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AIRCRAFT PASSENGER COMFORT EXPERIENCE

SUBJECTIVE VARIABLES AND LINKS TO EMOTIONAL RESPONSES

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DEDICATION

To my parents

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RÉSUMÉ

Les buts principaux de cette thèse étaient de connaître les aspects subjectifs de l'expérience de confort du passager en contexte de vol. De tels aspects sont décrits en termes des perceptions subjectives du passager ainsi que de sa réponse émotionnelle aux stimulis de l'environnement. Plusieurs études furent menées afin d'aborder les fondements théoriques de ces aspects ainsi que leur pertinence à l'égard du concept de l'expérience de confort passager en vol.

Pour débuter, des descriptions libres d'expérience de vol furent collectées de la part de 155 participants. De l'analyse de leur contenu sont ressortis huit thèmes décrivant les perceptions subjectives de l'intérieur de l'avion en lien avec l'expérience de confort passager : « paix d'esprit », « bien-être physique », « proxémie », « satisfaction », « plaisir », « social », « esthétique » et « association ». Les préoccupations des passagers ainsi que le contexte (siège, espace pour les jambes, température, pression, etc.) associés à chaque thème furent aussi soulignés. Au cours d'une étude de suivi avec un groupe de concepteurs d'intérieur de cabine passager, il fut démontré que les huit thèmes et leurs préoccupations associées pourraient être utilisés afin d'améliorer la communication au sein de l'équipe de conception. De plus, ces thèmes pourraient clarifier la définition des objectifs au cours du processus de conception.

Par la suite, la possibilité de distinguer les perceptions subjectives de confort passager des perceptions d'inconfort a été étudiée. 27 participants ont soumis la description d'une expérience de vol confortable ainsi que d'une expérience de vol inconfortable tout en classant par ordre d'importance pour chaque expérience les huit thèmes déterminés dans la première étude. Ces descriptions écrites furent suivies d'entrevues en profondeur. L'analyse n'a donné aucune différence significative entre les classements de thèmes, à part pour ceux de « plaisir » et « bien-être physique ». De surcroît, le thème « plaisir » a obtenu un plus haut classement en lien avec l'expérience de confort alors que le thème « bien-être physique » fut le plus haut classé en lien avec les descriptions d'inconfort. Il fut donc conclu que bien qu'il soit nécessaire d'éliminer les sources d'inconfort physique et d'améliorer les aspects plaisants du vol afin d'atteindre le confort, les huit thèmes s'appliquent autant aux états d'inconfort que de confort. Une autre conclusion suggère que l'évaluation de l'expérience de confort du passager dans son ensemble devrait couvrir le spectre se situant entre l'inconfort extrême et le confort extrême.

Les huit thèmes soulevés furent validés par une série d'études. En premier lieu, 161 descripteurs liés à divers aspects de l'expérience de confort passager furent recueillis grâce à études précédentes et une revue de littérature. En outre, les évaluations des participants sur ces descripteurs ont été utilisés pour mettre en évidence les descripteurs les plus pertinents, sélectionnez 58 descripteurs qui étaient plus d'impact sur le confort des passagers, et enfin les classer en huit facteurs qui visiblement correspondaient aux huit thèmes.

Finalement, les réponses émotionnelles des passagers au contexte de vol et à l'environnement de la cabine furent recueillies en utilisant la méthode d'échantillonnage d'expérience (ESM: Experience Sampling Method). 16 répondants ont complété un questionnaire évaluant leur niveau de confort ainsi que leurs émotions en trois moments au cours d'un vol long courrier et en deux moments au cours d'un vol court. Ces répondants ont aussi réalisé une évaluation rétrospective de leur confort global ainsi que du confort associé à chacun des huit thèmes 24 et 48 heures suivant le vol. L'analyse n'a révélé aucune différence significative entre les niveaux de confort et les réponses émotionnelles à différents moments au cours du vol. Aussi, l'évaluation au cours du vol et l'évaluation rétrospective du confort n'ont présenté aucune différence significative. L'évaluation globale rétrospective du confort en vol fut corrélée avec tous les huit thèmes pour les vols courts et avec six thèmes pour les vols long-courrier. Les deux thèmes n'ayant pas été associés à ces vols sont « social » et « esthétique ». Toutefois, ceci serait sans doute du au manque de diversité dans l'échantillon de population.

Sept émotions furent identifiées comme significatives lors de l'expérience de confort passager : la satisfaction, la frustration, le soulagement, la joie, le reproche, la gratitude et la haine. Elle furent classifiées en cinq groupes, chacun décrivant le mode d'appréciation et d'observation du passager. Ces modes d'appréciation sont la logique employée par les passagers pour l'évaluation des situations de vol, menant aux réponses émotionnelles et ultimement à l'expérience de confort. Cette connaissance met en lumière autant les aspects psychologiques que les aspects perceptifs de l'expérience de confort d'intérieur de cabine passager.

ABSTRACT

The main goal of this thesis was to create knowledge about the subjective aspects of passenger comfort experience in the flight context. Those aspects are characterized in terms of passengers' subjective perceptions and their emotional responses to the contextual stimuli. Several studies were performed to address the theoretical underpinning of those aspects and their relevance to the concept of aircraft passenger comfort experience.

First, open descriptions of flight experience were collected from 155 participants. A content analysis yielded eight themes signifying passengers' subjective perceptions of the aircraft interior in relation to their comfort experience. Those were 'peace of mind', 'physical wellbeing', 'proxemics', 'satisfaction', 'pleasure', 'social', 'aesthetics', and 'association'. Passengers' concerns and the contextual inputs (e.g. seat, legroom, temperature, pressure, etc.) associated with each theme were also highlighted. In a follow up study with a group of aircraft cabin interior designers, it was shown that the eight themes and their subsequent concerns could be potentially used for improving the communication within the design team as well as for setting the goals in the design process.

Furthermore, a study examined the possibility of differentiating the subjective themes of passenger comfort from those of discomfort. 27 participants submitted reports of one comfortable and one uncomfortable flight experience and rated the importance of the eight elicited themes for each of those experiences. The written reports were followed by in-depth interviews. The analysis yielded no significant difference between those ratings, except for the themes 'pleasure' and 'physical wellbeing'. In addition, the theme 'pleasure' achieved higher ratings in reports of comfort experience while the theme 'physical wellbeing' was rated the highest in discomfort reports. It was concluded that while it is necessary to eliminate sources of physical discomfort and improve the pleasurable aspects of the fight experience to achieve comfort, the eight comfort themes generally apply to both states. Another conclusion suggests that the evaluation of overall passenger comfort experience, as a whole, should employ one spectrum ranging from extreme discomfort to extreme comfort.

The eight elicited themes were validated in a series of studies. First a set of 161 descriptors, underlying various aspects of passenger comfort experience, was compiled based on above studies as well as literature reviews. Furthermore, participants' ratings on those descriptors were

used to highlight the most relevant descriptors, select 58 descriptors that were most impact on passenger comfort, and finally categorize them into eight factors which visibly corresponded to the eight themes.

Finally the emotional responses of passengers to the flight context and the cabin environment were collected using Experience Sampling Method (ESM). 16 respondents submitted 57 completed questionnaires addressing their real-time comfort level and emotions at three times during the long-haul and two times during the short-haul flights. They also rated their overall comfort and the comfort associated with each of the eight themes within the 24 to 48 hours after their flight, accounting for their retrospective evaluation. The analysis revealed no significant differenced between comfort levels or emotional responses at different times during the flights. Moreover, the real-time and retrospective evaluations of comfort were not significantly different. The overall retrospective evaluation of flight comfort correlated with all the eight themes for short flights and six themes for long flights, with an exception of ‘social’ and ‘aesthetics’. However, this was argued to be due to the lack of diversity in the recruited sample.

Seven emotions were identified as significant for the experience of passenger comfort: satisfaction, frustration, relief, joy, reproach, gratitude, and hate. Those were classified into five groups, each characterized by a unique appraisal pattern depicting passengers’ concerns and focus. Those appraisal patterns signify the logic employed by passengers for the assessment of the in-flight situation that lead to emotional responses and ultimately comfort experience. This knowledge sheds light on the psychological aspects of passenger comfort experience and the perceptual stimuli in relation to an experience of comfort in the cabin interior.

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LIST OF ACRONYMS ANDABRIVIATIONS

ESM	Experience Sampling Method
IFE	In-Flight Entertainment
OCC	Ortony-Clore-Collins model of cognitive structure of emotions (1988)
SAM	Self-Assessment Manikin

LIST OF APPENDICES

CHAPTER 1 INTRODUCTION

Modern air transportation has benefitted from technological advances to increase flight safety and reliability. However, airlines are also competing to attract more passengers by means of offering various levels of design, services, and prices. A number of studies (Richards, 1980; Vink et al., 2012) have shown that improving the sense of comfort associated with a trip results in an increase in the proportion of passengers who wish to use the same vehicle (aircraft) on future occasions. Brauer (2004) investigated convenience, comfort and cost to find means through which an airline could attract more passengers and still profit without compromising too much on its expenses. The results showed that a margin of 1% in profit, gained by 1% increase in the number of passengers, is equal to a 14% cut of maintenance costs. Brauer also showed that after criteria such as point-to-point trip, time, and price, around 35% of passengers base their selection on comfort, past experiences, and delays. Furthermore, passengers are shown to be willing to pay extra for enhanced in-flight service provision and level of comfort (Balcombe, Fraser, and Harris, 2009; Brauer, 2004) while comfort is shown to be the main contributor to passenger's acceptance of transportation systems (Tan et al. 2010).

The above studies justify the manufacturers' efforts to design more comfortable cabin interiors for the gain of a bigger market share. Due to the increasing competition among the airlines and manufacturers, passengers are also becoming more and more aware of comfort issues and consequently they have higher expectations for comfort. In order to increase passenger comfort, it is necessary to achieve a clear understanding of this notion, its variables and ways to enhance it efficiently. Recent research has particularly put an emphasis on the subjective and experiential aspects of comfort (Vink, Overbeeke, and Desmet, 2005a). The above suggests that careful attention to the aircraft interior design and the passenger flight experience is likely to improve the level of passenger comfort. This thesis aims to provide theoretical foundation for the concept of passenger comfort experience during the flight.

1.1 A research framework for the passenger comfort experience

Before beginning the research on the determinants of passenger comfort experience, it is essential to establish a framework for that experience. A model is therefore created for the purpose of this thesis, as shown in Figure 1-1, to illustrate the various elements that have been found to

contribute to the comfort experience of passengers and their inter-relationship. The theoretical underpinning of those elements and relevant research are further discussed in the literature review presented in chapter 2 of this thesis.

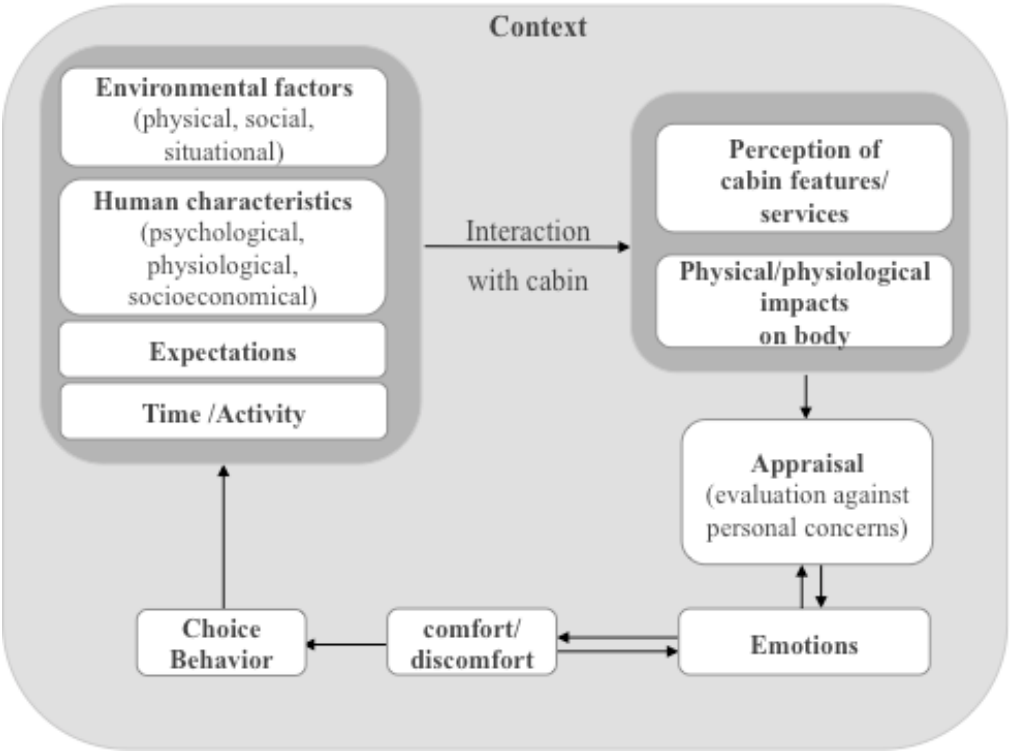

Figure 1-1. A framework to illustrate the elements of passenger comfort experience a, adapted from Ahmadpour, Robert, and Pownall (2013)

As shown in above Figure, the comfort experience within the flight context would emerge when a passenger, with certain characteristics and expectations, interacts with the cabin (with certain environmental factors) and performs certain activities during a limited time of the flight. The interaction has certain physical impacts on the passenger's body while also being perceived subjectively. Once the passenger evaluates these against his/her personal concern (i.e. appraisal), emotional reactions are elicited. Consequently the passenger would experience a level of comfort/discomfort and adapt his/her behavior towards the flight experience accordingly. Future choices regarding air travelling will be also influenced by these consequences. Elements of the model are further elaborated below.

The *environmental factors* are physical, social and situational in nature. The physical factors comprise cabin elements such as seat, legroom space, temperature, noise, air quality, etc. The

visual inputs and physical appearance of the environment such as color or graphics are incorporated into this factor. The social factors include social relationships between the passenger and other individuals during the flight (i.e. other passengers and crew). The situational factors consist of the flight class, type of aircraft, onboard services and similar factors.

Human characteristics include psychological factors (e.g., attitudes, moods, pre-dispositions, etc.), physiological factors (e.g., age, gender, height, weight, general health, etc.) and socio-economical factors (e.g., social status, education, occupation, or income), characterizing the demographic group of passengers. *Expectations* are related to pre-flight (such as the airport experience) and previous flight experiences.

Time and *activity* also impact the passenger comfort experience. Passenger expectations are, to a certain extent, determined by flight duration, meaning that what is expected of a long flight is not the same as a short flight. Passenger activities during the flight (e.g., eating, working, sleeping, and seating) influence their comfort level while, at the same time, the comfort level influences the types of activities passengers are willing to perform (Richards, Jacobson, Kulthau, 1978). For instance, if a passenger is unable to sleep, his/her impending comfort might be compromised during the rest of the flight and they might not feel at ease to do other activities such as working or reading.

Perceptions of cabin features and their various qualities form the subjective experience of passengers. Those are commonly expressed in the form of affective or experiential descriptors such as novel, interesting, sufficient, luxurious, etc. Acquiring knowledge about those perceptions is important because they give direct insight into passengers' view of the technological and engineering characteristics of the environment and the aspects they find pleasant and important for their comfort experience. The importance of users' perception of product qualities for comfort evaluation and product design has been demonstrated for hand tools (Kuijt-Evers et al., 2004; Ahmadpour and Babapour, 2010) and chairs (Zhang, Helander and Drury, 1996; Helander and Zhang, 1997; Helander 2003) through empirical research and analysis of qualitative data. However, there is limited information available on the experiential aspects of aircraft passenger comfort, and thus, this thesis is predominantly concerned with creating knowledge about those aspects.

Physical impacts on the body include the impressions of the environment on the human body as the result of the interaction. Physical health and passenger comfort is a well-established field of study in ergonomics research and is addressed through both subjective and objective assessments. Some examples are subjective evaluations of passenger postures while performing different activities during their flights using questionnaires and observation techniques (Rossi et al., 2012; Greghi et al., 2012) and assessments of body back discomfort by survey (Tan, Chen, and Rauterberg, 2010). Methods for collecting objective data on postural comfort include pressure distribution measurements, Electromyography (EMG), spinal load measurements, etc (de Looze, Kuijt-Evers, and van Dieën, 2003). Other physical impacts include temperature (Bartels, 2003; Strom-Tejsen et al., 2005a), sound, vibration (Quehl, 2001; Pennig, Quehl and Rolny, 2012), and air quality (Spicer et al., 2004; Strom-Tejsen et al., 2005b; Strom-Tejsen et al., 2007). De Looze et al. (2003) characterized these effects in terms of physical capacities of the human body including the limitations we experience while interacting with the physical world and the affordance of tasks/activities within those limitations. The physical aspects of passenger comfort experience are not examined in this thesis.

Appraisal is the cognitive process of evaluating the outcomes of an interaction with a stimulus based on one's personal concerns (Ortony, Clore, and Colins, 1988). Having formed a perception of the cabin environment, passengers evaluate the benefits or potential harm that objects, events or agents may cause, based on concerns such as goals, standards, or tastes. If those concerns were satisfied, the person would experience a *positive emotion* (e.g., admiration, joy); otherwise a *negative emotion* (e.g., frustration) is elicited. For instance, if the personal entertainment unit in the aircraft were broken, one would feel frustration, as it cannot be used properly. Here the concern is the ability to entertain oneself and the emotion is frustration. The emotional responses of passengers and the link of these to their comfort level are rarely discussed in research and are therefore of particular interest in this thesis.

Finally the above processes determine one's *comfort or discomfort* within the temporal, situated and social context of the flight and influence *behaviors* and future *choices*. It is not clear, from the literature review, whether passenger comfort and discomfort are determined by the same set of variables or different ones. This issue will also be addressed in this thesis, based on empirical evidence.

The model shown in Figure 1-1 depicts the whole experience of a passenger in form of a loop with an arrow connecting the consequences to the beginning of the process for two reasons. The first reason is that the passenger experience is dynamic and could evolve during the flight. The second reason is that comfort and discomfort levels may influence (Scherer, 2005) and/or be influenced by (de Looze et al. 2003) emotions at the same time.

1.2 Objectives of the thesis

The main goal of this thesis is to offer new insight into the subjective aspects of the aircraft passenger comfort experience in the cabin interior. This includes determining the variables of passenger perceptions of the environmental factors as well as emotional responses to the flight context. The resulting knowledge could be incorporated into the design of aircraft interiors in order to enhance comfort and deliver more pleasurable experiences. Moreover, the results could potentially inspire new ways to assess the comfort experience of aircraft passengers during the flight. The objectives (and activities) that contribute to the main goal of this thesis are described below.

Objective 1. As shown in the comfort framework (see Figure 1-1), passengers' perception of various contextual features of the flight is assumed to result in an experience entailing some level of comfort. Enhancing passenger comfort necessitates an understanding of those perceptions. This knowledge is not currently available in the literature. The first objective of this thesis is therefore to elucidate the subjective aspects of passengers' comfort experience, i.e. passengers' perception. That includes generating and validating a set of descriptive variables to address those aspects in relation to the contextual features of the aircraft.

Objective 2. A number of comfort researchers have discussed the possibility of differentiating between the variables of the comfort and discomfort experience. Seat comfort, for instance, has been shown to entail wellbeing, relaxation and aesthetics variables, whereas seat discomfort is involves the biomechanics and ergonomic variables (Helander, 2003). This information is particularly important for the comfort assessment, given that passengers spend a considerable amount of time sitting in the aircraft. The second objective of this thesis is, therefore, to examine the variables that determine passengers' experience of comfort and discomfort and identify their possible differences.

Objective 3. Previous research on passenger comfort relied either on real-time accounts of respondents' experiences or on their retrospective recollections. However, the dynamics and changes in the passenger comfort experience at different times during the flight and the comparison of those reports to their retrospective accounts of the experience have not been explored. The third objective of this thesis is therefore to address those dynamics and the relationship between real-time and retrospective assessments of the passenger comfort experience.

Objective 4. The literature has demonstrated an apparent relationship between comfort experience and emotional responses (Richards, 1980; Vink et al., 2005). However the type of emotions that are relevant to the comfort experience of passengers in the cabin has not been investigated to date. The forth objective of this thesis is therefore to identify the emotions associated with the comfort experience of passengers and to uncover the eliciting condition of those emotions. This information could inform the efforts towards generating positive and pleasurable reactions to the design of cabin interior.

1.3 Thesis outline

The general outline of this thesis and the contribution of each chapter to the research objectives are discussed in this section. Chapter 2 provides a review of the literature on comfort, the comfort experience, the relationship between the comfort experience and emotions, and presents different views on the underlying factors of comfort and discomfort. Furthermore, the passenger comfort experience and its assessment methods are discussed.

This thesis includes three journal articles, presented respectively in chapters 3, 4 and 5. The paper presented in chapter 3 is published in Ergonomics (Ahmadpour et al., 2014) and concerns the first objective of this thesis. It explores the nature of the subjective perception of passengers, categorizes them into a number of themes based on the association with their comfort experience and highlights their link to the flight context. A follow-up study confirms the advantage of using this information to cabin interior designers.

Chapter 4 is concerned with the validation of the experiential themes of passenger comfort (generated in chapter 3) and isolating their descriptors. Moreover, the second objective of the thesis is addressed through a comparison between the themes associated with passenger comfort

and discomfort separately. The respective paper is submitted to the Applied Ergonomics (Ahmadpour, Robert, Lindgaard, 2014a).

Chapter 5 satisfies the third and forth objectives of the thesis, conveying an investigation of the real-time and retrospective accounts of passengers' comfort and emotional responses and their relationships. The resulted paper is submitted to Applied Ergonomics (Ahmadpour et al., 2014b).

Chapter 6 offers an overview of the results of the studies presented in chapters 3 to 5 and their implications for cabin interior design and evaluations of passenger comfort experience. Finally conclusion and recommendations for future research are discussed in chapter 7.

CHAPTER 2 LITERATURE REVIEW

2.1 What is comfort?

The word comfort is derived from the Latin word *confortare*, meaning 'to strengthen much'. The Oxford Dictionary (2010) defines it as "a state of physical ease and freedom from pain or constrain". Other lexical definitions include the physical and mental wellbeing, freedom from pain, want or anxiety, the state of quiet enjoyment, refreshment, and satisfaction, and commonly regarding a positive effect for comfort or absence of negative effects.

Similar to the lexical diversity of comfort definitions, the scientific definitions are also diverse. Pineau's (1982) definition of comfort included everything that contributes to human wellbeing and convenience of the material aspects of life, while Slater (1985) described comfort as the physiological, psychological, and physical harmony between human beings and their environment that ultimately deliver a pleasant state. Tiger (1992) highlighted a connection between pleasure and comfort by suggesting that the human brain, which monitors the comfort of the body, rejects pain and seeks pleasure.

Furthermore, Dumur, Bernard, and Boy (2004) suggested four points of view towards comfort: 1) *psychological* comfort is a state of quiet enjoyment and being free from worry and disappointment with regards to basic human needs (e.g. food, security, etc.), entailing aesthetics comfort (satisfying one's taste for forms, sound, smell, etc.), socialization comfort (incorporating the need for social relationships as well as privacy) and conformity (the sense of belonging to a group); 2) *physical* comfort is the state of being free from issues pertaining to physical, physiological, and biomechanical states; 3) *sociological* comfort is related to one's ethnic and social class, and, 4) *technological* point of view in comfort refers to those material inputs from the environment that provide pleasurable sensations.

Taken together, the above definitions highlight several issues suggesting that comfort should be viewed as a subjective and personal state (de Looze, Kuijt-Evers, van Dieën, 2003) resulting from a reaction to the environment and influenced by psychological, physiological, physical, and social factors. These are incorporated into the approach of this thesis towards the issue of comfort.

2.2 Comfort experience

In recent years, a new approach (toward comfort) has emerged in the field of product design, viewing comfort as a dimension of subjective and personal experiences (Quehl, 2001). A new term *comfort experience*, is therefore used frequently in lieu of comfort. Vink, de Looze, and Kuijt-Evers (2005a) stated that comfort is a convenience experience that, when improved, enhances product pleasure. Vink and Hallbeck (2012) underscored the impact of expectations and the perceived effects of interaction on experiencing various degrees of (dis)comfort, hence subscribing to the experiential view. In relation to product use, Rozendaal and Schifferstein (2010) described comfort as the experience that incorporates the cherishment of human senses, freshness, satiation and tranquility, all of which complement pleasant experiences. Therefore, improving the comfort experience necessitates an enhancement of the pleasurable aspects of the experience and going beyond the mere prevention of usability issues and/or health problems.

The view of comfort as an experience has been addressed empirically. Zhang, Helander, and Drury (1996) and Helander and Zhang (1997) described chair comfort in affective terms. They first identified a number of chair comfort descriptors based on literature and field studies. A descriptor, there, is a statement or a phrase that explains an aspect of a person's experience with an office chair, for instance, feeling relaxed or feeling restless. Using cluster analysis, those descriptors were classified into *relaxation* (e.g. restful, calm), *wellbeing* (e.g. happy, pleasant), *impression and aesthetics* (e.g. softness, plush) and *relief* (e.g., refresh) as factors of comfort and *fatigue* (e.g. sleepy, tired), *restless* (e.g. fidgety), *pain/biomechanics* (e.g. sore, ache), *strain* (e.g. cramped), and *circulation* (e.g. numb) as factors of discomfort. In a series of studies, a number of descriptors that were less relevant to chair comfort were eliminated, leaving six descriptors as determinants of chair comfort and six of discomfort. Subsequently, these were used for the design of the *chair evaluation checklist* (Helander and Zhang, 1997). Employing a similar strategy, Kuijt-Evers et al. (2004) identified the descriptors of the comfort experience in relation to using hand tools which yielded three main categories *functionality* (e.g. reliable, functional), *physical interaction* (e.g. relaxed working posture, no irritation, handle does not feel clammy), and *appearance* (e.g. nice color, professional look).

Overall, the comfort experience is viewed as a reaction to a product or system, entailing previous experiences, physical aspects of the product, and emotional aspects of a person. de Looze et al.

(2003) and Vink et al. (2005a) emphasized the influence of emotions (such as being excited or relaxed) on the comfort experience associated with the interaction of a person with a product or environment. A relationship between comfort and emotions is therefore assumed. However, empirical evidence indicating the types of emotional responses that are relevant to comfort and the conditions that lead to their elicitation is scarce.

2.3 Comfort and emotions

The comfort experience is described in relation to emotions (Vink et al., 2005a) and feelings of relaxation and wellbeing (Zhang et al. 1996). Scherer (2005) categorized comfort and discomfort as affective states, encompassing a degree of pleasantness, changes to which influence one's emotions. In relation to product use, de Looze et al. (2003) established a direct relationship between seat comfort and emotions. Given that aircraft passengers spend the majority of their flight time seated, it could be assumed that passenger comfort may also be related to emotions.

