Creativity-supporting environments

An emotion-based framework for influencing designers' creativity through using design environments

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A thesis submitted for the Degree of Doctorate of philosophy

July 2016

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Abstract

Organisations need to develop their physical/psychological environments in order to build more creative, positive, activated and motivated spaces for people to work. Although previous research has investigated the effect of environment on creative performance, there has been little research into how it might support creative work that evolves through a sequence of divergent and convergent activities based on people's emotions. This research proposes a theoretical framework with which to design the environments to support creative thinking that recognize and apply components that link creativity and emotions. Environment, emotion and creativity are the 3 main elements that form the structure of this framework. It is called the CSE (Creativity-Support-Environment) framework. The framework uses the link between emotion and creativity to create physical and digital environments that actively enhance and maintain different types of creative thinking in the design workspace. The framework addresses that gap in knowledge in the fields of environmental design and psychology, the effect of physical and digital work environment on creativity on the one hand, and the impact of emotions on creativity in the environment. On the other, the framework gives rise to guidelines for designing physical and digital spaces that facilitate creative thinking. To validate the CSE framework, empirical studies were undertaken in different environments, a set of design guidelines that can be applied in designing spaces with different stimuli (physical and digital), to foster divergent and convergent creative thinking. The CSE framework is important because it examines creativity from the perspective of emotion and applies the link of creativity and emotion in designing the environment to improve creative thoughts. In practice, the design guidelines can be adopted by designers of physical and digital environments to ensure those environments better support divergent and convergent design tasks. The results of this research have implications for the development of further design guidelines to form the construction of creative design environments in organizations with the aim of optimizing creative potential.

Declaration

The work described in this thesis is based on research carried out at the Centre for Creativity in Professional Practice, City University London, London, United Kingdom. No part of this thesis has been submitted elsewhere for any other degree or qualification. All work is my own, unless stated otherwise.

Mobina Nouri   Date 26/07/2016

Acknowledgements

This thesis came to this point with great support of many people. First and foremost I would like to pay special thanks to my supervisor, Professor Neil Maiden. During the journey of my PhD, he patiently gave me great help and valuable comments to encourage me for improvement and growth. I appreciate all his contributions of time, ideas, and funding to achieve my PhD. I would also like to thank to all people from Centre for Creativity in Professional Practice and Centre for Human Computer Interaction Design that added joy and enthusiasm in this great journey. My appreciation is also due to Stuart Mackay, Alwin De Rooij, Graham Dove, Dr Sara Jones, Professor James Hampton, Rajiv Arjan, Dara Shirvani, Professor Gragury Poletta, Stuart Scott, and Mani Reyhani for their input and support. I would also like to acknowledge all people that participated in my studies with their time and patience that made this research possible. Finally, I would like to thank my parents for their beautiful love and encouragement in my entire life.

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1 Introduction

Design fulfils an increasingly important role in modern society. Products, services and environments are all the result of complex design processes, an activity now worth at least £2.5 billion a year to the UK economy (DCMS, 2014). And yet, although design is a process of shaping creative ideas to become practical activities and objects in people's lives (Design Council 2014), there has been relatively little research into the influences of creative thinking in design work. Although design activities have been studied empirically to reveal important cognitive phenomena such as idea fixation (Cross, 2004), little research has investigated factors that influence creative thinking in design processes. Therefore this research investigated one such factor – the environment for creative design. The physical and digital environment refers to all components that associated with visual and auditory senses in both physical and digital formats, and can conclude furniture, light, colours, plants, digital images, projector and computers.

An environment affects how people think, feel, work and interact. Many successful designers highlight the importance of their environments to their creative work. For instance, Paul Smith described his studio as such: "Why this room is just full of toys, beautiful books, strange objects, good fun things, [from which] you can get great inspiration? My whole life is about being childlike...which means that you have a lateral mind? And you're very curious... Life is about living young, being youthful and enjoying yourself everyday." (Yoo, 2013) These experience-based claims by designers show the importance of environment to inspire creative ideas. However, there has been little research to understand the effect of environment on creative activities, especially by considering the impact of environment on emotions and creative activities. Because the past research revealed particular emotions such as happiness and interest could improve creativity, people's emotions can directly influence by the environment and consequently it can expand creative thinking.

Sternberg and Lubart (1999) define creativity as “the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive to task constraints)”. Novelty is defined in different contexts with respect to H-Creativity (historical creativity) that is new to person-kind (Boden, 1990), P-Creativity (psychological creativity) that is new to the person, but not to person-kind or others (Boden, 1990), or S-Creativity (Situated creativity) that defines a designer had an idea for a specific task with novelty in that particular situation or domain (Suwa et al., 2000). S-creativity defines creativity as a dynamic concept that is situated in a place or space. It is not only the result of psychological impulse of one individual, but rather it is the process that always happens in that context (Belussi and Sedita, 2011).

Accordingly creativity cannot be treated as a uniform phenomenon. Rather, most repeatable and effective creative process are divided into creative activities such as *incubation* then *illumination* of ideas (Wallace, 1926), *mess finding* before *idea generation* (Osborn, 1953), or divergent *idea generation* before convergent *solution building* (Pslek, 1997). Each of these creative activities has different characteristics that could be supported more effectively by different environments. Of course, the new principles could be generated directly from existing creativity research. During creative divergence, for example, designers scope and explore different idea spaces (Boden, 1990), so a supportive environment might provide multiple stimuli to search and discover ideas in these spaces. Likewise, during creative divergence, designers select ideas and develop quick prototypes (Lockwood, 2010), so the environment might support designers to locate and experiment with ideas without hindrance, then construct simple prototypes.

This research argues that a new framework can construct environments to support different types of creative activities. This framework needs to incorporate factors established to affect cognitive creativity. Factors such as emotional states, specific emotions such as happiness, joy and interest can be created by using physical and digital features of the space to enable designers to improve their creative potentials via their influence within the environment.

This chapter presents and explains the structure and the scope of this thesis. First it defines the research problem and the challenges in understanding the research problem. Then it outlines the research scope, and establishes a theoretical structure of this research, then presents the research questions and objectives. The chapter finishes with the proposed contribution to the field.

1.1 Problem description in the research domains

1.1.1 Environment

Characteristics of an environment can tell us about the “personality” of that space. These characteristics are not only physical such as colours, lighting and objects, but also the smell, sound and even haptic factors of the space that cause us to have different feeling about that space. For example, being in a restaurant is not just about food, but also experiences of being in the particular environment that is formed through the smells, music, lighting, and seating.

Each environment has the potential to cause specific emotions in people. In architecture, this is called the “*genius loci*” a Roman expression that refers to a location's distinctive atmosphere, or a “spirit of place” that is related to some particular emotions (Graves & Poraj, 2009). Furthermore, more widely, the form and function of a space can reflect the culture, behaviours and priorities of the people within it (Doorley & Witthoft, 2012).

From a psychological point of view, an environment can change people’s emotions. People can experience different emotions in different environments. For example, if we imagine ourselves in an entertainment park, museum, theatre or hospital, we might feel different types of emotions. Environmental psychology is an interdisciplinary field that helps us to understand this relationship better. Kopec (2012) reports environmental psychology research about how a room affects people's behaviour, emotions and well being by reducing people's stress and increasing their satisfaction. However, there is still a lack of applicable guidelines for designing specific spaces to provide different emotional changes. For example, several researches revealed that positive emotions have an impact to improve creativity (Baas et. al, 2011). So the environment can be designed to stimulate more positive emotions, such as happiness, by applying vivid colours in the space, and as a result facilitating creative thinking.

1.1.2 The effect of environment on creative design

Although human creativity could happen anywhere, there are some studies that indicate that, environment designs could notably affect creativity (Moultrie et al, 2007; Taher, 2008; Landry, 2012). Environments with certain qualities and elements e.g. access to the nature, natural material, warm colours and window views, have been shown to foster human creativity (Doorley & Witthoft, 2012), and innovation (Moultrie et al, 2007). However, although the Make Space tool (Doorley & Witthoft, 2012) guides how environments can be manipulated to ignite collaborative creativity, there are few principles to inform the construction of environments to support creative activities.

IDEO is a good example of design organisation that believes that spaces can support visualisation, exploration and inspiration through access to materials and artefacts. Its approach considers the environment as a catalyser that develops design evaluation (Moultrie et al, 2008). In IDEO, a transparent open studio for the interdisciplinary work of designers, business strategists, and programmers supports the creative process of design by showcasing individual projects. Pixar environment represents the spontaneity and storytelling while Google spaces represent playful culture (Kahl, 2011).

Figure 1.1. Different settings of creative and non-creative space: left column - One limited location and one restricted way of engaging that cannot trigger positive emotions. It forces people to focus on the screens without any other possibility for change; right column - positive emotions and creative space, variety of stimulus, visual, textural and spatial alternatives that provide interaction between people and the environment and represent freedom to choose the space and activity.

However, with all this evidence, there is still little research and knowledge about which features, how and in what extent; space can enhance creativity. Therefore, the main challenge for this research is to understand the features of the environment that enhance creativity by influencing people's emotions.

1.2 Creative design in creative environments

The conditions of people in workspaces can impact their health and well being because they spend much of their waking time in those workspaces (Approximately 33% on a weekly basis) (Veitch, 2011). Existing knowledge in both workspace design and mental health proposes that workspace design influences mental health via the effect of light exposure, social behaviour, access to nature, privacy regulation and stimulus control (Veitch, 2011). As a consequence, a suitable workspace can improve job satisfaction, environmental satisfaction and job performance (Sundstrom et al., 1996).

According to a “Creativity in the workplace” report, creativity is now considered as a key factor of everyone’s job (Martin, 2010). In the report, creativity is strongly associated with motivation and satisfaction, and as a result can have a positive impact on productivity and robustness. Other research into work environments has revealed that 40% of office workers felt most productive at work on their own desk (Cooper, 2011). There is a need to investigate the workspace in terms of diverse needs of workers to enhance both their productivity and their creativity. A creative capacity could be affected by how people interact with their physical surrounding (Morel research, 2008).

Moreover, physical settings are very important in the workspaces in each organization (Moultrie et al., 2007). In designer’s jobs that involve a creative process, the role of workspace becomes even more crucial. Designers need the space that motivates and triggers creativity. However, poorly designed workspaces such as cubicles in limited spaces, desks in open areas, that cause interruptions and distractions, and poor lighting can all inhibit creativity. Such poor working conditions reduce productivity (Beach, 2015). However, good news is that technology companies reliant on effective design processes and problem solving in their projects now understand the vital role of workspace in worker’s wellbeing, productivity and creativity, and the importance of workspace has been demonstrated by better workspace designs in most successful organizations such as Google, Facebook, Apple and IDEO (Kahl, 2011).

However, there is still a need for greater understanding the characteristics and components of such spaces and how they can support creativity performance. Therefore, this doctoral research sought to fill this gap by understanding the creative process that supports such spaces and implementing new digital technologies to support it.

1.3 Research Scope and Definition of Concepts

To provide a baseline for and to the scope of the doctoral research, this section defines the research components in three main domains: emotion, creativity and environment, for use throughout the thesis.

1.3.1 Emotion

Scherer (2000) defines emotions as a " hypothetical construct denoting a process of an organism's reaction to significant events" (Scherer, 2000). Events can be *external* such as behaviour of others, a change in the current situation or novel stimuli or *internal* such as thoughts, memories or sensations (Scherer, 2000). Each emotion episode lasts for a certain duration of time, with decreasing intensity, before it fades away (Scherer, 2000). Emotion can change moment by moment, and are short term in duration. Evidence is that sights, smells, sounds and the external environment can trigger our emotions. The existing research demonstrates the direct effect of emotion on creativity (Bass et al., 2011).

1.3.2 Creativity and creative processes

1.3.2.1 Creativity

Sternberg & Lubart (1999) define creativity as "the ability to produce work that is both novel (i.e. original, unexpected) and appropriate (i.e. useful, adaptive to task constraints)". Boden (1990) categories creativity in three types: exploratory, combinational and transformational. Exploratory creativity is a search space of partial and complete possibilities and rules exist to enable traversal of search space. Combinational creativity makes unfamiliar connections between familiar possibilities in the search space. And transformational creativity challenges the constraints on the search space and enlarges space of possible ideas to explore (Boden, 1990).

Creative processes can be characterized as inspirational, situational and structural creative processes. Wallas (1926) defined inspirational process as interplay between consciousness and unconsciousness, insight and breakthroughs in 4 known stages of preparation, incubation, illumination and verification. A situational creative process is applied for social aspects of problem solving and interaction and collaboration in teams. Structural creative processes develop the creative ideas in a rational and systematic approach. It is an exhaustive, systematic and structured search for information and also structured and guided process to explore and solve problems (Osborn, 1953; Daupert, 2002). This research uses the last category, and seeks to support structural creative processes. Because this research focuses on creative design processes that support structural creativity and needs to follow the method of problem solving in design field.

1.3.2.2 Divergent and convergent thinking

In a creative processes people search for alternative answers to one problem (divergence) then evaluate one possible answer from the alternatives (convergence) (Isaksen, 2008). "Convergent thinking can produce new ideas scientifically, and divergent thinking can produce new ideas artistically. To produce meaningful art and creative science, artists and scientists combine convergent and divergent together for the best result of creativity" (Nilson, 2011). This research considers creativity as combination of divergent and convergent thinking.

1.3.2.3 Creativity in design

The UK's Design council (2011) states "Design shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end". Design also explained as a creative and user-centered approach to problem solving (Design council, 2011). Creativity and design are essential components of a developed economy that both have a strong impact on the innovative outcome in different countries (Hollanders & Cruysen, 2009).

Design thinking is another term that refers to the process of design with the aim of solving a problem. Design thinking is a human-cantered innovation process that includes observation, collaboration, fast learning, and visualization of ideas, rapid prototyping and concurrent business analysis (Lockwood, 2010). Therefore the influence of creativity in design is needed to improve creative thinking in education and industry, and the innovative performance of the society grows gradually (Hollanders & Cruysen, 2009).

1.3.3 Environment

Environment is defined as "the context, including the place and situation in which creativity take place" (Isaksen et al., 2009). Spaces that people live and work can be understood through their five senses analysed by the brain and influenced by function of mind and cognition process. Many researches have demonstrated that the physical environment influences creative output and thinking mode (McCoy, 2005; Deasy & Lasswell, 1990; Taher, 2008). The ways people feel in the space change their perception of the function of space and their activities shapes accordingly. For example, open-plan spaces reflect more flexibility, which enhances interactions and teamwork, while closed areas boost individuals' concentration and development of ideas. For example, most cafés are not limited to selling food and drinks. Smell, music, atmosphere, lighting and seating conditions, all influence how people experience and feel about space. The physical factors of an environment can influence peoples' emotions.

1.3.4 The links between emotion, creativity and environment, and the research scope

As will be reported in the literature review in chapter 2, there is research that has studied the associations between each two concepts: creativity-emotion, creativity-environment and environment-emotion that are showed in the intersections of each 2 circles (Figure 1.2). However, on connecting creativity, emotion and environment, there is still an absence of research to understand the links between emotion, environment and creativity in design work that is showed in the shared area of 3 circles (Figure 1.2).

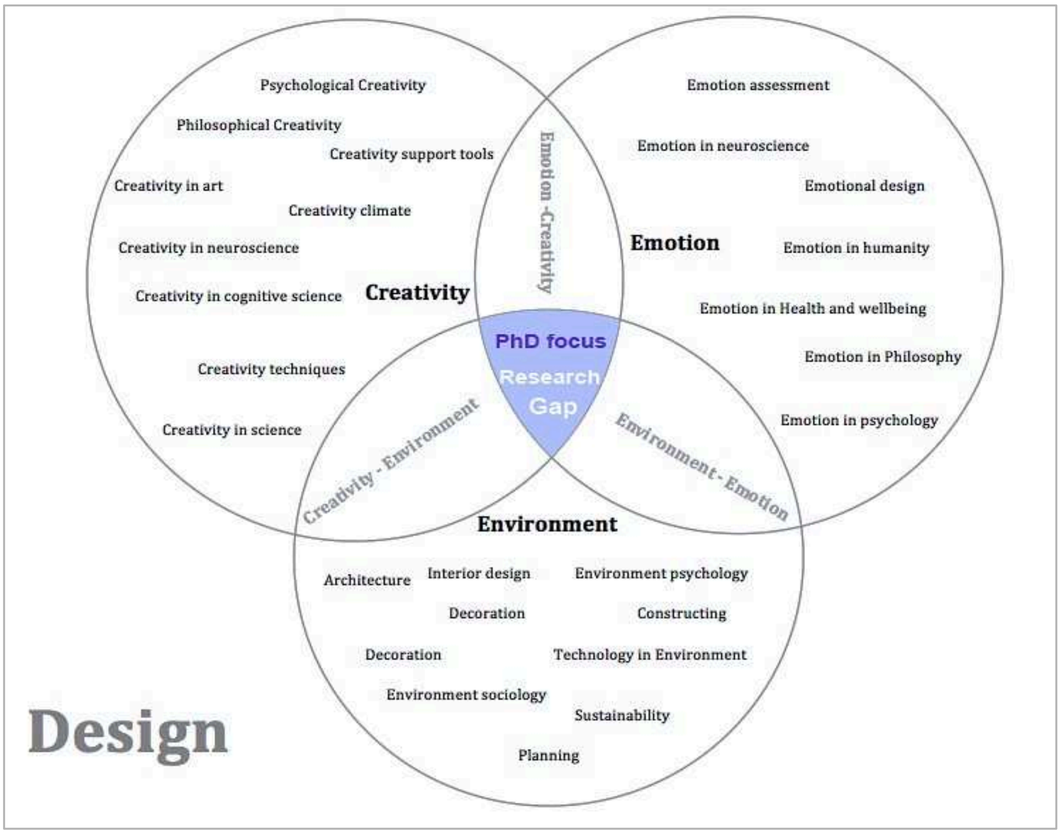

Figure 1.2. The scope of thesis in three main domains of research

1.3.4.1 The proposed structure of the relationships between emotion, creativity and environment

This research seeks to create and investigate a new type of creativity space to influence the relationship between emotion and creativity, with the aim of helping designers to exploit their creative potential. These environments can support creativity in design by manipulating designers' emotions.

This research introduces the concept of creativity support environments that aim to enhance designers' creative performance. To do this, the research seeks to manipulate the environments in order to influence designers' emotions at different stages of a creative process.

According to previous research, an environment with specific visual features such as colours, furniture and light could trigger particular emotions in designers and it can improve the creative performance. The structure in Figure 1.3 shows all connections between the main concepts (environment-emotion-creativity) in the creative design process, however the main research focus is on the affect arrows (illustrated with vertical arrows). How environment features affect emotions and then those emotions affect creative performance. To test the proposed structure the environment features will be implemented with different physical and digital stimuli.

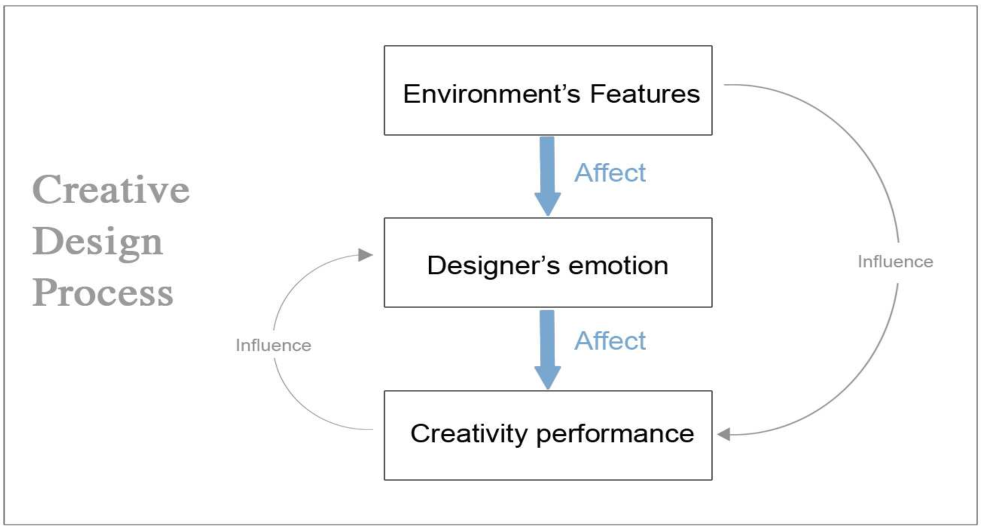

Figure 1.3. The structure proposed to use as a creativity supporting environments framework

1.4 Research challenges, questions and objectives

1.4.1 Research questions

With respect to the main challenge, which is to explore how environment could stimulate or inhibit creativity during design processes, the research questions are:

1. How do environments affect on designers' creativity by influencing their emotional states in a creative design work?

2. What kind of emotional states enhance creativity during the divergent and convergent stages of a creative design work?

3. How is an environment implemented during the divergent and convergent stages of creativity design work (divergent and convergent thinking) to manipulate designers' emotions, with the aim to enhance designers' creative thinking?

1.4.2 Research objectives

Answers to the three research questions will be sought in line with the following three objectives:

1. To investigate an original framework that can explain the relationship between creativity, emotion and environment to improve the creative performance in design process.

2. To design a physical/digital environment for supporting creativity because the different emotions of designers in each stage of creative process in divergent and convergent thinking.

3. To evaluate the framework by undertaking empirical studies to test different environments to improve designers' creative performance regarding to their emotions.

1.5 The PhD outline structure

The structure of the thesis this is shown in Figure 1.4. Each chapter is outlined in more detail. The approach was to review the research context, explore an initial theoretical model, test and refine it, and then develop a final model with recommendations on how to use it to design environment to enhance creative work.

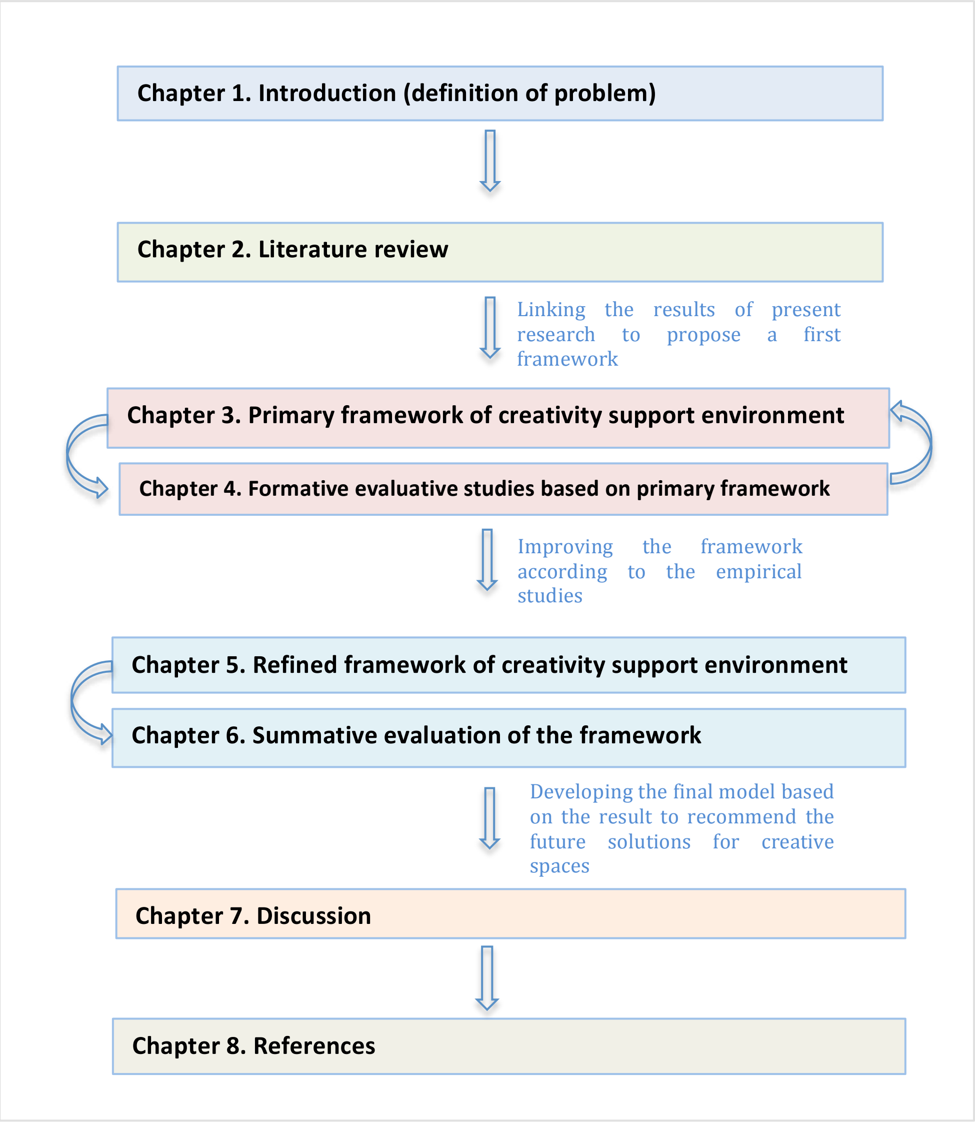

Figure 1.4. Thesis structure and the relationship between chapters

The remainder of the thesis is organised as follows:

Chapter 2: Literature review

This chapter demonstrates an understanding of and critiques the knowledge in the three main fields of research:

1. The importance of creativity in the design process
2. Environment and the features of environment that affect creative performance
3. Emotions that are associated with creativity

To conclude, the chapter reviews the connection between these three areas within a framework of previous research, and identifies the lack of research of the intersections of these areas. The existing research was then analysed to identify gaps in current research.

Chapter 3: Primary framework of a creativity support environment

This chapter presents the primary framework of a creativity support environment. The framework has been developed to explore the new environment for a creative work that helps designers to improve their creative capabilities by changing their emotions. It describes and explains the framework to explore how the environment can be designed to stimulate designer's emotions for enhancing creative thinking.

Chapter 4: Formative evaluative studies based on primary framework

This chapter reports the results of two studies that sought to validate the first framework. The first study was designed to test the positive and negative effects of environment using group of designers who undertook a creative design task. The output on this stage was a refined version of the framework to guide the research for the second study. The second study investigated how individual designers undertook divergent and convergent thinking. Three environments have designed, created and examined, each with specific characteristics, to boost divergent and convergent creativity and a controlled environment to allow comparison with the two other environments. The results investigated the effect of environment on each designer's creativity and emotions, and led to an expanded version of the framework that was reported in chapter 5.

Chapter 5. Refined framework of creativity support environments

In this chapter, the revised framework of a creativity support environment posits from the results of the two studies from Chapter 4. This framework is elaborated details and specification of different elements of environment and emotions.

Chapter 6. Summative evaluation of the framework

This chapter reports an empirical summative validation of the framework. To investigate the effect of environment on creative performance, two different environments were designed, created and evaluated to stimulate the specific components of designers' emotions. The empirical study involves 41 designer participants and explores how environment could change to support creative work that evolves through a sequence of divergent and convergent activities.

Chapter 7. Discussion

This chapter concludes the thesis by revising the objectives, answering the research questions and discussing future research. This research recommend the model of creativity support environment for future research, and make practical and theoretical contributions to the field.

1.6 Contribution to the field

The contribution of the research in the form of models, principles and guidelines of the new environments that are designed to manipulate the designers' emotions to enhance creativity, is a new approach to support creativity in the design sciences. This thesis provides new knowledge for creativity and design researchers, for academics and practitioners in creativity and design field. The new model could be investigated and experimented within theory, and then subsequently used to study designers' behaviours within different settings of environments and emotions. The framework is particularly important because the influence of emotions in physical and digital design spaces can potentially enrich the creative process and enhance creativity. It aims to enhance the designer's performance and creative thinking in the future design workspaces.

The future workspaces can provide an engaging interaction between designers and environment within the creativity design process, which includes both digital and physical features of the space. These features that lists in the design guidelines, practically could contribute in designing creativity-support-environments. This research investigates the environment that affect on emotions, the environment that affect on creativity and finally the environment that support creative process by considering the link between emotion and creativity. The framework is also intended to apply technology to enhance designer's environments with the aim to help designers to gain most of their creative potentials.

To conclude, this doctoral thesis provides the framework and design guidelines for both physical and digital spaces that can benefit the design thinking and creativity-emotion related researches. It claim that designing a new space for creativity performance that create the specific emotions in designers could be beneficial in improving the future settings of design experiments in both education and industry.

2 Literature review

This chapter reports previous research undertaken in three disciplines: creativity, emotion and environment. It then presents the relationships between the results of research in these three disciplines that underpins on approach that sought to enhance human creativity with elements of environment that influence emotions to foster creativity. At the end of the chapter, it concludes the relationships between the disciplines to determine links between creativity, emotion and environment concepts, to target the gap of knowledge, and propose a model for this research.

2.1 Creativity

Runco (2009) claims that creativity is more important now than ever before in a review of 25 years of literature focusing on creativity in different domains. Creativity plays an important role in our everyday lives, and is more than just a concept for art, invention and innovation. It can benefit both individuals and society (Runco, 2009). Creativity is also an economic aspect of innovative organizations that has become more and more important. Creativity research is now significant part of competitive domains such as business, education, social development, health, design and technology (Norman, 2006).

Creative work can be evaluated by 2 main characteristics of its definition from Strenberg and Lubart (1993); novelty (i.e. original, unexpected) and appropriateness (i.e. valuable, useful, adaptive). There are two types of novelty: P-Novel that is a new idea that might create by others before, and H-Novel that is never thought by anyone else before (Warr & O'Neil, 2005).

There is also a difference between individual novelty (I-Novel) and group novelty (G-Novel) in a creative design process (Warr & O'Neil, 2007).

Edward de Bono (2010, p.38), the father of lateral thinking, statesthat "Creativity involves breaking out of established patterns in order to look at things in a different way." Csiksentmihalyi believes that creativity is produced by seeing a new pattern in one domain by inclusion into the other domain (McIntyre, 2007). Guilford defines 'modern' creativity as applying four components of divergent thinking: fluency, flexibility, originality and elaboration. Creativity was also related to other features, such as newness and originality of insights (Csikszentmihalyi, 1999), motivation (Collins & Amabile 1999). In this research, the definition of divergent and convergent thinking in systematic creativity is used to explore the level of novelty, originality and usefulness of the ideas that create in different types of environment.

