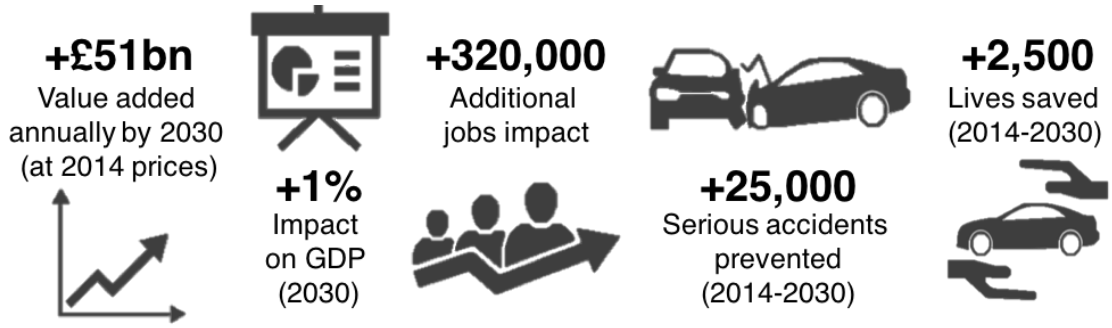


Figure 1.2 Economic and social impact of connected and autonomous vehicles (adapted from KPMG, 2015).

Rapid development of connected and autonomous vehicles has shaped the role of the automobile from that of a 'passive transport machine' for moving from point A to B, to that of a 'smart object' (Eichler, Schroth and Eberspächer, 2006). The concept of an automobile is said to have shifted from hardware to software, and from object to experience (Rousseau, 2015), adding multiple purposes such as communication, entertainment, leisure and business (Merchant, Schlaff and Pankratz, 2017).

These shifts aligns with the characteristics of the millennial generation, who were born between 1977 and 1994 (Williams and Page, 2011) and have grown up with digital technology. The phenomenon of a desire for experiences is particularly pronounced in this generation, which has become the fastest growing buyer segment (Kurylko, 2017). 'Rent, stream and experience' (Bradshaw, 2014) are some keywords that encapsulate their attitude to consumption and expectations of automobiles (Niewiadomski and Anderson, 2017; Warton, 2017). According to data from J.D Power and Associates' Power Information Network (Kurylko, 2017), 4.1 million

automobiles were sold to millennials in the United States in 2016; they are predicted to represent around 40 per cent of the U.S. new-automobile market by 2020 (Kurylko, 2017).

The rise of this powerful buyer group has highlighted the need for an in-depth understanding of human experience. The pursuit of better experiences in an automobile, as enabled by the connected digital environment, is continuously growing beyond the needs of basic mobility, exterior styling, and comfort and safety. An automobile is deeply, emotionally embedded in day-to-day life, as described by the phrase, *'We don't just use technology; we live with it'* (McCarthy and Wright, 2004). To better capture human experience, the following observation regarding how people remember their engagement with automobiles emotionally appears to be significant. According to Harvard Business Review (Magids, Zorfas and Leemon, 2015), a good understanding of emotional connection to products or services can yield high benefits in profits and customer retention, leveraging experience across sectors. Investigating emotional triggers that lead to customer's positive thoughts and profitable behaviour is thus considered to be crucial for every business. Indeed, experience can only be fully understood and designed through multi-layered contexts that are shaped by individual's emotions, thoughts and actions (Dewey, 1980; Desmet and Hekkert, 2007; Hassenzahl, 2010).

1.3 The Role of Emotion

Emotion plays an integral role in experience that interconnects thoughts, attitudes and behaviours (Gomez, Popovic and Blackler, 2011; Hanington, 2017). Emotion is a key driver of processing information to the experiential system, while logic performs the same function for the rational system (Epstein, 1994). Psychologists have shown that, when humans have experiences, their emotional system triggers their thoughts and actions (Nass et al., 2005). Therefore, emotion should be considered to be a central factor of cognitive processing or physical interaction (Hanington, 2017; Gomez, Popovic and Bucolo, 2004).

Although there are several theories of emotion that define different mechanisms of emotion elicitation, the process involves an interrelationship between emotion, cognitive process and physical interaction. In one view of the phenomenon, emotions may be elicited through individual's cognitive appraisal of specific concerns and product stimulus (Figure 1.3). When a

stimulus meets an individual's concerns – such as goals, standards and attitudes – the stimulus is appraised as positive, and the positive appraisal then evokes positive emotions. In contrast, a stimulus that does not match with an individual's concerns causes negative appraisal that leads to negative emotions. This mechanism needs to be more broadly understood though the interaction of three variables: appraisal, concern and product (Desmet and Hekkert, 2007). In a given interactive context, emotions are elicited when events stimulate a response (Scherer, 2005). From this perspective, awareness of a context that is environmentally, socially, culturally or internally influenced encompassing diverse aspects, appears to be significant in understanding emotional responses.

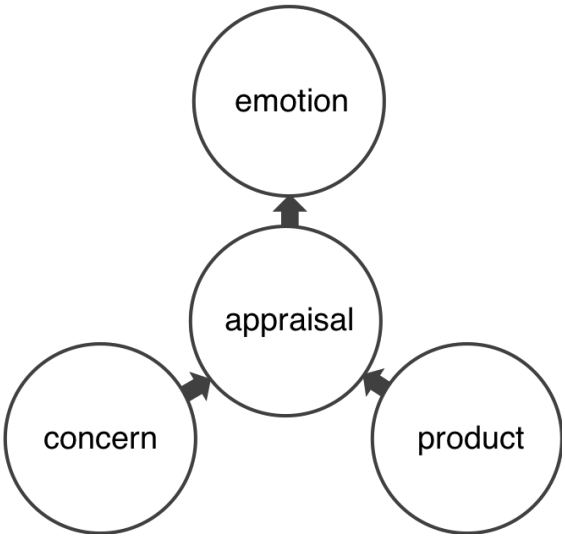


Figure 1.3 Basic model of product emotions (adapted from Desmet, 2002).

The significant role of emotion has been demonstrated in the complex driving context. Drivers' emotional states are likely to be influenced by various pieces of information from digital technologies, with possible impacts on behaviour and safety (Foen, 2012). Research (Lajunen and Parker, 2001; Foen, 2012) suggests that drivers are more likely to make risky decisions when negatively affected by emotions such as anger or frustration, potentially leading to accidents. Beyond issues of in-car context, emotion also plays a decisive role in building a bond between people, automobile and environments, which potentially leads to future car consumption or lifestyle habits with a car (Sheller, 2004):

> *The 'dominant culture of automobility' (Urry, 2000) is implicated in a deep context of affective and embodied relations between people, machines and*

> *spaces of mobility and dwelling in which emotions and the senses play a key part (Sheller, 2004, p. 221).*

While the emotional impact on driver behaviour has been studied extensively in the past, systematic investigations focusing on a complex automotive context that creates emotions are limited. An in-depth study of automotive contexts is thus necessary to gain a profound understanding of why certain emotions are elicited.

1.4 The Role of Context: 'Scenarios'

Because emotions are linked to the appraisal of an object, person or events taking place in an interactive context, it is important to use scenarios approach to help understand emotional context. A scenario is a contextual story that is a narrated description illustrating a sequence of events (Kahn and Wiener, 1967), an interaction between people and an artefact (Carroll, 2000) or possible future (Ogilvy and Schwartz, 1996). Despite the multiple connotations of the term 'scenario', the common idea is that it describes a certain context dealing with cause and effect. The scenario plays an important role in learning, planning and developing communication tools through the analysis of cause and effect within a context. For example, scenarios illustrating the event of the oil shocks were used to learn the lessons of the case, anticipate possible price shocks and communicate decisions among stakeholders in the 1970s (Wilkinson and Kupers, 2014). Scenarios are used in computer-system and software engineering to observe stakeholder's behaviour or attitudes in their interaction with systems. At the most fundamental level, scenarios offer people a tool for understanding human experience because the human storytelling approach situates people within a context (Alexander, 2004). A scenario designed from a certain person's point of view and involving their specific feelings can provide appropriate contextual information and greater opportunities to explore ideas (Goodwin, 2010) by:

> *Putting on the shoes of the people you've created, and looking at their problems and your solutions through their eyes (Kuniavsky, 2003, p. 149).*

Meanwhile, scenarios in the automotive domain have frequently been used to evaluate specific functional tasks related to driver and vehicle performance (Burnett, 2009; Stevens and Burnett, 2014). For example, typical automotive scenarios provide driving conditions (e.g. traffic, weather,

road types) for system performance testing (Safespot, 2006), such as pre-collision systems (Chien et al., 2014) or embedded systems integration (Davis, Patron and Lane, 2007). Concerns, however, have been voiced regarding whether existing automotive scenarios help to answer automotive design questions that are emotional, psychological or sociological (Gkatzidou, Giacomin and Skrypchuk, 2016). Further, it has been noted (Gkouskos, Normark and Lundgren, 2014) that current standardised automotive scenarios seem to be of little benefit to the design of automotive products, systems or services, due to their strong technical and task-based focus. In addition, emotion has been considered to be relatively less important, owing to the action-focused and task-based automotive stories in the available design scenarios. These do not adequately fulfil the expectations and growing demand for digital connectivity or manage the challenges of a complex automotive environment. Difficulties in answering some questions – such as why people respond emotionally in a certain situation and how to tackle potential issues to maximise a pleasant experience – have also arisen.

Further research investigating automotive contexts that trigger emotions is thus required. Awareness of the importance and current limitations of design scenarios in the field of automotive design motivates this research investigation. Through this research, emotion based design scenarios will be better able to support the automotive field and facilitate its uptake by automotive practitioners for testing or evaluating automotive products, system and service concepts.

1.5 Research Questions

This research was motivated by the belief that there is a need for an in-depth understanding of human experience in the automotive industry. To acquire such insight, this research focuses on the emotional context beyond the driver's physical activities. The aim of the research is to identify a set of affective scenarios – the emotional contexts that involve humans' various affective responses including emotions, feelings or moods with automobiles. To achieve this aim, key requirements of automotive scenarios will be explored by identifying human desires regarding automobiles in a complex digital environment. Furthermore, this thesis will provide an operational definition of the affective scenario and a scenario development process through the analysis and synthesis of the relevant literature on scenarios. Finally, a set of affective scenarios will be developed through a combined result collected across different settings. Therefore, the key research questions of this

thesis are:

- Research Question 1. How can an affective design scenario be defined?
- Research Question 2. How is the automotive experience with digital technology be related to emotional aspects?
- Research Question 3. How can an 'affective design scenario' be developed in a complete and rigorous manner?
- Research Question 4. What are the typical 'affective design scenarios' in automotive contexts?

1.6 Research Outcome and Future Application

The research outcome will highlight the importance of understanding various automotive contexts to which people emotionally respond and will propose a research basis for the creation of complete experiences in future automotive designs. The contribution of the research is two-fold: a methodological contribution (the process) and an artefact contribution (the scenarios).

This research will provide a methodology for in-depth qualitative studies that develop affective scenarios with automobiles. The presented methodology could be replicated to identify affective scenarios of specific products, subsystems or services (e.g. the navigation system or car-pooling service), providing more detailed and relevant contextual information on the actions, thoughts, places and agents involved.

The resultant research outcomes could be used to facilitate a discussion in the early design process regarding possible automotive concerns that involve emotional and sociological factors beyond functional road conditions, such as road types and traffic. The use of affective scenarios in the discussion could lead to a series of design questions focused on complex issues related to automobiles that might arise when humans are surrounded by an advanced digital environment and connected vehicles. This could be applied to the formulation of automotive design guidelines or checklists for concept testing of automotive products, subsystems or services.

1.7 Thesis Structure

The research in this thesis was designed and conducted in three phases: definition, exploration and development. Each phase was the subject of a major study. The first phase involved a literature review of human emotion and human memory systems and of the context – using scenarios, and a preliminary case study on automotive experience with the use of digital technologies. The second phase involved preliminary workshops on automotive scenarios to structure the main studies of the research in the thesis, the first scenario study in the online setting and the second contextual scenario study in a driving simulator setting to explore affective stories with automobiles. The third phase of the thesis contains the development of affective design scenarios in automotive contexts.

The thesis comprises 10 chapters that describe the research process undertaken to formulate the automotive affective design scenarios. Chapters 1 through 10 are summarised as follows:

- Chapter 1 provides an overview of the historical trends in automotive design, new digital technology and trends, and the role of emotion and scenario. The research questions, aim and objectives, research outcome and future applications and an overview of the thesis structure are addressed.

- Chapter 2 provides a systematic literature review of theories of emotion, definition of affect, human memory system, memory forgetting and ageing, memory retrieval and cues, and characteristics of emotional memories.

- Chapter 3 provides an extensive literature review of scenario usage and definition, scenario role and concern in automotive design, and the development process. Furthermore, an operational definition of scenario is introduced through the analysis and synthesis of existing definitions.

- Chapter 4 identifies the relationship between the individual's experience with an automobile and their emotional response by analysing contextual interviews with 18 participants, resulting in an operational definition of 'affective design scenario'.

- Chapter 5 identifies the key requirements in automotive design through a preliminary semi-structured interview study with 32 participants, which explores human desires in an automotive context, particularly focusing on digital device integrations. It reveals the importance of considering various human aspects, including emotional factors, in automotive design, providing the rationale for the conducted studies.

- Chapter 6 reports on a preliminary study for online questionnaire development. Two independent preliminary workshops investigating either driving or non-driving scenarios are carried out, in order to structure the main scenario identification activity. The questionnaire developed is pilot-tested and iteratively edited.

- Chapter 7 reports on an online study, in an uncontrolled setting, in which data is collected from 211 participants regarding individual's car stories that focus on something that occurred that made them respond emotionally. All responses from participants are based on long-term memory related to their cars as a driver or as a passenger, without prompting of context and state.

- Chapter 8 reports on a contextual study in a driving simulator setting, in which 34 participants give individual car stories that involve their emotions. Considering the benefit of context and state dependent memory, a controlled simulator operating in a pre-planned driving context that could evoke either positive or negative emotions was required.

- Chapter 9 provides an integration of themes from the scenario studies and exemplary scenarios of each of the main themes. Each stage of the scenario development process for this research is specified to illustrate how the typical scenario was formulated.

- Chapter 10 summarises the key findings against the research questions, describes research limitations, and suggests applications for further research.

2 Human Emotion and Memory

2.1 Human Emotion

2.1.1 Introduction

A systematic literature review of theories of emotion was performed using a set of search combinations, which took into consideration academic research from various perspectives in the area of defining and studying emotion, with the aim of forming a better understanding of what emotions are and what processes help elicit them. The chosen keywords were as follows: emotion/human emotion/emotional states AND theory/history/research/development. Ultimately, 64 books, journal papers, published articles from IEEE Explore, Google and Google Scholar were reviewed. In order to better understand how theories of emotion could work in the automotive context, only literature that provided different theories and definitions of emotion were reviewed and considered. The primary selection criterion — 'Does literature introduce theories and definitions of emotion?' was applied to determine relevant material to be reviewed. The following chapter presents a review of different theories of emotion that are most relevant to this thesis.

2.1.2 Theories of Emotion

Although the term emotion is frequently used in everyday language, there is no universal consensus on emotions, because of a century-long on-going debate over the meaning because of the inherent fuzziness that comes from different perspectives (Scherer, 2005; Jeon, 2017).

Many emotion theorists view emotions as discrete categories that are biologically classified and universal to all humans (Ekman, 1977). Discrete emotions are known as the standard description of basic emotions today: anger, disgust, fear, happiness, sadness and surprise (Ekman and Friesen, 1971, Figure 2.1 (a)). On the other hand, emotions are also viewed as dimensional categories that are a combination of several psychological dimensions (Russell, 1980). In Russell's circumplex model (Russell, 1980; Posner, Russell and Peterson, 2005, Figure 2.1 (b)), emotions are mapped in a circle according to their valence and activation (or arousal). Valence indicates how positive or

negative the affect experience is, and activation indicates how arousing the experience is.

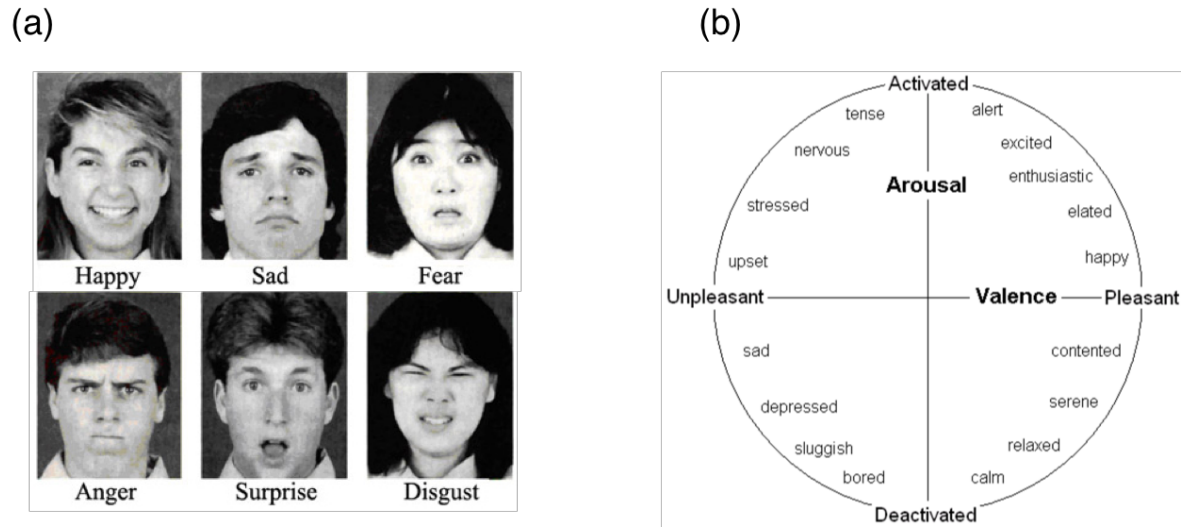


Figure 2.1 (a) Discrete six basic emotions (Ekman and Friesen, 1971), (b) Dimensional model of affect (Posner, Russell and Peterson, 2005).

In addition, the role of physiological arousal in emotions can be another way to define theories of emotion. Figure 2.2 describes three different theories of emotion. In 1884, the James-Lange Theory proposed that the emotion is the result of physiological arousal. As felt emotions can be labelled by recognising automatic bodily response and arousal, different emotions may be experienced by different patterns of arousal. This view is similar to non-cognitive theories by Ekman (1977) and Griffiths (1997), in that emotion response (autonomic physiological arousal) is directly connected to the perception of the stimulus without any evaluation or appraisal of the stimulus.

In contrast to James-Lange Theory (1884), Walter Cannon and Philip Bard (1927) proposed that emotions and physiological arousal occur simultaneously. According to LeDoux (2000), it is felt as if emotions are accompanied by arousal due to the fast speed of the process in creating a physical response in the limbic system with the perception of the stimulus.

Schachter and Singer's two-factor theory (1962) argues that a combination of arousal and cognition creates emotion. In the Two-Factor Theory, emotions are determined by a cognitive appraisal of the same arousal, which is one of the earliest cognitive theories. Whereas different patterns of arousal are examined in James-Lange Theory, Two-Factor Theory emphasises that the arousal is basically the same, but emotions may be differentiated by cognitive appraisal in

accordance with how the arousal is labelled. The cognitive components play an essential role in determining emotional responses in the early part of the emotion process (Izard,1992).

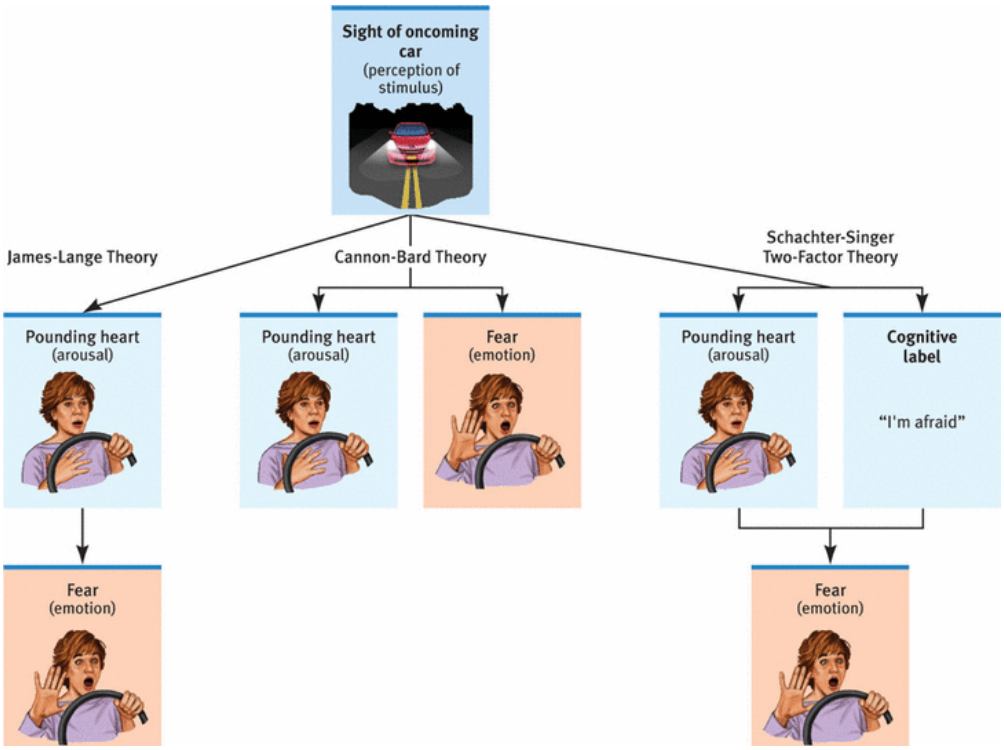


Figure 2.2 Three different theories of emotions by James and Lange (1884), Cannon (1927) and Schachter and Singer (1962) (adapted from Iverson, 2011).

According to Scherer (2005), it became hard to reach an agreement of the endless discussions in defining emotions as different theories and models emphasise different components that link to emotions. The five characteristics that connect to emotions proposed by Scherer (1982, 2001, 2005) follow:

- Cognitive component: Emotions influence or are influenced by thinking. There are still many views that emotions and cognition (appraisal) operate independently, but interact with each other.

- Neurophysiological component: This component relates to bodily symptoms such as hormones, heart-rate and sweating. Emotion theories that have a view of emotions as discrete categories emphasise physiological and expressive consequences of emotion.

- Motor expression component: Emotions are related to facial expressions, posture, vocal expressions.

- Motivational component: Action tendencies that relate to an individual's goals and intentions are linked to emotional arousals.

- Subjective feeling component: Emotional experience is labelled through conscious awareness of an emotional state.

2.1.3 Emotions and Affect

The current consensus among researchers is that affect indicates 'any type of affective experience' such as emotions, moods, or feelings (Forgas, 1995; Buchanan, 2007; Lottridge, Chignell and Jovicic, 2011; Jeon 2017). Of course, depending on the usage, emotions can be distinguished from other affective experience. Emotions are generally intense having a noticeable cause, whereas moods are relatively less obvious and subtle, but last longer than emotions (Jeon 2017; Forgas, 1995). Feelings are generally known as a conscious interpretation of physiological symptoms (Damasio, 1994). According to Scherer (2005), each affective phenomenon is differentiated based on the degree of participation in the following aspects:

- Event focus: Emotions and other affective states are generally elicited when specific events happen that trigger a response.

- Appraisal-driven: Different types of affective states are linked to the appraisal of an object, person or event and its consequences.

- Response synchronisation: Responses to events are interconnected to the appraisal analysis of events.

- The rapidity of change: This aspect refers to the rapid and constant change of emotional response due to receiving new information or re-appraisal.

- Behavioural impact: Emotions and other affective types (i.e. mood) have action tendencies and motivational grounds which impact on consequent behaviour.

- Intensity and duration: These relate to the degree of intensity and duration of emotion and other types of affective state. For example, emotions can be high intense and relatively brief, whereas moods can last longer with less intensity.

Throughout the review of theories of emotions and features of affective phenomena, the term 'affect' is considered appropriate for describing both emotions and other affect states (e.g., moods, feelings) in a more general fashion for the research.

Emotional components and different aspects of affective phenomena above proposed by Scherer (2005) that become gaining acceptance in this area highlight that emotions cannot simply be understood as a single expressed subjective feeling, physical consequence (e.g., facial expressions, vocal expressions, gestures, and movements) or physiological response (e.g., respiration, pulse rate, body temperature, and blood pressure) (Kanjo, Al-Husain and Chamberlain, 2015). Rather, it is necessary to fully understand emotions and affective states in a wider context in which various elements of interactive components and process (events, appraisal, physiological or expressive responses, motivation-related actions and behavioural impact) occur (Wieser and Brosch, 2012; Calbi et al., 2017). In fact, the significance of situational context has already been emphasised for an in-depth understanding of emotional experience (Barratt et al., 2016). For example, different interpretation of facial expressions could be made without an appropriate investigation of contextual information that includes an individual's physical responses (e.g., facial expressions and body movements) (Boll et al., 2011; Meeren, van Heijnsbergen and de Gelder, 2005; Aviezer et al., 2008), interaction with other agents and environmental features (e.g., visual scenes) (Kim et al., 2004; Barrett, Lindquist and Gendron, 2007; Schwarz et al., 2013).

Therefore, it is necessary to understand the human emotion and other affective states elicited within a multi-layered context. To gain a systematic view on this, an understanding of the human memory system is necessitated, as the human brain is interrelated to emotions. In the next section, thus a review of a human memory system and the relationships between memory and emotional events is followed.

2.2 Human Memory

2.2.1 Introduction

A systematic literature review was conducted to create an overview of human memory systems. Published articles, books, journal papers from IEEE Explore, Google and Google Scholar and Brunel University were reviewed. A set of search strings was used: human memory AND system/characteristics/types/retrieval/emotion. The selection criterion for the choice of material — 'Does it provide characteristics of human memory systems and emotional relations?' — was applied. The abstracts of published papers and contents index were first reviewed with the criterion above. Information from relevant source materials (26 Sources) was reviewed and synthesised. The following chapter introduces a review of human memory systems and characteristics that are most relevant to this thesis.

2.2.2 Human Memory System

A number of psychologists define that human memory as a complicated system for storing and retrieving information in brain that operates together, rather than a single function (Baddeley,1999). The mechanism of the memory system can be understood as a sequence of processing that visual and auditory stimuli of information are perceived and stored. The fractionation of human memory, the division into sensory memory, short-term memory and long-term memory, was first proposed by William James in 1890 (Nee et al., 2008); this understanding was widely accepted by the early 1970s (Baddeley,1999). The fractionation into three kinds of memory types is well described in the model proposed by Atkinson and Shiffrin (1968) (Figure 2.3). This model conceptualises an underlying mechanism of human memory that explains how sensory information is perceived, temporarily processed in a short-term storage and permanently stored in long-term storage.

- Sensory memory: This refers to the initial process in which information is perceived through human senses. The components of sensory memory are visual memory (i.e. iconic memory), which is influenced by the brightness of the stimulus, and auditory memory (i.e. echoic memory), which is associated with hearing. It lasts for a second and is continuously replaced by new sensory information.

- Short-term memory: This refers to the temporary storage of information. A general characteristic is that the information is temporarily stored in a limited capacity by repetition and it will usually be forgotten after a short period.

- Long-term memory: This refers to the permanent storage of information, which is the ability to remember information for a long time. Unlike the previous two memory systems, this memory type has an unlimited capacity for storing new information and skills. More specifically, long-term memory is mainly divided into two types of memory: episodic and semantic long-term memory, as proposed by Tulving (1972).

    - Episodic long-term memory relates to remembering experience and events. This includes contextual information of time and place in which events occur. Any life episode (e.g., a family trip, a marriage ceremony or a football match) is classified as episodic long-term memory.

    - Semantic long-term memory relates to knowledge of the world and facts (e.g., solar system) that are independent of an individual's time and place.

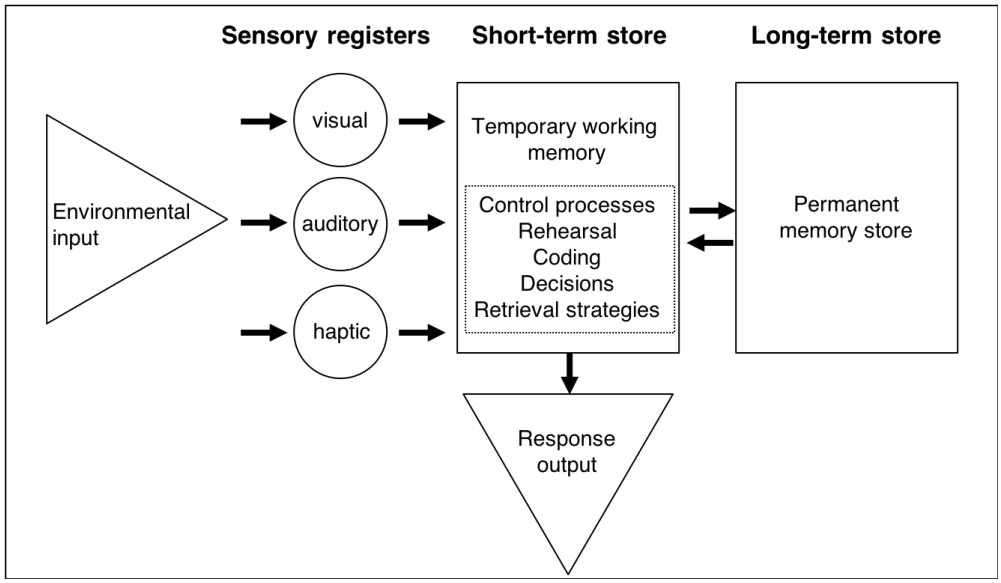


Figure 2.3 Conceptualised flow of information through the memory system (adapted from Atkinson and Shiffrin, 1968).

This review of distinctions between human memory systems attempts to clarify what type of the memory system is referred to in this research. For the purposes of this research, the term memory

is therefore specifically defined as episodic long-term memory, which concerns an individual's real-life experiences and stories that are stored durably in their permanent memory.

2.2.3 Memory Forgetting and Ageing

One attribute of human memory is forgetting. Forgetting is the inability to remembering the information learned (Baddeley,1999). Hermann Ebbinghaus (1885) experimented with remembering a list of nonsense syllables to measure the degree of memory forgetting by time ranging from 21 minutes to 31days (Baddeley,1999). According to Ebbinghaus's experiment (1885), the rate of forgetting was high in the beginning, and the curve was declining as time passed by which showed a clear relationship between remembering and time (Figure 2.4).

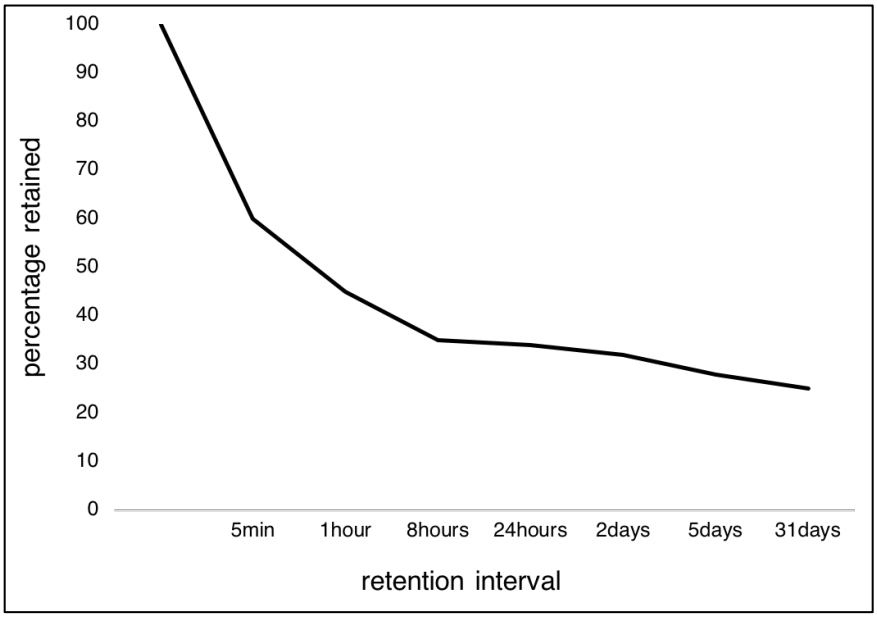


Figure 2.4 Forgetting curve (adapted from Ebbinghaus, 1885).

Ageing is also an influential factor in the slowing of cognitive processing. Warner Schaie (1989) showed that average performance in cognitive ability gradually declines in the sixth decade of life by testing the reasoning, spatial and verbal abilities of a sample of citizens in Seattle. More specifically, Baddeley and his colleagues (Baddeley, Emslie and Nimmo-Smith, 1994) conducted two recall tests after 20 minutes delays for long-term memory with age– visual recall of four different shapes of a cross and verbal recall of four different people names. The study shows that long-term memory generally deteriorates with age, in a slow and steady decline.

A number of studies (Berntsen, 2001; Field, 1981) support that there is a difference in memory recall between younger adults and older adults. According to a survey (Berntsen and Rubin, 2002), the general pattern for younger adults, in which negative memories are highly dominant and last longer than positive memories, reverses itself in the late 30s. This pattern, in which negative memories become less dominant and long-lasting, aligns with finding that the older adults' memories are more likely to be emotionally gratifying than younger adults' memories (Charles, Mather and Carstensen, 2003; Mather and Carstensen, 2003). A longitudinal study (Field, 1981) captured a similar pattern of increasing gratifying memories, through participants' interviews and the self-rating of their happy childhood over a 44-years period.

Many studies support the tendency for memory recall to decrease as time passes, as was first revealed in Ebbinghaus's curve (1885) and confirmed by later studies; there is growing evidence that ageing is associated with different patterns in remembering emotional events (either positive or negative). Nevertheless, many studies have found that people are likely to have a more detailed memory of events for a longer period, if the events are particularly impactful, vivid and emotional (Brown and Kulik, 1977; Reisberg et al., 1988). Similarly, memories that are lost can be retrieved by brain stimulation that triggers vivid memories (Baddeley, 1999).

2.2.4 Memory Retrieval and Cues

Retrieval is another main attribute in human memory, which enables to access the long-term memory trace. As specific information is stored in a way that it is categorised in long-term memory, particular information is possibly recalled given appropriate retrieval cues for searching the categories (Baddeley, 1999). Tulving and Pearlstone (1966) first showed that such a retrieval cue allows people to access information in the appropriate location in human memory.

Smells and tastes are known to be strong retrieval cues that resistant to forgetting for many people, which are relatively independent of other memory experiences due to the limitation in recreation and imagination (Engen and Ross, 1973; Baddeley, 1999). There is numerous evidence of internal or external cues that impact on memory retrieval (Tulving, 1967; Godden and Baddeley, 1975; Ucros, 1987; Smith and Vela, 2001; and Baddeley, Eysenck and Anderson, 2014).

- State-dependent memory: Memory can be better recalled depending on an individual's state proposed by Goodwin and colleagues (1969). Goodwin's experiment found that

memorised information in a certain state (e.g., when drunk) is well retrieved when the individual's state is the same as the information is learned.

- Context-dependent memory: The context in which an event occurred can act as another remarkable cue in memory retrieval. Godden and Baddeley (1975) experimented with training deep sea divers to identify the relationship between context and memory recall. Subjects recall words learned either on land or underwater was tested in both environments. Similar to a state-dependent memory, the study found that the percentage of words recalled correctly was high when the recall test took place in the same environment in which subjects learned words (Figure 2.5).

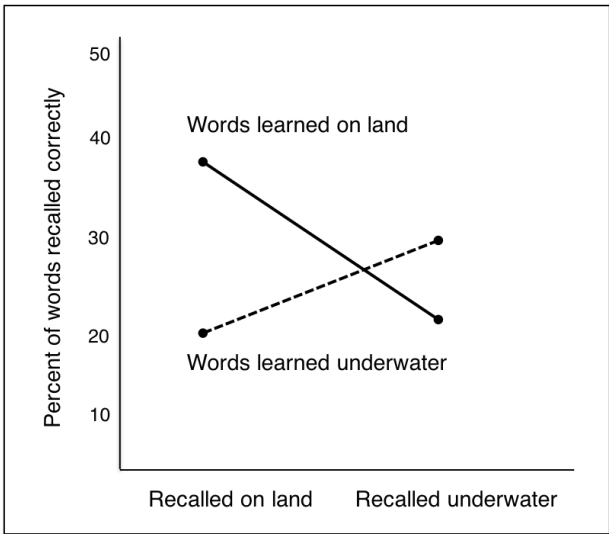


Figure 2.5 Context-dependent memory recall (adapted from Godden and Baddeley, 1975).

2.3 Memory for Emotional Events

Details of memories are likely to be remembered for a longer period when the events are vivid. Most of the vivid events are emotional and are closely connected to an individual's life issues, concerns or goals (Reisberg and Hertel, 2004). The general characteristics of emotional memories can be summarised (Reisberg and Hertel, 2004) as being:

- Closely related to the feelings and bodily responses

- Likely to be rehearsed to a higher degree than neutral events are
- Likely to be untypical
- Usually related to individual's concerns or goals in their life that is important for memory

A number of studies indicate that emotions can improve the memory of central events (Christianson and Loftus, 1991; Burke, Heuer and Reisberg, 1992; Reisberg and Hertel, 2004) increasing accuracy, vividness and durability (Reisberg and Hertel, 2004; Buchanan, 2007).

2.3.1 Accuracy of emotional memories

Brown and Kulik (1977) coined the term 'flashbulb memory' to describe the clear and detailed memory recall when a memory relates to emotional and consequential events (e.g., John Kennedy's assassination or Princess Diana's death) (Reisberg and Hertel, 2004). Some argue that emotional memories such as flashbulb memory, however, has some limitations regarding the accuracy due to the lack of assessing the actual events that already happened in people's lives. Nevertheless, findings from the majority of research on memory (Heuer and Reisberg, 1990; LaBar and Phelps, 1998; Ochsner, 2000) suggests that memory of individuals who experienced a negative event (e.g., accident or assault) may be more accurate than individuals who experienced a neutral stimuli or even, sometimes, a positive stimuli.

2.3.2 Vividness of emotional memories

The claim that arousal causes a narrowing of attention is rooted in the hypothesis proposed by Easterbrook (1959). In the hypothesis, aroused emotion, such as anger or joy, can help participants focus on remembering the gist of the event while impairing the remembering of peripheral information. Similarly, the hypothesis aligns with the attentional pattern known as 'weapon focus effect' referring to the fact that the witness may have a good memory of central items or scene in crime (e.g., perpetrator's gun or knife), but a poor memory for the peripheral details (Loftus, Loftus and Messo, 1987). In contrast to Easterbrook's hypothesis about memory narrowing, however, many studies claim that diminishing memory for peripheral details can be a natural consequence of a strong visual stimuli acting like a magnet that seizes a participant's focus in a laboratory setting, not directly produced by emotionality (Reisberg and Hertel, 2004; Laney, Heuer and

Reisberg, 2003). Although Easterbrook's idea of memory narrowing is not fully accepted, emotion's positive effect on the vividness of central memories has been demonstrated in many different ways (Bohannon, 1988; Bornstein, Liebel and Scarberry, 1998; Bower and Forgas, 2000; Bluck and Li, 2001).

2.3.3 Durability of emotional memories

The durability of emotional memories has been an important issue, particularly in forensic settings, when the victims or witness of the crime may be asked to recall their memories after long delays (Edelstein et al., 2004). Memories for stressful events are not likely to fade over time, and emotions instead may enhance memory after long delays (Yuille et al., 1994; Goodman et al., 1992). This aligns with the notion that emotional memories do not deteriorate with age (Robin et al., 2004). Rather, older adults tend to vividly recall emotional events and highly emphasised their feelings and thoughts than younger adults (Hashtroudi, Johnson and Chrosniak, 1990; Mather, 2004).