Emotions are more or less automatic responses of pleasure or displeasure following the evaluation of the outcomes of an event based on one's concerns (Frijda, 1986; Desmet & Hekkert, 2007). This evaluation process is called appraisal. Positive emotions (e.g. joy) are elicited when we find the outcomes of an event (e.g. using a seat) beneficial for the gain of our personal concerns (e.g. not experiencing pressure points on the back) and negative emotions are due to finding the outcomes of an event harmful to our concerns (Frijda, 1986). Note that perception and appraisal are different in that we constantly perceive the world around us irrespective of our personal concerns. We might find a seat novel but not be concerned with its novelty for any particular reason. Once we encounter a situation of interest, we start evaluating it (appraise it) and this evaluation results in experiencing emotions.

Emotions are defined as internal, mental states in reaction to ongoing situations that are perceived good or bad for one's concerns (Ortony, Clore, and Foss, 1987). Emotions are distinguished from other affective states (such as moods) in that they are focused on something/someone (e.g. afraid of someone, anxious about something, etc.), concern the present time (not future or past times) and are thus short-term reactions (Clore, Schwarz and Conway, 1994). For an emotion to be consciously recognized, a minimum level of physiological arousal, ranging from calm to activated, is required (Russell, 1980, 2003; Ortony, Clore, and Collins, 1988; Yik, Russell, and Steiger 2011). It is essential to differentiate mood from emotions. Moods are affective states

(valenced, i.e. entail a pleasant or unpleasant feeling) that, unlike emotions, do not have a specific focus, last for a longer time, are low in intensity, and do not necessarily concern the present time (Moors, 2009). An example of a mood is being depressed. The mere presence of mood could impact the type or intensity of emotions involved. In this thesis, passengers' appraisals and emotional reaction to the flight context will be examined and the impact of passenger moods on their emotions will be also uncovered.

2.4 Comfort versus discomfort

The notion of comfort naturally entails discomfort. Attempts to characterize the two have resulted in three main lines of argument. The first, an operational definition based on archival studies, holds that comfort and discomfort are two discrete states in the sense that comfort is the absence of discomfort (Hertzberg, 1972). This introduces comfort as a neutral state, which does not entail a positive effect such as pleasure. The second line of argument considers comfort a bipolar phenomenon whereby comfort is positioned at the extreme positive end, and discomfort at the extreme negative end of a continuum with a neutral point at the center of the scale. According to that argument, extreme comfort is only achieved when there are more positive effects than expected (Vink et al., 2005a). Along similar lines, Richards, Jacobson, Kulthau (1978) argued in favor of developing a continuous scale for evaluating several degrees of aircraft passenger comfort. Although they provided no empirical support for the argument, Richards (1980) asserted that the fact that passengers rated comfort across the entire continuum offers evidence that comfort comprises the positive state of a bipolar dimension.

The third line of argument holds that comfort and discomfort are two different entities, which are influenced by different variables and thus should be quantified independently (Helander and Zhang, 1997; Helander, 2003; de Looze et al., 2003). Consequently that view rejects the use of a single scale for evaluation of comfort and discomfort, proposing instead to use separate scales for each. In a series of empirical studies, Helander and Zhang (1997) showed that users perceived chair comfort in relation to factors such as aesthetics, relief, wellbeing and relaxation, while discomfort was related to fatigue, restlessness, pain and stress. Helander (2003) suggested that comfort and discomfort should be examined with a view clearly to differentiate the two in comfort studies, in particular studies that involve sitting comfort. This applies to passenger comfort since the experience in the aircraft interior is highly influenced by, although not limited

to, the seat. Passengers spend several hours seated in aircrafts while they are also exposed to numerous other stimuli (e.g. social, environmental, and physical). It is reasonable to assert that the research should be expanded to incorporate additional aspects of passenger comfort. The possibility of differentiating factors underlying passengers' impression of comfort from discomfort in the aircraft cabin is therefore examined in this thesis.

2.5 The passenger Comfort experience

Passenger comfort studies can be categorized into two groups. The first group includes studies of comfort attributed to particular feature(s) of the aircraft cabin such as seat, noise, temperature, pressure, vibration, etc. Vink, Overbeeke, and Desmet (2005b) classified those into thermal comfort, acoustic comfort, visual comfort (concerned with the design aspects of the cabin interior), physical comfort (related to seating and posture, physical loading, foot pressure, etc.), and discomfort related to vibration and shock. Among these, thermal and physical comforts are generally subjected to more research in the literature. The above fields are primarily concerned with maintaining passengers' health within the aircraft interior environment as well as defining the system measurements that conform to prevention of health issues. In other words, the majority of research on passenger comfort is dedicated to problem prevention. Dumur et al. (2004) used the term 'comfort of efficiency and management' for characterizing the studies on ergonomics features and technical aspect of cabin engineering. This group is not the focus of this thesis and thus it is not discussed in length.

A second group, which is the focus of this thesis, explores the holistic experience of passengers associated with a feeling of comfort. That is the overall comfort of the flight, influenced by all the cabin elements and the in-flight services as well as the psychological or social inputs in the context. Dumur et al. (2004) discussed four factors to demonstrate the overall comfort of passengers in modern aircrafts *the passenger bubble* (signifying the experience of privacy whereby one could pursue the desired activities), *the health factor* (focused on physical wellbeing and the absence of health issues), *the community factor* (focused on the shared and social experience of passengers in the cabin), and *the aesthetic-economical factor* (concerned with the enjoyment and pleasure delivered to passengers by the cabin environment at a given cost). The above characterization inspires a categorical view of passenger comfort factors in this thesis.

It must be noted that the overall comfort experience of passenger results from a favorable balance of the experiences delivered by various elements. However, the contribution of those elements to the overall experience of comfort may not be equal. This is evident from the discomfort pyramid proposed by Bubb (2008), in which the importance of various cabin elements in terms of their discomfort is prioritized. According to the model, illustrated in Figure 2-1, a disturbing smell is the most important determinant of discomfort. Respectively on top of smell are light, noise, vibration, climate and anthropometry. The pyramid suggests that a bad smell overrules other sensory experiences and prevent comfort experience, no matter how desirable the other aspects are. In other words, even the best anthropometric qualities of, for instance, a seat will not score points in the presence of a bad smell or high vibration. From this model, it is assumed that a certain trade-off of comfort factors shifts the balance towards comfort. It is therefore intended to prioritize the subjective aspects of passenger comfort in this thesis, based on their contribution to the overall flight experience.

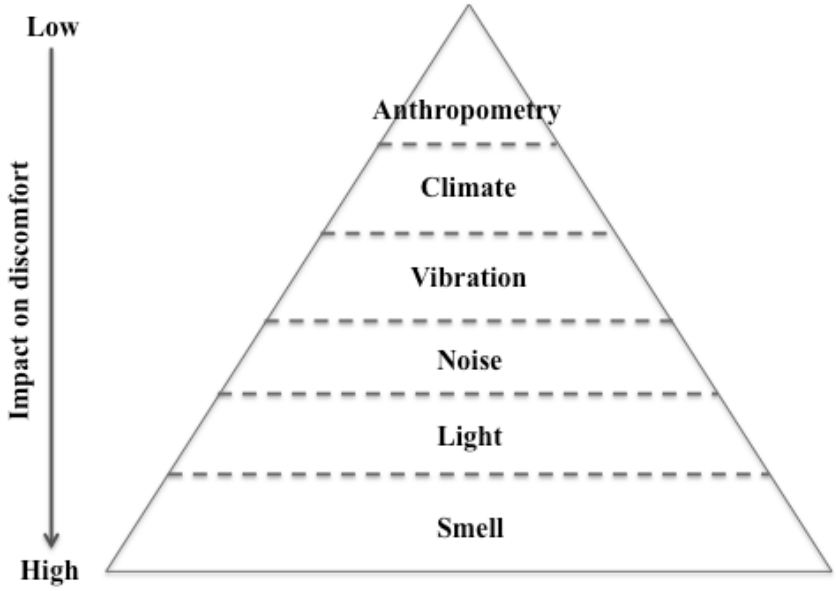

Figure 2-1. Discomfort pyramid, adapted from Bubb (2008)

Despite the emerging discussion on the comfort experience in the literature, research into this concept in relation to aircraft passengers is under-developed. Passenger comfort is influenced by a large number of perceptual stimuli (e.g. cabin interior features) in the flight context. Research taking a holistic approach toward passenger comfort typically provides information on features of the aircraft cabin that influence comfort, and less is known about the mechanism by which these

inputs are translated into passenger experience. Examples of subjective aspects of the holistic comfort experience were discussed earlier for chairs (Helander and Zhang, 1997) or hand tools (Kuijt-Evers et al., 2004) (see section 2.2). However, the subjective aspects of aircraft passengers' experience during the flight are discussed only in few publications. Two influential studies that address aircraft passenger comfort experience on a holistic level are described in the following.

Richards and colleagues performed one of the most influential studies to conceptualize passenger comfort, culminating in their proposed *Theory of Comfort* (Richards et al., 1978; Richards 1980). A visual representation of the theory is given in Figure 2-2. Richards argued that comfort is a continuous dimension of passenger experience, ranging from strongly negative (i.e. extremely uncomfortable) to strongly positive (i.e. extremely comfortable) with a neutral state in between.

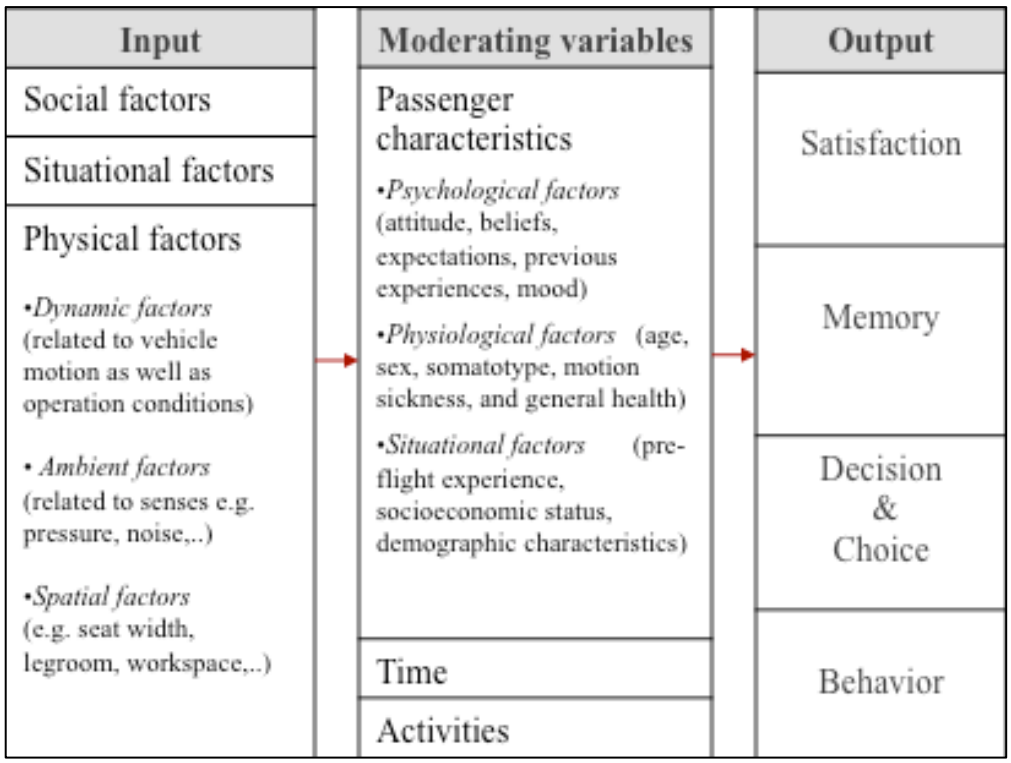

Figure 2-2. A model designed to visualize the components of the Theory of comfort t, adapted from Ahmadpour, Robert, and Pownall (2013)

The theory, based on a survey of 1619 passengers' onboard commercial flights, suggests that the comfort of a passenger (with certain physical, psychological, situational characteristics) performing certain activities during the flight (time), could be explained in relation to *satisfaction*

(willingness to fly again on the same type of aircraft), *memory* (of the flight experience), *decision and choice* (of future flights) and *behavior* (acceptance, purpose, frequency of flying). Three types of input from the aircraft cabin interior were identified as *physical* (dynamic, ambient, spatial), *social*, and *situational* factors. The study showed that discomfort experienced with certain physical factors such as legroom, seat and motion factors (side motion, up/down motion, general vibration) correlated strongly with passengers' overall comfort evaluations. Table 2-1 summarizes the Gamma correlation coefficient between those factors and overall comfort. Moreover, overall comfort was found to correlate highly with satisfaction and system acceptance (i.e. behavior). The memories of previous experiences also influenced passengers' expectations, meaning that if the trip impressions violate previous expectations, it will result in passenger dissatisfaction. Ratings on the difficulty for performing the four activities of sleeping, writing, reading, and concentrating correlated significantly with overall comfort.

Table 2-1. The Goodman and Kruskal's correlation coefficients between the overall comfort and the discomfort related to the physical factors in the cabin (Richardset al, 1978)

Physical factors	**Goodman and Kruskal's Gamma correlation coefficient**
Legroom	0.54
Seat firmness	0.54
Seat width	0.52
Seat shape	0.51
Work place	0.49
Side-to-side motion	0.48
Seat adjustment	0.47
Up-and-down motion	0.46
General vibration	0.44
Sudden jolts	0.43
Noise	0.41
Backward and forward motion	0.40
Sudden descent	0.35
Ventilation	0.31
Turning	0.28
Temperature	0.27
Lighting	0.27
Pressure	0.26
Tobacco smoke	0.23
Odors	0.15

Richards' arguments imply that comfort is a phenomenon that involves more than mere physical factors. However, that study did not attempt to examine the subjective aspects of passenger

comfort mentioned in the theory. The assessment of psychological factors in the survey was limited to attitude towards flying (i.e. how strongly passengers liked flying). The social factors were not evaluated either. Therefore, the subjective, psychological, and social factors contributing to this phenomenon are unfolded in this thesis.

Along similar lines, Vink et al. (2012) identified factors contributing to passenger comfort and determined their importance based on Internet reports of more than 10,000 passengers. Overall comfort scores were obtained and correlated with a number of factors pertaining to both the airport and aircraft experience mentioned in the trip descriptions. The correlation coefficients of those factors are listed in Table 2-2.

Table 2-2. The correlation coefficient between the overall comfort score and the assigned ratings to the factors of flight experience based on reports of 10,032 passenger reports

Flight factors	**Correlation coefficient**
Service	0.798
Fly again	0.730
Legroom	0.718
Hygiene	0.694
Crew	0.638
Seat	0.342
Luggage room	0.341
Food	0.331
Neighbor	0.330
Information	0.327
Waiting	0.316
Toilet	0.291
Noise	0.221
IFE	0.217
Bumpy flight	0.216
Flight time (o to 20 hrs)	0.221
In/-egress	0.221
Delay	0.159
Aircraft type (old, new)	0.156
Lost luggage	0.144
Aircraft type (narrow, wide, double deck)	0.118
Airline (low cost, other)	0.115
Air quality	0.113
Class (economy, premium, business, first)	0.111
Climate	0.091
Direct vs. stop-over	0.119

The results demonstrated higher correlations two physical factors namely legroom and seat and comfort. A strong correlation was also found between the social factor crew attitude and comfort. Situational factors that correlated with comfort included the newness of aircrafts, wide body aircrafts for long flights, flight class and flight delay. Similar to Richards (1980) claims, Vink et al. also found that expectations influence passenger comfort highly, meaning that comfort was achieved when passenger had more positive experiences than expected. Finally the study highlighted a correlation between comfort and satisfaction (fly again factor). The subjective aspects of passenger comfort experience (e.g. comfort descriptors) in relation to the abovementioned physical, situational, or social factors were not addressed in that study, nor were the psychological impacts of those (e.g. the impact of emotions or moods) explored. This thesis recognized the importance of those issues and uncovers their influence on passenger comfort.

Several other studies have addressed various aspects of the aircraft passenger experience and satisfaction, although comfort has not been directly examined in these. Chen (2008) investigated the relationship between service quality, perceived value, overall satisfaction, and behavioral intentions of passengers in Taiwan. The study highlighted the importance of crew and flight facilities for passenger satisfaction. Moreover, Chen (2008) proposed four factors for passenger expectations of the service each comprising a number of subjective descriptors; *employee and facilities* (willingness to help from staff, courtesy of staff, etc.), *product* (up to date entertainment on the flight, Provision of preferred seat option, etc.), *transaction* (Sufficient information on website, Booking function on website, etc.), and *reliability* (doing things right the first time, punctuality, etc). The approach of that study towards unfolding certain descriptive factors of passenger expectations is a practical example that inspires and informs the research on the subjective aspects of flight comfort experience carried out in this thesis.

Each of the above studies highlighted some factors to conceptualize the comfort experience of passengers. They offer valuable insight for designers of aircraft cabins by recognizing the priorities of the features that need to be addressed in order to enhance passenger comfort. However, a gap in the body of knowledge exists with regard to the subjective aspects of the comfort experience delivered through the abovementioned factors. Acquiring such knowledge could lead the efforts in designing the aircraft interior or services towards more pleasant and comfortable experiences. This thesis will focus on providing that knowledge based empirical evidence.

2.6 General methods for studying passenger comfort experience

Richards (1980) stated that the best method for studying passenger comfort is the empirical inquiry, due to the highly subjective nature of that experience. Other researchers have also emphasized the subjective and personal qualities of comfort (de Looze et al., 2003; Vink et al., 2005a; Helander, 2003). Subjective assessments of passengers' flight comfort and/or experiences are therefore common and subscribe to data collection methods such as self-reports submitted in real-time (during the flight) or retrospectively (after the trip).

Oborne and Clarke (1973; 1975) discussed the design of questionnaires for obtaining self-reporting data such as subjective estimates of the quality or the intensity of passengers' reaction to various stimuli in the environment. They proposed four groups of questions for the design of a comfort questionnaire. Those are questions about the respondent's demographic information (age, sex, height, weight, etc.), questions requiring descriptions of some sort (in casual format, as if the respondent is describing the experience to a friend), questions requiring the respondent to select an appropriate description of the stimulus from a predetermined categorical list (e.g. the felt vibration is: low, medium, high), and finally questions acquiring a numerical estimate of the investigated stimuli (using rating scales).

The recommendations by Oborne and Clarke are employed for the design of the questionnaires in this thesis, in order to assess the comfort experience of passengers in the flight context. Some or all groups of questions suggested by Oborne and Clarke will be included, depending on the purpose of the study. For example, the open-ended descriptions are used for exploratory purposes, such as eliciting the subjective descriptors of the experience. Questionnaires are also used in combination with interview techniques to obtain more in-depth data. Several other studies also benefitted from applying those techniques to passenger comfort research. Some examples are discussed below.

Vink et al. (2012) collected more than 10,000 retrospective trip reports submitted on the Internet to obtain a general rating on the overall comfort (on a scale of 0 to 10) and open-ended descriptions of passengers' experiences. Using multiple regression combined with correlation analyses, the results uncovered the most influential elements of the journey for the overall trip comfort and highlighted passengers' preferences with respect to each. In addition, they conducted 153 interviews at Schiphol airport in the Amsterdam whereby they targeted arriving passengers

to obtain ratings on the comfort associated with different elements of their latest flight and the overall comfort on a scale of 1 (very bad) to 5 (very good), general flight data (e.g. length of the flight), demographic information (age, height, etc.). Using the mean values of those ratings combined with t-test, they identified differences between various groups such as between shorter and larger individuals.

Chen (2008) also collected retrospective data in form of self-reports from 300 passengers at Koashiung International Airport in Taiwan to collect passengers' assessment of service quality, perceived value, overall satisfaction and behavioral intentions (i.e. likelihood to fly again with the same airline and likelihood to recommend the airline to others). For instance, respondents rated their perceived importance for 30 subjective descriptors of service expectations (1-least important to 5-most important) in addition to the perceived performance of those on their flight (1-strongly disagree to 5-strongly agree). As a result, the researchers were able to model the relationship between service descriptors using an exploratory factor analysis and classify the 30 items into four factors (facilities, product, transaction, reliability).

Although the above studies provided important information about passengers' trip impressions, they exclusively employed post-journey assessments and the extent to which those retrospective recollections correspond to the real-time impressions and experiences of passengers is not clear. The research on passengers' real-time in-flight experiences is also limited. Richards et al. (1978) recruited passengers to complete questionnaires during their flight (close to the end of the flight). The questionnaire comprised a number of comfort related questions, overall judgment and willingness to use the same means of transportation again. This gave a prioritized list of physical elements of the cabin (e.g. seat, noise, temperature) that contributed to the in-flight comfort. The subjective experiences of passengers and psychological factors of comfort were not formally evaluated, nor was it compared to the retrospective assessment of participants' comfort. Greghi et al. (2012) also employed real-time observation, questionnaire and interviews techniques in order to study passengers' activities (e.g. eating, working, entertainment, etc.). Comfort, in that study, was addressed as the level of discomfort (ranging from no discomfort to extreme discomfort) related to several activities and therefore linked to passenger's personal space. The relationship between real-time and retrospective evaluations was not investigated in that study either.

The above literature review necessitates a research on the relationship between real-time and retrospective evaluation of comfort. In addition, it seems appropriate to extend that to an examination of the changes in passenger comfort experience during the flight and their impact on the overall retrospective evaluation of comfort (after the journey). Those are important issues because while passengers' choices and expectations are based on their retrospective evaluation, the airlines can only tackle passengers' real-time experience through the design of the cabin interior or services. Acquiring the knowledge about the link between the two types of evaluation could inform the design of the in-flight experiences (i.e. design of the cabin interior and services).

CHAPTER 3 ARTICLE 1: THE THEMATIC STRUCTURE OF PASSENGER COMFORT EXPERIENCE AND ITS RELATIONSHIP TO THE CONTEXT FEATURES IN THE AIRCRAFT CABIN[1]

Abstract

This paper describes passenger comfort as an experience generated by the cabin interior features. The findings of previous studies are affirmed regarding a set of 22 context features. Passengers experience a certain level of comfort when these features impact their body and elicit subjective perceptions. New findings characterise these perceptions in the form of eight themes and outline their particular eliciting features. Comfort is depicted as a complex construct derived by passengers' perceptions beyond the psychological (i.e. peace of mind) and physical (i.e. physical wellbeing) aspects, and includes perceptual (e.g. proxemics) and semantic (e.g. association) aspects. The seat was shown to have a focal role in eliciting seven of those themes and impacting comfort through its diverse characteristics. In a subsequent study, a group of aircraft cabin interior designers highlighted the possibility of employing the eight themes and their eliciting features as a framework for design and evaluation of new aircraft interiors.

3.1 Introduction

Modern air transportation has benefited from technological advances to increase flight safety and reliability. However, airlines are also competing to attract more passengers by offering various levels of design, services and prices. Studies on passenger comfort (Richards, 1980; Vink et al., 2012) showed that improving the sense of comfort associated with a trip results in an increase in the proportion of passengers who wish to use the same vehicle (aircraft) on future occasions. Due to the growing competition among airlines and aircraft manufacturers, comfort is now a familiar concept for passengers as well and consequently they are forming higher expectations of it. In order to increase passenger comfort, it is necessary to understand this notion, its components and

[1] Paper published in Ergonomics; Ahmadpour, N., Lindgaard, G., Robert, J-M., Pownall, B. (2014). The thematic structure of passenger comfort experience and its relationship to the context features in the aircraft cabin. Ergonomics, 57(6), 801-815.

ways to enhance it. The purpose of this paper is to elucidate these elements in the field study reported here.

The paper is outlined as follows. The first section reports an overview of the literature on comfort, comfort experience and more specifically passenger comfort, followed by the problematic section that is addressed in this paper. The research contains two main sections corresponding to two studies. Study 1 is on passenger experience and is reported in Section 3.2, presenting the approach employed in the study, data collection, analysis and discussion. Section 3.3 presents Study 2 on designers' opinions and its subsequent data collection, analysis and discussion. Finally, the conclusion is presented in Section 3.4.

3.1.1 Comfort and comfort experience

The Oxford Dictionary (2010) defines comfort as 'a state of physical ease and freedom from pain or constraint', whereas the scientific literature offers a variety of definitions. Pineau (1982), for example, included everything that contributes to human wellbeing and convenience of the material aspects of life in his definition of comfort, while Slater (1985) suggested that comfort is 'the pleasant state of physiological, psychological, and physical harmony between human being(s) and (their) environment'. Dumur, Bernard, and Boy (2004) also defined comfort beyond the physical aspects of life and included psychological aspects. Taken together, these definitions highlight several issues suggesting that comfort should be viewed as a subjective and personal state resulting from a reaction to the environment and influenced by psychological, physiological, and physical factors (De Looze, Kuijt-Evers, and Van Dieen, 2003).

In recent years, a new approach (towards comfort) has emerged which views comfort as a dimension of subjective and personal experiences (Quehl, 2001). For instance, a study of seat comfort (Helander, 2003) described it in experiential terms such as relaxation (e.g. restful, calm), wellbeing (e.g. happy, pleasant), impression and aesthetics (e.g. softness, plush) and relief (e.g. refresh) rather than in terms of physical ergonomics features (related to proprioceptive feedback). Vink, Overbeeke, and Hallbeck (2005) stated that comfort is a convenience experience that, when improved, enhances product pleasure. Vink and Hallbeck (2012) also emphasised on the impact of expectations and the perceived effects of interaction on experiencing various degrees of (dis)comfort, hence subscribing to the experiential view.

The above-mentioned authors discussed the influence of users' perception on how they experience comfort and coined the term 'comfort experience'. Perception is a means for people to summarise and translate product features (e.g. content, style and functionality) in a simplified and subjective manner (Hassenzahl, 2003). For instance, describing a seat that offers certain features as novel implies a subjective perception of novelty.

3.1.2 Passenger Comfort

Despite the emerging discussion on comfort experience in the literature, research into this concept in relation to aircraft passenger experience is scarce. Passenger comfort is influenced by a large number of perceptual stimuli and features during a flight. Research taking a holistic approach towards passenger comfort typically provides information on features of the aircraft cabin that influence comfort and less is known about the mechanism by which these inputs are translated into passenger's experience including their comfort experience.

On that note, studies by Richards and his colleagues were one of the most significant attempts to conceptualise passenger comfort, culminating in their proposed 'Theory of Comfort' (Richards, Jacobson, and Kulthau, 1978; Richards 1980). The theory, based on a survey of 1619 passengers' onboard commercial flights, suggests that the passenger's experience is influenced by the physical, social and situational inputs from the aircraft cabin interior. The study prioritises the physical factors such as seat, noise or temperature which correlate with comfort but does not attempt to disclose the subjective aspects of passengers' comfort that is resulted from this process. The assessment of psychological factors in the survey was limited to attitude towards flying (i.e. how strongly passengers liked flying) and the social factors were not evaluated. Nevertheless, Richards' arguments imply that comfort is a phenomenon that involves more than mere physical factors. This phenomenon is yet to be unfolded.