Rhodes (1990) suggested categorising the overlapping components of creativity to include person, process, product and press in a framework called 4P's model of creativity (Figure 2.1).

[redacted]

Figure 2.1. The 4Ps model of creativity (Isaksen, 2011, p.7)

This work provides an overview to creativity as a system that does not exist without one of the components (Isaksen, 2011), and can cover all 'facets' of creativity in different domains. MacKinnon (1987) adopted this model as a key for creativity research to expand the understanding of this multi-faceted concept by understanding each component. It clarifies each aspect of this model to make it as a path of creativity that applies in this research.

2.1.1 Creative Person

The primary concept of a creative person suggests that 'all people can be creative' (Craft, 2003, 146). Other scholars have listed characteristics of a creative person such as originality, flexibility, fluency, risk taking, playfulness, elaboration, high energy, openness, complexity, imagination and curiosity (Treffinger et al, 2002). In other words, a creative person has the "capacity to produce new or original ideas, insights, inventions, or artistic products, which are accepted by experts as being scientific, aesthetic, social or has technical value" (Eysenk, 1995, p. 234).

Another characteristic of creative people is being sensitive to their environment. The nervous system of creative individuals is more sensitive to specific factors in the related domain. For example, a person that is sensitive to colours and light is more likely to be creative in painting and art, and similarly individuals that are interested in sound can easier innovate in music (Csikszentmihalyi, 1999). The higher sensitivity in creative individuals causes the experiences of joy (positive emotion) and pain (negative emotion) to be more extreme than in other people (Csikszentmihalyi, 1999). Therefore, understanding the emotions of a creative individual is key in fostering creativity. Later, this chapter explain how people's emotion and creativity can be associated in order to foster creativity.

2.1.2 Creative Process

The creative process is the tools, techniques, and models that enable people to think creatively. Edward de Bono reports that "the creative process is an interruption in the smooth flow of routine in order to pay deliberate attention at some point". People make their lives simple by setting up routines. Creative thinking is a tool that applies when they break the routine and changes their mind's pattern (Lloyd, 2013).

In general, a creative process is about motivation, perception, thinking, and communication. It is a "bisociative process" that means producing a creative idea by combining unrelated ‘matrix of thoughts’ (Dubitzky et al., 2012, p.16). One of the most known processes is Wallas’ model in 1926 that describes the stages of creativity as preparation, incubation, illumination and verification.

There are different approaches in different domains. For example IDEO, in the design field, describes this process as understanding, observing, visualizing, evaluating and implementing (Kelly & Littman, 2001). In education, the Cropley’s model (2001) is common and added stages to the Wallas’ stages in the process. Shneiderman (2000) also introduce a simple model: collect, relate, create and donate that could be used in many domains. None of these processes are linear. Each helps us to understand creativity better and use it as a skill to learn and teach.

2.1.3 Creative Product

“A creative outcome can be a physical outcome or a new solution depending on the domain of creativity in result of a creative process” (Cropley, 2011, p.11). A creative product is any product of mind, solution or idea that is novel and useful according to Sternberg and Lubert’s definition of a creativity outcome that should meet the user’s need. A creative product definition recognizes creativity as a product of the mind that is novel and useful: this is a helpful definition derived from interviewing 400 managers about their creative performances (Isaksen, 2009).

Creative products such as publications, paintings, poems, and designs are highly objective, and therefore very difficult for scientific research to evaluate the level of creativity of (Runco, 2004). Sometimes, the number of products is very important to evaluate creativity. For example, the quantity of productivity of Piaget, Picasso, and other creative proves their creativity (Simonton cited in Runco, 2004), but there is a need to distinguish between productivity and creativity. So an individual can be productive without being original. Rather “originality is the most widely acknowledged requisite for creativity” (Runco, 2004).

2.1.4 Creative Press

Press is considered to be the context of creativity that includes environment, place, situation, context or climate that creative activity takes place. Press is a broad container that explains the interaction between the person and situation that can promote or inhibit creativity (Isaksen, 2009). Rhodes (1987) stated that "press refers to the relationship of human and their environment." The effect of press may be caused by general aspects of the environment such as culture, organization, or family, or more specific such as environmental settings (Runco, 2004). Hasirci (cited in Runco, 2004) states that certain environmental designs for schools encourage creativity. In organizational settings, Amabile (2004) suggests that environments needs to provide stimulation but not distraction, and resources should be available for people to improve creative thinking. Mooney also believes that press includes the conditions related to an individual or group that involve a creative process to develop the final outcome (Richards, 1997). People's interaction with the environment makes a change in their creative thinking and behaviour.

2.1.5 Measuring creativity

There are two main approaches to measure creativity that are explaining in following sections.

1. Assessing the creative outcome of creativity

Novelty and usefulness are two attributes with which to assess a creative outcome (Warr & O'Neil, 2004). Novelty and usefulness (appropriateness) of an idea or product may be defined with relative view, either to the previous ideas of the individual (P-creativity, P for Psychological), or to the whole of human history (H-creativity, H for Historical) (Boden, 1999). Suwa's (2000) view that a situated creativity (S-Creativity) in the specific task should be novel in that particular domain. To assess the novelty and usefulness, the experts in that specific domain, and to rate the creative outcome. Another measurement for creative outcome is 'taxonomy of creative design' based on comparing the new ideas with the existing ideas and studies the creative outcome as a product in the specific context. The 5 main elements of this model are imitation (the replication of previous work), variation (the modification of existing work), combination (the mixture of two or more works), transformation (the translation of a work in to another medium or mode) and original creation (the creation of something previously unrecognized) that can measure the novelty of a product in the form or content (Figure 2.2).

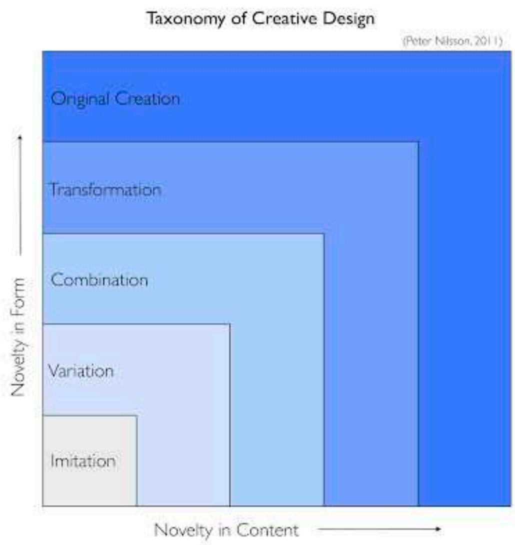

Figure2.2. Taxonomy of creative design, measuring the novelty of a product (Nilsson, 2011, p.4)

2. Assessing person's creativity: the Guilford model

A person's creativity in a divergent production can be assessed by four main measures: fluency, flexibility, originality and elaboration (Guilford, 1959). Fluency is the number of ideas or solutions, originality is the unusualness or uniqueness of the ideas, flexibility is the variety or diversity of the ideas, and elaboration is the number of added values and ideas) are the basic features to evaluate creativity (Runko, 2004). In addition, quality should be rated by two or more independent judges that are expert in the domain. All of these features can identify some characteristics of creativity, and supports researchers to evaluate and analyse different aspects of it (Warr & O'Neil, 2004).

2.2 Design

Ralph and Wand (2009, p 108) defined design, as “a specification of an object, manifested by some agent, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements, subject to some constraints”. The Design Council (2011) reports that “Design shapes ideas to become practical and attractive propositions for users or customers.” Design may be described as creativity deployed to a specific end. Design is a bridge between creativity and innovation as a management process for development new products and services. It also defines as a creative and user-centered approach to problem solving (Design Council, 2011).

Designers should cope with various challenges and different types of creative thinking in a design process. For instance, they should prepare some ideas, and then using the limitations that a design problem presents, they should focus and improve an idea for the real use in the real world.

Nigel cross (2004) describes design as “more like building a ‘creative bridge’ between the problem space and the solution space” (p. 129). Anyone could be a designer if they understand the knowledge of design thinking.

2.2.1 Design thinking

Design thinking defines a systematic solution-focused method to find both creative and functional solutions for problems (Kimbell, 2009). It is a human-centred innovation process (Lockwood, 2010). As a complex cognitive skill, it requires: 1. concentrated, reflective interaction with images of problems and solutions, and; 2. easy and rapid shift between doing and thinking (Cross, 2008, pp.135–136). Therefore designers need to develop a deep understanding of a problem, and be able to make creative connections to shape an idea as a real solution in each new challenge.

IDEO reports “Thinking like a designer can transform the way organizations develop products, services, processes”, and also the strategy that is called design thinking. It has three stages: inspiration, ideation, and implementation. *Inspiration* is the problem or opportunity that encourages the search for solutions. *Ideation* is the process of generating, developing ideas. *Implementation* is the path that leads from the project stage into people's lives (IDEO, 2011). Design thinking is seen as a creative process that enables designers to provide creative outcomes.

Kimbell (2009) presents scholars with different approaches in design thinking, see Table 2.1.

	Characteristic	Reference
Goal of design	To achieve fit between a form and its context	Alexander 1971
	Problem solving	Simon 1969
	The generation of new concepts and new knowledge; expandable rationality	Hatchuel and Weil 2009, Hatchuel 2001
	The resolution of paradoxes between discourses in a design situation	Dorst 2006
Modes of reasoning and thinking in design	Abductive	Cross 2006
	Inductive, deductive and abductive	Dunne and Martin 2006
	Balancing divergent and convergent thinking	Lawson 2006
	Designing new possibilities rather than selecting between alternatives	Boland and Collopy 2004
The nature of design problems	Determinate; ill-structured problems can be solved similarly to well-structured problems	Simon 1969; Simon 1973
	Indeterminate; design problems are wicked problems	Buchanan 1992
	Paradoxes between discourses; design problems are not knowable and evolve during the process	Dorst 2006
	A design attitude sees problems as opportunities for the invention of new alternatives	Boland and Collopy 2004
	Design and creativity are special cases of problem solving	Simon 1969 (Hatchuel 2001)
	Problem solving is a subset of innovative design	Hatchuel 2001
The nature of design processes and activity	Dynamic mapping between functions and design parameters	Braha and Reich 2003
	Selecting and identifying constraints and applying guidelines	Lawson 2006
	Exploratory and emergent	Cross 2006
	Functional decomposition	Alexander 1971, Hubka 1982
	Reflection-in-action; making 'moves' to reframe problems	Schön 1983
	Design processes do not end	Lawson 2006
	Working at high levels of abstraction as well as detailed level	
	Co-evolution of problem and solution	Dorst and Cross 2001
	Solution fixated	Cross 2006; Rowe 1987
	Experimentalism	Brown 2008
Designers' approach to knowledge production	Comfortable with ambiguity and uncertainty	Cross 2006, Michlewski 2008
	Integrating across knowledge domains	Hargadon and Sutton
	Consolidating multidimensional meanings	Michlewski 2008
	Empathy with users and stakeholders	Brown 2008; Dunne and Martin 2006; Michlewski 2008
	Design requires expanding concepts that are	Hatchuel and Weil

Table 2.1. Approaches in design and design thinking (Kimble, 2009, p.17)

2.2.2 Divergent versus convergent thinking

Guilford (1999) was the first to distinguish between divergent and convergent thinking. Divergent thinking is the ability to offer different, unique or variant ideas to support one theme while convergent thinking is the ability to find the "correct" solution to the given problem. Design thinking encourages divergent thinking to ideate many solutions (possible or impossible), then uses convergent thinking to chose and realize the best resolution.

Guilford (cited in Cropely, 2001, p.35) states that divergent thinking is the fundamental core of creativity, and the source of novelty. In divergent thinking, fluency and originality are important to access the creative outcome because it is the "production of variability" (Cropely, 2001). In a design process, designers first diverge as they create a number of alternatives ideas for each, then converge as they evaluate the alternatives and select the most promising and most desirable alternative (Dubberly, 2005).

Designers often describe themselves as creating many options (diverging) and then narrowing down their options (converging). Designers have described analysis as a process of breaking a problem into pieces—of "decomposing" it. Synthesis follows as re-ordering of 1the pieces based on dependencies, solving each sub-piece, and finally knitting all the pieces back together— "recombining" the pieces (Figure 2.2).

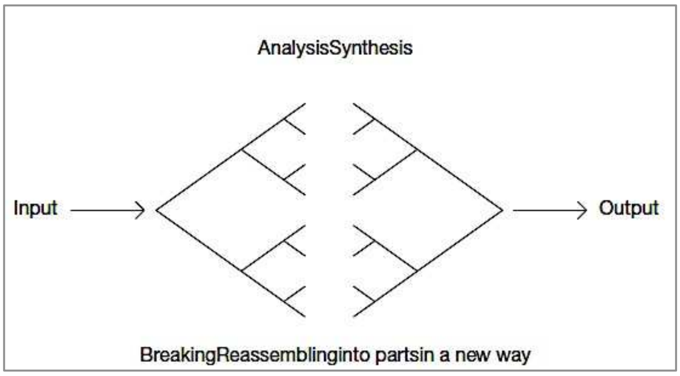

Figure 2.2. Design process of analysis and synthesis (Dubberly, 2005, p.22)

This decomposition-recombination process also diverges and then converges (Dubberly, 2005).

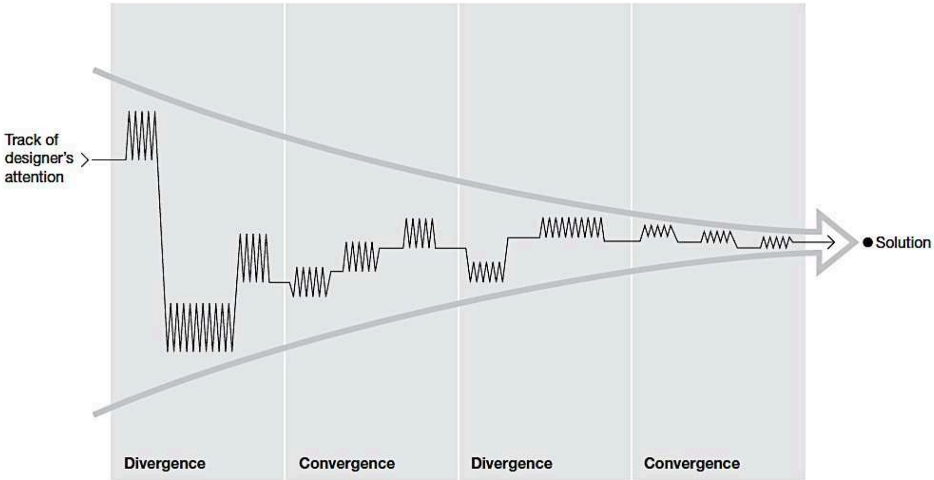

Figure 2.3. Totally convergent design process (Dubberly, 2005, p. 25)

Nigel Cross (2000) explains the overall aim of a design strategy is to converge on a final, evaluated and detailed design proposal, (Figure 2.3) but within the process of reaching that final design there will be times when it will be appropriate and necessary to diverge, to widen the search or to seek new ideas and starting points (Dubberly, 2005, p.25).

A simple descriptive model of the design process is based on the essential activities that the designer performs. The process of exploration to communication of a design is depicted in Figure 2.4 (Dubberly, 2005, p. 30).

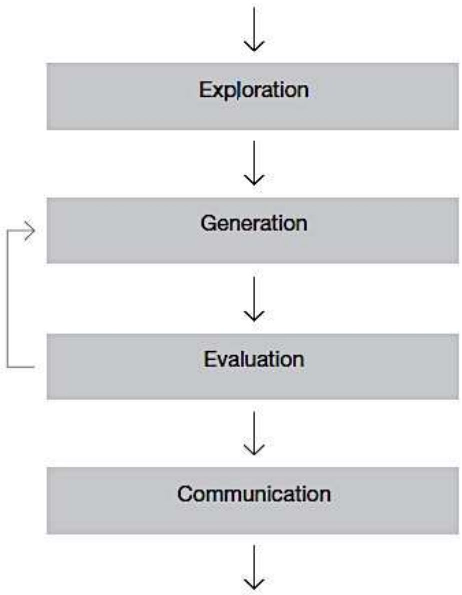

Figure 2.4. A simple model of design process (Dubberly, 2005, p.30, adopted from Nigel Cross, 2000)

2.2.3 The relationship between creativity and design

Creativity and design are inseparable concepts that are defined in different domains. Design can lead to the innovation. It is a path to shape creative ideas in reality. In simple words, creativity can exist without innovation, but innovation could not happen without creativity (Isaksen et al., 2009). So design is a bridge that makes it possible to travel the road from creativity to innovation (Design Council, 2011).

Designers can have a huge impact in shaping human life by creating or developing products, services, visual world, building and workspaces, public services, interfaces on digital devices and even working process. Design as a profession can be learned and improved (Design Council, 2011). One common model of a design process is the Double Diamond that presents four stages in design: discover, define, develop and deliver (Figure 2.5), which map the divergent and convergent stages of the design process (Design council, 2007).

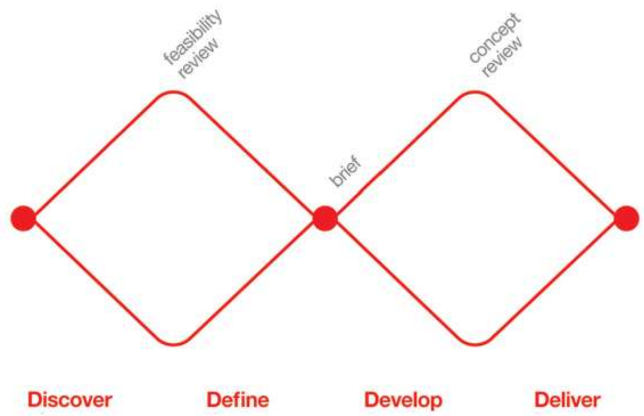

Figure 2.5. The 'double diamond' design process model (Design council, 2007)

Lawson, an architect, compares the creative process to the design process (Figure 2.6). “The period of ‘first insight’ simply involves the recognition that a problem exists and a commitment is made to solving it. The formulation of the problem may often be a critical phase in design situations. The next phase of ‘preparation’ involves much conscious effort to develop an idea for solving the problem. This period of preparation involves deliberate hard work and is then frequently followed by a period of ‘incubation’ which involves no apparent effort, but which is often terminated by the emergence of an idea (‘illumination’). Once the idea has emerged a final period of conscious verification starts in which the outline idea is tested and developed” (Dubberly, 2005, p. 42).

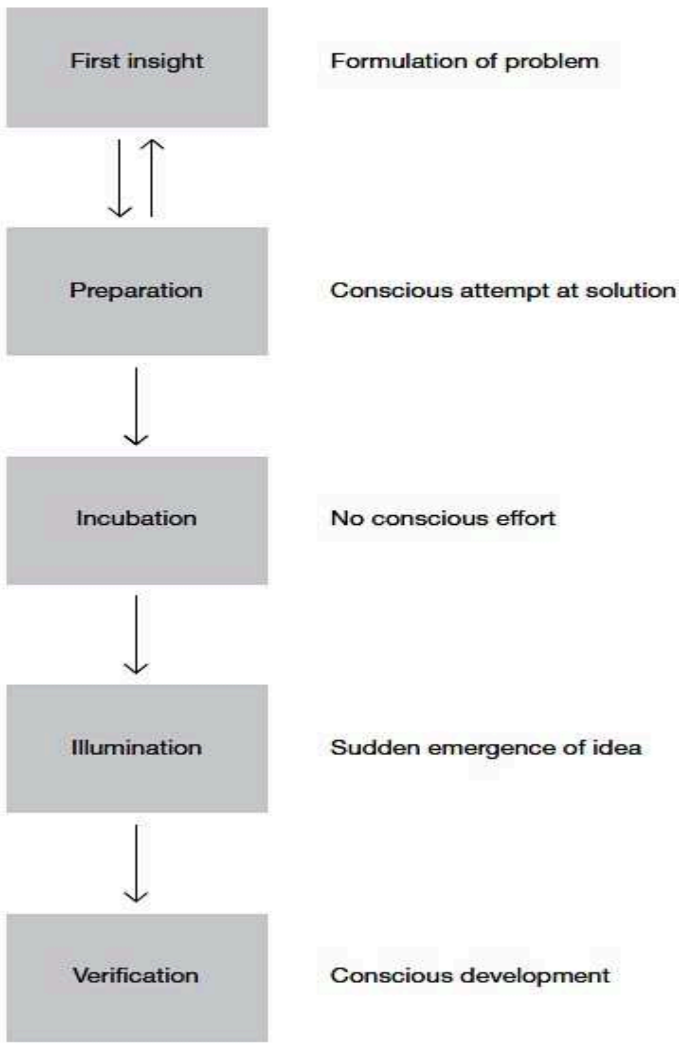

Figure 2.6. Creative process and design process model (Lawson, 2003, p. 42)

In addition, there are similarities between design methods and creativity techniques. A core idea element of both is production that reveals novelty and usefulness. Techniques from the design domain such as brainstorming, character profiles, customer journey mapping, fast visualization, focus group, physical prototyping, role-playing, scenarios, and user diaries all deliberately support creative thinking (Design Council, 2011).

2.2.4 Supporting designer's creativity

Nigel Cross (1999) stated that the designer is at the centre of a design process, and designer's work according to their intuition. He explained design thinking as a creative bridge between a problem and the solution. Buchanan (1992) also connects design to innovation and differentiates design from science, yet it is the crucial liberal arts that reflect the culture that designers use it as an insight to solve a wicked problem. Designers also work with a *cognitive-based design ideation* that is called creative problem solving. This approach helps designers to think out of box and generate ideas laterally and creatively (Dorst & Cross, 2001).

There are many publications about creative-thinking techniques that have been shown to improve creative performance. Some techniques that are used by designers for creative problem solving include brainstorming (Rawlinson, 1981) and the Delphi method (Linstone & Turoff, 1975), which encourage group activities among designers to stimulate the derivation of solution concepts while other techniques such as lateral thinking (De Bono, 1977), mind mapping (Buzan 2005), creativity templates (Goldenberg & Mazursky, 2002), TRIZ (Altshuller, 1997; Mann 2002), Synectics (Gordon, 1961), and morphological analysis (Fargnoli et al., 2006) to provoke creativity. All of these techniques help designer's thoughts to explore a solution in a creative way.

Most repeatable and effective creative process are divided into creative activities such as incubation then illumination of ideas (Wallas, 1926), mess finding before idea generation (Osborn, 1953), and divergent idea generation before convergent solution building (Plsek, 1997). Each different creative activity has different characteristics that might be supported more effectively by different environments. Of course, new principles could be generated directly from existing creativity research. During creative divergence, for example, designers scope and explore different idea spaces (Boden, 1990), so a supportive environment might provide multiple stimuli to search and discover ideas in these spaces. Likewise, during creative divergence, designers select ideas and develop quick prototypes (Lockwood, 2010), so the environment might support designers to locate and experiment with ideas without hindrance.

2.3 Emotion

2.3.1 Emotion definition

Emotions are "a psycho-physiological process or response, which is created every time a conscious or unconscious perception of important changes in the environment or in the physical body appears" (Marsella & Gratch, 2014). Mower (1960) stated that emotion is a complex psycho-physiological experience of an individual's state of mind as interacting with biochemical (internal) and environmental (external) influences see Figure 2.7. This research assess that emotions can be caused by environmental and the external stimuli.

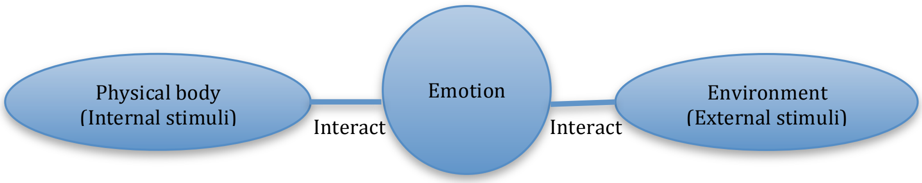

Figure 2.7. Emotion with general internal and external features (derived from Mower, 1960)

2.3.2 Theories of emotion

There are different theories in emotion classification. The simplest model is pain and pleasure. it supposed that all types of emotion in humans originate from these two basic emotions (Mowrer, 1960). Ekman (1972) devised 6 basic emotion based on different facial expressions. Moreover, a recent classification justifies emotions as primary, secondary and tertiary emotions in a tree structure (Parrot, 2001) using Plutchik's wheel of emotions (Figure 2.8). This model includes eight basic bipolar emotions: joy versus sadness; anger versus fear; trust versus disgust; and surprise versus anticipation. This model is depicted as a colour wheel, and the vertical dimension represents intensity, while the circle represents degrees of similarity among the emotions that provide a self-assessment tool in this research (Handel, 2012, p.195). The Plutchik's model provides as a self-assessment test because it is a model that categorises emotions with colours accordingly, so people can associate an emotion with words and colours to understand and choose quickly. The other positive points of Plutchik's model is that it introduces semantically consistent set of distinct emotions and has an organizational structure with a standard set of names including levels of intensity in emotions.

Figure 2.8. Plutchik's wheel of emotion (Handel, 2012)

More up-to-date theories that focus on research in the emotion field can be categorized into three main parts (Marsella & Gratch, 2014). First, discrete theories of emotion explain emotions as limited numbers that are determined naturally and biologically (such as sadness or anger). Second, appraisal theories focus on mental process that stimulates emotions, and a process of individual needs and external environments creates emotion. This appraisal theory is the fundamental dominant theory in psychology and computing in 20th century, however, there are some criticises of this theory because it treats emotions as a consequence while emotion is a reactive concept (Marsella & Gratch, 2014). Third, are dimensional theories that describe emotions as a continuous space in 2 or 3 dimensions. The 'PAD' model of emotion by Mehrabian & Russel (1974) is very common theory to use in numerous researches about environmental psychology. The three dimensions of PAD are pleasure (a measure of valence), arousal (the level of activation) and dominance (a measure of power or control).

PAD theory is very useful to assess human perceptions of their physical environment (Bakker et al., 2014). It has been used as an emotional assessment tool in previous studies. For instance, the PAD model has been used in organizational studies to collect the data of emotions towards specific factors such as motivation and productivity in the organisation (Lance, et al. 2008), for marketing studies of products (Desmet, 2003), and studying the consumer behaviour in different stores (Ratneshwar and Glen 2003).

Therefore, in this research uses this dimensional theory, was selected for use to evaluate emotional state of people in different environment according to external stimuli.

2.3.3 Emotions and 3 dimensions of hedonic tone, activation and regulatory focus

There are 3 dimensions of emotion - hedonic tone, activation and regulatory focus- that have reported, developed and compared for their predictive validity in emotion studies (Baas et al., 2008). Figure 2.9 shows the resulting emotional states based on the related dimensions.

Positive hedonic tone				Negative hedonic tone			
Deactivating		Activating		Deactivating		Activating	
Prevention focused	Promotion focused	Prevention focused	Promotion focused	Prevention focused	Promotion focused	Prevention focused	Promotion focused
Calm Serene Relaxed			Happy Upbeat Elated		Sad Discouraged Disappointed	Uneasy Tense Fear Disgust	Angry Frustrated

Figure 2.9. Emotional state based of hedonic tone, level of activation and regulatory focus (Baas et al, 2012, p.786)

For example, relaxed is an emotion with positive tone that is deactivating and prevention focused, while angry is the emotion with negative tone that is activating and promotion focused. This classification of components of emotions enables scholars to study and assess emotions systematically.

2.3.4 Circumflex model of emotions in dimensional theory

Russell (1980) defined the Circumflex model of emotions as a two basic dimensions of emotion, and emotional states can be described in terms of two underlying dimensions: value and arousal. *Value* is a judgment of positive versus negative in emotional states. People tend to base these conscious judgments on whether something is pleasant or unpleasant. *Arousal* shows the activation level of an emotion. Arousal in highest level represents anxiety and in the lowest level represents boredom (Figure 2.10). This research used these two dimensions to assess emotional states in the studies undertaken in this research. This tool can assess two important factors, pleasure and arousal that links to creativity. In addition, Circumflex model of emotions transfers the qualitative emotions into quantitative dimensions of emotion for further assessment that simplifies the model for participants to answer emotion questionnaires.

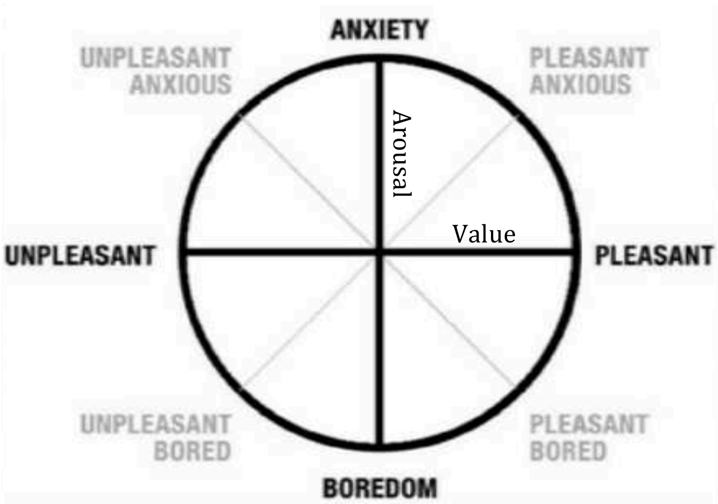

Figure 2.10. Circumflex model of emotion (Gorp, 2006, p.35, adapted from Desmet, 2002 and Russell, 1980)

2.3.5 Dimension of emotions that affect behaviour

Each dimension of emotion affects a different aspect of behaviour. Value affects whether we approach (i.e. pleasure) or avoid (i.e. pain), while arousal levels influence how motivated we are to do things. Both pleasant and unpleasant events and experiences can increase arousal levels. For example, fear and excitement are both high arousal emotions. The level of arousal also affects how intensely we experience a given emotion, and the more intense the emotion, the more attention is demanded (Gorp, 2006). Arousal also affects the level of motivation. Low arousal or boredom results in low motivation, while higher arousal results in higher motivation (Figure 2.11). An optimum level of motivation, arousal and performance is called flow, which is an emotional state that is associated to creativity, and is reported in section 2.3.8.