2.3.4 Some biases and a false alarm on emotional memory

Some researchers have raised concern about potential limitations on emotional memory, cautioning that emotional stimuli may increase the rates of both incorrect responses and correct responses (Windmann and Kutas, 2001). Some studies suggest that recalling negative events can even promote the recall of false memories, in contrast to recalling neutral or positive events (Brainerd et al., 2008). According to an experiment by Payne et al. (2002), participants who had experienced an induced stress were more likely to have false recognition of unrelated words that they had studied. The increased rates of a false alarm may occur due to the impact of stress on the human brain part (e.g., chronic exposure to stress) (John, Nolde and Leonardis, 1996). Edelstein et al., (2004) suggest that asking open-ended questions (e.g., "what did he do?") asking rather than yes or no questions (e.g., "Did he hit you?") may be useful to reduce the potential negative emotion induction bias.

2.4 Summary and Conclusion

This chapter has explored human emotion and human memory systems by reviewing relevant theories and empirical studies. The relationship between the mind and brain is complex and significant entities to deeply understand human experience as they are all connected and work together. A summary of the review in human emotion and memory follows:

- Given that emotions can be differentiated from other affective states (e.g., moods, feelings, or attitude) (Scherer, 2005), the use of word 'affect' is considered to be most appropriate to explain all different affective experiences including emotions for this research (Chapter 2.1.3 Theories of Emotion).

- It becomes crucial to fully understand emotions and affective state in a wider context in which various elements of interactive components and process (events, appraisal, physiological responses, motivation-related actions and behavioural impact) take place (Chapter 2.1.3 Theories of Emotion).

- Although forgetting and ageing affect human memory, human memory can be effectively retrieved using internal cues (state-dependency) or external cues (context-dependency) (Chapter 2.2.4 Memory Retrieval and Cues).

- Considering the emotional effect on improving the memory of central events (Bohannon, 1988; Bornstein, Liebel and Scarberry, 1998; Bower and Forgas, 2000; Bluck and Li, 2001), aroused emotions can be used as a memory retrieval cue in a laboratory setting (Chapter 2.3 Memory for Emotional Events).

- In order to prevent biases related to incorrect responses or false alarms (Windmann and Kutas, 2001), it is necessary to use open-ended questions when prompting participant's memory using emotional arousal to reduce potential biases and errors (Edelstein et al., 2004; Chapter 2.3 Memory for Emotional Events).

In consideration of the significance of understanding human memories for emotional events within a context, a systematic review of a 'scenario' that acts as a contextual story in which various human interactions take place is introduced in the following chapter.

3 Scenarios

3.1 Historical Trends in Scenarios

3.1.1 Introduction

A systematic literature review of scenario research was performed using a set of search combinations. The chosen keywords are as follows: scenario/design scenario AND concept/definition/process/development/research. 83 books, journal papers, conference papers, consultancy reports, governmental papers, news articles and magazine articles were identified from IEEE Explore, Brunel Library, Google and Google Scholar. The following chapter presents the historical usage, definition and role of scenarios in the design process and the scenario development process through analysis and synthesis of the relevant literature reviews on scenarios that are most relevant to this thesis. An intensive review of academic research across disciplines and industries in the area was performed to provide the operational definition of scenario involving emotional aspects, to avoid misunderstanding of the term.

3.1.2 Usage and Definition of 'Scenario'

The concept of a scenario originated as a military planning tool following World War II. Herman Kahn (Kahn and Wiener, 1967) coined the phrase 'thinking the unthinkable' as part of the effort to urge U.S. leaders to consider the consequences of a thermonuclear war (Wilkinson and Kupers, 2014). Kahn's approach to performing long-term forecasts emphasised the consideration of the possibly non-linear and disruptive changes that might be caused by unanticipated future events. The practice of using scenarios as planning tools was triggered by the oil shocks in the 1970s, when they were seen as a way of learning to cope with possible price shocks. Pierre Wack of Royal Dutch Shell (Wilkinson and Kupers, 2014) highlighted human storytelling as a means by which to situate and contextualise the data based on rigorous data analysis. The example set by Royal Dutch Shell led to the deployment of scenarios in numerous fields (Ringland, 1998; Reeder and Turner, 2011), such as by government planners, corporate managers and military analysts to assist with decision making (Mietzner and Reger, 2005).

Researchers claim that the use of scenarios as part of any design process provides opportunities for facilitating interaction, envisaging a possible future and aiding strategic thinking (Carroll, 2000; Neilson and Wagner, 2000). Further, Go and Carroll (2004) suggest that different disciplines each develop their own specific design scenarios, tailored to their focus and context. For example, the scenarios in human-computer interaction (HCI) are often used to identify requirements and enhance usability by analysing user's behaviour patterns in their interactions with computer systems (Carroll, 1997). The use of scenarios in this field has shifted the design focus from defining functional system specification to addressing a sequence of the user's behaviour to accomplish tasks or goals (Rosson and Carroll, 2002). Users in the scenarios play an active role in an iterative design process. Scenarios have also been used to refer to abstract description of system use, such as use cases in computer systems development, software engineering and requirements engineering (Jacobson, 1995). The use of technical and system-oriented scenarios in this field often focuses on enumerating user's possible reactions to systems (Jacobson et al., 1992).

The term 'scenario' has been used across different industries and disciplines to indicate somewhat different concepts. Despite there being no single universally accepted definition, standard English language dictionaries (Cambridge, Merriam-Webster, and Oxford) suggest that the word 'scenario' refers to at least two possible concepts:

- A description of a sequence of possible actions or events;
- A description of the characters and events in a film, play or stage.

In relation to the first concept, it can be noted that the physical aspects of what could happen have traditionally been the main focus of scenarios. Kahn and Wiener (1967) suggest that 'scenarios are simply a more or less imaginative sequence of events that are put together so that each event forms a context for the other events'. The Royal Dutch Shell scenarios, for example, described the traumatic societal effects of possible future oil price shocks, helping people to imagine the implications on their daily lives and society as a whole.

In relation to the second concept, greater emphasis can be noted regarding the need to capture the interactive and intentional aspects of the situation. According to Cooper (1999), a scenario is 'a concise description of a persona using a software-based product to achieve a goal'. Carroll (2000) instead suggests that 'a scenario is a story with a setting, agents or actors who have goals or

objectives, and a plot or sequence of actions and events'. Wilkinson and Kupers (2014) further note that scenarios provide a future stage upon which people imagine themselves as the actors. Scenarios thus play an important role in representing possible human activities (Carroll, 2000).

Individual studies spanning a range of disciplines from engineering to sociology have each defined the concept of 'scenario' in line with the values of the source discipline and the nature of the research question under investigation. A literature survey was therefore performed from the identified 83 peer-reviewed sources. Of the 83 sources, 69 explained the concept of 'scenario' in detail or defined the process of developing scenarios. Keywords and key sentences were extracted from the 69 most complete sources and were placed into a digital database. The digital database then served as the basis for a thematic grouping (Saldaña, 2015) activity to identify common themes from across the source materials.

To facilitate generalisation and reduce bias, three researchers who are familiar with coding and theme generation acted as the multiple reviewers throughout the current study. These coders were drawn from the fields of design (male aged 34), psychology (female aged 26) and engineering (female aged 36). While the group was limited in number due to the difficulties in recruiting expert coders, the variation in professional background and age did introduce some variation in viewpoint, as considered opportune by sector specialists (Berends and Johnston, 2005). The coders were asked to generate their groupings independently and a final workshop session was performed with all coders to reduce and harmonise the results. The analysis resulted in the following themes, attributed principally to the source materials that are indicated in parenthesis:

- A description of a sequence of events (Kahn and Wiener, 1967; Young and Barnard, 1987; Millett, 1988; Wright and Rowe, 1992; Jarke, Bui and Carroll, 1998; Rosson and Carroll, 2002)

- A description of users, contexts and tasks (Young and Barnard, 1987; Nardi, 1992; Campbell, 1992; Bødker and Christiansen, 1994; Cooper, 1999; Suri and Marsh, 2000; Bødker, 2000; Rosson and Carroll, 2002; Miller and Williams, 2006; Goodwin, 2010)

- A description of a possible future (Schoemaker, 1995; Ogilvy and Schwartz, 1996; Fink and Schlake, 2000; Godet, 2000; Staley, 2002; van Notten et al., 2003; Schwab, Cerutti and Hélène von Reibnitz, 2003; Mietzner and Reger, 2005; Wasserman, 2005; Alcamo,

2007; Wilkinson and Kupers, 2014)

As with most previous design studies involving scenarios, the current research was performed within a specific context – in this case, automotive. It was thus necessary to adapt the basic definition by adding context-specific information. The modern automotive context involves the linking of any number of sources of information enabled by the integration of digital and mobile technologies, which may be characterised by any types of agents (McKinsey and Company, 2014). After careful consideration of the contextual constraints, the working definition of 'scenario' adopted for the current study was taken to be:

> ***A scenario is a description of a sequence of events and activities that occur within a specific context, and which can involve other agents such as intelligent technologies, people or animals.***

3.1.3 Role and Concerns of Scenarios in Automotive Design

Scenarios in automotive design play an important role in setting the context and supporting usability testing, communication and stimulating new ideas (Figure 3.1). Scenarios capture human needs in the present or the future, and can assist researchers, designers or engineers in identifying specific requirements of a system, potential interactions, and other concerns or issues.

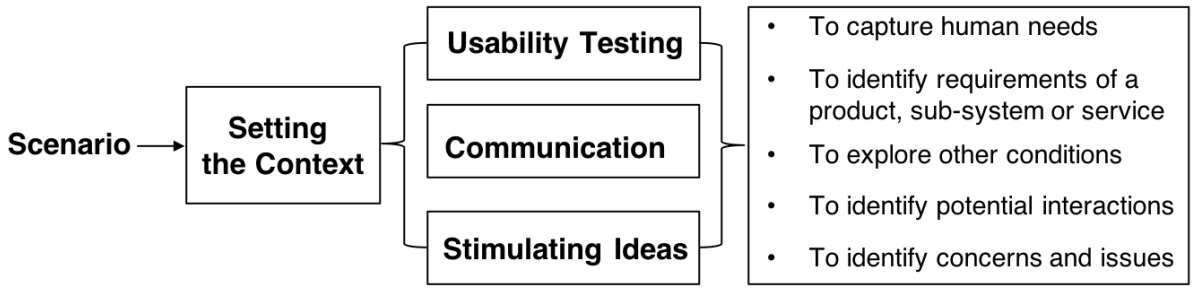


Figure 3.1 The role of scenarios in automotive design.

Each practical role of scenarios in automotive design can be summarised as follows (Bødker, 2000; Carroll, 2002; Houdek and Zink, 2004):

Support for usability testing

Scenarios support designers, engineers and marketers to identify requirements of a system and evaluate the usability of prototypes (Carroll, 1995). Human needs and benefits can be captured through a sequential description of interactions between people and automotive products, sub-systems and services. An iterative testing cycle regarding how users behave with the system produces a series of questions (Bødker, 2000). The following example scenario of the wiper system (Houdek and Zink, 2004) shows what the system requirement can be, and further, what other possible conditions in the same requirement might be:

> ***One of the front doors is not totally closed.*** *The driver doesn't notice this and drives as usual. A lorry driving next to the driver's car runs through a huge mud slop and causes many mud splashes on the car's windscreen. Unfortunately, the sun is low, shining from the front, so that* ***the driver can see almost nothing through the windscreen****. In this dangerous situation,* ***he immediately needs the wiper's washing functions to clear the windscreen.***

In this case, the identified requirement is the halting of the washing function to prevent the driver or passenger from getting wet, and avoid possible danger. Subsequently, the scenario can provide opportunities to explore other conditions in which the same requirement is needed (e.g. if the sunroof is opened). Further ideas can be explored about possible dangerous contexts (e.g. mud splash, sunshine) through scenarios.

Support for communication and discussion

Scenarios can act as a communication tool for shared understanding (Bødker, 2000) of automotive products, sub-system features, or services among stakeholders. Stakeholders from different departments such as Marketing, Design and Engineering can use scenarios to easily communicate regarding end user's needs. Scenarios can be further developed through discussions in the workshop (Gottesdiener, 2004). Stakeholders immersed in a particular role in the scenario can generate potential reactions to possible features (Houdek and Zink, 2004).

Support for stimulating further ideas

Scenarios that illustrate extreme cases can stimulate ideas of potential interactions and possible problems of future application (Bødker, 2000). Indeed, the use of scenarios can support the identification of interaction and conflicts between systems and sub-features in different parts of an automobile (Houdek and Zink, 2004). Scenarios provide a stage to observe how the control system and sub-features may interact, connect and conflict. Designers and engineers can use scenarios to obviate possible conflicts in a certain situation between distinctive parts that control the body, chassis, power train and telematics of an automobile. For example, if the Traffic Warning Waiting feature in the telematics system and the Call Waiting feature should simultaneously be initiated as soon as the on-going phone call has ended, which should happen first? (Houdek and Zink, 2004). Moreover, considering more intelligent, connected and automated automotive technology in the future, the financial benefit of pre-consideration in the early design process is considered to be substantial.

Meanwhile, concerns about understanding human experience through scenarios have been raised. Research claims that the central consideration of people can be missed, as existing scenarios mainly focus on the physical actions and interactions of how users accomplish tasks in one situation of the system (Bannon and Bødker, 1992; Cooper 2004). The action-focused and task-oriented scenarios may not fully address the more complex issues of human experience with automobiles, as they may discount fundamental aspects such as emotion. Indeed, human experience is perceived as a subjective synthesis of events involving multi-faceted aspects of human beings, such as emotions, behaviours and physiological reactions (Desmet and Hekkert, 2007; Hassenzahl, 2010). Scenarios that take into account human emotion can further bridge the gap between possible future experience in theories and present life (Candy, 2010). For better use of scenarios to help to understand human experience, the existing literature on scenarios must be revisited with a focus on the emotional aspects and is explored in the next section.

3.2 Emotions in Scenarios

A literature review was conducted to define the terminology of scenario that involves emotional aspects. In an extensive review of all sources (83 sources) collected from the initial search (3.1

Historical Trends in Scenarios), more specific inclusion criterion was applied for the choice of material to be reviewed. The criterion for inclusion of the identified source was:

- Provides a scenario definition or an explanation of what a scenario means

The information from all remaining sources (69 sources) was revisited to search for relevant materials. Based on the definition of 'emotion' in English language dictionaries (Cambridge, Merriam-Webster and Oxford) and of 'affect' in the previous chapter (2.1.3 Emotions and Affect), the word emotion and its synonyms were used in the search. The search words were as follows: emotion/ affect/ feeling/ passion/ sentiment/ sensation/ mood. Five sources were identified that included the words in their explanations of scenarios (Table 3.1).

	Title	Author (Year)	Scenario Descriptions
1	Exploring Persona-Scenarios - Using Storytelling to Create Design Ideas	Madsen, S and Nielsen, L (2012)	Persona-scenarios view the user as a particular person with **emotions**, actions, and needs and it is the persona who is the focal point of the persona-scenario, not the IT system.
2	Designing with Scenarios: Putting Personas to Work	Goodwin, K. (2010)	A good scenario contains the components of a story, setting, character with goals & **feelings**, conflict or problem to solve resolution, **emotion** plays a larger part in some scenarios than others.
3	Moving bodies, social selves: movement oriented personas and scenarios	Loke, L., Robertson, T. and Mansfield, T. (2005)	Scenarios are the patterns and forms of movement and the spatial trajectories as people move through the space and interact or engage with the exhibited material. These patterns and trajectories include aspects of timing, position and orientation that are influenced by social interaction and social protocol, people's aesthetic and **emotional** engagement with the exhibited work, as well as their response to physical properties of the space.
4	Scenarios-The art of strategic conversation 2nd Edition	Van der Heijden, K (2004)	But the rationalist should not forget the incredibly important role of motivation and **emotion** in strategy. Being able to mobilise this can make or break a strategy project. You have got to know your organisational psychology.
5	Scenario building as an ergonomics method in consumer product design	Suri, J.F. and Marsh, M. (2000)	It also depends upon aspects relating to the person's **mood**, goals, tasks, perceptions, expectations and capabilities. Scenario building provides a way of integrating these complex interplaying variables, allowing exploration and communication of qualitative aspects of the user experience at the earliest stages of design.

Table 3.1 Review of literature investigating scenario definitions with emotion-related words.

From the review, emotion-related words were found to indicate:

- one of the characteristics of a person that forms a scenario
- one of the important elements to influence a scenario

Given the importance of emotion when developing a scenario, the existing descriptions seem to be insufficient to understand the impact of emotion in scenario research. Thus, an additional activity to identify causality of emotion in scenarios was considered to supplement the scenario definition that involves emotion.

3.3 Scenario Development Processes

Studies have adopted different approaches to developing scenarios, ranging from simplistic stages to complex stages, and from qualitative inputs to quantitative inputs (Mietzner and Reger, 2005). Some studies (Phelps, Chan and Kapsalis, 1998), however, have claimed that there is a degree of similarity in all scenario development processes, which start by defining the scope and conditions, gathering information and constructing scenarios. Although this general process offers a theoretical idea of developing scenarios, it appears to be insufficient to build a complete scenario in practice, due to its lack of explanation of detailed stages.

In order to identify an appropriate scenario development process, the processes described in the 69 most complete sources (3.1.2 Scenario Usage and Definition) were reviewed. Consideration of the following criteria aided the reduction of the number of potentially appropriate processes:

- 'Is the process adequate to explore unanticipated requirements in automotive experience?'
- 'Does the process description provide full details of each stage of activity?'

The scenario development process described by Schwartz (1996) was found to be appropriate in relation to the selection criteria above, and it is widely cited in the literature as an approach that helps to identify and address unanticipated issues. Schwartz (1996) suggests eight steps for developing scenarios: *identify focal issue or decision, list key factors, list driving forces, rank key factors and driving trends, select the pertinent scenario logics, flesh out the scenarios, develop implications* and *select leading indicators*.

The scenario development process described by Alcamo (2007) was also found to be appropriate in relation to the selection questions, and was cited in the literature as an approach that leads to finely detailed and easily applicable scenarios. Alcamo (2007) suggested the following steps, which are required when developing scenarios: *select objectives and boundary conditions, select themes, select actors & factors, develop mini-scenarios for each theme, reduce the number of mini-scenarios* and *write full scenario storylines*.

The steps defined by Schwartz and by Alcamo were deemed appropriate for the purposes of the research in the thesis. The combination of the two sets of guidelines provided a comprehensive description of the items of information required, and a detailed list of the activities that must be performed.

Stage 1. Setting boundary conditions

The first stage – that of defining the 'boundary conditions' – was adapted from the steps Alcamo (2007) describes. The boundary conditions are deemed to be the major structural terms of reference of the design activity, such as any physical, manufacturing or cost barriers, the intended geographical coverage, the target population and the target time window.

Stage 2. Identifying key driving forces

The second stage – that of identifying the 'key driving forces' – was adapted from the steps Schwartz (1996) describes. According to Ogilvy and Schwartz (1996), the best way to identify a set of 'key driving forces' is to obtain the opinions of the main stakeholders through workshops, surveys and interviews, or Delphi methods. Moreover, in terms of constructing scenarios, there are two types of inputs: qualitative inputs, which are commonly used to identify complex situations, and quantitative inputs, which are typically used in computer modelling for energy and environmental forecasts (van Notten, 2005).

Stage 3. Developing mini-scenarios

The third stage – that of developing 'mini-scenarios' – was adapted from the steps Alcamo (2007) describes. The third stage combines Alcamo's suggestions regarding the selection of actors, the development of mini-scenarios and the reduction in the number of mini-scenarios. In this stage, the identified key driving forces are used to define the mini-scenarios. With the mini-scenarios

defined, an activity regarding the 'selection of actors' is performed as described by Alcamo (2007). The establishment of vivid personas has been suggested as a requirement for achieving useful scenarios (Ogilvy and Schwartz, 1996). Pruitt and Grudin (2003) further suggest the benefit of defining only a single persona per scenario, thus ensuring a focus on a single character, lifestyle and point of view.

Stage 4. Writing full storylines

The fourth stage – that of 'writing full storylines' – was adapted from the steps Alcamo (2007) and Schwartz (1996) describe. Once the main structure of each mini-scenario is available, an activity is required to detail the mini-scenario based on the character, lifestyle choices, emotional responses and other human characteristics of the associated persona. A storyline can be considered an enriched and upgraded version of a mini-scenario, appropriate for a general audience in a manner not dissimilar to a screenplay outline. The development activity can be guided by the narrative criteria proposed by Bødker and Christiansen (1994) for use when developing design scenarios: 'what is done', 'where', 'by whom and when', 'by what means' and 'in what way'.

3.4 Summary and Conclusion

This chapter has explored how the concept of scenario has historically been used, defined and developed, acknowledging the flexible nature of the scenario concept and process, which depends heavily on the context in which the word is used. A summary of scenarios follows:

- Since different disciplines develop tailored scenarios to specific focus and context, a scenario in automotive design can be defined as "*a description of a sequence of events and activities that occur within a specific context, and which can involve other agents such as intelligent technologies, people or animals*" (Chapter 3.1.2 Usage and Definition of Scenario).

- Scenarios in automotive design can be an important tool for supporting for usability testing, communication among different stakeholders and stimulating further ideas (Chapter 3.1.3 Role and Concerns of Scenario in Automotive Design).

- It becomes crucial to focus on human emotion when developing a scenario in automotive design because action-focused or task-oriented scenarios may not fully address the more complex issue of the automotive experience (Chapter 3.1.3 Role and Concerns of Scenario in Automotive Design).

- Given the insufficiency of the impact of emotion in existing scenario research, it is necessary to conduct additional research to identify the causes of emotion in scenarios to fully define an ‘affective scenario’ (Chapter 3.2 Emotions in Scenarios).

- To fulfill the comprehensive guidelines, the following four stages can be used to develop scenarios of automotive experiences: *Setting boundary conditions; Identifying key driving forces; Developing mini-scenarios*; *Writing full storylines* (Chapter 3.3 Scenario Development Processes).

4 Defining ‘Affective Scenario’

Chapter 3 discussed the importance of scenario use in automotive design while noting that existing scenario studies in the research literature did not focus on emotion. In order to answer the Research Question 1 posed in Chapter 1—‘How can an affective design scenario be defined?’— this chapter explores the relationship between emotion and experience with an automobile based on the hypothesis that individual’s experience with an automobile could produce a noticeable emotional response. The main goal in this chapter was to provide a working definition of ‘affective scenario’ in the automotive context.

4.1 Study Design

4.1.1 Research Approach

The study employed a contextual interview research method, which is particularly appropriate for a study that aims to explore an individual’s experience of a specific topic in a natural context in detail (Beyer and Holtzblatt, 1997; Kolko, 2014). Although the contextual interview method has drawbacks, such as its time consuming nature, its small scale and the potential for subconscious bias (Robson, 2011; Stanton et al., 2005; Alshenqeeti, 2014), there are significant advantages from using a contextual interview research method, namely, it:

- Provides contextual meaningful information (Denzin, 2001)
- Explores the critical source of vivid information for scenario development (Burgess, 1991; Tomlin, 2008)
- Has a high return rate and maintains effective control of samples (Kothari, 2004; Alshenqeeti, 2014)

4.1.2 Interview Questions

Because the study focuses on confirming the noticeable emotional response in an individual’s experience with an automobile, it employed open-ended questions, allowing researchers to explore

the subjects' responses, rather than closed-ended questions that would limit the answers to fixed options (Bryman, 2004). The contextual interviews were designed with the following simple question set, using the same question order for consistency and coherency in data collection and analysis:

1. Can you tell me about your experience with a car as a driver or a passenger?

2. How did you feel in that situation?

4.1.3 Sampling Strategy and Interview Procedure

Before participants were recruited, the university granted its full ethics approval (Appendix C), and all of the study's procedures were in compliance with both Brunel University's 'Code of research ethics' (CoE, 2014) and the UK guidelines (Data Protection Act, 1998). The study used purposeful sampling, which is suitable for a small-scale interview within a purposeful category by adding credibility, but is not representative of the group as a whole (Nastasi, 2009). The study sought to recruit participants who had driving experience or passenger experience within the last 12 months. The participant recruitment process was conducted internally at Brunel University, using an announcement that was posted around the Brunel campus and on the university website.

These interviews occurred by appointment in a car parked safely at Brunel University. Conducting the interviews in a car aided each participant (n=18) to recall automotive experiences vividly as a driver or a passenger and to answer the questions with an unlimited number of experiences by providing the same interview environment for every participant; the length of interviews averaged at 30 minutes. The participants included ten males and eight females, ranging from ages 26-36, with an average age of 29.3. Generally, participants sat in the driver's seat, unless they only had experience as passengers, in which case they sat in the front passenger's seat. They were allowed to adjust their seat, the mirrors, or even put their mobile phones in the cup-holder, as if they were in their own car.

4.1.4 Data Analysis

All of the collected responses collected were transcribed verbatim to be examined using thematic analysis (Braun and Clarke, 2006) by the researcher. This method extracts categories identified the

collected data by open coding (Elo and Kyngäs, 2008). All transcriptions were saved as digital forms, and initial codes generated for similar concepts were grouped together as categories using NVivo 10 software.

In order to reduce the researcher's bias and subjectivity in thematic coding process, a group of three researchers who are familiar with coding and theme generation acted as the multiple reviewers throughout the current study. These coders were drawn from the fields of design (male aged 34), engineering (female aged 28) and computer science (female aged 36). The coders were asked to generate their groupings independently and the results were harmonised during a final discussion among all of the researchers. Table 4.1 shows the resultant analysis divided into the themes that evoked each individual's emotion.

4.2 Findings and Summary

The interviews yielded 52 individual contexts as a driver or a passenger, which were grouped into 48 codes and 14 categories across eight each individual's different emotional responses within a context (Table 4.1). All of the individual contexts included some kind of emotion, underscoring the importance of this investigation. These emotional responses illustrate one or more discrete basic emotions (e.g., anger, fear, happiness) (Ekman and Friesen, 1971) and other affective states (e.g., shame, disappointment, relief) (Scherer, 2013). The study findings thus confirmed the hypothesis that individual's experience with an automobile could produce a noticeable emotional response.

Emotions	Categories	Codes
ANGER	Lack of Control- inexperience	No proper control of car by myself
		No proper control of car by other drivers (horn, traffic, tailgating)
	Lack of Predictability	Lane changing without indicator by other drivers
	Discrimination	Being treated differently such as less capability
	Lack of Trust	Giving me a lecture about my driving skills
	Lack of Personalisation	Had to wait cooling down the car due to the high temperature inside of a car
FEAR	Lack of Control- heavy cognitive workload	Not use Sat-Nav
	Lack of Control- inexperience	Almost hit the truck
		Hit the small truck
		Small accident at roundabout
		Could not change the lane

	Lack of Control-environment	Could not see the road, lanes properly
		Missed a road sign
		Need to take extra care
	Lack of Confidence-inexperience	Feel dangerous without guard rail
	Extra Effort	Need to have extra responsibility
	Tiredness	Due to lack of sleep, very tired
SHAME	Lack of Control-environment	Cannot fully control the car
DISAPPOINTMENT	Discrimination	Women stereotypes
	Lack of Control- heavy cognitive workload	Cannot reach out buttons for the rear seat windows while driving
	Lack of Personalisation	Due to her short height, front mirror does not protect her from the sunlight
		Lighting was not enough to install the car seat in a dark underground car park
	Extra Effort	Hard to connect iPhone to the system
FRUSTRATION	Lack of Confidence-inexperience	Too conscious others, skilled
	Confusion	Confused by many buttons
	Extra Effort	Had to slow down
		Made another way due to many potholes
	Lack of Control- heavy cognitive workload	Seeing road situations
		Cannot focus on driving
		Cannot control the situations
HAPPINESS	Full Control	Feel freedom
		Can enjoy driving, see around, feel interior design
		Feel the car on many curves
	Privacy	Listening to music
		Singing out loud
		Music influence my feelings with maximising volume
		Use the car as a private café parking alongside a river
	Socialising	Driving opening the rear door for a bit
		Use the car as a shelter opening the boot as a roof
		Personal space
		Playing music, singing, dancing
		Interacting with other drivers
		Playing music really high, enjoyed others' attention
		Driving 10m opening the door
RELIEF	Predictability	Know when to stop or to make a turn
	Privacy	Cried many times, calm
		Not too worried because of its private-ness
INTEREST	Privacy	Feel like a small house

Table 4.1 Analysis result of the contextual interviews for defining affective scenarios.

Self-reported emotions expressed in the interviews were treated as expansions of discrete basic

emotions, rather than dimensional emotions that are classified by valence (negative – positive) or activation (calm – excited). Given basic emotions in the individual's stories which is expected to produce a physiological response that refers to a physically automatic reaction to a stimulus (Ekman and Friesen, 1971), the working definition of 'affective scenario' adopted for the current study is:

> ***An Affective Design Scenario is a Design Scenario which is expected to produce in the individual a noticeable physiological response which can be described in terms of one or more of the basic emotions of anger, disgust, fear, happiness, sadness and surprise.***

The study findings discussed in this chapter have answered the Research Question 1— 'How can an affective design scenario be defined?'—by exploring the relationship between individual's experience with an automobile and emotions. The next chapter will further this study by providing an in-depth case study that investigates the relationship between emotions and the automotive experience, with a particular emphasis on how passengers and drivers respond to digital technology.

5 Preliminary Case Study: Exploring Stakeholders' Perspectives on Automotive Experience with Digital Technologies

This chapter explores stakeholder's perspectives to answer Research Question 2 from Chapter 1 – 'How can the automotive experience with digital technology be related to emotional aspects?' This chapter's main goal is to identify the relationship between the desire for automotive experiences with digital technology and emotional considerations, which can assist in understanding the emotional contexts and issues involving scenarios in automobiles.

5.1 Introduction

The automotive industry has rapidly transformed in recent years, triggered by new digital technologies (1.2 New Digital Technologies and Trends). Due to the frequent use of digital devices in automobiles, the efficient deployment of digital devices – such as brought-in smartphones – in automobiles has required substantial investment in new technologies for automotive design over the last decade (KPMG, 2016). What does 'automotive digital device integration' mean in practice? Standard English language dictionaries (Cambridge and Oxford) suggest that the word 'integration' refers to: 'the process of combining two or more things into one' or 'the action or process of integrating'. Automotive digital device integration denotes the notion that any given mobile electronic device can be connected and integrated into an automobile's electronic systems. The integration enables drivers and passengers to control the functions of the mobile electronic device and access many different kinds of apps through the automobile's on-board systems (McKinsey & Company, 2014). Figure 5.1 presents one possible representation of in-car digital device integration.

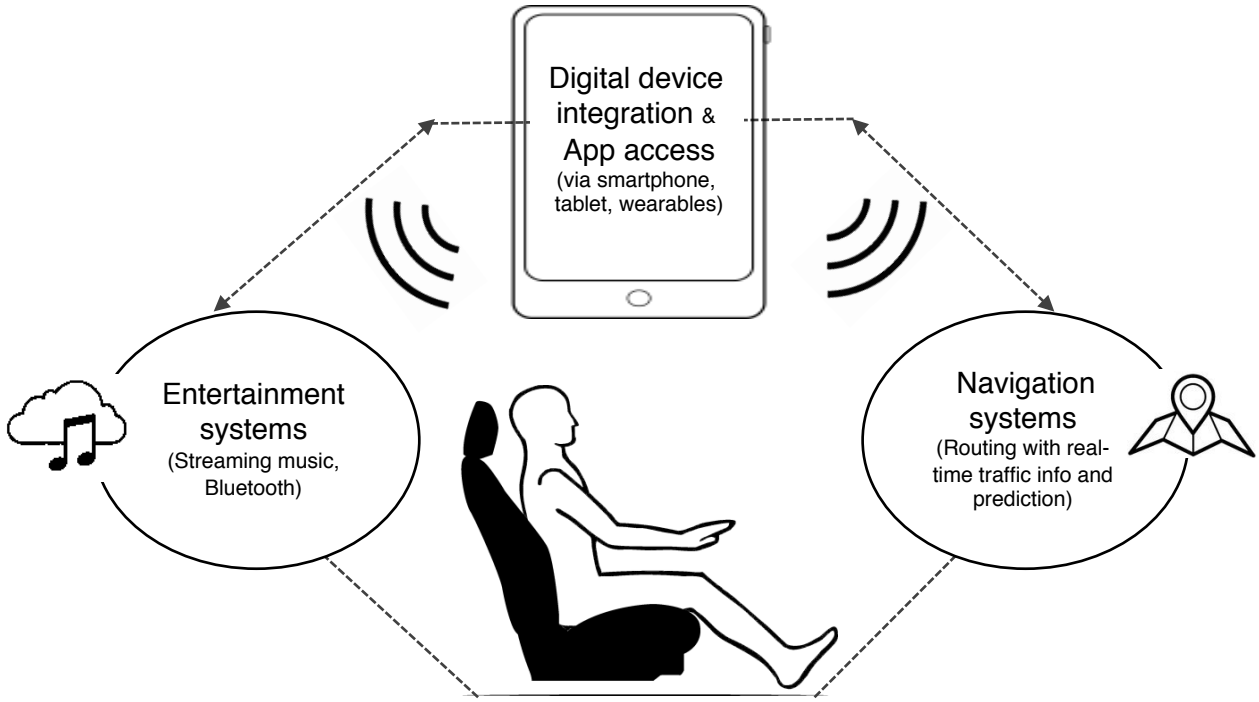


Figure 5.1 In-car digital device integration (adapted from McKinsey & Company 2014).

One example of automotive digital device integration is the use of mobile apps within the automobile (McKinsey & Company, 2014); this is particularly common for navigation and entertainment (McKinsey & Company, 2014). Based on such trends, digital device integration increasingly defines new automotive experiences (GSMA, 2013). According to one survey (Capgemini, 2012), 77 per cent of automobile owners with current digital device integration systems consider apps to be very important. Further confirmation of the growing importance of digital device integration comes from a recent survey of 175 automotive executives, which highlighted the need for a holistic human experience-focused approach to capture how people engage with automobiles in their complex digital lives (IBM Corporation, 2015).

Designing digital device integration systems for automobiles is not a matter that only concerns data connectivity and task definition. Various psychological and sociological constraints must also be considered in system specifications. Given the complexity of the digital context, it is therefore vital, in the early stages of the research, to gain an in-depth insight into what people desire from their automobiles in relation to the use of digital devices, as well as to identify their emotional connection to the automotive experience.

This chapter describes a preliminary case study conducted based on the hypothesis that emotional considerations can commonly be found in the main themes that emerge from the desirable automotive experience when integrating digital devices. Given the lack of any literature addressing desires for automotive experiences, and in particular any focusing on digital device integrations, the following basic questions arose and were covered in this chapter:

- What do people desire from automobiles in relation to digital device integrations?
- How can the automotive experience be related to emotional aspects?

5.2 Methodology

5.2.1 Stakeholder Model

It is not possible for any piece of research to collect everyone's opinions due to physical constraints. Given the reality of the research environment, it was necessary to consider an appropriate approach that would reach the targeted sample. For this reason, identifying this research's stakeholders was an important first step in establishing a logical structure for recruiting appropriate participants. Thus, the study adopted a stakeholder model to identify stakeholder groups for study participation according to the research objectives or goals (Overseas Development Administration (ODA, 1995). Using the most common and well-known definition of a stakeholder (Freeman, 2010), the definition this study used was that the term stakeholder 'includes persons, groups or institutions with an interest in the project's performance and in the outcome of proposed actions' (MacArthur, 1997; Newcombe, 2003; ODA, 1995). In order to achieve a logical structure for the recruitment of participants, the underlying framework for the stakeholder model was adapted from 'The Connected Car' by the Groupe Speciale Mobile Association (GSMA) and SBD Automotive (2012) (Figure 5.2), due to the similarity of their research objectives.

The structure suggested the following four groups of key stakeholders: 'consumers', 'vehicle manufacturers', '3rd parties' and 'governments'. Possible stakeholders for each of the four groups were listed in detail following the ODA criteria (1995), which aided potential purposive sampling (David and Sutton, 2011). The ODA criteria (1995) are as follows:

- Does the list include all primary (targeted groups who work in the research areas) and secondary (other groups who can possibly be involved in) stakeholders?
- Does the list incorporate all potential supporters and opponents of the topic?
- Does the list contain primary stakeholders who have been divided into user, occupational groups or vulnerable groups?
- Are there any new primary or secondary stakeholders who are likely to emerge as a result of the research?

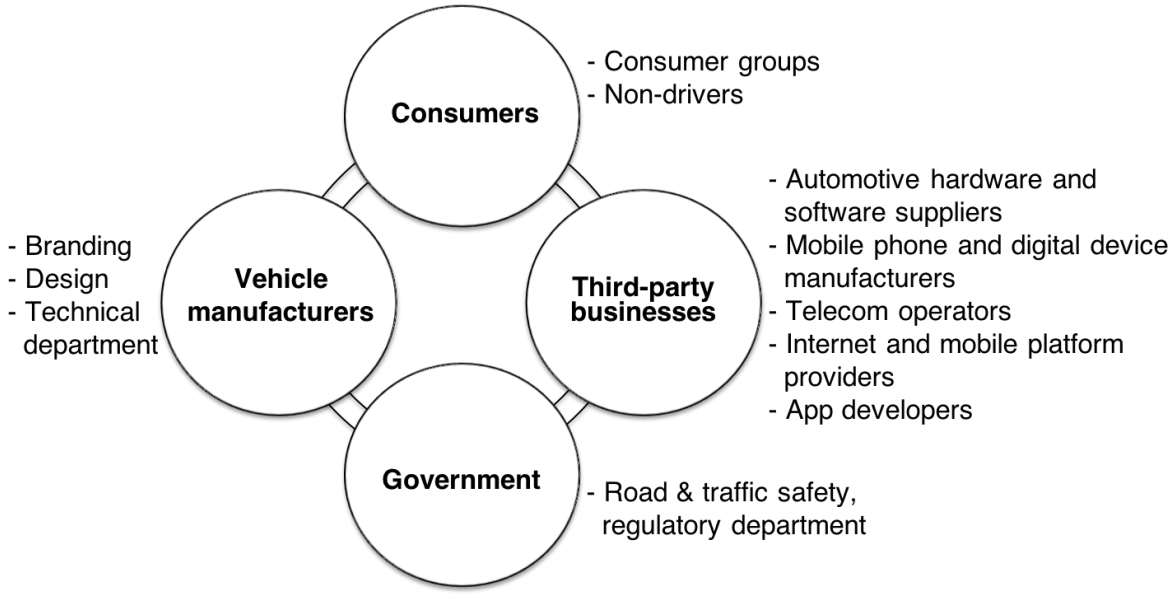


Figure 5.2 Stakeholder model.

In order to reduce any bias in listing the stakeholder subcategories, three other researchers in the same research group were asked individually to review the list and to add potential subcategories based on the above criteria.

5.2.2 Choice of Data Collection Method

This study used qualitative interviews to collect the data that was used to explore stakeholders' desires for automobiles and digital device integration and own experience as automobile users. This interview method has limitations, such as the interviewer's influence, which may lead interviewees' to skew their answer towards the interviewer's own perspectives (Poulson, Ashby and Richardson, 1996). There is also the challenge of assessing the reliability and validity of the results (Stanton et al., 2005), as all results are derived from the selected interviewee's own thoughts and their expressions of their experience. Conducting interviews, however, provides significant benefits to the study, as it aims to uncover detail in a certain area (Burgess, 1991) and to explore a variety of opinions from people (Easterby-Smith, Thorpe and Lowe, 2002; Stanton et al., 2005). In order to minimise any potential bias in the interview process and in the results in advance, three other researchers in a different field were involved in reviewing and revising the interview questions and protocol.