Along similar lines, Vink et al. (2012) identified factors contributing to passenger comfort and determined their importance based on Internet reports of more than 10,000 passengers. The results showed a significant correlation of comfort with several physical inputs (e.g. leg room, seats), social inputs (e.g. neighbours), situational inputs (e.g. flight delay), expectations and flying time.

Each of above studies highlighted some inputs that contribute to passenger comfort. They offered valuable insight for designers of aircraft cabins by recognising the priorities of the features that need to be addressed in order to enhance passenger comfort. However, as far as passenger experience is concerned, there is still a gap in the body of knowledge with regard to how these inputs in the context of flying are translated to 'a subjective personal state' as coined by De Looze, Kuijt-Evers, and Van Dieen (2003). For instance, based on Vink et al. (2012) the precedence of factors such as service and legroom are underlined for passenger comfort, but it is unknown what types of experience could and should be delivered through these factors, what types of changes in these factors could improve comfort and how passengers perceive the changes intended by designers.

3.1.3 Problematic

The research presented in this paper involves two studies. The first study addresses the aspects of passenger comfort experience as a subjective construct. A model proposed by Ahmadpour, Robert, and Pownall (2013), based on literature study, illustrates the underlying mechanism for this experience and denotes the investigation in Study 1. The model represented the elements of passenger comfort experience as follows. The environmental factors in the cabin provide a set of inputs to the interaction of the passenger (with certain human characteristics, e.g. expectations, psychological, physiological and socio-economical) who performs certain activities over a limited period of time. These inputs physically impact the passenger and are also perceived by him/her in a subjective manner. Consequently, the passenger experiences a level of (dis)comfort and emotions, develops behaviours, forms an overall judgement and ultimately considers these consequences in making future choices. Among the proposed consequences, only comfort, as a positive experience, is considered for this study.

Relying on the above background, Study 1 is concerned with two major issues as follows:

1) Passenger's personal perception of various elements in the cabin (during the flight) is assumed to result in some experience of comfort. Enhancing comfort necessitates an understanding of these perceptions and their subjective nature. Some studies examined some of these in particular cases such as pleasure and usability (Coelho and Dahlman, 2002) in car seat comfort or relaxation, aesthetics and wellbeing (Helander, 2003) in relation to office chairs. Similar knowledge is lacking for the aircraft interior. Hence, the

first objective of this paper is to provide some information about passenger's perceptions that leads to an experience of comfort. This is achieved through an empirical study and close analysis of qualitative data that disclosed a thematic structure for those perceptions.

2) Although the contextual features are shown to be a major contributor to passenger's comfort experience, it is still unclear how these features are translated into passenger perception. The second objective of this paper is to uncover the relationship between the contextual features (e.g. physical, social) and the subjective perceptions pertaining to passenger comfort. This is accomplished through further analysis of the qualitative data, generating a list of context features in the aircraft completed and verified by previous literature, and linking them to passenger's subjective perceptions.

Study 2 is concerned with the implications of the results of Study One for the design of aircraft interior. The objective of Study 2 is to, first, examine the awareness of the aircraft interior designers towards the knowledge elicited in Study 1 and, second, to understand the potential advantages of such knowledge in practice. To achieve these objectives, a team of designers participated in a workshop and gave feedback on the results of Study 1.

3.2 Study 1

3.2.1 Research Approach

This study aims at uncovering the themes of passenger's perceptions that correspond to flight comfort experience and their relation to the cabin environment. As an experience is essentially subjective, it was decided to conduct a qualitative study based on passengers' personal account of their flight comfort and to analyse the content of the data. The data were collected through an online questionnaire to reach out to a larger sample.

3.2.2 Procedure

Participants were contacted by email immediately upon their return from summer vacation, based on a number of mailing lists including personal contacts and those of students of Polytechnique Montréal. The email contained a link to the online consent form and the questionnaire. Respondents were not required to share their name or affiliation. They were informed that the study is part of a doctoral research thesis, that their participation is voluntary and that they would

not be compensated for their participation. The instructions emphasised that only those people who had just completed a long-haul trip (flights > 4 hours) should answer the questions.

3.2.3 Material

Participants completed an online questionnaire designed in Google documents, comprising two parts. The first part concerned background information including age, gender and number of previous flights for which three choices were presented: never, less than five times and more than five times. The second part included an open-ended question addressing passenger comfort inside the aircraft cabin. Respondents were encouraged to describe their recent flight experience as if they were describing it to a friend and to include details such as people, seating location, context, their feelings and how these influenced their sense of comfort. Respondents were prompted to describe only their experience inside the aircraft cabin and to not include details of other phases of their journey (e.g. airport experience). All responses were automatically stored on an online spreadsheet, accessible only by the first author. The questionnaire was pilot tested with two volunteers before distributing it; it took roughly eight minutes to complete.

3.2.4 Participants

A convenience sample of 158 participants was recruited in 10 days. Three incomplete datasets were removed, leaving 155 valid responses (98 males, 20-61years of age, M = 38, median 35 years), selected in a semi-random fashion, obtained through email contacts. All had more than five flight experiences. Most participants reported a generous amount of information and detail, with the longest report containing 548 words and the shortest 12 words (M = 90.26, *SD* = 80 words).

3.2.5 Data analysis

The data were compiled in an Excel file and content analysis was performed in a bottom-up approach to elicit a number of themes that could describe the comfort in a subjective manner. The analysis process comprised three steps. In the first step, addressing the first objective of this study, the volume of data was reduced to a number of emerging themes that could describe comfort. Once the first author had elicited the themes, another researcher assigned these to a randomly selected subset of participants comprising 10% of the raw data. A Cohen's kappa inter-

rater reliability analysis was performed to determine the degree of agreement between the two researchers. Subsequently, the first author conducted the remaining two analysis steps. In analysis conducted in Step 2, the content of the flight reports were examined to identify the cabin's context features (e.g. seat, leg room, noise), all of which apparently influenced passenger comfort. This information is essential for the analysis in Step 3 and to meet the second objective of the study. Step 3 aimed to uncover the relationship between passengers' comfort experience, i.e. the themes elicited in Step 1, and the context features, generated in Step 2, matched with each response in order to create a tangible understanding of the experiences. All responses were revisited in Step 3; the context features central to each comfort theme were identified and highlighted in a matrix.

3.2.6 Results

The results of each of the three data analysis steps are presented separately in this section. Thus, Section 3.2.6.1 presents the results of Step 1 in which passenger comfort themes were elicited. Section 3.2.6.2 outlines the findings from analysis in Step 2 identifying context features from the same data source. Finally, Section 3.2.6.3 contains findings linking the outcomes of Steps 1 and 2 into a model of the relationship between passenger comfort and context features.

3.2.6.1 Passenger comfort themes

The first step of the analysis resulted in some 857 different comments. A comment was defined as a statement describing an aspect of the flight experience (within the aircraft cabin) with clear impact on the respondent's comfort. If a participant made the same comment more than once, it was counted only once, thereby ensuring that each comment included in the count was unique. The comments were read several times before being summarised into a set of 244 descriptors. The next task was to identify commonalities among these descriptors and organise them into categories. A total of 79 categories were generated and subsequently grouped based on their similarities in content, resulting in 19 groups. Finally, similarities of these groups were identified and merged into eight themes. The 857 comments were then revisited in order to reassign them to those themes.

Due to the subjective nature of the analysis, another researcher was asked to read a random sample of 10% of the data and identify the comfort themes present in each response in the

sample. This researcher was given the definition of each of the eight themes and the 19 groups. The two researchers performed the analysis together for one report as an example in order to ensure a shared understanding of the themes. Cohen's kappa coefficient, calculated to identify the inter-rater reliability, yielded a value of K= 0.88 ($p < 0.005$) which, according to Vierra and Garrett (2005), implies almost perfect agreement between the two researchers. A summary of the eight passenger comfort themes, their subsequent groups and illustrative examples from respondents' comments are presented in Table 3-1.

The eight themes were operationally named peace of mind, physical wellbeing, proxemics, pleasure, satisfaction, aesthetics, social and association. Each of these themes is defined below, based on their underlying groups and comments in the flight context. When appropriate, the implications of some themes for product or interaction design are mentioned as well. As Table 3-1 shows, the themes 'peace of mind ', 'physical wellbeing' and 'proxemics' received the highest number of comments and 'association' theme contained the lowest.

Peace of mind: The comments in this theme referred to the mental state of being in peace and harmony without experiencing any disruptions. Kahneman and Krueger (2006) considered such state a contributor to one's subjective wellbeing and Desmet (2012) referred to being at peace as an emotion word and a contributor to product pleasure. The principal groups were security (feeling safe, prepared and able to predict the situation, e.g. due to receiving enough information, or care and attention), tranquility (feeling calm, without stress, e.g. not feeling confined) and relief (feeling relaxed, e.g. easy to rest and sleep).

Physical wellbeing: This theme explains the experience of physical/physiological convenience, i.e. absence of health issues such as pain. The theme comprises two main groups. The first group, energy, refers to feeling refreshed, alert and energetic, e.g. due to fresh air or receiving refreshing towels. The second group, bodily support, refers to accommodation of body by the physical surroundings (e.g. good fit into the seat, adopting a neutral posture). It also includes the ease of performing activities (e.g. a headrest with side ears supports the head when the passenger is sleeping).

Table 3-1. Eight passenger comfort themes, their subsequent groups and examples from respondents' comments

Theme	Groups	Examples	Total
Peace of mind	Security	I was comfortable because I was not hungry, thirsty, [..].	117
	Tranquility	[..]Calm with not much noise.	68
	Relief	There was no irritation or annoyance, I reclined the seat and slept	58
Physical well-being	Bodily support	The ears of the headrest supported my neck when I was sleep.	202
	Energy	They offered fresh wet towels at the end.	10
Proxemics	Autonomy & control	[..] able to easily get out the seat when I want without disturbing my neighbors.	66
	Privacy	I had to try and avoid physical contact with my neighbor due to narrow space.	53
Satisfaction	Accessibility	They had designed small storage compartments that were easy to access.	25
	Adequacy	The window was large enough to enable a good view.	28
	Quality	The sound was clear and flight attendant's voice was not all muffled.	37
Pleasure	Ambiance	I like it when it's cozy and warm.	15
	Stimulation	I liked the individual touch screens.	37
	Anticipation	I didn't expect to be offered free wine on a domestic flight!	18
Social	Tolerance	I don't like to talk or interfere with my immediate neighbor.	31
	Connectedness	Flight attendants were friendly with positive manner, offering their assistance.	16
Aesthetics	Neatness	The air was clean and there was no specific odor.	32
	Style	The cabin design was soothing with neutral colors.	10
Association	Recognition & evocation	It was like being at home.	21
	Imagination & symbolism	I wish there was a bar and a walking area.	13
Total			857

Proxemics: The term proxemics was originally coined by Hall (1963) to refer to the perceived relationship between the social and physical distance. It describes how we interpret distance, posture or orientation in relation to other people and environmental features (Ballendat et al., 2010). We borrowed the term to explain a person's reaction toward autonomy and control (feeling one could perform desired tasks freely, e.g. using personal light to read when desired) and entails a sense of privacy (no intrusion of personal space by neighbours or flight attendants) during the flight. The word freedom was mentioned frequently in this group.

Pleasure: Desmet (2012) attributed pleasure to the emotion category 'joy' in relation to human-product interaction. Similarly in our study, this theme underscores the pleasantness, delight and enjoyment experienced during flight. The main groups include stimulation (the joy and amusement offered by the environment, e.g. through insightful information on In-Flight Entertainment [IFE] unit), anticipation (serendipity due to pleasant and positive surprises, e.g. hot

meal on a domestic flight) and ambience (a subjective, semantic quality of the environment, e.g. cosy, mood setting).

Satisfaction: This term is generally attributed with effectiveness, efficiency, usability and goal achievement (ISO 9241-11, 1998), involving affective components and expectations (Lindgaard and Dudek, 2003). We coined the term satisfaction to communicate a sense of fulfilment and contentment as the result of achieving desired goals with the help of environmental elements and products. The theme includes three main groups: quality which is the goodness cabin features in terms of being solid and trustworthy, adequacy which is a product's ease of use and efficiency in terms of effort (e.g. an easy to adjust headrest) and accessibility, being the physical reachability of controls and storage space.

Aesthetics: Akin to Hekkert's (2006) definition of aesthetics, this theme is defined as the experiential sensory pleasure or displeasure. The aesthetic experience theme here includes gratification of any one of the five human senses. The two main groups referring to participants' perceived aesthetics in the cabin are neatness (e.g. looking and feeling clean, absence of unpleasant odours, looking new) and style (e.g. glamorous, elegant, modern, luxurious).

Social: Tiger (1992) coined the term socio-pleasure to the type of pleasure resulted from social interactions and Jordan (2000) linked them to product enjoyment. In the same vein, the social theme here is concerned with social interactions between the passenger and other people during the flight. The contextual features influence these interactions and if perceived as enjoyable, they contribute to comfort experience. Social interaction was identified in terms of social tolerance (the extent to which people tolerate certain aspects of social behaviours) and social connectedness (feelings of empathy towards others, e.g. a smiling flight attendant). Some comments that contained human personae such as neighbours did not necessarily indicate a human relationship. For instance, being bothered by a flight attendant who brushes off against the passenger's shoulder walking down the aisle does not indicate any human relationship but rather a design flaw due to narrow aisles. Hence, the social nature of the descriptors in this theme was emphasised.

Association: Association is operationally referred to as the interpretation of the cabin environment by passengers in terms of its meaning and personal significance. Similar description is employed in relation to product experience and particularly interactive products. For instance

Hassenzahl (2003) described it as a product attribute called evocation that could provoke (past) memories and contribute to user experience. The comments in this theme are categorised into two main groups. One is recognition and evocation, i.e. experiences in which the passenger recognises or creates a link to a familiar personal experience such as ‘sitting in a comfortable salon chair’ or ‘feeling at home’. The second group, called imagination and symbolism, includes experiences that are reminiscent of an ultimate comfortable experience, such as travelling in first class or a business jet, by someone who had never experienced it before.

3.2.6.1.1 Summary

The above themes are presented in a model in Figure 3-1 to give a visualization of their relation to the passenger in the aircraft cabin environment.

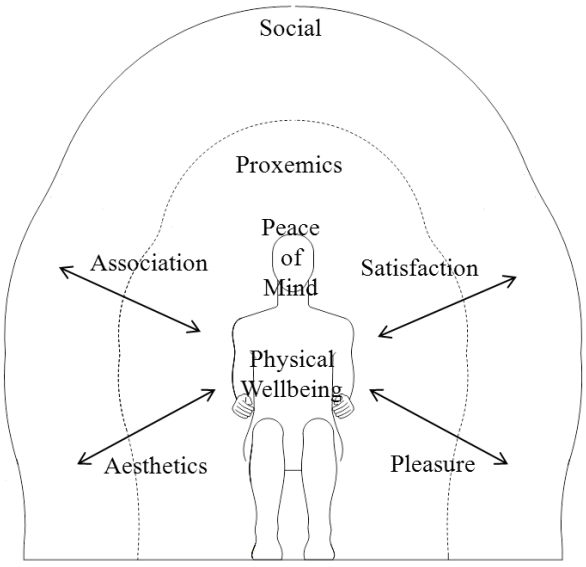

Figure 3-1. An overview of passenger comfort themes and their relation to the space

The theme ‘peace of mind’ mainly represents passenger’s psychological state while ‘physical wellbeing’ embodies his physical state; therefore, they are placed in the centre of the model together with the passenger. ‘Proxemics’ refers to passenger’s perception of control and privacy within the personal space, i.e. the space that passenger perceives as his (Hall, 1966), and so it is located immediately around the passenger. The space around one’s personal space is shared with others in the cabin environment. This is the social space accentuated by the ‘social’ perception. The other four themes could not be positioned anywhere in particular as they could be elicited

due to exposure to the stimuli at virtually any given distance from the passenger. Thus they are shown by arrows stretched through the entire space.

3.2.6.2 Context features contributing to passenger comfort

The analysis in Step 2 included content analysis with the intent to elicit the context features that influenced comfort in each response. The mere mention of a feature was not enough for it to be counted; it must have had a clear impact on some aspect(s) of the respondent's comfort. This impact was established when a report clearly attributed an external feature to a change in an experiential aspect of respondent's wellbeing (i.e. one of the readily identified themes in the previous step). For instance a passenger stated 'I found the cabin atmosphere cold but I put on my jacket and then I was fine [...]'. In this example, the low cabin temperature (as the external feature) was not attributed to any change in the passenger's experience (e.g. no change in physical wellbeing) despite its unpleasant nature and thus it was not accounted for in the analysis.

Once the context features had been derived from each comment, the number of people who mentioned each was calculated from the raw data. This resulted in a list of 22 features found to influence comfort during the flight. These features were compared with those of Richards, Jacobson, and Kalthau (1978) and Vink et al.'s (2012) studies to verify that the feature noted by those authors had been addressed here as well. The present analysis revealed one additional feature that had not been mentioned in either of those two studies, namely, 'cabin layout'. Moreover, Vink et al. (2012) did not mention 'activity', while Richards (1978) found a reciprocal relationship between passenger-performed activities and comfort.

The 22 features are listed in Table 3-2. Following the title of each feature, the number and percentage of participants who mentioned it is shown in column 2 along with an illustrative comment in column 3. Clearly, the number of participants who commented on each of the 22 features varied substantially, with by far the most participants mentioning aspects of the seat (n = 124, 80%), followed by legroom, IFE, temperature, activity, noise and service, each of which were commented on by at least 20% of participants.

Table 3-2. Twenty-two context features influencing passenger comfort, number and percentage of participants who mentioned each features along with an illustrative comment.

Context features	N (%) of participants	Example of passenger comments
Seat	**124 (80)**	Enough elbow room to not feel invaded and a curvature that actually matches human spine.
Legroom	**99 (64)**	[...] leg room was predominant due to my knee problems.
IFE *(In-Flight Entertainment)*	**57 (37)**	Seat back entertainment unit that is reliable and well stocked with entertainment programs
Temperature	**51 (33)**	Temperature is pleasant, not too cold and not too hot.
Activity	**43 (28)**	[...] I wanted to lean back and make myself comfortable to sleep.
Noise	**43 (28)**	[...] cabin was not noisy so I could listen to the music similar to at home.
Service	**34 (22)**	Friendly flight attendant was circulating to [...]
Air quality	30 (19)	Having enough air circulation to not feel stifled
Window	24 (15)	Windows were aligned with the seat; not too far ahead to behind [...]
Neighbor	19 (12)	It's terrible when there's an annoying neighbor who keeps talking loud.
Light	18 (12)	It was comforting to have individual lighting device.
Food	17 (11)	They served healthy, fresh food which was really nice.
(In-)Egress[2]	15 (10)	Being able to get out of my seat when I want, without having to displace the neighbors.
Hygiene	13 (8)	It was nice that there were no bad smell so I was feeling fresh upon arrival.
Cabin layout	10 (8)	Well-designed and nice-looking cabin and seats made me feel like I'm in modern plane that is trustworthy, so I could enjoy my flight.
Lavatory	10 (6)	The small washroom was not accommodating.
Information	9 (6)	It was comforting to see all emergency signs from my seat.
Crew	9 (6)	The well groomed flight attendants with warm personalities made me feel comfortable.
Storage space	7 (5)	I had to store my backpack between my feet for the whole flight.
Luggage bin	6 (4)	People had carried way too many bags and occupied too much space in the bin, so I was not able to store mine close to my seat.
Pressure	5 (3)	The pain in my ears, especially 30 minutes before landing, really diminished my comfort.
Turbulence	4 (3)	I liked the occasional small turbulences; it makes me feel I am on a moving vehicle.

3.2.6.3 Relationship between context features and passenger experience

The analysis conducted in Step 3 attempts to establish the relationship between comfort themes and context features across participants. One participant, for example, described a comfortable experience as feeling a level of privacy by having sufficient space around him to avoid physical contact with the immediate neighbour. The central comfort theme to this part of the comment is ‘proxemics’, and the relevant group is ‘privacy’. By the same token, the lateral space that

[2] Entering (ingress) or exiting (egress) the seat

predominantly captures privacy in the situation mentioned corresponds to seat width. Hence, that comment suggests a relationship between 'proxemics' and the context feature 'seat' in the analysis in Step 3.

Other relationships were devised by performing a similar analysis for all 857 comments derived in Step 1 (see section 3.2.6.1). The number of times that each of the 22 features elicited in Step 2 (see Table 3-2) corresponded to a comfort group elicited in Step 1 (see Table 3-1) was calculated. The number of comments belonging to a theme is represented by the total of the groups within that theme. A summary of the analysis is presented in Table 3-3.

Table 3-3. Relationship between context features and passenger experience

Themes	Groups	seat	leg room	IFE	temperat	activity	noise	service	window	air	light	neighbou	food	in-	hygiene	lavatory	informati	crew	storage	luggage	pressure	torbulanc	cabin	TOTAL
	security	13		4	40			16		19	2		7		1	2	8	2			2	1		117
	tranquility	17	3				35	2	1			3		2		2						3		68
Peace of	relief	22	2			25		1		1	2	4										1		58
mind	*total*	***52***	*5*	*4*	***40***	*25*	*35*	*19*	*1*	*20*	*4*	*7*	*7*	*2*	*1*	*4*	*8*	*2*			*2*	*5*		***243***
	bodily	89	89			10			1	6				5							2			202
Physical	energy		1					1		8														10
well-being	*total*	**89**	**90**			10		1	1	14				5							2			**212**
	control	21	3	10	10	8		1			5			7			1							66
	privacy	39	8			1		3						2										53
Proxemics	*total*	***60***	***11***	*10*	*10*	*9*		*4*			*5*			*9*			*1*							***119***
	accessibility	1	3	18						2			1											25
	adequacy	3		1					17							5			1	1				28
	quality	17		4				1					12				3							37
Satisfaction	*total*	***21***	*3*	***23***				*1*	*17*	*2*			*13*			*5*	*3*		***1***	***1***				***90***
	ambiance	2			1						8				1								3	15
	stimulation			32				1	4															37
	anticipation			8				9															1	18
Pleasure	*total*	*2*		***40***	*1*			***10***	*4*		*8*				*1*								*4*	***70***
	tolerance	7	2				6	2				14												31
	connectednes	6	1									2						7						16
Social	*total*	***13***	*3*				*6*	*2*				***16***						*7*						***47***
	neatness	8								8					13	1							2	32
	style	1						1			2												6	10
Aesthetics	*total*	***9***						*1*		*8*	*2*				***13***	*1*							*8*	***42***
	evocation	5	1	5	4		1					2	1		1								1	21
	symbolism	4	2			1		3				2	1											13
Association	*total*	***9***	*3*	***5***	*4*	*1*	*1*	*3*				*4*	*2*		*1*								*1*	***34***
TOTAL		**255**	**115**	**82**	**55**	**45**	**42**	**41**	**23**	**44**	**19**	**27**	**22**	**16**	**16**	**10**	**12**	**9**	**1**	**1**	**4**	**5**	**13**	**857**

In order to uncover the main contributing context features to each theme of passenger's comfort experience, the data displayed in Table 3-3 was examined in order to isolate two features that

were mentioned the most within each theme. Some themes were found to share their underlying features, for instance legroom is salient in eliciting a perception of ‘physical wellbeing’ as well as ‘proxemics’. In total seven features were isolated two of which differed from those seven features mentioned earlier in Step 2. The features activity and noise (28% of all comments, n=43 each) were now omitted and two other features namely neighbour and hygiene are added. The reason is that in the theme ‘peace of mind’ (n=243), the number of comments on activity (n=25) and noise (n=35) were less than those on seat (n=52) and temperature (n=40). On the other hand, two context features namely neighbors (n= 16) and hygiene (n=13) that were not listed among the most mentioned features across participants had substantial impact on the themes ‘social’ (n=47) and ‘aesthetics’ (n=42), respectively.

The above result shows that relying on the number of comments across all themes does not capture particular aspects of passenger’s comfort experience effectively and the features corresponding to each theme should be generated independently within that theme. This information is especially useful when there is a need to improve the ‘social’ or ‘aesthetics’ aspect of passenger’s experience in an aircraft, for instance in the business and corporate jets that transport fewer passengers who spend a significant amount of time socialising in a special seating arrangement and have particular aesthetics and styling demands.

Figure 3-2 illustrates above relationships by linking each comfort theme to the two features with highest comments within that theme. The percentage of these comments within the relative theme appears on the connecting lines. For instance, in the theme ‘physical wellbeing’ (n=212), 42% (n=89) of all comments were concerned with the seat while another 42% (n=90) of them were related to the legroom.

The association of some features such as seat, IFE, service, and legroom with more than one theme in Figure 3-2 implies that different characteristics of these features could generate different perceptions. For instance, the seat influences ‘association’ theme by providing a familiar experience such as sitting in the lobby of a hotel due to the particular form or material of the seat. This is different from its impact on the ‘social’ theme due to facilitating a social interaction, for instance a couple could feel more comfortable by removing the armrest and creating a more intimate space. The impact of the seat on ‘satisfaction’ results from the adequacy or accessibility of the provided adjustment system or the quality of its material. The shape, colour or the clean

look of the seat contributes to the ‘aesthetics’ perceptions, whereas passenger’s ‘peace of mind’ could be altered when the seat provides small compartments for storage of personal belongings hence creating a sense of being prepared. The influence of the seat on ‘physical wellbeing’ is related to accommodating bodily needs such as a neutral posture while its association to ‘proxemics’ is linked to a sense of control provided by various options for personalisation or a sense of privacy provided by proper separation from neighbours.