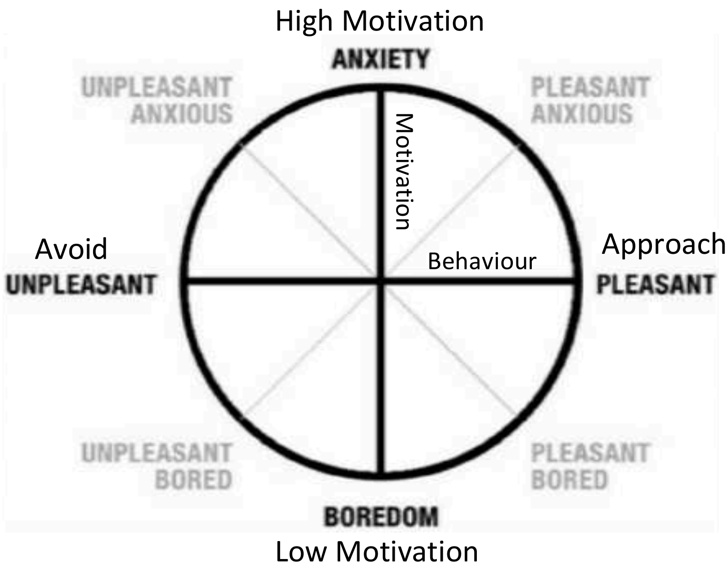

Figure 2.11. Circumflex model of emotion and behaviour (adapted from Russell, 1980; van Gorp, 2012, p.44)

2.3.6 Emotions and moods

Emotion can change moment by moment, and are short term in duration. Emotions are intentional meanings that sights, smells, sounds and external environment can trigger (Gorp, 2012, p 45-47). *Moods* describe the pattern of emotional responses over the short term, but are longer than emotions, usually for hours or days and are non-intentional because they are not directed at anything particular (Gorp, 2012). Studying mood requires research monitor to people's mood for days and weeks. Furthermore, moods are non-intentional to evaluate. Emotions that are acute and intentional can be evaluated more accurately. They change quickly by the external environment, and the features that can trigger them are from human 5 senses about a person's environment. Therefore, the focus of this research is on emotion rather than mood.

2.3.7 What is flow state?

Flow is a state in which people become completely immersed in an activity that their level of skill matches the level of challenge (Csikszentmihalyi, 1990). It exists when people are completely motivated and absorbed in a task (Gorp & Adams, 2012) Other Scholars calls this type of experience 'motivational activity', which refers to a mental/emotional state where all of people's attention (or energy) is totally focused on an activity that they experience in flow. It can be experienced while engaging in very diverse activities such as mountain climbing, meditation, playing chess, or creating art (Norman, 2004). Novak (1998) described the flow elements in three different categories that are causes, characteristics and consequences of flow (Table 2.2).

Causes of Flow	*Characteristics of Flow*	*Consequences of Flow*
A clear goal	Total concentration and focused attention	Distortions in the perception of time
Immediate feedback	A sense of control over interactions	Loss of consciousness of self
Balance between challenge and skill	Openness to new things	Activity is perceived as intrinsically rewarding
	Increased exploratory behaviour	
	Positive feelings	
	Increased learning	

Table 2.2. Causes, characteristics and consequences of flow (Gorp, 2012, p73, adopted from Novak, 1998)

2.3.7.1 Flow and associated emotions

The basic model of flow describes how people that are in flow state experience different emotions according to the balance between challenge and skills. Challenge with too little skill causes anxiety; and too little challenge with too much skill causes boredom. A border between anxiety and boredom is the state that flow happens (Figure 2.12).

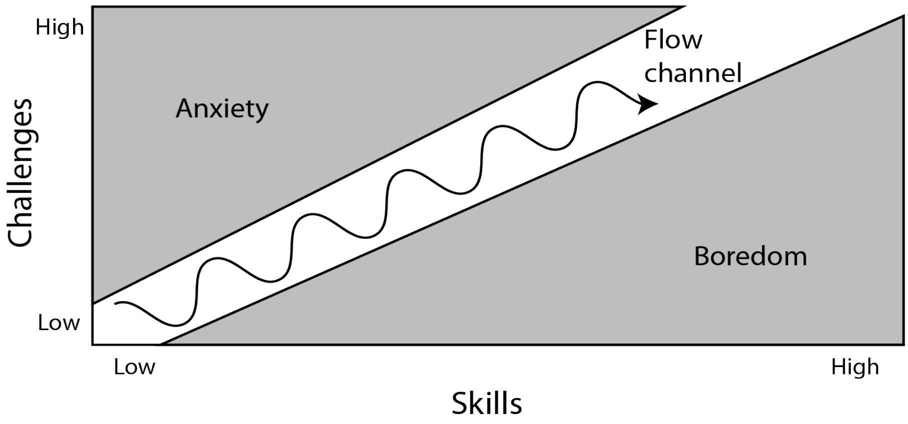

Figure 2.12. Flow, anxiety and boredom (Gorp, 2012, p.75, adopted from Csikszentmihalyi, 1990)

Csíkszentmihályi (1997) published a chart that shows one further aspect of flow (Figure 2.13). It reveals that it can only occur when the activity at hand is a higher-than-average challenge and requires above-average skills. The centre of this chart represents one's average levels of challenge and skill. The further from the centre an experience is, the greater the intensity of that state of being (whether it is flow or anxiety or boredom or relaxation). Being in control and higher arousal are the safest borders for being in the flow state (Figure 2.13).

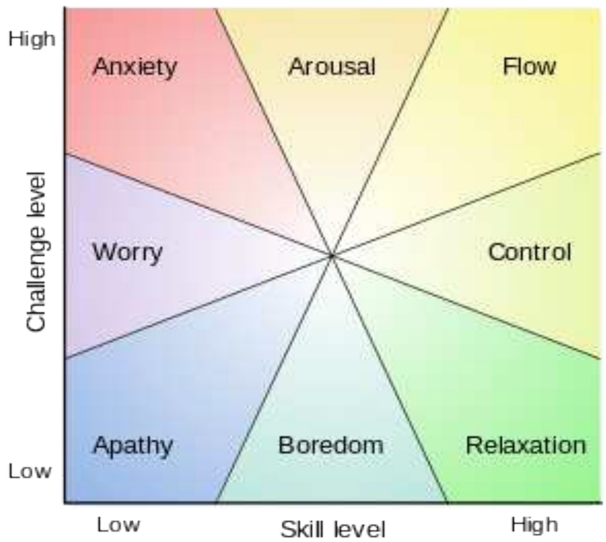

Figure 2.13. Emotional state according to flow (Csíkszentmihályi, 1997, p. 98)

Furthermore, the flow area can be matched in the circumplex model of emotion, as shown in Figure 2.14. In the flow model, boredom creates the lowest arousal and anxiety is the highest arousal, and the other emotions between them encompass both pleasant and unpleasant. This model reveals how it is possible to evaluate how people experienced flow state by measuring the valence and arousal level of their emotions as a tool that was used in this research.

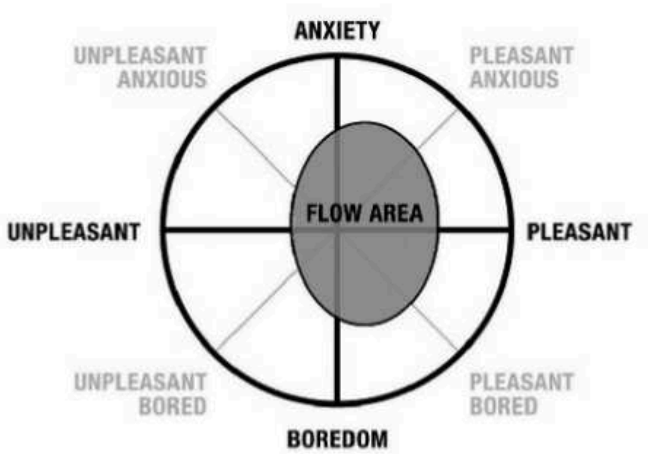

Figure 2.14. Flow area matches by emotional state in the affect circumflex (Gorp, 2012, p.59)

2.3.7.2 Being in the flow can enhance creativity

Flow generally leads to more attention and creativity (Csíkszentmihályi, 1990). It is the state of mind that people's emotions are pleasurable and joyful when doing some special activity. People remains in the flow state enjoying the task if the level of challenge and skills are balanced. This research assumes the challenge and skills for designers can be changed during a creative process. They might tend towards anxiety or boredom, which leads to less attention and joy of what they do. So one intention of this research is support designers to remain in the flow emotional states that foster creativity.

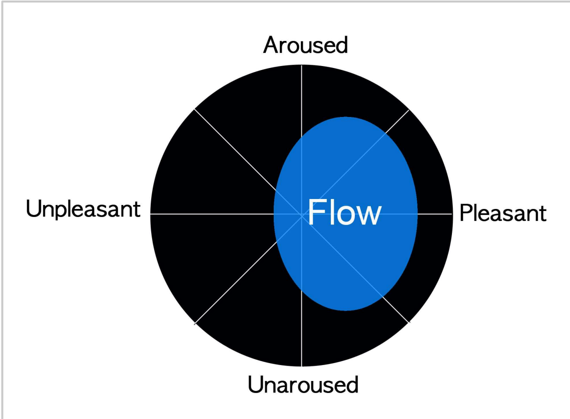

Figure 2.15. Flow emotional state in two dimensions of emotion (adopted from Gorp, 2012)

2.3.7.3 Dimensions of emotions in flow

Both pleasant and unpleasant objects and experiences can increase arousal levels. For instance, fear and excitement are both high arousal emotions. The level of arousal also affects how intensely people experience a given emotion, and the more intense the emotion, the more attention is demanded. Arousal also affects our level of motivation. Low anxiety or boredom results in low motivation, while higher anxiety results in higher motivation. This continues to an optimum level (i.e. the balance of flow), after which motivation and performance decrease, while anxiety increases (Gorp, 2006).

Arousal as a component of emotion is largely unconscious, but it provides an especially powerful channel to command attention and influence behaviour. For example, large images, bright-saturated colours and high contrast all increase arousal levels. When the level of arousal increases, the focus of attention narrows and goes to whatever is causing the stimulation. A good example of this is a stop sign, which uses a bright red to command attention within the busy visual environment of the street.

2.3.8 Different tools to measure emotions

Measuring emotions is difficult. People are challenged to describe how they feel, and to distinguish between different emotions. It is also difficult to identify the exact cause of a particular emotion, in part because emotions change quickly. However, there are different techniques that can help researchers to measure or capture emotions. These include1. self-reporting

2. technological tools that captures physiological changes and 3. coding systems based on expressive behaviour (Laurans, 2011). Each is reported in turn in the following sections.

2.3.8.1 Self-reports assessment

The most common technique in emotion research seeks to capture conscious feelings that users report about themselves. These self-report tools include verbal measurement tools and nonverbal measurement tools (Agarwal & Meyer, 2009).

1. Verbal measurement tools

These tools are a self-report category that indicates the emotions by scales and with names of emotions (e.g. Geneva emotion wheel (GEW) questionnaire, see Figure 2.16) that categorises emotions based on their high/low control and high/low pleasure with different degrees of intensity of emotions.

[redacted]

Figure 2.16. Geneva emotion wheel, a verbal measurement tool (Scherer, 2005, p. 723)

However, the main problem with these tools is that they can only capture the conscious emotion of the participant. In addition, because emotions are immediate and automatic, this might distort the initial feeling of user or the difficulties in emotional memory to remember the exact emotion. However, researchers still use this tool because it is easy to use and develop. The PAD

Semantic Differential scale is another verbal tool (Agarwal & Meyer, 2009) that uses three-dimensional scales of pleasure, arousal and dominance. The pleasure-displeasure scale measures how pleasant an emotion might be. The arousal-no arousal scale measures the intensity of the emotion, and the dominance-submissiveness scale represents the controlling and dominant nature of the emotion.

2. Nonverbal measurement tools

These tools represent emotions by using visual human cartoons instead of words (e.g. Self-Assessment Manikin (Bradley & Lang, 1994) see Figure 2.17) Participants choose the visual emotion that is closest to their feeling. These tools are good for low intensity and mixed emotions.

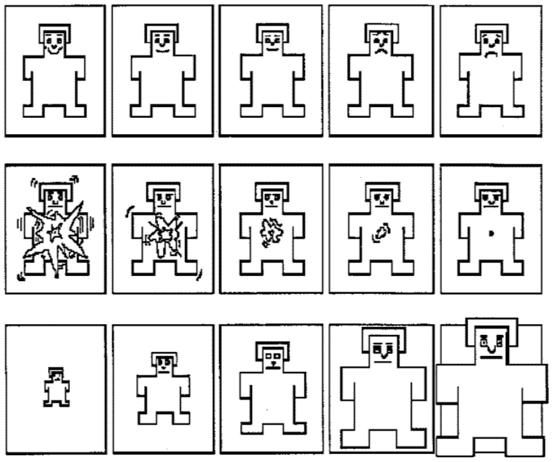

Figure 2.17. Self Assessment Manikin, SAM questionnaire (Bradley & Lang, 1994, p. 54)

Other nonverbal tools include PAM (Desmet et al., 2012), PreEmo (Desmet, 2003), Facial Action Coding System (Ekman & Friesen, 1978), and Emocards (Desmet, 2000). Some measurements are a combination of verbal and nonverbal, for example Emocard was used to evaluate the usability on interface by different used both verbal and characters (Desmet, 2000). The advantage of these tools is that they are independent from language and can use in any language. However, one disadvantage is that the perception of pictures is not the same for all people, and it is hard to measure the mix emotions.

2.3.8.2 Physiological tools

Physiological changes in the body (e.g. while we are experiencing an emotion can be used to evaluate emotion with technological tools. Changes in inner organs to measure body arousal are a common topic in psychophysiological research. Some electrical signals in response system of body provide valuable information about emotion changes. The most frequent measure in research is electrical activity (EDA), which includes all changes in skin and minor sweating deviations connected to the brain signals in experiencing special emotion. Although this device often generates ambiguous results and technical difficulties, it is common in both human-computer interaction and marketing research (Laurans, 2011).

2.3.8.3 Facial expressions

Facial movement captured in video recording is a suitable source of information that can be applied in coding system to recognize different emotion. This approach reads points and edges of the face muscles that appear in a particular emotion. Most techniques are limited to a small number of 7 basic emotions (neutral, happy, surprised, sad, scared, disgusted, and puzzled). For example, the facial action system (FACS) is an anatomically based comprehensive system that presents affect and any visible change on the face. Max, Affex and Emface are some existing facial expression coding tools that have been applied in current research. Three are some companies that have this coding for some usability testing clients, such as Face-reader from Noldus, nViso and Emovision. These tools generate a 3-dimensional model of a face and recognise the main points of the face by each muscle movement in order to represent 7 basic emotions (Figure 2.18).

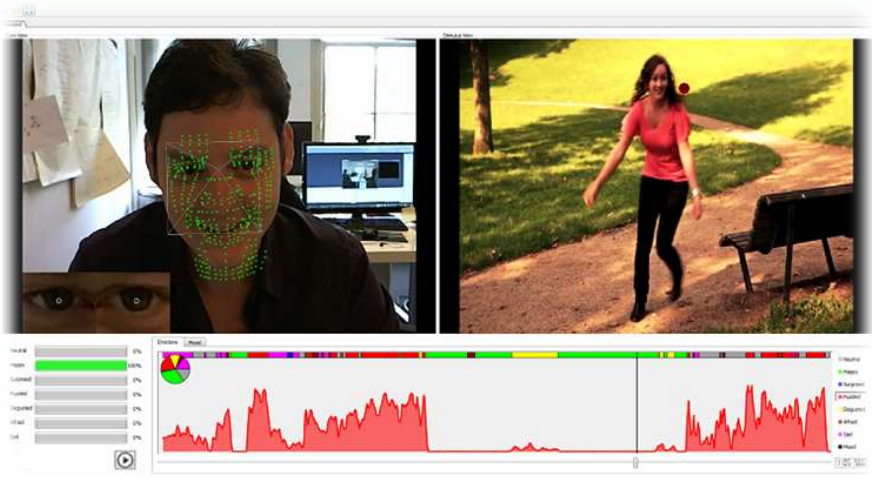

Figure 2.18. Face-reader using to assess seven basic emotions (Lee, 2013)

Results from facial expression analysis are more valid when there is a stimuli like an commercial advertisement, movie or computer-game that make the participant looking directly to the camera and the program is able to find, recognise and classify emotions by representing some visual graphs at the same time (Terzis et al., 2010). These tools can measure between 6 and 8 basic emotions but not the mixed emotions and the accuracy of them is between only 60 and 80% (Desmet, 2012).

2.3.9 The relationship between emotion and creativity

Much research has sought to investigate the relationship between emotion and creativity from different perspectives. "Attractive things work better" is an idea that supports three levels of mind processing in which states as visceral, behavioural and reflective (Norman, 2004). It describes how people can be more creative when faced with an attractive design. For example, someone who is relaxed, happy, and in a pleasant mood, is often a more creative, more able to overlook and cope with minor problem. In contrast when people are anxious, they are more focused (Norman, 2004).

Other studies have revealed that high levels of negative emotions lead to greater artistic creativity. One demonstrates how special biological components of depression and other affective disorders can trigger artistic creativity (Akinola & Mendes, 2008). Other scholars classified creative capacity to emotional creativity and cognitive creativity. These two types of creativity are not the same, but go hand in hand. They have many similarities concerned with intellectual efforts and interpersonal contexts that require sharing and collaborating. It also involves competition, jealousy, secrecy, and other interpersonal issues (George et al., 2007).

2.3.10 Meta-analysis of creativity-emotion links

One of the most significant studies in this field is a meta-analysis. Bass harvested the collection of associated research in 25 years of emotion–creativity research. The result of this analysis contains three fundamental classifications of hedonic tone, activation, and regulatory Focus (Baas et al., 2008). These three factors play a significant role in some of the reported studies. This meta-analysis synthesized 102 effect sizes reflecting the relationship between specific emotion and creativity. The basic results can be summarised as:

- Positive emotions produce more creativity than emotion-neutral controls;
- Creativity is enhanced most by positive emotions states that are activating and associated with an approach motivation and promotion focus (e.g., happiness), rather than those that are deactivating and associated with an avoidance motivation and prevention focus (e.g., relaxed);
- Negative, deactivating emotion with an approach motivation and a promotion focus (e.g., sadness) were not associated with creativity, but negative, activating moods with an avoidance motivation and a prevention focus (fear, anxiety) were associated with lower creativity, especially when assessed as cognitive flexibility;
- With a few exceptions, these results generalized across experimental and correlational designs, populations (students vs. general adult population), and facet of creativity (e.g., fluency, flexibility, originality, eureka/insight);
- The emotion–creativity link is better understood as a function of various aspects of specific moods than simply in terms of hedonic tone or level of activation;

- Decomposing creative performance into several facets (flexibility, originality, and fluency) highlights the fact that some emotional states reliably influence some facets of creativity but not others, and that other emotional states influence other facets more;
- Anger produced more creativity than relaxed emotion and comparable levels of creativity to happiness.

Studies of the effect of positive and negative emotions related to creativity also generated contradictory results (e.g., Kaufman, 2003). Some researches revealed that negative emotions sometimes promote creative performance to a greater extent than positive emotions (e.g., Bartolic et al., 1999; Gasper, 2003). However, other results revealed that positive emotions trigger more creative outcomes than did negative emotions (e.g., Grawitch et al., 2003; Hirt et al., 1996).

It might be that these contradictory results were caused by the fact that emotions are complex concepts to measure, and that emotions require assessment with a broader view of emotion dimensions. Positive and negative emotions are only one dimension of emotion, and it is not enough to get the whole aspects of the concept and link it to creativity. Therefore, other approaches to the study of emotion and creativity tend to understand emotional states as emotional components including hedonic tone (positive versus negative), the involved level of activation (activating versus deactivating), its association with regulatory focus (promotion versus prevention), or some combination of these that is described in following 3 sections.

2.3.10.1 Hedonic tone (pleasure) and creativity

There is a long history in psychological analyses of hedonic tone. These analyses show that positive emotional states increase dopamine levels in the brain that mediate many of the cognitive affects. In this view, creative problem solving is improved because dopamine release in the frontal cingulate cortex improves the alternative cognitive sets (Valentin & Turken, 2002). On the other hand emotions have a signalling role. Positive emotions signal a satisfactory and safe state of mind (Forgas, 1995; Schwarz & Bless, 1991). In some studies, hedonic tone is related to creativity if it is used as input information in the task such as negative or positive task (Martin & Stoner, 1996; Baas et al, 2008).

2.3.10.2 Activation (arousal) and creativity

Research studies about the activation (arousal) component of emotion related to creativity and performance also are high in the number. Low levels of arousal caused inactivity and avoidance, neglect of information, and low cognitive performance. Extremely high levels of arousal decrease the capacity to identify, process and assess the information, and increase a dominant response more than a creative response (Berlyne, 1967; Easterbrook, 1959). On the other hand, there are some studies that focus more on the level of arousal by time. The findings of this research revealed that if the level of arousal increases from low to moderate levels, it could enhance the cognitive process that leads to broader and more flexible creative performance (De Dreu et al., 2008). The research also revealed an increase in cognitive persistence that may cause more insight, creative ideas and solutions (Carver, 2004). From the neuroscience point of view, based on Baas (2008) review, some research indicates a direct association between levels of arousal and, the release of dopamine that can boost the understanding, thinking and working memory mild levels of arousal were shown to foster performance of task-relevant information and help to shift attention from one task to other (Colzato et al., 2007, P 23-28). Furthermore, other scholars in the Baas review reported that high activation accelerates flexibility, process, abstract thinking and accessing to long-term memory. In conclusion, activating compared to deactivating emotions can lead to more creativity (De Dreu et al., 2008). Activating emotions (e.g., angry, fearful, happy, elated) were reported to lead to more creative fluency and originality compared to deactivating emotions (e.g., sad, depressed, relaxed, serene). Furthermore, activating moods influence creative fluency and originality because of enhancing cognitive flexibility when tone is positive, and because of boosting persistence when tone is negative (Baas et al., 2008). Emotional arousal is also related to novelty, uncertainty, and complexity of the stimuli. In addition, Mehrabian & Russell (1974) suggested the information rate-arousal theory that indicated the direct relationship between arousal and the total information in a space.

The most recent research in the link of activation and creativity is a the dual pathway model shown in Figure 2.19. This model suggested that activating emotions enhance creative fluency and originality more than deactivating emotions. However, the route depends on the tone of emotion, positive tone leading to higher cognitive flexibility and negative tone leading to the higher cognitive perseverance.

[redacted]

Figure 2.19. The model of dual pathway of tone and activation and the link with creativity (Carsten et al, 2008, p. 742)

2.3.10.3 Regulatory focus and creativity

Other studies (Friedman & Forster, 2001) revealed that promotion focus emotional states increase creativity compared to prevention focus. The scope of attention can be stimulated by promotion state to facilitate the conceptual access to cognitive information. So restructuring the problem can foster creativity and insight in both conceptual and perceptual level (Bass et al., 2008). Overall, the interaction between activation and regulatory focus can predict creativity. Activating emotions with promotion focused (e.g., joy, anger) enhance creativity. In contrast, activating emotions that are prevention focused (e.g., fear) impede creativity (Bass et al., 2008).

2.3.10.4 Task and creative performance

Regarding to the nature of the task associated to creativity, research shows that negative emotions tend to produce more creativity than positive emotions when the task is framed as serious and performance oriented, whereas positive moods perform better when the task is framed as fun and enjoyable that is an important for present research.

2.3.11 Emotions and early versus late creativity production

Studies (Kaufmann, 2002) revealed a significant crossed interaction between emotion and early versus late idea production. Many creative tasks can be divided, to early and late idea generation. Early is related to the ideas that are produced in the beginning of a creative task, while late ideas are produced at the end of a creative task. Positive emotion led to the highest number of scores in early idea production and the lowest number in late production, whereas both control and negative emotion led to relatively better task performance in late production (Figure 2.20).

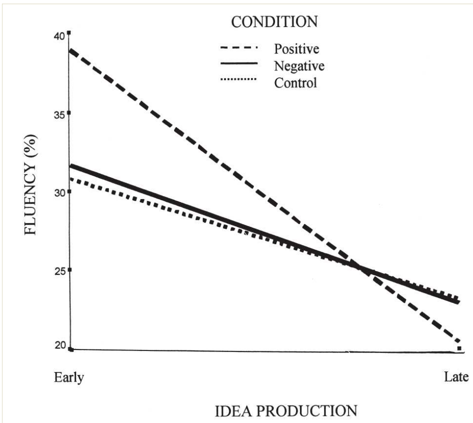

Figure 2.20. Mean fluency score across early and late production time for positive, negative and control mood (Kaufmann, 2002, p. 375)

The conclusion from this research is that positive emotions facilitate creative problem solving. Positive affectivity was found to be significantly and positively related to important problem-solving attributes including flexibility and originality. It suggested that the relationship demonstrated between elevated positive affect and creativity may reflect increased productivity, but not necessarily a higher quality of creativity (Kaufmann, 2003).

2.4 Environment

Augustine, (2009) reports that "the design of physical space influences the mental states of people in that space, that shapes their attitude and behaviour" Therefore "even the most abstract mind affected by the impressions that impinge on the sense from the outside environment." (Csikszentmihalyi, 1997, p127) The relationship between environment and human in recent decades has received much attention in different areas of research for example '*social science'* such as psychology, geography, sociology, anthropology- and 'environmental-design' such as architecture, urban design, planning and interior design. The result of this high demand study leads on the one hand to prepare a stimulating multidisciplinary knowledge, and difficulty in communication and confusion on the other. They focus on essential theoretical matters or real-world problems of environmental design.

The focus of this research is the environment that people interact with. It defines the environment, mainly by studying human interaction with it. Place Science is a term that explains the environment with considering people in it, a discipline that tries to design the spaces that work best for the people that use it according to physical elements of the environment that make mental statements of mind. It is a discipline that helps us to make specific mental state of mind for users by using the structured physical elements of the space (Augustine, 2009). In addition, people have the combination of rational and irrational categories of thoughts and emotions, so their responses to the environment are complex (Vischer, 2005). This means that our perception of an environment would be different from one person to another. People are influenced by an environment, and it can shape their perception, feeling and reaction in the environment (Augustine, 2009). We all have connections to things around us, and also we have individual memories that affect our responses to the space (Augustine, 2009). Sundstorm (1986) suggests that the relationship between environment and people is mutual not passive, so it results the action of giving and taking. This approach to the environment as the interaction with people is the focus of the research reported in this thesis.

Furthermore, the blended places are the new concept to blend physical spaces and digital spaces. Benyon (2014) proposes to design the physical spaces with understanding the social psychology of the environment to shape peoples' behaviours via interaction between human senses and the space. Different environments create different perceptions of territory, control, interaction and feelings in people. Now people use personal digital devices for their communication, work and many other functions. The concept of blended spaces can create new experiences for people that have their own personal digital spaces while connecting to the sharing digital spaces while they are in such interactive physical places (Benyon, 2014, p. 82-85).

Moreover, environment was studied as a motivating factor for people to improve their activities. For instance specific environments can lead to more satisfaction and production. Sundstorm (1986) also suggested that preparing the ideal condition of an environment could make the ideal efficiency and productivity for people that use it.

2.4.1 Creative environment

People can be creative anywhere, and have an ability to adapt to most environments, yet it is very beneficial to design the environment to stimulates creativity (Landry, 2012). Creative environments or spaces are not a new idea. They refer to special spaces that encourage people to work, learn and be creative. In Renaissance times, artists and designers had their own studios to work or test and experiment their new inventions. Nowadays creative spaces shifts to design studios, architects offices, science labs, rehearsal rooms and corporate fun or fab labs (Martin et al, 2008). The importance of the environment on creative performance is well documented – the *Press* of the original *4P*s model of creativity (Isaksen et al., 2011, p.7) described the environment, place, situation and climate in which creativity takes place. However, the creative problem solving methods derived from it as reported by Isaksen (2011, p.182-190) provide few principles with which to construct environments to support creative activities. Environment as a stimulating tools and resources can potentially boost the creative design process by supporting problem finding, solving and implementation (Moultrie et al., 2008). IDEO is a good example in design firm that believes spaces support visualisation, exploration and inspiration through access to materials and artefacts. Their approach considers the environment as a catalyser that develops design evaluation (Moultrie et al., 2008).

Research into creative spaces studied 20 successful companies that inspire creative activity through their spaces. The study suggested four types of space that support creative activity should enable people to engage and energies them: spaces to stimulate, reflect, collaborate and play (Groves, 2013). Stimulating space is the space for inspiration that enables people immerse themselves in a space and motivate their energy to be activated. A reflect space is the place for intense focus, and uninterrupted thoughts about the same problem or subject. This kind of space is often mistreated in open plan offices that are good for communication but not for reflection. A collaborative space is the space to share, improve and progress. Meeting rooms are technically the place for collaboration, but in reality, collaboration happens in hallways, food stops or outside areas. The most creative collaborative spaces enable people to get together informally and share thoughts and ideas not in the traditional hierarchy way. Play space is the space to connect and explore. The power of play in the work environment is less intentioned because our mind usually associates work with serious tasks while play and fun are the opposite concepts. However, play could result in deep exploration and experimentation, and add a facility to human interaction that leads to better and easier relationships between people. People can connect and feel relaxed and distressed in a playful space that caused more productivity in the long term (Groves, 2013). Meyer (2009) also states that we should shift from a workspace to a play space because it can encourage innovation, learning and changing through a dynamic engagement of people.

2.4.2 Physical environment for creativity

The physical environment includes the objects, lights, colours, smells, music, forms and all other aspects of the space that influence human five senses. For example, research has shown that a window view to nature and indoor plants and flowers can foster creativity in the workspace (McCoy & Evans, 2002). Important elements of a physical work environment that are related to creativity as revealed in previous empirical studies and experiments are shown in Table 2.3.