5.2.3 Sampling Strategy, Sample Size and Recruitment

A purposeful sampling strategy, commonly employed in in-depth qualitative research (Higginbottom 2004; Marshall, 1996), was adopted to recruit participants relevant to the research topic area (David and Sutton, 2011). Based on the stakeholder model (Figure 5.2), additional criteria for identifying characteristics of interviewees were considered to search for appropriate target interviewees to represent each stakeholder subcategory. As the study aimed to obtain a wide range of information and insights from interviews in a relatively short period of time (Marshall, 1996), the following criteria for key informant selection (Tremblay, 1957) and the qualities of key interpreters (Verganti, 2009) were used as a guide. This focused the selection of the sample on those with certain traits or qualities that were deemed necessary to answer the research question:

- Willingness to share their knowledge
- Influential in the emergence of new meanings for products, services or technology
- Engaged in forward-looking and pioneering projects
- Involved in small, local and large global companies

Furthermore, the level of seniority and the domain of the professionals were considered when targeting interviewees, as this helped to balance views and opinions with different degrees of experience, backgrounds and age. In addition to sampling professionals based on the stakeholder group, targeted sampling of a younger generation—such as individuals from Generation Z born after 1995 and defined as 'digital natives' (Wallop, 2014)—was considered next. As these individuals have never lived without the Internet and have learnt via high mobile technology whilst experiencing a deluge of information (Bershidsky, 2014; Williams and Page, 2011), it was imperative to recruit a Generation Z group. This group may determine additional, new design themes that could fill the gap between generations, helping to answer the research question. As for the selection criteria for this group, willingness to share their knowledge and experience with the consent of their parents was the most important trait or quality. Age, gender and level of seniority in school were additionally considered in order to find interviewees who had a balanced range of opinions.

The most commonly recommended sample size for the qualitative interview method is between 20 and 30 participants (Creswell, 1998; Mason, 2010; Nastasi, 2009). The majority of qualitative studies generally follow the concept of data saturation (Glaser and Strauss, 1967), where researchers continue sampling until no new data emerges; this was also applied to determine when to stop further sampling or to confirm that the sample size was sufficient. Considering the smallest acceptable sample, which is 15 per group in Bertaux's guidelines (1981), a minimum number of 15 participants from each of professional group and non-professional group were required. The sampling process was continued until the sample size reached 30 to confirm data saturation, although data saturation was achieved before the sample size met the predetermined number.

For the professional group, initial invitations containing the interview request were sent out though a professional social networking site. Initial contact was also made with the Generation Z (non-professional) group in three schools in London, in order to contact young students with different levels of seniority. No response was achieved from two schools and one school refused the request to interview their students, citing their school policy. Considering the difficulty with recruiting young students and the limited time, the researcher's personal networks were used to recruit the Generation Z (non-professional) group.

5.2.4 Interview Question Design

First, a list of topics based on the research questions were drafted, indicating what should be covered during the interview: context (what people currently think and do with their mobile phones from within their car); meaning and needs (things that people currently think are important about mobile phones and cars); and possible futures (apps that people would wish to have in their car in the future). These topics were used to structure specific interview questions, employing various frameworks.

In order to capture context, specific criteria were considered—what people wanted to achieve, how they would use mobile devices in given future circumstances, how they would interact and communicate with other people and objects, and the things that they want to have or do not want to have. The study used the five aspects of the A.E.I.O.U framework– activity, environment, interaction, objects and users (Martin and Hanington, 2012, Figure 5.3), which appeared to be appropriate for structuring questions to learn more about each specific situation or context.

In order to collect rich narratives and to interpret meanings appropriately, five types of descriptive ethnographic interview frameworks were applied (Spradley, 1979). These questions opened up unlimited possibilities to express more specific aspects of the events and to elicit more specific and differentiated desires from the interview participants. Further, a semantic differential framework, which is used to measure meaning (Osgood, Suci and Tannenbaum, 1957), and the 5Ws (Who, When, Where, What and Why) and H (How) framework, were adopted to balance the composition of meaning in questions.

In particular, questions deploying a backcasting framework were designed, in order to encourage the interview participants to envision possible futures (Robinson, 1988) regarding the integration of non-existing technology and automobiles. To uncover future views and requirements of technological innovations and future scenarios (Deszca, Munro and Noori, 1999; Jeoung, 2002), a trigger question was used, allowing the interview participants to become more immersed in situations from the near future to the far future (e.g. *"Imagining that you are in the year 2030, how might you wish to communicate with other people from within your car?")*

To understand the **context**	To understand the **meaning and needs**			To understand the **possible futures**
A.E.I.O.U framework	**Ethnographic framework**	**5Ws and H framework**	**Semantic differential framework**	**Backcasting framework**
Activity, Environment, Interaction, Objects, Users	Grand tour, Mini tour, Example, Experience, Native-language	Who, When, Where, What, Why, How	Evaluation, Potency, Activity	Normative approach Less bounded by present Desirable future, not likelihood

Figure 5.3 Criteria for designing interview questions (adapted from Martin and Hanington, 2012; Osgood, Suci and Tannenbaum, 1957; Robinson, 1988; Spradley, 1979).

The specific interview questions and the order of the questions were discussed with three other design researchers to find the most appropriate question arrangements for the interviews and to avoid ambiguity in the questions. 11 questions were finally designed (Appendix A).

5.2.5 Study Protocol

According to David and Sutton (2011), the structured interview type refers to 'the degree to which the form and order of questions asked are kept identical from interview to interview'. For coherence and consistency, the same sequence of questions was used for all the interviews; however, given the flexibility in collecting qualitative data, and particularly when interviewing the young age group, the interview was semi-structured (Bryman, 2008). Some basic interview protocols were used with the interviewees from the beginning to the end; however, follow-up questions were added in order to ask participants to elaborate and to provide more detailed information, depending on their initial answers. Moreover, the use of some of the wordings was flexible in order to improve the interviewee's understanding of the questions, particularly in the young student group. For example, in Q6, as 'business trip' was not appropriate given their age, the word 'business' was replaced with 'family', so as to allow them to recall their experience. In Q8, 'technically savvy' needed to be explained in detail in order to improve their understanding of the question, adding the definition given in Standard English language dictionaries (Cambridge), 'knowing a lot about modern technology, especially computers'.

The semi-structured interviews were conducted via phone or video call at the time and date agreed, from April to June 2014. After the interview procedure had been explained, interviewees agreed to a voice recording for data analysis. A target interview time of approximately 45 minutes (Nastasi, 2009) was chosen so as to minimise the bias that can occur due to learning or fatigue effects (Giacomin, 2005). Prior to performing the activities, research ethics approval was sought and granted by the Brunel University Research Ethics Committee (Appendix C). This covered all aspects of the activity, including participant selection, interviewing, data collection, data analysis, data security and confidentiality. In accordance with the code of ethics, the research participants were fully aware of the process and they were informed that they could withdraw from the interview at any time and that the information provided would be kept strictly confidential and anonymised. Consent of information was agreed in advance.

5.2.6 Data Analysis

The interviews yielded raw data with recordings of over twenty-five hours of audio conversations, which were transcribed verbatim in full. Following the recommendations of Saldaña (2013), coding was conducted manually, because it helped the researcher to have more control of the raw data and to improve the familiarity with the work. Qualitative thematic analysis was used to identify implicit ideas beyond the explicit words and phrases that were present in the interview data (Boyatzis, 1998; Braun and Clarke, 2006; Burnard, 1991). There are some criticisms of the qualitative thematic analysis method, such as researcher subjectivity (Gray, 2009) and the lack of widely accepted guidelines compared with quantitative, statistical analysis (Bryman, 2008; Berg and Lune, 2012; Saldaña, 2013; Morgan, 1993). This study, however, used the method because of the following benefits:

- It provides a clear understanding of the participants' attitudes, thoughts and experiences of issues (Alhojailan, 2012; Crawford, Brown and Majomi, 2008)
- It creates concepts and theories from complex phenomena (Neuman, 2003)
- It is a flexible research method with detailed and complex qualitative data (Braun and Clarke, 2006)
- It highlights similarities and differences across the data set (Braun and Clarke, 2006)

The thematic analysis described in this chapter employed an inductive approach (Figure 5.4), which starts with open coding from the data and grouping the codes into themes (Elo and Kyngäs, 2008), following standard thematic analysis guidelines (Braun and Clarke, 2006).

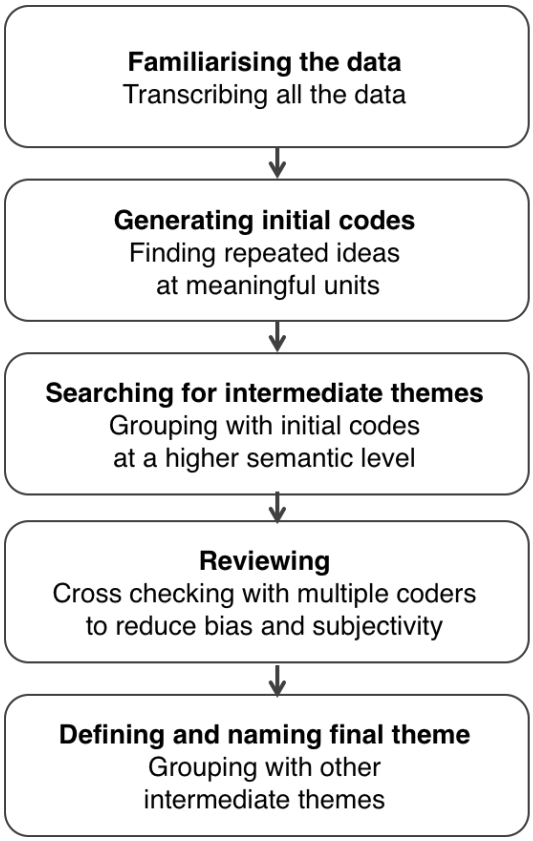


Figure 5.4 Process of qualitative thematic analysis (adapted from Braun and Clarke, 2006).

All transcriptions were re-read and cross-checked by the lead researcher. The words, phrases, sentences and paragraphs were then reduced to a set of 'codes', which were organised by means of a colour-coded spreadsheet. The individual 'codes' were then collated to a higher semantic level by each of the three researchers who had been chosen to act as the multiple reviewers for the study. Each researcher was then asked to further collate the subthemes to the higher semantic level of main themes. To reduce bias and subjectivity, the complete group of researchers (the lead researcher and the three multiple reviewers) reviewed the main themes via an iterative negotiation process until the team agreed on a final set of main themes and subthemes. During the iterative process, the principle selection criterion was: 'Could this main theme be related to a possible current or future digital device integration system?'

5.3 Results and Discussion

This current study's primary aim was to investigate what people desire to experience with digital technologies in an automobile and to identify the relationship between the desire and emotional considerations via qualitative interviews with stakeholders (n=32). The hypothesis underlying this research was that emotional considerations could be commonly found in the main themes that emerge from desirable automotive experience in relation to digital device integrations.

All of the interviewee's responses (n=32) were analysed to determine their desirable automotive experiences in relation to digital device integration. Table 5.1 provides a summary of desires for automotive experience, determined from the complete data set achieved by thematic analysis. The main results with exemplary interview transcripts and the implications of the findings are addressed and discussed following the research questions (5.1. Introduction).

5.3.1 Discussion of Desires for Automotive Experience with Digital Technologies

The four main themes and nine sub themes were commonly derived from both the professional (p) and non-professional (np) groups (Table 5.1). The themes were characterised by the several obvious similarities to driving forces that have been identified in relation to digital media and mobile technologies. Diewald et al. (2011) have in fact previously noted such similarities and have suggested that people seem to treat their automobiles as a smart device rather than simply as a means of transport, transferring metaphors and expectations from the source domain (mobile technologies) to the target domain (automobiles).

Main Theme	Sub Theme
All-in-one tool	• Tech-utility tools, such as navigation, Bluetooth and music systems, are expected to support driving conditions. • Multi-functional features via an integrated digital device are desired.
Seamless integration of real-time information & Productive time management	• All user activities are expected to be continuous, and data should automatically cross over onto different platforms. • Vehicle-related information alerts, like traffic status, fuel, security or maintenance, are desired to be provided at the right time and place. • Users expect customised information that is related to their lifestyles, including health monitoring, shopping suggestions or travel, to become significant.
Lifestyle companion	• A digital work-life assistant, such as for managing calendar scheduling, is viewed as a useful feature. • A digital private life consultant encompassing tasks, such as taking care of housework, is considered beneficial.
Limitless environment and vehicle autonomy	• Interviewees suggested that they desire telecommunications systems that are much more expansive and extensive. • WiFi that is integrated and supports the connectivity of vehicles is considered desirable, and a greater degree of vehicle autonomy is considered desirable.

Table 5.1 Summary of themes investigating automotive experience in relation to digital device integrations.

All-in-One Tool

Previous research regarding mobile technologies (Chung, Yoo and Kim, 2013) has suggested that rapid increases in data traffic has led to requests for 'convergence systems' that interpret driver intentions and provide personalised services by configuring devices and sensors.

The interviewees suggested that integrating mobile devices into automobiles appears to be a 'tool' with multi-functionality that allows easy and simple access to individually desired functions. Along with these multi-functionalities, however, the expectation of a unifying feature that would collect all of the customised individual functions into one tool was identified as being important (Np=95 and Nnp=64, the number indicates the total frequency of codes in relation to the theme in each group). This suggested that an increasing number of multi-functions might not be an ideal way to integrate mobile devices and automobiles. Participants explained their views on this as follows:

'Like a Swiss army knife. [...] I guess it is almost like a brain to people' (p).

'There are so many functions that require me to individually remember things but one overriding app, that could be useful. I want easy access to everything in one device' (np).

Seamless Integration of Real-Time Information and Productive Time Management

Previous research regarding wireless networks and mobile computing (Agrawal and Famolari, 1999) has identified the systematic integration of technologies and the seamlessness of the user experience as key requirements of success in the sector. Similar conclusions about the importance of seamlessness have also been drawn by automotive sector reviews (Klier and Rubenstein, 2011) and by reviews of future mobility (Huber, 2013).

Most interviewees imagined a daily future context in which they engaged in continuous activity through the integration of mobile devices and automobiles that would allow for seamless connectivity. Although there was a slight difference that the professional group sometimes desires a status of 'disconnectivity' whereas the non-professional group never wants to be disconnected from network society, both interview groups highlighted that consistent levels of connectivity with real-time information, regardless of the place or the device, would be crucial in their future lives

(Np=56, Nnp=36). This seamless experience implies that all information would automatically be synced and transmitted across the user's devices, which would make the user's life more convenient, as demonstrated in the following quotes from participants:

'...when you get in the car, you can just continue reading that book [...], car remembers the last chapter you were reading' (p).

'You just shouldn't touch your phone when you get into a car. It has to be absolutely synced' (p).

'If you are travelling with other people in a different car, [...], the phone can detect where your friend's car is, so it can track back where they are and go to that place' (np).

In relation to the desire for a seamless automotive experience, managing time productively within the automobile was one of the required characteristics mentioned by both interview groups (Np=20, Nnp=11). Time saving was often exemplified in the description of benefitting from accessing information by remotely checking the status of the automobile and managing schedules via a real-time journey calculation system. One participant referred to:

'...Things, which control its environment where you don't need to go in person, to go to certain places to double check if that is okay' (p).

Interviewees from both groups expected that integrating mobile devices and automobiles would be beneficial with regard to enhancing their productivity, regardless of the form of the integration. This theme also suggested that the intention to use mobile devices in automobiles had the aim of making productive and effective use of time. As one participant explained:

'Rather than time-wasting by doing other things, I usually check over what I need to do in the day' (np).

Lifestyle Companion

Previous research regarding mobile computing has also suggested that the success of the devices depends on the compatibility of their interfaces with the characteristics of human cognition and emotion. For example, Ladd et al. (2010) noted the need to consider human 'cognition and

emotion/motivation' characteristics. A large body of evidence supports the claim that people tend to treat computers in much the same manner as they treat human beings (Reeves and Nass, 2006), reaching as far as potentially finding companionship if the digital device exhibits characteristics appropriate to the meeting of human cognitive and emotional needs (Wilks, 2010).

In the interviews, enthusiasm was expressed for an intelligent lifestyle companion that holistically manages professional and social activities and relationships. This was a common theme for both interview groups, who both craved greater convenience in their lives (Np=41, Nnp=40), as reflected in these quotations:

'Beverage in the morning [...] Check for mails, juice, check for everything...it's endless' (p).

'If I haven't contacted my girlfriend much during the day, it would remind me to contact her or drop her a text' (np).

In addition to the typical role of a personal assistant, including managing schedules, interviewees expressed the need for an intelligent companion that is able to provide social tips in accordance with different cultures, and to read the other person's emotional status to improve personal relationships.

'I would connect to apps on my child's phone to see if she is okay, I would want to know how she's feeling' (p).

Limitless Environment and Vehicle Autonomy

Previous research regarding network services has identified ubiquitous in-car connectivity as an important requirement. For example, a 2016 whitepaper by the Groupe Speciale Mobile Association (GSMA) has suggested that the decoupling of apps from phones, changes in pricing models and other network service developments are leading to an increasing amount of data being provided. This data acts in support of safety, security, convenience, navigation, infotainment, electric vehicle operation, vehicle relationship management, usage-based insurance, fleet management and electronic toll collection. The concepts of ubiquitous in-car connectivity can be seen to be present to some degree in all of the themes and subthemes identified by the current study, but with particularly strong manifestation in the theme of Limitless Environment and

Vehicle Autonomy (Np=44, Nnp=25). As one participant stated:

'One can be free to socialise and communicate. I can do whatever I do at home in my car as a personal space. [...] It will bring about a rearrangement of the interior of the car' (np).

The theme of *Limitless environment and vehicle autonomy* can perhaps be interpreted as a declared desire to avoid all possible barriers to data and service access, despite the physical constraint of being in a vehicle:

'Work, watch films, sleep, work emails, or have meetings [...] The driver becomes the passenger' (p).

'I can play 3D videos on the transparent windshield [...] My car will be a theatre' (p).

The current study did not detect any fundamentally new driving forces. Instead, it confirmed a significant transferral of metaphors and expectations from the source domain of mobile technologies to the target domain of the automobile. Or, viewed in another way, it showed a degree of commonality between the two contexts.

5.3.2 Discussion of the Relationship between Automotive Experience and Emotional Aspects

To better understand automotive experience as characterised by the four main themes (Table 5.1), the consideration of the emotional relationship beyond functional efficiency appears to be significant in automotive design. This confirmed the hypothesis that emotional considerations were commonly found among the main themes in relation to digital device integrations.

The desire for functional efficiency coupled with advanced technical support is reflected in the themes, 'All-in-one-tool', 'Seamless integration of real-time information and productive time management' and 'Limitless environment and vehicle autonomy'. Advanced Internet and mobile technology that expands the capacity of in-car connectivity has increased the demand for functional efficiency in an automobile (Sheller, 2004; Massy, 2007). To meet this demand, functional efficiency when it comes to digital device integrations has long been the prime concern in automotive design (Gkouskos and Chen, 2012). Indeed, the impact of functional efficiency can

be immense in more ubiquitous connected automotive environments, maximising the driver and passengers' convenience and time efficiency while travelling (Mahmassani, Abdelghany and Kraan, 1998). More importantly, the study commonly captured peoples' fundamental desire to avoid negative emotions like anger or frustration, which are caused by functional inefficiency. This fundamental desire underlay these main themes. These themes involving efficient, connected and seamless digital device integrations into an automobile were considered as consequential features and contexts reflecting individual's hidden desires.

The desire for an emotional relationship with an automobile is most strongly manifested in the theme '*Lifestyle companion*'. It reflects the changed perception regarding automobiles, from a transport machine to an emotionally bonded companion, like a family member (Sheller, 2004). Further, this findings implies that an automobile is an affective and embedded habitat in which emotions occur (Gkatzidou, Giacomin and Skrypchuk, 2016). Given the impact of emotions on the success of many products and services, including human machine interaction in automobiles (Gkouskos and Chen, 2012), emotion in the automotive experience must be considered. Picard and Wexelblat (2002) have highlighted that designing products, systems and services without considering the emotional aspect of human experiences is likely to fail to satisfy human needs and desires. Gomez, Popovic and Bucolo (2004) have also suggested that a strong emotional bonding between the human and the machine may significantly influence the automotive experience.

Although previous research has investigated emotional aspects, the focus of the studies was on aesthetic aspects (Desmet, 2002) and social requirements (Pelly, 1996), rather than affective contexts that create emotion (Sheller, 2004) as a companion. Emotional aspects in automotive experiences have received relatively less focus as criteria for success in the field of automotive design when compared to the great attention and investment given to functional requirements. To properly understand the automotive experience, therefore, the emotional aspects in the automotive context should be considered beyond improving product attributes and functionalities (Gomez, Popovic and Blackler, 2011).

5.4 Summary and Conclusion

This chapter sought to answer the second question that was initially posed in the first chapter,

‘How can the automotive experience with digital technology be related to emotional aspects?’ Here, this study confirmed the hypothesis that emotional considerations are commonly found when studying peoples’ desirable automotive experiences related to digital device integration.

By interviewing thirty-two stakeholders belonging to four key stakeholder groups, the study found four main themes when discussing desirable automotive experiences: all-in-one tool; seamless integration of real-time information and productive time management; lifestyle companion; and limitless environment and vehicle autonomy. The most commonly captured desire in the study was the development of an emotional relationship beyond functional efficiency; this desire indicates that these four themes may play a critical role in designing better automotive experiences. It is evident in these findings that there is an implicit fundamental desire for complete freedom from the negative emotions caused by functional inefficiency, which an automotive designer should consider. The preliminary case study therefore confirmed that an in-depth understanding of emotional aspects, particularly of specific contexts with automobiles that elicit emotions could be a stepping-stone to enhance the automotive experience.

The limitations of the methodology, particularly the influence of the researcher’s bias on qualitative data during the interview and thematic analysis process (Gray, 2009), could be alleviated through further reliability checks on the themes. Nevertheless, the results of this preliminary case study provide a strong rationale for subsequent research studies to investigate various contexts with automobiles that trigger emotions beyond functional requirements.

6 Affective Scenario Development Part 1: Developing the Online Questionnaire

In order to answer Research Question 3, which was posed in Chapter 1 – 'How can an 'affective design scenario' be developed in a complete and rigorous manner?'— the following two objectives were established: (1) to develop an appropriate online questionnaire that best captures affective scenarios in automotive contexts, and (2) to take a triangulation approach for formulating affective design scenarios. This chapter focuses on the first of three parts of the study: how to develop an appropriate questionnaire that best captures affective scenarios. The next two chapters focus on formulating affective design scenarios using a triangulation approach (Jick, 1979).

Standard English language dictionaries (Cambridge, Merriam-Webster and Oxford) suggest that the word 'questionnaire' refers to a set of written questions that are used to collect information from a number of people and that are designed for the purposes of a survey or statistical study. The questionnaire can play a central role in drawing relevant responses from people, even though the quality of responses may vary depending on the questionnaire (Krosnick and Presser, 2009). In order to get valid results from the study, it is necessary to collect appropriate responses that can be analysed (Reja et al., 2003). To reduce response errors, questionnaires should be developed carefully.

In order to be thorough in developing affective scenarios, this study prioritised reaching out to the target sample as widely as possible, using a web-based survey format. This format was used due to its obvious advantages, including its faster speed, comparatively wider coverage and the lower cost of data collection, in comparison to traditional approaches like face-to-face interviews (Heiervang and Goodman, 2011). Therefore, the term questionnaire here is used to refer generally to the instrument for collecting relevant data through the online survey platform (Cohen, Manion and Morrison, 2013).

The development of this online questionnaire took the following considerations and procedures into account (Crawford, 1997; Kelly et al., 2003; Radhakrishna, 2007): the selection of research methods; the development of questions to elicit detailed contextual information and information

about emotions that people frequently experience with automobiles in their real life; the questionnaire's layout; and iterative testing and validation of the developed questionnaire.

6.1 Selecting the Research Method

Numerous methods have been developed to assist designers and researchers to understand human needs and desires. The available design methods have been listed and aggregated based on various criteria such as the design phase (Martin and Hanington, 2012; Kumar, 2013), its characteristics and user involvement (IDEO, 2003), frequency of use, author's knowledge and experiences or even designer's perceptions (Goodman-Deane et al., 2008). As suitable methods can vary depending on research purpose and end-goal, determining whether a method aligns with the achievement of a research goal is an important consideration in the early design process. This was particularly significant for the current research, which is focused on identifying automotive contexts that involve human emotions.

The first step was searching publications – including books, journal papers and industrial toolkits – that generate a list of design methods, using the search keywords 'design methods'. This review initially identified 126 design methods from publications (Appendix B). This research resulted in the development of a primary question to successfully obtain a variety of emotional contexts from a large number of people: 'Is the method designed to extract deeper feelings and details motivating participants?' (Lucero and Mattelmake, 2007). When the researcher reviewed the possible 126 design methods with this key question in mind, the potential methods were subsequently narrowed down using a set of secondary questions in order of priority (Figure 6.1).

The selection of methods was cross-checked in a review by a group of three researchers to minimise researcher bias in selection. The selected reviewers were came from different professional backgrounds in design, to ensure a greater breadth and depth of experience in employing design methods. Subsequently, reviewers were drawn from the fields of industrial design (male aged 35), fashion design (female aged 31) and product design (male aged 27). Each reviewer independently evaluated the description of each method and reviewed the list of methods against the established questions above. A final discussion that included the researcher and all of the reviewers was held in order to reach agreement among all of the reviewers regarding the

methods. Before recruiting interview subjects, the project was granted the ethics approval by the Brunel University Research Ethics Committee (Appendix C). This approval covered all aspects of the study, including selecting methods, formulating the questionnaire and pilot testing and validating questionnaire.

Figure 6.1 summarises the method selection results, according to the researcher and the three independent reviewers, against the primary and secondary questions from the list of 126 methods. As a result of cross-checking, three methods were deemed appropriate for the research: ‘The love letter & the breakup letter’, ‘Freelisting’ and ‘Sentence completion’. Considering that a mixed-methods approach can improve the accuracy of the results by collecting different types of data (Jick, 1979), the main concepts were adapted to add rigour to the data collection.

Key questions		Methods selected by			
		Reviewer 1 (main researcher)	Reviewer 2	Reviewer 3	Reviewer 4
Primary question	• **Is the method designed to extract deeper feelings and details motivating participants? (Lucero and Mattelmake, 2007)**	Bodystorming Collage Critical incident technique Cultural probes Design ethnography Diary studies Freelisting Photo studies Picture cards Role-playing Sentence completion The love letter & the breakup letter Triading Walk a mile immersion	Bodystorming Collage Critical incident technique Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter Triading Walk a mile immersion	Artifact analysis Collage Critical incident technique Cultural probes Design ethnography Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter Triading	Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter Triading
Secondary question	⬇ • **Is the method stimulating and fun? (Hemmings et al. 2002, p48)**	Bodystorming Collage Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Bodystorming Collage Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Collage Critical incident technique Cultural probes Freelisting Sentence completion The love letter & the breakup letter	Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter Triading
	⬇ • **Does the method encourage participation whilst not overly burdening the participant with work? (Herd et al, 2009, p199)**	Cultural probes Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Bodystorming Collage Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Collage Cultural probes Freelisting Sentence completion The love letter & the breakup letter	Cultural probes Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter
	⬇ • **Is the information easily documented, collected, and stored? (Mattelmaki 2006, p75-6)**	Cultural probes Freelisting Sentence completion The love letter & the breakup letter	Bodystorming Collage Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Collage Cultural probes Freelisting Sentence completion The love letter & the breakup letter	Diary studies Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter
	⬇ • **Is it possible to conduct the method with a large scale of participants?**	Freelisting Sentence completion The love letter & the breakup letter	Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Freelisting Sentence completion The love letter & the breakup letter	Diary studies Freelisting Photo studies Sentence completion The love letter & the breakup letter
	⬇ • **Is it possible to systematically analyse the method?**	Freelisting Sentence completion The love letter & the breakup letter	Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Freelisting Sentence completion The love letter & the breakup letter	Diary studies Freelisting Photo studies Sentence completion The love letter & the breakup letter
	⬇ • **Is it appropriate to conduct the method using a digital platform?**	Freelisting Sentence completion The love letter & the breakup letter	Freelisting Photo studies Picture cards Sentence completion The love letter & the breakup letter	Freelisting Sentence completion The love letter & the breakup letter	Diary studies Freelisting Photo studies Sentence completion The love letter & the breakup letter

Figure 6.1 Summary of methods selection results by reviewers.

‘The love letter & the breakup letter’ method (Smart Design, 2009) uses a personal letter to allow participants to express their emotions and describe detailed contexts regarding products, services or experiences (Martin and Hanington, 2012). Descriptions in the love letter can describe various contexts that create positive emotions, illustrating why people love a product, service or experience. Correspondingly, the breakup letter can describe the concerns, issues or events that evoke negative emotions, indicating a broken relationship with a product, service or experience (Martin and Hanington, 2012). Writing a letter personifies the product, service or experience, allowing participants to share their real-life stories. Therefore, this method was considered to be appropriate for collecting participant’s real-life stories in automotive contexts in which either positive or negative emotions are experienced.

‘Freelisting’ and ‘sentence completion’ are used to explore participant’s emotional concerns, attitudes or perspectives (Barton, 2015). Freelisting allows participants to list words or items that are considered to be important or impactful to them. For example, a question may ask a participant to “Think briefly about all of the events and developments which have happened in the past approximately 500 years. List three which, in your opinion, are the most important” (Seixas, 1994, p. 301). Sentence completion allows participants to complete a provided sentence with a couple of their own words. For example, “I like to learn about …” (Barton, 2015). These methods can be adapted to any topic, and used with a large number of participants to probe participants’ subconscious thoughts (Barton, 2015). These were considered be appropriate for eliciting a participant’s deeper feelings and impactful memories in relation to automotive contexts.

6.2 Formulating the Online Questionnaire

The quality of the questions posed is directly linked to the response that is collected; since participant’s responses to questionnaires may differ depending on question topics, specific wording and question order in the questionnaire, it is very important to carefully plan for these while developing a questionnaire for a survey to succeed (Kelly et al., 2003). Several researchers have suggested that a useful approach to developing an optimal set of questions involves using target samples and experts in the field of research topic or even relying on colleagues, as these methods have the benefit of covering appropriate information that can help structure questions (Kelly et al., 2003).

For this reason, the researcher conducted a preliminary study involving target samples (general public) and experts in the automotive industry in order to identify key constructs for structuring the online questionnaire to draw out detailed contextual information and emotions related to automobiles. This attempt to obtain preliminary categories from a group of potential samples could help determine the relevance of the questions (Frary, n.d.). Further, the study used a workshop format in order to formulate key constructs to (Muller, 2002; Steen, Manschot and De Koning, 2011): (1) improve mutual learning and understanding, (2) integrate different people's ideas and jointly create new ideas, and (3) enhance communication and cooperation between different people.

Workshop Procedure

The workshop aimed to identify key constructs through preliminary categories of automotive scenarios that can be used as a basic structure for the online questionnaire in the research. The workshop allowed participants to explore real-life automotive experiences, both driving-related scenarios and non-driving-related, and to integrate automotive scenarios into categories as a group.

The study used two workshops with different participant groups to capitalize on the benefits of using target samples and industry experts when developing this questionnaire (Kelly et al., 2003). The first was an automotive-professional group (n=7) recruited through an industrial partner (Jaguar Land Rover, an automobile manufacturing company in the UK). The second group was comprised of non-automotive-professionals (n=7) whose members were recruited through a professional social networking site and the Brunel University website. The workshops took place in Coventry, UK and London, UK in 2015. All study processes were followed according to both Brunel University's 'Code of research ethics' (CoE, 2014) and the UK guidelines (Data Protection Act, 1998), and the university's ethics approval was fully granted prior to beginning participant recruitment (Appendix C).

In order to create a single data set, each workshop adopted the same structure. Both workshops had three phases lasting 2.5 hours: Introduction, Generation and Discussion. The Introduction phase included an overview of the research background, the workshop's aim, and defined scenarios and presented examples of the terms to help participants understand the workshop's goal. To clarify the terms 'driving-related scenarios' and 'non-driving related scenarios', an explanation of

tasks (Geiser, 1985; Kern and Schmidt, 2009; Thorslund et al., 2013; Tönnis, Broy and Klinker, 2006) was given with the following examples:

- *Driving-related scenarios*
- primary task: e.g. 'My wife spilled coffee on me, while I was driving. It was really dangerous'.
- secondary task: e.g. 'While I was adjusting my seat at a red signal, I mistakenly pressed the accelerator'.

- *Non-driving related scenarios*
- tertiary task: e.g. 'I was annoyed as someone wanted to take my car park, when I was trying to get some sleep in my car while waiting for my wife'.

During the generation phase, both sets of workshop participants were asked to independently list any possible driving and/or non-driving scenarios on sticky notes. This allowed them to explore as many of their real-life automotive experience as possible. Then they were asked to categorise the generated scenarios into groups and give them a label as a team (Figure 6.2). After the generation session, all workshop participants discussed the generated categories with predefined categories that induce driver's erroneous behaviour, such as road infrastructure, vehicles and other road users etc. (Stanton and Salmon, 2009), in order to check whether the generated categories covered all possible categories.

Figure 6.2 Workshop for identifying preliminary categories of automotive scenarios.

Data Analysis

The purpose of data analysis was to extract key constructs of automotive experience by

categorising collected scenarios into meaningful themes. Between the two groups, the workshops generated 190 individual scenarios written on the sticky notes (99 from the automotive professional group, 91 from the non-automotive professional group); these were subsequently typed and saved in a digital form to efficiently manage all of the written data. These were analysed through thematic analysis, which is a widely used analytic method in qualitative research (Burnard, 1991; Boyatzis, 1998; Attride-Stirling, 2001; Braun and Clarke, 2006). The analysis was conducted in five phases, from generating codes and themes to refining and presenting themes (Table 6.1). To ensure the validity of the themes generated by the lead researcher, a group of three researchers acted as independent multiple coders to perform thematic analysis. Each theme and subtheme was discussed until all researchers reached agreement.

Phase	Description of the process
1. Generating initial codes	Organising the data into meaningful groups.
2. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
* Validity of the categorising method	Inviting multiple coders to generate category systems without seeing the researcher's list.
3. Reviewing themes	Checking if data within themes would cohere together meaningfully.
4. Defining and naming themes	Refining each theme and generating clear names for each theme for deeper level of analysis.
5. Summarising and Interpreting patterns	Presenting the main themes and patterns characterising it.

Table 6.1 Thematic analysis process (adapted from Burnard, 1991; Braun and Clarke, 2006).

Preliminary findings

The workshop data set resulted in 12 categories, which were characterised by the cause and effect that form typical automotive scenarios (Figure 6.3). Either positive or negative emotions were involved in the scenarios, which were influenced by the three main causes: functional systems, social communication with people and basic requirement.

- *'Functional systems'* covers five categories:

- **Digital technology integration**: Participants emotionally responded when they used their mobile devices that were connected to the infotainment systems in cars (e.g. making calls using apps in a car).

- **Usability**: Participant's stressful stories were expressed concerning the ease of use and learnability of the buttons, a boot and seats in cars.
- **Personalisation**: Relative to usability, the desire for bespoke in-car features or services in accordance with a driver's settings and preferences were identified.
- **Feedback from car**: Participant's unpleasant emotions were illustrated due to their confusion about all the different types of warning signals from the car.
- **Sat-nav**: Participant's stress was related to inconvenience due to counterintuitive interface of sat-nav.

- 'Social communication with people' includes two categories:

- **Social interaction**: Unpleasant emotions due to discomfort were described in participant's stories with regards to in-car communication and interaction between the driver and the passenger. Happiness also appeared relative to interaction with family and friends in a car.
- **Symbol of identity**: This was related to the participant's belief that the posture of a driver in a car, or the car itself, represents the driver's own characteristics and identity.

- *'Basic requirement'* explains two categories:

- **Maintenance**: Concerns about regular cleaning and mandatory servicing of a car were expressed through participant's frustration and stress.
- **Safety**: Participant's fear and anger were expressed emphasising caution about safety regarding unexpected and dangerous situations caused by faulty functions in a car, or lack of driving skills and carelessness.

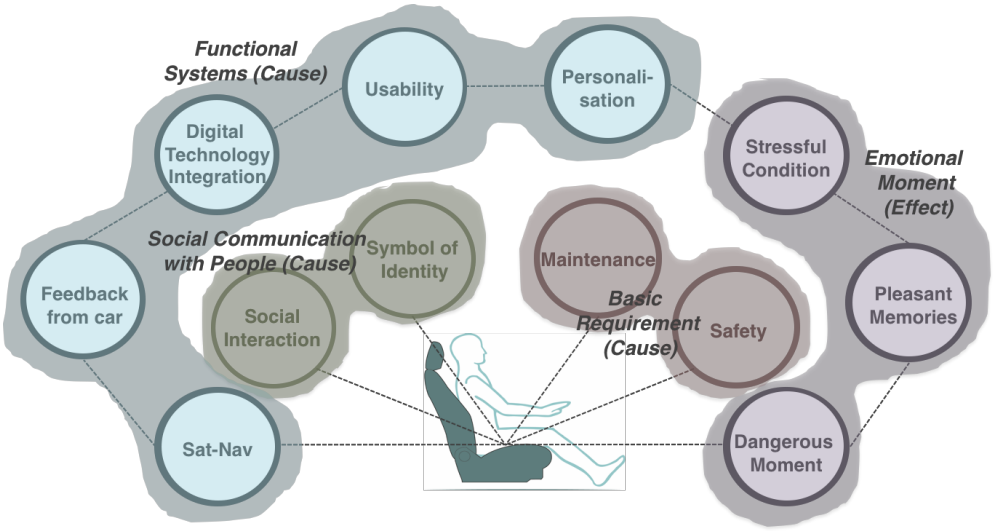


Figure 6.3 Preliminary categories of automotive scenario.

These four constructs were used as a foundation to develop a basic structure for the questionnaire in the research. For example, the final questionnaire used terms like ‘functional systems’, ‘social communication with people’ or ‘stressful’, ‘pleasant’ and ‘fearful’ which were used in these workshops.

6.3 Online Questionnaire Layout

The overall layout directly influences data quality and the respondent’s willingness to complete the online survey (Kelly et al., 2003). Poor visual design, technical errors, ambiguous wordings and complicated ordering of questions may prevent respondents from thoroughly answering the questions. The form of the questions, wordings and order of the questions were carefully designed to aid respondents’ understanding and interpretation of the questions (Foddy, 1993; Kelly et al., 2003).

Question type

The study used open-ended questions to discovering a wide spectrum of experiences and perspectives, rather than close-ended questions that would limit respondent’s opinions to the set of options provided (Lazarsfeld, 1944; Foddy, 1993). The freedom of open-ended questions, however, made it even more important to word the questions explicitly and carefully to prevent

respondents from providing vague and overly broad answers (Reja et al., 2003).

Criteria for checking questionnaire layout – Form, Wordings, Order

Self-reported online questionnaires do not allow the researcher to communicate with respondents, which can limit the respondent's understanding of the questions and makes it impossible for the researcher to encourage them to provide specific answers. To check the details of the overall questionnaire content, the following set of criteria, summarised by Krosnick and Presser (2009), was applied:

- *Question structural form*
- avoid leading or loaded questions that push respondents toward an answer;
- ask about one thing at a time;
- avoid questions with single or double negations.

- *Question wordings*
- use simple, familiar, specific and concrete words, simple syntax;
- avoid words with ambiguous meanings;
- make response options exhaustive and mutually exclusive.

- *Question order*
- place questions that can be easily and pleasantly answered in the early stage;
- explicitly address topic of the survey at the beginning of the questionnaire;
- place questions on the same topic together;
- proceed questions from general to specific;
- place questions on sensitive topics at the end of the questionnaire.