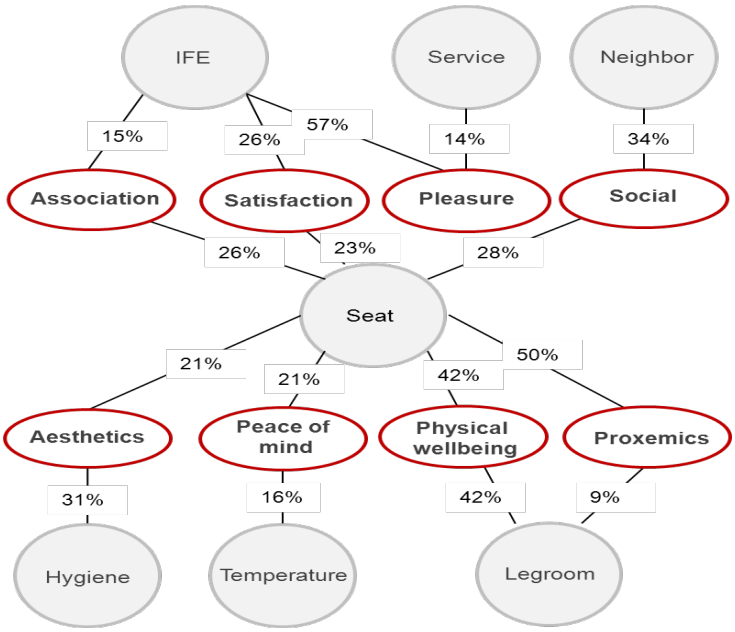

Figure 3-2. Each of the eight comfort themes is linked to two context features that dominated the comments within that theme. The percentage of the comments received for each feature within the theme is shown on the line connecting them

Figure 3-2 clearly depicts the need for creating a harmony between different themes of the flight experience as they seem to be interconnected through the impacting features. The results showed that several themes could share a feature to be prominent to their effect, but a closer look at the data made it clear that these themes do not share the same characteristics of those features. This means that not only there are often more than one way to manipulate a certain theme and consequently the passenger’s experience, but that those changes also need to be carefully targeted in order to be effective.

3.2.7 Discussion on Study One

The analysis performed in Step 1 gives a comprehensive description of passenger's perceptions in relation to comfort experience during the flight by recognising its experiential and contextual aspects. These perceptions are categorised in eight themes and some, such as 'peace of mind' and 'physical wellbeing', received higher regards compared to others. The result of Step 2 provides a list of 22 context features that contribute to these themes. These could be put into three categories namely environmental features, passenger's activity and social features (i.e. neighbours and crew). The environmental features could be characterized as ambient (temperature, noise, light, air quality, and pressure) which are fast changing features, dynamic features (turbulence, ingress/egress, IFE, service) and spatial features (seat, legroom, cabin layout, window, lavatory). The names of the inputs are adopted from Richards (1980).

As mentioned in the introduction, a systematic structure clarifying passenger's experience was lacking in the literature resulting in ambiguity in the attempts to enhance this experience. Step 3 of this study established the relationship between the themes of passenger perceptions in relation to comfort and the context features impacting them. These relationships describe how the context features are translated into passenger's actual experiences. When the data were examined for the features that were mentioned the most within each theme, seven features were isolated and paired two by two in association with each theme. It was noticed that this list is different from that introduced earlier in Step 2 in two features. The reason is the local selection strategy adopted in Step 3, i.e. selecting a feature based on its local impact within a certain theme as opposed to its impact over all the themes. Thus, while the context features generated in Step 2 were comparable to previous studies such as Richards (1980) and Vink et al. (2012), Step 3 showed that the most frequently mentioned features overall do not necessarily influence all themes effectively.

Moreover, certain features were found to have multiple impacts on comfort themes. We showed that a single feature, such as seat, could provide various experiences due to its diverse characteristics. This could inform the decision-making process when there are limited resources to allocate to design improvements. In that case the features which tackle most themes and bear grander impacts need to be given higher priorities. On that note, the theme 'proxemics' requires particular attention especially since its association with passenger comfort has not been discussed

in previous literature. This theme introduces the perception of control and privacy to the concept of passenger comfort experience.

The physical proximity of passengers to one another for a period of time leaves them to crave more autonomy and recognition of personal space by others. Hall (1966) indicated a clearance distance of 0.45m from one's body to others' as an optimum personal space, i.e. perception of personal space rather than physical fit. The knee-buttock depth of international population (male and female mixed) is measured as 0.56m (SD=0.064) (DINED anthropometric database; Delft University of Technology, 2014). This value is readily higher than (and therefore contradicts) Hall's recommended personal space. DINED database introduces a hip breadth of 0.35m (SD=0.052) and shoulder breadth of 0.41m (SD=0.052) for the international population. The legroom space in economy class of modern aircrafts commonly ranges between 0.71 and 0.83m and the seat pan width 0.43 and 0.47m (Bombardier Aerospace, 2013). The above measurements suggest that the fit of the body in the aircraft seats is most likely to result in a free lateral space of <0.45m between two adult passengers. So, while the currently available leg space in aircraft's economy class theoretically caters to both Hall's and anthropometric demands, the average lateral distance between two passengers falls short to recognise those guidelines on personal space.

Given that most commercial aircrafts today practice a seating arrangement that does not allow single seats but rather combinations of two or three seats in a row, it seems implausible to expect airlines to offer more lateral space. Perhaps this constraint could be compensated through other solutions that gives passengers a feeling of privacy such as better separation between the seats (which constitutes 50%, n=60 of comments in the 'proxemics', n=119) to avoid physical contacts or offer more options for controlling and adjusting the immediate space such as through IFE.

The challenge in employing the eight introduced themes to enhance passenger's comfort experience in a given context is to first verify the themes with higher significances by investigating the characteristics of the given aircraft. Although we showed the higher priority for 'peace of mind' and 'physical wellbeing' for commercial aircrafts, it is quite possible that the order of other themes change due to specific situational variables. Depending on the themes that need to be improved and the resources available by the industry/airline, the themes and context features introduced in this study could be applied to practice numerous opportunities to reinforce passenger's comfort experience in an optimum way. It must be noted, however, that there are

some limitations in the scope of this study, in that it was not attempted to make further distinctions between the comfort experience corresponding to different classes (e.g. economy, business, first) or flight durations (as was previously addressed by Vink et al., 2012). Therefore, the results are expected to be valid for economy class mainly. This necessitates an investigation of the correlations of those factors with comfort themes and with larger sample in future research.

3.2.7.1 The model of passenger's comfort experience

The findings of Study One are used to illustrate the underlying process of aircraft passenger's comfort experience in a model, shown in Figure 3-3, consisting five elements of which those marked by dashed boxes are not particularly investigated in this paper. The inputs to the process include human characteristics and context features. Human characteristics are passenger's socio-economical state, expectations formed prior to the flight or passenger's physical and psychological state. These characteristics were discussed previously by Richards (1980). A level of comfort results from passenger's interaction with context features (e.g. environmental, social) during the flight, performing certain activities, experiencing certain physical and bodily impacts (e.g. various pressures, the felt temperature) and subsequently forming certain perceptions (characterised by eight themes).

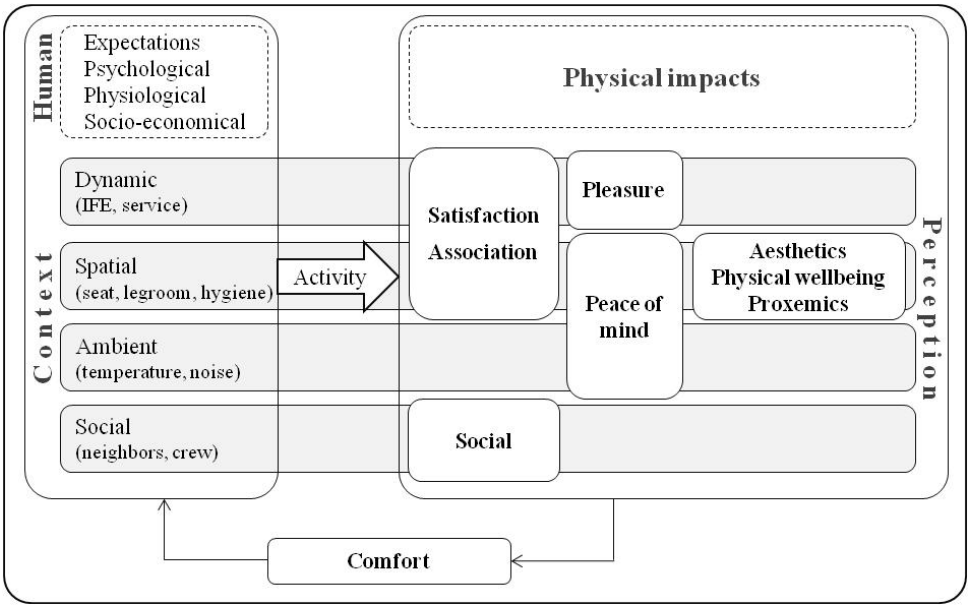

Figure 3-3. Passenger comfort experience model; portraying the relationship between the contextual features in the aircraft interior, passenger's perceptions of those and comfort as the result.

The model highlights the subjective nature of comfort by conceptualising it in relation to a person's perception of the context. Using the data from Study 1, the eight themes of passenger's perception are linked and positioned in relation to the context feature categories that are most likely to influence them. For instance, 'pleasure' is placed on the same level as dynamic features due to the impact of IFE and services in this category on it. Moreover, the model depicts spatial features (such as seat and legroom) as the central determinants of several themes (e.g. 'proxemics', 'aesthetics', 'peace of mind', to name a few) introducing them as imminent features for impacting various aspects of comfort experience. As portrayed in the model, those spatial features along with dynamic features account for the most diversity in passenger's perception, given their links to seven (out of eight) themes.

The passenger comfort experience model connects comfort to the inputs of the process with an arrow which is justified from two stand points. First, the dynamic nature of the flight experience could potentially change passenger's comfort whenever a change occurs in any of the context features and thus it is important to acknowledge those variations. Second, the comfort that is experienced during a flight influences passenger's future expectations and consequently comfort experiences and the arrow acknowledges this impact as well.

The results of Study 1 provided a novel insight into passenger's perceptions related to comfort experience by giving operational definitions for their themes in the context of flying, prioritising them based on the frequency with which these themes generated a comfort experience in passengers' reports and associating them with their eliciting features. Consequently, 'peace of mind', underlying the psychological aspects in relation to comfort, achieved the highest remarks while the physical aspects of comfort, reflected in the theme 'physical wellbeing', appeared only after that. This suggests that the psychological aspects of passenger comfort are as important (if not more) as the physical aspects of it. Interestingly, the two themes shared a spatial feature, namely, seat, as their eliciting feature although in relation to different effects (see Figure 3).

It should be noted that every passenger finds only some of the features in the aircraft cabin to influence their experience due to their physical capacity (De Looze, Kuijt-Evers, Van Dieen, 2003) and personal preferences. This means that a limited number of factors in the cabin are likely to impact a particular person's experience in idiosyncratic ways. Indeed, future research

should provide more detail about the relationship between subjective aspects of passenger comfort experience and context features.

3.3 Study 2

3.3.1 Procedure

A team of aircraft interior designers was invited for a workshop session. They were informed that the result of the session will be used for a doctorate research. A presentation was made on the eight comfort themes, their succeeding groups and definitions, as well as the 22 context features generated in Study 1. There was no reference to numbers or priorities of these themes and features and only operational descriptions along with some relevant examples were presented in a random order to ensure that a common understanding was achieved in the team. The team was then given three tasks as follows: (1) providing a rank order of the comfort themes based on their importance for the design of an aircraft interior, arbitrarily named AB1[3], with given specifications, (2) choosing five context features that are generally important for the design of that interior and (3) providing two context features that are most influential in association to each of the eight comfort themes (given that a feature could be repeated).

3.3.2 Material

The participants were given a slide presentation by the main researcher and each was provided with a list of the three tasks to perform.

3.3.3 Participants

Convenience sample of eight participants was obtained. All participants were educated, with university degrees in industrial design, and all were working in the same team designing the cabin interior for an aircraft manufacturer (that could not be named for confidentiality purposes). Seven of the participants were male. The participants were 28-40 years of age (M = 33, median 32 years).

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[3] Any reference to the aircraft type and its interior is prohibited by confidentiality agreement.

3.3.4 Results

The mean rank and SD of each theme was calculated as the result of task one and they are presented on the left side of Table 3-4. The theme ‘physical wellbeing’ is ranked the highest (mean rank=2, SD=1.3) indicating it as the most important aspect of the comfort experience for that particular design task. The least importance was given to the ‘social’ theme (mean rank=7.3, SD=0.7), while in Study 1 it was placed before ‘aesthetics’ and ‘association’. The table also shows that the theme ‘proxemics’ was given less importance than ‘pleasure’ and ‘satisfaction’ by designers, whereas the results of Study 1 highlighted ‘proxemics’ as more important than those two themes. Moreover, the relatively higher values of SD for ‘pleasure’, ‘proxemics’ and ‘association’ (compared to other themes) indicate the dispersion of opinions about the importance of these themes for passenger comfort.

The result of task two yielded eight features as being highly influential. The seat received the maximum number of mentions (n=7) whereas five features, namely, cabin layout, turbulence, activity, temperature and service received equal number of mentions (n=3). Consequently, it was not possible to isolate exactly five features for this task (as intended) due to the diversity of results. A comparison of the eight mentioned features to those introduced in Section 3.2.6.2 elicited from passengers’ reports indicates that the feature legroom is completely overlooked by the interior designers and replaced by cabin layout and turbulence.

The results of the third task are presented in the right column in Table 4. A number of context features were assigned to each theme by the designers and those that were mentioned most frequently in relation to a theme are specified in the table (the frequency of mentions is indicated in front of each feature). The results pinpoint two context features per each of the five themes, ‘physical wellbeing’, ‘peace of mind’, ‘proxemics’, ‘aesthetic’ and ‘social’, while the comments associated with the other three themes were more diverse yielding three to four features for each. These links were compared to Study 1. It is observed that only the features attributed to ‘physical wellbeing’, i.e. seat (n=6) and legroom (n=3), were similar to those in Study 1. The only other associations for the seat are ‘pleasure’ (n=2) and ‘aesthetics’ (n=3) which are not as strong as its link to ‘physical wellbeing’. That marginalises the impact of the seat to only three themes, whereas the findings in Study 1 connected it to seven (out of eight) themes with an exception of

'pleasure'. This comparison suggests that the diverse influence of this feature on passenger's comfort experience is not fully appreciated by designers.

Table 3-4. Results of the three tasks performed by interior designers

Mean rank of each theme (1 to 8)±SD	Theme	Context features associated with each theme (N of mentions)
2.0 ± 1.3	Physical wellbeing	Seat (6) Legroom (3)
2.8 ± 1.3	Peace of mind	Temperature (3) Noise (3)
3.6 ± 1.5	Satisfaction	Legroom(2) Service (2) In/Egress(2)
4.0 ± 1.9	Pleasure	Activity (3) Seat (2) IFE (2) Food (2)
5.1 ± 2.3	Proxemics	Neighbor (2) Cabin layout (2)
5.3 ± 1.5	Aesthetics	Cabin layout (5) Seat (3)
6.0 ± 2.6	Association	Cabin layout (3) Service (2) Information (2)
7.3 ± 0.7	Social	Cabin layout (3) Crew (3)

Furthermore, Table 2 shows that in each of the themes 'peace of mind' and 'aesthetic', the two studies shared only one attributed feature (temperature and seat, respectively) and in theme 'pleasure' they shared one attributed feature (i.e. IFE) out of the four features stated by the designers. Finally, the features linked to the themes 'social', 'satisfaction', 'association', and 'proxemics' by designers were not shared by the opinion of passengers from Study 1 at all. For instance, Study 1 highlighted IFE and the seat as contributors to the theme 'satisfaction' while designers linked it to three other features, namely, legroom, service, and ingress/egress. These comparisons put the latter four themes at complete odds with Study 1. Overall, there is little agreement between the two studies in this task. This is discussed further in Section 3.3.5.

3.3.5 Discussion on Study Two

The study performed with aircraft interior designers bears a limitation. The aircraft interior addressed in the three tasks performed by the team of designers may be very different from those experienced by the participants in Study 1. Nonetheless, this difference is more likely to be caused by the latent weight of each comfort theme rather than their integral part in shaping passenger's comfort experience. The type of aircraft in addition to the situational or contextual elements that are put in place by an airline could potentially generate various levels of comfort experiences (i.e. the balance of themes) but this study showed that the assembly of the introduced themes is mainly relevant to most flight contexts. To some extent, this justifies the discrepancy between the rank order of the themes and context features in Study 1 and those elicited from the first two tasks in Study 2. However, this is not the case for the results of the third task performed in the latter study.

The context features that were associated with each comfort theme by the designers give three indications. First, there is a low level of coherence between the two studies in that regard. This is unlikely to be due to the particular characteristics of AB1 interior but rather how the themes are generally understood by each designer.

An example is 'proxemics' which designers translated into lack of personal space. Consequently, it received a low level of priority as it was attributed to the predetermined number of seats in the cabin layout and the inevitable inter-personal (and possibly intruding) interactions in the social context of the flight. However, the definition of 'proxemics' in terms of control and privacy offers a new perspective on the impact of seat design, differentiates it from the social aspects and emphasises on the passenger as an individual. The cabin interior design often addresses a group of passengers in a designated space by incorporating their physical characteristics and this necessitates a high degree of generalisation. 'Proxemics' outlines *a passenger*, not only as a member of a larger group, but also as a person whose individuality and space must be recognised on its own. Observing passengers' activities and behaviours during the flight and stereotyping their use of personal space should be considered for improving proxemics experience. Similar misconception is observed regarding 'social' theme which was assigned the lowest rank because the service (provided by the airline) and social interactions were viewed inaccessible through the cabin design. However, Study 1 showed that seat design could improve this aspect of the

experience when different scenarios for passenger's social interactions are considered (e.g. accommodating preferences of passengers who travel single, with family or in groups).

Second, some divergence is observable among the mentioned features that address a theme. The theme 'pleasure' was associated with four different features among which only one was similar to Study 1. This might be due to lack of prior communication among the team members and lack of a common understanding of the experiential aspects of passenger comfort. One potential application for the passenger comfort experience model and results of Study 1 is to create a means of communication among the members of a design team. The challenge in doing so is to quantify and organize the correlation of context features with the themes for a given aircraft type. This should be considered for future research.

Third, the role of seat as a highly influential feature on passenger comfort is not acknowledged in the responses given by designers. Study 1 associated the seat with seven comfort themes leaving out the theme 'pleasure'. The results of Study 2 confirmed the link between the seat and 'physical wellbeing' and 'aesthetics' among those seven themes, and added the theme 'pleasure'. Furthermore, Study 1 emphasized that the impact of seat on passenger's experience is beyond its apparent effect on 'physical wellbeing' and extends to passenger perceptions such as 'proxemics' and 'peace of mind', to name a few, whereas the evidence from Study 2 suggests that the capacities of this feature for mediating various impressions are not fully appreciated in practice. Although issues related to cushion firmness, pressure distribution and bodily postures are commonly studied and practised in seat design to improve 'physical wellbeing', other competences of this feature, e.g. offering control and privacy ('proxemics'), satiation and security ('peace of mind') or facilitating social interactions, need to be acknowledged as well. This could only be achieved when passenger's interaction with the seat is considered in the temporal, social and dynamic context of flight. .

Finally it must be noted that Study 2 is conducted with a small sample of participants who were all members of the same team. Comparing the result with that of another team could offer new insight into the design practice and the opportunities for employing passenger comfort experience model. Nevertheless the indications of this study manifest a need for a unified design framework to inform communications, product development and evaluation of passenger comfort experience

in aircraft interior. Study 2 implies that the eight themes and their relationship with context features could provide such framework.

3.4 Conclusion

This paper affirms that passenger comfort experience during the flight essentially involves physical, physiological and psychological elements. However, due to the lack of more specification in the literature, this paper attempted to conceptualise passenger's perception of the contextual features that are relevant to a feeling of comfort. As a result, passenger comfort is configured through the thematic structure of contextual perceptions and their eliciting features.

Modern aircrafts today provide a level of comfort by meeting the design standards that incorporate passenger's physical health and safety issues. The two studies presented in this paper suggest that future design efforts should go beyond prevention of adverse health issues by enhancing the perception of 'physical wellbeing' in terms of bodily support and energy; 'peace of mind' to provide security, tranquility and relief; 'proxemics' by acknowledging passenger's privacy and autonomy; 'pleasure' by providing stimulation while maintaining passenger's 'satisfaction' with the quality and adequacy of the environment. It was shown that the 'aesthetics' impression need to be addressed in terms of neatness and style and that the cabin interior design should facilitate 'social' interactions in order to improve comfort experience. In addition, it was shown that the interior design could evoke an 'association' with symbols, memories and other familiar experiences outside the aircraft and comfort could be experienced if those associations have positive or comforting significance for the passenger.

The paper also unfolds the link between passenger's perceptions (i.e. comprising eight themes) and their eliciting context features. It is shown that some features have more pronounced impacts on certain themes and thus to improve comfort effectively, it is vital to pay particular attention to the underlying features of each theme. A study with a group of aircraft interior designers provided positive feedback on implications of the above-mentioned finding for evaluating the comfort of cabin concepts. Future research should address the inter-relationship between these themes and features with more detail.

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CHAPTER 4 ARTICLE 2: AIRCRAFT PASSENGER COMFORT EXPERIENCE: THEMES VALIDATION AND DIFFERENTIATION FROM DISCOMFORT[4]

Abstract

Aircraft passenger comfort has become an important concern for the aerospace industry and a competitive edge for airlines in recent years. We previously defined passengers' comfort experience through their context-dependent concerns and a set of underlying experiential themes such as 'peace of mind', 'physical wellbeing', 'pleasure', etc. Those themes represent passengers' perception of the contextual inputs (e.g. physical, social) during the flight and once balanced favorably, result in an experience of comfort. One objective of this research was to validate those themes. Another objective was to determine the degree to which the experience of comfort might differ from discomfort in terms of their defining themes. In the first study, written accounts of passenger comfort and discomfort experiences were collected separately and followed up by interviews in order to capture their highly personal and subjective nature. The theme 'pleasure', denoted by one's concern for stimulation, ambience, and exceeded expectations, was found to be particularly salient in reports of enhanced comfort experience while the theme 'physical wellbeing' characterized as a sense of bodily support and energy, was highly influential on discomfort. However, no significant difference were found between the other underlying themes of comfort and discomfort; implying that both could be described or evaluated using the same set of themes. It also suggests that the evaluation of overall passenger comfort experience, as a whole, should employ one spectrum ranging from extreme comfort to extreme discomfort and correlated. This result rejects the need for employing separate rating scales for addressing passenger comfort and discomfort. In study two, seven comfort themes were clearly validated using their core descriptors with an exception of 'proxemics' (concerning one's privacy and control over their situation) but it was argued that this is due to the nature of the theme itself, which is generally perceived and acted upon by the unconscious mind.

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4.1 Introduction

Although researchers have been investigating the construct of passenger comfort since the 1970s (Richards, Jacobson, Kulthau, 1978), the concept is still poorly understood. To date, only few publications are concerned with the subjective experience of aircraft passengers during a flight. Vink et al. (2012) studied the impact of several environmental factors on passenger comfort during the flight, and though not directly linked to comfort, Chen (2008) investigated passenger satisfaction in terms of service quality, perceived value and behavioral intention. A comprehensive definition of passenger comfort as a subjective personal construct and as part of the flight experience is thus still lacking. Comfort, as a general phenomenon, has been conceptualized mainly as a subjective experience that involves physical, physiological and psychological harmony between a person and their environment (de Looze, Kuijt-Evers, van Dieën, 2003). Moreover, Vink et al. (2005, pp. 16) noted, "it is unknown how the environment influences the comfort experience". Likewise, unfolding passengers' experience of the flight environment would seem to be an important consideration when proposing a definition of comfort in flight contexts. In some context-specific research, such a definition of comfort is delivered through a number of descriptive factors of the subjective experience. For example, Kuijt-Evers et al. (2004) identified six comfort factors of hand tools including functionality (described in terms of being easy to use, reliable, etc.), aesthetics (described in terms of styling, nice color, etc.) and so on. Following that line of research, we introduced eight themes (i.e. factors) of passenger comfort in an earlier study (Ahmadpour et al., 2014a). These themes, explained briefly in section 4.1.1, formed the basis for the present research. One objective of this paper was to validate those themes and their underlying descriptors empirically.

The notion of comfort naturally entails discomfort. As a consequence, attempts to differentiate the two have resulted three main lines of argument. The first, an operational definition based on archival studies, holds that comfort and discomfort are two discrete states in the sense that comfort is the absence of discomfort (Hertzberg, 1972). This introduces comfort as a neutral state, which does not entail a positive effect such as pleasure. The second line of argument considers comfort a bipolar phenomenon whereby comfort is positioned at the extreme positive end, and discomfort at the extreme negative end of a continuum with a neutral point at the center of the scale. According to that argument, extreme comfort is only achieved when there are more

positive effects than expected (Vink et al., 2005). Along similar lines, Richards et al. (1978) argued in favor of developing a continuous scale for evaluating several degrees of passenger comfort. Although they provided no empirical support for the argument, Richards (1980) asserted that the fact that passengers rated comfort across the entire continuum offers evidence that comfort comprises the positive state of a bipolar dimension.

The third line of argument holds that comfort and discomfort are two different entities, which are influenced by different variables and thus should be quantified independently (Helander and Zhang, 1997; Helander, 2003; de Looze et al., 2003). Consequently that view rejects the use of a single scale for evaluation of comfort and discomfort, proposing instead to use separate scales for each. In a series of empirical studies, Helander and Zhang (1997) showed that users perceived chair comfort in relation to factors such as aesthetics, relief, wellbeing and relaxation, while discomfort was related to fatigue, restlessness, pain and stress. Helander (2003) suggested that comfort and discomfort should be examined with a view clearly to differentiate the two in comfort studies, in particular studies that involve sitting comfort. This applies to passenger comfort since experience in the aircraft interior is highly influenced by, although not limited to, the seat. Passengers spend several hours seated in aircrafts while they are also exposed to numerous other stimuli (e.g. social, environmental, and physical). It is reasonable to assert that the research should be expanded to incorporate additional aspects of passenger comfort. A second objective of this study was therefore to examine the possibility of differentiating factors underlying passengers' impression of comfort from discomfort in the aircraft cabin. The background and principal assumptions for this research are discussed next.

4.1.1 Background

In a survey conducted earlier (Ahmadpour et al, 2014a), a sample of 155 passengers submitted their trip report related to a recent flight in which they described their experience of comfort in the aircraft cabin during the flight. A set of eight descriptive themes of comfort experience (corresponding to 19 groups of passenger concerns) emerged from the analysis and summarized in Figure 4-1. The implication is that passengers hold certain concerns about their flight experience, which, once satisfied, deliver certain thematic experiences that lead to a state of comfort.