Elements of the Physical Work Environment That Are Possibly Related to Creativity		
Element	**Description**	**Examples of Empirical Studies That Relate the Element to Creativity**
Furniture	Furniture (e.g., chairs, tables, cupboards) that are placed in the workplace	Ridoutt, Ball, and Killerby (2002)
Indoor plants/flowers	Natural plants or flowers that are placed in the workplace	Ceylan et al. (2008) Shibata and Suzuki (2002, 2004)
Calming colors	Colors that provide a relaxing experience (e.g., green, blue, or blue violet)	Ceylan et al. (2008)
Inspiring colors	Colors that provide a stimulating experience (e.g., yellow, orange, pink, red, or red violet)	McCoy and Evans (2002) Stone (2003)
Privacy	The possibility of being secluded from the presence or view of others	Aiello et al. (1977) Stokols, Clitheroe, and Zmuidzinas (2002)
Window view to nature	Having visual access from the work environment to the outer natural environment (e.g., trees, plants)	McCoy and Evans (2002)
Any window view	Having visual access from work environment to any outer environment	Stone and Irvine (1994)
Quantity of light	The amount of light in the work environment	Knez (1995)
Daylight	The light coming from the sun into the work environment	Ceylan et al. (2008)
Indoor (physical) climate	The temperature, velocity, humidity, and composition of the air in the work environment	Hygge and Knez (2001)
Sound (positive sound)	Positive sounds (e.g., music, silence, absence of noise)	Alencar and Bruno-Faria (1997) Stokols et al. (2002)
Smell (positive smell)	Positive odors (e.g., fresh air, absence of bad smell)	Knasko (1992)

Table 2.3. Important elements of the physical work environment that are possibly related to creativity (McCoy & Evans, 2002, p. 421)

There is more research into the visual aspects of environments that affect creativity compared to other senses. Some studies focused on the effect of different lighting conditions (Dijkstra, 2010). More experimental research into the effect of environment colour on creative performance revealed it to be improved in an environment lit with blue, whereas the same environment lit with red enhanced performance on more detail-oriented tasks (Mehta &

Zhu, 2009). Blue-coloured lighting was considered to be more beautiful, calm and light in comparison to red (Dijkstra, 2010). Other research in this field showed higher lighting quality through coloured lighting lead to a better performance of office workers (Veitch et al., 2011). Moreover, the effect of coloured lighting on the creativity levels of individuals and groups was studied with Philips Company. It revealed that higher light levels and colour temperatures link with high creative performance (Dijkstra, 2010).

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Figure 2.21. Use of different colures according to user's emotions (Mehta & Zhu, 2009, p. 2173).

McCoy & Evans (2002) investigated different elements of interior design that affected creative performance, and discovered that it could be improved by spaces that were spatially complex, visually detailed, used natural materials (wood and glass) and provided a view of a natural environment. Their results are summarises in Table 2.4.

	Effect on creativity	Space elements
Tests of actual creative Performance in two different physical settings	Increasing creativity potential	Spatial complexity
		Visually detailed
		View of natural Environment
		Use of natural Material
		Societal design
	Decreasing creativity potential	Cool color temperature (blue)
		No view
		Manufactured/composite material

Table 2.4. Role of specific interior design elements on creativity (McCoy & Evans, 2002)

The Centre of Creativity at the University of Brighton is a good example of an environment that applied these physical components of environment to encourage creativity in learning spaces. The centre applied movable walls, colour, lights, 3D projected images, the music and the curved wall for the space that was called Leonardo (Figure 2.22). Leonardo was used for a various range of learning aims, for example – to generate ideas, explore design problems, improve proposals, display technology, network, role-play, collaborate and cooperate. Result of the use showed that the Leonardo space could stimulate the energy needed for intuitive and flexible exploration that breaks traditional limits in a learning environment. The newness and unusual components of the space made people feel that they were somewhere special, and raised motivation and energy in the space (Martin, 2010).

Figure 2.22. Leonardo space designed to stimulate flexibility and creativity in learning environment (Martin, 2010, p. 78)

Groves (2013, p. 34) reported “the future of work demands more creative thinking and problem solving, more social connectivity and agility.” She reported that the main places that inspire people are the spaces that make people connect more to their unconscious mind. Nature, activity and movement, social setting, the bath, and shower are good examples. Some organizations have now started to use these examples to encourage and stimulate creativity (Figure 2.23).

Stress-redacting atmosphere in Google, Tel Aviv

A lunchtime run at Nike WHQ for healthy mind

Idea exchange café in Urban Outfitters HQ

The “Water Lounge” at Google, Zurich

Figure 2.23. Examples of space in workspace that stimulate creativity (Groves, 2013)

Google’s new concept for the headquarters in Mountain View, California will construct greenhouse buildings with transparent walls, surrounded by green fields, a running track, bike path, and a stream. The basic aim is to connect people in workspace to nature (Figure 2.24).

Figure 2.24. Google headquarter office concept in Mountain View (Google, 2015)

Furthermore, a recent study investigated people’s perception of environment by relating the particular physical components such as high ceilings, open spaces and colours to some specific notions such as productivity, creativity and pressure. The results revealed that the most significant factors on productivity and creativity are lighting, ceilings, wall space, and views to co-workers, acoustics, quiet space, colour, and flexible furniture. For example, participants associated productivity to ‘higher ceilings heights’, motivation and sharing ideas to ‘open plan spaces’, focus on important and urgent task to ‘quiet spaces’, and energy and creativity to ‘colourful spaces’ (Bryant, 2012). The transitional spaces, meeting areas and creative service facilities supported individual and collaborative divergent thinking, and its isolated and private home bases supported workers to concentrate and analyse problems more effectively (Conty, 2013).

Cooper (2013) revealed that different natural materials were associated with increased creative performance in different cultures, for example wood and water in Germany, window views in Sweden, and green and purple colours in the United Kingdom. This experiment concluded that physical elements such as texture, glass, warm colour, transparent, and 3D dimensional objects in the interior environment have the potential to foster pcreativity (Cooper, 2013). Cooper's research into creative workspaces also indicated the different countries that were affected by various physical component of the space. Happiness, creativity and productivity was associated with different component of the space such as colours, green indoor spaces and natural material (Figure 2.25). The survey results showed for example that, Germans associate creativity to elements of greenery with wood and water whereas in UK people link creativity to purple and green colours. Cooper (2013, p.11) main finding revealed a "*Biophilia* theory that humans have an innate affinity with nature, and are happiest and most productive when surrounded by natural elements."

[redacted]

Figure 2.25. The effect of physical environment on Happiness, Creativity and Productivity in different countries (cooper, 2013, p22)

Fewer experimental studies into the effect of sound on creative performance have been reported, however moderate levels of ambient noise in a café environment were shown to improve creative performance compared to a relatively quiet environment (50 decibels) and high level of noise (85 db.) (Doorley & Witthoft, 2012). These modest levels of background noise were hypothesized to generate sufficient distraction to make information processing difficult, which promoted abstract processing and increased creative performance (Mehta et al, 2012).

Inspiring surroundings for play can be a catalyst for creativity, although Csikszentmihalyi acknowledges that we cannot prove this, as the relationship is not simple. Csikszentmihalyi (1999) states that different environments could be productive in different stages of the creative process. For example, a stimulating space is good for insight and generating new ideas, while preparation, evaluation and implementation are fitted better in an ordinary space. Consistent with this idea is 'Thinkubator', an environment specifically designed to foster creativity in a creative activity (Haman, 1989). This space is a meeting room in Chicago that stimulates human five senses in a brainstorming session including: ergonomically designed chairs that simulate floating, soothing the mind, hundreds of toys and creativity tools, modelling clay to crayons to wall-size whiteboards, the relaxing scent of lavender, peppermint and other aromas, and varieties of sounds, and music, such as pianos, karaoke machines. Business teams gather to be away from their usual ordinary offices and feel comfortable, inspired, and stimulated (Haman, 1989).

2.4.3 Psychological environments for creativity (climate)

Previous research has indicated that people feel different in different environments. It is part of the environment that is hidden from our eyes and affect people psychologically. The concept of climate was developed in the late 1930s in social science (Lewin et al., 1993). Climate is used as a context to explain the feeling, air or atmosphere of one environment or organization. There are links between the climate of an organization and motivation, productivity, profits and success (Lewin et al., 1939). For example, Isaksen and Ekval (2007) studied the climate in different organizations and uncovered nine basic factors for a creative climate such as challenge, freedom, trust, idea-time, playfulness, conflict, idea-support, debate and risk taking. They could support or inhibit creative productivity in the context of work.

In addition, a creative environment is seen as a place to protect ideas. Idea generation requires a space that is risk-free zone. For example, at Walt Disney Imagineering the risk-free zone is in the blue-sky phase that allows dreaming, imagining, and creating new ideas that might seem strange and weird (Lloyd, 2013). People come to these spaces without any fear of judgment by others. And because the main principal of this space is producing unusual and strange ideas, people are more likely to be open for creation.

There are 6 properties that a small change of them can alter the nature of an interaction in the space (Doorley & Witthoft, 2011, p 43-46). They are posture, orientation, surface, ambience, density and storage, See Figure 2.26. For instance, in posture, the position of a body in an activity signals relaxed and reflective engagement or active and excited participation. Body language can communicate intent, emotion and behaviour. Spaces need to provide different postures of standing, sitting and laying for people (Doorley & Witthoft, 2011).

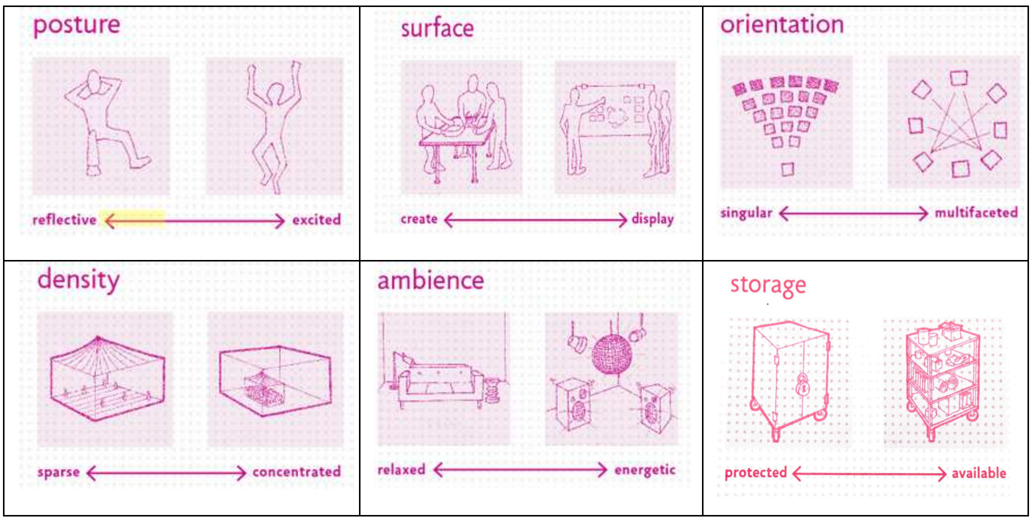


Figure 2.26. Properties of a space (Doorley & Witthoft, 2011, p 43-46)

2.4.4 Using technology in environments to encourage creativity

In recent years, environments have been changed by new technologies, and some of theses technologies can enhance the capacity of a space to enhance creativity. For example, one type of shared design space is a collaborative tabletop environment, which is designed with digital pens and an augmented tabletop setup for brainstorming. This device is a combination of virtual and real 2-dimensional drawings and digital data, which are transferred into a single information space by supporting face-to-face collaboration especially in the design process (Haller et al., 2006). This digital tabletop setup is an interface that people can share a broad range of verbal and non-verbal ideas to collaborate effectively but still keep a private space (Figure 2.27).

Figure 2.27. The collaboration mode allows designers to sketch the same document and using PC, Tablet or digital pens (Haller et al, 2006, p. 192)

Collaborative information seeking systems are another context for digital spaces. Recent research presents a design space for collaborative search systems on interactive tabletops devices. For example, WeSearch is a prototype designed to support groups conducting collaborative Web search tasks. WeSearch is a space that can be used by a group of colleagues selecting a location for their company's next offsite meeting. It allows users to have their own personal search space as well as share space for in order to share their ideas and decision-making (Morris et al., 2010).

Another such interactive environment includes one table and a large wall display equivalent to the paper-based brainstorming (Hilliges et al., 2007). It is a multi-user application that was designed for co-located collaborative problem solving to support the group communication (Figure 2.28). Students showed the similarities in the number of ideas in both the interactive environment and classical paper-based condition, but the quality of the ideas was slightly higher in the electronic brainstorming (Hilliges et al, 2007).

Figure 2.28. Wall and table displays in an interactive environment (Hilliges et al, 2007, p.144)

JISK was a project that sought to create creative conversations in design education. It aimed to support design-related activities in the classroom or studio by using learning technologies shown in Figure 2.29. It was composed of an information spaces built to help learners present their design work with peers and tutors, supported by both physical and digital resources. It enables students to write, draw and sketch on a range of horizontal and vertical surfaces captured through audio and video recordings, and photographs for later reflection. Different case studies encouraged the effective engagement in a creative and productive conversation during a learning process, and revealed that the environment could encourage conversation by reviewing and replaying the captured conversations, increasing the speed of conversation using pens, and structuring and managing the conversation for better facilitating improved the reflection process.

[redacted]

Figure 2.29. Using technology to build a collaborative and creative space for design learning (Jisk, 2011)

A similar design space was a workspace that integrates an interactive table and tangible tools with vertical display. The table was used for interacting with digital artefacts (shared action space), while the vertical display was used for reflection (shared reflection space 33) (Figure 2.30). The digital pen & paper and multi-touch interaction helped users to engage in the design task and collaborate with others creatively in the flow of the design technique with the phases of ideation, presentation and discussion (Geyer et al., 2011).

Figure 2.30. Workspace design: shared action space (a), reflection space (b), personal spaces (c) and transfer spaces (d) (Geyer et all. 2011, p. 337)

Another interactive tangible system that supports (the sharing of) moments of reflection during brainstorming was called NOOT a research tool to show how physical materials and social interactions can support people's sense-making efforts. Each clip of NOOT has a wireless radio inside each clip that can audio playback from central speakers. NOOT acted as a natural extension of writing a sticky-note: one comes up with an idea, writes it down on a sticky, and then one attaches a clip to the sticky-note, linking 'talk' to 'text'. It also helps the reflection in the way if somebody finds a moment interesting in brainstorming to think more about that, could revisit it later by taking a NOOT (Figure 2.31). It could enable the insight stage in creativity to be recalled, related and used in an efficient way (Dijk et al, 2011).

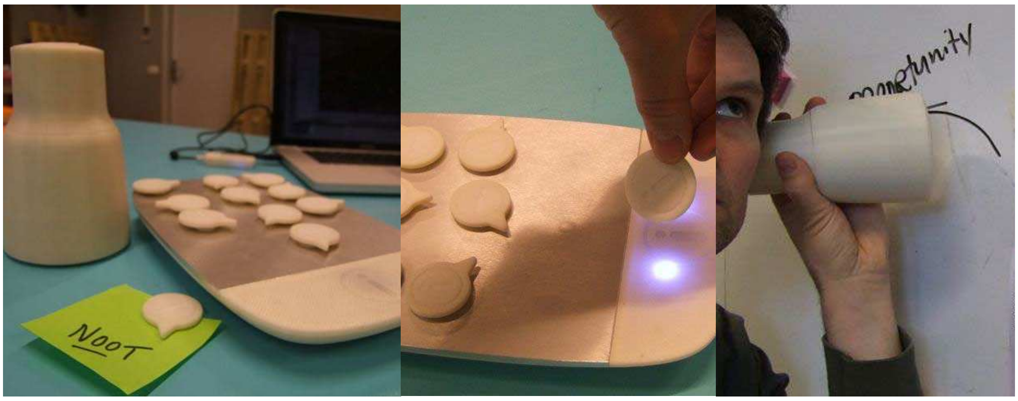


Figure 2.31. Noot, flexible scaffoldings in reference to the physical space. Listening to the ideas in brainstorming by recording ideas instead of writing ideas in sticky notes (Dijk et al., 2011, p. 125)

TRACES was an interactive floor to guide the creation of shared insights and support the transition from individual thinking to group-level integration (Dijk et al., 2011). Physical elements in the environment in the basic creative session included post-its, sketches, diagrams on the whiteboard, and personal notes, which are ‘traces’ that people leave behind as a result of the creative process. The system sought to find new ways of creating ‘traces’ and using them as cognitive platforms to support communication and the improvement of shared perception. Traces enabled people to be more actively engaged, especially during the ‘integration’ phase, and invited them not only to create materials during idea generation but also to actively use these materials during the integration phase. Over time, the interactions between people supported by the traces on the floor and it could be saved for later reflection. To use traces, users stepped onto the central meeting floor; a circle with ‘your’ traces is projected around you, enabling you to walk around with them. Participants could move, remove, throw away, arrange, modify, or classify their traces before stepping into the discussion by stepping on to a trace. In a group floor setting, participants were able to give traces to each other, or build up a shared set on the ground with multiple viewpoints (Figure 2.32) (Dijk et al., 2011).

Figure 2.32. Generate and integrate ideas in a shared creative workspace (Dijk et al., 2011, p. 127)

Do & Gross (2007) reported design research based on the observation that making things in groups could lead to more creativity. When people make things by hand, they create during the process of making. Creativity is seen here as a capacity that could be cultivated through experience of making things physical, such as jewellery or a Lego sculpture, or that have no material presence, such as songs, poems, or software. The projects focus on 'making things', building computationally enhanced artefacts that are objects to think with, to play with, and to reflect ideas about design. A lab for making things is a potential environment for creativity. Gesture modelling is a tool that, instead of using software for modelling, used hands to generate three-dimensional form that enables designers to design with computers as freely as one could in making sculpture out of clay (Figure 2.33) (Do & Gross, 2007).

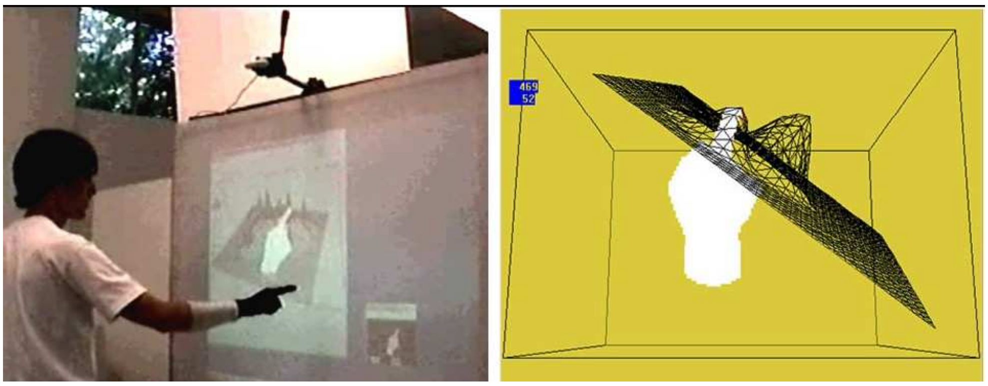


Figure 2.33. A space for deforming a mesh model with hand gesture (Do & Gross, 2007, p.30)

Other digital environments enable bodily engagement and performative action in an architecture context, and reveal how the diversity of material resources affects collaborative creativity. Artefacts with different materials involve our senses and are connected to perceiving, expressing and. experiencing materiality and interaction in collaborative settings with experiencing material artefact could lead to creativity. Participants used close-up pictures of different materials that are then projected onto the wall to maximize the dimensions of the physical model, and walked through it with an endoscope (Figure 2.34). This system enabled designers to see and evaluate an object when puts it in the physical space in relation with other objects scales and dimension in the space (Jacucci & Wagner, 2007).

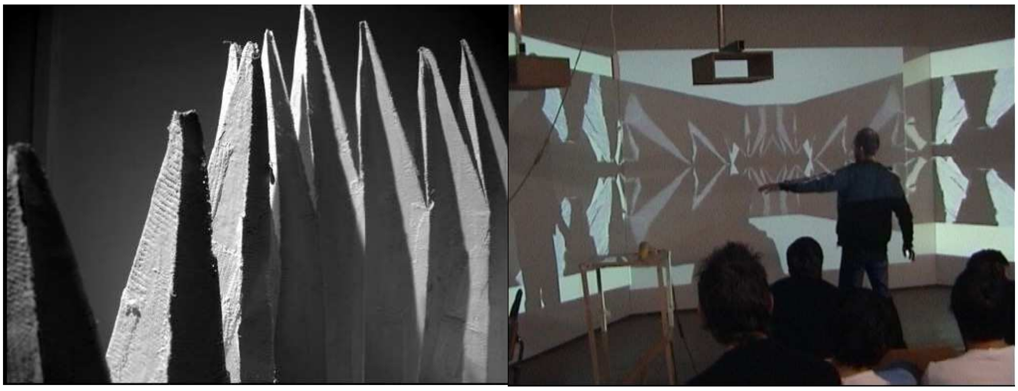


Figure 2.34. Small detail into a spatial collage (Jacucci & Wagner, 2007, p.78)

To summarise, most reported research has focused on different technologies to enhance creativity. My analysis reveals a gap to investigate an environment as a creative space that support people's creativity in design domain without such technologies. Using artefacts and other features of the environment can also enhance creativity in the creative process of design by taking into account people's different and changing emotions.

2.5 Relationship between creativity, environment and emotion

The concluding Section, of this Chapter, presents the emerging focus of this research in terms of structured relationship between three main domains of this research including creativity, environment and emotion. The relationship between these three sought to identify forms of environment that can be applied to support designer's emotion to augment creativity in a creative design process.

2.5.1 The influences of 3 main domains in the previous research

The fundamental structure of the components of this research in a creative design process is based on the impact that each component causes. First, the environment can influence designer's emotion, and designer's emotions can influence their creativity. Moreover, the environment affect on the creativity in both outcome and performance. Therefore, the main components and their influences in this research in the context of design shown in Figure 2.37 presents the influences between different components that are named influence1, influence 2, influence 3 and influence 4, and which are presented in the following sections.

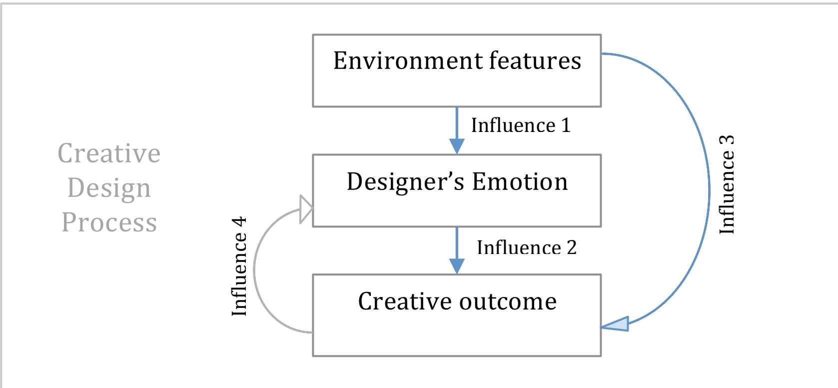


Figure 2.37. The influences of 3 domains in this research

2.5.1.1 The environment features influence designer's emotions (influence 1)

The environment can create particular emotions that people feel when they see the space for the first time, or while they occupy it. People experience feeling of calm, relaxed and happiness in some specific places and they feel scared, surprised or alert in other spaces. Google, Facebook and many other tech companies are examples that point, "It is ok to have fun and play here" to create positive emotions for people that work. So the environment carries different messages such as playful, fun, communicative, collaborative or motivated. In environmental psychology, research revealed that when people change the environment, they experience and act differently, (Gifford, 2014). Moreover, Kopec (2012) studied about how does a room affect on people's behaviour, emotions and well being considering decrease people's stress and increase their satisfaction. However, there is still the lack of applicable guidelines for designing the specific space to make particular emotional affects.

2.5.1.2 Designers' emotions influence creativity output (influence 2)

The result of the analysis of Bass (2011) contains 3 fundamental classifications of valence, arousal, and regulatory focus. Creative performance was enhanced most by positive emotion states that are high arousal and associated with an approach motivation and promotion focus (e.g., happiness), rather than those that are deactivating and associated with an avoidance motivation and prevention focus (e.g., relaxed). Emotions with positive valence improved creative performance through enhanced cognitive flexibility and inclusiveness while activating moods with negative valence lead to creative performance through enhanced cognitive perseverance and persistence.

Furthermore, an activity that is linked to such emotions can enhance creativity. For example, De Bono suggested that play can overcome limited thinking by lateral thinking and encourage people to generate ideas by making some nonsense connections (LIoyd, 2013). Other research that investigated using in divergent and convergent task for children demonstrated that fantasy and play is essential in facilitating divergent thinking. Furthermore, it showed that children that act in divergent manner perform better in flexibility and creativity. As a result, they do the convergent task better afterwards, although the effects are short term (Lillard et al., 2013). This condition is a good example to indicate that emotions that caused by play are high activated and positive valence therefore could help the divergent task. However, the volume of research exploring the affect of emotion on creativity is increasing there is a lack of research to study the link of emotion-creativity by considering the impact of the environment.

In the design context, the research of Sas & Zhang (2010) investigates different emotions that designers experience at various stages of creative design processes, and showed that in general, positive emotions facilitate creative problem solving and increase cognitive flexibility, while negative emotions have mixed impact. Also she found that the creative design process involved high arousal and positive valence emotions in all stages of Wallace model apart from incubation. Instead of designers involve low arousal and negative emotion in incubation stage (Sas & Zhang, 2010).

2.5.1.3 Environment features influence creativity (influence 3)

Research into the psychological press suggested that the social environment is key to creativity for both individuals and groups in organizations (Amabile, 1996). Csikszentmihalyi (1990) suggests that three elements of society, culture, and individual, and how these elements interact together can shape creativity. But there is less research in the link between physical press and creativity. These studies (Csikszentmihalyi, 1990; McCoy, 2000; Kristensen, 2004; Lewis and Moultrie, 2005; Moultrie et al, 2007; De Dul et al, 2011, Williams, 2013) revealed associations between physical environment and creativity to support the creative performance of users. However, there are not a systematic and practical approach that suggests functional principles to design the space for now and future to support designers creative performance.

2.5.1.4 Creative outcomes influence designer's emotions (influence 4)

Creative thoughts can produce the positive emotions in a creative process. For example, the qualitative research of the daily diaries of 222 employees in seven companies indicated that the emotion-creativity cycle is a two-way relationship (Amabile et al., 2014). The results indicated that positive emotion relates positively to creativity, but creative outcomes can also boost positive emotions. Therefore the creative outcomes have the negative or positive affect on designers' emotions. For instance if designers are positive about their creative performance, it could boost their emotions positively and positive emotions can improve the creative performance.

2.5.2 Current thesis in the gap of research

There has been relatively little research into designing the environment that views whole components of the CSE framework, considering the link of creativity and emotion to design such environment. Most of the work undertaken in different areas studied, either emotion or creativity, particularly in the design domain. Some related work showed how the digitally embedded stimuli that were priming positive, negative and neutral pictures, can induce emotions and influence the creativity. The results of that study showed that positive pictures can improve the quality of creative ideas (Lewis et al., 2011). During idea generation, positive (e.g. a dessert) images compared to the negative images (e.g. a dead body) enhanced creativity. Morris et al. (2010) claimed that music can be an induction for creativity, and influence creativity, for instance positive music compared to sad music can improve creativity in idea generation. However, this is a relatively new field to explore.

To fill the gap, this research sought to integrate these components with the aim to 1. investigating the relationships between the components with the focus on creative design process 2. proposing a theoretical framework to explain the relationship between the components and 3. suggesting design guidelines that could be implemented in designing the environment that enhance creativity through designers' emotions. The research questions that were mentioned in Chapter 1, with respect to influences 1, 2, 3 in the CSE framework, are:

1. How do environments affect on designers' creativity by influencing their emotional states in a creative design work? This question explores the influences 1 and 2 to investigate what are the relationships between environment and creativity with respect to different emotions that designers experience during a creative design work.

2. What kind of emotional states enhance creativity during the divergent and convergent stages of a creative design work? Research question 2 is based on influence 3 and studies the effects of the environment setting build by CSE framework on designer's creative performance?

3. How is an environment implemented during the divergent and convergent stages of creativity design work (divergent and convergent thinking) to manipulate designers' emotions, with the aim to enhance designers' creative thinking? Research question 3 is based on all 3 influences in the framework, and aims to create an environment, that will apply the CSE framework in a creative design process to support creativity.

To answer the questions and investigate the influences, different environment had designed and applied following some design guidelines. This research aimed to assess emotion and creativity and compare the results regarding to CSE framework that is explaining in the next chapter.

3 The first framework of creativity support environment (CSE)

This chapter presents a new framework for a creativity support environment based on gaps identified in previous research. The focus of the research was to create a framework to describe the important relationships between an environment, designers' emotions and creative design. The framework offers a new perspective on environment for designers by considering the relationship between emotion and creativity to support a creative design process during a limited period of time.

The framework assumes two specific parts of a creative design process: inputs and outputs (Figure 3.1). A creative design starts with a design problem as input then designers individually or in groups try to solve the problem and generate new design ideas that are the output of a creative design process (Figure 3.1).

Figure 3.1. Input and output in a creative design process

3.1 The framework of creativity support environment and 4Ps of creativity

As I explained in Section 2.1, the Rhodes model of the 4Ps was applied to structure the framework of a creativity support environment. In the framework, which is derived from Dul et al. (2011, p 33), the creative person is a designer and the framework's focus is on the emotions of designers that can influence the *process* of creative design. The *product* is the creative (original and useful) outcome that is an output of the creative process. This creative *product* can either be new design ideas or a functional specification. The press is the environment that creativity take place and divided into two parts: 1) the physical environment, and 2) the psychological environment that will define in section 3.1.4.