6.4 Pilot Testing of the Online Questionnaire

The pilot study, or 'try out' investigation (Waite, 2001) was used to assess the study's feasibility and to prevent any potential problems in a larger main study where there would be more samples (Thabane et al., 2010). It was also used to determine recruitment rate and estimate the necessary resources, including time and budget (van Teijilingen and Hundly, 2002). It also allowed us to

ensure that the form is appropriate, and that the questionnaire clearly targets the required sample (Lancaster, Dodd and Williamson, 2004). All study processes were followed according to both Brunel University's 'Code of research ethics' (CoE, 2014) and the university's ethics approval was fully granted prior to conducting pilot testing (Appendix C).

Procedure

Each of the chosen data collection tools (Survey 1 used 'The love letter & the breakup letter', Survey 2 used 'Freelists and sentence completion') was used in separate web survey interfaces to reduce potential issues to prevent the participants from becoming confused. Both surveys were posted at the same time and were advertised using Google, Facebook, the Brunel University website and the research participation websites.

- Survey 1 used a 1-minute video clip to illustrate brief instructions on what participants should write about in order to facilitate useable responses. The participants were asked to write either a love letter or a breakup letter and answer a set of general demographic questions (Figure 6.4 (a)).
- Survey 2 asked the participant to fill in the blanks, and then asked them to list three words and answer a set of general demographic questions (Figure 6.4 (b)).

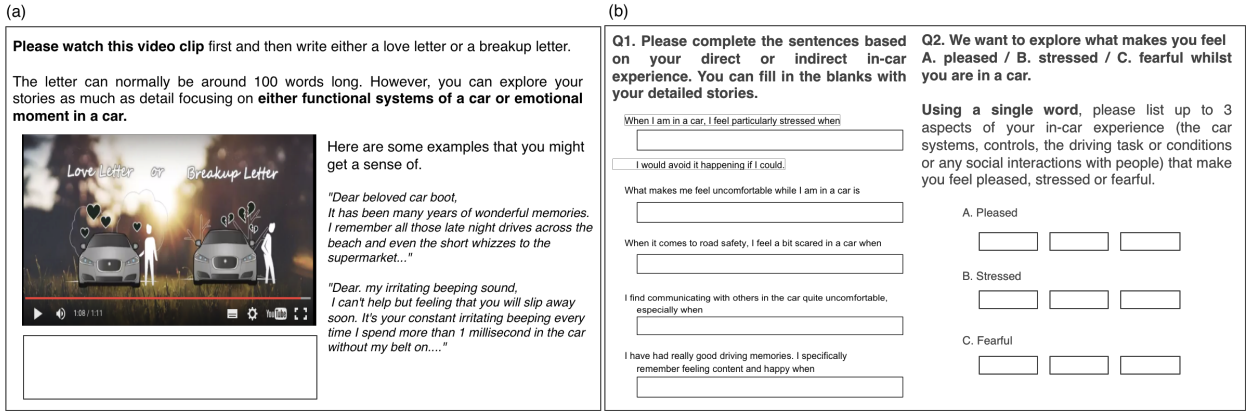


Figure 6.4 (a) Survey 1 'The love letter & the breakup letter', (b) Survey 2 'Freelists & sentence completion'.

Data Analysis and Results

70 completed responses (Survey 1: 22, Survey 2: 48) were collected. In survey 1, 15 of the participants were males and seven were females. The mean age of the participants was 31 years. In survey 2, 20 of the participants were males and 28 were females. The mean age of the participants was 36.3 years. Although both surveys had a similar number of page views (Survey 1: 250, Survey 2: 225 respectively), the complete response rate of survey 1 was 9 per cent while survey 2 had a complete response rate of 19 per cent.

The purpose of the analysis in the pilot study was to check the usefulness of the collected responses, so as to assess the feasibility of the chosen methods and questionnaire and to determine other potential issues. A series of questions in terms of the usefulness of the data set and the appropriateness of the chosen method and questionnaire were raised:

- Does the data set include all of the critical factors that compose scenarios?
- Does the data set include all the important causes that prompt emotions?
- Is the questionnaire complicated and demanding of participants?

Findings

Nvivo software (10.2.2) was used to aid the systematic analysis of a large amount of qualitative data (Bazeley and Jackson, 2013; Zamawe; 2015). The software was used primarily to help the researcher identify the most frequently-appearing words using a word cloud feature. This was useful in determining the elements that were lacking in the pilot questionnaire. The main findings are summarised as follows:

- Responses to surveys 1 and 2 allowed the researcher to identify the main causes of what create emotions. For example, the exact words ‘memories’, ‘comfort’, ‘relaxed’, ‘seat’, ‘music’ etc. appeared frequently in the love letters to describe pleasant in-car conditions. The exact words ‘annoying beeping’, ‘irritating lights’, ‘small boot’, ‘heavy traffic’, ‘rainy weather’, ‘bad road condition’, ‘overtaking’ and ‘tailgating’ were frequently derived from the breakup letter and stressful, uncomfortable or fearful in-car conditions.

- Survey 2's data set clearly showed the main causes that create stress, happiness and fear, however, other possibly important causes that connect other emotions such as 'anger', 'disgust' or 'sadness' could not be collected in from the given questionnaire. Therefore, specific questions to obtain all possible causes that create emotions were needed in the subsequent questionnaire.

- Survey 1's data set showed detailed contexts from the stories, however, different semantics that implied emotional moments in stories, such as 'miss' or 'irritate', could not be collated arbitrarily. Considering the different semantics used in the responses, integrated analysis of all the responses did not seem to be feasible without the participant's further explanation of their exact meaning. Reflecting upon the issues that appeared, six basic emotions (Ekman and Friesen, 1971) and an 'other' option were needed in the questionnaire to minimise arbitrary interpretation of emotional wordings in responses. Furthermore, the question about emotions that occurred needed to be placed at the end of the questionnaire so that each story connected to particular emotions was consistently analysed.

- The data set from survey 1 and 2 could not be consistently integrated, as the responses from each survey were collected from different participants. The two surveys therefore needed to be consolidated into one questionnaire survey for integrated data analysis.

- Despite the two surveys receiving the same exposure for the same period, there was almost twice the number of responses for survey 2 compared to the survey 1. The opened ended writing activity appeared to be a demanding task to participants. In order to reduce the participant's reluctance to complete the survey, the questions needed to be divided into smaller questions that asked about each aspect of a scenario, such as contexts, places, specific activities, agents and occurred emotions with options based on the scenario definition (3.1.2 Scenario Usage and Definition).

The questionnaire was therefore redesigned to resolve these issues. The redeveloped questionnaire was tested and edited, as explained in the next section.

6.5 Validating the Questionnaire

There are common aspects of questionnaires that cause respondents to misinterpret questions, such as ambiguous wordings, leading questions and difficult vocabularies (Belson, 1981; Hunt, Sparkman and Wilcox, 1982). These commonly identified faults may cause misunderstanding of the topic or lead to different focus that the questions did not intend. Although a testing questionnaire cannot guarantee avoidance of all misinterpretation, an in-depth checking process of the questionnaire is regarded as a critical step for detecting potential difficulties and for minimising problematic questions (Foddy, 1993).

The questionnaire had to be examined in relation to its relevance to the topic, feasibility and clarity of the wordings used. Content and face validity are usually used to evaluate each detail of the questionnaire, focusing on how well it reflects the research topic in terms of the questionnaire's relevance to the study purpose, feasibility, readability, consistency of style and formatting, and the clarity of the language used (Haladyna, 1999; Parsian and AM, 2009). Acknowledging the drawback of content or face validity due to its high subjectivity (Bolarinwa, 2015), a combination of content validity and face validity was considered to strengthen the validity of the questionnaire (Anderson et al., 2002; Mackison, Wrieden and Anderson, 2010).

Two phases of validation with criteria were established to determine content validity and face validity of the questionnaire based on the procedures suggested and summarised by William Foddy (1993). Suggested procedures were deemed the most appropriate for the purpose of this validation study against the criterion: 'Does the method suggest practical guidelines?'. The independent respondents, who participated in selecting methods for the research, were invited for the validation process. It was considered that the variety of their characteristics in age, gender and professional backgrounds in design might add more value through individual perspectives in assessing the questionnaire. Respondents were drawn from the fields of industrial design (male aged 35), fashion design (female aged 31) and product design (male aged 27).

- *Phase 1. Question testing by asking respondents to rephrase questions in their own words*

  Phase 1 aimed to assess general interpretation of each question by respondents. In this phase, each question was presented, and all respondents were independently asked to precisely rephrase the questions using their own words. The respondents' interpretations

were recorded verbatim and checked to determine whether the interpretations fell into one of the following four categories: (a) fully correct—leaving out no vital parts, (b) generally correct—no more than one part altered or omitted, (c) partially wrong—but indicating that the respondent knew the general subject of the question, (d) completely wrong and no response. The results of *phase 1 Question testing* showed that the interpretations of all respondents fell into category (b) generally correct (no more than one part altered or omitted), which was considered to be acceptable.

- *Phase 2. Editing rules to aid the formulation of questions*

  Phase 2 aimed to identify any improvement points in the questionnaire by assessing each question understood by respondents as intended. After phase 1, all respondents were asked to fill in a form about question editing rules (Figure 6.5) with regards to the prepared questionnaire, in order to clarify the editing points in the questionnaire. The editing rules mainly assessed (a, b, c) the clarity of the topic, (d) the relevance of questions to participants, (e) the balance between questions and options, (f) the simplicity of question wordings, and (g) the sufficiency of the information. A further three columns (Yes, No, If no why?) were added to the form for practical use in the validation process.

Question Editing Rules	Yes	No	If no, why?
(a) Make sure that the topic has been clearly defined			
(b) Be clear both about the information that is required about the topic and the reason for wanting this information			
(c) Make sure that the topic has been defined properly for the respondents by:			
-avoiding the use of 'blab' words (i.e. words that are so abstract or general that they lack specific empirical referents)			
-avoiding words that are unlikely to be understood by all respondents either because they are rarely used in everyday life, or are specialist (i.e. jargon) words			
(d) Make sure that the question is relevant to respondents by:			
-using an appropriate filter			
-avoiding asking for information respondents are likely to have forgotten			
-avoiding hypothetical issues			
(e) Make sure that the question is not biased by:			
-ensuring balance in the introduction to the question (e.g. some people like X, and some people dislike X. - Do you like X or dislike X?)			
-ensuring that sets of response options are complete			
-ensuring that sets of response options are balanced			
-avoiding using words that are likely to invoke stereotypical reactions			
(f) Eliminate complexities that prevent respondents from easily assimilating the meaning of the question by:			
-avoiding asking 2 or more questions at once			
-avoiding the use of words that have several meanings			
-checking whether the question has been worded as simply as possible			
-avoiding the use of too many 'meaningful' words in the one question			
-avoiding the use of qualifying clauses and phrases and the addition of complicating instructions which cause respondents to start to answer, before they have been exposed to the whole question- if qualifying clauses and phrases have to be used, they should be placed at the beginning rather than at the end of the question			
-making sure that the question is as short as possible			
-avoiding the use of both negatives and double negatives			
(g) Ensure that respondents understand what kind of answer is required by:			
-setting the question in context			
-informing respondents why the question is being asked			
-informing respondents what will be done with the information they give			
-specifying the perspective that respondents should adopt			

Figure 6.5 The sheet of question editing rules (adapted from Cantril and Fried, 1944; Selltiz et al., 1965; Hunt, Sparkman and Wilcox, 1982; Belson, 1986; Foddy, 1993).

From *phase 2 Editing rules*, five sections (a,b,d,e,f) among seven sections in Figure 6.5 were assessed as having sufficient validity by all respondents. Some suggestions for editing were obtained for two sections, (c) and (g). The wording of 'incident' was commonly shown to be problematic, as it seemed to lead only to negative events, such as car accidents. Two respondents suggested the wording 'story' instead, as this is a more neutral term to respondents. Another common comment among respondents was the necessity of an explanation about the next steps that would be taken using the data collected in the questionnaire.

The validation process confirmed that the overall clarity of the questionnaire appeared to be acceptable for a large sample. The results of the validating questionnaire were used to formulate the final version of the questionnaire (Figure 6.6).

Visual icons that represent the six basic emotions for the question 6 were used in order to enhance intuitiveness in selecting emotions experienced by participants. The icons of facial expressions,

developed by Spindler and Fadrus (2009), were built into the survey form to effectively deliver emotions, as depicted by McCloud (2006). Other visuals or moving clips were not purposefully inserted in the final questionnaire to minimise potential technical failure by loading visuals.

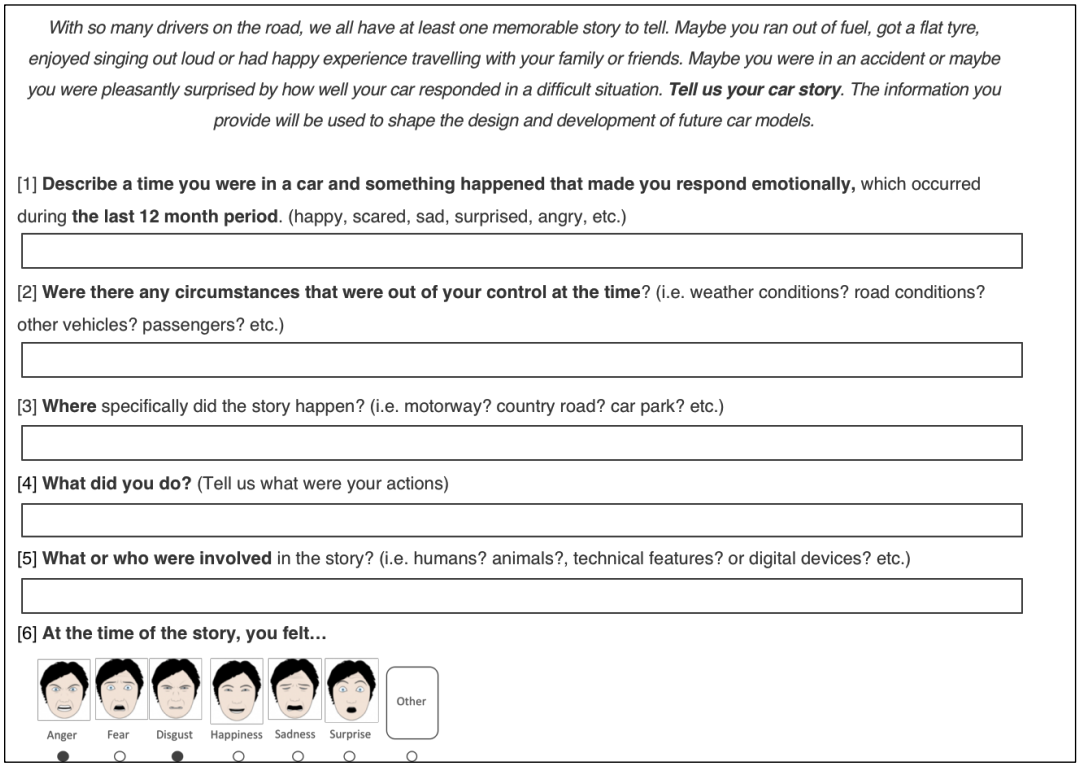


Figure 6.6 Questionnaire for investigating affective design scenarios in automotive contexts.

6.6 Conclusion

Due to a lack of a basic structure or guidelines for formulating the questionnaire to achieve affective design scenarios from past studies, comprehensive efforts were made in the series of preliminary studies described in this chapter to produce optimal outcomes. This entire process of questionnaire development highlighted the importance of this preparatory step in order to collect quality data, which is essential for scenario research in automotive design. Each process detailed for selecting an appropriate method, structuring questions, pilot testing and validating the questionnaire can assist automotive designers and researchers to better understand how to formulate a final questionnaire in a rigorous manner that is best suited to the research purpose. Moreover, the overall methodology of this study could be replicated to formulate questionnaires

for specific automotive products or subsystems.

Using the questionnaire developed here, two studies for formulating affective design scenarios, taking a triangulation approach, will be introduced in Chapters 7 and 8.

7 Affective Scenario Development Part 2: Exploring Affective Scenario Themes in an Uncontrolled Online Setting

In order to respond to Research Question 3., posed in Chapter 1 – 'How can an 'affective design scenario' be developed in a complete and rigorous manner?' – the study developed a research method and online questionnaire to optimise the ability to develop affective scenarios in automotive contexts. Using the questionnaire, this chapter describes the first steps in using a triangulation approach to explore affective design scenarios themes in automotive contexts.

7.1 Introduction

Scenarios in the automotive domain have frequently been used to evaluate functional tasks or examine the actions related to driver and vehicle performance (Burnett, 2009; Stevens and Burnett, 2014). For example, typical automotive scenarios are used to imitate various driving conditions for testing automotive system performance (Safespot, 2006; Davis, Patron and Lane, 2007; Chien et al., 2014). These driving scenarios play a role in testing how the system performs under different conditions (e.g. traffic, weather, road types).

There have, however, been questions raised (Gkouskos, Normark and Lundgren, 2014) about whether or not current automotive scenarios satisfactorily evaluate automotive products, subsystems and services because of their almost exclusively technical focus. Furthermore, the current scenarios may not fully answer complex questions that involve emotional, psychological or sociological responses (Gkatzidou, Giacomin and Skrypchuk, 2016). As the demand for digital connectivity increases in the complex automotive environment, difficulties arise in answering some questions, such as: Why do people respond emotionally in certain contexts? What are the typical automotive contexts that people find impactful? How can potential issues be managed to improve user experiences? These current limitations highlight the need for an in-depth understanding of emotional contexts.

Most emotional memories are characterised by the ability to vividly, accurately and durably remember events (Reisberg and Hertel, 2004; Buchanan, 2007), as they usually involve individual's important concerns or goals. Thus, these emotional memories are crucial to consider (Solomon, 2016). Furthermore, understanding real-life emotional contexts can impact a business's success, because emotional experiences can influence people's thoughts, attitudes, decisions and purchasing behaviour (Sanchez, 2017). According to Kantar TNS's Marketing Monitor study (Lawrence and Nishandar, 2016), identifying people's memorable real-life stories has become a high priority in improving customer's experiences. Furthermore, understanding emotional experiences can strongly benefit profits and customer retention across industries (Harvard Business Review, 2015). Therefore, it is necessary to investigate real-life experiences with automobiles because of the potential influence of emotional experiences on purchasing automotive products or services.

This chapter describes an empirical study of real-life stories of people's emotions regarding automobiles and driving. Because these stories vary greatly and are often unique to individuals, they are difficult to generalise. To address this diversity, the study used a wide approach to target the general public. The study employed a web survey; this format enabled the researcher to reach a large number of people beyond the physical constraints of time and geography.

This study investigated the hypothesis that people's typical stories with automobiles could be obtained using an online study in an uncontrolled setting. Typical stories were defined as themes that could be categorised from the participant's responses to assist a better understanding of people's memorable experiences. These stories could also support testing of both current and future automotive products, sub-systems and service concepts, as well as lay the groundwork to facilitate idea generation in design workshops to improve future automotive designs.

7.2 Study Design

7.2.1 Sampling Strategy, Sample Size and Distribution

Sampling Strategy

Appropriate sampling strategies were considered to achieve the research goal. Relevant data can only be obtained if the research reaches the targeted sample (Palinkas et al., 2015). The use of mixed purposive sampling strategies (Tongco, 2007) was thus necessary for the achievement of the research goal: a wide coverage of cases, including non-typical cases of interest (Teddlie and Yu, 2007). A purposeful sampling based on basic demographic criteria such as gender and age (Trochim and Donnelly, 2006) was chosen to reach as a broad sample as possible. An extreme case sampling (Teddlie and Yu, 2007) was also chosen to achieve especially valuable information from the most non-typical cases related to automotive experience.

Sample Size

The study's sample size was determined using the criteria for both quantitative and qualitative research. The study aimed to obtain qualitative data from a large sample that could be quantified. Johnson and Christensen (2012) suggest that the sample size criteria used in a quantitative study should be appropriate for ethnographic surveys with a large sample. A common guideline for a quantitative study's given population was thus applied (Krejcie and Morgan, 1970). This led to using the UK's population (Department of Economic and Social Affairs, 2017) and the number of registered cars in the UK (DVLA/DfT, April 2017) to establish the target population for the study. The result is that the study established 384 (assumes standard error = .05) as the appropriate sample size necessary for the study to have statistical power (Krejcie and Morgan, 1970). More importantly, the minimum sample size was determined using the criteria of sample size in qualitative studies. Data saturation plays an important role in indicating when to stop collecting data in qualitative studies (Johnson and Christensen, 2012). This has been the most widely applied criterion to determine a minimum sampling size in qualitative studies, as it suggests the point when no new or relevant information seems to be emerging (Miles and Huberman, 1994). The minimum sample number for the study was determined when data saturation appeared, and then more data

was collected to ensure that the data has been saturated. Figure 7.1 shows the points of data saturation at which new themes did not emerge from the study result. This was checked using the number of themes and chronological order of participant's responses from the researcher's analysis and was at n=132.

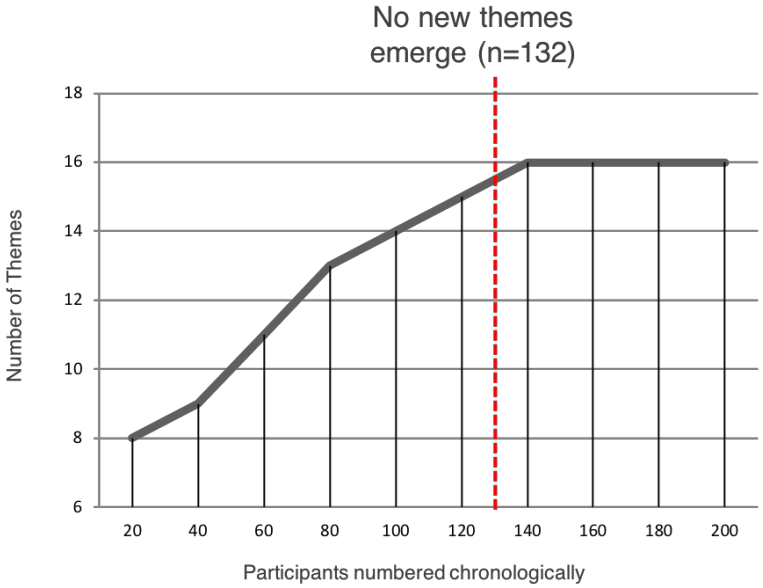


Figure 7.1 Capturing data saturation based on the number of themes and chronological order of participant's responses.

Distribution

Multiple means of distribution were considered to effectively reach the target sample in a given timeframe. First, the researcher performed a systematic search for possible organisations that may either internally or externally distribute online questionnaires. Following the extreme case sampling strategy, a set of simple search combinations of each extreme user group were performed via the Google search engine. The chosen keywords were as follows: aging/ disabled/ mobility/ transport/ bus/ taxi/ chauffeur/ ambulance/ police/ fire truck/ car enthusiasts AND organisation/ charity/ community/ club. An initial list of organisations (80 organisations) was compiled. For the purpose of multiple channel contact, the list was prioritised by the primary selection criteria, which was the size and type of the organisations. It also specified the following inclusion criteria, due to difficulties in accurately determining the number of employees or customers of each organisation:

- Well-known public organisations

- UK-based organisations
- Organisations that provide contact information

Possible practical support was taken into account to contact the prioritised organisations (14 organisations), including digital support (i.e. sending an email, making a phone call or filling out an online-enquiry form) and conventional support (i.e. visiting in person, attending events or activities). Four organisations agreed to distribute the study web link to their employees or community members. Three organisations allowed the researcher to directly recruit participants in person at their event site. The participation recruitment process was conducted simultaneously widely through multiple channels to reach a large number of people, including the Brunel University website, several professional social networking services and research participation websites.

7.2.2 Data Analysis

The analysis aimed to organise the online study data into design themes depending on how people emotionally respond in automotive contexts. In order to select the most appropriate analysis method for a large amount of text data (Mayring, 2014), two main questions were used: 'Is the method most appropriate to quantify qualitative data?' and 'Is the method appropriate for systematically analysing text data as a meaning unit in a context, not a word by word?' According to several research studies (Downe-Wambolt, 1992; Texas State Auditor's Office, 2017; Krippendorff, 2004), the content analysis method has been used widely to quantify largely qualitative text data and to make meaningful inferences from it. Content analysis thus appeared to be the most suitable method.

The analysis was performed using commonly accepted steps for content analysis (Mayring, 2014) (Figure 7.2). Following the research question (Step 1), automotive contexts from car stories were defined as an analysis category. Contextual information with specific places and agents involved were defined as a level of abstraction (Step 2). The full set of emotional contexts achieved from all responses was coded as a meaning unit. Words and collections of sentences that were derived from the initial coding activity were assigned 56 codes and were collated into 36 subcategories (Step 3 and 4). The subcategories were then grouped together to build the list of main categories. Initially, the researcher established 14 main categories, which aligned the suggested number of

categories for such analysis, which is a set of 10 to 30 categories (Mayring, 2014) (Step 5).

Next, multiple coders performed the intercoder reliability check in order to minimise subjectivity and bias by the researcher during the analysis process; the involvement of multiple coders in the coding process is a widely accepted practice for carrying out the intercoder reliability check (Mayring, 2014). The coders were three researchers with experienced in coding qualitative data and theme generation, and were drawn from the fields of design (female aged 28), business (male aged 36) and computer science (female aged 35). Because of the difficulty in recruiting expert coders for the research, the variation in professional background, gender and age were taken into account when choosing the coders, as differing perspectives introduces some variation in interpretation (Berends and Johnston, 2005).

The coders were asked to independently code the raw responses following the procedures, analysis units, category definition and level of abstraction. The degree of agreement from all three coders was calculated by three different measurements for the intercoder reliability checks (Step 6). 12 main themes out of 14 main themes were found to be reliable. The detailed result of the inter-coder reliability check is introduced in the results section (7.3 Results). The final themes were then reported based on the results of the reliability check (Step 7).

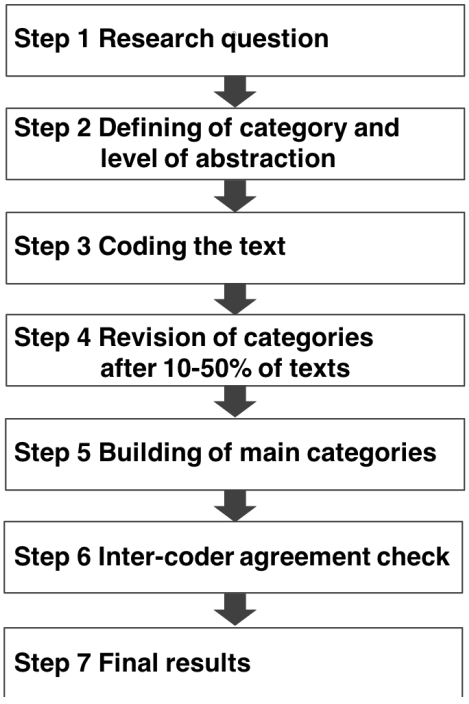


Figure 7.2 Content analysis process (adapted from Mayring, 2014).

7.2.3 Ethics

This entire research process adhered to the ethical rules and guidance on Good Research Practice suggested by Brunel University Research Ethics Committee (UREC), which supervises all research ethics matters involving human participants performed by Brunel University London staff and students. There were four categories that were focused on during the planning and conducting of the research activities as part of the ethical rules. Those were veracity (truthfulness or absence of deception), privacy (freedom from unwarranted public intrusion), confidentiality (non-disclosure) and fidelity (accuracy in recording and reporting data). The researcher carefully followed both Brunel University's 'Code of research ethics' (CoE, 2014) and the UK guidelines (Data Protection Act, 1998) to ensure that research activities were performed in an ethical and professional manner.

In compliance with the ethical rules and guidelines, appropriate measures were taken to ensure that all participants were fully aware of the research process and knew that they could withdraw from the research at any time. The Brunel Research Ethics Committee granted ethics approval for all research activities, which were considered low-risk, prior to recruitment (Appendix C). Informed consent was given and the information for research participation was provided to the participants prior to the research activity (Appendix C).

All participants were guaranteed confidentiality and were assured that all information provided (including names or personal information) would be kept confidential and anonymised at the earliest stage. They were informed that names or personal information of participants will not appear in any reports or publications. All hard copy forms and soft copy forms obtained via the online survey platform were destroyed at the end of the data collection phase. All electronic data was kept securely in restricted-access folders on password-protected Brunel University computer systems and destroyed after the completion of the study.

7.3 Results

As a result of the content analysis (7.2.3 Data Analysis), the lead researcher derived 56 codes from

a total number of 211 completed automotive stories during the initial coding activity. The codes were grouped into 36 subcategories, which were then re-grouped together to determine the list of 14 main themes, 12 of which were found to be reliable during the intercoder reliability checks. Based on the frequency of each theme's appearance in participant responses, it is possible to see the prevalence of an attitude among the general public (Breen, 2006). Therefore, each main theme is presented in order of frequency in the following section (Table 7.1).

Inconsiderate driver behaviour

The most frequent typical story involved the inconsiderate behaviour of other drivers, which included overtaking, insulting and arguing, and being forced to give way; these behaviours triggered negative emotions, particularly fear, while driving.

Car accident

The second most frequent story involved car accidents (i.e. bumping into another car or an obstacle hit by another car, witnessing an accident, memory of an accident). Particularly, traumatic stories about accidents were observed as memorable automotive contexts.

Road use circumstances

Various elements of road use circumstances also influenced drivers' emotions. Heavy traffic, road infrastructure (i.e. road signs, traffic lights) and other road users (i.e. motorbikes, pedestrians, animals) were included in this theme. An unexpected road environment that could not be controlled by participants caused negative emotions.

Infotainment

The study captured both positive and negative emotions when users interacted with radios, smartphones, or other infotainment systems. In this dataset, music was regarded as the most obvious trigger to create emotion when interacting with an infotainment system.

Car hardware system malfunction

Malfunction or warning alerts in the car system and controls were other typical stories about automobiles. Fear, surprise and anger were frequently captured in these contexts.

Unexpected driver behaviour

Other vehicle drivers' unexpected manoeuvrings on the road (i.e. sudden stop, sudden road entry, sudden lane changing) were frequently mentioned as emotional automotive experiences.

Inexperienced driver behaviour

Negative emotions occurred due to any mistakes or confusion in manoeuvring on the road, as well as the first time driving in conditions or slow driving by others.

Driving with a loved one

Having a good time with family or friends in a car was clearly a context in which positive emotions (i.e. happiness) mainly occurred.

Kind driver behaviour

Other vehicle drivers' acts of kindness on the road were another context that mainly involved happiness. Stories about getting help or other drivers giving way were obtained as positively memorable contexts.

Vehicle observation and familiarity

Positive emotions were captured when users were having a familiar experience with a car. Here, the car's role went beyond technical features to being a familiar space, like a home, in which drivers feel comfortable.

Car software system malfunction

Drivers' negative emotions (i.e. fear, anger, surprise) were triggered by a malfunction of car software system, including navigation error, flat phone battery and IOS CarPlay error. Drivers' frustration was heightened as these system malfunctions stopped drivers from using their desired functions while driving.

Driving landscape

Driving with scenery visible through the car windows was mentioned as an enjoyable memory. The contexts include seeing incredible scenery while driving (i.e. sheep, a moonrise, sunshine) and

night driving with stars.

These 12 main themes and 34 subthemes that frequently appear are summarised in Table 7.1 The order indicates the how common the emotional automotive experience likely is within the general public (Breen, 2006).

Main themes	Subthemes	Frequency
Theme 1. Inconsiderate driver behaviour	- Overtaking - Insulting - Being forced to give way - Argument	56 (27%)
Theme 2. Car accident	- Bumping into another car or obstacle - Being hit by another car - Witnessing an accident - Recalling a memory of a prior accident	26 (13%)
Theme 3. Road use circumstances	- Heavy traffic - Road infrastructure (i.e. road signs, traffic lights) - Other road users (i.e. motorbikes, pedestrians, animals)	21 (10%)
Theme 4. Infotainment	- Music on the radio - News from the radio / calls	19 (9%)
Theme 5. Car hardware system malfunction	- Warning alerts - Broken down - Partial system malfunction (i.e. drained battery, broken brakes, broken gear box, flat tyre…)	16 (8%)
Theme 6. Unexpected driver behaviour	- Sudden stop - Sudden road entry - Sudden lane changing	15 (7%)
Theme 7. Inexperienced driver behaviour	- Mistakes/confusion - First time driving in conditions - Slow driving	14 (7%)

Theme 8. Driving with a loved one	- Driving with family - Driving with friends	10 (5%)
Theme 9. Kind driver behaviour	- Getting help - Giving way	8 (4%)
Theme 10. Vehicle observations and familiarity	- Experience with car features - Feeling relaxation - Hearing the sound of the engine	8 (4%)
Theme 11. Car software system malfunction	- Navigation/GPS error - Flat phone battery - IOS CarPlay error	7 (3%)
Theme 12. Driving landscape	- Seeing incredible scenery (i.e. sheep, a moon rise, sunny) - Night driving with stars	7 (3%)

Table 7.1 Affective scenario main themes and subthemes with frequency.

The total number of the six basic emotions was 291. This comprised fear (n=83), anger (n=64), surprise (n=64), sadness (n=28), happiness (n=28) and disgust (n=24). 19 other emotion-related words (i.e. frustration, calmness, confusion) were also collected. The frequencies of basic emotions with associated themes are shown in Table 7.2 and Table 7.3. Inconsiderate driver behaviour appeared to be the most typical trigger, with the highest frequencies across the basic emotions, except for happiness.

Fear		**Anger**		**Surprise**	
n	Associated theme	n	Associated theme	n	Associated theme
26	Inconsiderate driver behaviour	29	Inconsiderate driver behaviour	16	Car accident
14	Car accident	8	Car accident	10	Unexpected driver behaviour
12	Car hardware system malfunction	7	Car hardware system malfunction	9	Inconsiderate driver behaviour
10	Inexperienced driver behaviour	5	Inexperienced driver behaviour	7	Car hardware system malfunction
8	Unexpected driver behaviour	6	Unexpected driver behaviour	6	Road use circumstances
6	Road use circumstances	6	Road use circumstances	5	Inexperienced driver behaviour

3	Car software system malfunction	2	Car software system malfunction	4	Kind driver behaviour
1	Infotainment	1	Infotainment	2	Vehicle observations and familiarity
1	Driving with a loved one			2	Driving landscape
1	Kind driver behaviour			1	Infotainment
1	Vehicle observations and familiarity			1	Driving with a loved one
				1	Car software system malfunction

Table 7.2 Frequency of basic emotions (fear, anger, surprise) with associated themes.

Sadness		**Happiness**		**Disgust**	
n	Associated theme	n	Associated theme	n	Associated theme
10	Inconsiderate driver behaviour	6	Infotainment	11	Inconsiderate driver behaviour
10	Car accident	6	Driving with a loved one	4	Road use circumstances
2	Infotainment	5	Driving landscape	3	Car hardware system malfunction
2	Car hardware system malfunction	4	Kind driver behaviour	2	Car accident
2	Inexperienced driver behaviour	4	Vehicle observations and familiarity	2	Inexperienced driver behaviour
1	Road use circumstances	2	Road use circumstances	2	Unexpected driver behaviour
1	Car software system malfunction	1	Car hardware system malfunction		

Table 7.3 Frequency of basic emotions (sadness, happiness, disgust) with associated themes.

Intercoder Reliability Check

As the results can only be trusted when the coding process is reliable (Singletary, 1993; Neuendorf,

2002), the extent of agreement among independent coders in the coding process is significant (Tinsley and Weiss, 2000). The extent of agreement is calculated as a numerical index of themes derived from each independent coder.

Considering the large volume of qualitative data, it was considered sufficient to analyse a sample of around 10 per cent of the total responses t (Lombard, Snyder-Duch and Bracken, 2010). In this study, over 20 per cent (50 raw responses) of the total responses (n=211) were given to ensure that possible themes derived from the entire data set could be covered. A constraint was also established to avoid different focus when extracting codes from the raw data ('What triggers people's emotions?').

Three different measurements for intercoder reliability were chosen to ensure the reliability of the coding exercise under different conditions: Per cent agreement, Fleiss's kappa (1971) and Cohen's Kappa (1960, 1968). Per cent agreement is the percentage of all coding results concluded by pairs of coders. The values range between 0.00 (no agreement) and 1.00 (perfect agreement). While it is easy to use this measurement to calculate the agreement of the coding results, research suggests that (Lombard, Snyder-Duch and Bracken, 2002) this measurement is often overestimated because it does not account for agreement by chance. In order to offset this limitation, the study used multiple measurements (Lombard, Snyder-Duch and Bracken, 2002), including Fleiss's Kappa and Cohen's Kappa. Fleiss's Kappa and Cohen's Kappa have been widely used for intercoder reliability calculations and take the expected agreement by chance into account in their formulas. Values of .61–.80 are considered substantial agreement, and values of over .81 are interpreted as almost perfect agreement (McHugh, 2012).

In Table 7.4, the calculation of each measurement of agreement between coders is presented. These calculations show that of the 14 initial themes, 12 themes were considered reliable (six themes met the target reliability rate minimum of 61 per cent (substantial agreement), and another six themes met the reliability rate of 81 per cent (almost perfect agreement)).

Main themes	Per cent agreement	Fleiss's Kappa	Cohen's Kappa
Theme 1. Inconsiderate driver behaviour	0.93	0.71	0.71
Theme 2. Car accident	0.97	0.87	0.87

Theme 3. Road use circumstances	0.95	0.66	0.66
Theme 4. Infotainment	0.99	0.92	0.92
Theme 5. Car hardware system malfunction	0.97	0.82	0.82
Theme 6. Unexpected driver behaviour	0.93	0.71	0.72
Theme 7. Inexperienced driver behaviour	0.96	0.73	0.70
Theme 8. Driving with a loved one	0.99	0.79	0.77
Theme 9. Kind driver behaviour	1.00	1.00	1.00
Theme 10. Vehicle observations and familiarity	1.00	1.00	1.00
Theme 11. Car software system malfunction	1.00	1.00	1.00
Theme 12. Driving landscape	0.99	0.79	0.77

Table 7.4 Results of inter-coder reliability check.

7.4 Discussion

This research aimed to investigate individual's real-life stories with automobiles that involve human emotions. After performing an online study in an uncontrolled setting with 211 participants, 12 inter-coder reliability checked themes emerged that, when analysed, confirmed the research hypothesis that people's typical stories with automobiles could be successfully obtained through an online approach in an uncontrolled setting. The results of the study suggested key components of automotive affective scenarios.

Furthermore, the emotion frequencies revealed in the study are also good indicators of which emotions should be dealt within automotive contexts. The themes associated with each emotion also suggested a strong connection between particular emotions and typical contexts. The difference between the study results cannot directly be compared to previous studies focusing on driver's immediate emotions, since previous scholarship addressed immediate emotions that were detected in an on-road study based on people's short-term memories, while this study was based on people's long-term episodic memories of experiences (Tulving, 1972; Chapter 2.2.2 Human Memory System). Nevertheless, understanding the emotions that are common to both different types of memories may play an important role in prioritising the most prevalent emotions in future automobile design.

As digital technology advances in the automotive industry, it is increasingly important to apply

attention to experience (Sheller, 2004). As previous research studies have indicated, understanding emotional experiences in real-life has become particularly essential to satisfying people's expectations and needs (Gkatzidou, Giacomin and Skrypchuk, 2016; Sanchez, 2017; Solomon, 2016). The current study's findings can assist automotive designers and researchers to understand people's real automobile experiences by providing an overview of frequent triggers that create emotions in automotive contexts.