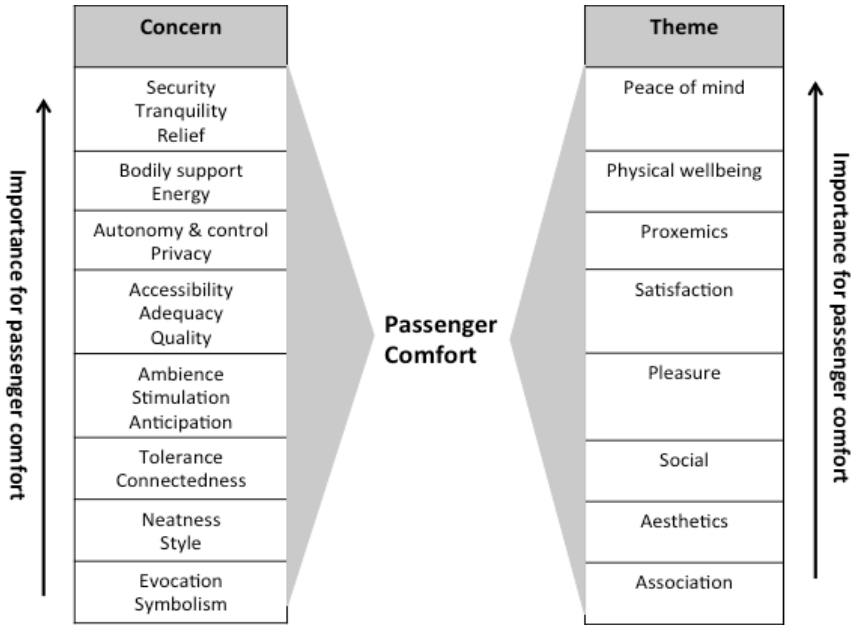

Figure 4-1. An overview of passenger comfort themes in relation to their concerns (Ahmadpour et al., 2014b)

The themes ‘peace of mind’ implicates a state of psychological ease and corresponds to concerns for security, tranquility and relief. ‘Physical wellbeing’ indicates the physical aspect of comfort concerning bodily support and energy. ‘Proxemics’, previously introduced by Hall (1963) in the field of environmental psychology, is defined in relation to concerns for autonomy, control, and privacy that the passengers potentially achieve within the limits of their seat in the aircraft. ‘Satisfaction’ represents an experience of gratification once concerns for accessibility, adequacy, and quality of design are fulfilled. ‘Pleasure’ is reminiscent of a joyful experience concerning cabin ambience, the stimulation offered to the passenger and the level to which their anticipations are exceeded. ‘Social’ is the between-person experience of passengers in the aircraft concerning their tolerance for others’ behaviors and attitudes as well as empathy (i.e. connectedness) towards them. ‘Aesthetics’ refers to the sensory pleasantness offered to the passenger in terms of the neatness and style. Finally, ‘association’ is concerned with evocation of familiar memories and symbolism. The themes and concerns, respectively ordered in Figure 4-1 from the most to the least importance based on the frequency with which respondents referred to them, are examined and validated in this paper.

The results showed that some passengers described their comfort experience in terms of positive impacts while others referred to the absence of negative impacts. For instance “[...] I feel

comfortable when I have some space around. I don't like to have physical contact with my neighbor due to the interior or the seat being too small […]". In this example it is not clear whether the passenger evaluates comfort on account of privacy in its own right as a positive experience or with regard to the absence of discomfort due to lack of privacy. These kinds of statements raised the question of the need to differentiate passenger comfort and discomfort. The present study also attempts to highlight possible differences between the two concepts.

4.1.2 Research approach

The research was conducted in two studies. Study One explored differences between an experience of comfort and discomfort. Study Two aimed to validate the passenger comfort themes and establish a set of underlying descriptors.

4.2 Study One: differentiating the passenger comfort and discomfort experience

4.2.1 Method

A questionnaire comprising seven questions was designed. It included five demographic questions about age, gender, height, disability, and number of previous flights in total (never/1-5 times/more than 5 times) followed by an open-ended question prompting respondents to describe (in detail) one flight experience characterized by a sense of comfort, and the other by a sense of discomfort. The question focusing on discomfort was presented first, as the pattern of responses in a previous survey study had revealed a tendency to begin reports with negative accounts of their experience. Next, a list of the eight comfort-related themes was presented along with a short (operational) definition of each. Using a 5-point scale (1 being slightly influential, to 5 being highly influential), respondents were asked to identify the degree to which each theme had influenced their respective sense of (dis)comfort of the experiences just described. Finally, a blank section invited them to add and rate additional influencing theme not included in the list.

A convenience sample of 27 participants (12 female), all aged 18-55 years (18-34, n = 20; 35-55, n = 7), with average height of 174 cm (median=176 cm) was recruited through personal contacts in Montréal, Canada. All participants had university education. Everyone had more than five flight experiences and all agreed to share information about two flights undertaken within the

past two years. Of the 54 reports, 44 involved long flights (> 4hours) and the rest were short haul flights. Each participant received an email with a link to the online questionnaire and the informed consent form. They were told that they would be contacted for follow-up interviews after completing the survey. All responses were collected in two weeks. Once a report had been submitted, the first author contacted the respective respondent for an interview held at their work place or school.

To begin the interview that followed completion of the questionnaire, each respondent was given the following definition of comfort: 'a pleasant state of wellbeing, ease, and physical, physiological and psychological harmony between a person and the environment'. The following definition of discomfort was also provided: 'a state where one experiences hardship of some sort which could be physical, physiological or psychological' to ensure a common understanding of the two concepts. Moreover respondents were asked to specify the duration of their flight for each experience report. The respondent was prompted to give more information about the reported flights along with their feelings, physical state, intensions, and reactions to the environment and social situations. Adopting the laddering technique, the researchers asked "why" in response to every statement about an aspect of the flight in order to capture the motives behind it (Jordan, 2000) until she had gained an understanding of the underlying themes of each experience. At the end of the interview, the respondent reviewed their earlier ratings and was asked to provide additional information to justify them.

4.2.2 Results and analysis

The survey and interview transcripts from each respondent were merged and then analyzed in two steps. In the first step, we assigned themes to the comfort and the discomfort transcripts (in similar manner as the previous study) separately and then assessed the consistency between those and participants' ratings in each report. In the absence of significant differences between them, we assumed that the ratings did, in fact, capture passenger experiences and could be used as a basis for differentiating comfort and discomfort. In the second step, we looked for significant differences between the ratings from the comfort and the discomfort experiences.

In the first step of the data analysis, each report transcript was divided into several comments. This yielded a total of 269 comments (137 related to comfort; 132 to discomfort). Next, these were sorted by topic and arranged into the set of 19 semantically different concern groups

identified in a previous study (see section 4.1.1) and then placed into the eight themes and summed. For instance, the comment "A group of people were partying and drinking, making loud noises which I found quite disturbing" in a discomfort report was associated with social tolerance concern in social theme. The results are shown in Table 4-1 in which the number of comments received on each theme within comfort and discomfort reports are displayed separately and the mean (SD) of the ratings of the same theme is reported next to them. The total sum of comments (plus their percentage across comments) is reported in the forth column. Table 4-1 shows that the number of comments and the mean rating of 'pleasure' were higher for comfort than for discomfort, and that the reverse was true for 'physical wellbeing'. This indicates 'pleasure' to comfort. 'Peace of mind' was equally important to both comfort and discomfort, being rated the second highest in both states (see column two and four in Table 4-1).

Next, an arbitrary rating was assigned to the themes elicited from report transcripts whereby the presence of a theme was rated 1 and its absence 0. A Wilcoxon signed rank test was performed and the results indicated that the ratings assigned to the comfort and discomfort themes are not significantly different from ratings given by respondents.

Table 4-1. Number of comments and mean ratings (SD) for comfort, discomfort and total (% across all comments) generated from the survey on the flight experiences followed by semi-structured interviews.

Themes	Comfort comments N	Mean ratings (SD) in comfort (1-5)	Discomfort comments N	Mean ratings (SD) in discomfort (1-5)	Total N (% across all comments)	Total Mean (SD) comfort and discomfort (1-5)
Peace of mind	26	2.9 (2.2)	28	3.4 (1.5)	54 (20)	3.2 (0.3)
Physical wellbeing	16	2.1 (2.1)	37	4.0 (1.5)	53 (20)	3.1 (1.0)
Satisfaction	15	1.6 (1.8)	20	2.1 (2.1)	35 (13)	1.9 (0.3)
Pleasure	28	3.0 (1.9)	6	0.6 (1.3)	34 (13)	1.8 (1.2)
Proxemics	20	2.3 (2.2)	16	1.6 (2.0)	36 (13)	2.0 (0.4)
Social	13	1.5 (1.9)	17	1.9 (2.2)	30 (11)	1.7 (0.2)
Aesthetics	12	1.2 (1.8)	5	0.5 (1.3)	17 (6)	0.9 (0.4)
Association	7	0.8 (1.4)	3	0.3 (0.8)	10 (4)	0.6 (0.3)
Total (% across all comments)	**137 (51)**		**132 (49)**		**269**	

In the second step, a Wilcoxon signed rank test was performed on respondents' ratings to examine if comfort and discomfort were rated differently within each theme. The results revealed significant differences only for 'physical wellbeing' and 'pleasure' (both $p<0.001$). Similar to the previous step, 'pleasure' was highlighted as being more relevant to comfort while 'physical wellbeing' was more related to discomfort. This trend implicates that comfort is greatly reduced

in the presence of negative physical conditions, while an experience of joy enhances passengers' experience of comfort. However, due to the complex and dynamic context of a flight, experience of comfort and discomfort are not limited to these two themes but involve six other themes that would influence both states in similar ways. This result refutes the argument that passenger comfort and discomfort are two independent entities, suggesting that the concept of passenger comfort (underscored by eight themes) is a holistic concept, ranging from comfort to discomfort experiences.

Following the above result, comfort and discomfort comments were combined for each theme; semantically similar comments were eliminated. This yielded 161 idiosyncratic descriptors, i.e. describing an aspect of comfort. Differentiating descriptors for each theme on long and short-haul flights showed that all themes could apply to both flight lengths.

4.3 Study Two: validating passenger comfort experience themes

4.3.1 Method

A literature review was conducted to identify comfort descriptors not already included in the set of 161 items from Study One. This was followed by two independent sessions of brainstorming to assert the comfort requirements from experts in the field of manufacturing aircraft interiors at Bombardier Aerospace in Montréal (Canada). In order to organize the ideas and define descriptors with a natural relationship to the concept of passenger comfort, a technique called "affinity diagram" was used (Foster, 2010). The brainstorming topic was introduced as "what are the aspects of the experience that make passengers comfortable?" in response to which participants wrote their ideas on post-it notes and stuck them on the wall. Following a discussion of the contents, they organized the ideas into groups and subgroups. The first session included eight members (6 male) of an industrial design team. The second session included five participants, two of whom were from the customer relations group, one from human factors and one from the advanced design group at Bombardier Aerospace. They were not informed about the results of the first session. The results of each session were compared to the initial inventory of 161 descriptors from Study One in order to potentially add new items to it.

The next step included removing those descriptors less relevant to comfort from the inventory. A convenience sample of 27 participants (20 male, 25-61 years of age, M=37, median=32) was

recruited. In a questionnaire including all descriptors, respondents were asked to indicate the relevance of descriptors to passenger comfort on a 3-point scale (related, not related and do not know). Items selected as relevant were then used in a subsequent survey in which respondents rated the potential impact of each descriptor on a 5-point scale ranging from no impact to strong impact. A convenience sample of 41 new participants (22 male), 22-58 years of age (M=36, median=33) was recruited for that survey.

4.3.2 Results and analysis

The literature review did not revealed any additional descriptors to the initial pool of 161 identified in Study One. The first brainstorming session with Bombardier experts yielded 113 descriptors, organized into seven comfort groups. These corresponded nicely to the comfort themes (see section 4.1.1) with an exception of the 'social' theme (with respect to a passenger's experience of empathy and their tolerance for behavior/attitudes of others in the cabin). The second brainstorming session resulted in some 63 descriptors consistent with six groups that corresponded to six of the comfort themes with the exception of 'social' (as mentioned above) and 'proxemics' (denoting the experience of privacy while seated and control over surrounding) themes. Once compared to the descriptors from Study One, the experts' insights did not add any additional items.

In the next step, items rated as relevant to comfort by at least 70% (N=19) of respondents were isolated, resulting in 60 descriptors that were used for the next survey where ratings on potential impact of descriptors were obtained. The results were analyzed using a Principal Component Analysis (PCA) with varimax rotation and respondents' ratings on the impact of descriptors on passenger comfort were arranged into eight factors (each with eigenvalue>1), in total accounting for 70.25% of the variance. The eigenvalue for each factor and factor loadings greater than 0.4 (in descending orders) are shown in Table 4-2.

Two descriptors with factor loadings below 0.4 were eliminated. Upon closer scrutiny, seven of the comfort themes clearly matched the emerged factors (as labeled in Table 4-2) except for Factor 6. This factor, expected to correspond to the theme 'proxemics', contained only three descriptors among which only one (i.e. I can store my belongings properly) had an established connection to autonomy and control concerns. Other descriptors, predicted to fall under Factor 6, were distributed among factors labeled 'peace of mind' (e.g. my activity is not interrupted, I am

able to adjust my immediate space to my liking), ‘Pleasure’ (e.g. I feel I have a degree of freedom to make choices), and ‘physical wellbeing’ (e.g. I have no physical contact with my neighbors).

Some descriptors were loaded on more than one factor, in which case they were categorized under the factors to which they matched most reasonably, based on the interview transcripts in Study One to result in a coherent definition to each theme. For instance “*the cabin interior looks clean*” was loaded on both Factor 1, labeled ‘aesthetics’, and Factor 2, ‘satisfaction’. In a previous study (Ahmadpour et al., 2014a), ‘aesthetics’ was operationally defined as a pleasant experiences linked to sensory perception. Therefore it was more appropriate to consider that descriptor in Factor 1. Similar logic applied to descriptors related to temperature and odor that followed, all validating passenger concerns for neatness. The ‘aesthetic’ concern for style was validated by the descriptor regarding visual clutter.

The theme ‘peace of mind’ was validated based on descriptors contributing to concerns for security (e.g. being taken care of), tranquility (e.g. feeling content, satisfied with expectations met) and relief (e.g. feeling relaxed and not restless). ‘Pleasure’ was validated by concerns for anticipation (e.g. pleasant surprises), ambience (e.g. soothing environment), and stimulation (e.g. being entertained). ‘Satisfaction’ concerns for accessibility (e.g. space to stretch legs), adequacy (e.g. controls found effective and easy to use), and quality (e.g. finding the space reasonable) were validated. The theme ‘physical wellbeing’ was validated for concerns with regard to bodily support (e.g. not feeling stiff, not having heavy legs) and energy (e.g. feeling refreshed). ‘Association’ was found validated in terms of evocation (e.g. feeling like sitting in a car) and symbolism (e.g. finding the atmosphere cozy) concerns. Finally the theme ‘social’ was validated through the descriptors that concern tolerance (e.g. the service was courteous) and connectedness (e.g. the ease to interact with other passengers).

Table 4-2. Factor loading (>0.4) on comfort descriptors, resulted from the principal component analysis (varimax rotation)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Eigenvalue	15.20	6.43	4.91	3.81	3.30	3.25	2.83	2.42
Descriptors	**aesthetics**	**peace-of-mind**	**pleasure**	**satisfaction**	**physical-wellbeing**	**proxemics**	**association**	**social**
I feel no fear or have no concern	0.90							
I feel my well-being will be evenly maintained during the flight	0.82							
I do not have sore muscles	0.79							
I find the environment is reliable and trustworthy	0.75							
the space does not feel cluttered	0.67							
The cabin interior looks clean	0.62			0.57				
I am not sensing bad odors	0.55			0.52				
I am feeling nor cold neither hot	0.46						0.52	
I am not restless		0.87						
I feel content		0.76						
I like the interior		0.76						
the interior looks nice		0.72						
My activity is not interrupted		0.70						
the design and service are professional		0.70						
the design is relevant to what I expected		0.67						
I feel satisfied		0.60						
I am able to adjust my immediate space to my liking		0.58						0.60
The cabin's general layout is efficient		0.52				0.45		
I feel relaxed		0.60						
I feel welcomed		0.49						
I am being taken care of		0.49	0.51					
I do not feel pressure on my ears		0.47						
I am not frustrated		0.41			0.42			
I feel like being in a hotel			0.85					
I feel at home			0.72					
I experience pleasant surprises			0.71					
I feel I have a degree of freedom to make choices		0.41	0.68					
I experience none or moderate torbulances			0.65					
I find the surfaces and materials nice to touch			0.63					
I feel entertained			0.60					
the ambiance is soothing			0.60					
I am able to perform various activities			0.55					
I have a luxurious experience				0.71				
I find buttons and controls to do the job effectively				0.70				
I find buttons and controls easy to use with minimized efforts (i.e. do the job efficiently)				0.69				
I am not feeling embarrased				0.54		-0.43		
the designated personal space is reasonable				0.50				
I am able to strech out my legs				0.50				
it is easy to shift or change position					0.74			
I am not feeling stiff					0.66			
I could adapt a relaxed posture					0.65	0.46		
I have no physical contact with my neighbors					0.60			
I do not have cramps					0.60			
I feel refreshed			0.41		0.49			
I am not having heavy legs					0.48			
I am not feeling confined					0.44			
I am not feeling numbness in any bodyparts					0.43			
I can store my belongings propperly						0.74		
I find the cabin spacious						0.66		
I do not feel uneven pressure on my body						0.53		
I feel like sitting in a car							0.61	
I am not feeling tired							0.58	
I am not aggitated or stressed	0.56						0.57	
I find the atmosphere cozy							0.56	
the air does not feel dry							0.55	
the cabin design is modern		0.60					0.51	
It is easy to interact with other passengers in this environment								0.85
the service is courteous								0.51

4.4 Discussion

Study One examined the possibility of differentiating passenger comfort and discomfort. To that end, respondents described their flight comfort and discomfort experiences separately and rated those on eight experiential themes that expressed their personal translation of some contextual impacts. The evidence suggested that the underlying themes of those two states do not differ significantly. The exception to that were the differences between the ratings on the themes 'pleasure' and 'physical wellbeing' in comfort and discomfort reports. Moreover, 'pleasure' received higher ratings in comfort reports, and 'physical wellbeing' was rated higher in discomfort reports. This supports Helander's (2003) argument that chair comfort is related to one's wellbeing and pleasure whereas discomfort is related to biomechanics issues and physical pain, but it contradicts those results in that unlike chair comfort, other generated themes (e.g. 'peace of mind', 'social', etc.) corresponded to both passenger comfort and discomfort. The studies also differ in that Helander's arguments on chair comfort concern a less dynamic experience compared to the experience of aircraft passenger, which includes variables such as 'proxemics' and 'social' aspects involving human interactions in the flight context. Our study also showed that passenger discomfort cannot be considered purely physical (as was suggested by de Looze et al., 2003 and Helander, 2003), as the theme 'peace of mind', representing psychological ease, was rated as the second most influential factor in the discomfort reports (see Table 4-1) followed by six other themes. In other words, the results imply that, in order to achieve a neutral state, it is most necessary to eliminate sources of physical pain and health issues in the cabin in addition to sources diminishing 'peace of mind' such as safety issues and/or annoyance (e.g. loud noises, sudden movements of airplane, broken or dysfunctional products or cabin elements, sight of wears and tears, etc).

Based on above arguments, we conclude that passenger comfort and discomfort are not represented by two different sets of variables (i.e. themes) but they share the same set of variables and those could be used to describe various levels of passenger comfort (ranging from extreme comfort to extreme discomfort) as a single holistic state. Consequently, a single graded scale ranging from comfort to discomfort would suffice for evaluation purposes and the eight proposed themes elicited in a previous study adequately explain, in experiential terms, the state of passenger comfort as a whole. Note, however, that overall passenger comfort is a multifaceted

experience influenced by a combination of physical, psychological, semantic, and social variables, some of which diminish discomfort more than others (e.g. physical wellbeing) whereas some enhance comfort more saliently (e.g. pleasure).

Study Two aimed to validate the elicited comfort themes and establish a set of descriptors for each theme. The results of the PCA mainly validated seven of those themes with an exception of 'proxemics'. The expected descriptors of that theme were scattered across four other factors, i.e. 'satisfaction', 'pleasure', 'peace of mind', and 'physical wellbeing'. This may suggest passengers' proxemics concerns namely control and privacy are not independently perceived. Instead, it may appear that those two concerns are closely tied to one's experience of the space, and how satisfactory, pleasurable, secure, or physically fitting they find it in terms of ability to move about, adapting a desired posture with reasonable distance from neighbors while performing desired activities without interruption. We argue that this does not necessarily dismiss the theme 'proxemics' all together. We propose to keep this theme within the set of eight for two reasons.

The first reason is that the in-depth interviews in Study One indicated pronounced proxemics concerns when respondents were recounting their lived flight experiences. The fact that proxemics descriptors did not stand out as a factor in Study Two could be due to lack of relevant context when the surveyed respondents were rating the potential impact of descriptors. That is, passengers may not be fully aware of the impact of proxemics issues, whereas, when faced with a situation in which their privacy is respected or violated, their comfort experience changes accordingly. Similar conclusions were reached by other researchers into proxemics. Hall (1963, pp.1003) suggested that proxemics concerns (and behavior) are in fact "unconscious". The psychological conscious commonly refers to a global state of an individual, in which one is mindful or aware of their subjective experiences and performs self-initiated behaviors and actions (Winkielman and Schooler, 2012). Conversely, the psychological unconscious is referred to the mental processes that impact one's experience, thoughts and behaviors without the individual being aware of those processes (Kihlstrom, 1987). For instance childhood experiences can influence certain aspects of an adult's characteristics or behaviors but cannot be restored consciously by that individual even through deliberate efforts. The unconscious mind is, then, instinctual and automatized through experiences (Kihlstrom, 1987) and therefore not accessible to us by demand, which also applies to proxemics concerns and behaviors. Note that our use of

the term ‘proxemics’ is somewhat different from that of Hall. While he used it to refer to human behavior in organizing surrounding personal space and interpersonal communication in contrast to one’s micro-space, we applied an operational definition to the term to refer to the experience of privacy and control when one is seated in the aircraft. Nevertheless, it appears that Hall’s theory of unconscious proxemics behavior, characterized by unintentional reactions to the sensory fluctuations (e.g. change of postures), is not in essence different from our interpretation of ‘proxemics’ as a comfort theme; they both indicate that a person cannot purposefully decide or be aware of their proxemics reactions because those are highly driven by the context.

The second reason for recovering ‘proxemics’ as a comfort theme is that in dismissing this theme and incorporating its descriptors into other themes such as ‘physical wellbeing’ or ‘peace of mind’, we may entirely dismiss an important aspect of comfort. Addressing ‘proxemics’ (signified by concerns for privacy and control) in research and design of aircraft interior space serves a difference purpose compared to addressing ‘physical wellbeing’ or ‘peace of mind’. Robson (2008) argued that regulating privacy by providing physical, visual and acoustic barriers in the environment offers a person more control and subsequently reduces the stress levels in public places. More specific to public transportation, Ewans and Wener (2007) showed that a lack of personal space or impression of privacy for seated passengers in trains results in a feeling of not having control over the situation (i.e. control concern), which is a salient indicator of the traveler’s stress level. Therefore translating the proxemics descriptors into design solutions when they are classified under physical wellbeing would miss an opportunity to address the privacy and control concerns (and potentially reducing negative impacts such as stress level) described by above studies. Similar issue arises with regards to those proxemics descriptors classified under ‘peace of mind’ (generally concerned with mental wellbeing and tranquility). Pheasant et al. (2010) argued that tranquility and relaxation is achieved through sensory stimulation when it sufficiently engages a person hence providing opportunities for reflection. It is clear the goal in addressing ‘peace of mind’ in design, as suggested by Pheasant and colleagues, are different in comparison to ‘proxemics’, which aims at eliminating sources of stress, violation of privacy and lack of control.

Other factors emerging from the PCA showed a good fit to the comfort themes in general. Some descriptors were loaded on more than one factor, implying association to different types of

experiences. However, those do not disrupt themes validation especially that the majority of descriptors within each factor generally set a relevant theme.

The aerospace industry is very sensitive to the efficiency and effectiveness of the cabin design. The result of the studies in this paper would be an empowering tool for improving passenger comfort with a high degree of predictability. Indeed the future work should focus on quantifying the impacts of various cabin features linked to comfort themes and their weight in determining the comfort experience as a whole.

4.5 Conclusion

The differentiation of comfort and discomfort has been debated for more than four decades. In this paper, we employed an operational definition of comfort experience in the form of eight themes from a previous study and aimed to understand whether aircraft passengers experience comfort and discomfort differently with reference to those themes. We conclude that while it is necessary to eliminate sources of physical discomfort to achieve comfort, the eight comfort themes generally apply to both. The theme 'peace of mind' was found to be an important indicator for both states while 'pleasure' highly influences comfort and influence of 'physical wellbeing' are more salient for discomfort. This suggests that passenger comfort experience involves various degrees from extreme comfort to extreme discomfort and that the overall effect could be evaluated using one single scale. Seven themes were clearly validated using their core descriptors with an exception of 'proxemics' but it was argued that this is due to lack of context in Study Two as well as the nature of the theme itself, which is generally perceived and acted upon on an unconscious level. We proposed that 'proxemics' should still be considered as a theme in order to address the aspects of privacy and control in comfort experience.

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CHAPTER 5 ARTICLE 3: REAL-TIME VERSUS RETROSPECTIVE: THE DYNAMICS OF AIRCRAFT PASSENGERS' EMOTIONAL RESPONSES AND COMFORT EXPERIENCE [5]

Abstract

Passengers' subjective experiences and comfort is commonly studied on the basis of retrospective evaluations, inquiring for assessment of the flight aspects once it is over. There is a lack of research on the representativeness of retrospective evaluation for the real-time experience of comfort. In addition, the emotional responses of passengers to the flight experience have not been addressed in previous studies. This paper investigates data obtained in real-time of passengers' comfort experience and emotional responses during the flight using the Experience Sampling Method (ESM) and compares them to their retrospective accounts within 24 to 48 hours after the flight. The average of real-time evaluations of comfort was found similar to the retrospective assessments of participants with no significant differences, implying that a retrospective evaluation is reasonably representative of the actual comfort experience. Certain cabin features (legroom, temperature, noise, air quality, lighting, service, hygiene, luggage space) were found to highly correlate with the comfort experience on both short- and long-haul flights. The results of real-time emotional assessment highlighted the importance of fulfilling passengers' concerns relevant to seven types of emotions (satisfaction, frustration, relief, joy, reproach, gratitude, hate) in order to enhance their comfort experience. The cognitive structure of aircraft passenger emotions was proposed, classifying those into five emotion groups each characterized by a unique appraisal pattern, including passengers' concerns (goals, standards, and aspects) and focus (cabin features, service). Finally, passenger comfort experience on short flights correlated significantly with the eight suggested thematic variables (e.g. peace of mind, physical wellbeing, proxemics, pleasure, etc.). On long flights, six of those variables were significant for comfort. It

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was concluded that the eight experiential themes could successfully capture the notion of passenger comfort experience for evaluation purposes.