Figure 3.2 presents a conceptual model of the relationship between a creative person, the work environment and creative process. Dul et al. (2011, p 33) proposed this model to test the effect of both psychological and physical environments on the creative performance in the work environment of 49 organizations. It is based on the original 4Ps model of creativity (person/who, process/how, product/what and press/where) with a focus on the press as the environment for creativity (Rhode, 2011). This focus on press is because even the most creative person, using the best process has difficulties to create the optimum product or service without a supporting environment for creativity (Couger, 1994).

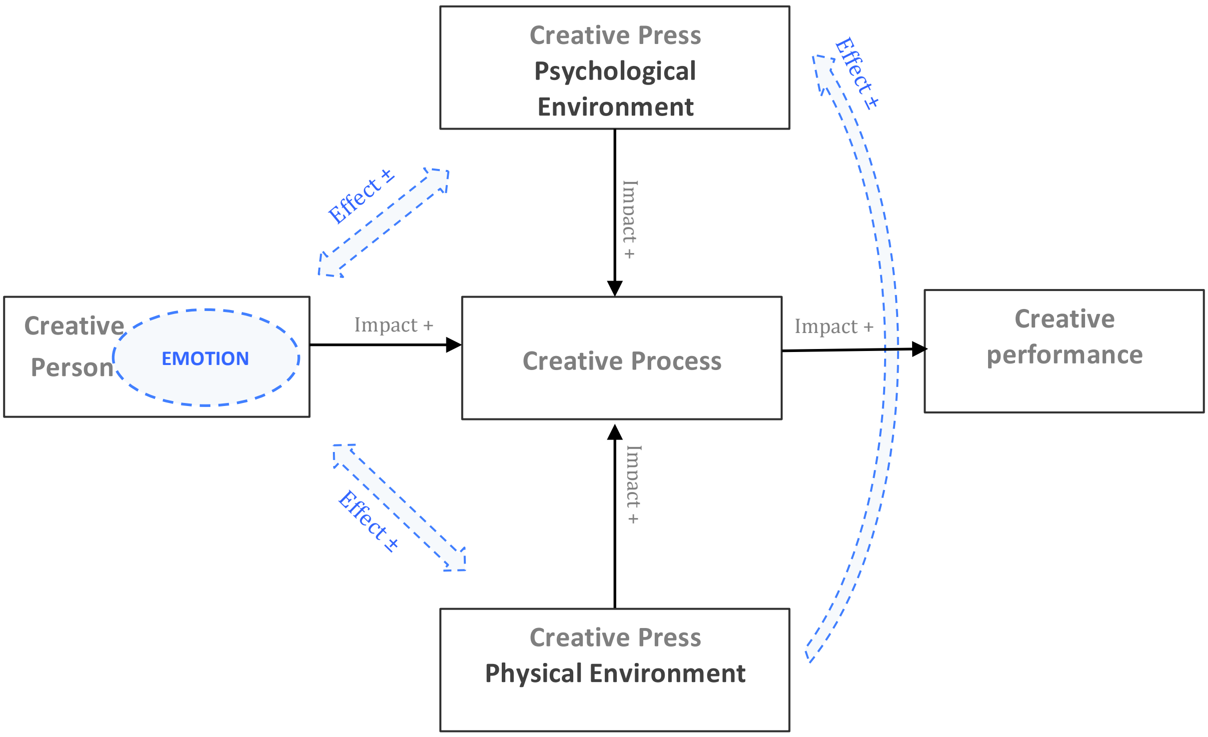


Figure 3.2. Relationships between 4Ps of creativity and emotion based on original model of Dul & Ceylan (2011, p33) "the relationships between creative person, creative work environment and creative performance"

I have extended this framework (Figure 3.2) to define the relationships between different parts of the components related to this research. The research proposed that emotions that are very important qualities of a creative person (designer), and can influence both the climate as a psychological environment, the perception of the physical environment and the way people feel about. Furthermore, the climate and physical environment can impact on people's emotions. The creative process in the middle of the model can be influenced by emotions in either positive or negative ways, showed with (±) arrows. The process also has a direct impact on creative performance. The definition and assumption of each part of the model is described in the following section.

3.1.1 The creative people (designers)

“A designer is a person who designs. More formally, a designer is an agent that ‘specifies the structural properties of a design object. In practice, anyone who creates tangible or intangible objects, such as consumer products, processes, laws, games and graphics, is referred to as a designer.” (Ralph & Wand, 2009). Designers are creative people that are familiar with some creativity techniques and problem solving skills.

The focus of this research is on emotions of designers that would change during the creative process. In this model, emotions are needed to support different stages of a creative design process (e.g. positive emotions can facilitate creative problem solving to increase cognitive flexibility) (Sas & Zhang, 2010).

3.1.2 The creative design process

A creative design process is part of a wider design process (Figure 3.3) that results in creative products. The ideas in a creative design process tend to be too raw to present as a design output to the market or manufacture. The creative design process that is the focus of this thesis is a subset of the early stages of design process that leads to creative output. Creative outputs refers to any creative ideas that are both novel and useful (Howard et al, 2008).

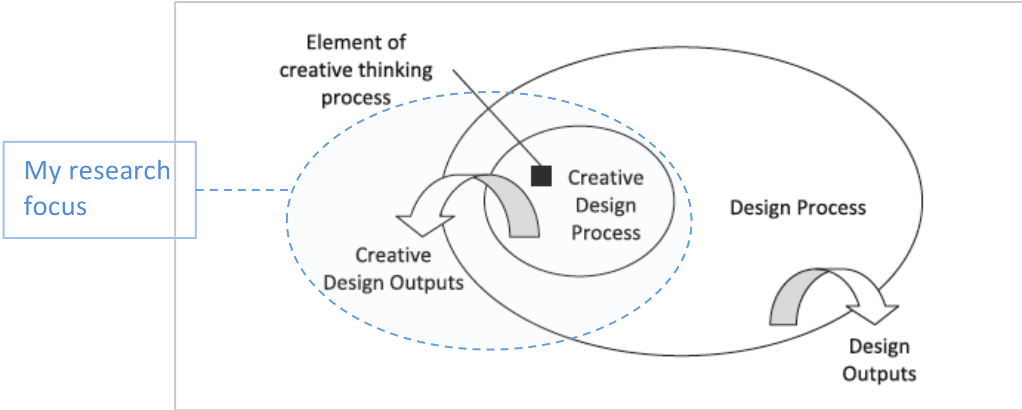


Figure 3.3. Creative design process as early stage of design process (Wong, 2011) and the focus of this research is creative design output and creative design process not the whole design process and output

Furthermore, according to the essential activities that designers perform, Cross (2000) developed a simple model of a design process (Figure 3.4). The last stage of this model is communication that the design outcome is ready for manufacturing or presenting to the market. This would be the final product of a design process. The creative design process refers to the early stages of Cross's model (exploration, generation and evaluation) that designers created by writing the ideas and some drawings for a design concept related to the design problem. In this research, the exploration, generation and evaluation that is a divergent-convergent process was considered to get the creative design output that describes in the next section.

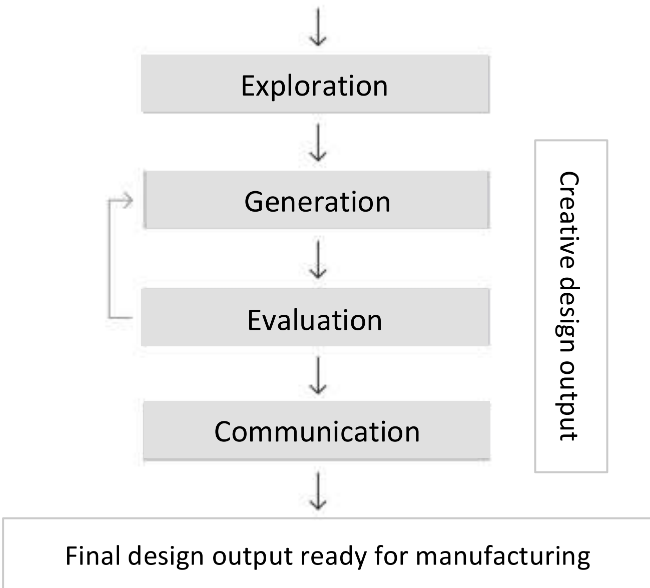


Figure 3.4. The Cross model of design process in 4 stages of exploration, generation, evaluation and communication and the output (adopted from Cross, 2000, p.30)

3.1.3 The creative performance and outcome

The output of the creative process is one or more ideas that are considered novel and potentially useful. Therefore, a creative outcome should be both novel and functional in the related context of design that presents solutions to solve the problem creatively and accomplish the real and recognisable goal (MacKinnon, 1962). This outcome can be related to products, services, processes, and systems. Innovation then starts by implementing these ideas (Dul & Ceylan, 2011).

Design seen from the perspective of an entity is the product of different creative actions:

1. A drawing or sketch
2. A graphic presentation
3. A particular plan or method
4. A reasoned purpose
5. A deliberate intention (American heritage dictionary, 2013)

Designers start by understanding the design problem and exploring the new solutions by sketching, simple prototyping, sketch planning, and story boarding. Designers can work on their ideas until they become satisfied with their solutions for a design problem. Design concepts should be improved in these stages to add more details and solve the sub-problems of designs technically and realistically, i.e. the generation and evaluation stages in the Cross model, see Figure 3.4, and make it ready for manufacturing or presenting to the clients during the evaluation and communication stages in the Cross model, see Figure 3.4.

[redacted]	**Exploration + Generation Evaluation (in concept)** Creative design output: Designer’s sketches on a paper plate mat in a restaurant in Italy Visual Inspiration and stimuli: Lemon and shape of squid Environment: Pizzeria restaurant, Il Corsaro, Italy
[redacted]	**Exploration + Evaluation** Adding more details to the main concept to make it ready for production (e.g. materials, dimensions, functionality)
[redacted]	**Evaluation + Communication** Final product Produced by Alessi company and presented to the market

Figure 3.5. The example of a successful creative product, that shows design outputs in different stages of design process in Cross’s model (Juicy Salif that designed by Starck in an Italian restaurant inspired by lemon and squid)

A famous example of a creative product design is the *Juicy Salif* concept that Philippe Starck generated while having dinner in a restaurant and thinking about the lemon squeezer project that Alessi design company requested. He started to sketch on paper place mats to develop his ideas, inspired by the shape of the squid that was in his plate. This is a quick creative process of sketching and thinking. Starck used his sketch in the process of discovery and invention in design (Chan, 2015). It was a creative outcome that was presented as a solution for the design problem, however it needed more details for production such as choosing right material, exact dimensions and efficiency to getting juice efficient for final design outcome, see Figure 3.5.

3.1.4 The creative press (environment)

The creative press refers to the context in which creativity take place, and includes its environment, place, situation and climate. It can also refer to the environment that the person is in and can explain the interaction between the person and situation that can promote or inhibit creativity (Isaksen et al, 2009). It includes the work environment, which "consists of practices, systems, norms, events and physical surroundings within a work context. The work environment for an individual is made up of all surrounding factors" (Dul et al., 2011). In this research, the creative environment in the framework is composed of two components: the physical environment and the psychological environment or climate (Figure 3.6). Each is defined in the following two sections.

3.1.4.1 The physical environment

The physical environment is defined as "the people's context of work in terms of the physical surroundings, such as the immediate workplace and surrounding buildings" (Dul & Ceylan, 2011, p33). It refers to the all features of the environment that is associated with sensory input that is related to 5 human senses for example visual features, sound, food, smell and touch (Williams, 2013). Furthermore, Williams (2013) categorized the features of the physical press into three main environmental factors: 1) *place* (e.g. public busy place, outside or inside, open plan space), 2) *properties* (e.g. quiet, private, safe and busy), and 3) *affordances* (e.g. walking inside, play and tech toys, visual equipment, face to face communication and relaxation). Therefore, the physical features that were considered in this research included 1) *space* (e.g. the size of the space, lighting, and windows, view of nature, colours, forms and shapes), 2) *Furniture* (e.g. desk, table, chair, sofa, divider, texture, shape, colour), 3) *Artifacts* (e.g. posters, pictures, artworks, plants, objects, toys, creativity equipment's, visual details, colour, and shape), and 4) *Sound* (e. g. music as an auditory element of the environment. These elements ware elaborated on the section of design guidelines.

3.1.4.2 The psychological environment (climate)

Climate can describe "the feeling, air or atmosphere of an environment or organization" (lewin et al., 1939). It can support or inhibit creative productivity in the context of work. Dul et al. (2011) described climate as social work environment that refers to 'the employee's social context in terms of teamwork, reward system and leadership styles.' In this research, climate is treated as the psychological environment of a group of designers. Furthermore, physical environment can influence the climate of a group (see figure 2). Challenge, freedom, trust, idea-time, playfulness, conflict, idea-support, debate and risk taking have all been identified as factors of climate that can affect creativity (Isaksen & Ekval, 2007). Therefore, in the first study of this research, these climate factors were used to evaluate the creative climate of the group to compare the effect of different physical environments.

3.2 Relationship between environment features, designers' emotions and creative outcomes in a creative design process

The framework describes the relationships between a designer's environment, emotions and creative outcomes in Figure 3.6. The framework focused on manipulating designers' emotions by designing the environment to foster creativity.

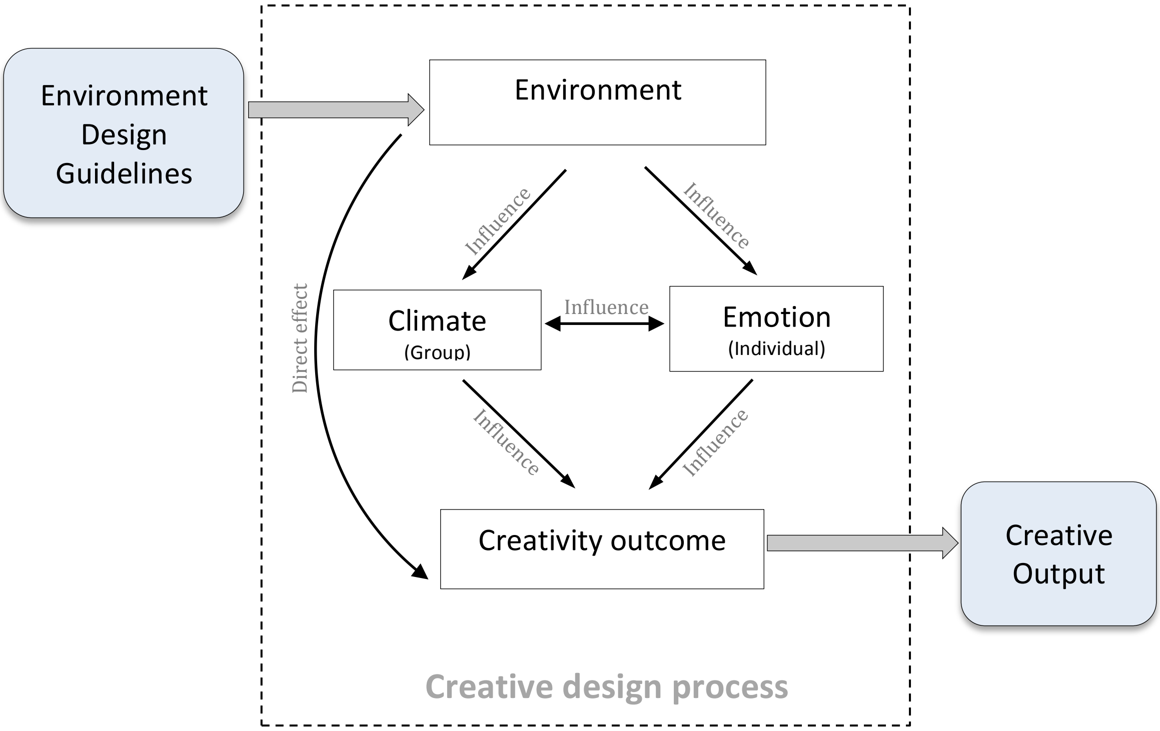


Figure 3.6. The framework of creativity support environment showing the relationship between environment, emotions and creative output in a creative design process

The framework defines that features of the environment can affect both designer's emotions (individual emotions) and climate (the emotions of a group). There is an interaction effect between emotions and climate that can influence each other. For instance, the negative emotions of one designer can impact negatively on the creative climate of a group, and a positive climate of one group can change the individual's emotions positively and enhance the group emotional state.

The emotional state of both individual designers and groups can influence creativity outcomes and performance. Previous research has shown that environment is a stimulating tool and resource that can potentially boost the creative design process (Moultrie et al., 2008). Physical environment can also support creative visualisation, exploration and inspiration through access to materials and artefacts. This approach considers the environment as a catalyser that develops design evaluation (Moultrie et al., 2008).

3.3 Basic design guidelines of an environment to enhance creativity

Basic design guidelines in Table 3.1 were derived from the existing researches that studied the link between different environments and creativity. These elements are the results and concepts of studies that linked the physical work environment to enhance creativity (McCoy, 2009; Barrett & Barrett, 2010; Dul et al., 2011. Martens, 2011, Cooper, 2014; Moultrie et al., 2007; Williams, 2014), and some of the physical elements are adopted from the real creative environments such as thinkubator (Sittenfeld, 1999), Catalyst Ranch, Disney, Google and Pixar by looking at their creative spaces and uncovering the features of their physical environment that stimulate creativity of people in the work environments.

I categorized 6 basic guidelines based on the essential and standard requirements for an affordable environment (comfort) and 5 human senses (sight, hearing, taste, smell and touch). Comfort is related to affordance of the environment to meet the people's needs in work environment (William, 2014). It should provide ease of use, wellbeing and comfort for people as a foundation of an environment to make the feeling for people as they are at their own home. Hanan, the creator of thincubator (McGuinness, 2015), that is a place for triggering creativity, believed that creativity could foster by stimulating all 5 senses of human at the same time. People can gain information from their environment through the sensory inputs from their 5 senses. Each sensory input such as sight, hearing, smell, taste and touch has the potential to improve cognitive process of thinking and creativity.

Basic guidelines to enhance creativity	Details of physical environment and properties that stimulate creativity
1. Comfort (Williams, 2013) (Augustine, 2015) (Bryant, 2012) (Cooper, 2013) (Dul, et al., 2011) (Groves, 2010) (Moultrie et al., 2007)	1.1 Comfortable furniture to provide flexible positions for sitting
	2.1 Appropriate temperature (a bit of cold for a group create dynamic)
	3.1 Soundproof environment to protect people from distraction
	4.1 Fresh air
	5.1 Easy access to technology and work surface

2. Sight (Gray, 2011) (Cooper, 2012) (Groves, 2013) (Williams, 2013) (Jaff, 2013) (Landry, 2012) (Groves, 2010) (Lloyd, 2013) (Martin 2010) (McGuinness, 2015) (Moultrie et al., 2007) (Nouri & Maiden, 2013) (Taher, 2008)	**Lighting**	1.2 Natural lighting
	View	2.2 View to the nature, Window view
	Material	3.2 Glass, colourful, transparent, natural
	Texture	4.2 Stimulating texture
	Colours	5.2 More bright and stimulated colour (specially purple, green, red)
	2D visual elements	6.2 Posters, models, pictures on the wall
	3D visual elements	7.2 Artefacts, toys, manmade landmarks, unusual objects in form
	Furniture	8.2 Unusual furniture
	Naturalize (Biophilia)	9.2 Plants
		10.2 Indoor greenery along with wood and water
		11.2 Natural material
	Spaciousness	12.2 Construction (High ceiling, Sound proofing, echo baffling)
		13.3 Physical movement to provide the freedom of movement
		14.2 Multiple places to work: co-location
		15.2 Size of space to fit team and task
3. Hearing (Williams, 2013) (McGuinness, 2015) (Mehta, 2009) (Lesiuk, 2005) (Chronopoulou, 2012)		3.1 Mild ambient noise (café noise, background noise between 65-75 db.)
	Music	3.2 Classical and jazz without lyrics for concentration
		3.3 Motown as most accepted music universally
4. Taste (McGuinness, 2015) (Colzato et.al. 2015)		4.1 Food (chocolate, fruit and beverages)
		4.2 Coffee delivers clear, quick thinking
		4.3 Low fat and high protein food contribute to creative performance
		4.5 Food supplement l-Tyrosine (TYR) -a biochemical precursor of dopamine- can enhance creative convergent (deep) thinking
5. Smell (McGuinness, 2015) (Augustin, 2015)		a. Peppermint, Lemon, Jasmine, orange, vanilla and cinnamon scent
6. Touch (Kramer & Block, 2014)		6.1 Physical contact and touch an object increase creativity

Table 3.1. Basic guidelines of the environment that stimulate creativity in 6 main categories of comfort, sight, hearing, taste, smell and touch

Particular visual and sound stimuli (Table 3.1) are associated to higher creativity, e.g. glass, colourful, transparent, natural material and stimulating texture inspire creativity. 3 other senses of taste, smell and touch can be the elements that enhance creativity. However, there has been relatively little research on sensory input and stimuli that relates to taste (Colzato et al., 2015), smell (Augustin, 2009; Knasko, 1992) and touch (Karmer & Block, 2014) in creativity research and empirical support for this possibility is still lacking of significant correlation between them.

Therefore, this research sought to focus on visual and sound stimuli and sensory input of the environment related to the sense of sight and hearing in human and comfort as a basic foundation to design the environment that can stimulate and foster creativity. I investigated the comfort elements plus lighting, view, material, texture, colours, 2D visual elements, 3D visual elements, furniture, naturalize (Biophilia), spaciousness as sight stimuli and also music and ambient noise as sound stimuli (Table 3.1) to design creative environments with higher creative potential. These basic guidelines were used to design the environment for the first study.

The next section presents how these basic design guidelines could be specified for different types of creative thinking, divergent versus convergent thinking and for the next two studies I used these specific guidelines.

3.4 High stimulated versus low stimulated digital environment and their design elements

Gorp (2012) claimed that, for new digital platforms such as websites or applications, it is essential to know what is the aim of a digital environment to deliver a good design that engages the users. Different contexts of use require different designs to provide flow that is a state of fully attention and engagement. In his categories these environments are either entertainment-oriented or goal-oriented.

Entertainment-oriented environments (such as game websites or applications) require higher arousal levels to keep the user engaged and interested in the task. Such environments are less challenging and more exploratory (Gorp, 2012, p76). and need to be visually attractive and more aesthetically appealing to users to demand the higher attention and lead to flow experience (Gorp, 2012, p77). Specific design guidelines could trigger higher unconscious emotional arousal in the user, such as interesting visual elements, bright colors or high contrast colours.

In comparison the goal-oriented environment requires user's focus and concentration (e.g. website/application designed for bank or flight). Tasks such as booking a flight or transfering the money require focus to complete the task. In a stressful environment, the level of creativity can decrease. Focus attention help users to reach higher engagement and facilitating flow in goal-oriented environments. Therefore, the environment should offer in a lower arousal stimulation. Such environments should provide less aesthetically rich and overwhelming stimuli, so that users that already have higher emotional arousal can focus and complete the task. Visual elements of designs in such environments should be neutral in colour and offer less visual features or movement in the page of the website, to keep the user focused and engaged with challenging task. In the environment, the elements of design more than visual element are categorised to tactile and auditory (Gorp, 2012) that are related to sight and hearing and touch senses (Table 3.2).

Arousal Stimulation	High arousal High stimulation	Low arousal Low stimulation
Visual	Angular shape	Curved shape
	Straight line	Round line
	Heavy colour	Light colour
	In motion pictures	Not moving pictures
	Cool colour	Warm colour
Tactile	Rough	Smooth
	Hard	Soft
Auditory	Louder	Quieter
	Deeper	Higher

Table 3.2. Stimuli that provide high and low arousal in a digital environment (Van Corp, 2012)

Therefore, this research sought to extend these guidelines to support both divergent and convergent thinking in a physical environment.

3.5 Divergent and convergent thinking and their characteristic

According to the different aspects of divergent and convergent thinking in the creative design process, this research introduces a new creativity support environment to empower designers in their creativity work by manipulating their emotional states to stay in the flow emotional state, in order to leads to more creativity (Csikszentmihalyi, 1998). Therefore, designing the environment needs to offer high activated (stimulated) and low activated (focused) spaces for designers to be in the state of emotions needed in each stage.

The research assumed that the nature of divergent thinking is more entertainment-oriented and require higher arousal to stimulate flow and creativity, whereas convergent creativity is more goal-oriented and needs more focus attention, so that people can finish the task with higher engagement that lead to flow and creativity. Table 3.3 describes the desirable characteristics of these two types of thinking (divergent vs. convergent) that derived from literature review.

	Divergent creativity	**Convergent creativity**
Level of arousal	Higher arousal	Lower arousal
Characteristic	Generating	Focusing
	Entertainment-oriented	Goal-oriented
	Experiential-flow	Task directed-flow
	Fantasize and imagine	Clarify and refine
	Stimulating	Calming
	Exploring	Decision making
	Playful	Thoughtful
Visual elements of the environment	High stimulated visual elements	Low stimulated visual elements
	Complex design	Simple design
	Bright and high value colours	Low value colour (neutral)
	High contrast colours	Low contrast colours
	3D shapes and visual complex form	Simple shapes and visual forms

Table 3.3. Comparing characteristic of divergent and convergent thinking, arousal and example of required visual elements to stimulate creativity

Based on these characteristics, an environment that can support divergent thinking should inspire entertainment-oriented, high exploratory action with high entertainment performance, whereas a convergent thinking space should provide a support on task-oriented with higher concentration on goal with lower entertainment and higher calmness and concentration to accomplish the task. The design elements of the environment can be visual, auditory and tactile. Design guidelines such as customised form, shapes, pictures, colour, light, and sound can be used to design a pleasant environment to foster creativity in different types of creative thinking.

3.6 Refined framework of creativity support environment (CSE) to support divergent and convergent thinking

Figure 3.7 describes the new framework of creativity support environment (CSE) expanded from Section 3.3. This framework divides the creativity design process into separated divergent and convergent thinking.

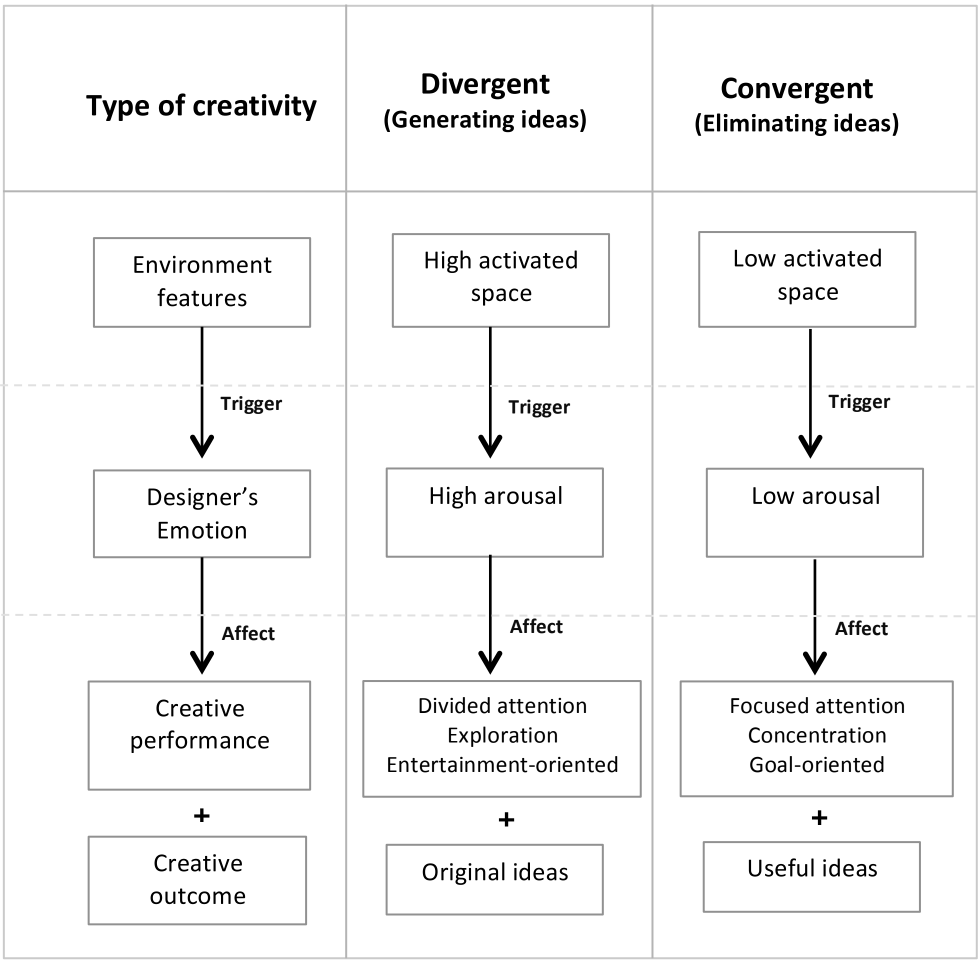


Figure 3.7. The model for creativity support environment (CSE) in divergent and convergent creativity

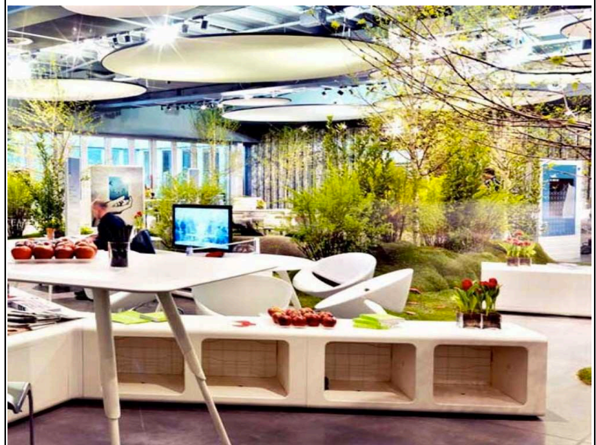
The CSE framework considers the significant influence of environment on emotion to affect creativity performance and outcomes and in a creativity design process. Higher arousal can cause divided attention, exploration and entertainment to improve the creative performance during the divergent thinking. In contrast, lower arousal creates more focus attention, concentration and goal-oriented performance for designers during convergent thinking. Moreover, the creative outcome in divergent thinking can improve the originality and increase the number of generated ideas. In contrast, the usefulness and value of may improve in convergent thinking by focusing and concentration that is the result of low emotional arousal.