7.4.1 Discussion of Affective Scenario Themes

The affective scenario themes listed function as key components of the automotive experience. They can be found in typical automotive contexts and involved emotional reactions that were caused by other vehicle driver's behaviour, by an unexpected driving environment, including hardware or software car systems or road infrastructure, and by the driver or passenger's inner conflict.

1. The highest frequency context for affective experiences were situations caused by the behaviour of the driver of another vehicle; these contexts involved eight main themes (i.e. Theme 1, 2, 3, 4, 6, 7, 8, 9). This may reinforce the perception that automotive context is deeply associated with social relationships between cars, other drivers, families and friends (Sheller, 2004). In this dataset, the most likely cause for triggering a participant's negative emotional response was inconsiderate behaviour that may affect safety and security. This might indicate that any behaviour that may be antisocial or anti-community has a significant impact on negative emotions in automotive contexts.

2. The second most frequent automotive context involved the respondent's interaction with an unexpected driving environment, with particularly strong manifestation in seven main themes (i.e. Theme 2, 3, 4, 5, 10, 11, 12). These situations included functional system errors or interruptions and problems in the driving surroundings, such as traffic flow, roadway lightings or scenery. These contexts tended to trigger strong emotions, which is in line with the previous research regarding key components of automotive scenarios (Omasreiter and Metzker, 2004; Chrysler, Ahmad and Schwarz, 2015), which may suggest that unexpectedness and uncontrollable situations have a great impact on human emotions in

automotive contexts.

3. The least typical automotive contexts were related to emotional aspects caused by the self, which partially appeared in three main themes (i.e. Theme 2, 4, 7). These contexts, such as the memory of an accident or a driver's confusion and mistakes are rarely addressed in either currently available automotive scenarios or in the preliminary categories of automotive scenario (Chapter 6.2 Formulating the Questionnaire). As previous scenario studies have not focused on specific contexts in which emotions occur, it is possible that the occurrence of emotions due to internal conflict is less likely to be captured by such research. This is a clear indication that these contexts, which have an important impact on human emotion in automotive contexts, need to be more comprehensively included in automotive affective scenarios.

7.4.2 Discussion of Frequencies of Basic Emotions

Across the individual types of emotion in the stories with automobiles, fear (29%) was clearly the most frequent emotion in the study results. This aligns with previous research that shows that fear is an emotion typically associated with automobiles (Sheller, 2004). Both anger (22%) and surprise (22%) were the second most frequently occurring emotions in the study. According to previous research on emotion by Roseman (2011), anger can be a typical emotional response caused by others. Likewise, anger was closely associated with other driver's behaviour, such as overtaking, insulting or interruption. Roseman (2011) also suggests that surprise can be a typical emotional response that emerges in an unexpected interaction with the environment in which people have a low potential for control. Similar to the previous research (Roseman, 2011), surprise frequently appeared in response to unexpected car hardware system malfunctions, bumping into an obstacle on the road, or road signs and traffic light errors. Joy was the emotion that occurred least in several previous studies focusing on driver's emotions (Tischler et al., 2007), whereas happiness was a more frequently occurring emotion than sadness and disgust in people's long-term memories. This knowledge could be used as design criteria for exploring automotive concepts that can minimise the most typical negative emotions and maximise positive emotions.

7.5 Assessing Validity and Threats to Validity

In order to assess the validity of qualitative research, it is necessary to ensure the trustworthiness of results; this is particularly true when using inductive content analysis, as categories are drawn from the raw data by the researcher's open coding and abstraction process (Elo et al., 2014). The common purpose of evaluating trustworthiness proposed by several qualitative studies (Lincoln and Guba, 1985; Ihantola and Kihn, 2011; Schreier, 2012; Elo et al., 2014) is to report the content analysis process accurately and clearly. The most widely used criteria for evaluating trustworthiness is checking the following aspects of the content analysis process (Lincoln and Guba, 1985): credibility (accurate descriptions of research participating), dependability (stability of data under different conditions), conformability (congruence between independent coders), transferability (ability to be generalised) and authenticity (capturing the lived experiences of people). These criteria were applied to assess the trustworthiness of the content analysis process in this study.

Credibility

Every step of research participation was described in order to improve the credibility of the study, from preparation (i.e. data collection method, sampling strategy, size and distribution of the questionnaire) to the organisation and reporting phase of the study (i.e. data analysis and results). Every decision in each step was reported based on factual activity.

Dependability and Conformability

The dependability and conformability of the results were assessed through the intercoder reliability check (7.3 Results). Over 20 per cent of a total number of participant's raw responses was analysed by three independent coders to ensure the stability of the resulting themes. The degree of agreement to each resulting theme among the three independent coders was calculated to check the consistency of open coding. This process confirmed that the resulting themes were considered to be stable and consistent across the multiple measurements, which met at least a minimum target rate of 61 per cent.

Transferability

The resulting themes with high frequencies were considered to be typical automotive stories that

create emotions. As the themes are common patterns derived from content analysis of 211 participant's real stories with automobiles, this suggests that the themes are representative of common emotional contexts with automobiles.

Authenticity

This study investigated participant's real-life experience with automobiles through their written stories that detailed the emotions that occurred. Participant's long-term memories were evoked with a detailed sequence of events, actions, feelings and thoughts. In this way, the study attempted to obtain the authentic lived experience of people with automobiles.

The study's overall trustworthiness was assessed from the perspective of the evaluation criteria above. Nevertheless, the obvious potential threats to validity in this study are also listed in the following section. These include the researcher's bias and the experimental setting.

Researcher's Bias

To mitigate the researcher's potential bias across the study, multiple coders or reviewers were involved in any decision relating to the data collection method or data analysis. However, the choice of researchers as multiple coders or reviewers may have influenced the results of decision, as they were selected using the researcher's criteria alone (i.e. different background, age and experience of content analysis or thematic coding).

Experimental Setting

The characteristics of an 'online study' and 'uncontrolled experimental setting' might influence the results. The study was conducted with the general public without any exclusion criteria. However, some people who were not able to access the Internet might have been unintentionally excluded from the study due to its online setting. As the majority of data was collected through a web link, except for the few cases of researcher's direct recruitment with a printed questionnaire in public places, this was considered to be a potential limitation. Further, the experiment setting of memory control may also influence the results. The participant's long-term memories may be prompted to produce more detailed or new stories in a controlled setting. Therefore, further investigation of the same topic, but with face-to-face research in a contextual setting was necessitated to mitigate

potential threats to the validity of the study, thus ensuring the trustworthiness of the resulting themes.

7.6 Conclusion

This chapter described the first study of a triangulation approach to explore affective design scenarios themes to answer the Research Question 3.– 'How can an 'affective design scenario' be developed in a complete and rigorous manner?'. By investigating real-life stories in automotive contexts, it is possible to see that people commonly experience a lot of emotional situations in automobiles.

Understanding these real-life stories is a significant part of human-centred approach. Designing an automobile is no exception; using people's authentic emotional stories, rather than assumptions, offers greater connectivity by integrating technology in a way that satisfies people. Understanding how people remember their experiences with automobiles and how these memories are emotionally connected in a complex layer of psychological and sociological contexts can guide automotive designers and researchers to create better designs for both current and future automobiles.

The resulting themes derived from the study were used as primary components for the formulation of affective automotive scenarios, which will be described in Chapter 9. Each subtheme can also support automotive practitioners to understand the details of the key issues for consideration. To counter the potential limitations of the experimental setting identified in this study, a subsequent study was conducted in a contextual setting, which will be introduced in Chapter 8.

8 Affective Scenario Development Part 3: Exploring Affective Scenario Themes by Prompting Memory in a Simulator Setting

This chapter focuses on the second study of a triangulation approach to explore affective design scenarios themes, responding to the Research Question 3. posed in Chapter 1 – 'How can an 'affective design scenario' be developed in a complete and rigorous manner?'. In the previous chapter, an online study in an uncontrolled setting was used to reach a large number of people. That study explored a broad range of typical stories that frequently elicited emotions in automotive contexts. While the previous study identified commonly experienced emotional contexts with automobiles, there were further questions about getting more results by prompting particular kinds of memories. The research presented in this chapter uses stimuli to elicit emotional stories with automobiles.

8.1 Introduction

Many examples of past research in psychology (Reisberg and Hertel, 2004) have highlighted the significance of emotional memory. This memory is based on 'episodic long-term memory', which concerns individual's real-life stories (Chapter 2.2.2 Human Memory System). As emotional memory is closely connected to important matters in people's lives, its influence on their behaviours, perceptions and beliefs can be significant (Reisberg and Hertel, 2004).

Most automotive research, however, has focused primarily on either detecting the driver's emotion or measuring the driver's reactive behaviour caused by a particular emotion i.e. road rage by anger (Wells-Parker et al., 2002). The broader aspects of emotional experience have not been investigated in automotive research. Thus, it is necessary to focus on studying a wide range of emotional experiences within automotive contexts to fully understand individual's experience with automobiles in a complex digital environment.

In additional to emotional memory, research on memory retrieval (Tulving, 1967; Godden and

Baddeley, 1975; Ucros, 1987; Smith and Vela, 2001, and Baddeley, Eysenck and Anderson, 2014) suggests that the ability to access memories can either be varied or manipulated by utilising the retrieval cue technique, first developed by Tulving and Pearlstone (1966). Experimental evidence reveals that the internal or external environment can effect memory retrieval. Memory can be dependent on an individual's state known as state-dependent memory (Goodwin et al., 1969) or it can be dependent on context known as context-dependent memory (Godden and Baddeley, 1975).

Since memory is affected by state and context, the online study from the last chapter may have important gaps, raising the question of whether additional possible themes could potentially be established based on prompted memories. While the web-format survey allowed the researcher to obtain a variety of highly emotional automotive scenarios from a wide variety of people, it could not stimulate individuals emotions to yield in-depth memorable stories. Here, the study used a driving simulator to stimulate a participant's emotions in a laboratory setting; the simulator is an appropriate tool, because it activates retrieval cues to promote either positive or negative emotions from participants, by reproducing real-driving contexts in a laboratory environment.

The study introduced here is based on the hypothesis that, by stimulating a spectrum of emotions, which include both positive and negative expressions within a contextual setting, additional stories with automobiles may be captured using the same survey questions. The data was thematically coded through content analysis and the validation criterion was the number of new themes and/or subthemes achieved. The study results could be used to select typical automotive affective scenario themes in comparison to the study's results described in Chapter 7. Furthermore, this knowledge could assist in creating a better understanding of how emotional stimulus can be beneficial to recalling memory with automobiles in the automotive sector.

8.2 Study Design

8.2.1 Driving Simulator Set-Up

Driving simulators have typically been used to assess human behaviour and safety in numerous research studies (Blana, 1996; De Winter, van Leeuwen and Happee, 2012; Bella, 2014; Chrysler, Ahmad and Schwarz, 2015). According to De Winter, van Leeuwen and Happee (2012), using

driving simulators has the following advantages over real vehicles, they are:

- Easy to control and to create standardised conditions
  Driving environment (e.g. traffic, weather, road layout) can be purposefully created in a driving simulator, making it easier to build standardised testing conditions, unlike the hard-to-control conditions of real driving.

- Ease of data collection
  It is possible to efficiently measure data on driving performance and driving behaviour in a simulator, and it is possible to gather information such as the exact position on the road, which is not possible in a real vehicle.

- Demonstrating hazard events without being physically at risk
  A driving simulator can virtually create unpredictable road conditions, like collisions or car system malfunctions, which cannot be demonstrated in a real automobile context.

- Novel opportunity for feedback and instruction
  Running simulator scenarios and different modalities offers more flexibility for feedback and monitoring.

There are some difficulties in capturing accurate emotional expression within a driving simulator due to the unrealistic driving environment created by low-fidelity simulators (De Winter, van Leeuwen and Happee, 2012; Jones and Jonsson, 2005). The environment's controllability (i.e. placing road users in certain situations that would be hazardous or unexpected) is however highly effective for inducing affective states (Jeon, 2012) or for evaluating the driver's responses (Chrysler, Ahmad and Schwarz, 2015). For this study, the use of a driving simulator stimulated the participant's affective state in a contextual setting by triggering their memories of past automotive situations.

This study used a simulator that was built upon the BMW Mini body shell (Figure 8.1).

- Visual stimuli were presented through a 2m wrap around projection screen for a 270° view with five WUX4000 projectors. The LCD panel resolution was 1920 x 1200 (WUXGA), 2304000 pixels and the image ratio was 16:10. The rear view mirror, LCD screen and LCD

wing mirror allowed the seated participant a surrounding view.

- The Advance Driving Package simulation software by XPI DS2 Full Car Simulator was chosen to create various driving conditions using simple drag and drop options. The simulation software ran on a single computer with two monitor screens in a separate room, operating Microsoft Windows 7 Professional on an Intel Core i7 processor, 64 bit, 3.40 Ghz and 4 GB of RAM 4. The main monitor displayed the driving scenario map; the other monitor displayed the seated participant.
- From a separate room, the researcher was able to use a microphone to ask the participant in the simulator to perform tasks; these sounds were played through embedded speakers in the car. The default sound effects included engine noise, turning indicators and collisions. A portable Bluetooth speaker was also placed in the car in order to increase the realism of the driving environment. Additional sound effects (i.e. warning message, honking, ambulance sirens or music) were used to overcome the limited choice of sound effects from the software.

All participants experienced pre-defined routes for the experiment, which are presented in subsequent sections.

Figure 8.1 BMW Mini with projectors and screens in the driving simulator.

8.2.2 Driving Simulator Scenarios

The simulator scenarios were used to stimulate participants' affective state by activating purposefully designed stimuli. Given the lack of previous research into emotional reactions to

automotive stimuli, previous automotive study databases achieved from the online study (Chapter 7) and from real road tests under the same industrial project (AutomoHabLab, n.d.) were reviewed, which include information about detailed automotive contexts and experienced emotions.

Data selection criteria

In order to extract information with a high probability from the previously generated databases, the selection criteria was used: 'how frequently did each of the emotions occur?' Subsequently, using the frequency of each of the six basic emotions from the other databases, the researcher chose to replicate those emotions and the triggers that caused the particular emotion in an automotive context. In order to narrow down the study further, a secondary selection criterion was applied: 'is it possible to apply the trigger in the simulator software?'.

Using the online study database and the two road test databases, the researcher identified six triggers that frequently caused one of the six basic emotions. These triggers were listening to music, being forced to give way by other vehicles, overtaking, car accident, high traffic density, navigation alert. Some triggers (e.g., personal interaction, long wait at traffic light, bump on road etc.) that were initially extracted from the road tests databases could not be replicated in the simulator software, and were therefore excluded.

In order to stimulate a positive or negative affective state in each participant, the triggers were structured based on valence, rather than the accurate stimulation of a particular emotion. This resulted in the creation of two types of scenarios.

Stimuli characteristics

Because the driving simulator provides a fully controllable experimental environment (Bella, 2014; Blana, 1996; van Gennip, van den Hoven and Markopoulos, 2015; Schreuder et al., 2016), four typical stimuli were used in the simulator scenarios: road type (city, country, motorway, etc.), weather conditions (daylight, night, fog, rain, snow etc.), traffic (number of different type of vehicles) and events (playing music, overtaking, collision etc.).

Two driving simulator scenarios were used including four stimuli characteristics to activate retrieval cues. The first, called driving simulator scenario A, was designed to stimulate positive emotions (i.e. happiness), while the second, called driving simulator scenario B, was designed to

stimulate negative emotions (i.e. fear, anger, surprise, disgust, sadness). Details in each scenario were decided based on the extracted triggers that frequently caused emotions.

- **Driving simulator scenario A:**
  - Road type: Country road / motorway (rural area layout surrounded by trees)
  - Weather conditions: Daylight, fog level (none), rain level (none)
  - Traffic: No other vehicles on a road
  - Events: Listening to self-selected music by each participant for greater emotional response (Blood and Zatorre, 2001; Panksepp, 1995; Rickard, 2004; Schubert, 2013)
- **Driving simulator scenario B:**
  - Road type: City road (urban area layout surrounded by shops and buildings)
  - Weather conditions: Fog level (high) and rain level (high)
  - Traffic: Full of vehicles on a road (including a car, bus, lorry, ambulance, bike, motorbike)
  - Events: Overtaken by other vehicles, car accident, navigation/ filter warning alerts

The section-by-section details and level of traffic and weather conditions of each scenario were iteratively edited through pilot tests by the researcher to create optimal configurations (i.e. layout of roads, duration of each event, potential error removal). Specific events, such as music playing, overtaking, car accident or navigation alerts were inserted in appropriate locations. For example, self-selected music by each participant in driving simulator scenario A was played immediately after the participant started driving without any issues to provide pleasant drive experience. Furthermore, the default artificial intelligence traffic and pedestrians were removed in order to prevent unexpected events (i.e. collision) in both Scenario A and B.

Each scenario lasted for no longer than 10 minutes to maximise participant's task engagement and to minimise boredom and fatigue (Saxby et al., 2013) and to avoid simulator sickness (Wesley, Sayer and Tengler, 2005). Every event stimulus in both scenarios was thus limited to within 10 minutes.

8.2.3 Sampling Strategy, Sample Size and Participant Recruitment

Sampling Strategy

A purposeful sampling strategy is commonly used in qualitative research (Higginbottom, 2004; Marshall, 1996). In this study, this approach was chosen to reach a sample that has the characteristics relevant to the research topic area (David and Sutton, 2011). As simulator driving and actively sharing their past driving experiences were key factors for the study, the selection criteria of participants established whether they had a full driver's license and were willing to take part in the driving simulator study.

Sample Size

There is no single universally accepted answer about sufficient sample size in qualitative research. Several research studies suggest that the sample size should be estimated depending on the research approach and purpose (Baker and Edwards, 2012; Nastasi, 2009). Nevertheless, the most commonly recommended sample size for the qualitative method is 20 to 30 (Creswell, 1998; Mason, 2010; Nastasi, 2009). Following that suggestion, 25 was determined as a minimum sample size. The concept of data saturation (Glaser and Strauss, 1967), which is generally adhered to by the majority of qualitative studies (Miles and Huberman, 1994), was also applied to confirm that the sample size was sufficient. As data saturation implies that new data will not appear further, the researcher was able to determine when to stop further sampling for the study.

Participant Recruitment

Due to the use of Brunel University's on-site driver simulator for the study, participant recruitment was mainly conducted on Brunel University campus, through its websites, its students' social media and on bulletin boards across the campus. A total number of 34 participants (n=34) took part in the study. The group included 18 males and 16 females, ranging from ages 17–54, with an average age of 29.7. The university's ethics approval was fully granted prior to beginning participant recruitment (Appendix C) and all study processes were followed according to both Brunel University's 'Code of research ethics' (CoE, 2014) and the UK guidelines (Data Protection Act, 1998).

8.2.4 Study Protocol

After a short introduction about the study and its process, each research participant was asked to complete the information sheet, the consent form and the health form (Appendix C).

Participant's simulator sickness has been a critical issue for studies performed in a virtual environment, which can cause blurred vision, nausea, migraine or vertigo (De Winter, Van Leuween and Happee, 2012). Previous studies have emphasised careful attention and management to mitigate potential sickness in a simulator (De Winter, Van Leuween and Happee, 2012). Every participant was thus recommended to wear an acupressure wristband, the Sea Bands approved by FDA in 2004 (PR Newswire, 2004), to minimise potential simulator sickness (Wesley, Sayer and Tengler, 2005). All participants were also informed that the simulator driving task should be stopped when any of the above-mentioned symptoms occurred, following a simulator sickness protocol.

After completing a simulated drive of less than 10 minutes, which would maximize the stimulation of participants' targeted emotions (Saxby et al., 2013). The researcher in the control room used a stopwatch to control the timer. When a participant reached the 10-minute time limit, they were instructed to end the simulator driving. Also, if a participant stopped by mistake before any retrieval cue had appeared in the simulator scenario, they were required to drive again from the beginning of the allocated scenario. The Advanced Driving Package simulation software setting was adjusted to the pre-defined simulator scenario type. In each study, the researcher, therefore, needed to decide on scenario type for each participant. One of the two simulator scenario types was allocated to maintain the balance in number between each scenario type and gender. The simulator driving was expected to stimulate a comparable number of both positive and negative emotions, which might affect the participant's remembering of past experience of car stories. After completing the simulator driving task, participants were verbally asked to describe their current emotional state in the simulator. This process confirmed whether each participant had the targeted emotions.

After ending the simulation, each participant sat at a dedicated chair and table in the simulator room and accessed the online questionnaire page on the researcher's laptop computer. The participants used the same online questionnaire (Figure 8.2) as in the previous study to write down their past stories with automobiles that caused emotions.

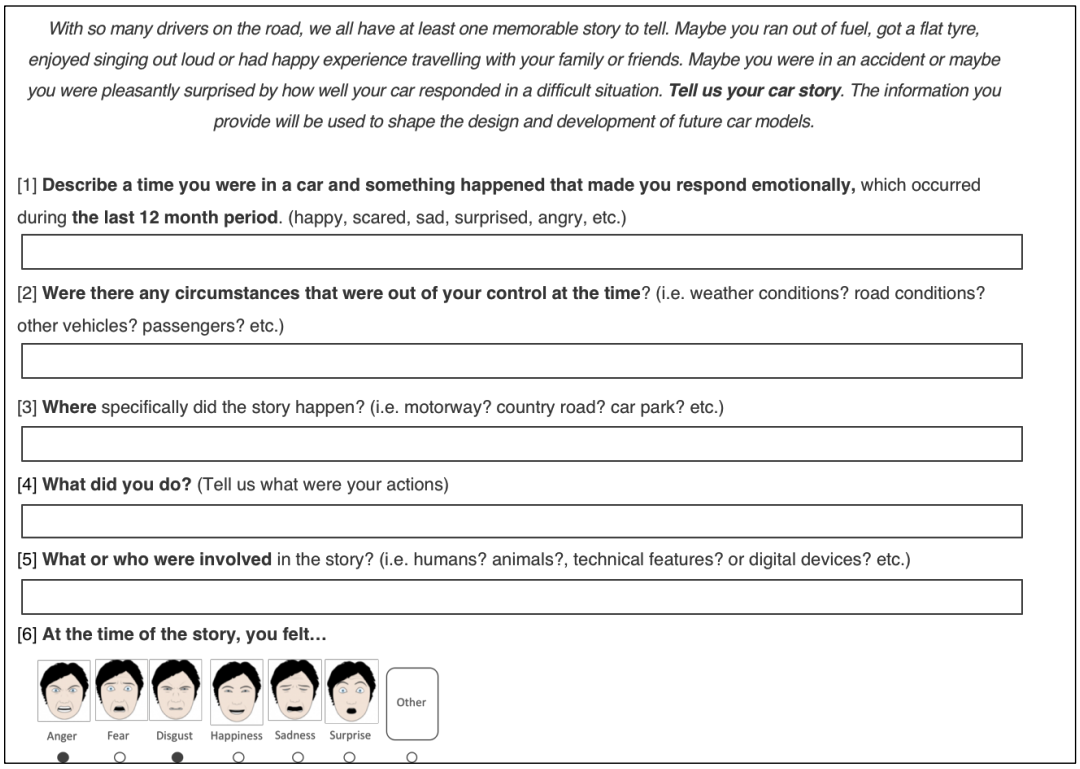


Figure 8.2 Questionnaire for investigating affective design scenarios in automotive contexts.

To reduce any potential bias due to the researcher's presence while conducting the study, the researcher waited in the next room until the participant completed the study. After completing the online questionnaire task, the participant was asked to verbally summarise the story written in order to fill in any potential gaps that may have been missed in the provided responses. All participants then completed a simulator sickness questionnaire (Appendix C) to ensure no symptoms from the driving simulator remained, to ensure the participant's health and safety.

8.2.5 Data Analysis

The data analysis aimed to categorise all participant's car stories into design themes in response to the question of why people have emotions in automotive contexts. The content analysis method was chosen based on its suitability for analysing text data as a meaning unit in a context (Krippendorff, 2004; Mayring, 2014; Texas State Auditor's Office, 2017). As described in the previous online study, seven commonly used steps in the content analysis process were also applied to this study (Figure 8.3) as the process provides practical guidelines that appeared to be comprehensible to follow.

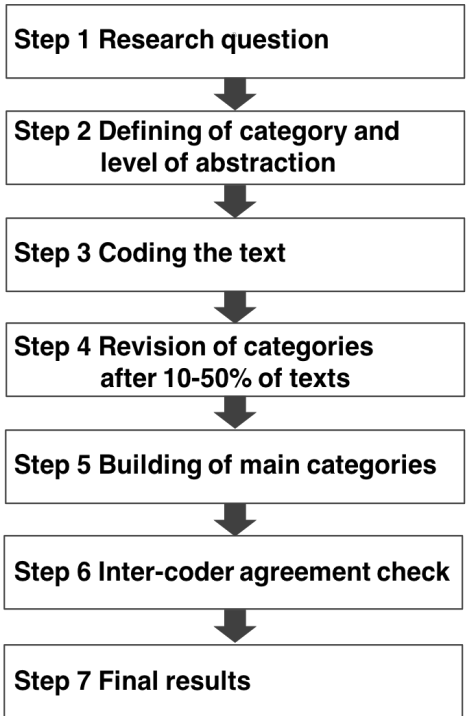


Figure 8.3 Content analysis process (adapted from Mayring, 2014).

The full set of emotional contexts from car stories attained from the study was coded as a meaning unit, which produced 34 codes. The codes were then grouped into 25 subcategories, which were collated together to build 11 main categories. Figure 8.4 shows the example coding process whereby the codes were collated into subthemes and subsumed by a main theme.

Codes	Subthemes	Main themes
- blew the front left tyre - had a flat tyre	Flat tyre	Car hardware malfunction
- ran out of fuel - low on fuel - fuel light on	Low fuel	

Figure 8.4 Example of content analysis coding process (from Step 3 to 5).

8.3 Results

8.3.1 Affective Scenario Themes

As a result of the content analysis, the 34 stories with automobiles collected were grouped into 11 main themes and 25 subthemes. The themes consisted of the main causes for people having certain emotions in automotive contexts. The main themes in Table 8.1 were presented in order of prevalence in order to compare the results to commonly appearing resultant themes from the previous study. Prevalence was counted in terms of the number of stories that related to each theme across the entire data set (Braun and Clarke, 2006). As the ultimate goal of both studies was to list a set of typical affective scenarios that might realistically happen in people's real automotive contexts, the degree of prevalence was an important criterion for the research. The 8 subthemes that are shown in bold in Table 8.1 were new ones that were not captured in the previous online study.

Main themes	Subthemes	Frequency
Theme 1. Driving with a loved one	- Driving with family - Enjoyable driving with people	6
Theme 2. Car hardware malfunction	- Flat tyre - **Low fuel**	5
Theme 3. Car accident	- Bumping into obstacle - Being hit by another car - Witnessing an accident - **Witnessing a dog's death**	5
Theme 4. Abrupt manoeuvring on the road	- Sudden lane changing without a signal - Sudden stop - Sudden turn without a signal - **Sudden reversing**	5
Theme 5. Lack of awareness in driving	- Mistakes in parking - First time driving in conditions	3

	-	Lack of confidence of driver	
Theme 6. Generous behaviour on the road	-	Getting help	3
	-	**Giving way to the ambulance**	
	-	**Helping others**	
Theme 7. Uncontrollable road conditions	-	**Poor road surface**	3
	-	**Poor road design**	
	-	Heavy traffic	
Theme 8. Road violations	-	Other driver's aggressive behaviour	1
Theme 9. Usability	-	**Adjusting mirror angles**	1
Theme 10. Infotainment	-	Enjoyable driving with music	1
Theme 11. Familiar in-car environment	-	Feeling relaxation	1

Table 8.1 Affective scenario main themes and subthemes (including new themes) with frequency.

As shown in the following section, each main theme was elucidated in the same order as in Table 8.1.

Driving with a loved one

The most frequently appearing theme from the study involved family and friends while driving. These enjoyable driving contexts included memory recall of family members, as well as having a conversation with a loved one in which positive emotions mainly occurred e.g. happiness.

Car hardware malfunction

Stories about low fuel and flat tyres were the contexts that caused fear, surprise and sadness. These negative emotions were also brought on by other vehicle's malfunction in the car system and controls on road.

Car accident

Stories linked to a car accident were obvious contexts that created negative emotions i.e. fear,

surprise, sadness and disgust. These included accidents involved either humans or animals.

Abrupt manoeuvring on the road

Other vehicle driver's abrupt manoeuvring while driving had an emotional influence on some participants. Sudden lane changing, reversing, or stopping composed this theme, which triggered negative emotions (i.e. surprise, fear and anger).

Lack of awareness in driving

Lack of awareness in driving was another cause of emotion occurrence in automotive contexts. Insufficiency of driver's knowledge and perception of a driving situation led to driver's mistakes or confusion in manoeuvring on the road, which impacted on their emotions.

Generous behaviour on the road

Drivers' acts of kindness on the road was another memorable context that created happiness, which included getting help, giving way to someone and helping others.

Uncontrollable road conditions

Various road conditions that could not be controlled by participants caused negative emotions while driving. These conditions included heavy traffic or unusual road design.

Road violations

Other vehicle driver's violations on the road (i.e. tailgating) triggered negative emotions.

Usability

The discomfort of adjusting mirrors in a car and dissatisfaction as a response to lack of usability was expressed in a participant's story.

Infotainment

Playing music through an infotainment system appeared in the database as another scenario that creates enjoyable driving.

Familiar in-car environment

A familiar in-car environment in which drivers feel relaxed was one of the main causes that created happiness.

8.3.2 Frequencies of Basic Emotions with Associated Themes

A total number of 68 emotions were collected across six basic emotions. The basic emotions were composed of fear (n=19), surprise (n=19), happiness (n=12), anger (n=8), sadness (n=7) and disgust (n=3). The associated themes for each emotion are shown in order of frequency in Table 8.2 and Table 8.3.

Fear		**Surprise**		**Happiness**	
n	Associated theme	n	Associated theme	n	Associated theme
5	Car hardware system malfunction	4	Car accident	6	Driving with a loved one
4	Car accident	4	Abrupt manoeuvring on the road	2	Generous behaviour on the road
3	Abrupt manoeuvring on the road	3	Car hardware system malfunction	1	Infotainment
2	Lack of awareness in driving	2	Generous behaviour on the road	1	Car hardware system malfunction
2	Uncontrollable road conditions	2	Uncontrollable road conditions	1	Lack of awareness in driving
1	Driving with a loved one	2	Driving with a loved one	1	Familiar in-car environment
1	Generous behaviour on the road	1	Road violations		
1	Road violations	1	Lack of awareness in drivin		

Table 8.2 Frequency of basic emotions (fear, surprise, happiness) with associated themes.

Anger		Sadness		Disgust	
n	Associated theme	n	Associated theme	n	Associated theme
2	Abrupt manoeuvring on the road	3	Car accident	1	Car accident
1	Driving with a loved one	2	Car hardware system malfunction	1	Abrupt manoeuvring on the road
1	Car hardware system malfunction	1	Abrupt manoeuvring on the road	1	Lack of awareness in driving
1	Lack of awareness in driving	1	Uncontrollable road conditions		
1	Uncontrollable road conditions				
1	Road violations				
1	Usability				

Table 8.3 Frequency of basic emotions (anger, sadness, disgust) with associated themes.

8.3.3 Emotion Stimulation by Simulator Scenario Type

In order to ensure that all participants had one of the appropriate targeted emotions immediately after the simulator driving, they were asked by the researcher to verbally describe their current affective state using one word. A total number of 16 participants (8 male and 8 female) who experienced simulator Scenario A were checked for positive feelings and emotions (Table 8.4). 18 participants (10 male and 8 female) who drove simulator Scenario B were also checked for their negative emotions. Although the emotional wordings varied by participants, each verbal description of affective state confirmed that the targeted emotions in both Scenario A and B were stimulated by the driving task in the simulator. The words in the following table are simply shown in order of participation.

	Participants (n=16) driving simulator Scenario A (stimulating **positive emotions**)	Participants (n=18) driving simulator Scenario B (stimulating **negative emotions**)
Verbal description of affective state by participants	P3. relaxed	P1. confused
	P4. pleasant	P2. anger
	P6. happy	P5. anger

	P9. content	P7. frustration
	P12. relaxed	P8. frustration
	P14. happy	P10. anxious
	P15. happy	P11. annoyed
	P16. enjoyable	P13. confused
	P19. exciting	P17. upset
	P24. happy	P18. headache
	P27. happy	P20. annoyed
	P28. great	P21. annoyed
	P29. nice	P22. nerve-racking
	P30. good	P23. annoyed
	P31. relaxed	P25. annoyed
	P34. pleasant	P26. stressful
		P32. nervous
		P33. stressed

Table 8.4 Verbal description of affective state right after the simulator driving by participants.

Out of the 16 participants who drove in simulator scenario A, 11 recalled car stories involving negative emotions, while only 5 participants in the same scenario A shared car stories that created positive emotions (Table 8.5). Similarly, 13 participants among 18 participants who experienced simulator scenario B provided stories with automobiles that caused negative emotions. Additionally, all car stories with positive emotions were derived from younger adult age group (one story from the 17-24 age group, nine stories from the 25-34 age group).

	Number of car stories with **negative emotions**	Number of car stories with **positive emotions**
Simulator Scenario A	11	5
Simulator Scenario B	13	5

Table 8.5 Number of emotional car stories by simulator scenario type.

8.3.4 Intercoder Reliability Check

Like the previous studies in this project, the independent coders were two academic researchers

and one industry professional who were familiar with coding data and generating themes. The selected coders were characterised by different professional backgrounds, genders and ages, in order to maximise a wide range of perspectives in the coding activity (Berends and Johnston, 2005). These coders were thus drawn from the fields of design (female aged 35), engineering (male aged 27) and business (male aged 37).

Each independent coder was asked to analyse the total responses (n=34) of the study following the instructions given. Focusing on a constraint ('What triggers people's emotions?'), 11, 12 and 13 themes were derived from the three coders.

Since the final resulting themes obtained from the previous study (Chapter 7) and the current study would be combined to generate a set of affective scenarios, the same criteria for reliably measuring themes were applied to both studies. As described in the previous study (Chapter 7.3 Results), per cent agreement, Fleiss's Kappa (1971) and Cohen's Kappa (1960, 1968) were used for this study. The results of the calculation are shown in Table 8.6. A total number of 11 themes appeared to be reliable, with seven themes meeting the target reliability rate minimum of 61 per cent (substantial agreement) and another four themes meeting the reliability rate of 81 per cent (almost perfect agreement).

Main themes	Per cent agreement	Fleiss's Kappa	Cohen's Kappa
Theme 1. Driving with a loved one	1.00	1.00	1.00
Theme 2. Car hardware system malfunction	0.94	0.78	0.78
Theme 3. Car accident	0.88	0.61	0.61
Theme 4. Abrupt manoeuvring on the road	0.94	0.78	0.78
Theme 5. Lack of awareness in driving	0.98	0.86	0.86
Theme 6. Generous behaviour on the road	0.96	0.65	0.64
Theme 7. Uncontrollable road conditions	0.90	0.61	0.60
Theme 8. Road violations	1.00	1.00	1.00
Theme 9. Usability	1.00	1.00	1.00
Theme 10. Infotainment	0.98	0.74	0.77
Theme 11. Familiar in-car environment	0.98	0.74	0.77

Table 8.6 Results of intercoder reliability check.

8.4 Discussion

This study investigated emotional stories with automobiles of people in a driving simulator setting. By conducting a contextual study with 34 participants using a driving simulator with pre-defined scenarios, the researcher sought to stimulate participant's emotions and thus prompted their past memories with automobiles. The themes derived from the content analysis activity confirmed the research hypothesis that additional stories with automobiles could be captured with the same questions by stimulating a spectrum of emotions within a contextual setting. This information reinforced the notion that aroused emotions could help memory recall.

The study results validated the use of affective scenario themes of typical stories with automobiles through comparison to the previous online study. Commonly appearing themes and linked emotions from both study results indicated that they seem to have a high possibility of emergence in real automotive contexts. Moreover, the attempt to prompt memory using stimuli could contribute to the creation of a complete view of automotive contexts that elicit emotions.

8.4.1 Discussion of Affective Scenario Themes with Basic Emotions

When the results of the online study described in chapter 7 are compared with the results of the simulator study, there is substantial overlap between the themes that are uncovered, with the exception of one additional theme that was suggested by the simulator study (Theme 9: Usability). This overlap suggests that those overlapped contexts between the two studies are highly likely to occur and highly likely to have an impact on people's emotions, making them useful for creating a practical design guideline for preventing negative experiences and enhancing positive experiences in automobiles. These themes could also be used to improve existing automotive products, subsystems or services or to explore new concepts. For example, specific subthemes, such as low fuel or flat tyres on the road, could be used to support the design of an attentive alarm-like feature to avoid potential negative emotions (i.e. fear, surprise, anger). Conversely, the subthemes that created positive emotions (i.e. happiness) could be used to generate new ideas for personalised in-car service to enhance enjoyable driving with family and friends.

The patterns of frequently occurring emotions in the simulator study were strikingly similar to the previous study results (Chapter 7.3 Results). The most frequently occurring emotions were fear

(28%) and surprise (28%), with happiness (18%) occurring more than sadness (10%) and disgust (4%) in the database. This knowledge could foster a better understanding of typical emotions that happen in automotive contexts, which could lead to the provision of better design criteria for decision-making of affective human-computer interaction in the automotive domain. The themes associated with each emotion could also be used as a specific design guideline for setting the context when controlling particular emotions.

With the growing importance of a human-focused approach in automobile design, understanding of human emotion through people's real-life stories becomes essential. These fundamental aspects within a context that link to their thoughts, attitudes and behaviours can be found in their stories, not based on researcher's assumptions through such observations. The scenario themes and associated emotions derived from the authentic stories supplied in both studies thus provide a great opportunity to develop automotive products, subsystems or services that align latent human needs and desires. Also, these insights offer the groundwork for appreciating how people emotionally engage with and remember their automobiles and what fundamental aspects might affect their future experience with automobiles.

8.4.2 Discussion of Emotion Stimulation in a Driving Simulator Setting

In contrast to the previous study conducted in an uncontrolled setting, the current study was designed to use memory retrieval cues in a contextual setting designed to assist with remembering emotional events. The use of a simulator appeared to be effective for stimulating a variety of emotions. As shown in Table 8.4, the driving task in each type of simulation scenario successfully induced the targeted emotions, either positive or negative. A complex driving task in a driving simulator, however, has been found to be more appropriate in automotive research to stimulate the driver's affective state for a longer period of time than being simply exposed to visual or auditory stimulus (Jeon, 2012). Furthermore, the contextual research setting enabled the researcher to mimic similar emotional states that might happen in automotive contexts, which led participants' responses to focus on various past experiences with automobiles.

8.4.3 Discussion of Emotional Memory Recall

This study partly questioned whether or not using a driving simulator to stimulate emotional

memories by using a contextual setting would be useful in eliciting additional stories about emotions and automobiles. The study was not designed to test the degree of memory recall or the accuracy of recalled stories by stimulus with the same participants, thus it is not possible to evaluate. The fact that new themes were revealed in this study in addition to those revealed from the online survey suggests that encountering emotional stimuli in a driving simulator context helped participants to focus on their past memories with automobiles to some degree. Given the relatively small number of participants (n=34) for the study in comparison to the previous investigation, which had 211 participants (n=211), the newly found themes may have been influenced by the emotions aroused in the driving simulator setting. As some cues (i.e. certain places, particular songs, objects) can trigger emotional memory (Lamia, 2012), a driving task related to pre-defined scenarios may act as a cue to help in remembering emotional memory related to automobiles. This also supports theories of state-dependent memory (Goodwin et al., 1969) and context-dependent memory (Godden and Baddeley, 1975) (Chapter 2.2.4 Memory Retrieval and Cues).