5.1 INTRODUCTION

The subjective experiences of passengers in aircrafts have attracted researchers' attention in recent years (Vink and Brauer, 2011; Ahmadpour et al. 2014a;2014b). The reason is the ever-increasing competition among manufacturers and carriers for attracting more customers through introducing cost-effective changes in design of the cabin interior and the services offered onboard. Passengers are shown to be willing to pay extra for enhanced in-flight service provision and level of comfort (Balcombe, Fraser, and Harris, 2009; Brauer, 2004) and comfort is shown to be the main contributor to passengers' acceptance of transportation systems (Tan et al. 2010). It is widely accepted that a state of comfort involves physical, physiological and psychological components (Slater, 1985; de Looze, Kuijt-Evers, and van Dieen, 2003). Consequently, several researchers have attempted to conceptualize passengers' perceived values (Chen, 2008) and comfort experience (Ahmadpour et al. 2014a; Ahmadpour, Robert, Lindgaard, 2014b) in the aircraft interior environment.

Comfort experience is defined as a convenience experience, enhancement of which increases product pleasure (Vink, Overbeeke, and Desmet, 2005) and is subjective and personal in nature (Ahmadpour et al. 2014a). Passengers' flight comfort experiences are commonly studied empirically though self-reports submitted after the trip and based on retrospective recollection or evaluations of the events. For instance, Vink et al. (2012) examined more than 10,000 Internet trip reports in addition to interviews at the airport to obtain passengers' rating on comfort and open descriptions of experiences. The results prioritized elements of the journey that impact the overall trip comfort. They highlighted legroom, hygiene, crew and seat as significantly correlating elements with passenger comfort. Ahmadpour et al. (2014a) also assessed descriptions of passengers' experiences in the aircraft cabin after their summer vacations and suggested a framework comprising eight thematic variables found to represent those aspects of the passenger comfort experience relevant to passenger concerns (categorized in 19 groups) and contextual elements (22 cabin features and service). The thematic variables are peace of mind (i.e. psychological ease), physical wellbeing (i.e. physical ease), proxemics (i.e. having privacy and control over personal space), satisfaction (i.e. fulfillment of gratification due to fulfillment of

needs), pleasure (i.e. the joy experienced upon exceeded anticipations), social (i.e. empathy and relevance of social interaction to one's tolerance), aesthetics (i.e. sensory pleasures), and association (i.e. evocation of familiar memories and symbols). Seat, legroom, In-Flight Entertainment (IFE), temperature, noise, and service were found particularly influential context element in that study.

In a series of empirical studies, Ahmadpour et al. (2014b) validated the abovementioned variables. They obtained ratings, from participants with at least five flight experiences, on the relevance of those eight themes and their corresponding descriptors relevant to flight comfort and discomfort experiences. This gave rise to a clear understanding of what constitutes passenger comfort and how it differs from discomfort. The latter was motivated by Helander's (2003 argument that the seat comfort and discomfort could co-exist as independent concepts and that they are associated with different sets of variables. Ahmadpour and colleagues showed that bodily issues such as pain could diminish comfort to the point of extreme discomfort while enhanced pleasures can potentially boost positive effects and even bring about extreme comfort. However, their analysis found no significant differences between the other thematic variables of passenger comfort and discomfort, i.e. the single notion of comfort was found to encompass various levels, underscored by eight experiential aspects. Improvements to these were found to affect comfort positively, while the failure to improve them was found to diminish discomfort. They proposed that, for assessment purposes, a single rating scale ranging from discomfort to comfort could be applied to assess overall comfort. Similarly, when referring to the passenger comfort experience, all levels of comfort are considered in this paper, and discomfort is regarded as a lack of comfort and presence of adverse physical effects (e.g. presence of bodily pains and lack of energy).

Although the above studies provided important information about passengers' trip impressions, they mainly employed post-journey assessments. The extent to which those retrospective recollections correspond to the real-time impressions and experiences of passengers remains unclear. Research into passengers' real-time in-flight experiences is also limited. Richards, Jacobson, Kulthau (1978) asked passengers to complete questionnaires close to the end of their flight which involved a number of comfort-related questions, overall judgment and willingness to use the same means of transportation again. This yielded a prioritized list of physical elements of the cabin (e.g., seat, noise, temperature) contributing to the in-flight comfort. Passengers'

subjective experiences and psychological factors of comfort were not formally evaluated, nor were these compared to the retrospective assessment of participants' comfort. Greghi et al. (2012) employed in-flight observations, questionnaires and interviews to study passengers' activities (e.g., eating, working, entertainment, etc.). Comfort in that study was addressed as the level of discomfort (ranging from no discomfort to extreme discomfort) related to several activities. These were linked to the appropriateness of the physical space allocated to each passenger. The relationship between real-time and retrospective evaluations was not investigated. One objective of this paper is therefore to address that relationship. In addition, it seems appropriate also to examine the dynamics and fluctuations of the comfort experience during the flight and how those impact the overall retrospective evaluation of comfort after the journey. This paper considers comfort as a multifaceted subjective experience. Several researchers have acknowledged the importance of emotions for such experience, however the issue has not yet been clearly developed or addressed empirically. This leads to the second objective of this paper, as discussed in the next section.

5.1.1 Comfort and Emotion

Comfort experience has been mentioned in relation to emotions (Vink et al. 2005), expectations (Vink and Hallbeck, 2012), and feelings of relaxation and wellbeing (Zhang, Helander, Drury, 1996). Scherer (2005) categorized comfort and discomfort as affective states, encompassing a degree of pleasantness, changes to which influence one's emotions; de Looze et al. (2003) established a direct relationship between seat comfort and emotions. Given that aircraft passengers spend the majority of their flight time seated, it could be assumed that passenger comfort is also related to emotions.

The above studies inspire investigation into passengers' emotional responses in the flight context and the association of those with comfort evaluation. Acquiring understanding of that relationship could potentially increase the predictability of the comfort experience through changes to the aircraft cabin and service design. Those issues have not been examined in the literature before. The study presented in this paper aims to identify emotions that emerge during a flight experience and how those emotions relate to passenger comfort. Those questions shape the second objective of this paper which includes uncovering the types of passengers' emotional responses, their eliciting conditions and relation to real-time comfort in the aircraft cabin interior

during a flight. In addition, we study the association of emotional responses to retrospective evaluations of comfort experience. The definition of emotion and its eliciting conditions are discussed next.

5.1.2 The cognitive structure of Emotions

Emotions are defined as internal, mental states in reaction to ongoing situations perceived as being good or bad (Ortony, Clore, and Foss, 1987). Emotions are distinguished from other affective states (such as moods) in that they are focused on something/someone (e.g. afraid *of* someone, anxious *about* something, etc.), concern present time (not future nor the past) and are thus short-term reactions (Clore, Schwarz and Conway, 1994). For an emotion to be consciously felt, a minimum level of physiological arousal, ranging from calm to activated, is required (Russell, 1980, 2003; Ortony et al., 1988; Yik, Russell, and Steiger 2011). It is essential to differentiate mood from emotions. Moods are affective states (valenced, i.e. entail a pleasant or unpleasant feeling) that, unlike emotions, do not have a specific focus, last for a longer time, are low in intensity, and do not necessarily concern the present time (Moors, 2009). An example of a mood is being depressed. The mere presence of moods could impact the type or intensity of emotions involved. For that reason, we also addressed moods in the study presented in this paper.

Among many theories and definitions of emotions, we adopted the 'cognitive structure of emotions' by Ortony et al. (1988) for its clarity and emphasis on the eliciting conditions that precede emotions. The model, referred to as the 'OCC model' in this paper, establishes a formal structure for analyzing the conditions that elicit emotions. The theory asserts that emotions are valenced reactions (i.e. affective reactions based on the perceived goodness or badness of things) determined by how a person understands the eliciting condition. According to the OCC model, eliciting conditions could be structured into a number of appraisal patterns (i.e. the evaluation logic), each determining a type of emotion. Types of emotions that share the same appraisal pattern are therefore grouped together. Essential elements of the appraisal patterns are a person's focus and concern. The focus could be an object, event or agent. People develop a positive or negative affective reaction to those and consequently form an evaluation based on their personal concerns. The level of physiological arousal determines the emotional intensity, i.e. how intensely an emotion is felt.

Ortony and colleagues introduced 22 emotion types (e.g. joy, distress, pride) categorized in six groups (e.g., wellbeing, attribution, attraction) characterized by their appraisal patterns. Those groups and emotions are illustrated in the model shown in Figure 5-1. Note that the OCC model insists on the unique appraisal patterns for distinguishing among emotions rather than relying on the folk taxonomy of emotion words. For that reason, it is emphasized that each emotion type represents a family of similar words that share the same unique appraisal pattern.

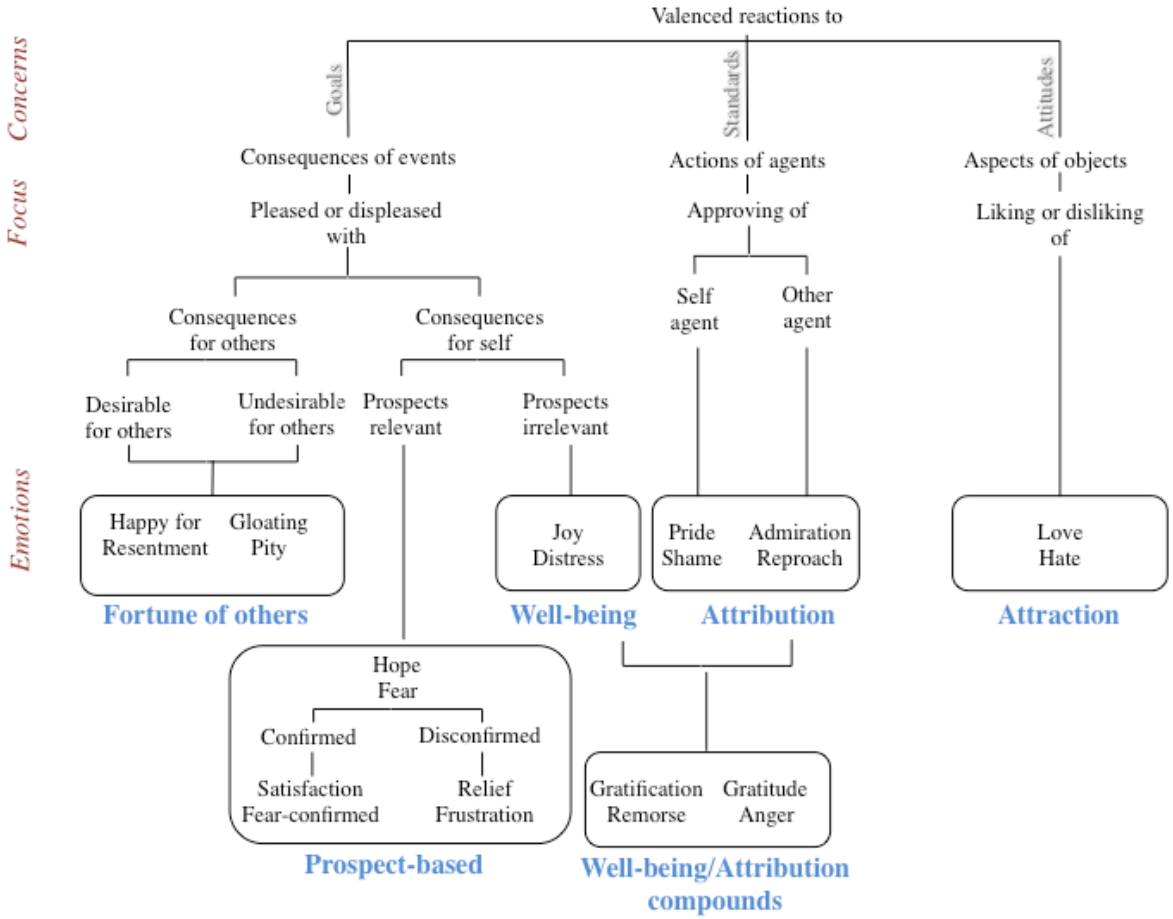

Figure 5-1. An illustration of the cognitive structure of emotions adapted from Ortony, Clore, and Collins (1988), also known as OCC model.

Each emotion group stems from a unique appraisal pattern depending on one's focus at the time, their concerns and evaluation of the situation. Starting with 'Goals' in the leftmost part of the Figure, when focusing on consequences of events, one would evaluate their desirability with respect to certain goals (i.e. concerns) and potentially be pleased or displeased with them (i.e.

affective reactions). If the evaluation is focused on consequences for oneself, wellbeing (e.g. joy, distress) or prospect-based types of emotion (e.g. hope, fear, satisfaction) may be elicited. However, if the evaluation is focused on consequences for others, fortune-of-others emotions (e.g. pity, resentment) are elicited. Next, in the 'Standards' column, if one's focus is on the actions of agents and forming an evaluation of their praiseworthiness relative to certain standards, this elicits attribution emotions (e.g. reproach, admiration). Upon the co-occurrence of the conditions for the wellbeing and attribution emotion groups, i.e. when one evaluates consequences of events instigated by agents, the emotions in the wellbeing/attribution compound (e.g. gratitude) are elicited. Finally, in the 'Attitudes' column of the Figure, a focus on aspects of objects and evaluating the appeal of their aspects according to one's attitude or taste, elicits an affective reaction of (dis) liking and the emotions in attraction group.

In this paper, we use the OCC emotion types to address the emotions experienced by passengers and employ the appraisal patterns to analyze their eliciting conditions and relation to the comfort experience. The Experience Sampling Method (ESM), described briefly below, was used for collecting real-time data from passengers.

5.1.3 Experience Sampling Method (ESM)

The Experience Sampling Method (ESM) was developed for collecting real-time data about subjective experiences in psychology (Csikszentmihalyi, Larson, and Prescott, 1977; Larson and Csikszentmihalyi, 1983) and is widely used to gain insight into the nature and context of experiences (Anderson, 2002). The method requires the respondent to pause at pre-determined times during the experience and describe their state at the time (Csikszentmihalyi and Csikszentmihalyi, 1988). The ESM is easily applicable to assessments in natural environments in which the experience occurs. It eliminates the memory bias in respondents' answers, which in turn increases the validity of the results (Scollon Kim-Prieto, and Diener, 2003). With respect to human-product interaction, Demir, Desmet, and Hekkert (2009) employed ESM to examine the appraisal patterns of emotional responses to product use. The method proved successful and gave indications about the mechanism and eliciting conditions of four emotions, namely joy, satisfaction, anger and disappointment.

An electronic device or a cell-phone is commonly used in ESM to notify respondents with a beep or text message at random times (Anderson, 2002), but if interruptions are impractical at that

time, an event-contingent protocol is applied in which the report is requested immediately after a particular, pre-determined event (Christensen et al. 2003). In this study, we used an event-contingent protocol due to the prohibited use of electronic devices such as phones during a flight. In addition, access to flight schedules was not possible for all participants.

ESM commonly collects several reports from one individual. One important aspect of analyzing such dataset is to outline whether the person or the experience is the unit of analysis (Samdahl, 1989; Anderson, 2002). In the research presented in this paper, we used the sampled experience as the unit of analysis, i.e. flight experience. A similar strategy was used, for example, in the study of real-time and retrospective assessments of physical discomfort (Redelmeier and Kahneman, 1996; Redelmeier, Kahneman, and Katz, 2003) using the experience as the unit of analysis in search of the time most associated with the overall judgment of the pain and discomfort during some medical procedure.

5.2 Method

5.2.1 Participants

A convenience sample of 16 participants (13 male), each with at least five flight experiences, was recruited through personal contacts. They were between 20 and 59 (8 participants were 20-39, 8 were 40-59) years of age with average height of 179.3 (160-185.4, SD=8.6) cm. Ten respondents reported long-haul flights (>4hrs) and trans-Atlantic from north America to other continents, and six reported short-haul flights (<4hrs). Four participants in the short flight group were frequent business (solo) travellers travelling between Toronto and Montréal every other week, and three participants on long flights also reported business trips. Only two participants traveled in business class on long-haul flights to Asia, and the rest traveled in economy class.

5.2.2 Questionnaire

Each questionnaire contained five sections as follows.

Section One − the first section contained questions on demographic information, flight duration, and an assessment of the respondent's mood using the Self-Assessment Manikin (SAM)(Lang, 1980) 5-point scale to assess valence (sad to happy) and arousal (calm to active).

Section Two to Four – these sections were identical, aiming to assess the real-time comfort experience and emotional responses at different times during the flight. They questions in each included the time of reporting, an overall comfort assessment at the time on a 9-point rating scale (1=slightly comfortable and 9=very comfortable) and the level of comfort associated with a number of cabin features; seat, legroom, temperature, noise, air quality, lighting, In-Flight Entertainment (IFE), service, hygiene, and luggage space, all of which had been identified as generally influential on passengers' comfort in a previous study (Ahmadpour et al. 2014a). A 5-point scale (1=slightly comfortable, 5=very comfortable) was provided for the rating of those features. Section two to four each contained an emotional assessment using the 22 emotion types on the OCC model, each represented with a 5-point scale (1= slightly feeling the emotion and 5=intensely feeling the emotion). A blank space also allowed the respondent to give justifications for their ratings and report any emotion that was not readily included in the list.

Section Five – this section addressed the retrospective assessment of the experience. It contained a 9-point scale representing the overall comfort of the flight (similar to above) and a question regarding the comfort level (9-point scale) experienced with respect to each of the eight thematic variables of passenger comfort (Ahmadpour et al. 2014a; 2014b). For each variable, a short definition was also provided.

5.2.3 Procedure

Each participant was contacted (by phone or in person) individually and asked to complete the questionnaire as follows. The information in section one (demographic information and mood assessment) should be entered before the aircraft takes off. Sections two to four, consisting the real-time assessments, are to be completed at the beginning (time to unfasten the seatbelt), halfway mark and the end of (10-15min before landing) the long flight. On short flight, only two sections at the beginning and end of the flight were to be completed. Each participant was also given a brief introduction to the emotion types used in the questionnaire and reminded that each emotion represents a family of similar emotion types. They were advised to reserve section five of the questionnaire (the retrospective account of their experience) for after the flight and complete that section between 24 to 48 hours of their flight. A brief introduction to the thematic variables of comfort was provided. Then the questionnaires and consent forms were emailed to the respondents to print and take with them on their flights.

5.3 Results

Each participant submitted ESM reports for several flights. In total, 76 reports were collected from 16 participants. Reports in which data were missing in more than one section were eliminated, yielding a total of 57 reports for the analysis (74% response rate), 44 of which were related to short flights.

5.3.1 Real-time versus retrospective evaluation of comfort

The average duration of short flights was 53.84 (60-110) minutes and for long flights it was 447.69 (300-665) minutes. Table 5-1 gives a summary of the mean value (and standard deviation - SD) of (real-time) overall comfort ratings and time of reporting during the long and short flights. The average comfort level appears to remain nearly constant throughout both short and long flights (real-time comfort) and similar to the retrospective report. The value for the average comfort ratings on short flights was clearly higher than on long flights.

Table 5-1. The average time and ratings of real-time and retrospective comfort (1-9) on short and long flights

	short flight			**long flight**			
	real-time		**retrospective**	**real-time**			**retrospective**
	beginning	end		beginning	halfway	end	
mean comfort (SD) (1-9)	4.7 (2.4)	4.8 (2.5)	4.6 (2.5)	2.5 (1.8)	2.4 (2.0)	2.8 (2.0)	2.8 (1.4)
average time (SD) of report (min)	12.8 (4.5)	53.8 (16.6)		30.9 (19.5)	220.7 (72.5)	447.7 (172.4)	

A one-way ANOVA revealed no significant differences among the overall comfort evaluations of short flight obtained at the beginning, end and retrospectively. Similarly for long flights, a one-way ANOVA conveyed no significant differences among the comfort evaluations obtained at the beginning, halfway through, end, and retrospectively

Next, Pearson Product Moment correlation analysis was performed to understand the relationship between real-time overall comfort and the comfort of cabin features. A summary of the correlation coefficients is given in Table 5-2 (short and long flights separated). Overall comfort for short flights correlated significantly ($P<0.05$) with all listed cabin features except for the IFE. It should, however, be noted that most of the reported short flights provided no interactive entertainment unit (commonly placed on the seat in front of the passenger). The strongest correlations were found for the lighting ($r=0.60$) and hygiene ($r=0.59$).

Table 5-2. The correlation coefficients between ratings on real-time ratings of overall comfort and comfort of cabin features for short and long flights

overall comfort	seat	legroom	temperature	noise	air quality	lighting	IFE	service	hygiene	luggage
long flight	0.29	**0.34***	**0.33***	**0.52***	**0.48***	**0.36***	**0.60***	**0.52***	**0.52***	**0.47***
short flight	**0.43***	**0.54***	**0.38***	**0.24***	**0.48***	**0.60***	0.03	**0.45***	**0.59***	**0.47***

* $P<0.05$

Correlations for long flights were significant for all features ($P<0.05$), except for the seat. Comfort on those flights strongly correlated with the IFE ($r=0.60$) but, surprisingly, not with the seat. One explanation for this lack of correlation for the seat might be that passengers on long flights form low expectations for the seat, possibly due to previous negative experiences, and instead focus on elements that are more likely to meet or even exceed their expectations, hence the significance of IFE, service, and hygiene for comfort on long flights. Interestingly, the luggage space equally correlated with real-time comfort on short and long flights ($r=0.47$, $P<0.05$), highlighting its importance for comfort regardless of the flight duration.

5.3.2 Real-time emotional responses and their correlation with real-time comfort evaluation

A t-test performed on the ratings of real-time emotions at the beginning and end of short flights was not significant. The same was true for the one-way ANOVA computed for the real-time ratings of emotions at the beginning, halfway and end of long flights. This implies that the initial emotional reactions at the beginning of flights set the general themes for the rest of the experience.

Next, a Pearson Product Moment correlation was conducted between real-time emotions and 1) the real-time comfort scores (overall and those specific to cabin features), and 2) the pre-flight mood. The results for short and long flights are summarized in Tables 5-3 and 5-4 respectively.

Table 5-3. Correlation coefficients between emotion types and ratings on mood, overall real-time comfort and comfort of cabin features on short-haul flights

Emotion type	mood		overall comfort	cabin features									
	valance	arousal		seat	legroom	temperature	noise	air quality	lighting	IFE	service	hygiene	luggage
anger	-0.01	-0.07	-0.01	-0.04	-0.05	-0.11	-0.03	0.00	-0.07	-0.01	-0.10	-0.10	-0.12
gratitude	-0.05	0.10	0.10	**0.20***	**0.19***	0.14	0.09	0.18	0.14	**0.19***	**0.24***	0.14	0.15
gratification	0.01	-0.04	-0.09	-0.08	-0.02	-0.01	0.10	0.11	0.03	0.14	0.06	0.02	0.08
reproach	-0.02	-0.08	-0.15	-0.04	**−0.19***	**−0.2***	-0.12	-0.16	-0.15	-0.07	-0.11	-0.16	-0.12
admiration	-0.11	0.16	0.05	0.12	0.07	0.06	0.03	0.03	0.08	-0.14	0.14	0.04	0.10
frustration	0.14	**−0.35***	0.09	-0.06	0.02	-0.07	0.05	0.08	-0.01	0.03	-0.04	-0.07	-0.17
joy	-0.10	**0.23***	-0.09	0.01	0.08	0.16	0.00	0.12	0.07	-0.01	-0.01	0.10	-0.02
relief	0.07	-0.09	-0.02	0.04	0.01	0.11	-0.06	-0.02	-0.11	-0.05	-0.02	-0.04	-0.02
fear-confirmed	-	-	-	-	-	-	-	-	-	-	-	-	-
disappointment	0.17	-0.18	0.01	0.12	0.12	0.05	-0.08	0.07	-0.01	0.03	-0.02	0.11	-0.16
satisfaction	-0.09	0.10	**−0.23***	**−0.22***	-0.08	0.13	-0.05	0.02	0.06	0.02	-0.12	-0.05	0.06
hope	-0.02	0.11	-0.13	0.10	0.10	0.08	0.08	0.16	0.04	0.09	-0.09	0.12	0.06
fear	0.09	-0.01	-0.06	-0.02	-0.04	-0.10	0.16	-0.08	-0.12	0.02	-0.07	-0.13	-0.08
pity	-0.02	-0.11	0.09	0.03	0.08	0.07	0.02	-0.01	0.06	0.00	0.09	0.12	0.02
resentment	-0.13	-0.15	0.04	0.04	0.05	-0.07	0.01	0.05	-0.02	0.04	-0.07	-0.13	-0.08
gloating	-0.02	0.10	0.05	0.09	0.08	0.13	0.16	0.12	0.13	0.25	0.09	0.19	0.22
happy for	-0.07	0.05	0.00	0.13	0.17	0.16	0.14	**0.22***	**0.19***	**0.37***	0.10	**0.32***	**0.33***
hate	**0.27***	0.01	**−0.19***	-0.11	**−0.25***	**−0.30***	0.04	**−0.34***	**−0.34***	**−0.19***	**−0.25***	**−0.34***	**−0.27***

* P<0.05

Table 5-4. Correlation coefficients between emotion types and ratings on mood, overall real-time comfort and comfort of cabin features on long-haul flights

Emotion type	mood		overall comfort	cabin features									
	valance	arousal		seat	legroom	temperature	noise	air quality	lighting	IFE	service	hygiene	luggage
anger	0.15	0.12	0.16	0.03	0.12	-0.12	-0.01	0.00	-0.12	-0.10	-0.07	-0.09	-0.06
gratitude	-0.13	0.16	**0.33***	0.20	0.22	0.19	**0.39***	**0.39***	**0.32***	**0.36***	**0.32***	**0.38***	**0.45***
gratification	-0.28	-0.22	0.04	-0.17	-0.07	0.04	-0.07	-0.03	-0.12	0.17	-0.05	-0.02	-0.01
reproach	-0.24	-0.14	-0.14	0.22	0.22	0.29	0.31	**0.34***	0.19	**0.32***	0.03	**0.34***	**0.37***
admiration	-0.01	0.16	-0.14	0.02	0.04	-0.08	-0.05	0.05	-0.03	-0.01	0.03	0.11	0.21
frustration	-0.03	0.08	0.14	**0.34***	0.06	**0.32***	-0.03	-0.02	0.00	0.03	0.20	0.08	0.08
joy	**−0.5***	-0.16	-0.22	-0.07	-0.07	0.08	-0.03	0.12	0.22	0.13	0.04	0.17	0.09
relief	**0.36***	0.12	0.23	-0.01	0.02	-0.07	**0.34***	0.06	-0.11	-0.09	-0.08	0.00	0.00
fear-confirmed	-	-	-	-	-	-	-	-	-	-	-	-	-
disappointment	-	-	-	-	-	-	-	-	-	-	-	-	-
satisfaction	**−0.33***	-0.14	0.19	0.19	-0.12	-0.05	0.02	0.14	0.25	0.28	0.28	0.14	0.11
hope	0.21	0.01	-0.06	-0.27	0.10	-0.17	-0.02	-0.14	-0.15	-0.16	-0.12	-0.14	-0.12
fear	-0.02	0.22	-0.08	0.10	0.05	-0.05	0.06	0.14	0.11	-0.02	0.04	0.16	0.18
pity	-	-	-	-	-	-	-	-	-	-	-	-	-
resentment	-0.01	0.16	-0.06	0.02	-0.15	0.29	-0.14	-0.15	-0.14	-0.12	-0.12	-0.12	-0.12
gloating	-	-	-	-	-	-	-	-	-	-	-	-	-
happy for	**0.41***	0.21	0.17	0.04	-0.30	-0.07	-0.20	-0.30	**−0.32***	-0.12	-0.08	-0.29	**−0.36***
hate	-	-	-	-	-	-	-	-	-	-	-	-	-

* P<0.05

As can be seen in Table 5-3, on short flight, the correlations were significant (P<0.05) between overall real-time comfort and two emotion types, satisfaction (r= -0.23) and hate (r= -0.19). In turn, satisfaction also correlated with the seat comfort (r=-0.22) and hate correlated with comfort of all cabin features except for the seat and noise. Emotion hate also correlated with valence (r=0.27, P<0.05) at the beginning of the flight. However, there was no association between

satisfaction and the mood variables. The comments on satisfaction were concerned with the seat pockets as well as with the personal space and its suitability for resting and working.