3.6.1 Multiple design guidelines for a high-activated environment to support divergent thinking

To boost creativity in generating part of creative design activity, the features of environment should be designed in high activated/stimulated conditions to create higher emotional arousal, as shown in the middle column of Figure 3.7. Activating and stimulating refers to the physical features of the environment that caused higher emotional arousal affect positively on creative performance and outcomes. It supports creative performance to encourage entertainment-oriented behaviour, exploration, play, divided attention, fantasy and imagination that are the characteristic of divergent creativity.

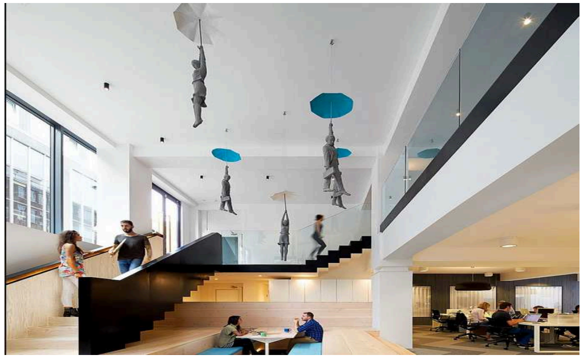
To create such an environment, in addition to the general creative environment elements that was described in section 3.2, this research proposes the following design guidelines for creating the high-activated environment:

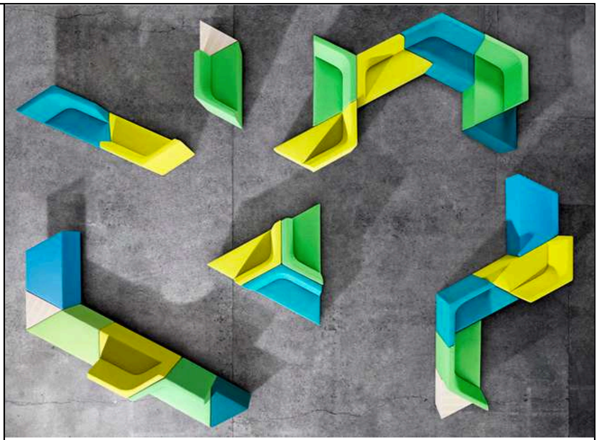
Multiple design guidelines for environment to stimulate higher emotional arousal					
No	**Design Guidelines**	**Description**	**Reason**	**Supporting Reference**	**Workspace example**
No.1	**Provide any window view to the outside**	Provide visual access from the design environment to any outer space	A window view creates more speciousness in the space, as well as an entrance for natural light that that can improve creative thinking.	(Stone & Irvine, 1994)	 Google, Dublin http://www.home-designing.com/2013/02/googles-new-office-in-dublin/google-office-design-2

No.2	**Provide window view to nature**	Provide visual access from the design environment to nature (e.g. trees and plants).	A view of nature engages involuntary yet undemanding attention, promote the feeling of liveliness and encourage the creative thinking.	(Kaplan, 1989) (McCoy & Evans, 2002)	 Cano Architecture Office, Spain http://www.archdaily.com/21049/selgas-cano-architecture-office-by-iwan-baan
No.3	**Use natural plants in interior garden**	Use natural green plants inside the design environment.	"*Biophilia is the theory* that humans have an innate affinity with nature, and are happiest and most productive when surrounded by natural elements." Such a design environment can enhance people's creative potential.	(Shibata & Suzuki, 2004) (Ceylan et al., 2008) (Cooper, 2013, p1)	 Think Garden in Milan, Italy http://eprofits.com/article/top-5-coolest-workplaces-ever

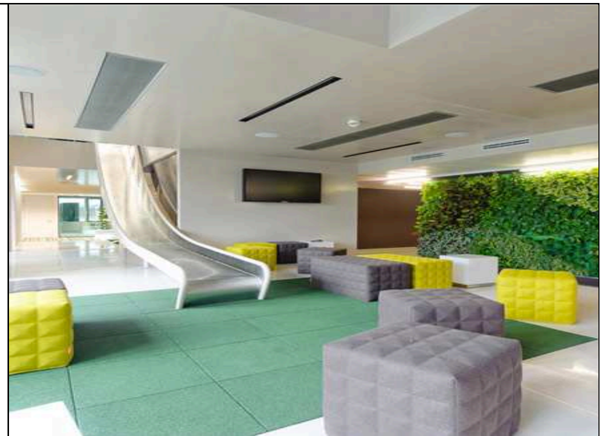
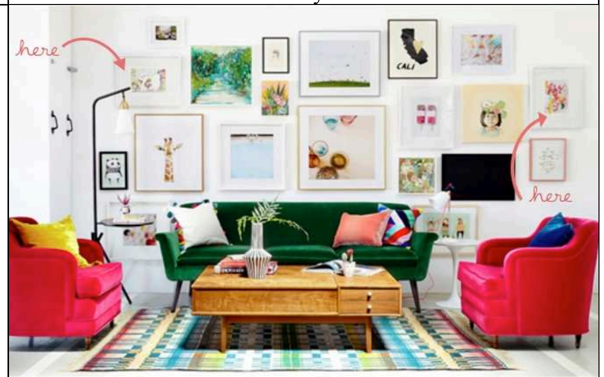
No.4	**Use bright colours**	Use bright colours such as red, yellow and green, purple, pink as the accent in the environment.	These bright colours are inspiring and stimulating and can create higher arousal and energy in the environment. People often associated energy and creativity with a colourful environment.	McCoy & Evans, (2002) Stone (2003) Gorp (2012) (Bryant, 2012)	 Motorola innovation centre www.wightco.com/projects/motorola-innovation-center
No.5	**Use contrasting colours**	Use colours that are in contrast, from opposite sides of colour wheel (e.g. orange with blue)	The use of contrasting colours in environment is visually appealing and is a basic rule in art to stimulate higher arousal and positive emotions that encourage creativity.	Gorp (2012)	 Quirk office www.officelovin.com/2016/03/02/inside-quirks-cape-town-office/

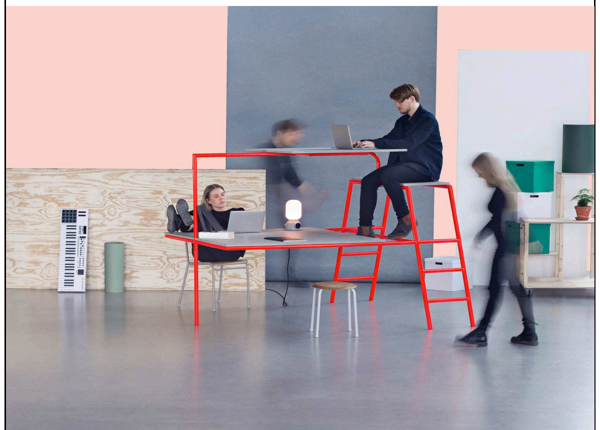
No.6	**Design private, separate spaces**	Use some space to create privacy and the feeling of ownership and belonging to a community.	Separate spaces inside a large open environment can create some privacy and the freedom of choices that makes people feel better in the environment. "Owned" space signals that an individual has standing in the community.	(Stokols et al., 1996) (Doorley, 2012)	 Google
No.7	**Use unusual objects**	Use unusual objects to enhance visual interest and surprise with a theme (e.g. a circus, the seaside, movie sets and so on)	The newness and unusual components of the space make people feel that they were are somewhere special and it raises motivation and energy to think creatively	(Martin, 2010) (Martin et al, 1996)	 Ogilvy & Mather, China

No.8	**Use objects in unusual places**	Place objects in unusual places (e.g. hang objects from ceiling (e. g. hats, books ,glasses and arts work)	Placing objects and art works in unusual scenes can generate surprise in the space that leads to higher emotional arousal and thinking differently. Newness and unusual components in the space makes people feel that they are somewhere special, and it can raise motivation and energy in the space for open-mind creation.	(Nouri & Maiden, 2013) (Martin ,2010)	 Fold7 London http://www.thecoolhunter.com.au/article/detail/2324/fold7-ad-agency--london
No.9	**Design the space for games**	Use the environment to show games, represent fun and create a feeling of playfulness (e.g. cards, dice, dominos and darts, balls, table football and pool)	Using games in the environment creates the conditions to explore, connect and interact with others that lead to better and easier relationships between people. People can connect and feel relaxed and de-stressed in a playful environment. Play also can improve lateral thinking.	(Meyer , 2010) (Groves ,2013)	 Google http://blog.smartglassinternational.com/10-strange-but-creative-offices/

No.10	**Use angular shapes and straight forms in furniture**	Use angular shapes and straight forms (e.g. rectangle and triangle)	Angular visual forms and shapes can increase emotional arousal that can enhance creative thinking.	(Gorp, 2012)	 Prisma p://media.designerpages.com/3rings/2013/09/03/prisma-by-alexander-lotersztain-for-derlot-editions/
No.11	**Design with Visual details**	Use a place to show varied personal objects, toys and games	Use of visual details in design environment can stimulate some positive and high arousal emotions that can lead to higher creative performance.	(McCoy & Evans, 2002)	 Disney office, London https://uk.pinterest.com/wrcreative/graduation-party/

No.12	**Use playful furniture**	Use playful furniture such as swing chairs, slides	Exchanging normal furniture to add the experience of fun while using them makes people experience higher energy, excitement and playful movement that is child-like and can help them to improve their creative lateral thinking.	(Groves, 2013) (Meyer, 2009)	 Candy mind http://techcitynews.com/2014/01/21/mind-candy-work-hard-play-hard/
No.13	**Use angular layout in floor plan**	Use angles in the layout in floor plan of the environment if there is enough space for movement	Angular visual layout represents higher movement potential and more body postures that can increase emotional arousal that lead to higher creative thinking.	(Gorp, 2012)	 Studio RAAAF http://english.cri.cn/12394/2014/12/19/3821s857348_2.htm

No.14	**Use flexible furniture**	Encourage people to move by using flexible light furniture in a spacious place	Flexible furniture encourages physical movement, dynamism and energy in the environment that leads to higher level of comfort and satisfaction in individuals and groups.	(Groves, 2013) (Meyer, 2009)	 Microsoft office Vienna tp://www.dezeen.com/2012/06/08/microsoft-headquarters-in-vienna-by-innocad/
No.15	**Design the space with visual appeal**	Use rich visual features such as different colourful pictures and artworks on vertical surfaces such as walls and boards and on tables and desks	Appealing visual pictures and artwork presents more complexity and visual details that is stimulating and inspiring, and creates higher emotional arousal and positive emotions. People associate artwork with creativity that can encourage their own creative potential.	(McCoy & Evans, 2002)	 Lego office http://www.lego.com/en-us/aboutus/news-room/

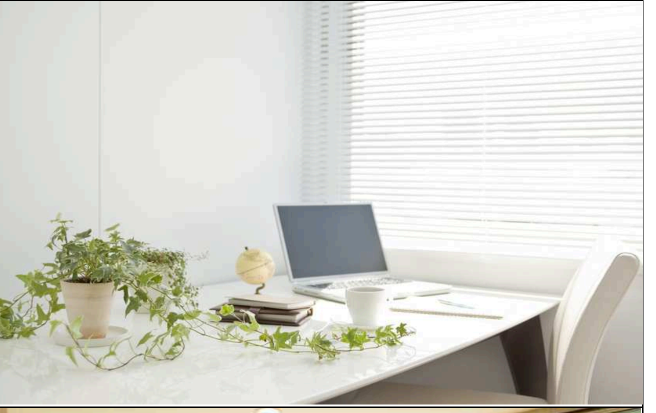
No.16	**Make the work space Playful**	Add play and fun to the environment as stimulation for creativity. (e.g. a pit ball room, a movie set, video game and so on)	Using specific spaces in the work environment for play can enhance improvisation, imagination and out of box thinking that can augment creativity. Adding the play and fun to the space can connect people with their inner child and results higher creativity.	(Groves, 2013) (Meyer, 2009)	 Pearlfisher office, London Pearlfisher office, London
No.17	**Provide different human postures**	Provide different positions of sitting, standing, leaning, perching or even lying down (bed and cushions)	If the environment provides different sitting and sleeping postures, it offers the freedom and flexibility of the space that enables people to choose and it can enhance the feeling of comfort and freedom. It is also good for change that leads to higher creativity.	(Groves,2013)	 www.dezeen.com/2 016/04/20/in-our-office-furniture-lund-university-students-rolf-hay-stefan-diez-milan

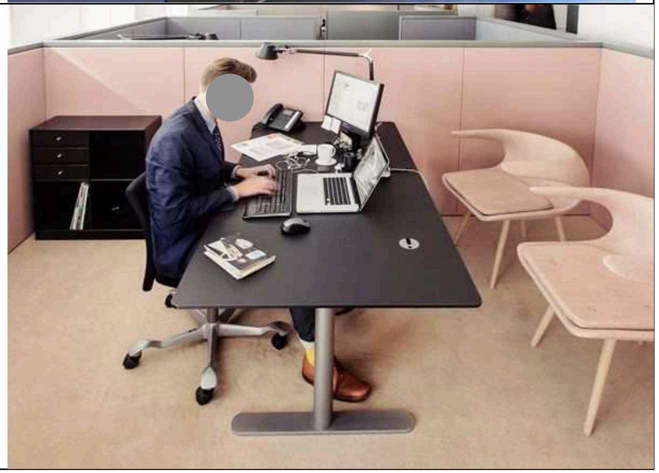
No.18	**Create home settings**	Design at least part of the environment to represent home with home furniture, rugs and curtains instead of usual office furniture.	Implementing the home settings and furniture can create the feeling of being at home that makes comfort and happiness that results higher creativity.	(Williams, 2013)	 Ubiquitous office http://www.officedesigngallery.com/2012/11/22/the-ubiquitous-manufacturing-company-office/
No.19	**Use home objects**	Use a variety of home small objects to deliver a feeling of being at home in the work environment (e.g. a bowl of fruit, a glass of water on the table, flower box)	Using some objects that normally seen at home can represent the feeling of welcome and being at home and provide comfort and joy of being in the lovely space with higher engagement.	(Williams, 2013)	 SAP office France https://experience.sap.com/news/boosting-creativity-collaboration-renovating-saps-office-spaces/

Table 3.4. Multiple design guidelines for environment to stimulate higher emotional arousal with examples

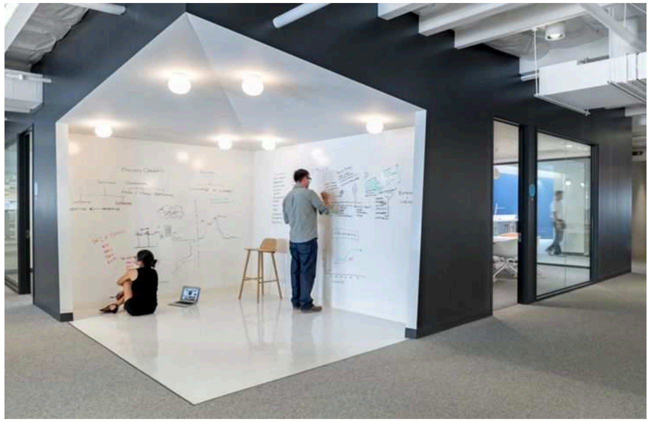
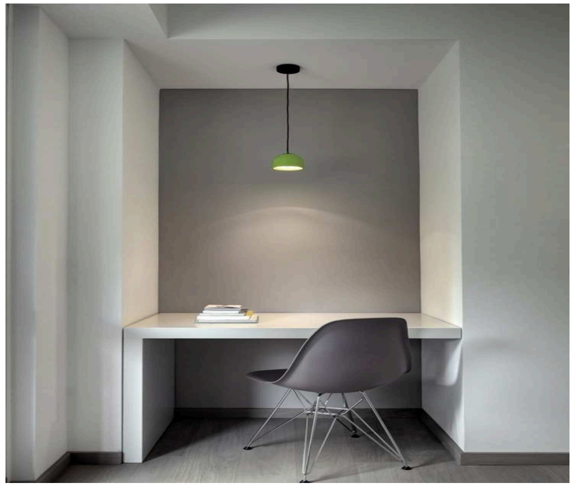
3.6.2 Multiple design guidelines for low-activated environment to support convergent thinking

To improve creativity in designers in convergent part of a creative design activity, the features of environment should be designed in low activated/ stimulated conditions to create lower emotional arousal as specified in the right-hand column Table 3.2. Lower emotional arousal in designers supports creative performance to encourage goal-oriented task. It increase the level of focus and concentration in designers work to stay more engaged in the task and flow emotional state that leads to higher creativity. I will argue based on this framework that the outcome of convergent thinking part of creative design process, that needs more focus attention to support rational thinking, clarifying, analysing, refining and decision making in designers may create higher level of usefulness, functional and practical ideas. The design guidelines for low-activated environment are as below:

Multiple design guidelines for environment to stimulate lower emotional arousal					
No	**Design Guidelines**	**Description**	**Reason**	**Supporting reference**	**Workspace example**
No.1	**Use plants to bring a part of nature inside the space**	Add plants in the simple designed environment on the table or hang it from the ceiling.	Connecting to the nature makes people calm and liveliness (Biophilia), even by one green plant or flower. It can create positive feelings that encourage creativity and productivity. In addition, when people take care of a plant, they experience a feeling of hope and belonging.	(Shibata &Suzuki, 2002,2004) (Ceylan et al, 2008) (Cooper, 2013)	
No.2	**Provide natural light from windows**	Provide a window that has a view to the nature to bring natural daylight.	Natural light and a view to the nature can promote the feeling of calm and relaxed with less emotional arousal and encourage the creative thinking.	(Kaplan, 1989) (McCoy & Evans, 2002)	

No.3	**Use neutral colours**	Use neutral colours e.g. different shades of grey and white in the environment.	Neutral colours have a calming impact on people's feelings and create less emotional arousal. Indeed these colours can create a restful environment with more focus and less distraction.	(Gorp, 2012)	
No.4	**Use pastel colours (e.g. light blue, lower shades of orange)**	Design the environment with lighter and softer versions of any colour that makes low contrast.	Pastel colours produce a more intellectual environment of atmosphere, in contrast to more stimulating bright colours. Pastels have the same calming effect as neutral tones, with slightly more liveliness.	(Gorp, 2012)	

No.5	**Design with curved shapes and round lines**	Provide round shapes and curved lines instead of linear and angular forms of furniture and objects.	Curves versus sharp lines can create less emotional arousal. People can feel more relaxed, calm and safe in environments with curves and round forms.	(Gorp, 2012) (Jaff, 2013)	
No.6	**Keep design simple and minimal**	Use the minimum number of objects in the environment to make it less distracting.	Design through simplicity and apply the design rule of "less is more" to create the serene and calm environment that encourage the concentration and focus in an environment with less distracting elements.	(Gensler, 2013)	

No.7	**Do not use pictures and visual features on wall, table and floor**	Create a simple and clean visual environment without any visual distractions; devote the attention to a particular task or project.	Any visual pictures and objects in the environment attract some part of attention and decrease a person's focus and emotional arousal. Simple environment without visual elements in the environment can enhance focused attention.	(Gorp, 2012) (Gensler, 2013)	
No.7	**Maintain an organized, clean and tidy desk**	Maintain a clean desk to enhance focus attention.	Mess and clutter can divide attention and decrease concentration and focus. In contrast a clean desk without any mess, can focus attention.	(Gensler, 2013)	

No.8	**Develope quiet spaces that convey the message of 'focus'**	Use the furniture and the environment to create privacy and focus.	A private space can provide a feeling of belonging to the space, and create higher focus in the task, as well as less distraction and less emotional arousal.	(Doorely, 2012)	

Table 3.5. Multiple design guidelines for environment to stimulate lower emotional arousal with examples

The next chapters report design and testing of conditions of the environment with regard to the CSE framework. The features of the environment in proposed design guidelines will design, create and test in the real physical setting to investigate the CSE framework structure by implementing the basic and multiple design guidelines. Reported empirical studies will examine the CSE framework in designers' work and environment either individually or in-group in a creative design process.

4 Empirical studies to test the first CSE framework

This chapter reports results of the next 2 studies undertaken to understand the validity of initial CSE framework and refine it according to the results. The first study sought to investigate the effect of physical environment to encourage emotions that enhance the cognitive flexibility and inclusiveness, and hence creativity of designers. It tested two different environments of negative and positive spaces for creativity in the group creative activities that were designed using guidelines in chapter 3. The second study investigated individual designer's emotions during divergent and convergent thinking and the effect of the physical environment to support different types of creative thinking (divergent vs. convergent), again based on the design guidelines in chapter 3 to augment creativity outputs.

4.1 Study I: A practice with the environments' effects, A creativity workshop in two different spaces

Space designers have argued that an environment that is more creative could foster the people's creativity (Doorley, 2012). Not only can the characteristics of a space directly afford more creative behaviour, for example through collaborative working around shared artefacts (Warr & O'Neill, 2007) but the qualities of the space can influence peoples' emotions so that they are more predisposed to be creative (Baas, 2008).

Consciously or not, people feel and internalize what the space tells them about how to work, influencing their emotions as a precondition for more effective creative thinking (Mehta et al., 2012). This research claims that environment has the capacity to enhance the creativity of designers by encouraging emotions that enhance cognitive flexibility and inclusiveness based on activating emotions with positive tone, therefore the first exploratory study was undertaken to seek evidence for the claim.

Using this empirical study, the research sought to explore the link between environment, creative climate (group emotion) and creative outcomes in a collaborative creative task based on the specific elements of the CSE framework shown in Figure 4.1. It is called a framework, not a model. Because a framework is the theoretical understanding that helps to create models. The framework of this research shows the structure of relationships between environment, emotion and creativity. This structure called framework instead of model to indicate the perspective, which used to approach this research and addressing research questions. A model is developed within a framework after test and proof with much stronger indications.

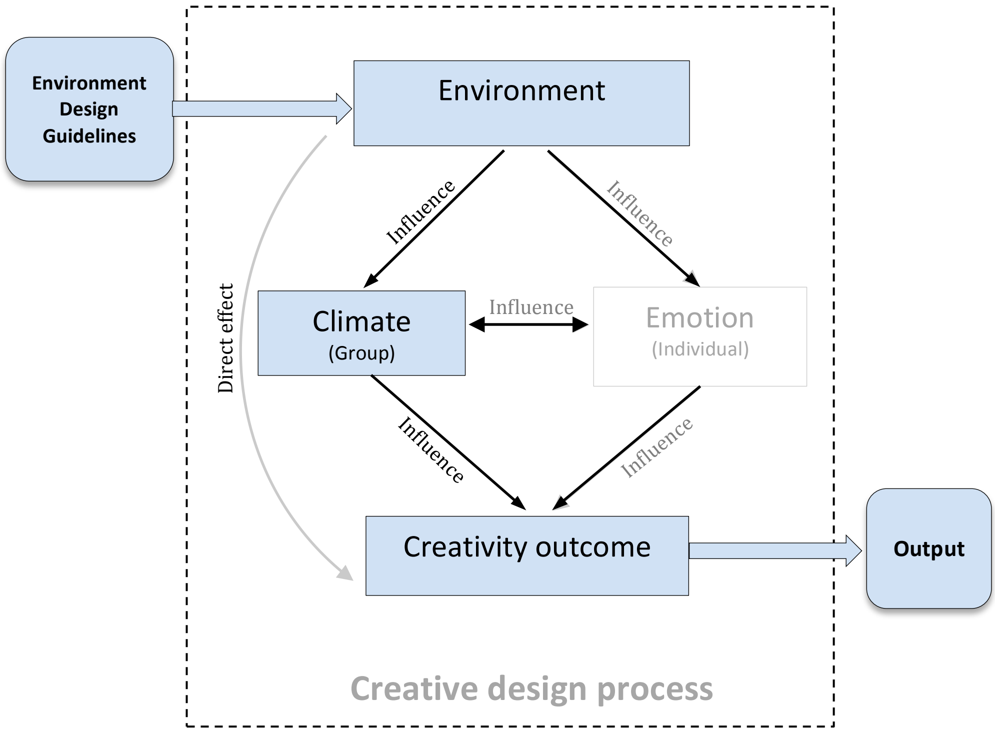


Figure 4.1. CSE framework in study 1, (the blue parts of framework was tested to explore group climate that triggered by the environment to enhance creative output

The elements from the CSE framework shown in the highlighted boxes in Figure 4.1 are the features that the first study sought to investigate. In particular the study investigated the effect of environment developed by using the design guidelines reported in Chapter 3, the climate of a group and creativity outcomes.

Although the individual emotions are not in the scope of the first study, I had previously investigated emotions informally in a collaborative design work by observing post-graduate design students during face-to-face group creative tasks over a 5-weeks period. Results revealed that, at the beginning of each session, most students reported more negative and uncertain emotions such as *unsure*, *confused* and *frustrate,* whilst most students at the end of the same creative tasks reported emotions such as progress, relief, funny and productive. Designers' emotions appeared to change during creative work, but reasons for these changes were unclear, leaving scope for more empirical research.

Therefore, the research examined a more rigorous empirical investigation of designers' emotions during a collaborative creative task in two different environments, one designed to provoke emotions that have been identified to enhance creativity, the other to provoke emotions that inhibit creativity by implementing some of basic design guidelines that described in section 3.3.

4.1.1 The design guidelines that were applied to an environment to provoke or inhibit creativity

Elements of a physical environment that have been shown to enhance creativity included its spatial 3D forms, the use of natural materials, warm colours, texture and glass, and a view on nature. In contrast, cold colours and manufactured and composite materials have negative effects on creativity (Doorley & Witthoft, 2012). Therefore, I designed two different environment based on basic design guidelines reported in Section 3.3. A positive space was designed by using these guidelines deliberately to encourage creative thinking of the designers. In contrast, a negative space was designed applying opposite of the basic design guidelines to discourage creativity. The applied guidelines are reported in Table 6.1.

No	**Details of basic design guidelines to support creativity for this study**
1.1 5.2 8.2	Comfortable furniture to provide flexible positions for sitting, standing or lying by using furniture with different height such as an inflatable bed with 6 cushions, round table with 4 high chairs around it and low 3 high comfortable chairs and table
2.1	Appropriate temperature (a bit of cold for a group create dynamic)
3.1	A soundproofed environment to protect people from distraction
4.1	Fresh air

1.2	Natural lighting
2.2	View to nature, a window view
3.2	Glass, colourful, transparent, natural material
4.2	Stimulating texture (a long glass board on the wall in dark purple colour for post it notes, floor covered with a carpet, furniture with different texture of fabrics and wood)
5.2	More bright and stimulated colour (specially yellow, green, red and orange)
6.2	Posters, models, pictures on the wall
10.2	Indoor plants
11.2	Natural materials (wood and glass)
12.2	Constructions (such as high ceiling, sound proofing, echo baffling)
13.2	Physical movement to provide freedom
14.2	Multiple places to work: co-location
15.2	Size of space (4.5m * 8 m) to fit team and task and provide easy physical movement
4.1	A chocolate box with different flavours (dark and milk chocolate) on the table
4.2	Coffee that met people's preference (I asked them in the middle of task which kind of coffee they like and gave them what they ordered)

Table 4.1. Positive environment for creativity: the basic design guidelines for testing the environment that enhance creativity including comfort, sight and taste features (each number shows the particular guideline that applied in designing the environment to encourage creativity)

In contrast, the negative environment that was meant to inhibit creative thinking in the designers was designed to be the opposite of positive environment in comfort, sight and taste based on basic design guidelines for creative environment in section 3.3. Therefore two dividers were used to make the space smaller and limited the ease of use or physical movement. In addition, there was no food in the space and the visual features were limited to negative pictures with black and white and grey colours on the whiteboard.

Table 4.2 shows the elements of basic design guidelines that applied to design a negative environment for creativity. The numbers that followed by "support" shows the guideline implemented in design, and the numbers that are followed by "contradict" are the basic design guidelines applied in reverse to make an opposite impact (negative effect) on creativity in the environment.

No	Condition	Details of reverse basic design guidelines to inhibit creativity in the negative environment for creativity, in this study
1.1	Contradict	Normal furniture including a rectangular table and 4 simple chairs
2.1	Support	Appropriate temperature (a bit of cold for a group to create dynamic)
3.1	Support	Soundproof environment to protect people from distraction
1.2	Contradict	No natural lighting, florescent lighting
2.2	Contradict	No window view, it covered by the curtains
5.2	Contradict	Neutral colour (grey, white)
6.2	Contradict	Posters and pictures on the wall with negative theme such as war, shooting, angry, upset and depressed faces
10.2	Contradict	No plants
13.2	Contradict	Tight space that limited the freedom of physical movement
14.2	Contradict	One place to work on the table (no co-location)
15.2	Contradict	Size of space (2.5m * 4 m) not matched with the size of group
4	Contradict	No food

Table 4.2. Negative environment for creativity: the opposite use of the basic design guidelines for testing the environment that inhibit creativity including comfort, sight and taste features (symbol negative by - before each number shows the guideline used in opposite that applied in designing the environment to discourage creativity)

Using these guidelines, the environment was sketched to develop the floor plan and the perspective of the two environments to prepare the all furniture, objects, pictures, plants and facilities required to construct each environment, as shown in Figure 4.2 for the positive environment and in Figure 4.3 for the negative environment. The numbers in circles at figures 4.2 correspond to the various creativity conditions in table 4.1. For example 14.2 supports co-location that using multiple places to work.