8.4.4 Discussion of Negative Emotions about Stories with Automobiles

The study utilised a driving simulator to stimulate participant's emotions with the purpose of prompting their memories with automobiles. It seemed interesting to check for a potential relationship between the stimulated affective states and emotional memories that were retrieved. The study indicated that negative emotions were dominant in memorable stories with automobiles regardless of the stimulated emotions in the simulator. As shown in Table 8.5, the number of stories that concerned negative emotions was more than twice than the number of stories that concerned positive emotions in both simulator scenario types. The possible discomfort caused by the driving simulator setting may impact the findings that the positive scenario (scenario A) was less successful at triggering positive memories. Indeed, several studies (Charles, Mather and Carstensen, 2003; Mather and Carstensen, 2003; Reisberg and Hertel, 2004; Chapter 2.3 Memory for Emotional Events) support the notion that memory for negative information lasts longer than positive memories, particularly for younger adults, while negative memory fades faster than positive memory for older adults. However, the study results show that automobile related stories were more likely to engage with negative emotions regardless of the participant's age. A closer examination of the number of negative stories and positive stories according to the range of age

for older adults (35-44, 45-54) reveals that all stories were related to negative emotions. Moreover, the previous investigation with 211 participants also found similar patterns, in that stories with negative emotions dominated people's automotive experiences. For older adults (45-54, 55-64, 65 or older), the ratio between the number of negative stories and positive stories became even larger with age. For example, there were fifteen times more negative stories than positive stories for the 65 or older group, while the numbers of negative stories were three times higher than positive stories in the 45-54 age group. The study finding aligns with the notion that emotional memories generally are not more likely to deteriorate with age than neutral information (Edelstein et al., 2004) and that stressful memories are not prone to fade over time (Yuille et al., 1994; Goodman et al., 1992; Chapter 2.3 Memory for Emotional Events). However, there is growing evidence that older adults' memories are more emotionally gratifying (and typically more focused on positive emotions) than younger adults' memories (Charles, Mather and Carstensen, 2003; Mather and Carstensen, 2003), and it is surprising that this information is dissimilar to previous theories about memory and ageing to some degree (Chapter 2.2.3 Memory Forgetting and Ageing). As this study was not intended to identify the relationship between memory and age of the same individual, its use for generalisation could be limited. Nevertheless, these findings could indicate that negative emotions in stories in the automotive domain are more likely to be memorable to people across age groups.

8.5 Assessing Validity and Threats to Validity

There is no one-size-fits-all solution to eliminate potential errors and bias that might threaten the validity of research. As activities involving humans may interchange cause and influence with another source of errors and bias (Norris, 1997), and efforts that focus on how to cope with potential threats are crucial to ensuring the trustworthiness of results. The most common method is to treat anything that can influence the process, such as the quality of data and reports suggested by a number of pieces of research, critically (Norris, 1997; Schreier, 2012; Elo et al., 2014). Here, we will use the same broadly used criteria for evaluating the trustworthiness of this study's data that were used to evaluate the online survey study in the last chapter: credibility, dependability, conformability, transferability and authenticity.

Credibility

The research reported every detail of the process in order to enhance credibility. Each selection process and criterion applied throughout the study was described honestly based on the researcher's factual activity.

Dependability and Conformability

Like the other studies, this study included an intercoder reliability check (Chapter 8.3.4) to improve the dependability of the data and consistency among multiple coders. All of the raw responses were independently analysed by three coders through the content analysis process and the degree of agreement among them was calculated to check the conformability of the coding activity. This checking process confirmed that the 11 resulting themes were considered to be stable and consistent, since they met at least a minimum target rate of 61 per cent (substantial agreement).

Transferability

The resulting themes of the study alone cannot be described as typical automotive contexts that created emotions, in terms of generalising the phenomenon, as the themes are the result of content analysis using a relatively small number of participant's responses (n=34). However, the comparison of the resulting themes from the previous study with a second one allowed the researcher to identify common themes, which suggests the high possibility of their occurrence in real driving contexts. Transferability of the results was thus checked.

Authenticity

This study was conducted to investigate participant's emotional experience with automobiles in reality. The variety of stories that were collected was derived based on the participants' long-term episodic memory with specific contexts. The study therefore confirmed that the resulting themes reflect people's authentic stories with automobiles.

Although the overall research process and results were self-criticised according to the above aspects, some obvious biases may be potential threats to validity. These include selection bias of the sampling and of simulator scenarios.

Selection Bias of Sampling

The most obvious potential bias might be due to the sampling of people. To mitigate the effects of sampling in the research, attempts were made to recruit a variety of people including not only university students but also staff. Adverts for the study were internally sent to university staff and students via email, and research participation information was posted across the campus. However, some physical constraints of time and place might have influenced the sampling of participants, as the study had to be performed on campus, on a weekday, in order to have access to the driving simulator. In future studies, a wider range of participants from off campus should be included.

Simulator Scenarios

Another potential bias might be related to the simulator scenarios. The order of events created within both scenarios may impact on participant's memory recall. For example, the first event (abrupt jumping-in by a cyclist) or the last event (car accident with ambulance sirens) in Scenario type B may influence how participants remembered past automotive experiences. Moreover, all participants were asked not to tell friends or colleagues about the scenarios they experienced, in order to prevent possible bias from potential participants. The researcher, however, noticed that friends or colleagues had informed some of the participants about the scenarios. In these cases, the researcher switched the type of simulator scenarios to ones they would not expect. In future studies, prior checking of the participants' knowledge of expected scenarios and a follow-up inquiry regarding memory triggers should be included to minimise the impact of bias in the simulator scenarios.

8.6 Conclusion

This study addressed the third research question posed in the first chapter, which asked : 'How can an 'affective design scenario' be developed in a complete and rigorous manner?'. By using a triangulation approach in the second study to explore affective design scenarios themes and developing a new method for eliciting emotional memories regarding automobiles, this study both reinforced the findings of the earlier study by identifying common scenarios and emotional responses and helped to find new scenarios and responses that could not be generated through an

online study alone.

When the resulting themes from the uncontrolled online study and the simulator study are compared, it allows the researcher to re-confirm the most common themes with the highest possibility of occurrence in real driving contexts. The two-pronged approach adopted in chapters 7 and 8 suggests a highly appropriate way to identify typical automotive contexts in a holistic manner. The format of collecting real-life stories allowed participants to provide their individual, specific experiences with automobiles that involved psychological and sociological aspects beyond the automobile's functional aspects.

Indeed, past automotive research studies (Jeon and Walker, 2011; Harris and Nass, 2011) have used some automotive contexts in which negative emotions would occur for the purpose of creating simulator driving courses. Some of the hazard events (i.e. cutting off car, traffic, sudden U-turn or a crossing animal on a road) that were included in those contexts also appeared in this study's dataset. The study, however, suggests a wide range of automotive contexts that would trigger either positive or negative emotions. Moreover, the study's findings could help highlight some of the constraints that limit identification of affective contexts with automobiles that were already addressed in past automotive practices (i.e. small number of participant's particular responses, researcher's personal experience or applicability of simulation software). This could open up the opportunity to expand the scope of existing affective automotive contexts, which might be beneficial for creating a driving environment to test automotive products or subsystems in a simulator.

As driving is a complicated task that demands physical, mental and emotional focus and various cognitive issues (Harris and Nass, 2011), it is not surprising that negative emotions seem more likely to be associated with driving contexts. This research, which focuses on emotional contexts, supports that notion, finding that negative emotions tend to dominate individual's memorable stories about automobiles regardless of their age group. Those emotional memories with automobiles can influence people's general thoughts and attitudes towards driving, and further, they can possibly impact on purchasing decisions and behaviour. This knowledge represents a strong rationale and foundation for automotive researchers and designers to consider emotional contexts to create better experiences through future automotive design. In the next chapter, a formulation of a set of affective design scenarios in automotive contexts is introduced using the affective scenario themes achieved from the previous (Chapter 7) and current studies (Chapter 8).

9 Affective Design Scenarios in Automotive Contexts

This chapter focuses on formulating affective design scenarios in automotive contexts using the scenario themes described in the previous chapters, responding to the Research Question 4. addressed in Chapter 1 – 'What are the typical 'affective design scenarios' in automotive contexts?'. In order to achieve the aim, individual research activities following each stage of the scenario development process are summarised in this chapter.

As defined in Chapter 3, the scenario development process for this research consists of four stages: Stage 1. Setting boundary conditions, Stage 2. Identifying key driving forces, Stage 3. Developing mini-scenarios and Stage 4. Writing full storylines. Prior to conducting the research activities, the boundary conditions (Stage 1) were determined to clarify the scope of the research. Two scenario studies for identifying key driving forces (Stage 2), which were major parts of the scenario development process, were described comprehensively in Chapter 7 and 8. Using the key driving forces, the stages from mini-scenarios (Stage 3) to full storylines (Stage 4) are elaborated on in this chapter. Moreover, an assessment of the validity and threats to validity of the research process are discussed.

This chapter also articulates how detailed example scenarios for each theme were proposed following the scenario development process. Initially, the research performed the various steps to develop mini-scenarios and full storylines; this was because of the researcher's familiarity with large-scale collected data and systematic data extraction. The level of detail (i.e. story length, tones, wordings) in each scenario was thus adjusted accordingly through a checking process using independent reviewers in order to minimise the researcher's bias and subjectivity (Chapter 9.1.5 Checking Process of Theme Titles and Example Stories). With the benefit of visual support in terms of assisting individual's imagination of contexts (Dahl et al, 2001), each of the main storylines are encapsulated in a static visual cut, which is presented in Chapter 9.2. The affective design scenarios in automotive contexts could theoretically be used to enhance understanding of a spectrum of real-life affective contexts with automobiles and they could also be used practically to identify the fundamental requirements of an automotive system, the potential interactions, and the concerns and issues regarding emotional responses (Appendix D).

9.1 Scenario Development Processes

9.1.1 Stage 1: Setting Boundary Conditions

As the first stage, adapted from the steps described by Alcamo (2007), the boundary conditions that framed the major structure of the specific design research activities were determined at the beginning of the research. The research investigated a broad range of individuals' recent experiences within an automotive context and therefore targeted the general public within the current time frame. The intended geographical coverage was constrained to UK residents to avoid potential misinterpretations of collected data that can result from cultural differences. No other physical boundary conditions were established.

9.1.2 Stage 2: Identifying Key Driving Forces

In the second stage of identifying the 'key driving forces', two individual scenario studies were conducted to identify key driving forces. Qualitative input through surveys, workshops or interviews is commonly suggested as the best way to identify a set of 'key driving forces' that capture complex situations (Ogilvy and Schwartz, 1996). Previous scenario Study A described in Chapter 7 explored a broad range of affective contexts with automobiles through an online survey with 211 participants (n=211), which resulted in 12 main themes. The first online study attempted to cover as many varied contexts as possible that frequently occur in real-automotive contexts. The second scenario study, described in Chapter 8, also achieved 11 main themes, including an additional new automotive context through the same survey questions, by prompting participants' memories in a driving simulator. The aim of the second scenario study was to identify a comprehensive array of possible affective scenario themes to enrich the first scenario study results. The main themes that were achieved from each scenario study were reviewed with independent coders through an inter-coder reliability checking process (Chapter 7.3 Results and Chapter 8.3.4 Intercoder Reliability Check).

The themes covered affective scenarios in automotive contexts that people frequently experienced

in their real lives and revealed why people emotionally respond in certain situations with automobiles. Most of the main themes identified from the second scenario study – except for an additional theme (Theme 13. Usability) – were a subset of the main themes identified in the first scenario study. For this reason, the main themes as key driving forces shown in table 9.1 were thus described in the order of frequentcy in which these themes were identified from the first scenario study appeared.

Regardless of the different wordings used, the themes from the two studies were consolidated into a single theme when the core idea overlapped. The wordings in themes were also edited in order to avoid generic terms and to enhance the clarity of the meaning toward each theme, addressing the design criterion: Do the wordings of each theme clearly illustrate the concept of each theme and subthemes?

Main Themes	Sub Themes
Theme 1. Road violations	S1. Overtaking S2. Insulting S3. Being forced to give way S4. Argument S5. Tailgating
Theme 2. Car accident	S1. Bumping into another car or obstacle S2. Being hit by another car S3. Witnessing an accident S4. Recalling a memory of a prior accident S5. Witnessing a dog's death
Theme 3. External environment conditions	S1. Heavy traffic S2. Road infrastructure (e.g., Road signs, Traffic light, Street light, Poor road surface, Poor road design) S3. Other road users (e.g., Animal, Motorbike/Cyclists, Pedestrians) S4. Parking space S5. Unfamiliar road S6. Weather
Theme 4. Infotainment	S1. Music on the radio

	S2. News from the radio / calls
Theme 5. Car hardware system malfunction and alerts	S1. Warning alerts S2. Broken down (e.g., Dead engine, Drained battery) S3. Partial system malfunction (e.g., Broken brakes, Broken gearbox, Broken seatbelt, Flat tyre, Low fuel)
Theme 6. Abrupt manoeuvring of driver	S1. Sudden road entry S2. Sudden stop S3. Sudden turn S4. Sudden lane changing S5. Sudden reversing
Theme 7. Lack of awareness in driving	S1. Mistakes/confusion S2. First time driving in conditions S3. Slow driving S4. Lack of confidence of driver
Theme 8. Driving with a loved one	S1. Driving with family S2. Driving with friends
Theme 9. Generous driving behaviour on the road	S1. Getting help S2. Giving way S3. Helping others
Theme 10. Driver's in-car experience	S1. Experience with car features S2. Feeling relaxation S3. Hearing familiar sound of the engine
Theme 11. Car software system malfunction	S1. Navigation/GPS error S2. Flat phone battery S3. IOS CarPlay error
Theme 12. Driving landscape	S1. Seeing beautiful scenery (i.e., animals, a moon rise, sunshine) S2. Night driving with stars
Theme 13. Usability	S1. Adjusting mirror angles

Table 9.1 13 Affective scenario themes as key driving forces (13 main themes and 44 mini-scenario themes).

9.1.3 Stage 3: Developing Mini-Scenarios

In this third stage, mini-scenarios were structured based on the identified key driving forces. Each subtheme in Table 9.1 was determined as the mini-scenario theme that could easily detail the

concept of each main theme. Participants' real responses collected from the two previous scenario studies were extracted by the researcher to elaborate each mini-scenario theme, by maximising the reality of each individual's perspectives within specific contexts (Ogilvy and Schwartz, 1996; Pruitt and Grudin, 2003; Alcamo, 2007). In order to minimise the researcher's bias and subjectivity in extracting collected responses from the studies, independent reviewers checked example storylines of mini-scenarios, as described in the section 9.1.5.

The following selection criterion for extracting participant's real responses was applied: 'Does each example automotive story clearly illustrate the sub theme?'. Once an example story was selected, further information from the participant who wrote the story was extracted from the survey dataset. The further information included location (where the story happened), participant's vehicle type (what type of vehicle that they were driving at the moment described), participant's gender and age, and the elicited emotion, which might assist with the vivid imagination of real contexts based on factual data. Table 9.2 shows one of exemplary mini scenarios and further information about the 44 mini-scenarios. 'Overtaking' was determined as one of the mini-scenario themes, which is categorised under the main theme of 'Road violations'. The description of the specific contexts and further information (e.g., Motorway, female driver or anger and disgust) were extracted from participants' real responses.

Main Themes	Mini-Scenario		Location	Vehicle Type	Gender	Age	Emotion
Theme 1. Road violations	S1. Overtaking	A car sped up behind a driver's car and overtook the car in front.	Motorway	Sport utility cars (i.e. Hyundai Santa Fe)	Female	17-24	Anger, Disgust

Table 9.2 Example mini-scenario and further information extracted from the survey dataset.

9.1.4 Stage 4: Writing Full Storylines

The fourth stage of 'writing full storylines' was adapted from the step described by Alcamo (2007) and Schwartz (1996). Each mini-scenario was required to make depictions based on the viewpoints and emotional responses of the associated persona. Bødker and Christiansen (1994) suggested that writing a storyline for the activity of each mini-scenario can be done by following the narrative criteria: 'what is done', 'where', 'by whom and when', 'by what means' and 'in what way'. The

extracted mini-scenario examples were enriched with the guidelines given above and full storylines of 44 mini-scenarios were written (Appendix D). Table 9.3 shows an example storyline of Theme 1 based on information given in the mini-scenario.

Main Themes		Full Storylines
Theme 1. Road violations	S1. Overtaking	A driver was driving in the fast lane on the motorway when a car sped up behind her and overtook her in the front using the middle lane. The driver was so angry that she beeped her horn. Someone dangerously manoeuvring to overtake her without any notice made her feel a sense of disgust since the speed in the fast lane was already high.

Table 9.3 Example full storylines of extracted mini-scenario examples.

Since writing style can vary greatly (Sebranek, Kemper and Meyer, 2006), a conscious effort was made by independent reviewers to achieve a similar length of narrative for each scenario, to avoid technical or social jargon, and to maintain a neutral tone. The reviewer checking process is fully described in the following section.

9.1.5 Checking Process of Theme Titles and Example Stories

The purpose of the checking process was to improve the reliability of the main theme titles and example storylines of the mini-scenarios. Multiple reviewers were involved to ensure each theme's wording and examples clearly illustrate each mini-scenario in order to improve the clarity of theme title and full scenario storylines. As the primary task in this reviewing process involved English language usage and some wordings may be used differently in different cultures, the checking process required English native speakers as reviewers.

For this reason, two independent reviewers who are English native speakers (British male aged 31 and British female aged 29) were invited to check the use of precise semantics and example stories. A checking sheet with the following questions was provided: Q1. Does each main theme title clearly include the associated sub themes? Q2. Does each example story clearly illustrate the associated sub theme? (Figure 9.1). As a result of the checking process, the reviewers all agreed on the example stories in general. The wording in the main themes was edited i.e. 'generous behaviour' to 'generous driving behaviour on the road'.

		Q1.				Q2.		
Main Themes	Mini-Scenario Themes	Yes	No	If you said 'No', why?	Full Storyline	Yes	No	If you said 'No', why?
Theme 1. Road violations	S1. Overtaking				A driver was driving in the fast lane on the motorway when a car sped up behind her and overtook her in the front using the middle lane. The driver was so angry that she beeped her horn. Someone dangerously manoeuvring to overtake her without any notice made her feel a sense of disgust since the speed in the fast lane was already high.			
	S2. Insulting				A driver was going over a speed bump on a tight city road when a car approached the driver head on. The driver in the other car was annoyed that he hadn't waited behind and given way to him—even though neither driver had right of way. As the two drivers converged, the waiting driver shouted from within his car, made angry gestures and swerved his car towards the driver as if about to hit him. The approaching driver swerved out of the way (although the driver couldn't go very far as there was cars parked either side). He was very angry at another driver's behaviour.			
	S3. Being forced to give way				Two drivers were approaching each other on a tight city road that only had space for one to pass at a time. One driver refused to give way, even though they had several opportunities in the road to slot in between parked cars, and forced the approaching car to stop and manoeuvre with great difficulty into a very tight space. The driver was forced to give way, so she tried to swerve out of the way even though she couldn't go very far. She was very angry at the selfish behaviour of the other driver and she was concerned that her car was damaged by other cars parked when avoiding the approaching car.			
	S4. Argument				He was a passenger in a car on a high street road and the driver of another car got into a verbal confrontation. It later turned physical and he was scared and surprised, so he tried to defuse the situation by talking calmly to both drivers.			
	S5. Tailgating				A car sped up behind a driver's car, pressuring her to change lanes so they could go on ahead. The outer lane was congested and she could not move out of the way. The car continued to follow her very closely and it was quite unsafe.			

Figure 9.1 Example of checking sheet for theme titles and example storylines.

9.2 Representation of Affective Design Scenarios in Automotive Contexts

Full storylines of each affective design scenario in automotive contexts were formulated based on real participant's responses through four stages of scenario development process described in the previous sections. In order to effectively present a set of 13 affective design scenarios in automotive contexts, the following considerations were adopted for optimising appropriate length, language usage and visual details for use of the scenarios by automotive designers, engineers and researchers.

- The linguistic description:
  - Natural language (i.e., no jargon, technical terms, location names etc.) was used to capture hidden needs and requirements underlying the contexts, which can be understood by both technical and non-technical drivers and passengers (Hoisl, Sobernig, and Strembeck, 2014).

  - Each description was a three to five sentence illustration of a context, which provided a physical, perceptual, cognitive or emotional interaction in different automotive contexts. This was done to balance conciseness and completeness when communicating the information (Foddy, 1993). Given the number of scenarios (44 sub-scenarios in Appendix D) as an entire scenario set, the full length of each scenario was kept to a minimum (i.e., one or two sentence describe one of the scenario elements—a situation, interactions or actions and emotion).

- The visual description:
  - A static image of generic sketchy cut that represents each context of a scenario was produced for ease-of-deployment in the design process (i.e. concept generation workshop settings), which can assist an individual's imagination of specific contexts and elicited emotions (Dahl, Chattopadhyay and Gorn, 2001).

Representations of exemplary scenarios are presented with possible questions in order to suggest a brief idea of what an example scenario may produce for automotive practitioners in Figure 9.2 to 9.14. The full set of 44 scenarios subthemes is provided in Appendix D.

ROAD VIOLATIONS

The most obvious typical story involved violations by the drivers of other vehicles on the road. Such inconsiderate behaviour included situations of forcing to give way, overtaking, insulting, arguments and tailgating, which triggered negative emotions, particularly fear, while driving.

Being forced to give way

Two drivers were approaching each other on a tight city road which only had enough space for one to pass at a time. One driver aggressively beeped the horn on the steering wheel and refused to give way, even though there were opportunities in the road to slot in between parked cars. The second driver was forced to stop and backup into a very tight space. She was forced to turn the steering wheel quickly to swerve out of the way even though she didn't have much space to move. She was angry at the selfish behaviour of the other driver and was concerned that she might have damaged her car, because it was difficult to see out of the side window and difficult to hear sounds coming from the rear of the car.

Figure 9.2 Affective Design Scenario – Road Violations.

CAR ACCIDENT

Stories linked to a car accident were apparent contexts that created negative emotions (i.e., fear, surprise, sadness and disgust). In particular, traumatic stories about accidents were observed as memorable automotive contexts (i.e., bumping into another car or an obstacle, being hit by another car, witnessing an accident and recalling a memory of a prior accident).

Bumping into another car or obstacle

A passenger was riding in her friend's car as they approached a roundabout. Her friend suddenly pushed on the accelerator and crashed into a stopped car ahead! If the car had been equipped with some form of collision avoidance system maybe the accident could have been avoided. The collision caused quite a lot of damage to both cars. The entire left side of one car was pushed back, jamming the front door, while the other car's bumper was cracked. They got out of their car to check the damage. It was quite a shock for her as a passenger because her friend had caused a serious accident and the damage to both cars was substantial. She wondered why cars always suffered such expensive damage even from small crashes.

Figure 9.3 Affective Design Scenario – Car Accident.

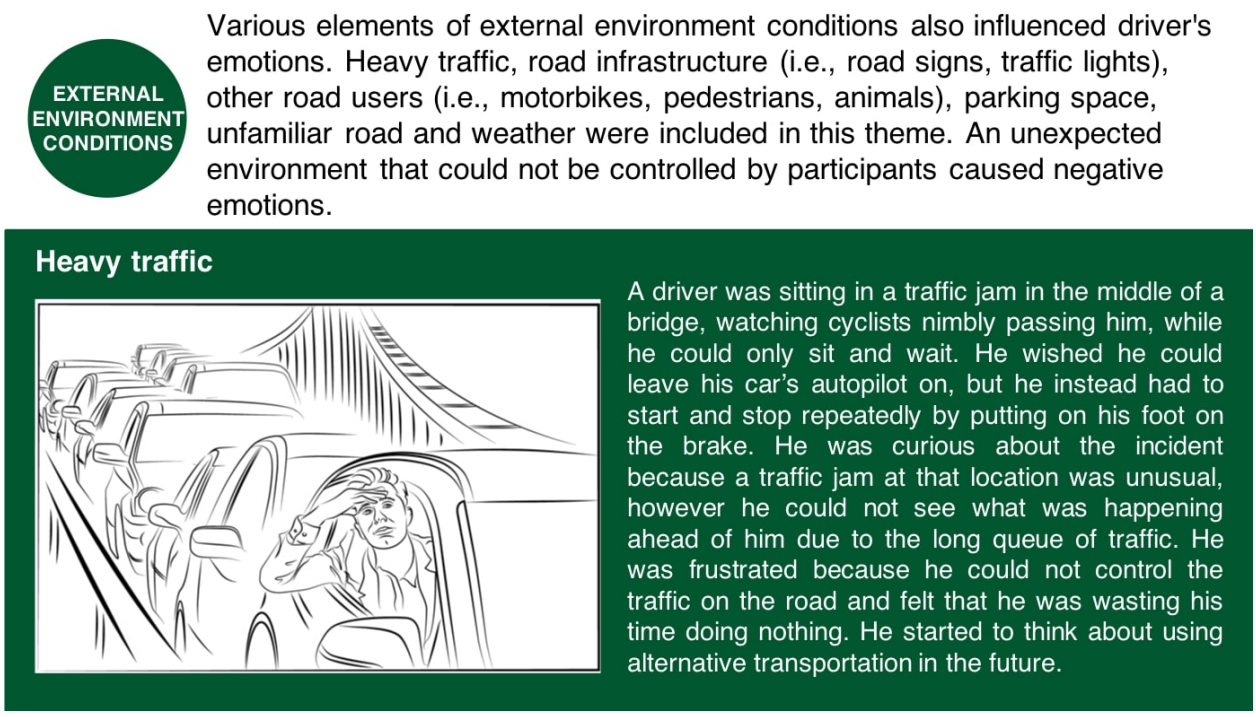


Figure 9.4 Affective Design Scenario – External Environment Conditions.

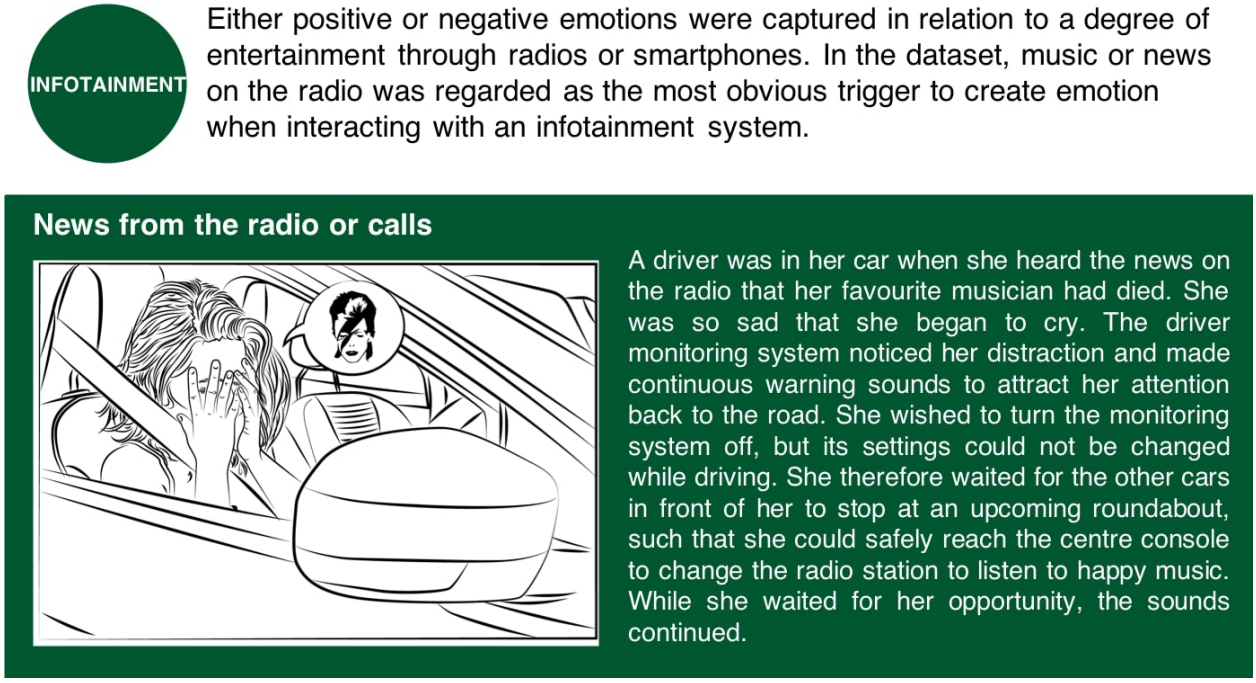


Figure 9.5 Affective Design Scenario – Infotainment.

CAR HARDWARE SYSTEM MALFUNCTION & ALERTS

Warning alerts, partial or full malfunction in the car system, and controls were other typical stories about automobiles. Fear, surprise, anger and sadness were frequently involved in these contexts.

Warning alerts

A driver had an engine warning light on the dashboard come on whilst driving down a city road. He ignored the warning light for a few days, however a further warning light eventually came on while he was driving. He felt pressured and burdened because it meant that he needed to take his car to a mechanic right away. He could not just ignore the alerts, but he thought that he was very busy and that he did not live near a mechanic. He wondered why the issue had not been noticed when he had recently taken the car to the dealership for its annual servicing.

Figure 9.6 Affective Design Scenario – Car Hardware System Malfunction & Alerts.

ABRUPT MANOEUVRING OF DRIVER

Other vehicle driver's abrupt manoeuvring on the road (i.e., sudden road entry, sudden stop, sudden turn, sudden lane changing and sudden reversing) was frequently mentioned as an emotional automotive experience, which triggered negative emotions (i.e., surprise, fear and anger).

Sudden road entry

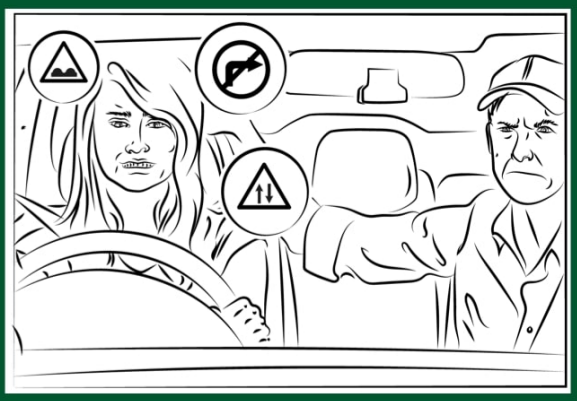
A driver was travelling at about 40 mph on a quiet residential road when another car suddenly popped out of a narrow side street without stopping. The driver had to slam on the brakes to avoid collision, and beeped his horn violently. He was surprised and shaken. He was amazed that he had managed to stop his car in such a short amount of time. When he had calmed down sufficiently, he wondered why his car did not have some sort of system to warn him of the danger.

Figure 9.7 Affective Design Scenario – Abrupt Manoeuvring of Driver.

LACK OF AWARENESS IN DRIVING

Lack of awareness in driving was the main cause of emotion that occurred in automotive contexts. Insufficiency of driver's knowledge and perception of a driving situation led to driver's mistakes or confusion in manoeuvring on the road, which impacted on their emotions.

Lack of confidence in driver



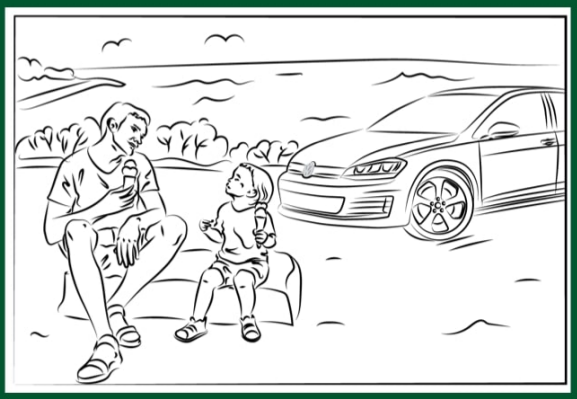
A son was riding in his mother's car. The mother was not certain what the speed limit of the road was, and thus kept pressing the brake to slow down. She wasn't noticing the speed limit, therefore the son kept pointing out the speed limit signs to her. Although the son had told his mother that the car was equipped with an adaptive cruise control system, she did not agree to use it, and she continued to appear confused and nervous. The son was concerned about what else his mother might not be noticing. He tried to remain calm, but was uncomfortable sitting in the front passenger seat.

Figure 9.8 Affective Design Scenario – Lack of Awareness in Driving.

DRIVING WITH A LOVED ONE

Having a good time with family or friends in a car was clearly the context in which positive emotions (i.e., happiness) mainly occurred.

Driving with family



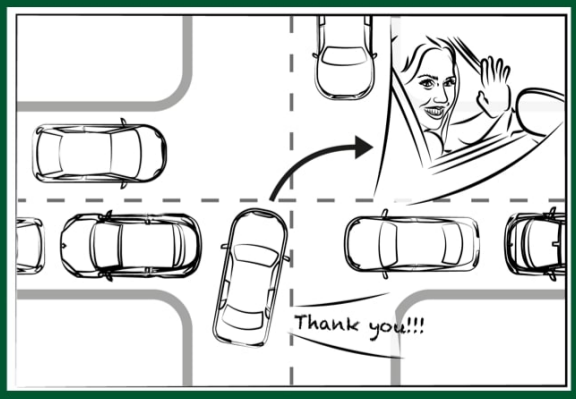
A father bought a new car and took it out with his son for a first drive. They enjoyed taking the seat protector sheets off together. After the father pressed the ignition button, his son became excited, playing with every dial in the centre console and touching the satnav, as these were new to him. The father took a picture of his son playing in the car to capture the moment. They then drove to the local coastal area and parked at the beach for ice cream. The father thought that his son would soon be a man, and wished that he had more than just a picture to remember the special day.

Figure 9.9 Affective Design Scenario – Driving with a Loved One.

GENEROUS DRIVING BEHAVIOUR ON THE ROAD

Acts of kindness by drivers of other vehicles on the road was another context that mainly involved happiness. Stories about other drivers giving way, getting help or helping others were obtained as positive memorable contexts.

Giving way



A driver who needed to enter busy London rush hour traffic was watching for her chance to go. She was nervously thinking that it was a terrible time of day to have to enter the larger road. She put her turn signal on, knowing that she needed a car from the larger road to allow her to make her right turn. Though she could not see the oncoming traffic well through the corner of her car's windscreen, she waited for her opportunity. Finally, a driver from the larger road gestured to her, kindly giving way. She immediately pressed the accelerator to make the right turn as quickly as she could, and she smiled and waved her hand gratefully. She felt that it was nice of somebody to have shown kindness. The experience restored her faith in people.

Figure 9.10 Affective Design Scenario – Generous Driving Behaviour On The Road.

DRIVER'S IN-CAR EXPERIENCE

Having familiar experience (i.e., experience with car features, hearing the familiar sound of the engine) with a car created positive emotions. The role of a car was not only about experiencing technical features but also about being in a familiar space, like a home, in which drivers feel comfortable.

Feeling relaxation

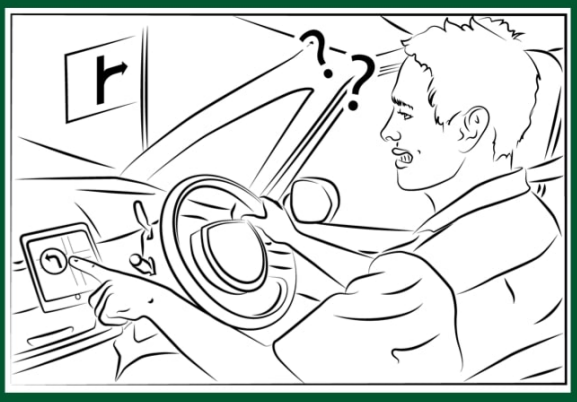
Upon reaching her car in the car park of an airport, a driver opened her car's door, entered, sat back, and relaxed. She thought that it was good to be in her car again after a long flight. Without needing to think about it, she leaned back in the seat and pressed the car's "on" button. She then asked the car to play her favourite music. Before moving, she checked the fuel to see whether or not she had enough to reach home. There was enough fuel, so she just relaxed, and switched the selector to 'drive'. The familiar sights, sounds and smells produced feelings of pleasantness and calm. She felt as though she had already arrived home. She enjoyed her hour long drive home.

Figure 9.11 Affective Design Scenario – Driver's In-Car Experiene.

CAR SOFTWARE SYSTEM MALFUNCTION

Drivers' negative emotions (i.e., fear, anger and surprise) were triggered by malfunctions of car software systems, including navigation error, flat phone battery and IOS CarPlay error. Drivers' frustration was heightened as these system malfunctions stopped them from using their desired functions while driving.

Navigation or GPS error



Badly positioned signs on a motorway confused a driver, leading him to miss the exit which he had intended to take. The car's navigation system had been slow to warn him of the upcoming exit, making the mistake easier to make. Worse, after exiting the motorway the navigation system suffered an error and stopped working altogether. The driver made frantic efforts to reboot the system by pressing various buttons, but it would not start. The driver was now on the wrong road, confused and with no place to pull over to stop the car. The confusion quickly lead to frustration and anger due to the danger and the lack of control. The driver wondered why the car was slow to react and why it seemed to pay so little attention to his actions.

Figure 9.12 Affective Design Scenario – Car Software System Malfunction.

DRIVING LANDSCAPE

Driving with scenery visible through the car windows was mentioned as an enjoyable memory. The contexts include seeing incredible sights or scenery while driving (i.e., animals, a moonrise, sunshine) and night driving with stars.

Seeing beautiful scenery

A driver was travelling on a country road that ran along the coast. The scenery was beautiful, the weather was sunny and favourite music was on the radio. The driver asked the car to increase the music volume while singing along. With the windows open the view of the road and of the surroundings from her sitting position was magnificent. Since there was little traffic, she was driving on autopilot so as to be freer to enjoy the experience. She hoped that telephone calls, car communications or other unanticipated events would not ruin the experience.

Figure 9.13 Affective Design Scenario – Driving Landscape.

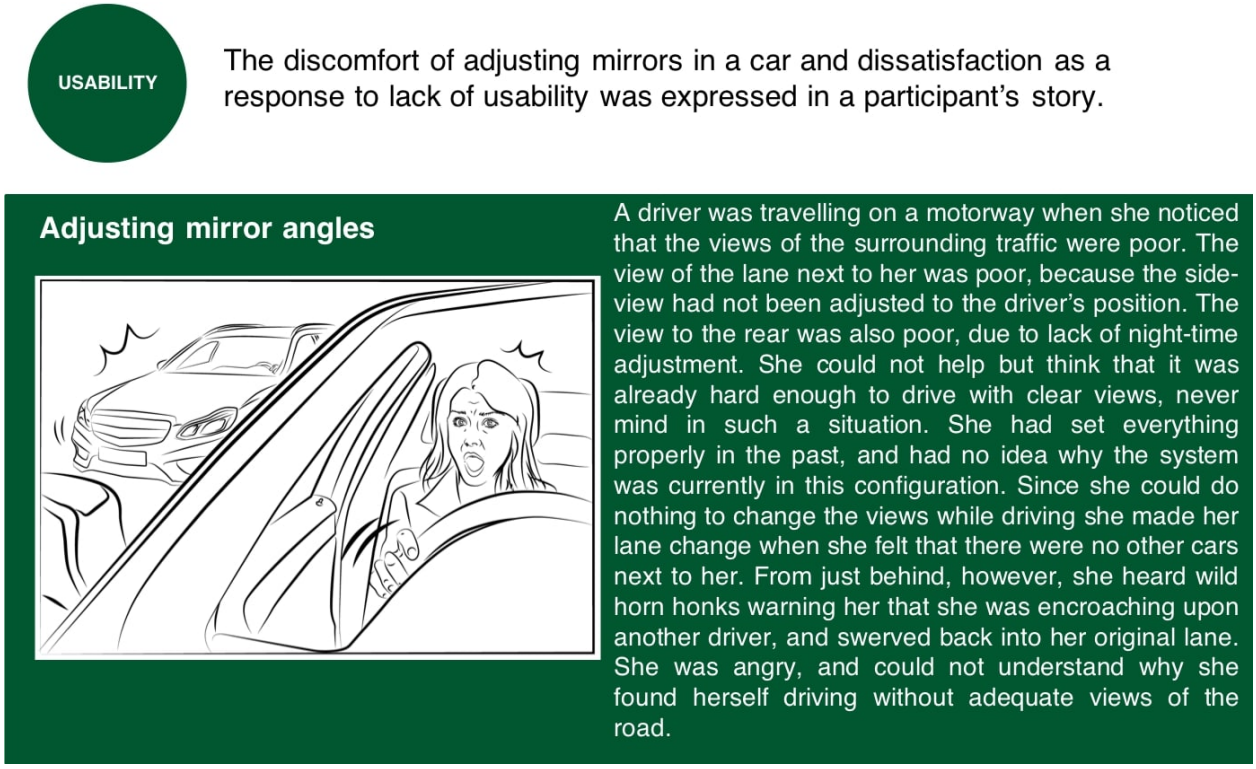


Figure 9.14 Affective Design Scenario – Usability.