Three other emotions, namely gratitude, reproach, and happy-for, also correlated significantly with the (real-time) comfort of cabin features but not with the overall real-time comfort. Upon the inspection of the respondents' comments, it was clear that the term 'happy-for' was misleading; respondents had perceived it as a state of 'being happy' and 'pleased with something' (similar to emotion joy) about the freshness of the air (air quality), impression of daylight in the cabin (lighting), the variety of magazine/newspaper offered onboard, the cleanliness of the cabin and/or the luggage space. Gratitude was mentioned with respect to the shape of the seat back, the amount of legroom, the variety of entertainment material (IFE), and professionalism of the service. Comments on reproach were related to the insufficiency of legroom or unfavorable temperature and one's lack of control on it.

As Table 5-4 shows, only emotion gratitude correlated significantly with overall real-time comfort on long-haul flights. It also yielded significant correlations with noise, air quality, lighting, IFE, service, hygiene and luggage. However, there was no significant correlation between gratitude and respondents' mood at the beginning of the flight. Four emotions, namely reproach, frustration, relief, and happy-for, were found to be associated with the comfort of cabin features but not with the overall real-time comfort. Again, the review of comments revealed a misconception with regard to the term 'happy-for' and inclination towards joy and pleasure. This emotion, i.e. happy-for, was associated with the quality of light and the amount of luggage space in the overhead bin or at the seat. Comments on reproach concerned air quality and its freshness, IFE and its functionality or responsiveness, hygiene and maintenance of the cabin interior, as well as the space available in luggage bins. Comments on frustration were concerned with the physical issues related to the temperature and the fit of the seat. Relief was related to the noise level in the cabin and its relation to one's ability to rest and relax.

5.3.3 The retrospective evaluation of comfort and its correlation with the thematic variables

Finally the ratings on the thematic variables of comfort that were reported retrospectively were correlated with real-time and retrospective overall comfort ratings. The results for short and long

flights are summarized in Table 5-5. On short flights, all themes correlated significantly (P<0.05) with the real-time (both at the beginning and end) and retrospective assessment of comfort. Retrospectively assessed comfort correlated most highly with the themes peace of mind and social (r=0.70 for both). On long flights, five themes of peace of mind, physical wellbeing, proxemics, satisfaction, pleasure, and association had significant correlations (P<0.05) with real-time comfort on halfway mark and end, as well as with retrospective assessment of comfort. The retrospective comfort had the strongest correlation with the themes association (r=0.82) and pleasure (r=0.81). The negative correlation of proxemics with retrospective assessment suggests that lack of privacy or control highly deteriorates discomfort experience.

Table 5-5. Correlation coefficient; Comfort at the beginning, end and after (retrospective) the flight correlated with the ratings of the eight thematic variables of passenger comfort, obtained retrospectively.

	short flight			**long flight**			
	real-time		**retrospetive**	**real-time**			**retrospective**
thematic variables of passenger comfort	beginning	end		beginning	halfway	end	
peace of mind	**0.65***	**0.54***	**0.70***	-0.15	**0.77***	**0.71***	**0.59***
physical wellbeing	**0.31***	**0.30***	**0.40***	-0.04	**0.82***	**0.74***	**0.62***
proxemics	**0.47***	**0.39***	**0.54***	-0.20	**−0.26***	**−0.38***	**−0.50***
satisfaction	**0.53***	**0.42***	**0.62***	-0.10	**0.81***	**0.77***	**0.69***
pleasure	**0.50***	**0.49***	**0.60***	0.09	**0.83***	**0.79***	**0.81***
social	**0.68***	**0.62***	**0.70***	-0.23	0.23	0.15	0.36
aesthetics	**0.36***	**0.39***	**0.35***	0.30	0.36	0.23	0.49
association	**0.58***	**0.53***	**0.63***	0.07	**0.91***	**0.90***	**0.82***

* P<0.05

5.4 Discussion

Repeated evaluations of comfort and emotions during flights using an ESM protocol gave insight into the dynamics of passengers' real-time experiences and verified the features that commonly elicit those responses. Participants' post-flight assessments provided an opportunity to explore the relationships between real-time and retrospective accounts of comfort. The ESM was therefore found to be a relevant method for passenger comfort data collection. Despite requiring participants to stop and report on their state, this was not proved to be too intrusive, judging by the 74% response rate obtained.

5.4.1 Real-time comfort

The dynamics of the real-time comfort during the flight demonstrated a high influence by passengers' first impressions (comfort level and emotions) of the cabin interior and the service. An important revelation of this study was that the passenger's experience within the first 12.8±4.5 min of short and 31±19.5 min of long flights determines the comfort of the whole experience. In order to improve those impressions, the comfort experience associated with several features should be enhanced. Those are legroom, temperature, noise, air quality, lighting, service, hygiene, and luggage. The experience and comfort levels delivered through these features upon first impressions determine not only the real-time comfort during the flight, but also the retrospective assessment, which in turn predicts the chances of a person using the same airline/aircraft in the future. Special attention should therefore be paid to passengers' preferences with regard the design and maintenance of features. For instance the temperature stability and adjustability should be improved. The design of the seat should to focus on new innovations to overcome the apparent bias against the seat comfort on long flights. Moreover, the importance of hygiene for the flight comfort necessitates high levels of maintenance, refurbishment of the interior and its cleanliness (Ahmadpour et al. 2014a).

5.4.2 Real-time emotions

Emotions inform human behavior and generate appropriate responses for coping with their environment (Frijda, 1986). Strong negative feelings, such as frustration, could alter a passenger's interaction with other travellers or the crew during the flight and be potentially troublesome. They also impact comfort and, in turn, passengers' future choice of an airline.

Much like real-time comfort, the emotions of participants during the flight were highly influenced by their initial emotional responses within the first 12.8±4.5 min of short and 31±19.5 min of long flights. The impact of participants' moods (the valence variable) on their initial emotional responses was limited to emotion hate on short flights and emotions joy and relief on long flights. That implies that the general negative or positive valence due to pre-flight experiences such as those at the airport or check-in influence how much the passenger will like/hate the forthcoming flight experience, how much the flight will be enjoyed by the passenger and/or the extent to which the passenger feels at ease and relieved. Providing a smooth and event

free airport and boarding experience clearly contributes to a positive mood and thus emotional and comfort experience.

Emotions satisfaction, hate, gratitude, reproach, and joy (replacing happy-for, due to the participants' misinterpretation of the term) were significant to either overall comfort or the comfort attributed to some cabin features on short flights. These emotions, interestingly, also appeared to have some relevance to the comfort of long flights, with an exception of the first two. In addition, emotions relief and frustration were also influential on comfort of long flights. The similarities and recurrence of certain types of emotion lead us to consider them as relevant to passenger comfort experience in general. Using the insight gained in this study and the appraisal patterns of emotions suggested by the OCC model, we propose the model of aircraft passenger emotional responses as shown in Figure 5-2. A discussion on the structure of the model follows.

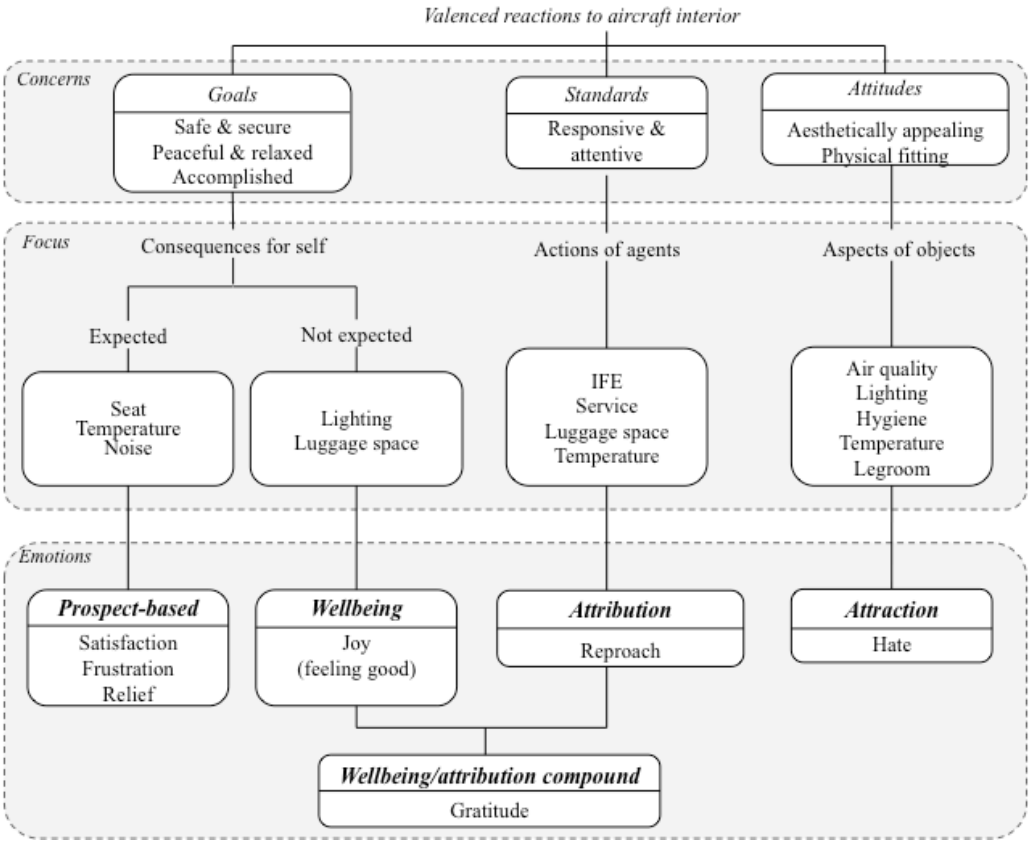

Figure 5-2. The model of aircraft passenger emotional responses during the flight

Emotional responses of passengers in relation to their comfort, as shown in Figure 5-2, represent five of the emotion groups suggested by Ortony et al. (1988) in the OCC model. Each emotion

group contains one or more emotion types and is characterized by a unique appraisal pattern consisting of passengers' concerns and focus. The cabin interior features and service that correlated with emotions in both short and long flights are shown in the focus section. When a group comprised more than one emotion type, the cabin features that were mentioned in all those emotion types and/or those with highest correlation coefficients were considered. Discussion on each group follows.

Prospect-based – this group of emotions emerge from a focus on the consequences and outcomes of events for oneself and upon confirmation of the hopes and anticipations relevant to one's prospect (i.e. goals). Satisfaction, relief and frustration share the same appraisal pattern in this group. When passengers' expectations with regard to the seat are fulfilled, satisfaction and comfort are elicited, whereas violation of those expectations results in frustration. Those expectations include achieving goals such as being safe and secure in the seat, and able to accomplish the desired tasks without interruption. Relief was elicited when the noise level in the cabin allowed a peaceful and relaxing journey.

Wellbeing – emotion joy in this group, recovered from the ratings on emotion type 'happy-for', is elicited when the consequences of events exceed one's anticipation with respect to goals such as feeling at ease and secure without any worries. Two features, lighting and luggage space, applied to both long and short flights. Here is an opportunity for airlines and manufacturers to provide positive stimulation and deliver pleasant surprises.

Attribution – emotion reproach in this group is elicited when the actions of agents are evaluated based on personal standards. An agent is not necessarily a human agent but rather any element from which a certain response is expected. The data revealed temperature (in short flights), IFE and luggage space (in long flights) as passengers' focus in this group, being evaluated based on responsiveness as a standard. A broken IFE that does not respond to the passenger's command could cause reproach, same as the fluctuations of temperature that cannot be controlled by the passenger.

Wellbeing/Attribution compound – emotion gratitude in this group is experienced due to the co-occurrence of the eliciting conditions for wellbeing and attribution groups, i.e. when the actions of agents yield pleasant consequences that fulfill passengers' personal goals. For instance, the IFE and service (the agents) that are responsive and attentive (the standard) and the consequences

of their actions put the passenger at ease (the goal), elicit gratitude. This information introduces an opportunity to the airlines for improving passenger comfort by exploring what constitutes a responsive IFE or an attentive service and addressing those in the design.

Attraction – hate or dislike results from a focus on the aspects of objects when being evaluated against one's taste or attitudes towards them (e.g. aesthetics attitude). Upon finding those aspects unappealing, one could develop various levels of dislike or even an extreme emotion such as hate. Such negative emotion consequently diminishes comfort particularly on short flights. Elements such as the air quality, lighting, hygiene, temperature, or legroom correlated with this emotion more strongly. This appears to be a visceral reaction to the appearance of the cabin interior and the fit and form of the space. It also significantly correlated with the general valence (positive or negative feeling) of the passenger ($r=0.27$, $P<0.05$) at the beginning of the flight, meaning that this feeling is influenced by pre-flight experiences at the airport and check-in. Addressing passengers' first impressions (12.8±4.5 minutes of short flights) in terms of the interior appearance could potentially enhance their mood and prevent negative visceral reactions that would diminish comfort at the beginning of the journey and further on.

5.4.3 Real time versus retrospective evaluation of comfort experience

Passengers' retrospective evaluations of comfort experience were consistent with their real-time evaluation irrespective of the flight length. This suggests that the retrospective evaluation of passenger comfort is a reasonable assessment of their actual experience. It also verifies the importance of the cabin first impression for overall passenger comfort.

The thematic variables of passenger comfort experience were found highly relevant to the real-time and retrospective comfort evaluation. However the themes social and aesthetics were not among the determinants of comfort experience for long flights. This could be due to a limitation of this study in that the majority of participants were solo travellers and mainly on business trips. They had no travel companions and on long flights, they expressed a preference for a relaxing flight where they could rest, without disturbance, before or after their business meetings. Those participants disliked social interaction and were primarily concerned with their privacy (not being disturbed), hence the high relevance of the theme proxemics. Overall, the thematic variables could be considered as a measure of passenger's overall comfort experience, although their effectiveness for the assessment of long flights comfort should be further investigated.

5.5 Conclusion

The overall passenger's comfort level and emotions are highly influenced by the first impressions of the cabin and in particular legroom, temperature, noise, air quality, lighting, service, hygiene, luggage space. The retrospective evaluation of comfort is a valid representative of the actual comfort experience during the flight. Improving passenger's comfort experience necessitates fulfilling concerns relevant to seven emotions types (satisfaction, frustration, relief, joy, reproach, gratitude, dis-like). A model of passenger emotional responses was proposed which classified those emotion types into five groups each characterized by a unique appraisal pattern. Those patterns specify the components of the appraisal process in terms of passenger concerns (goals, standards, and aspects) and focus (cabin features, service). Finally, the eight thematic variables of passenger comfort experience generated in the previous studies were validated for short flights and partly for long flights. We suggest that overall; the eight experiential themes could be used to capture the notion of passenger comfort experience.

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CHAPTER 6 OVERVIEW AND DISCUSSION

The main goal of this thesis was to create knowledge about the subjective aspects of passenger comfort experience in the flight context. Those aspects were characterized in terms of passengers' perceptions and their emotional responses to the contextual stimuli. Those goals were exemplified in form of four objectives. This chapter offers an overview of the results of the studies presented in this thesis and their compliance with the research objectives. Furthermore, the implications of the results for the design of the aircraft interiors and the evaluation of passenger comfort are discussed.

6.1 Results overview

Overall eight studies were performed in this thesis, satisfying the four outlines objectives. The data collection mainly included employing questionnaire and interview techniques. A summary of the studies, their results and contribution to objectives are presented in Table 6-1.

As shown in the table, the fist study included a qualitative investigation in order to achieve an understanding of the subjective aspects of passenger comfort experience. Consequently, a set of eight thematic variables, pertaining to passengers' perception of 22 contextual features (environmental, activities, social) was presented in chapter 3 and the relationship between those was also highlighted. It was shown that some features have more pronounced impacts on a theme and thus potentially improve the comfort experience more effectively. For instance the seat and temperature had stronger impacts on the theme 'peace of mind' compared to other features. In addition a feature (or a group of features) may possess parallel effects on several themes. An example is the association of the spatial features (seat, legroom, cabin layout, window, lavatory) with several themes namely 'satisfaction', 'association', 'peace of mind', 'aesthetics', 'physical wellbeing', and 'proxemics'. The advantage of the above knowledge for the design practice was shown in a study (in chapter 3) with a team of aircraft interior designers. The above studies contribute to the first objective of the thesis regarding the definition and nature of the subjective aspects of passenger comfort experience.

Table 6-1. A summary of the studies presented in this thesis (participants, method, results) and contribution to objectives

Ch. No.	Participants	Method of inquiry	Type of question	Retrospective or real-time report	Objective No.	Results
Ch.3	155 passengers	Questionnaire	Open-end	Retrospective	Obj. 1	Eight themes of passenger comfort experience 22 contextual features Relationship between themes and features
	8 designers	Brainstorming	Checklist	–		Knowledge about the comfort themes in relation to contextual features is advantageous
Ch.4	27 passengers	Questionnaire + interview	Open end description of comfort and discomfort experience Ratings the impact of eight themes on each experience (5-point scale)	Retrospective	Obj. 2	Comfort and discomfort are underlined by the same set of variables (i.e. eight themes)
	8 designers	Brainstorming	Affinity diagram	–		113comfort descriptors, organized into seven groups
	5 specialists	Brainstorming	Affinity diagram	–		63comfort descriptors, organized into six groups
	27 passengers	Questionnaire	Rating the relevance of 161 descriptors to passenger comfort (3-point scale)	Retrospective	Obj. 1	Reducing a pool of 161 descriptors to 60 descriptors
	41 passengers	Questionnaire	Rating the impact of 60 descriptors on passenger comfort (5-point scale)	Retrospective		Validation of eight passenger comfort themes based on PCA Introducing 58 descriptors assigned to the eight themes
Ch.5	16 passengers	Questionnaire (ESM)	*Pre-flight:* Mood (5-point scale) *Real-time:* Rating overall comfort (9-point scale) Rating comfort related to ten contextual features (9-point scale) Ratings emotional responses (5-point scale) *Retrospective*: Rating overall comfort (9-point scale) Ratings comfort with respect to each theme (9-point scale)	Real-time and retrospective	Obj.3 Obj.4 Obj.1	Pre-flight level of valence influences attraction emotion on short slights while it impacts emotions joy and relief on long flights Dynamics of passenger comfort experience during the flight is mainly determined by their first impressions The ten selected contextual features had significant correlations with overall comfort Real-time and retrospective evaluations of comfort are not significantly different Seven emotions categorized in five groups generally describe passenger emotions in relation to comfort. Each group possesses a unique appraisal pattern.

Next the possibility of differentiating the thematic variables underlying passenger comfort and discomfort experiences was explored in chapter 4. This addressed the second objective of the thesis. In that study, 27 (new) participants submitted 54 reports of flight comfort and discomfort experiences and their ratings on the thematic variables for each experience. The analysis indicated that both passenger comfort and discomfort are associated with the same set of variables. Furthermore, those variables we compared to those generated from literature, two brainstorming sessions with specialists, and the first study. They were then reduced and validated in number in a series of studies, whereby participants' ratings on the descriptors of passenger comfort experience were used to highlight the most relevant descriptors, select those with most impact on passenger comfort, and finally categorize them into eight factors which visibly corresponded to the eight themes.

Finally, the dynamics of passenger comfort experience during the flight was examined in chapter 5, meeting the third objective of the thesis. For that purpose, 57 reports were collected from 16 participants using Experience Sampling Method (ESM). It was shown that passengers' first impressions influence their real-time and retrospective evaluation of the flight comfort. The significant correlations between overall comfort evaluation and the comfort in relation to the eight themes further validated those thematic variables. Finally, the real-time assessment of passengers' emotions in the same study highlighted the significance of five emotion groups for their comfort experience, satisfying the forth objective of thesis. Each group was characterized by a unique appraisal pattern, indicating the logic employed by passengers for evaluating the contextual inputs in relation to their concerns.

6.2 A new insight into the experiential aspects of passenger comfort

Previous literature on passenger comfort failed to specify what type of concerns need to be addressed through the design and engineering of the contextual features in the aircrafts. Furthermore, they failed to define passenger comfort experience beyond the general aspects such as physical/physiological, psychological and social aspects. Instead, the contextual features that influence those aspects and bring about an overall feeling of comfort were often discussed in previous research. In this thesis, the studies presented in chapter 3 and 4 elaborated those aspects in terms of eight thematic variables signifying passengers' perceptions of 22 contextual features, i.e. the experience of comfort from the passenger's point of view.

The psychological aspects of such experience are defined in terms of feeling secure, relaxed and tranquil (theme ‘peace of mind’) whereas the physical aspects were defined in terms of bodily support and feeling energetic (theme ‘physical wellbeing’). As a consequence of sharing the cabin space with others, comfort is also influenced by the perception of privacy and control (theme ‘proxemics’) as well as one’s tolerance of and connectedness to others (theme ‘social’). The design of the cabin and service are perceived in terms of ‘satisfaction’, ‘pleasure’, ‘aesthetics’, and ‘association’. Theory of comfort for aircraft passengers (Richards, 1980) was consequently updated to include the subjective aspects of the passenger experience and their link to the contextual features (see Figure 3-3).

The diversity of the eight themes indicates the complexity of the passenger comfort experience and its various aspects. This thesis theorizes that the balance of the eight themes and the emotional responses of passengers ultimately result in a certain level of comfort.

6.3 Emotional responses related to passenger comfort experience

Emotions are situated responses to the interaction of human with the contextual stimuli. They do not last for a long time after the encounter and therefore, the most reliable method to investigate them is real-time inquiry. Aircraft passenger comfort experience is often described as subjective in nature and hence connected to the emotional responses to the flight elements. However, the types of emotions attributed to passenger comfort were never investigated in the literature before. This thesis successfully specified and categorized those emotions as well as their appraisal patterns in connection to the flight context (see Figure 5.2). That included uncovering passengers’ concerns, focuses and the mechanism they employ for evaluating the contextual inputs. The OCC model was found a useful framework for structuring those patterns.

The association between passenger emotions and comfort as a subjective experience was established on two levels in chapter 5. First, a direct correlation between the two was recognized. On the second level, a link was observed between the concerns identified for emotion groups and the subjective themes of passenger comfort. To that end, the emotion groups prospect-based (e.g. satisfaction, frustration, relief) and wellbeing (e.g. joy) were connected to concerns for being secure, relaxed, and accomplished. Those concerns visibly correspond to the descriptors of the themes ‘peace of mind’ and ‘proxemics’ (see chapter 4). In addition, the cabin elements seat and

temperature mentioned in relation to those emotions were also emphasized in relation to ‘peace of mind’ and ‘proxemics’ (see chapter 3). Similarly passengers’ standards such as the responsiveness and attentiveness of agents that were connected to attribution and wellbeing/attribution compound emotions, clearly correspond to the theme ‘satisfaction’. Finally the emotion group attraction was connected to passenger concerns for the aesthetics and physical aspects of objects in the cabin. These are similar to the descriptors of the themes ‘aesthetics’ and ‘physical wellbeing’. The above implies that passenger’s subjective interpretation of the flight features is related to their comfort experience and their emotional reactions, hence suggesting a link between them. The comfort model presented in chapter 1 should therefore be recognized as a valid.

The importance of satisfaction for comfort experience was previously mentioned in the literature (Richards, 1980; Chen, 2008). The results of the study in chapter 5 not only confirm the significance of that suggestion but also provide practical information. The concerns (i.e. feeling safe and secure) and cabin features (e.g. seat) associated with passenger satisfaction should therefore be incorporated into the cabin interior design in order to deliver a comfortable experience. Similar information was provided for other positive emotions such as joy and pleasure.

It is concluded that if the cabin elements or in-flight services succeed in eliciting higher levels of pleasure and satisfaction, passengers are expected to experience an enhanced level of comfort. Emotions motivate human actions and behaviors (Frijda, 1986). That implies that passengers’ choices of future flights are also influenced by their emotional responses to the flight experience. The information provided in the emotional model of passengers enables the aircraft cabin interior designers to satisfy passenger concerns that bring about specific (positive) emotions. In other words, that model could potentially inspire a *design for emotions*.

6.4 Implications for the cabin interior design

A unique design implication suggested by this thesis is that the first impressions of the cabin environment within the 12.8±4.5 min of short and 31±19.5 min of long flights highly determines passengers’ overall comfort experience. The features influencing those reactions the most could be elicited from table 5-2 based on the strength of their correlation with comfort.

Practical information was also provided in terms of addressing the subjective aspects of passenger comfort through the cabin interior design. This thesis isolated the local influence of seven cabin features for the eight experiential themes (see chapter 3). Those features were seat, IFE, service, neighbor, hygiene, temperature, and legroom. The significance of these features for the real-time comfort experience was also confirmed in chapter 5 for short and long flights.

A novel outcome of the above result was that the most frequently mentioned features overall do not necessarily correspond to the most important feature for each theme. This means that relying on overall impacts, which is a common practice in most comfort studies; to inform decisions about cabin interior comfort and design may not be effective. Understanding the local relationship between each thematic variable of passenger comfort and its impacting features provides a unique insight that could inspire new ways of designing the aircraft interior. Furthermore, certain features impact comfort experience in multiple ways (see chapter 3). For instance, the seat provides diverse experiences due to its diverse characteristics. This could inform effective decision making when there are limited resources available for the deign improvements and the effectiveness of the changes in design are emphasized. In that case the features that could potentially tackle various themes of passenger experience should be given higher priorities.