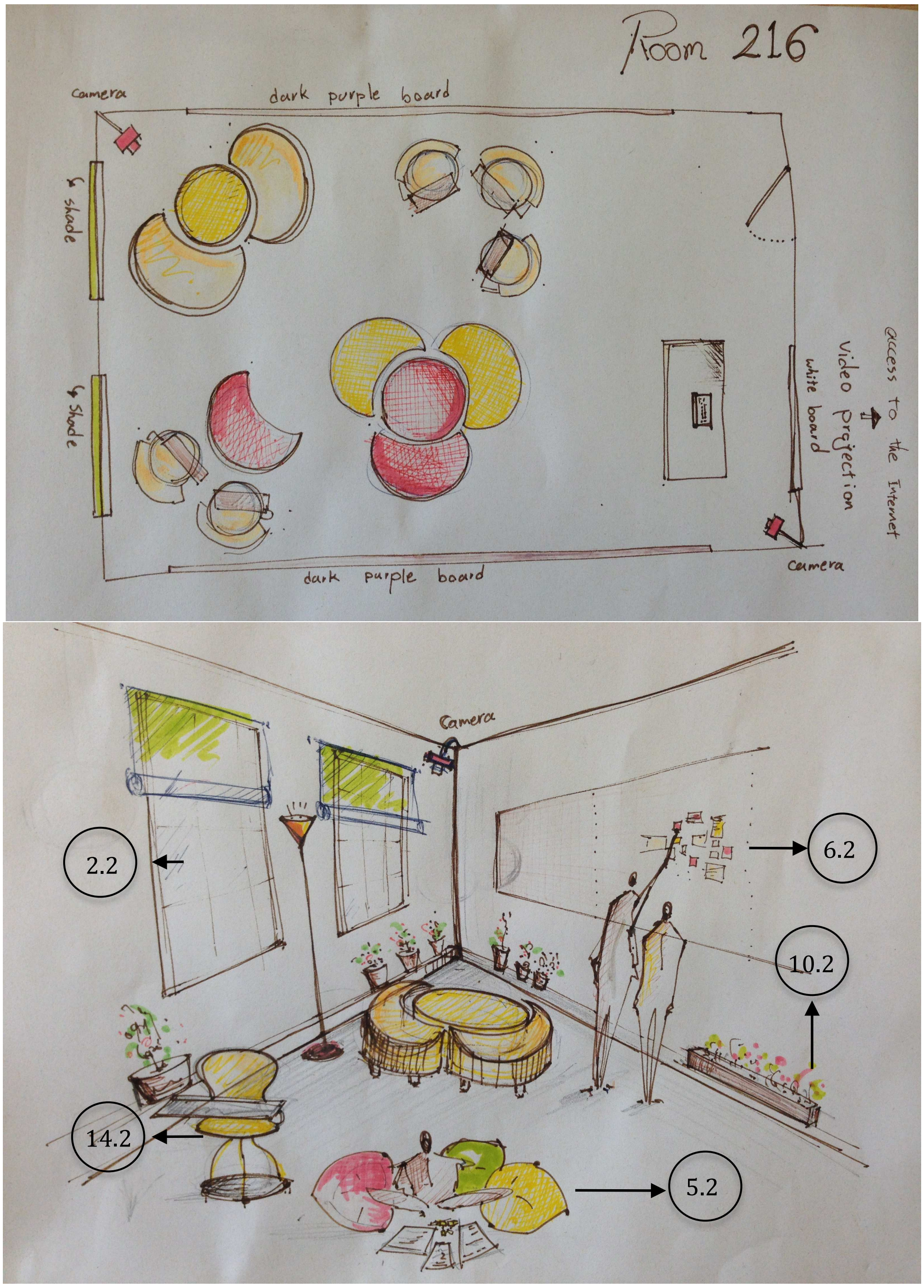


Figure 4.2. Sketches of the environment to support the design guidelines for a positive environment to enhance creativity (top sketch is the floor plan and the below sketch is the perspective, the circles with numbers shows examples of design guidelines that considered in designing the environment)

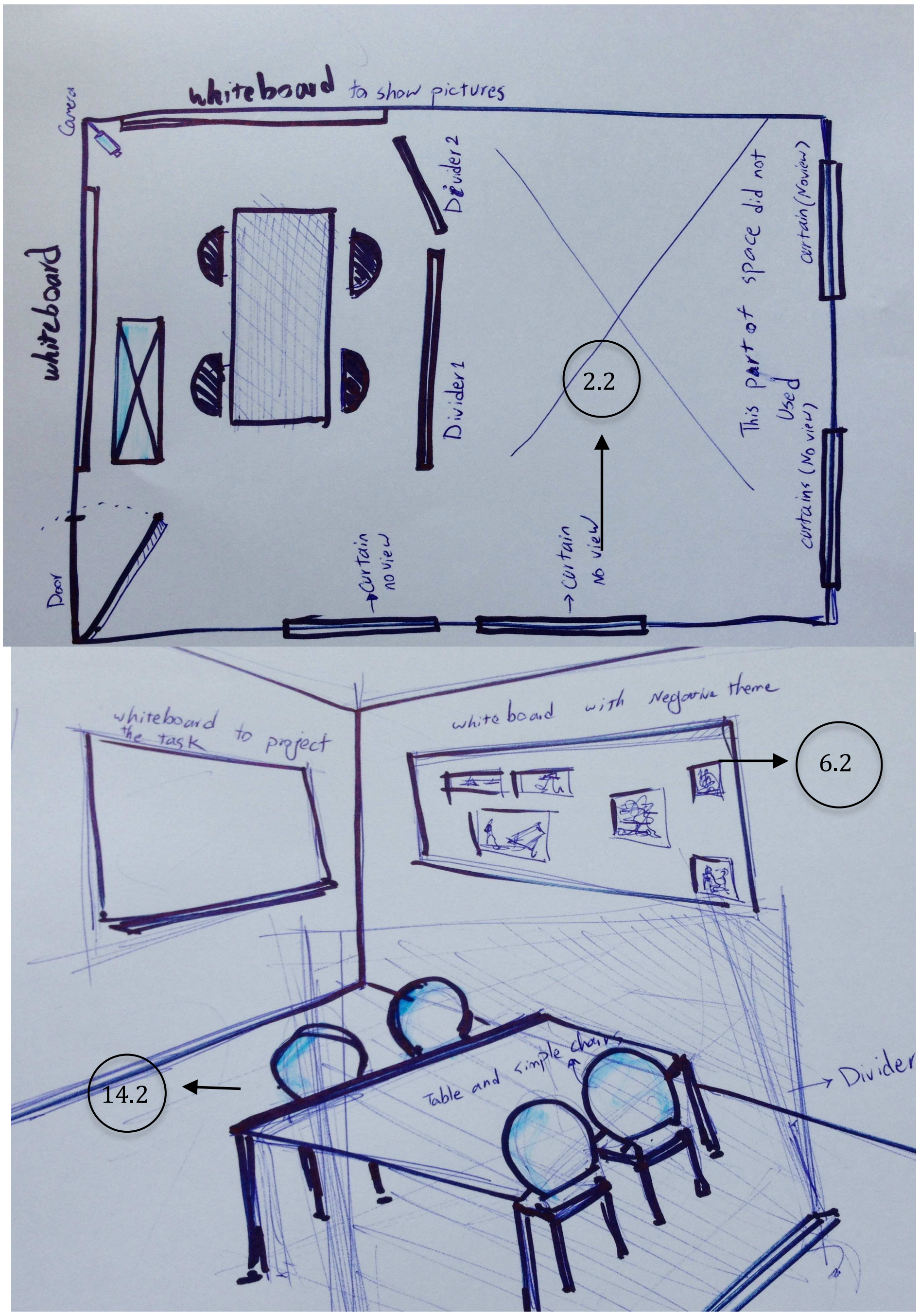


Figure 4.3. Sketches of the environment that is contradict to the design guidelines for a negative environment to inhibit creativity (top sketch is the floor plan and the below sketch is the perspective, the circles with numbers shows examples that are contradict to design guidelines that considered in designing the negative environment for creativity)

Likewise, the numbers in circles at Figure 4.3 correspond to the various creativity conditions in table 4.2. For instance, No 6.2 shows posters and pictures on the wall with negative theme such as war, shooting, angry, upset and depressed faces for creating negative ambience. The ideal list of condition outlined in table 3.1 was subject to restrictions of finance and time and regulations of the university. The space provided by the university, complete with the furniture had to be adapted to create the essential condition for the research such as comfortable and relaxing environment.

4.1.2 Making the positive space to enhance designers' creativity

The design of the positive space drew of previous investigations on the role of interior design on creativity (Gray, 2010 & McCoy, 2002). In this study, the basic elements of environments applied to create a positive environment for creative thinking are explained in Table 4.1. The space included colourful, round-shape furniture at different heights, a bed and vivid cushions that could support people standing, sitting in different positions and even lying. The intention was to create a feeling of being at home, as depicted in Figure 4.4. Other features of the positive space, such as hanging handmade lanterns to decrease the ceiling height, colourful pictures with positive themes such as food, nature, happiness, excitement, people, pot plants, and windows to provide views of nature.

Figure 4.4. Images from the positive space with warm colour, indoor plants and a view of nature from the window

4.1.3 Making The negative space to inhibit designers' creativity

In contrast, the design of the negative space was intentionally untidy and full of digital equipment. The space also included grey curtains that obscured any view of nature, few warm colours, a square table and chairs in a limited space, as well as pictures depicted negative content such as war, a cemetery, people fighting and sad portraits represented with neutral colours, as shown in Figure 4.5.

Figure 4.5. Images from the negative space showing more neutral colours and pictures and no view to the outside

4.1.4 Material and measurement

4.1.4.1 Participants

The participants were post-graduate students familiar with creativity techniques that worked in design groups composed of 3 designers each. Each group was allocated to one of the two design conditions. The participants were divided into two design groups randomly allocated to the one in the positive environment or the negative environment.

4.1.4.2 Design task

The overall design task lasted for a maximum of 80 minutes. The design task was to redesign a supermarket car park service from the event of making the payment at a checkout to placement purchased shopping in the car. The design task and the different parts of study were presented in a displayed PowerPoint presentation that enabled each group to return through the slides as needed (Appendix section 1.1).

4.1.4.3 The four design stages

A facilitator divided each workshop into 4 segments of 20 minutes each. During each segment the group undertook the task with a different creativity technique. The four stages introduced four creativity techniques that each group was required to follow. The techniques were data collection, brainstorming, constraint removal and desktop walkthrough:

1. Data collection: The first segment involved data collection for 20 minutes; each group used a laptop connected to a projector to search the Internet for information and images about supermarkets and supermarket services.

2. Brainstorming: The second segment was an open-ended, non-critical brainstorm to generate and document as many new ideas as possible (Michalko, 2006). Each group was given post-it notes, marker pens and blank paper during this segment. Group members could share their ideas with others participants in the group.

3. Constraint removal: This creativity technique was facilitated in 3 stages: exploring the constraints, selection of constraints to remove, and reducing constraints importance to generate space for creative thinking. Reducing the importance of the constraint was done by eliminating the constraint completely, diminishing the strength of constraint and interpreting the constraint differently. Therefore, during the segment of constraint removal (Onarheim, 2012), each group found multiple constraints on the supermarket car park service, selected constraints to eliminate, diminish or re-interpret, and then generated new ideas in the less-constrained ideas spaces. Again the ideas were documented on post-it notes using marker pens.

4. Desktop walkthrough: A desktop walkthrough is a technique that presents a small-scale 3D model of service environment (Stickdorn & Schneider, 2010). Participants were encouraged to build the environment out of props, toys and objects, provide participants with Lego and related objects, then to act out scenarios and explore emerging interactions in the 3D model. Each group undertook one or more desktop walkthroughs to present future possible service designs with objects that included Lego pieces and Plasticine as well as paper and post-it notes. The design process of both groups was video and audio-recorded, and all design outcomes were documented.

The design task and the four stages of the design in the study that presented to the participants, showed in Figure 4.6.

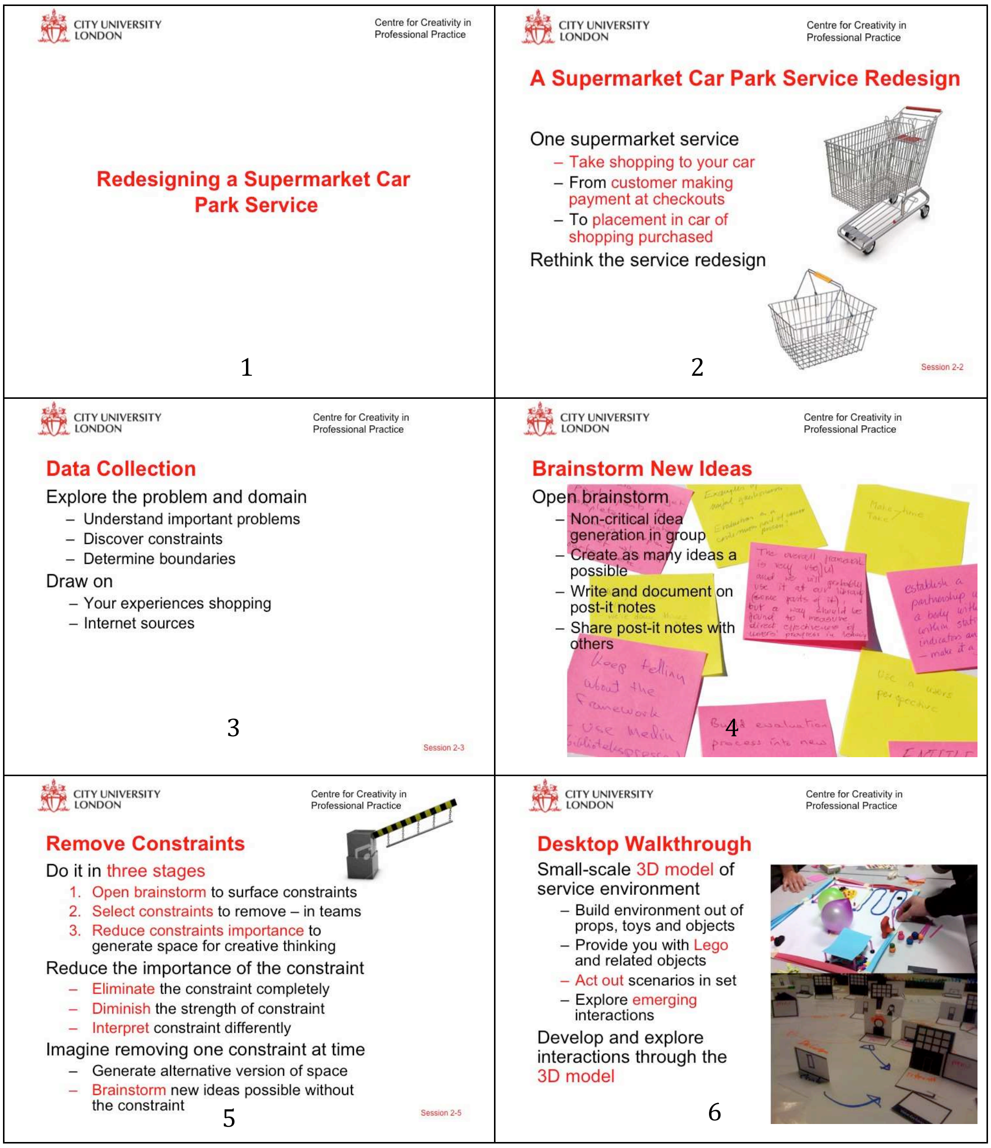


Figure 4.6. Design task and four stages of the study that were presented to participants

4.1.5 Procedure

The study procedure was divided into 4 stages:

1. **Introduction:** Each group was guided to the allocated environment and introduced to the study. The researches explained that the research was to investigate "the effect of environment on creativity", but participants were not given the full details and situation of the study until they finished the study. Participants signed the informed-consent form and answering demographic questions about personal data. Participants were then introduced to the space and were enabled to explore the space for a few minutes.

2. **Describing the task:** The design task about supermarket parking was presented in the PowerPoint presentation in Figure 4.6 by the facilitator, then all 4 segments of the study (the four creativity techniques and their descriptions) and timings were described.

3. **Doing the design task:** Each group did the design task following the 4 stages of design. Each stage of design was done in 20 minutes. The facilitator coordinated timing.

4. **Answering participants' questions about the study and appreciate participants' time and contribution:** At the end of the study I explained the aim of the study and answered participants' questions and got their feedback. To appreciated participant's time and efforts in my research, each participant received a £10 Amazon voucher.

4.1.6 Measuring creative climate

To measure the creative climate of each group, two independent experts who were professionals in their field and had the knowledge in design and creative processes were invited to watch the videos of each group and rate the climate. One was a designer and researcher from IDEO with 10 years experience. The other was a university lecturer in human-cantered design courses with 6 years experience in-group design work. After the workshop, the two experts independently reviewed the video and audio-recordings to assess and categorize the creative climate of each group during each segment of each workshop. Assessment was undertaken using 10 established dimensions of a creative climate developed to determine how the social behaviour of a group in different climate could influence the individual's behaviour (Ekval, 1996). Isaksen (2002) identifies 10 most important dimensions that influence a creative climate: (i) *challenge and involvement* - how challenged, emotionally involved, and committed people are; (ii) *freedom* - how free are the people to decide how to do their work; (iii) *idea time* – to what extent do people have time to think things through before acting; (iv) *dynamism* - the eventfulness of life in the organization;

(v) ***i**dea support* – what resources are available to give new ideas a try; (vi) *trust and openness* – to what extent do people feel safe speaking their minds and offering different points of view; (vii) *playfulness and humour* – how relaxed is the workplace; (viii) *conflicts* – the degree to which people engage in interpersonal conflict; (ix) *debates* – the extent to which people engage in debates about issues, and; (x) *risk taking* – the extent of the acceptance of failure. Table 4.3 summarizes the typical qualities of creative and non-creative climates against each of these 10 dimensions.

Climate dimension	Creative climate	Non-creative climate
Challenge	Involved, intrinsically motivated, contribution to the success, dynamic, electric, inspiring	Feeling of alienation and indifference, apathy, lack of interest and interaction
Freedom	Initiative and sharing	Strict guidelines and roles
Idea time	Using time for elaborating and developing new ideas that are not planned in the task	Idea pressure
Dynamism	Energetic, Enthusiasm	Apathy, unconcern, boredom
Idea support	Constructive space, Accepting ideas kindly, listen and encouraging people, trying new ideas	Refusing ideas by counter-argument, fault finding, obstacle raising to new ideas
Trust/openness	Emotional safety, no fear of reprisals and ridicule, open and straightforward communication	Afraid and Scared of being robbed of their ideas
Playfulness/humour	Spontaneity and ease, relaxing atmosphere for jokes and laughter	Gravity and seriousness, stiff, gloomy and cumbrous
Conflicts (Focusing on people and their relationship)	Respecting and mature manner, controlling emotions and impulses	Dislike or hating other people in group
Debates (Focusing on issues and ideas)	Involving encounters, exchanges or clashes among ideas, challenging each other's thinking	Following authoritarian pattern without questioning
Risk taking	The tolerance of uncertainty and ambiguity	Caution and hesitant mentality, preferring safe side and no decisive action

Table 4.3. Climate's dimensions in creative and non-creative environment (Isaksen, 2001, p.171)

The two experts rated each of the four segments of each workshop – data collection, brainstorming, constraint removal and desktop walkthrough against each of the 10 dimensions on a 0-5 integer scale guided by the definitions defined in Table 4.3. This generated a total of 40 ratings for each workshop. The experts were guided to provide quantitative ratings using qualitative descriptions, for example, a 0 on any dimension indicated that the climate quality was not observed at all in that segment, 3 indicated that the climate quality was observed often in the segment, and 5 indicated that the quality was observed throughout the segment. The reported final rating for the segment was the mean of the two dimension ratings if the difference between the ratings was 0 or 1. However, if the difference between the two expert ratings in each dimension for each segment was greater than 1, the two experts were requested to view the video of the segment again to reconsider their rating for that segment.

4.1.7 Results

The two groups undertook all of the activities in all 4 segments of each workshop, and produced at least one possible solution for the supermarket car parking service. In this sense, both workshops were a success. Observations revealed that there was no formal facilitator or leader in each group, although one individual in each group appeared to take an informal leadership role. While neither was formally acknowledged as the group leader, their groups appeared to defer to them on issues such as which were the best ideas and how the dynamics of the session should proceed. However, throughout both, members of the design groups often needed encouragement to share ideas. Final design of each group that presented in 3D model shown in Appendix Section 1.2.

Figure 4.7. Design ideas as a 3d model in Desktop walkthrough segment in positive (top photo) and negative (below photo) space for creativity

The research analysed the ideas generated during the brainstorming and constraint removal segments in both workshops. The design group in the positive space generated 17 ideas in the brainstorming segment and 23 ideas in the constraint removal segment, whereas the group in the negative space only generated 7 and 9 ideas in the two spaces respectively. The desktop walkthroughs also differed. The group in the negative space designed the service around an underground supermarket below a natural space. In contrast, the group in the positive space designed the service in which customers collected their shopping when exiting the car park. The 3D model of the final design ideas, the outcome of the final stage of design (desktop walkthrough) of both group showed in the Figure 4.7. The workshop outcomes indicated quality and quantity differences emerging from design groups in the positive and negative spaces.

The data that had been rated by the experts showed in Table 4.4 at each stages of design.

Different segments of design	1.Data collection		2.Brainstorming		3. Remove constraints		4.Desktop walkthrough	
Environment	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
1.Challenge/Involvement	4	3	4	3	4	3	5	5
2. Freedom	4	3	5	3	3	3	5	5
3.Trust/openness	4	2	5	3	4	4	3	4
4.Idea-time	3	2	3	3	3	3	3	4
5. Playfulness	3	2	4	2	3	2	5	5
6. Conflict	1	1	1	3	1	1	1	1
7. Idea support	4	1	5	3	5	3	3	4
8. Debate	5	3	4	4	3	2	2	4
9. Risk-taking	3	1	4	3	3	2	4	5
10. Dynamism	2	1	4	1	2	3	5	5

Table 4.4. The data gathered form experts in rating 10 elements of creative climate in 4 segments of design and in 2 environments

The agreed expert assessments of the climate of each workshop segment are presented in four spider diagrams in Figures 4.5, 4.6, 4.7 and 4.8. The ratings of the design group in the positive space are depicted in blue and the ratings of the design group in the negative space are depicted in red. The first of the diagrams in Figure 4 shows the ratings of data collection segment against the 10 climate dimensions. The comparison of the ratings reveals that the design group in the positive space was rated as having a more creative climate on 9 of the 10 dimensions. When the people in the design group came to the positive space, they appeared to find the room exciting but also both welcoming and positive. Some appeared to behave as if they were in their own house, and one even took her shoes off, suggesting a place that was comfortable and hospitable for them. Moreover, the climate's support for idea support and for debate was rated as much higher than for the design group in the negative space. The assessments suggest that noticeable differences between the climates of the two design teams in this first segment of the workshop (Figure 4.8).

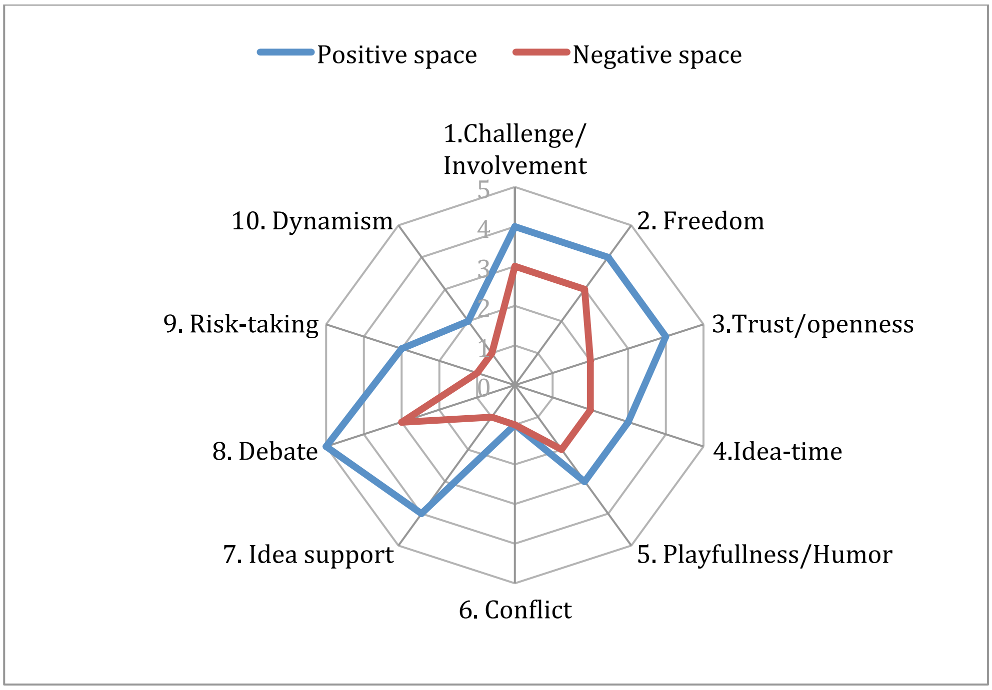


Figure 4.8. Mean of creative climate ratings of group design work in data collection segment

Figure 4.9 shows the ratings of the segment with the brainstorming technique against the 10 climate dimensions. The comparison of the ratings reveals that the design group in the positive space was rated as having a more creative climate on 7 of the 10 dimensions. In contrast to the data collection segment (Figure 4.8), the design groups were rated as having the same creative climate for idea-time and for debate, whilst the experts rated the design group in the negative space as having greater support for handling conflicts. The rated differences between the two design groups was less than during the data collection segment. That said, during brainstorming, the design group that was in the positive space appeared to behave more creatively and to think with more originality. It exhibited greater divergent thinking and generated more ideas. The experts observed more collaborative behaviour to support creativity. The members of this group paid attention to the positive pictures, and this appeared to help inspire them to come up with a wide variety of new solutions. In contrast, the design group in the negative space was less engaged in all aspects of the brainstorming task.

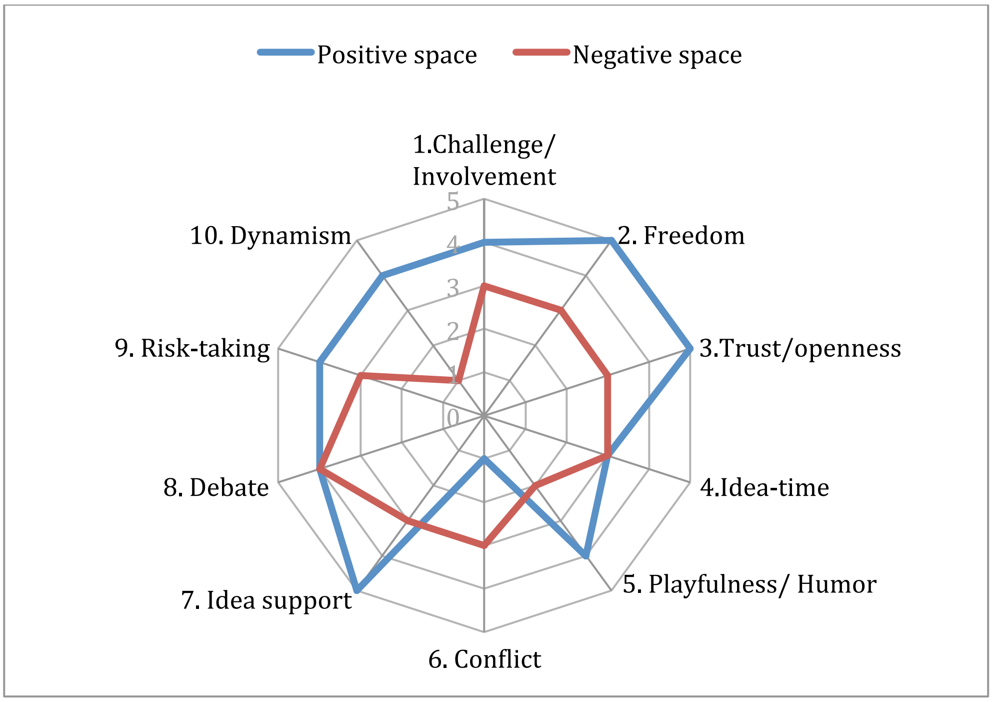


Figure 4.9. Mean of creative climate ratings of group design work in brainstorming segment

The ratings of the third segment in which the *constraint removal* technique was used against the 10 climate dimensions are illustrated in Figure 4.10. Members of each design group brainstormed obvious constraints on the supermarket service such as shopping weight and supermarket layout then systematically removed or diminished each constraint to generate and document new ideas. However, unlike in the first two segments, the ratings revealed less difference in the creative climate of the two design groups than was identified in the first two segments. The design group in the positive segment provided a more constructive space for idea generation, however the two workshops were rated as having similar creative climates for half of the 10 dimensions, and the design group in the negative space was rated as being more dynamic than the group in the positive space.

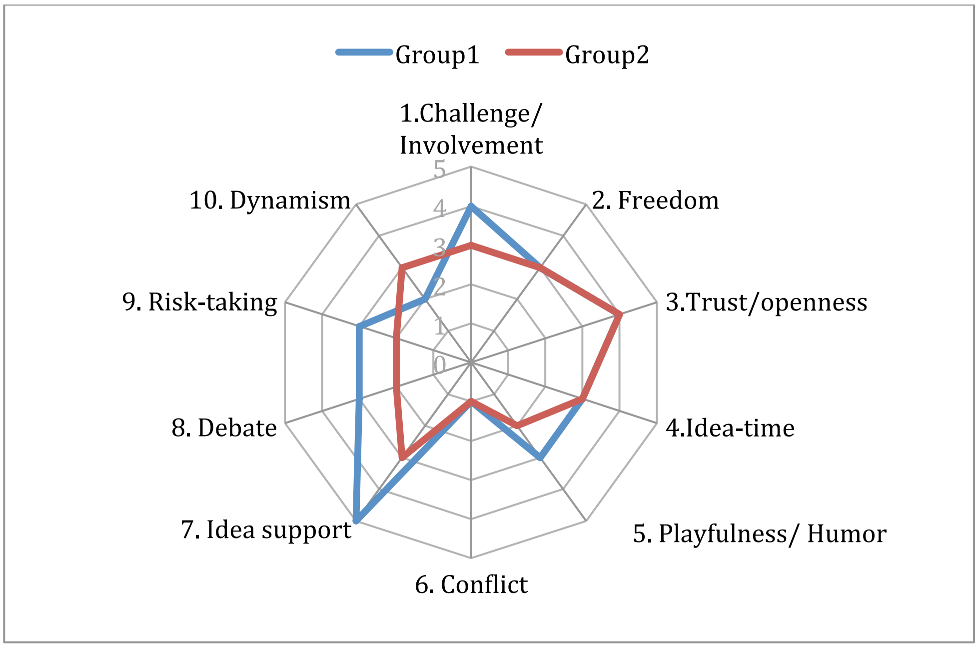


Figure 4.10. Mean of creative climate ratings of group design work in constraint removal task segment

Finally, Figure 4.11 shows the ratings of the final segment in which both groups undertook desktop walkthroughs against the 10 climate dimensions. The design group in the negative space was rated as having a more creative climate on 4 of the 10 dimensions while the design group in the positive space was not rated as more creative on any single dimension. The experts perceived that the atmosphere of the design group in the negative space changed during the desktop walkthroughs. The trust and members support of ideas, challenge and freedom increased compared to previous creativity techniques and even it showed slightly higher than positive environment.