The proposed affective design scenarios use human emotions in descriptions, indicating the main causes of actions and behaviours. Each scenario above is not merely a description of an interaction with an automotive product, service or subsystem, but a description of fundamental reasons that create either positive or negative emotions. As there is growing attention towards human emotional aspects in the rapidly changing automotive industry, this research outcome can enlarge the spectrum of critical contexts in which people commonly want automobiles to improve their experience.

9.3 Assessing Validity and Threats to Validity

Qualitative research involves phenomenological interpretation of non-numerical data, which tie in with human bias and subjectivity (Leung, 2015). Given the nature, importance of various efforts to minimise potential bias and subjectivity that might possibly threaten research, validity and reliability have been highlighted. Assessing validity in qualitative research is related to checking

the ‘appropriateness’ of the research process and results, which connect to the genuineness of the research (Anderson, 2010; Leung, 2015). Moreover, assessing reliability in qualitative research involves checking the ‘consistency’ or ‘stability’ of the data (Anderson, 2010; Leung, 2015). The most widely used criteria, suggested by Lincoln and Guba (1985), provide five aspects to assess the ‘appropriateness’ and ‘consistency’ of the research process and results: credibility (honest and fair reporting of research participating), dependability (stability of data), conformability (consistency between independent coders), transferability (ability to be generalised) and authenticity (real experiences of people). These criteria were thus applied to assess the validity and reliability of proposed scenarios.

Credibility

Each stage of scenario development was reported including every detail of the decision process. In Stage 2 (Identifying Key Driving Forces), the detailed process in which the scenario themes with different theme title wordings were consolidated was described to enhance credibility of the research process and the final themes.

Dependability and Conformability

Stage 3 (Developing Mini-Scenarios) and Stage 4 (Writing Full Storylines) required the extraction and elaboration of descriptions from the real participant’s stories collected from the studies. To minimise the researcher’s subjectivity during this work and to improve the dependability and conformability of the process, multiple reviewers were involved to check the use of precise semantics and example stories against criteria established for each stage. The final outcome reflected feedback from these checking processes.

Transferability

The set of scenarios was formulated based on the consolidated dataset, which was collected through a triangulation approach. The common results from two different methods and experimental settings (Chapter 7 and Chapter 8) were obtained using the same questionnaire and therefore may be perceived as representative in the research topic. Although the outcome cannot be generalised across different cultures due to the geographical boundary condition applied to the research, the research attempted to enhance the transferability of the results within the boundary

through the triangulation approach.

Authenticity

The proposed scenarios were developed using scenario themes that were achieved from the studies focusing on real-life emotional experiences with automobiles. The exemplary stories of each mini-scenario were also elaborated based on real participant's responses and the information they provided. The authenticity of the research outcome was thus ensured. Each stage of the scenario development and research outcome were self-evaluated according to the above criteria to check the appropriateness and consistency of the research, and the overall process and results were considered to adequately meet each aspect of the criteria. Nevertheless, some selection bias may pose a potential threat to validity.

Selection Bias of Exemplary Stories

The obvious potential bias might lie in the initial process of selecting exemplary stories in Stage 3 (Developing Mini-Scenarios) from a number of participants' responses. While undertaking the selection process, the researcher's decision in terms of the clarity and sufficiency of stories with regard to the concept of each sub theme could not be fully detached from subjectivity. Thus, consistent efforts to check examples, involving independent reviewers, were taken to minimise potential bias while extracting stories from participants' responses. However, some physical constraints of time might have influenced the overall extracting and checking stories, as independent reviewers checked stories that were pre-selected by the researcher due to large amount of data. In future studies, exemplary stories selected by reviewers based on all participants' responses might better reduce potential selection bias.

9.4 Conclusion

This chapter, which answered the fourth research question posed in the first chapter—'What are the typical 'affective design scenarios' in automotive contexts?'—described the formulation of affective design scenarios in automotive contexts using the scenarios themes described in the previous chapters.

The majority of available scenarios used in past automotive studies (Jeon and Walker, 2011; Harris

and Nass, 2011) focus on hazard events (i.e. cutting off car, traffic, sudden U-turn or a crossing animal on a road). The events were designed for the purpose of creating simulator driving courses to observe the impact on the driver's performance and behaviour, which were prominent in the study results. However, beyond the awareness of hazardous road conditions, memorable contexts that closely involve human emotions should be developed to better cater for people's use of automobiles. Therefore, the proposed affective design scenarios in automotive contexts can expand the spectrum of automotive contexts in which people are perceived to emotionally respond. The multifaceted approach taken enabled the researcher to obtain illustrations of real automotive contexts and the emotions that occur in those contexts, and therefore produce knowledge with regards to what causes certain emotions. This knowledge can be useful to better address potential issues that might arise for the automotive industry due to the rapid development of connected and automated vehicles. The proposed scenarios and suggested questions can allow automobile researchers, designers and engineers to learn how to cope with the challenges that result from the main, frequently occurring causes in automotive contexts. Consequently, these scenarios can also provide automotive professionals with a robust foundation to explore tangible ideas for improving automotive experiences in relation to human-machine interactions.

10 Conclusions and Future Research

10.1 Summary of the Research Findings

The aim of the research was to investigate affective design scenarios with automobiles by exploring individual's real-life stories involving situations in which automobiles elicit humans' emotional responses. The studies described in Chapter 4 to 9 of this thesis were conducted in response to the research questions outlined in Chapter 1 about affective scenarios in automotive contexts. The findings are summarised in view of the initially posed research questions:

- ***How can an 'affective design scenario' be defined?***

The goal of Chapter 4 was to define the concept of 'affective scenario' to create a clear understanding of the term used in the research. Due to the broad nature of the idea and its varying use across sectors and contextual constraints within automotive-specific information for the current research, a systematic review of the scenario concept from 69 sources showed that scenario refers to: ***a description of a sequence of events and activities that occur within a specific context and which can involve other agents such as intelligent technologies, people or animals.***

Although emotion is a central part of the human experience, no clear definition of scenarios that involves emotional responses was found in the currently available sources. A supplementary interview activity was thus performed to define the concept, focusing on the relationship between human emotions and the key characteristics of scenario in the automotive contexts. These interviews asked each participant (n=18) to recall automotive experiences and various stories about automobiles and emotional responses were collected. From these interviews, events, activities and specific actions in participants' stories involving automobiles were illustrated, describing a cause and effect that closely linked to their emotions. Throughout the reviewing theories of emotions and features of affective phenomena in Chapter 2, the term 'affect' was chosen to embrace a wide range of emotion and other affect states (e.g., moods, feelings) in the working definition for the research. Taking the physiological responses that describe one or more basic emotions in participants' stories: anger, disgust, fear, happiness, sadness and surprise (Ekman and Friesen, 1971), the working definition of 'affective design scenario' adopted for the current study was taken

as: ***a Design Scenario which is expected to produce in the individual a noticeable physiological response which can be described in terms of one or more of the basic emotions of anger, disgust, fear, happiness, sadness and surprise***.

- ***How can the automotive experience with digital technology be related to emotional aspects?***

Advanced digital technology has allowed people to be able to access connected and synced information by integrating brought-in devices within an automobile. Their expectations and demands towards upgraded automotive experience have continuously increased. Given the lack of any overview addressing automotive digital integration and emotional elicitation, a preliminary case study described in Chapter 5 was conducted based on the hypothesis that emotional considerations can be commonly found in the main themes that emerge from desirable automotive experiences related to digital device integrations. Stakeholders' (n=32) views were obtained via semi-structured interviews with the aim of understanding what people desire to experience when interacting with digital technology in an automobile. This was also expected to provide a rationale for how emotional aspects can shape the automotive experience in relation to digital device integrations.

The desires for automotive experiences with digital technology were categorised into four main themes that derived from a thematic analysis activity: *All-in-one tool*; *Seamless integration of real-time information and productive time management*; *Lifestyle companion*; and *Limitless environment and vehicle autonomy*. The desires related to an emotional relationship beyond functional efficiency in automotive experience, as were manifested in the identified themes. The findings indicate that building an emotionally connected relationship in the automotive experience may become more significant in future automobiles, beyond making the user's life easier with advanced technologies. Moreover, a fundamental desire underlying the four themes that appeared was people's expectation to be completely free from the negative emotions of stress, discomfort or irritation caused by functional inefficiency in relation to automotive experience with digital technology. From the preliminary case study, it was confirmed again that a deep understanding of emotional aspects seems to be a stepping-stone to enhance the automotive experience.

- ***How can an 'affective design scenario' be developed in a complete and rigorous manner and what are the typical 'affective design scenario' in automotive contexts?***

In chapters 6 through 9, the goal was to develop a rigorous set of affective design scenarios, from the systematic development of the online questionnaire, which was iteratively checked by multiple reviewers and using pilot tests (Chapter 6), to working to create the most comprehensive set of possible automotive scenario themes through a triangulation approach and inter-coder reliability checks of the collected data (Chapter 7 and 8), to, finally, confirming the typical affective scenarios in automotive contexts (Chapter 9).

The affective design scenario themes in automotive contexts suggest 13 critical testing conditions that automotive designers must take into account for future automotive design, which were developed based on their frequent occurrence in our study. The 13 conditions were summarised in Chapter 9: *Road violations; Car accident; External environment conditions; Infotainment; Car hardware system malfunction and alerts; Abrupt manoeuvring of driver; Lack of awareness in driving; Driving with a loved one; Generous driving behaviour on the road; Driver's in-car experience; Car software system malfunction; Driving landscape;* and *Usability*.

Developing and using this set of critical testing conditions can contribute to better strategies for integrating technology into the automotive context, such as artificial intelligence technologies in connected and autonomous vehicles (CAVs). Human emotion becomes an essential way to create a more effective experience by helping to design an automobile that better responds to the new technologies. At this juncture, these 13 conditions set the groundwork that implies how an artificial intelligence adopts real-contexts in which human responds emotionally with automobiles and how the technology should behave to minimise or maximise the issues that physiological, behavioural and emotional aspects involved.

Each of 13 testing conditions might be used in the ideation stage of package, interior and occupant of an automobile within the automotive design process. They specifically assist automotive designers and researchers understand the following aspects: (1) what are the main decisions and problems that occur with automobiles, (2) which automotive components or systems people are interacting with, and (3) what are the possible issues in relation to specific safety, comfort, general

experience in automobiles. One typical example of affective design scenarios, 'being forced to give way', which mainly caused anger in the context, is provided below. This example addresses the driver's decisions to swerve out of the way to avoid a collision with the approaching car on a tight city road and concerns about potential damage by other cars parked in the context of being forced to give way.

Theme 1. Road violations: Being forced to give way *Two drivers were approaching each other on a tight city road which only had enough space for one to pass at a time. One driver aggressively beeped the horn on the steering wheel and refused to give way, even though there were opportunities in the road to slot in between parked cars. The second driver was forced to stop and backup into a very tight space. She was forced to turn the steering wheel quickly to swerve out of the way even though she didn't have much space to move. She was angry at the selfish behaviour of the other driver and was concerned that she might have damaged her car, because it was difficult to see out of the side window and difficult to hear sounds coming from the rear of the car.*

This example suggests what future automotive functions or services should be developed, enhanced or tested in the context of being forced to give way on a tight city road. Future automobile research can employ the 13 critical conditions to address possible issues and considerations, which will be suggested in the next section.

10.2 Suggested Applications for Future Research

Chapter 1 introduced one of the major potential shifts in the automotive industry— the rapid development of connected and autonomous vehicles (CAVs). Table 10.1 below revisits the 13 critical affective design scenario themes (critical testing conditions) in automotive contexts proposed in this research, addresses a series of questions (Questions for CAVs) that relate to potential issues and considerations that may be raised from connected and automated vehicles on the road. Some concerns about trust, data privacy, regulations and cyber security should be considered. This research also identifies possible stakeholders and suggests potential considerations for each question, which could be applied in future automobile design to explore

potential interactions or conflicts between systems, infrastructure and sub-features in different parts of autonomous vehicle.

Critical testing conditions	Questions for CAVs	Potential considerations to the question	Potential stakeholders in relation to the question
Road violations	• What if non-automated vehicles could interrupt CAVs moving on a tight road? • How could smart infrastructure manage violated data about non-automated vehicles? - Are there any ethical issues in data management?	- Regulation of communication between CAVs and non-automated vehicles - Informed consent of violated vehicles	- Automobile manufacturers - Government (Traffic and road safety, Privacy) - Cloud solutions & networking companies
Car accident	• What if a CAV hit a pedestrian right after the transition to the driver's control on level 3 automation? Whose fault would it be?	- Improved object or pedestrian detection and controls during the transition (V2V, V2I, V2P etc.)	- Automobile manufacturers - Government (Traffic and road safety) - Insurance companies - Cloud solutions & networking companies
External environment conditions	• What if a CAV on level 4 automation failed to update road maps during driving in the middle of a junction with which the occupant is unfamiliar? - Could the car be stopped? - Would it be alerted to the occupant for control handover?	- Improved data management of infrastructure - Improved machine to machine communication for path prediction/ detours	- Automobile manufacturers - Government (Traffic and road safety) - Cloud solutions & networking companies - Telecom operators
Infotainment	• What if all the phone conversations could be stored in a CAV and were hacked? - Are there any ethical issues? - Who would own the data? - How could the effectiveness of security be measured?	- Regulation of data privacy and ownership	- Automobile manufacturers - Government (Information Technology and Communications) - Mobile devices manufacturers - Telecom operators
Car hardware system malfunction and alerts	• What if a CAV system broke down suddenly due to system malfunction or cyber hacking? - Whom should an occupant call? - Could the data be automatically transmitted to the relevant stakeholders?	- Regulation of cyber security - Improved data transmissions between vehicle and relevant stakeholders	- Automobile manufacturers - Government (Information Technology and Communications) - Insurance companies (AA) - Cloud solutions & networking companies - Mobile devices manufacturers - Telecom operators
Abrupt	• How quickly could an occupant in a CAV on level 3 automation during the control respond to a	- Support for an occupant's vehicle control with AI and	- Automobile manufacturers - Third-party companies

manoeuvring of driver	non-automated vehicle's sudden lane changing?	deep learning systems to automatically adapt to changes	(LIDAR, sensors, radar, cameras etc.) - Cloud solutions & networking companies
Lack of awareness in driving	• What if an occupant failed to read the traffic signage on level 3 automation? - Which traffic signage should the occupant follow?	- Improved traffic signage recognition - Occupant trainings or an attentive guidance for CAVs - Improved human-computer interaction	- Automobile manufacturers - Government (Driving licence, Traffic and road safety) - Third-party companies (LIDAR, sensors, radar, cameras etc.) - Cloud solutions & networking companies
Driving with a loved one	• What if a child occupant could accidently intervened to control a CAV on level 4 automation being without an adult occupant? - How could this situation be avoided?	- Highly advanced and personalised safety security by the main occupant (i.e., finger print)	- Automobile manufacturers - Government (Traffic and road safety) - Third-party companies (Safety and security) - Cloud solutions & networking companies
Generous driving behaviour on the road	• Assuming all CAVs traffic automatically gives way for emergency vehicles, such as an ambulance or a police car, what if an emergent situation happens in a privately-owned CAV? - How could it be communicated to the relevant networks? - How could personal emergency situations be prioritised? - What if someone could abuse this network?	- Advanced V2V and V2I communication - Improved situational awareness through physical and behavioural information in individuals - Credits/benefits to an occupant for generous driving behaviour on the road	- Automobile manufacturers - Government (Traffic and road safety, emergency response and recovery) - Cloud solutions & networking companies
Driver's in-car experience	• What if an occupant longed for the familiar sound of their old car's engine purring, and a CAV could not provide any sensory impact of driving to the occupant?	- Personalisation that can fulfil the sensory in-car experience - Improved human-computer interaction	- Automobile manufacturers
Car software system malfunction	• What if the entire software system of a CAV could malfunction due to being outside of the networked boundary (e.g. moved to another country)?	- Regulation of data transmissions and protection between countries	- Automobile manufacturers - Governments (Traffic and road safety) in different countries - Cloud solutions & networking companies - Telecom operators
Driving landscape	• What if CAVs encounter unexpected long queues at touristic spots due to idling by many CAVs so occupants can view scenery? - Could a CAV overtake the other CAVs?	- Regulation of lane changes - Personalised local touristic information (real-time traffic status, detours etc.)	- Automobile manufacturers - Governments (Traffic and road safety, Tourism) - Local communities and councils - Cloud solutions & networking companies

Usability	• How could personalised data be stored and managed? - Are there any ethical issues? - Who would own the data?	- Regulation of data management, privacy and ownership - Informed consent of transmitting behavioural information	- Automobile manufacturers - Governments (Traffic and road safety) - Third-party companies (LIDAR, sensors, radar, cameras etc.) - Cloud solutions & networking companies

Table 10.1 Potential issues, considerations and stakeholders of Connected and Autonomous Vehicles (CAVs) based on 13 affective scenario themes (critical testing conditions).

The list of questions for CAVs in the table can be expanded and made more specific by further research studies. Automotive industry has currently experiencing the great transition between partial automation (level 2) and conditional automation (level 3) in CAVs due to road sharing with non-automated vehicles. At this juncture, the critical testing conditions could aid to frame possible automotive contexts in which potential issues can be addressed and to guide how the relevant stakeholders (automobile manufactures, government and other organisations) should prepare for the social and economic impact of the CAVs .

10.3 Research Limitations

The research presents limitations in the following areas: researcher bias, experimental setting and application of the results. The suggestions proposed here may be used to mitigate potential limitations in future research.

Researcher Bias

The inherent limitations of researcher bias exist in any decision relating to sampling people, data collection or data analysis throughout the research. Multi-layered attempts to recruit people from various channels were made to mitigate the potential bias in sampling. Under the supervision of the main researcher, two or more coders or reviewers were involved in all decisions, to independently check the developed questionnaire and to analyse the raw data with criteria given by the main researcher to reduce subjectivity. Nevertheless, potential bias in the coders' data analysis could not completely be removed, as thematic coding in the data analysis process cannot be performed without an individual's own categorising system. Given the innate limitations of

human involvement in research, multiple variables – such as an independent coder's background and knowledge – may help to minimise potential bias for future research.

Experimental Setting

All activities throughout the research were conducted with people who live in the UK. The geographical setting was purposefully limited in order to avoid any confusion in interpretation of collected data that might be derived from cultural differences. Thus, the research findings and proposed typical affective automotive scenarios could possibly vary when the same research is conducted in other cultures. Further studies that are conducted with a variety of cultures are required to identify affective design scenarios in automotive contexts that can be representative across different cultures.

Application of the Results

Since the research was designed to take the first step of developing a set of affective design scenarios in accordance with the research purpose and expected end results, an implementation of the proposed scenarios in a design process was beyond the research scope. The matter of how the scenarios could possibly be applied and acted upon in the automotive design process thus remains as a limitation of this research. A future study focusing on applying the proposed scenarios in the early design process could provide practical value to the field and enhance understanding of the roles of affective design scenarios (e.g. an automotive product, service concept generation or testing workshop).

10.4 Closing Remarks

This research sheds light on how design scenarios, particularly those focusing on human emotions, can be beneficial to the automotive sector and which aspects in automotive experience should be revisited. Developing affective design scenarios that rely on individual's real stories and their associated emotions provides an opportunity to gain insights into what people want to enhance in their experience with automobiles. Given their strong emotional impact on human thoughts, attitudes and behaviours, awareness of emotional contexts that frequently occur in real life involving automobiles can signal ways that future automobiles could better cater for people.

It is impossible to predict the future technologies that will rapidly progress development in the automotive industry, due to its changeability in accordance with the current trends. However, anticipation of fundamental aspects in humans, such as emotions, can be relatively stable, as trends cannot change these. Therefore, a scenario approach rooted in human emotion can allow automotive researchers and practitioners to agilely learn about, plan for and cope with unanticipated future events in reverse. The researcher anticipates that the findings of this research could provide greater clarity on the complex concept of scenarios, as well act as a stepping-stone for the field so that the automotive sector can fully benefit from the role of design scenarios.

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12 Appendix

- Appendix A: Semi-structured questions (Chapter 5)
- Appendix B: 126 design methods (Chapter 6)
- Appendix C:
    - Ethics approval (all research activities)
    - Model consent form (all research activities)
    - Model information for research participation (all research activities)
    - Health form (Chapter 8)
    - Simulator sickness questionnaire (Chapter 8)
- Appendix D:
    - Full storylines of 44 mini-scenarios (Chapter 9)
    - Visuals produced for affective design scenario themes (Chapter 9)
    - Practical benefit of each scenario (Chapter 9)

Appendix A

- 11 questions used for semi-structured interviews in Chapter 5

Questions
1. Are there any objects, brands or people in your life that you feel to be (as functionally important as / as emotionally engaged with as) your (mobile phone / car) ?
2. What do your phone and your car have in common? I.e. are there any times when your car and your phone serve the same purpose ?
3. Can you tell me about a time (when / where / why) you used your mobile phone while driving? And how did using it make you feel ?
4. If you were waiting (at the Tesco car park / at the car wash) what would you do with your mobile to pass the time ? And how would it make you feel ?
5. If you went out for the evening but realised that you had left your mobile phone at home, what things would you not be able to do in that situation? And how would that make you feel ?
6. If you were on a business trip for a few days and had left your car at home, what aspects of your car would you like to check up on by means of your phone ? And how would it make you feel ?
7. In your opinion what types of app do you feel might prove attractive to individuals who consider themselves to by (young / new) drivers ?
8. In your opinion what features would a car have to have in order to be attractive to individuals who consider themselves to be mobile and technically savvy ?
9. If you had the opportunity to request an app which permits you to do something which you personally feel is useful or clever, with either the car or the mobile phone, what would it do ?
10. Imagining that you are in the year 2030, how might you wish communicate with other people from within your car ?
11. Imagining that you are in the year 2030 and that a mobile app was developed which incorporated enough human intelligence to act as personal assistant, what would be the first three tasks which you would ask it to do for you ?

Appendix B

- 126 design methods that initially identified from the review of the publications in Chapter 6 (alphabetical order from left to right)

A/B Testing	AEIOU	Affinity Diagramming	Alternative Worlds	Analogous Models	Artifact Analysis	Automated Remote Research
Behavioral Mapping	Bodystorming	Business Origami	Card Sorting	Case Studies	Cognitive Walkthrough	Collage
Concept Mapping	Concept metaphors and Analogies	Content Analysis	Content Inventory & Audit	Contextual Inquiry	Creative Toolkits	Critical Incident Technique
Crowdsourcing	Cultural Probes	Design Ethnography	Design Workshops	Desirability Testing	Diary Studies	Directed Storytelling
Elito Method	Entities Position Map	Eras Map	Ergonomic Analysis	Evaluative Research	Evidence-based Design	Experience Prototyping
Experience Sampling Method	Experience Simulation	Experiments	Exploratory Research	Eyetracking	Field Visit	Financial Profile
Five Human Factors	Flexible Modeling	Fly-on-the-Wall Observation	Focus Groups	Freelisting	Generative Research	Graffiti Walls
Heuristic Evaluation	Image Boards	Industry Diagnostics	Innovation Evolution Map	Insights Clustering Matrix	Interest Groups Discussion	Kano Analysis
Key Performance Indicators	KJ Technique	Laddering	Literature Reviews	Mental Model Diagrams	Mind Mapping	Observation
Opinion Polls	Opportunity Mind Map	Parallel Prototyping	Participant Observation	Participatory Action Research	Participatory Design	Personal Inventories
Personas	Photo Studies	Picture Cards	POEMS	Prototyping	Questionnaires	Rapid Iterative Testing & Evaluation
Remote Moderated Research	Research Through Design	Role-playing	Round Robin	Scenarios	Secondary Research	Self-documentation
Semantic Differential	Semantic Profile	Sentence Completion	Shadowing	Simulation Exercises	Site Search Analytics	Speed Dating
Stakeholder Maps	Stakeholder Walkthrough	Storyboards	Subject Matter Experts Interview	Surveys	SWOT Analysis	Symmetric Clustering Matrix
Task Analysis	Territory Maps	The Love Letter & the Breakup Letter	Thematic Networks	Think-aloud Protocol	Time-aware Research	Touchstone Tours
Tree/Semi-Lattice Diagramming	Triading	Triangulation	Unobtrusive Measures	Usability Testing	User Groups Definition	User Journey
User Journey Maps	User Response Analysis	User Surveys	Utopian/Dystopian View	Value Hypothesis	Value Opportunity Analysis	Venn Diagramming
Video Ethnography	Walk a Mile Immersion	Web Analytics	Weighted Matrix	What's on your Rader	Wizard of Oz	Word Clouds

Appendix C

- Ethics approval (all research activities)
- Model consent form (all research activities)
- Model information for research participation (all research activities)
- Health form (Chapter 8)
- Simulator sickness questionnaire (Chapter 8)

- Ethics approval (all research activities)

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6 October 2015

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-LR-10/2015-80

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority, is satisfied that the amendments accord with the decision of the Committee and has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee and completion of a sub-form.
- Please remove this from your participant information sheet as this age group is not being sampled.
  (Age ☐ 17 or younger)

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Professor Hua Zhao

Chair

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8 October 2015

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-A-10/2015-75

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority, is satisfied that the amendments accord with the decision of the Committee and has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed workshop protocol must be followed. Any changes to the protocol will require prior approval from the Committee.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
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Professor Hua Zhao

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28 November 2016

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-A-11/2016- 4635-1

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
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Professor Hua Zhao

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13 March 2017

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-A-Mar/2017- 6767-1

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

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- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
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Professor Hua Zhao

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26 April 2017

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-A-Apr/2017- 7130-1

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

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10 November 2017

LETTER OF APPROVAL

Applicant: Ms Kyung Joo Cha

Project Title: Scenario identification activity

Reference: 0117-A-Nov/2017- 8704-1

Dear Ms Kyung Joo Cha

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
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Professor Hua Zhao

Chair

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London

- Model consent form (all research activities)

Appendix 4

Consent Form for Research Participants

Please complete this form after you have read the Information Sheet.

Empirical study on affective scenarios for automobiles

This study has been approved by the Brunel University Research Ethics Committee. Thank you for your interest in taking part in this research. Before you agree to take part, the person organising the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in.

Participant's Statement

Please tick the appropriate box

• Have you read the Research Participant Information Sheet?	YES ☐ NO ☐
• Do you understand that you will not be referred to by name in any report concerning the study?	YES ☐ NO ☐
• Do you understand that you are free to withdraw from the study before the results are published without having to give a reason for withdrawing?	YES ☐ NO ☐
• I agree that the research project named above has been explained to my satisfaction and I agree to take part in this study.	YES ☐ NO ☐
• I understand that the information I have submitted will be published as a report and that I can contact the researchers to get a copy.	YES ☐ NO ☐

Signed: ……

Participant Name: …… **Date**: ……

- Model information for research participation (all research activities)

Appendix 3

Brunel University London

Information Sheet for Research Participation

You will be given a copy of this information sheet.

Empirical study on affective scenarios for automobiles

What is the study about?
The aim of this study is to investigate people's life stories with automobiles involving physical, social and emotional aspects to develop scenarios by asking questions in order to gain a deeper understanding of driver or passenger's experience and emotion. Results of this study will directly feed into a large automotive project at Brunel University -the Automotive Habitat Lab- funded by Jaguar LandRover. This innovative design-driven lab consists of physical spaces, specialised items of equipment for field use in road vehicles, specialised algorithms for classifying and clustering field data for purposes of mission synthesis and optimised protocols for analysing experiential, psychological, sociological, ethical and behavioural aspects of new product and service concepts.

What do the researchers want to find out?
The researchers want to gain a deeper understanding of driver or passenger's experience and emotion.

Do I have to take part?
No. It is completely up to you whether you take part or not.

What happens to my information?
All information, is kept confidential (private) within the research team. No one outside the research team will have access to information which could be used to identify you. The researchers will remove any information, which could identify you (like your name) so that the data we keep is anonymous. Once this has been done, it will not be possible to withdraw your data. When we write our study report, we will not mention any names or other identifying information.

Can I find out the results of the study?
Yes. If you would like to be sent a copy of the study report, please contact the researcher using the email or phone number in the email.

All data will be collected and stored in accordance with the Data Protection Act 1998.

- Health form

Appendix 5

Health Form for Research Participants

Please complete this form after you have read the Information Sheet.

A driving simulator study to inform the design of an Automotive Habitat Lab.

This study has been approved by the Brunel University Research Ethics Committee.
Thank you for your interest in taking part in this research.

Participant's Statement

Please tick the appropriate box

Do you suffer from any of the following:

Migraines	YES □	NO □
Epilepsy	YES □	NO □
Motion Sickness	YES □	NO □
Vertigo	YES □	NO □
Postural Instability	YES □	NO □
Blurred Vision	YES □	NO □
Fatigue	YES □	NO □
Ear blockages	YES □	NO □
Upper respiratory illness	YES □	NO □

Have you recently (in the last 12 hours) taken medications or alcohol? YES □ NO □
Are you or could you be pregnant? YES □ NO □

Signed: ……
Participant Name: ……Date: ……

- Simulator sickness questionnaire

Appendix 7

Simulator Sickness Questionnaire

Instructions: Circle how much each symptom below is affecting you right now.

1.	General discomfort	None	Slight	Moderate	Severe
2.	Fatigue	None	Slight	Moderate	Severe
3.	Headache	None	Slight	Moderate	Severe
4.	Eye strain	None	Slight	Moderate	Severe
5.	Difficulty focusing	None	Slight	Moderate	Severe
6.	Salivation increasing	None	Slight	Moderate	Severe
7.	Sweating	None	Slight	Moderate	Severe
8.	Nausea	None	Slight	Moderate	Severe
9.	Difficulty concentrating	None	Slight	Moderate	Severe
10.	<Fullness of the Head>	None	Slight	Moderate	Severe
11.	Blurred Vision	None	Slight	Moderate	Severe
12.	Dizziness with eyes open	None	Slight	Moderate	Severe
13.	Dizziness with eyes closed	None	Slight	Moderate	Severe
14.	*Vertigo	None	Slight	Moderate	Severe
15.	**Stomach awareness	None	Slight	Moderate	Severe
16.	Burping	None	Slight	Moderate	Severe

*Vertigo is experienced as loss of orientation with respect to vertical upright.
** Stomach awareness is usually used to indicate a feeling of discomfort which is just short of nausea.

Appendix D

- Data extraction from the previous automotive studies for creating driving simulator scenarios.
- Full storylines of 44 mini-scenarios in Chapter 9
- Visuals produced for affective design scenario themes
- Practical benefit of each scenario in Chapter 9

- Frequencies of six basic emotions and main triggers that caused emotions in previous automotive studies under the industrial project.

Emotion	**Database 1 (online study)**		**Database 2 (road test A)**		**Database 3 (road test B)**	
	Frequency	Main cause	Frequency	Main cause	Frequency	Main cause
Happiness	27	• Listening to music	73	• Listening to music	147	• Interaction with another person
Disgust	21	• Being forced to give way by other vehicles • Overtaking	60	• Sunlight blinding • Long wait at traffic light	121	• High traffic density • Bad road conditions
Surprise	59	• Car accident	57	• Personal interaction • Bump on road	115	• Bad road conditions • Navigation alert
Anger	62	• Overtaking	11	• High traffic density	112	• Checking navigation • Navigation alert
Sadness	27	• Car accident	5	• Sunlight blinding	53	• Navigation alert • Bad road conditions
Fear	74	• Overtaking	0	N/A	13	N/A

- Full storylines of 13 main themes and 44 mini-scenarios in Chapter 9

Main Themes	Mini-scenarios		Location	Vehicle Type	Gender	Age	Emotion
Theme 1. Road violations	1. Overtaking	A driver was driving in the fast lane on the motorway when a car sped up behind the driver and overtook her from the middle lane without using turning signals. She was so angry that she beeped her horn. Someone dangerously manoeuvring to overtake her without any notice made her feel alarmed since the speed in the fast lane was already high.	Motorway	Sport utility cars (i.e. Hyundai Santa Fe)	Female	17-24	Anger, Disgust
	2. Insulting	A driver was going over a speed bump on a tight city road when a car approached from the opposite direction. The driver in the other car was annoyed that the first driver hadn't waited to cross the speed bump and given way to him—even though neither driver had right of way. As the two drivers converged, the waiting driver shouted from within his car, made angry gestures and swerved his car towards the first driver as if about to hit him. The first driver swerved out of the way, though he couldn't go very far as there were cars parked either side. He was very angry at the other driver's behaviour.	City road	Medium cars (i.e. Volkswagen Golf)	Male	17-24	Anger, Sadness
	3. Being forced to give way	Two drivers were approaching each other on a tight city road which only had enough space for one to pass at a time. One driver aggressively beeped the horn on the steering wheel and refused to give way, even though there were opportunities in the road	Motorway	Sport utility cars (i.e. Hyundai Santa Fe)	Female	35-44	Anger, Fear, Disgust, Sadness, Surprise

		to slot in between parked cars. The second driver was forced to stop and backup into a very tight space. She was forced to turn the steering wheel quickly to swerve out of the way even though she didn't have much space to move. She was angry at the selfish behaviour of the other driver and was concerned that she might have damaged her car, because it was difficult to see out of the side window and difficult to hear sounds coming from the rear of the car.					
	4. Argument	A passenger was riding in a car on a high street road, and he observed the driver of another car had got into a verbal confrontation in the middle of the road. It later turned physical and the passenger was scared and surprised, so he tried to get out of the car and defuse the situation by talking calmly to both drivers.	City road	Medium cars (i.e. Volksw agen Golf)	Male	17-24	Fear, Sadness
	5. Tailgating	A car sped up behind a driver's car, pressuring him to change lanes so they could go on ahead. The outer lane was congested and he could not move out of the way. He was so angry because the car continued to follow him very closely, which threatened his safety.	Motorway	Medium cars (i.e. Volksw agen Golf)	Male	25-34	Anger, Fear, Surprise
Theme 2. Car accident	6. Bumping into another car or obstacle	A passenger was riding in her friend's car as they approached a roundabout. Her friend suddenly pushed on the accelerator and crashed into a stopped car ahead! If the car had been equipped with some form of collision avoidance system maybe the accident could have been avoided. The collision	Roundabout	Medium cars (i.e. Volksw agen Golf)	Female	17-24	Surprise

		caused quite a lot of damage to both cars. The entire left side of one car was pushed back, jamming the front door, while the other car's bumper was cracked. They got out of their car to check the damage. It was quite a shock for her as a passenger because her friend had caused a serious accident and the damage to both cars was substantial. She wondered why cars always suffered such expensive damage even from small crashes.					
	7. Being hit by another car	On the way to work, a driver was hit by another car on a country road. She got out of the car to check the damage. The damage did not seem huge; just the driver side headlamp was broken and the bumper was cracked. However, she became anxious and upset because it was her first collision. She pulled over safely to exchange contact details. She felt frustrated, as she had to make several phone calls to sort it all out.	Country road	Medium cars (i.e. Volkswagen Golf)	Female	25-34	Fear, Sadness, Surprise
	8. Witnessing an accident	A driver witnessed a minibus accident on a country road that killed all 12 passengers and was very upset. At that time, there was nothing for the driver to do, so he had to just pass by the scene, however, such a traumatic experience on the road amplified his concern about safety.	Country road	Sport utility cars (i.e. Hyundai Santa Fe)	Male	25-34	Sadness

	9. Recalling a memory of a prior accident	Recently, when a driver was passing a road where he had an accident almost 6 years ago, he recalled the memory of the accident and became angry. In that accident, someone crashed into him. Although he was not at fault and the accident was quite minor, there was a three-year legal battle to recover damages from the other driver.	City road	Small cars (i.e. Peugeot 207)	Male	35-44	Anger
	10. Witnessing a dog's death	A driver found a dog on the motorway. She loves dogs, so she was very worried that he may get hurt. She parked her car on a hard shoulder and tried to help the dog get away from the road. Unfortunately, he was hit by another car. She then returned to her car and started driving again. She was sad, cried a lot and took about 10 minutes to calm down.	Motorway	Medium cars (i.e. Volkswagen Golf)	Female	25-34	Fear, Sadness
Theme 3. External environment conditions	11. Heavy traffic	A driver was sitting in a traffic jam in the middle of a bridge, watching cyclists nimbly passing him, while he could only sit and wait. He wished he could leave his car's autopilot on, but he instead had to start and stop repeatedly by putting on his foot on the brake. He was curious about the incident because a traffic jam at that location was unusual, however he could not see what was happening ahead of him due to the long queue of traffic. He was frustrated because he could not control the traffic on the road and felt that he was wasting his time doing nothing. He started to think about using alternative transportation in the future.	On a bridge	Executive cars (i.e. Audi A6)	Male	55-64	Disgust

	12. Road infrastructure	A driver got green lights all the way on her 250-mile journey home from a successful job interview. She reached the centre console to turn on the radio, playing pop music. She was elated and amused that the traffic lights seemed to want to celebrate with her.	Motorway	Small cars (i.e. Peugeot 207)	Female	17-24	Happiness, Surprise
	13. Other road users	A passenger was taken by surprise when the driver braked suddenly due to a pedestrian walking onto the road. As a passenger, she felt fearful for a half second because the driver nearly hit the pedestrian, which would have been a horrible experience. Once the pedestrian had walked past safely, the car started to move.	Side road	Medium cars (i.e. Volkswagen Golf)	Female	65 or older	Surprise
	14. Parking space	A driver tried to find a car parking space near a shopping centre on Sunday on a residential road. The streets were full of cars; he spent an hour circling the same roads trying to find a space! He was frustrated and tired. He wished he had a feature in his car that could direct him to an available parking space.	Residential road	Sport utility cars (i.e. Hyundai Santa Fe)	Male	35-44	Anger
	15. Unfamiliar road	A driver was approaching an unfamiliar junction. Other drivers seemed to be driving along comfortably but he felt a bit perplexed by the confusing junction, and then stupid for not knowing where to go. He barely used the satnav; however, this time there was no choice for him to find the right direction without it. He pressed the voice command button to set the postcode of his destination.	Junction	Large cars (i.e. Lexus ES)	Male	35-44	Annoyed