A distinctive result of the study in Chapter 3 was the introduction of the theme ‘proxemics’, recognizing the importance of personal space for the comfort experience. Passengers are concerned with privacy and control within that space. The minimum distance of 0.45m between people in all directions was found to be most effective in creating a sense of personal space. Other solutions to reinforce a feeling of privacy included better separation between the seats prohibiting physical contacts or more options for controlling the immediate space e.g. better storage at the seat, better means of non-verbal communication.

Based on the study with a group of aircraft interior designers, it was shown that there is a lack of knowledge and agreement about the subjective aspects of passenger comfort experience among practitioners in the aerospace industry. It is proposed to employ the eight themes of passenger comfort and their respective descriptors (verified in chapter 4), to provide practical input for the design activities, improve the communication within the design team or set the goals and

objectives of the design process. Moreover, the themes could be employed for the assessment of the overall comfort experience of passengers.

6.5 Implications for comfort evaluation

The subjective themes of passengers' comfort experience were verified in several steps in this thesis, implicating that they could be used effectively for the purpose of evaluating those experiences. A single graded scale, ranging from extreme discomfort to extreme comfort, should be considered for evaluation purposes in order to adequately capture the state of passenger comfort as a whole. This is based on the empirical evidence suggesting that passenger comfort and discomfort are not represented by two sets of variables; they share the same set of thematic variables, relating to different levels of passenger comfort as a single holistic state.

An important conclusion based on the results presented in chapter 4 necessitates eliminating sources of physical pain and health issues in the cabin in addition to sources diminishing 'peace of mind' such as safety issues and/or annoyance (e.g. loud noises, sudden movements of airplane, broken, worn-out or dysfunctional products, etc.) in order to achieve a neutral state. Enhancing pleasure attributes elevates passenger's state to higher comfort level.

A retrospective evaluation of passenger comfort is a reasonable measure of their real-time experience, regardless of the flight length (see chapter 5). The evidence rejects the necessity of real-time inquiry for the evaluation of passenger comfort and validates the retrospective methods of assessment for that purpose. This is particularly important, given that acquiring real-time data about flight experiences are often complicated and require a high degree of commitment from respondents. Moreover, the analysis of the real-time data is more time consuming compared to the retrospective data.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

7.1 Conclusion

Modern aircrafts today excel at meeting the design standards that incorporate passenger's physical health and safety issues. The studies presented in this thesis suggest that future design efforts should go beyond prevention of adverse health issues in a systematic way and by means of enhancing the subjective aspects of passenger comfort as proposed in this research (i.e. comfort themes). That includes the perception of 'peace of mind' to provide security, tranquility and relief, 'physical wellbeing' in terms of bodily support and energy, 'proxemics' by acknowledging passenger's privacy and autonomy, 'pleasure' by providing stimulation while maintaining passenger's 'satisfaction' with the quality and adequacy of the environment. It was shown that the 'aesthetics' impression need to be addressed in terms of neatness and style and that the cabin interior design should facilitate 'social' interactions in order to improve comfort experience. In addition it was shown that the interior design could evoke an 'association' with symbols, memories and other familiar experiences outside the aircraft and comfort could be experienced if those associations have positive or comforting significance for the passenger.

Passenger comfort experience is a complex and multifaceted phenomenon entailing positive effects such as the experience of joy, pleasure, and satisfaction. The psychological ease and emotional responses of the passenger to the flight context are important determinants of the overall comfort experience, and no less influential than the physical impacts.

7.2 Limitations and recommendation for future research

The samples recruited for the studies presented in this thesis were limited in diversity. Addressing the experience of participants with disabilities or those travelling with family members and children should be included in future research in this field. Moreover, observation techniques could potentially verify the significance of the results further.

Another limitation of this thesis was the lack of control over the flight types or environments that were reported by participants. Experimental studies in controlled lab environments could potentially overcome that limitation and validate the impact of cabin features on various aspects of comfort experience.

Furthermore, future research should consider the development and validation of appropriate assessment tools (e.g. questionnaire) by incorporating the provided knowledge about the subjective aspects of passenger comfort.

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APPENDIX A – QUESTIONNAIRE USED IN ARTICLE 1

The questionnaire used in Article 1 of this thesis inquires about passenger comfort experience using an open-ended question.

Part 1 - Personal information

Age: ____ years old

Gender: Female __ Male __

Number of previous flights:

Never __ 1 – 5 times __ More than 5 times __

Part 2 – Flight comfort experience

Referring to your recent air travel, how would you describe your comfort experience during the flight? We would like to know, your vision of comfort. Think about when YOU were comfortable inside the cabin during the flight, the feelings associated with your comfort, the impact of people, seating location and other environmental inputs, tell us your story as if you are telling it to a friend, and please do not hesitate to be as elaborate as possible, share your thoughts.

In telling your story, we would like to ask you to focus on your experience inside the aircraft interior rather than the airport or other phases of the journey.

APPENDIX B – QUESTIONNAIRE USED IN ARTICLE 2

The first questionnaire used in Article 2, in conjunction with the interview technique, was used to differentiate comfort and discomfort experiences and as a step for validation of the eight comfort themes.

Question 1.

Age:

- 18-34
- 35-55
- 55+

Question 2.

Gender: ◯ Male ◯ Female

Question 3.

Height: ____

Question 4.

Physical disabilities: ◯ Yes ◯ No

(if yes, please explain_____)

Question 5.

How many times you have flown before?

- Never
- 1-5 times
- More than 5 times

Question6.

Please describe a flight discomfort in detail.
Referring to an experience during a flight, describes what made you uncomfortable. Think about your feelings at the time, the activities, location or people involved in your experience. Tell us your story as if you are telling it to a friend, and please do not hesitate to be as elaborate as possible, share your thoughts.

Below you will find a list of aspects, which may have influenced the flight discomfort experience you just described. Find those aspects had an impact on your discomfort level, then mark the extent of that influence from 1 (slightly influential) to 5 (very influential). If you do not find an aspect of your experiences, please add them to the comment section.

Discomfort aspects	**Influence**				
Social Refers to the social interactions among people in the cabin (i.e., passengers, flight crew) characterized by one's tolerance for other's behaviors as well as the level of connectedness to or empathy towards others.	1	2	3	4	5
Satisfaction Refers to a sense of fulfillment and contentment that results from achieving desired goals with the help of the environmental elements, based on the adequacy, quality and accessibility of those elements.	1	2	3	4	5
Physical wellbeing Refers to the relationship of the human body to the environment. It entails a feeling of convenience in body, when the body functions without pain or other bodily harms. It also includes feeling energetic and/or refreshed.	1	2	3	4	5
Peace of mind Refers to the state of being safe, secure, tranquil, and/or relieved. It described a feeling of not having worries and concerns where one is able to rest and relax.	1	2	3	4	5
Control and privacy Refers to the feeling of having a level of independence in performing desired tasks or activities, within the personal space, where one is in control of personal affairs, has options to make appropriate choices, without interruptions or violation of privacy.	1	2	3	4	5
Symbolic and association aspect Refers to the personal significance of the environment and the meanings associated to it. It entails how the environment could evoke certain memories or be recognized in relation to other familiar environments (e.g. a room that reminds one of a hotel room).	1	2	3	4	5
Pleasure Refers to the stimulating, joyful, or novel experiences offered by the elements of the environment. It may also refer to the desirability of the ambience of the environment.	1	2	3	4	5
Aesthetic Refers to aspects which please human senses (visual, auditory, smell, taste, touch), for instance beauty or ugliness of objects (e.g. color, form, harmony) or pleasantness of odors, etc.	1	2	3	4	5
Comment	1	2	3	4	5

Question 7.

Please describe a flight comfort in detail.
Referring to an experience during a flight, describes what made you comfortable. Think about your feelings at the time, the activities, location or people involved in your experience. Tell us your story as if you are telling it to a friend, and please do not hesitate to be as elaborate as possible, share your thoughts.

Below you will find a list of aspects, which may have influenced the flight comfort experience you just described. Find those aspects had an impact on your comfort level, then mark the extent of that influence from 1 (slightly influential) to 5 (very influential). If you do not find an aspect of your experiences, please add them to the comment section.

Comfort aspects	**Influence**				
Social Refers to the social interactions among people in the cabin (i.e., passengers, flight crew) characterized by one's tolerance for other's behaviors as well as the level of connectedness to or empathy towards others.	1	2	3	4	5
Satisfaction Refers to a sense of fulfillment and contentment that results from achieving desired goals with the help of the environmental elements, based on the adequacy, quality and accessibility of those elements.	1	2	3	4	5
Physical wellbeing Refers to the relationship of the human body to the environment. It entails a feeling of convenience in body, when the body functions without pain or other bodily harms. It also includes feeling energetic and/or refreshed.	1	2	3	4	5
Peace of mind Refers to the state of being safe, secure, tranquil, and/or relieved. It described a feeling of not having worries and concerns where one is able to rest and relax.	1	2	3	4	5
Control and privacy Refers to the feeling of having a level of independence in performing desired tasks or activities, within the personal space, where one is in control of personal affairs, has options to make appropriate choices, without interruptions or violation of privacy.	1	2	3	4	5
Symbolic and association aspect Refers to the personal significance of the environment and the meanings associated to it. It entails how the environment could evoke certain memories or be recognized in relation to other familiar environments (e.g. a room that reminds one of a hotel room).	1	2	3	4	5
Pleasure Refers to the stimulating, joyful, or novel experiences offered by the elements of the environment. It may also refer to the desirability of the ambience of the environment.	1	2	3	4	5
Aesthetic Refers to aspects which please human senses (visual, auditory, smell, taste, touch), for instance beauty or ugliness of objects (e.g. color, form, harmony) or pleasantness of odors, etc.	1	2	3	4	5
Comment	1	2	3	4	5

APPENDIX C – QUESTIONNAIRE USED IN ARTICLE 3

A questionnaire in eight sections was designed for the Experience Sampling Method (ESM) inquiry presented in Article 3.

Name: .....

Gender: Male / Female Height: .....

Age: 18-20 21-29 30-39 40-49 50-59 60+

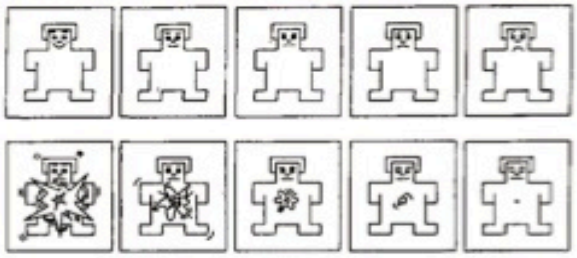
1. Background

1.1 Type of aircraft:..... 1.2 Airline: .....

1.3 Seat location: Aisle / Center / Window 1.4 How long is the flight duration in total? __hrs___min

1.5 We would like to have an assessment of your current mood and feeling, before you start reporting you experiences. We introduce a character called SAM, for you to describe your sentiment (from smiling happy to frowning sad SAM) and intensity (from tense to calm).

Please mark the characters to express your sentiment and intensity.



2. About your experience (at the beginning of the flight)

2.1 How long have you been on the flight so far? ____hrs ____min

2.2 With respect to this flight, what were you thinking about just now? Please elaborate.

2.3 What was the main activity you were doing just now? Please include the products or people involved in this activity.

2.4 Why were you doing this activity?

- I had to do it
- I wanted to do it
- I had nothing else to do
- other

2.5 Please rate your *Overall Comfort*

Slightly comfortable	1
	2
	3
	4
	5
	6
	7
	8
Very comfortable	9

2.6 Please specify the reasons for your rating.

Tell us also how your flight experience up to this point influenced your level of comfort.

2.7 Please rate the comfort level associated with the following features from 1 (slightly comfortable) to 5 (highly comfortable)?

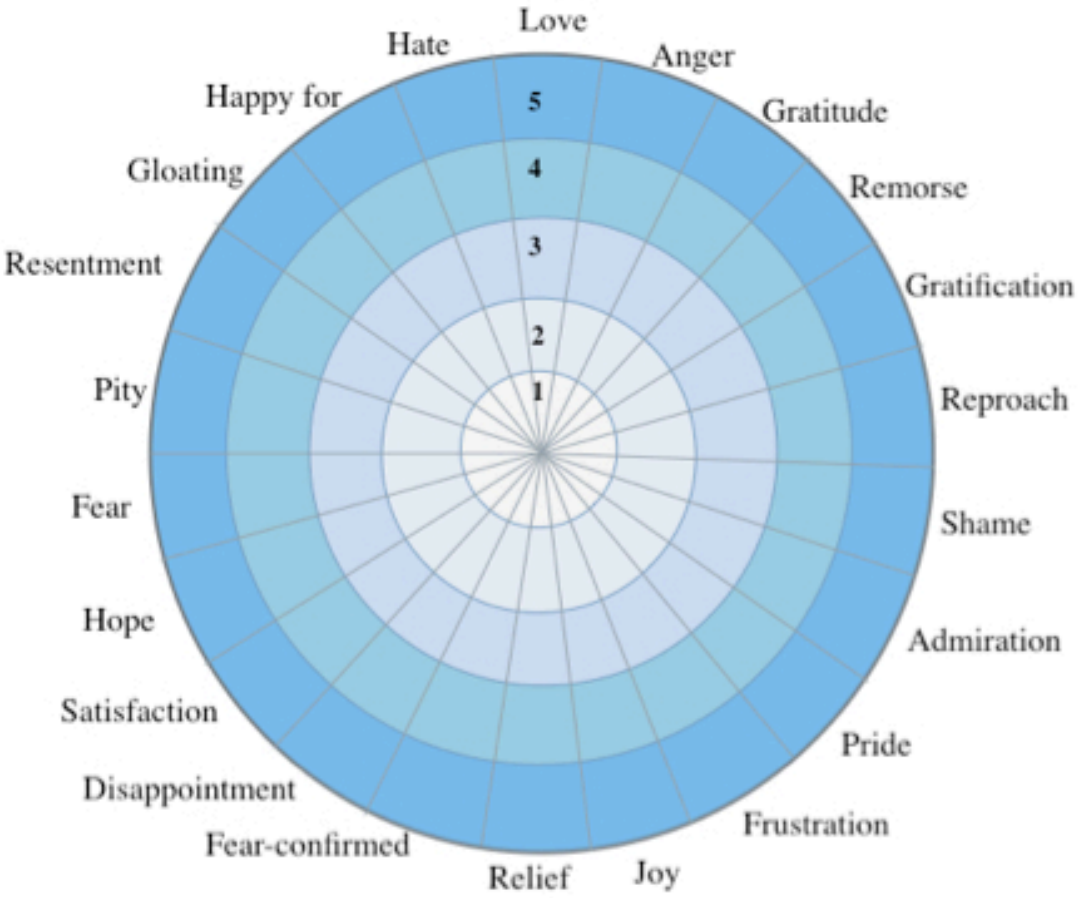
Seat	1	2	3	4	5
Legroom	1	2	3	4	5
Temperature	1	2	3	4	5
Noise	1	2	3	4	5
Air quality	1	2	3	4	5
Lighting	1	2	3	4	5
IFE	1	2	3	4	5
Service	1	2	3	4	5
Hygiene	1	2	3	4	5
Luggage	1	2	3	4	5
Other					

2.8 What made this flight most memorable so far? Please describe.

3. Emotions

Please use the emotion shown below that were most significant to you at this point in your flight. Once you identified the emotions, mark the intensity of each emotion from 1 (at the center) representing 'barely felt' and 5 (the largest circle) representing 'strongly felt'. You could use the comment section to specify some reasons for your rating. If you have experienced an emotion which you do not find on the wheel, tell us about it in the comment section below.

Please note that each emotion word represents a family of emotions and can stand for a whole range of similar emotions. For instance, joy could also represents cheerful, delighted, glad, and happy.



Comments: _____

_____

_____

_____

_____

4. *About your experience (half way through the long flight)*

4.1 How long have you been on the flight so far? ____hrs ____min

4.2 With respect to this flight, what were you thinking about just now? Please elaborate.

4.3 What was the main activity you were doing just now? Please include the products or people involved in this activity.

4.4 Why were you doing this activity?

- I had to do it
- I wanted to do it
- I had nothing else to do
- other

4.5 Please rate your *Overall Comfort*

Slightly comfortable	1
	2
	3
	4
	5
	6
	7
	8
Very comfortable	9

4.6 Please specify the reasons for your rating.

Tell us also how your flight experience up to this point influenced your level of comfort.

4.7 Please rate the comfort level associated with the following features from 1 (slightly comfortable) to 5 (highly comfortable)?

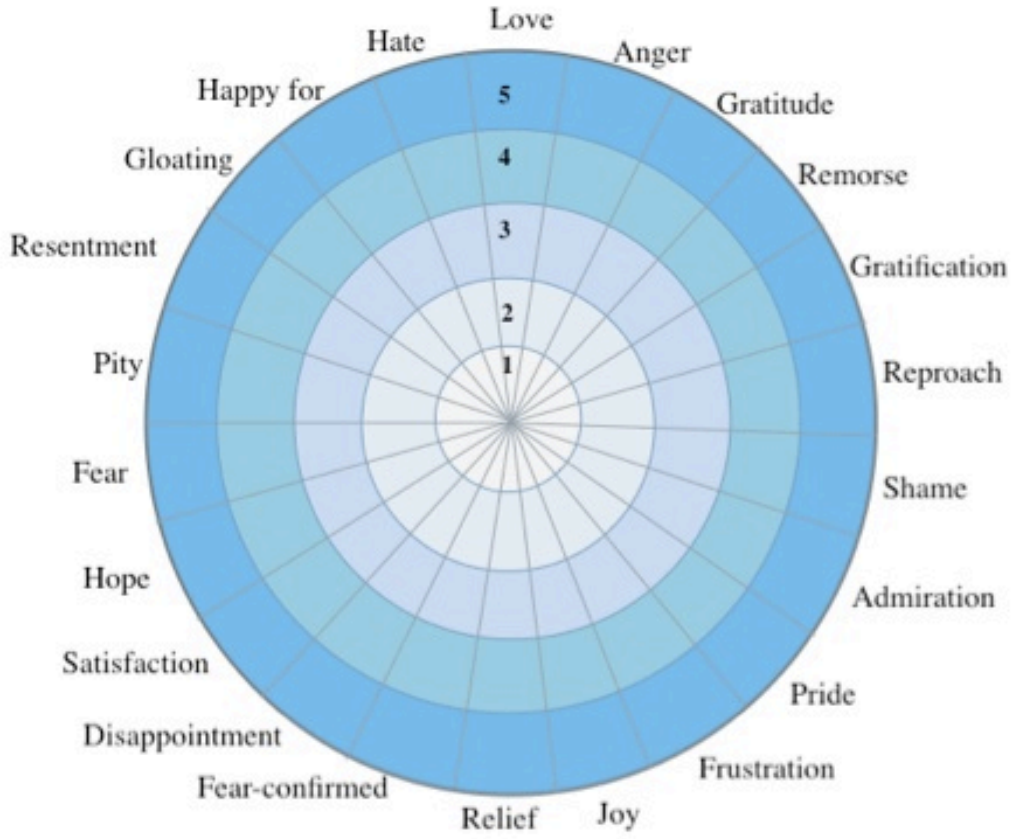
Seat	1	2	3	4	5
Legroom	1	2	3	4	5
Temperature	1	2	3	4	5
Noise	1	2	3	4	5
Air quality	1	2	3	4	5
Lighting	1	2	3	4	5
IFE	1	2	3	4	5
Service	1	2	3	4	5
Hygiene	1	2	3	4	5
Luggage	1	2	3	4	5
Others					

4.8 What made this flight most memorable so far? Please describe.

5. Emotions

Please use the emotion shown below that were most significant to you at this point in your flight. Once you identified the emotions, mark the intensity of each emotion from 1 (at the center) representing 'barely felt' and 5 (the largest circle) representing 'strongly felt'. You could use the comment section to specify some reasons for your rating. If you have experienced an emotion which you do not find on the wheel, tell us about it in the comment section below.

Please note that each emotion word represents a family of emotions and can stand for a whole range of similar emotions. For instance, joy could also represents cheerful, delighted, glad, and happy.



Comments: _____

_____

_____

_____

_____

6. About your experience (toward the end of the flight)

6.1 How long have you been on the flight so far? ____hrs ____min

6.2 With respect to this flight, what were you thinking about just now? Please elaborate.

6.3 What was the main activity you were doing just now? Please include the products or people involved in this activity.

2.4 Why were you doing this activity?

- I had to do it
- I wanted to do it
- I had nothing else to do
- other

6.5 Please rate your *Overall Comfort*

Slightly comfortable	1
	2
	3
	4
	5
	6
	7
	8
Very comfortable	9

6.6 Please specify the reasons for your rating.

Tell us also how your flight experience up to this point influenced your level of comfort.

6.7 Please rate the comfort level associated with the following features from 1 (slightly comfortable) to 5 (highly comfortable)?

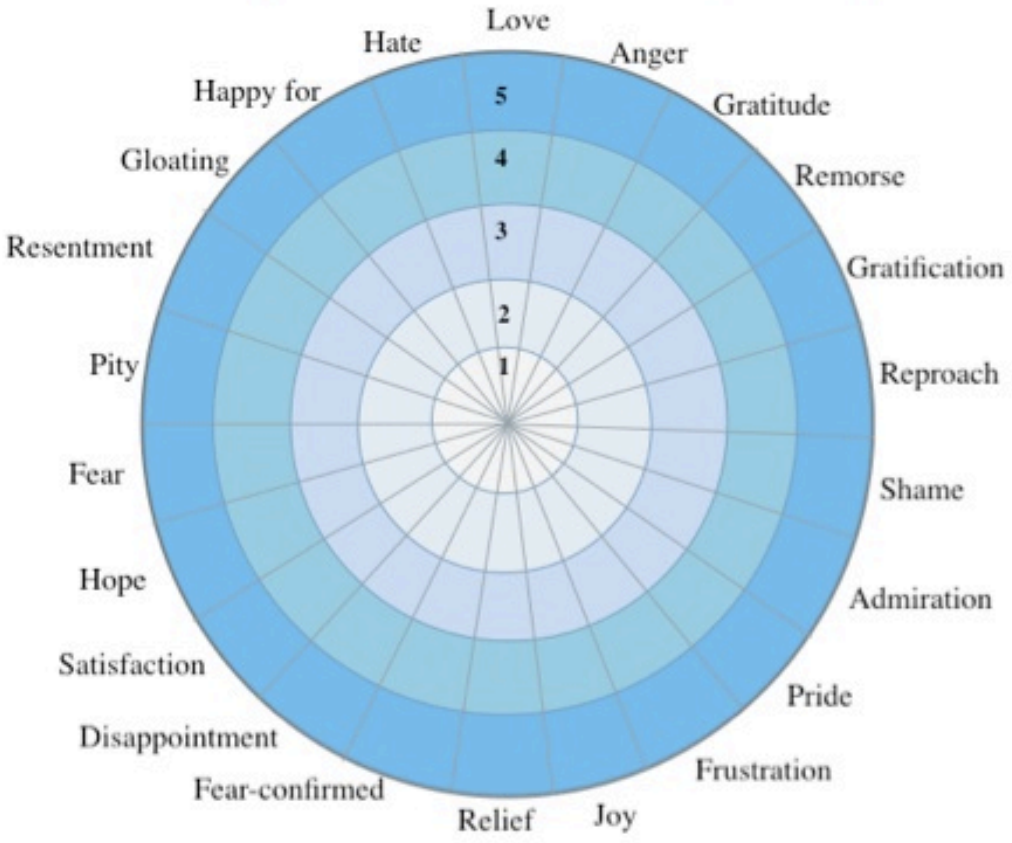
Seat	1	2	3	4	5
Legroom	1	2	3	4	5
Temperature	1	2	3	4	5
Noise	1	2	3	4	5
Air quality	1	2	3	4	5
Lighting	1	2	3	4	5
IFE	1	2	3	4	5
Service	1	2	3	4	5
Hygiene	1	2	3	4	5
Luggage	1	2	3	4	5
Others					

6.8 What made this flight most memorable so far? Please describe.

7. Emotions

Please use the emotion shown below that were most significant to you at this point in your flight. Once you identified the emotions, mark the intensity of each emotion from 1 (at the center) representing 'barely felt' and 5 (the largest circle) representing 'strongly felt'. You could use the comment section to specify some reasons for your rating. If you have experienced an emotion which you do not find on the wheel, tell us about it in the comment section below.

Please note that each emotion word represents a family of emotions and can stand for a whole range of similar emotions. For instance, joy could also represents cheerful, delighted, glad, and happy.



Comments: _____

_____

_____

_____

_____

8. Trip follow-up

8.1. How would you rate the overall comfort of this flight?

Slightly comfortable — Very comfortable

1	2	3	4	5	6	7	8	9

8.2 Below you will find a list of aspects which may have an influence on your comfort experience. Please read their definitions then think about the comfort of this flight, as you remember it. Choose those aspects which were presented in your experience. Then mark their level of influence (1 being slightly influential and 9 being very influential) and give your reasons. If you do not find an aspect of your experiences in the checklist, please add them at the end of the list in comment section with a short description.

Aspects	**Influence** 1 slightly influential 9 very influential	**Reason**
Social Refers to the social interactions among people in the cabin (i.e., passengers, flight crew) characterized by one's tolerance for other's behaviors as well as the level of connectedness to or empathy towards others.	1 2 3 4 5 6 7 8 9	
Satisfaction Refers to a sense of fulfillment and contentment that results from achieving desired goals with the help of the environmental elements, based on the adequacy, quality and accessibility of those elements.	1 2 3 4 5 6 7 8 9	
Physical wellbeing Refers to the relationship of the human body to the environment. It entails a feeling of convenience in body, when the body functions without pain or other bodily harms. It also includes feeling energetic and/or refreshed.	1 2 3 4 5 6 7 8 9	
Peace of mind Refers to the state of being safe, secure, tranquil, and/or relieved. It described a feeling of not having worries and concerns where one is able to rest and relax.	1 2 3 4 5 6 7 8 9	
Control and privacy Refers to the feeling of having a level of independence in performing desired tasks or activities, within the personal space, where one is in control of personal affairs, has options to make appropriate choices, without interruptions or violation of privacy.	1 2 3 4 5 6 7 8 9	
Symbolic and association aspect Refers to the personal significance of the environment and the meanings associated to it. It entails how the environment could evoke certain memories or be recognized in relation to other familiar environments (e.g. a room that reminds one of a hotel room).	1 2 3 4 5 6 7 8 9	
Pleasure Refers to the stimulating, joyful, or novel experiences offered by the elements of the environment. It may also refer to the desirability of the ambience of the environment.	1 2 3 4 5 6 7 8 9	
Aesthetic Refers to aspects which please human senses (visual, auditory, smell, taste, touch), for instance beauty or ugliness of objects (e.g. color, form, harmony) or pleasantness of odors, etc.	1 2 3 4 5 6 7 8 9	
Comment	1 2 3 4 5 6 7 8 9	