	16. Weather	A driver remembered feeling afraid last time there was bad weather and the roads were slippery when she braked. Because she was concerned about a collision on a slippery road, she focused on the way and drove at a very low speed, continually checking the speedometer.	City road	Small cars (i.e. Peugeot 207)	Female	17-24	Fear
Theme 4. Infotainment	17. Music on the radio	A driver was in her car and her favourite song came on the radio. She was very happy because the musician's songs weren't on the radio very often. As she was dancing and singing along while in a queue at a petrol station, another driver saw her through the windows and mouthed 'same song' at her, smiling.	Gas station	Small cars (i.e. Peugeot 207)	Female	45-54	Happiness
	18. News from the radio / calls	A driver was in her car when she heard the news on the radio that her favourite musician had died. She was so sad that she began to cry. The driver monitoring system noticed her distraction and made continuous warning sounds to attract her attention back to the road. She wished to turn the monitoring system off, but its settings could not be changed while driving. She therefore waited for the other cars in front of her to stop at an upcoming roundabout, such that she could safely reach the centre console to change the radio station to listen to happy music. While she waited for her opportunity, the sounds continued.	Roundabout	Small cars (i.e. Peugeot 207)	Female	25-34	Sadness

Theme 5. Car hardware system malfunction and alerts	19. Warning alerts	A driver had an engine warning light on the dashboard come on whilst driving down a city road. He ignored the warning light for a few days, however a further warning light eventually came on while he was driving. He felt pressured and burdened because it meant that he needed to take his car to a mechanic right away. He could not just ignore the alerts, but he thought that he was very busy and that he did not live near a mechanic. He wondered why the issue had not been noticed when he had recently taken the car to the dealership for its annual servicing.	City road	Large cars (i.e. Lexus ES)	Male	55-64	Anger, Disgust, Sadness
	20. Broken down	A car broke down in a car park and the driver called AA at 11:10am. AA sent the recovery van to the wrong location. The driver had to wait for four hours in the car park until the van came. She was very annoyed and complained to the AA. Such a bad experience and poor service while dealing with a broken down vehicle left her feeling disappointed.	Car park	Medium cars (i.e. Volkswagen Golf)	Female	65 or older	Anger, Fear
	21. Partial system malfunction	A driver was at a friend's house and, when she was about to leave, she realised her car's engine was dead. She pushed the engine start button several times, but it failed. Feeling anxious and not knowing what to do, she waited for the AA to arrive and eventually got going.	Residential road	Small cars (i.e. Peugeot 207)	Female	65 or older	Fear

Theme 6. Abrupt manoeuvring of driver	22. Sudden stop	When a lane of traffic on a motorway suddenly stopped moving, a driver had to brake hard to avoid crashing into the car in front of her. She was surprised and, checking the next lane, she moved over as soon as she could. The unsafe experience, caused by the other driver's abrupt manoeuvring, made her afraid.	Motorway	Sport utility cars (i.e. Hyundai Santa Fe)	Female	35-44	Fear, Surprise
	23. Sudden road entry	A driver was travelling at about 40 mph on a quiet residential road when another car suddenly popped out of a narrow side street without stopping. The driver had to slam on the brakes to avoid collision, and beeped his horn violently. He was surprised and shaken. He was amazed that he had managed to stop his car is such a short amount of time. When he had calmed down sufficiently, he wondered why his car did not have some sort of system to warn him of the danger.	Residential road	Small cars (i.e. Peugeot 207)	Male	17-24	Fear, Disgust, Surprise
	24. Sudden turn	A driver was very surprised and angry when another car unexpectedly turned without signalling. Then, when he honked his horn at them, the other car's driver replied with some rude hand signs. He wondered why other drivers just jumped into the road or turned like that, ignoring the basic rules of the road.	Country road	Small cars (i.e. Peugeot 207)	Male	25-34	Sadness, Surprise
	25. Sudden lane changing	An erratic driver constantly changed lanes to pass other cars on the motorway. Another driver wanted to avoid the car, so he slowed down and let him change lanes because it looked	Motorway	Sport utility cars (i.e. Hyundai Santa Fe)	Male	25-34	Anger, Fear, Disgust

		very dangerous and made him feel anxious.					
	26. Sudden reversing	A driver was taking a driving lesson and heading along a busy road towards the city centre. Suddenly, a car reversed out of their driveway and across two lanes in front of him! He had to brake very quickly and, at first, he was scared because he was worried he couldn't stop in time. Then he became angry that somebody so irresponsible has been allowed to pass their driving test and be on the road.	Residential road	Small cars (i.e. Peugeot 207)	Female	25-34	Anger, Fear, Surprise
Theme 7. Lack of awareness in driving	27. Mistakes/ confusion	As a driver went around a roundabout fairly slowly, her car shifted out of gear and she unintentionally turned the steering wheel as she reached out for the gear stick. The car only hit the curb and the driver managed to recover control immediately. Her mistake scared her, so she paid more attention to her driving.	Roundabout	Medium cars (i.e. Volkswagen Golf)	Female	65 or older	Fear
	28. First time driving in conditions	The passenger's brother had just passed his driving test. Being driven by his brother for the first time was an emotional experience. Sitting in the front passenger seat, the atmosphere was tense. He was really scared, but at the same time he was excited and happy for his brother. It was raining lightly and that made him think about the road surface. It made him nervous since he was fully aware of the dangers of driving in wet conditions.	Main road	Small cars (i.e. Peugeot 207)	Male	17-24	Fear

	29. Slow driving	A driver was travelling on busy city road. He was quite upset when another driver ahead of him was driving under 10 mph and kept braking even though the speed limit was 40 mph. He felt frustrated by such an indecisive or inexperienced driver, who was slowing down traffic.	City road	Medium cars (i.e. Volksw agen Golf)	Male	25-34	Anger, Disgust
	30. Lack of confidence in driver	A son was riding in his mother's car. The mother was not certain what the speed limit of the road was, and thus kept pressing the brake to slow down. She wasn't noticing the speed limit, therefore the son kept pointing out the speed limit signs to her. Although the son had told his mother that the car was equipped with an adaptive cruise control system, she did not agree to use it, and she continued to appear confused and nervous. The son was concerned about what else his mother might not be noticing. He tried to remain calm, but was uncomfortable sitting in the front passenger seat.	Country road	Large cars (i.e. Lexus ES)	Male	35-44	Fear
Theme 8. Driving with a loved one - driving with company	31. Driving with family	A father bought a new car and took it out with his son for a first drive. They enjoyed taking the seat protector sheets off together. After the father pressed the ignition button, his son became excited, playing with every dial in the centre console and touching the satnav, as these were new to him. The father took a picture of his son playing in the car to capture the moment. They then drove to the local coastal area and parked at the beach for	Country road	Medium cars (i.e. Volksw agen Golf)	Male	17-24	Happiness

		ice cream. The father thought that his son would soon be a man, and wished that he had more than just a picture to remember the special day.					
	32. Driving with friends	A driver picked up her flatmate from work. She felt bad for her flatmate having to walk the 40-minutes home, as it was Winter. Her flatmate appreciated the lift. While they were driving home on the city road, they had a nice chat, so both felt very happy even though there was busy traffic on the road.	City road	Medium cars (i.e. Volksw agen Golf)	Female	25-34	Happiness
Theme 9. Generous driving behaviour on the road	33. Getting help	After an accident, another driver helped the driver in the accident onto the hard shoulder on the motorway near a junction. He got out of his car and came to give him directions to a roadside assistance company. He made sure the driver was ok and then drove off. The driver felt reassured, happy and surprised that he had been helped.	Motorway	Medium cars (i.e. Volksw agen Golf)	Female	35-44	Fear, Happiness, Surprise
	34. Giving way	A driver who needed to enter busy London rush hour traffic was watching for her chance to go. She was nervously thinking that it was a terrible time of day to have to enter the larger road. She put her turn signal on, knowing that she needed a car from the larger road to allow her to make her right turn. Though she could not see the oncoming traffic well through the corner of her car's windscreen, she waited for her opportunity. Finally, a driver from the larger road gestured to her, kindly giving way. She	Intersection	Medium cars (i.e. Volksw agen Golf)	Female	45-54	Happiness, Surprise

		immediately pressed the accelerator to make the right turn as quickly as she could, and she smiled and waved her hand gratefully. She felt that it was nice of somebody to have shown kindness. The experience restored her faith in people.					
	35. Helping others	A driver was driving with her friends on a country road and passed an elderly man whose car had run out of fuel and who was asking for assistance. It was getting dark and there weren't many cars passing through, so they stopped, offered their help and brought him some fuel from the petrol station nearby. It was quite a good feeling for her to help a stranger.	Country road	Medium cars (i.e. Volkswagen Golf)	Female	25-34	Happiness, Surprise
Theme 10. Driver's in-car experience	36. Experience with car features	A driver's rental car offered an engine-start experience that he had never witnessed before. In order to start the car, the key only needed to be on him (i.e., in his pocket), and he was then free to do what he liked. He was excited and amazed at the technology, and had a very positive and seamless experience. He just got into the car in the car park, pressed start and off he went!	Car park	Executive cars (i.e. Audi A6)	Male	25-34	Happiness, Surprise
	37. Feeling relaxation	Upon reaching her car in the car park of an airport, a driver opened her car's door, entered, sat back, and relaxed. She thought that it was good to be in her car again after a long flight. Without needing to think about it, she leaned back in the seat and pressed the car's "on" button. She then asked the car to play her favourite music. Before moving, she checked the	Motorway	Luxury cars (i.e. Mercedes S-class)	Female	25-34	Happiness

		fuel to see whether or not she had enough to reach home. There was enough fuel, so she just relaxed, and switched the selector to 'drive'. The familiar sights, sounds and smells produced feelings of pleasantness and calm. She felt as though she had already arrived home. She enjoyed her hour long drive home.					
	38. Hearing familiar sound of the engine	A driver borrowed her step mum's car for a few days, as she felt comfortable and familiar with the car. As she accelerated, the engine purred, giving her a great driving experience and pleasure. For her, the sound of the engine was one of the most exciting sensory experiences of driving.	Garage	Executive cars (i.e. Audi A6)	Female	35-44	Happiness
Theme 11. Car software system malfunction	39. Navigation/GPS error	Badly positioned signs on a motorway confused a driver, leading him to miss the exit which he had intended to take. The car's navigation system had been slow to warn him of the upcoming exit, making the mistake easier to make. Worse, after exiting the motorway the navigation system suffered an error and stopped working altogether. The driver made frantic efforts to reboot the system by pressing various buttons, but it would not start. The driver was now on the wrong road, confused and with no place to pull over to stop the car. The confusion quickly lead to frustration and anger due to the danger and the lack of control. The driver wondered why the car was slow to react and why it seemed to pay so little attention to his actions.	Motorway	Small cars (i.e. Peugeot 207)	Male	35-44	Anger

	40. Flat phone battery	A driver was lost in the middle of a country road at night and her phone battery died. Her phone was the only way for her to get directions since her car did not have a navigation system. She went to use her phone battery charger, but realised she had left it at home. She drove to the first petrol station she could find to ask for directions. She felt quite scared driving in unknown areas late at night.	Country road	Small cars (i.e. Peugeot 207)	Female	17-24	Fear
	41. IOS CarPlay error	A driver became angry because the IOS CarPlay software malfunctioned in the middle of his podcast and the surrounding traffic was too intense for him to take his eyes off of the road. Because it was too difficult to reboot CarPlay while driving, he was unable to listen to the podcast or radio or perform other desired functions for most of the trip. He attempted several unsuccessful software reboots.	Motorway	Large cars (i.e. Lexus ES)	Male	45-54	Anger
Theme 12. Driving landscape	42. Seeing beautiful scenery – animals, a moon rise, sunshine	A driver was travelling on a country road that ran along the coast. The scenery was beautiful, the weather was sunny and favourite music was on the radio. The driver asked the car to increase the music volume while singing along. With the windows open the view of the road and of the surroundings from her sitting position was magnificent. Since there was little traffic, she was driving on autopilot so as to be freer to enjoy the experience. She hoped that telephone calls, car communications or other unanticipated events	Country road	Small cars (i.e. Peugeot 207)	Female	25-34	Happiness, Surprise

		would not ruin the experience.					
	43. Night driving with stars	A driver was giving someone a lift home at night. It was a clear, moonless night and the stars seemed endless. Sometimes night driving made him scared; however, this time, the visibility of the road and the other cars were all good, which made him comfortable in driving. He rolled back the sunroof and felt at one with the star-filled sky. It was a wonderful drive at night.	Country road	Van	Male	55-64	Happiness
Theme 13. Usability	44. Adjusting mirror angles	A driver was travelling on a motorway when she noticed that the views of the surrounding traffic were poor. The view of the lane next to her was poor, because the side-view had not been adjusted to the driver's position. The view to the rear was also poor, due to lack of night-time adjustment. She could not help but think that it was already hard enough to drive with clear views, never mind in such a situation. She had set everything properly in the past, and had no idea why the system was currently in this configuration. Since she could do nothing to change the views while driving she made her lane change when she felt that there were no other cars next to her. From just behind, however, she heard wild horn honks warning her	Motorway	Medium cars (i.e. Volkswagen Golf)	Female	25-34	Anger

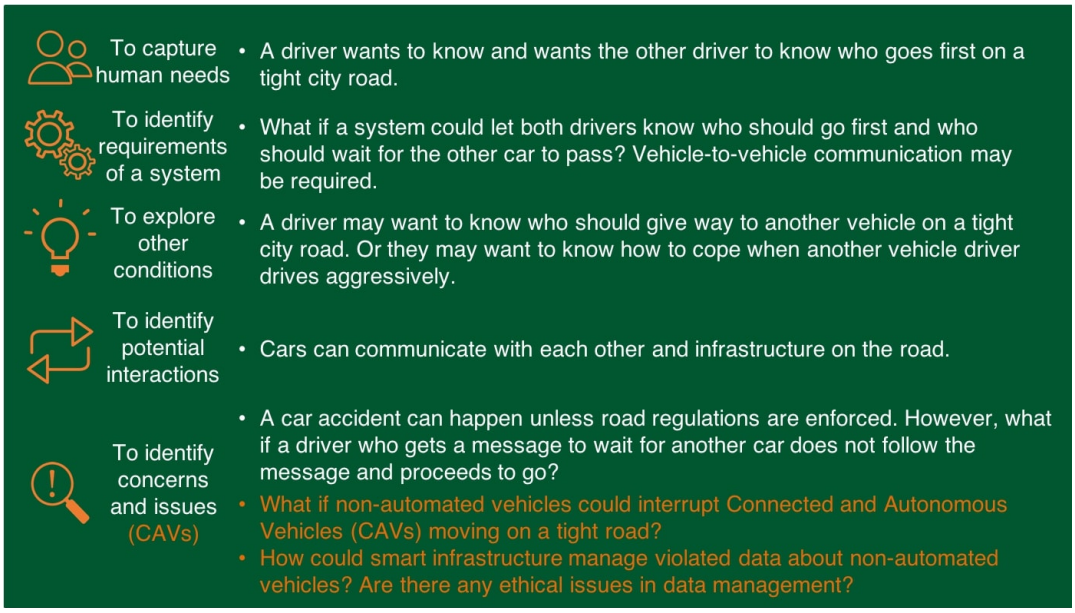
		that she was encroaching upon another driver, and swerved back into her original lane. She was angry, and could not understand why she found herself driving without adequate views of the road.					

- Visuals produced for affective design scenario themes

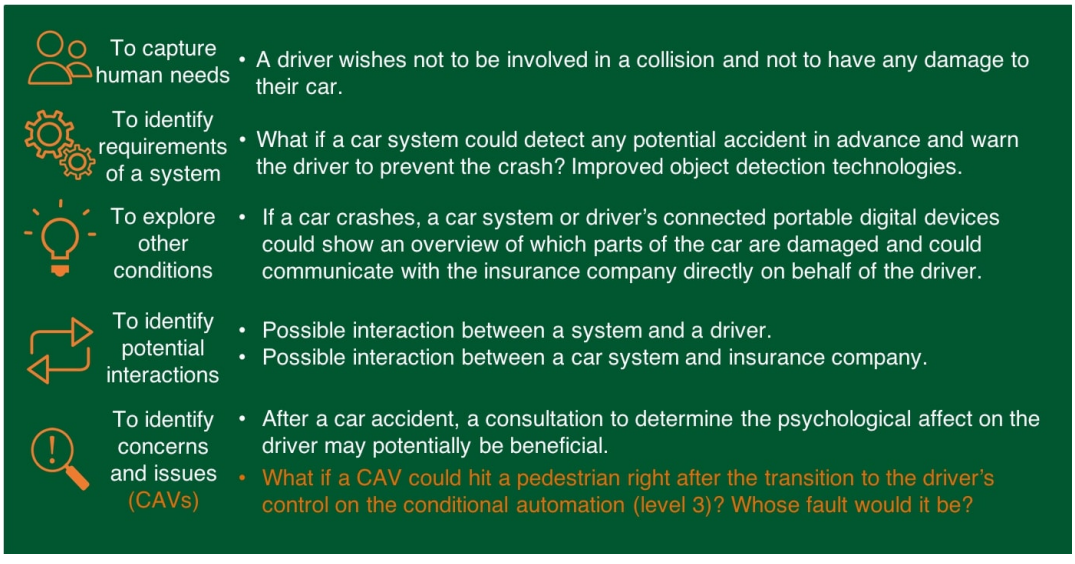
- Practical benefit of each scenario

- Identification of the fundamental requirements of an automotive system, the potential interactions, and the concerns and issues regarding emotional responses

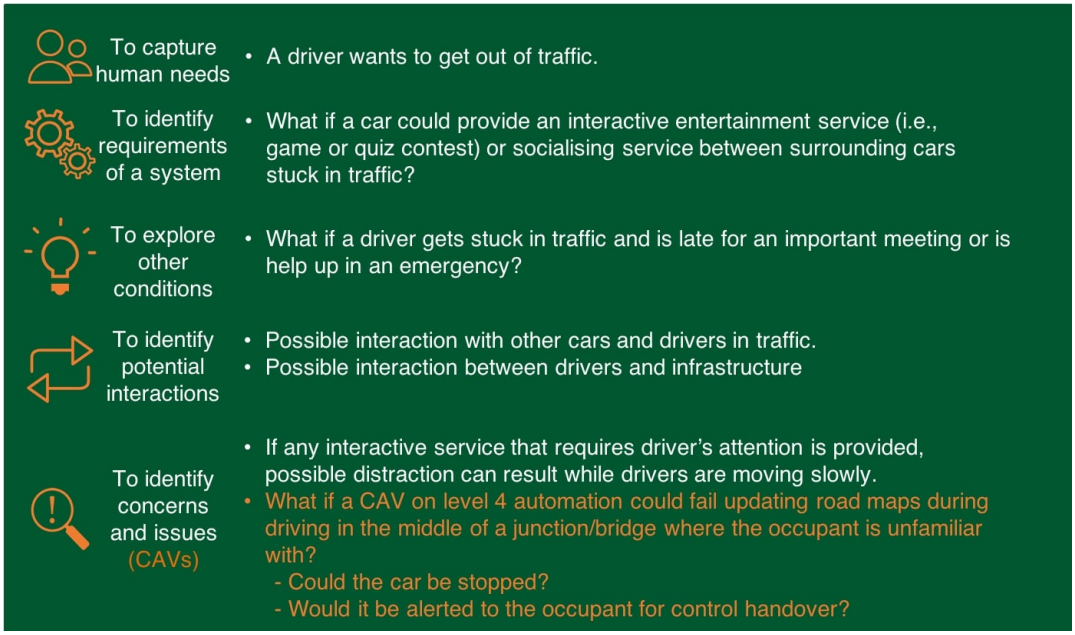
1. **Road Violations: Being forced to give way**



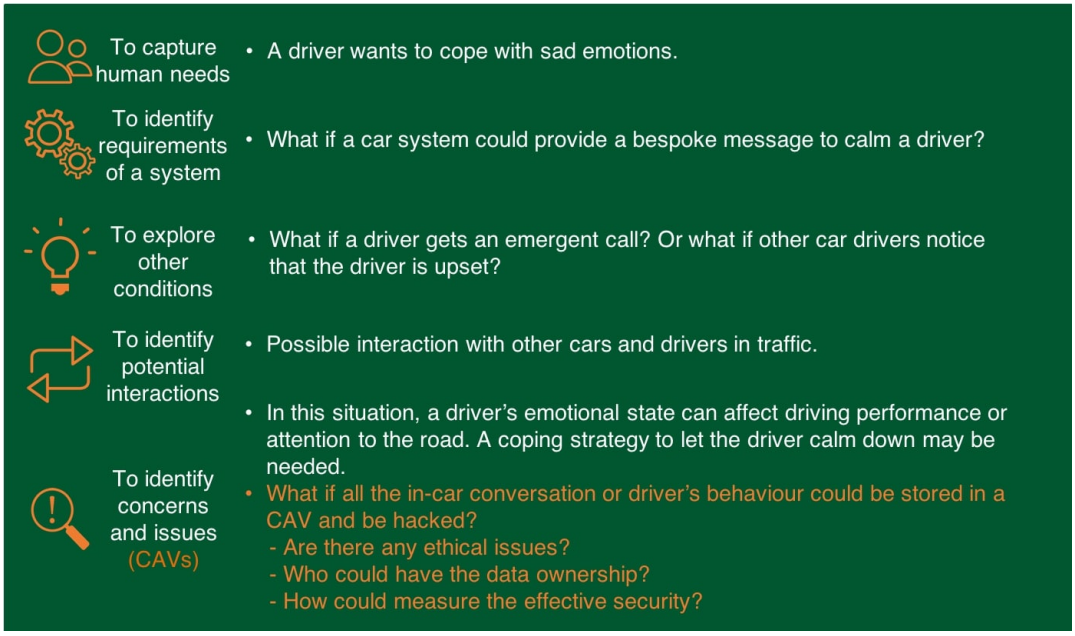
2. **Car Accident: Bumping into another car obstacle**



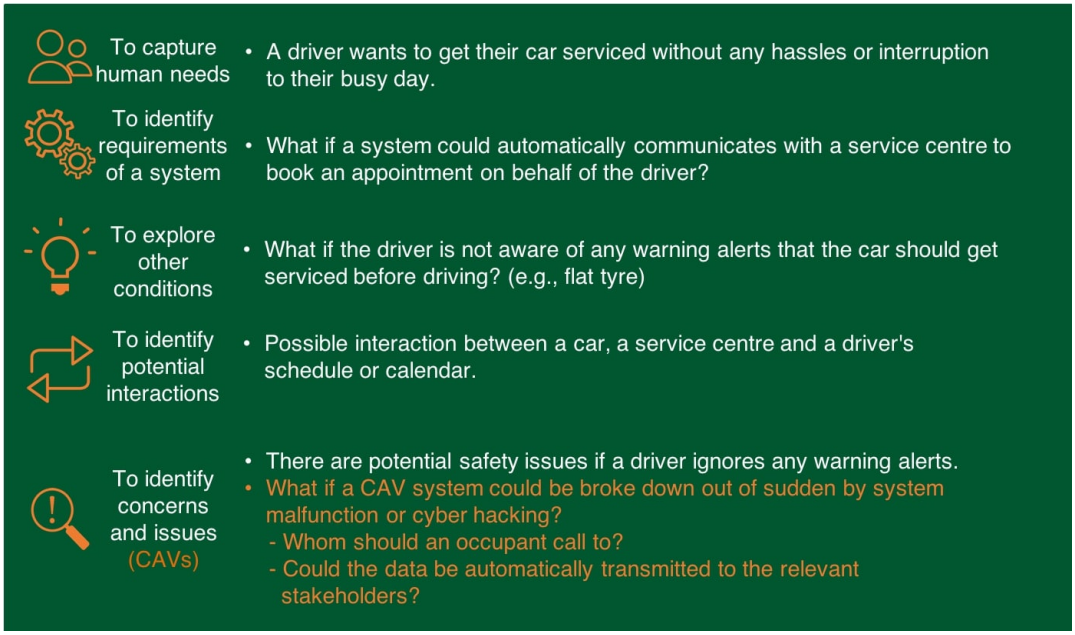
3. External Environment Conditions: Heavy traffic



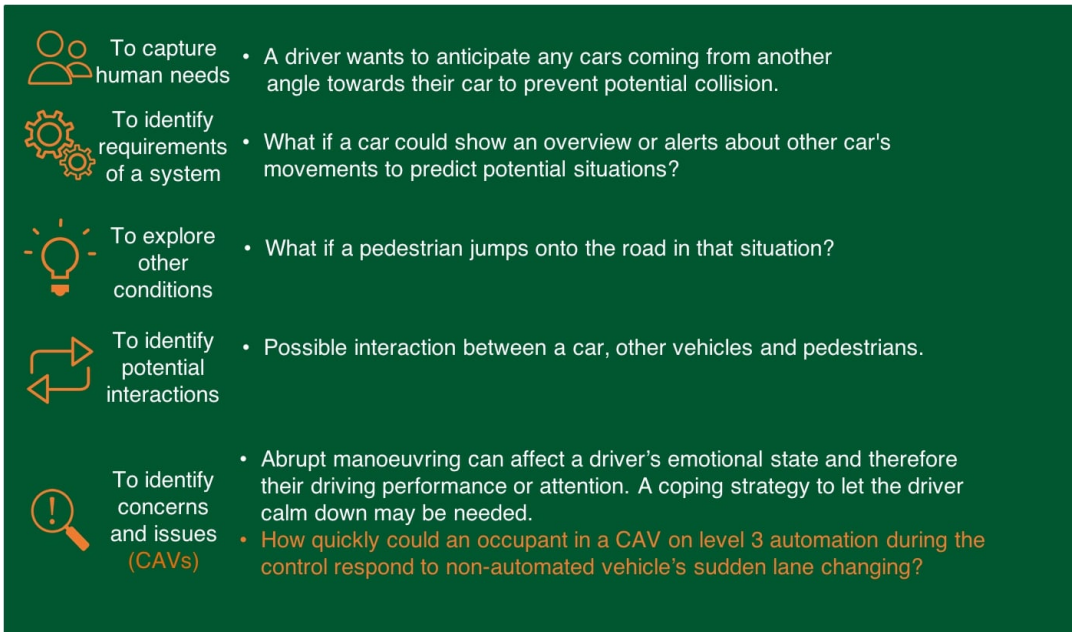
4. Infotainment: News from the radio or calls



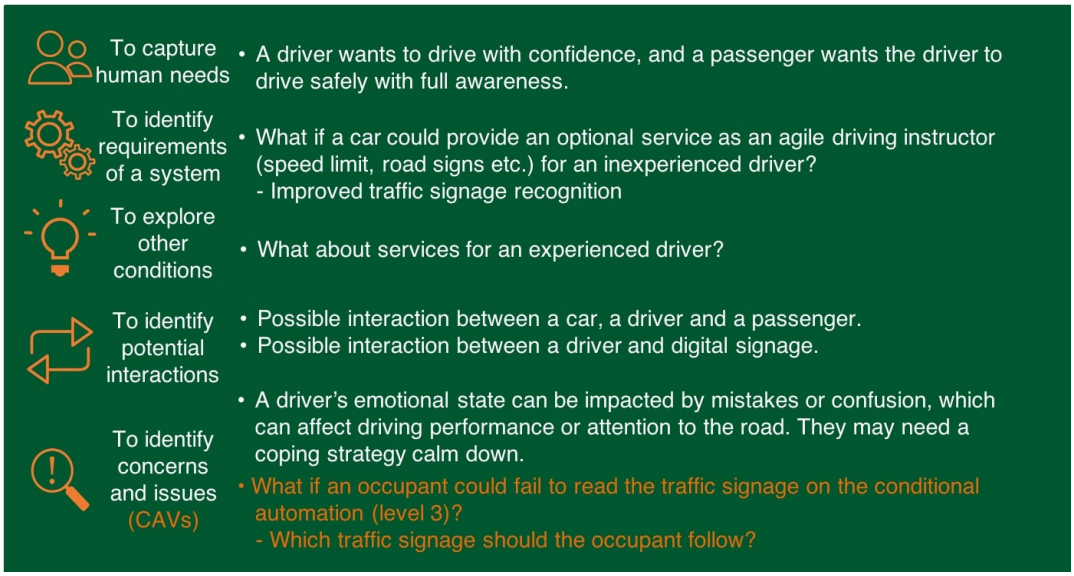
5. Car Hardware System Malfunction and Alerts: Warning alerts



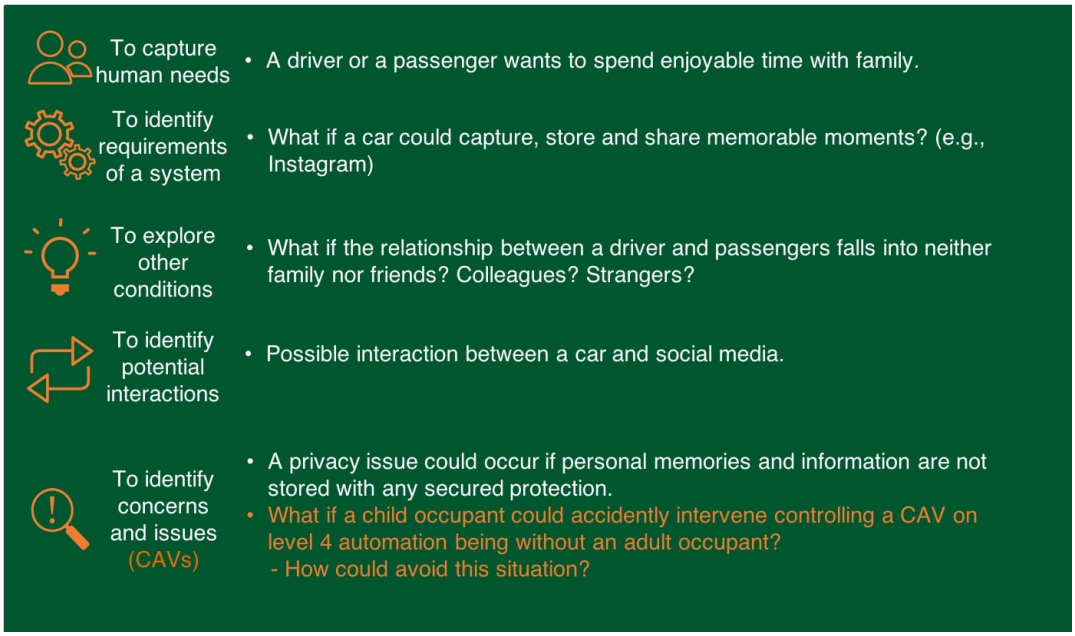
6. Abrupt Manoeuvring of Driver: Sudden road entry



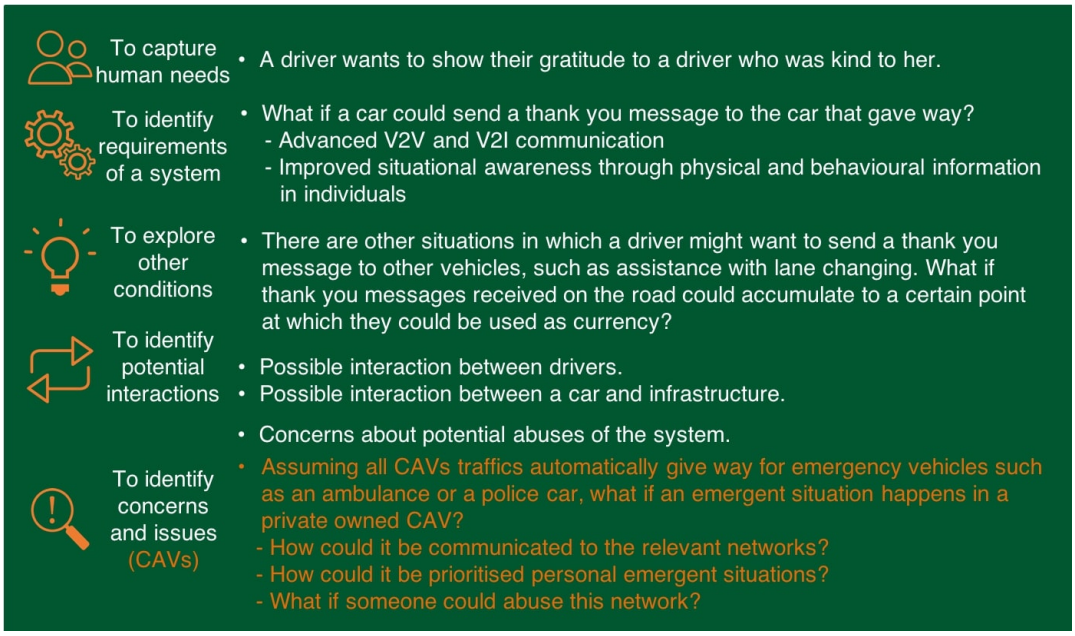
7. Lack of Awareness in Driving: Lack of confidence in driver



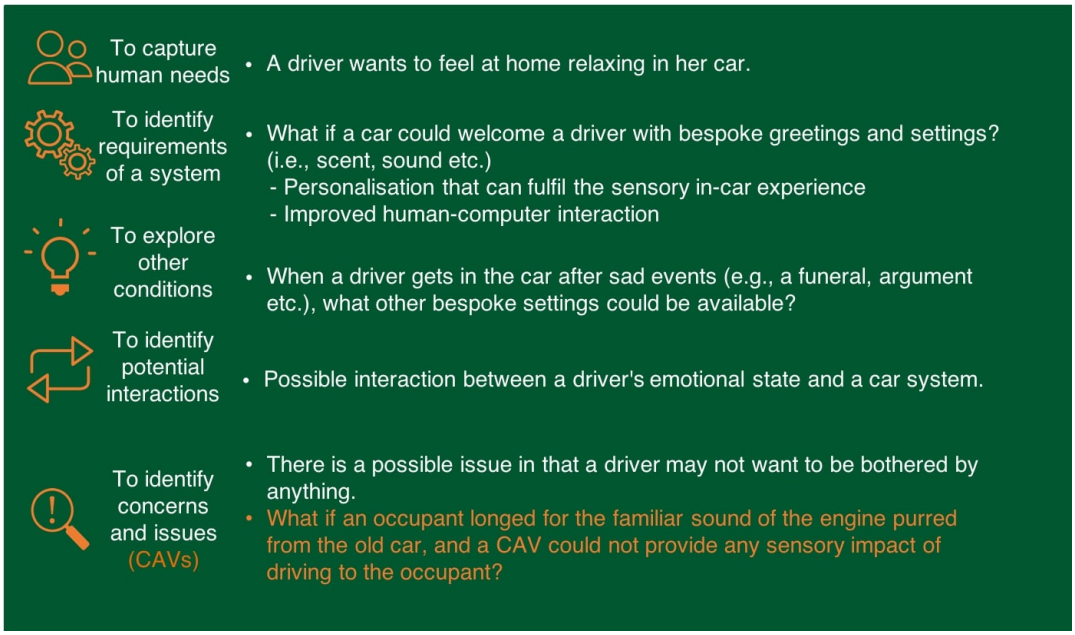
8. Driving with a Loved One: Driving with family



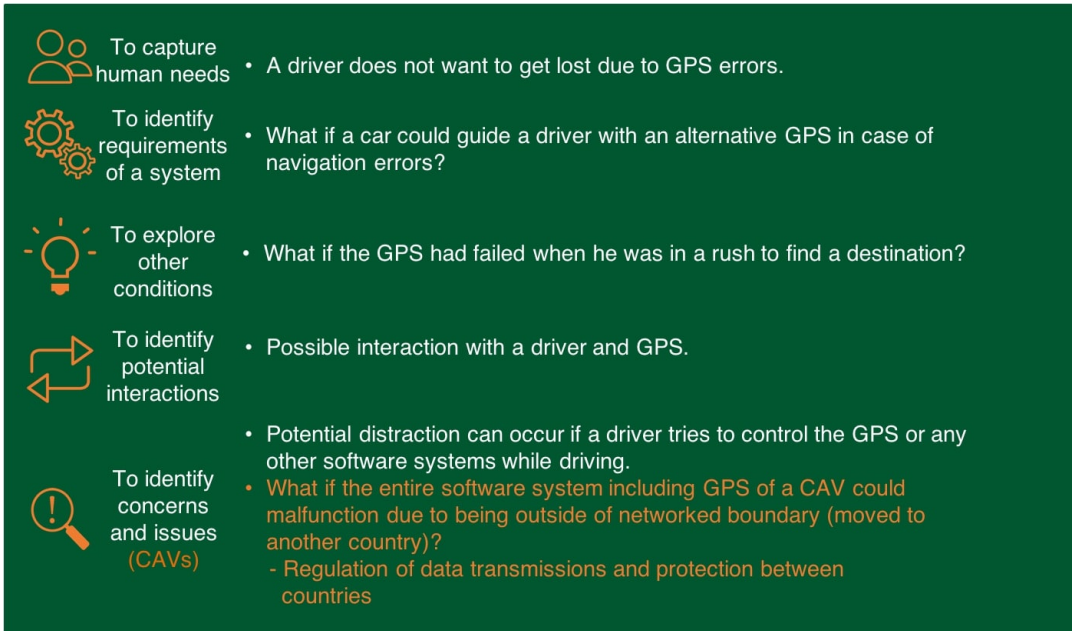
9. Generous Driving Behaviour on the Road: Giving way



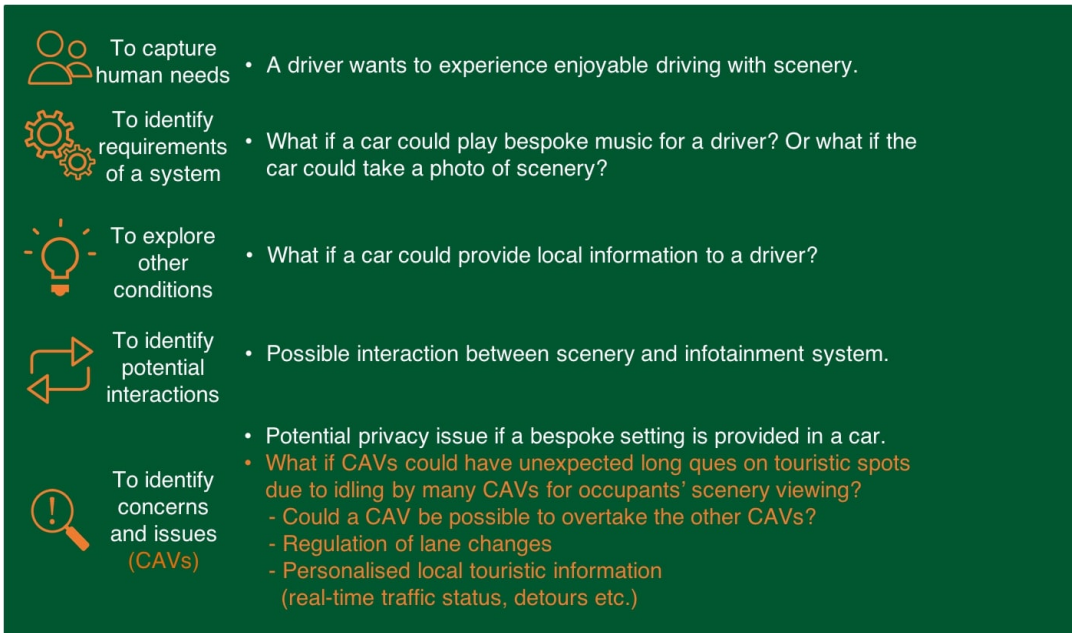
10. Driver's In-car Experience: Feeling relaxation



11. Car Software System Malfunction: Navigation or GPS error



12. Driving Landscape: Seeing beautiful scenery



13. Usability: Adjusting mirror angles

To capture human needs	• A driver wants to have a side mirror that can give a full view of other cars next to the driver's car.
To identify requirements of a system	• What if the mirror's angles could be automatically adjusted according to the driver's setting?
To explore other conditions	• What if the driver's steering wheel could automatically be moved to avoid a potential collision? Or at least the car could warn the driver by playing a sound?
To identify potential interactions	• Possible interaction between a driver and mirror settings.
To identify concerns and issues (CAVs)	• In this situation, a driver's emotional state can affect driving performance or attention to the road. A coping strategy to let the driver calm down may be needed. • How could the personalised data be stored and managed? - Are there any ethical issues? - Who could have the data ownership?