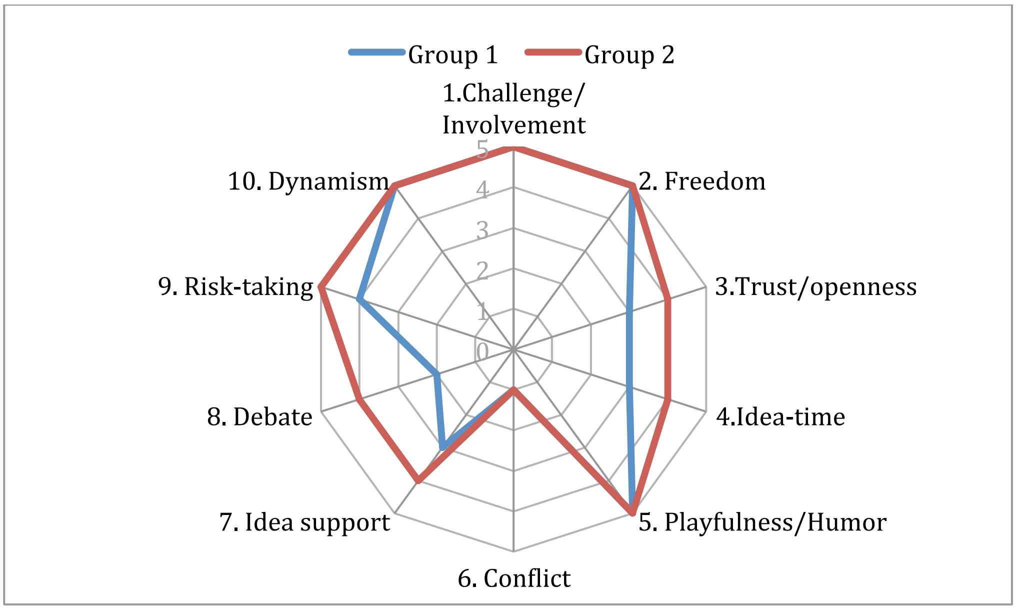


Figure 4.11. Mean of creative climate ratings of group design work in desktop walkthrough segment

4.1.8 Discussion

The first research question was how an environment affects designers' creativity by influencing their emotional states in a creative design work. The results showed that changing the climate is one of the key factors to improving creative thinking in the group design work. It might be argued that the change in the environment can create some changes in the climate that improve the creative thoughts, however the effect of changes did not last during the time and the impact disappeared over time.

Results from the study revealed that the design group in the positive space (the environment that designed based on the basic design guidelines) was observed to have a more creative climate than the design group in the negative space (the environment that designed in opposite of the basic design guidelines), however the difference between the groups appeared to diminish over time. In line with present research that reported positive emotions could enhance creative thinking (Isen et al., 1985), it seems that the changes in the environment made continual injections of positive emotions (e.g. joy and excitement and surprise) into the space that leads to improve creative climate.

Furthermore, the different creativity techniques deployed in each segment appeared to influence the creative climate. The results suggested that the desktop walkthrough technique was an important influence on the climate and its use in both design groups increased the level of interaction, involvement and communication compared to the other techniques. The design group in the negative space became more positive with this technique, suggesting that artefacts such as Lego became part of the environment. These findings are in line with Karmer & Block (2014), who reported physical contact with objects and touch increase the confidence and improve creative performance that leads to more creative thoughts.

In addition, the investigation of the effect of a physical environment on the creative climate of designers revealed some unexpected findings. Whilst the positive space did have an enhancing effect on the perceived creative climate of the design, this effect appeared to be short-lived. During the workshops, differences between the creative climates of the design groups disappeared. The importance of change of the environment in a creative work should not be under-estimated. Change of the climate of the environment that was appeared by changing the creativity techniques recognized to be an important determinant of creativity. Therefore, designing physical environments to support creativity over continuous design processes both needs to encourage frequent changes and incorporate the effect of creativity techniques to foster positive emotions and influence creative thinking.

In the next study, the research focused on individual designers to investigate which types of emotions that produce by the environment could promote creativity outcome for different types of creative thinking. The environment was designed to provide the changes in divergent and convergent thinking during design work. The research sought to investigate the effect of the potential features of the environment on emotional responses of designers and the impact of those emotions that are linked to creativity.

4.2 Study II. The effect of high and low activated environments on individual creativity during the divergent and convergent stages of a creative design process

According to past research undertaken into the effect of emotions on human creativity, three components of emotion - *arousal*, *valence* and *control* - are associated with creativity. In creativity research, there is evidence that high arousal emotions can foster creative thinking (Baas et al., 2011). Moreover, during creative design work, different emotions that designers experience at different stages of a design process, and there is evidence that designers experience high arousal and positive emotions in all stages of the Wallace model except during the incubation stage, when designers experience low arousal and negative emotion in incubation stage (Sas & Zhang, 2010). This evidence was derived only from interviews with designers about their general design experiences, based on designers' experiences while they undertook actual creative design tasks. These tasks were divided into the divergent and convergent stages of design in order to investigate how their creativity was influenced by emotions. These emotions were triggered by the medium of the environment.

4.2.1 Examining the creativity support environment (CSE) framework in individual designers' work

To test the CSE framework that was presented in Chapter 3, the empirical study was designed to investigate environments that could trigger the specific emotions in which designers need to support two types of cognitive performance (divergent and convergent) in a creative design process (Figure 4.12). The main focus of this study was on individual designers to explore the emotional states that enhance designers' creative thinking supported by the environment.

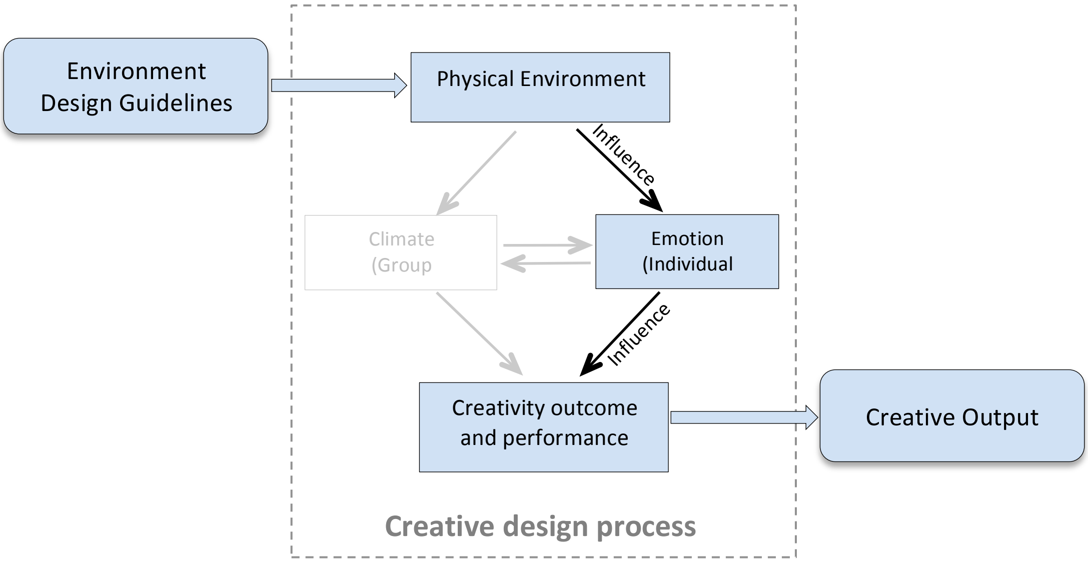


Figure 4.12. CSE framework in study 2, (the blue parts of framework was tested to explore individual designers' emotional state that triggered by the environment to enhance divergent and convergent creative thinking

This empirical study was designed to test the features of an environment that triggers the right emotional states for individual designers to enhance creative thinking in each divergent and convergent stage of creative design process. It sought to explore components of emotion (valence, arousal, and control) that are more effective on divergent and convergent thinking in a creative design process (Figure 4.12).

Figure 4.13 illustrates the components of the CSE environment that were investigated. It was important to explore the relationships between different components of emotions (valence, arousal and control) on creativity output (originality and usefulness) by applying the design guidelines to create the specific features of environment as the required stimuli (Figure 4.13).

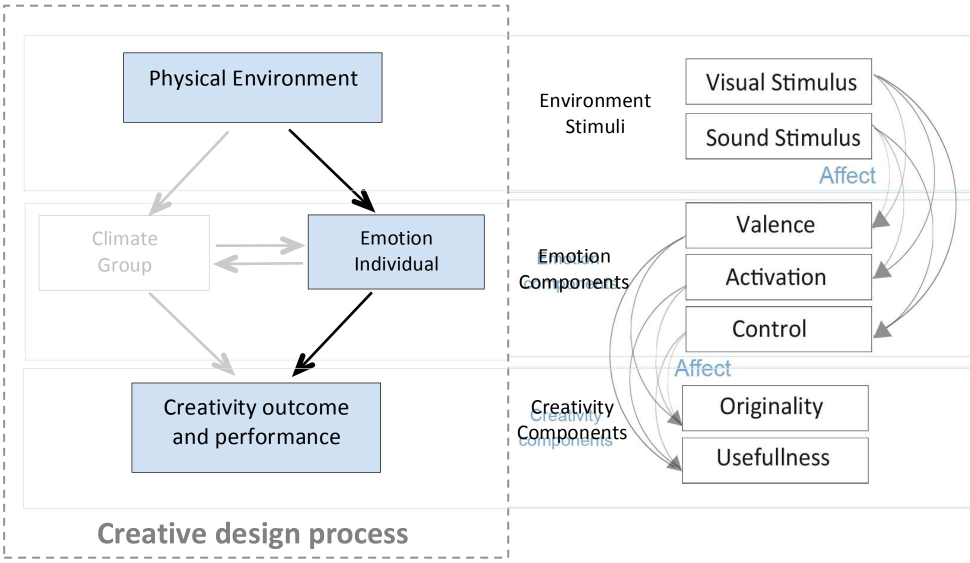


Figure 4.13. Components of each element in the CSE framework: exploring the effect of Environment stimulus (visual, sound) on different components of designer's Emotions (Valence, arousal, Control) and the affect of emotional states on creativity component (originality and usefulness) in creative design process

4.2.2 Research questions

To study the framework, the following more specific research questions were investigated:

1. Does environment affect individual designers' emotions in order to enhance creativity?
2. Does high-activated environment (HA) increase designers' emotional arousal and foster divergent creativity?
3. Does low-activated environment (LA) decrease designers' emotional arousal and foster convergent creativity?

4.2.3 Method

4.2.3.1 The designed environments to support divergent and convergent creativity

Based on the different characteristic of divergent and convergent thinking reported in Section 3.5, it is reasonable to assume that an environment that supports both divergent and convergent thinking will need to have different characteristics to support the different stages of the creative design process. In this study, the environments were designed to support divergent and convergent performance by activating or deactivating emotional stimuli for designers, by applying different visual features of the environment to support those characteristics of different stages of the process. For example, divergent thinking activities are more generating, experiential, entertainment-oriented, imaginary, stimulating, playful and exploring, while convergent thinking activities are more focusing, goal-oriented, refining, calming, and supporting decision making (Isaksen et al., 2011). The visual features of the environment to support these characteristics are presented in Section 3.5. To design the space based on these characteristics, multiple design guidelines from Section 3.6.1 and 3.6.2 were applied to design and create the environment that can support each of divergent and convergent creative thinking, resulting in the design of implementation of 3 different spaces:

1. A high activated (stimulated) environment for divergent creativity (HA)
2. A low activated (stimulated) environment for convergent creativity (LA)
3. A zero activated usual environment as a control for the study (ZA)

4.2.3.2 The high activated environment (HA) to support divergent creativity

The high-activated environment was designed to support open idea generating by triggering entertainment-oriented flow that put people in high states of joy, and to encourage more playfulness in the space. Divergent thinking enhances generating ideas, imagination and fantasy (Isakson et al, 2011, p. 48). Therefore, the environment was designed to trigger imagination as well as to activate emotional states to support idea generation. Environment features were designed to provide a stimulating space with bright and high value colours with high contrast and complex 3D forms and shapes, to provide more texture and visual perspective in the space. Different objects such as hanging hats and books, a typewriter, cushions, wooden cubes, darts, random coloured pictures on the whiteboard and paintings frame in front of the windows and playing cards, were used.

All of these objects added more details to the high-activated space, in order to stimulate the designers' imagination. Likewise a swing chair, and a carpet with pillows on the floor provided different types of sitting and lying postures to support and encourage the free movement and playfulness in the designers. Figure 4.14 depicts the high-activated environment to support divergent creativity visually. More information is provided in Appendix Section 2.7.

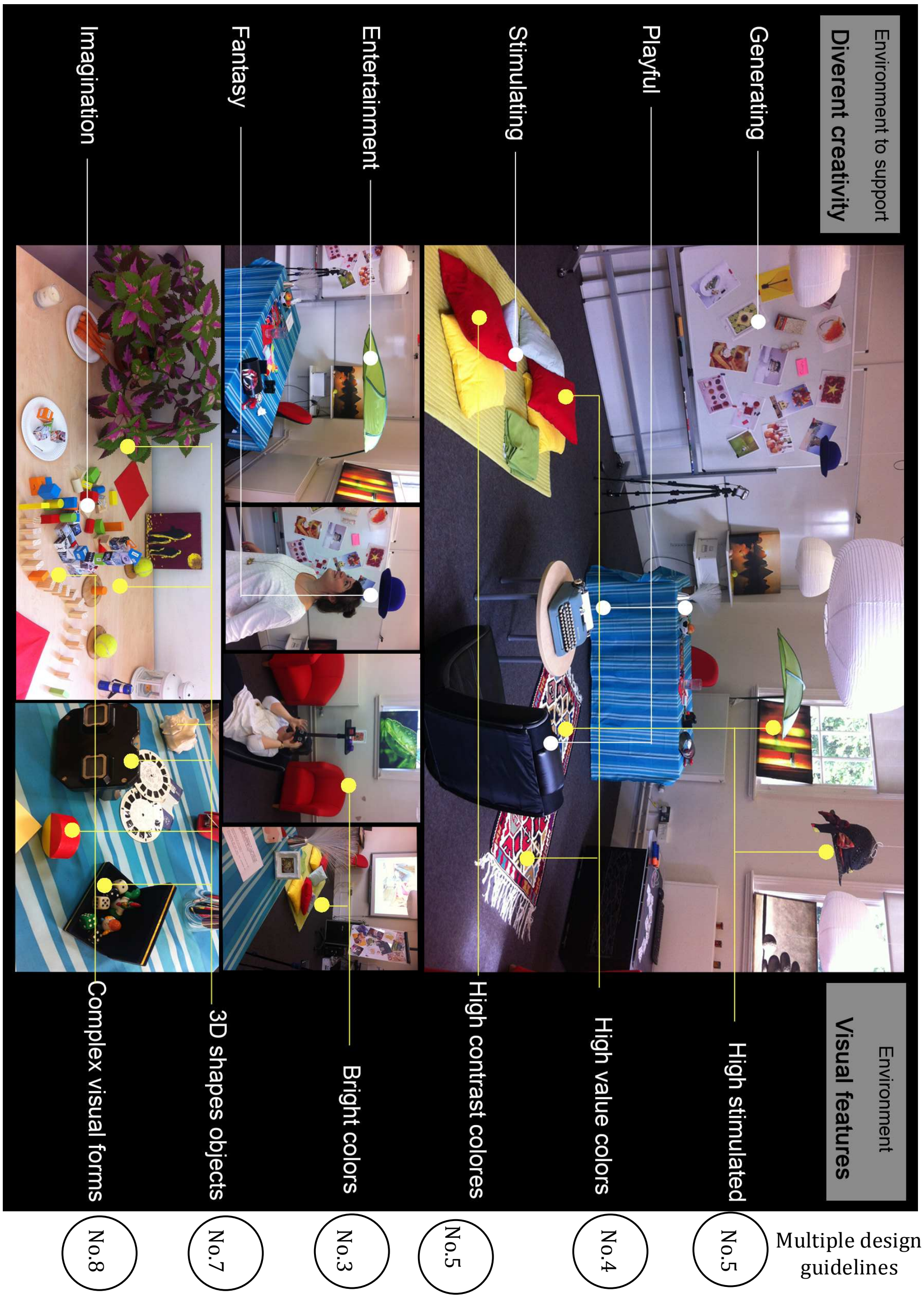


Figure 4. 14. The high activated environment (HA) to support divergent creativity (the numbers in the circle showed the example of multiple design guidelines reported in Section 3.2.1)

4.2.3.3 The low activated environment (LA) to support convergent creativity

In contrast, to support convergent creativity, designers need to be more task-oriented and focused. Therefore, the environment needed to provide the conditions for more goal directed-flow to enable participants to make decisions and develop a new design concept that is an appropriate solution for the task (Isaksen et al, 2011). To design an environment to support greater focus, I implemented low-activated visual features such as low value colour and monochrome shades, low contrast, simple shapes, less complex visual forms and simple furniture to minimize distraction. This environment was designed to encourage high concentration and focus for convergent creativity to produce low activated emotional states such as being calm and relaxed. Figure 4.15 showed the low-activated visual features of this environment. More information provided in Appendix Section 2.8.

Figure 4.15. The low-activated environment (LA) to support convergent creativity (the numbers in the circles showed the example of multiple design guidelines in Section 3.2.2)

4.2.3.4 Zero activated environment (ZA) as a control space

The research also implemented an environment described in Appendix Section 2.9 with which to provide a baseline control for data collection from the divergent and convergent environments. This environment was a typical university classroom with dividers to create the space as an internal space that lacked the visual features compared to two other, as shown in Figure 4.16.

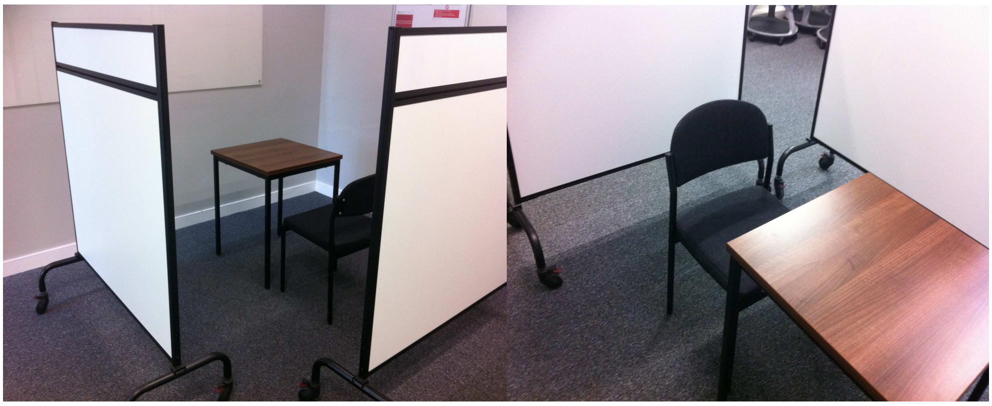


Figure 4.16. Environment without design elements (zero-activated) to applied as a space lacked the visual design guidelines (typical university classroom)

4.2.4 Material and measurement

4.2.4.1 Participants

The participants in the study were 30 post-graduate students, 14 males, 16 females, average age 26, from different design backgrounds e.g. human computer interaction design, computing system design, service design and product design, but familiar with creativity techniques. Each participant was allocated randomly to one of these different environments, resulting in 10 designers in the high-activated space, 10 designers in the low-activated space, and 10 designers in the control space.

4.2.4.2 Design task

The overall design task lasted for a maximum of 30 minutes. The task was to design a new restaurant that encouraged social collaboration whilst remaining in a pleasant eating experience. The task was undertaken in two main parts with two different design techniques: brainstorming and storyboarding. Full data reported in Appendix Section 2.1. Each participant was given post-it notes, marker pens and blank paper for brainstorming, then requested to use brainstorming to generate as many ideas as they could create within 15 minutes. Storyboarding was then undertaken on a storyboard A4 sheets that included 6 frames, and applied to evaluate their ideas and come up with one possible appropriate solution for the design task within a second 15 minutes. The design journey of each participant was video- and audio-recorded, and all design outcomes including post-it notes of ideas and storyboards were documented for creativity assessment purposes.

4.2.4.3 Procedure

The study procedure was divided into 6 stages:

1. **Introduction:** when each participant arrived s/he was guided to the allocated environment and introduced to the study. The researcher used a cover story that explained the purpose of the research "the effect of environment on creativity", but participants were not given the full details and role of the study until they finished it. Participants signed the informed-consent form and answered demographic questions. Participants were then introduced to the allocated space and were enabled to explore it for a few minutes.

2. **First emotion self-assessment questionnaire:** each participant was seated on the chair and asked to fill in a simple questionnaire about his/her emotions in the space. The questionnaires were based on the two emotion measurement tools shown in Figure 4.17, as explained and justified in Section 2.3.8, to assess participants' emotion in 2 dimensions of valence and arousal. More information about the questionnaire is provided in Appendix Section 2.5.

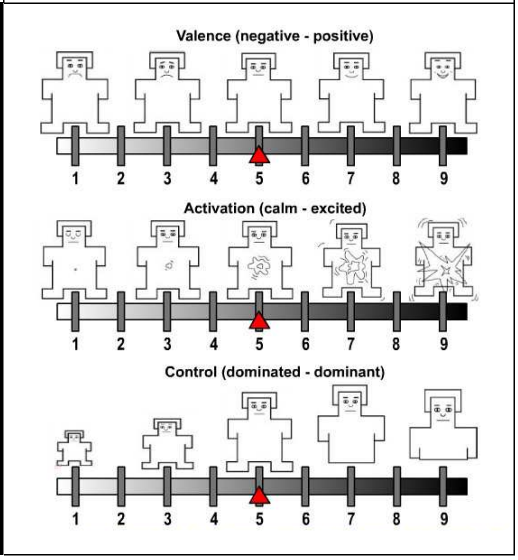
Plutchik’s wheel of emotions	SAM questionnaire
	

Figure 4.17. Two types of questionnaire that used for emotional self-assessment

3. **Describing the task:** the two parts of the task – the brainstorming and the storyboarding, in which a user describes their start-to-end experience with the new service, were explained as below:

> **Design task**: Design an experience for a restaurant that encourages social collaboration whilst remaining a pleasant eating experience (by considering economic, sustainable and inclusive constraints)
>
> - First 15 minutes: Brainstorming, create as many as ideas you can without attention to constraints.
> - Second 15 minutes: Storyboarding the best ideas with considering the constraints mentioned in the task.

For divergent task, participants were asked to be as creative and free in their thinking and create as many new ideas as possible. For the convergent task participants were asked to consider practical aspects such as cost and viability.

4. **Doing the design task:** participants read the design task and undertook an open brainstorm to generate the ideas, then created a storyboard to describe their improved ideas for designing the restaurant based on the design task.

5. **Second emotion self-assessment questionnaire:** when each participant finished the study, s/he was asked again to fill in the same emotion questionnaire about environment. Full results were reported in Appendix section 2.6.

6. **Watching the video record session with each participant:** Each participant was then asked to watch her/his video back, and after each 3 minutes the video paused and participant fill in the emotion self-assessment questionnaire, resulting in total of 12 questionnaires per participant.

7. **Answering participants' questions about the study and reward participants' for their time and contribution:** At the end of the study the aim of the study was explained the study and answered participants' questions and collected further feedback. To reward participant's time and effort, each participant received a £10 Amazon voucher.

4.2.5 Results

4.2.5.1 Measuring Emotion: Data from emotion questionnaire

Figure 4.18 shows the timings of the study tasks and when each participant replied to the emotion self-assessment questionnaires that are called measure points.

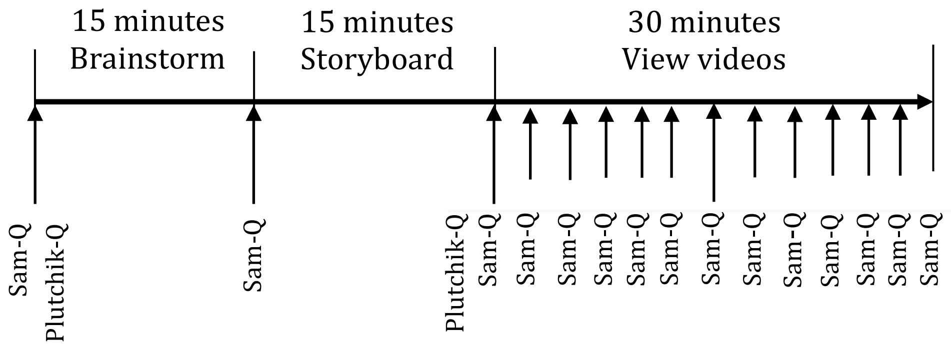


Figure 4.18. Timing of the study and the times that each participant answered the emotion Sam questionnaire while view their own videos (measure points)

The data from the emotion self assessment questionnaires was categorized to 3 different emotion data:

1. **Concurrent emotion data** – the Sam questionnaire were used to collect evidence of pleasure, arousal and dominance on a 1-9 scales. Each participant answered this questionnaire before and after the task about her/his emotions related to the environment. The data collected from this questionnaire is referred to as the *Concurrent emotion data* during the rest of this chapter.

2. **Start-end emotion data** - the second questionnaire was Plutchik's wheel of emotions to collect evidence about specific participant emotions experienced in the environment. The data that was collected from this questionnaire is referred to as the *start-end* data during the rest of this chapter.

3. **Retrospective emotion data** - participant's emotional states during the task was also measured. Each creativity session was video- and audio-recorded. After each session the participant watched the video of the session, which was paused every 3 minutes so that s/he could fill in the Sam questionnaire. Therefore each participant answered the questionnaire, expressing his or her emotions at 12 measure points (6 measure points in the brainstorming section and 6 measure points in the

storyboarding section of design). Measure points were the moments during the task at which participants had to self-report their emotional states. These data is referred to as the *Retrospective emotion data* during the rest of this chapter.

4.2.5.2 Measuring creativity outcome

1. Assessing fluency of brainstorming design task

To keep the assessment clear and practical, fluency (the number of ideas created in the given time, as reported in Section 2.1.5, was chosen to evaluate the creativity resulting from the brainstorming task. In the divergent stage of the design task, participants were asked to write each idea on one post-it note, and the totals of different notes were counted to assess creative fluency. An example of the brainstorming data is shown in Figure 4.19 and full results are available in Appendix Section 2.10.

Figure 4.19. Fluency, the number of ideas in brainstorming task (Example of different ideas generated by one participant)

Figure 4.20 shows the difference between the designed environment and mean number of ideas that participants generated in the first task. The number of ideas in the ZA space was less than in the LA and HA spaces, suggesting that during divergent task, the environment had an influence on creative outcomes, and the HA environment with many visual stimuli improved the volume of the creativity outcomes.

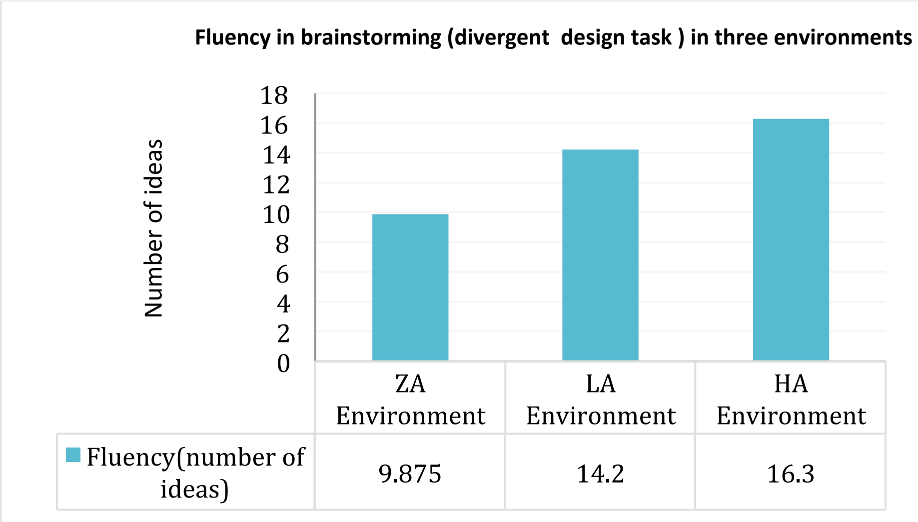


Figure 4.20. Mean of fluency recorded in the 3 different spaces in the brainstorming design task

2. Assessing originality and usefulness of storyboard design task

The creativity outcome assessment for convergent task was based on outcome originality and usefulness, as judged by experts in the field. Expert judgment was used to assess the novelty and usefulness of each storyboarded design. A total of 12 restaurants' domain experts were invited, for example restaurant managers and designers, to rate the creativity of each design, and the 5 experts listed in Table 4.5 accepted. Each expert was asked to rate the originality and usefulness of each design storyboard (Appendix section 2.11) on a scale of 1 to 7 (1 the lowest and 7 the highest) using their knowledge and experience of restaurants within considering the design constraint.

	Domain of expertise	**Experience**	**Age**
1	Restaurant manager and owner	20 years	54
2	Hotel restaurant manager	8 years	36
3	Restaurant manager	13 years	39
4	Head Chef	25 years	48
5	Restaurant interior designer	7 years	33

Table 4.5. The job, experience and age of the experts that rated creativity in storyboard design task

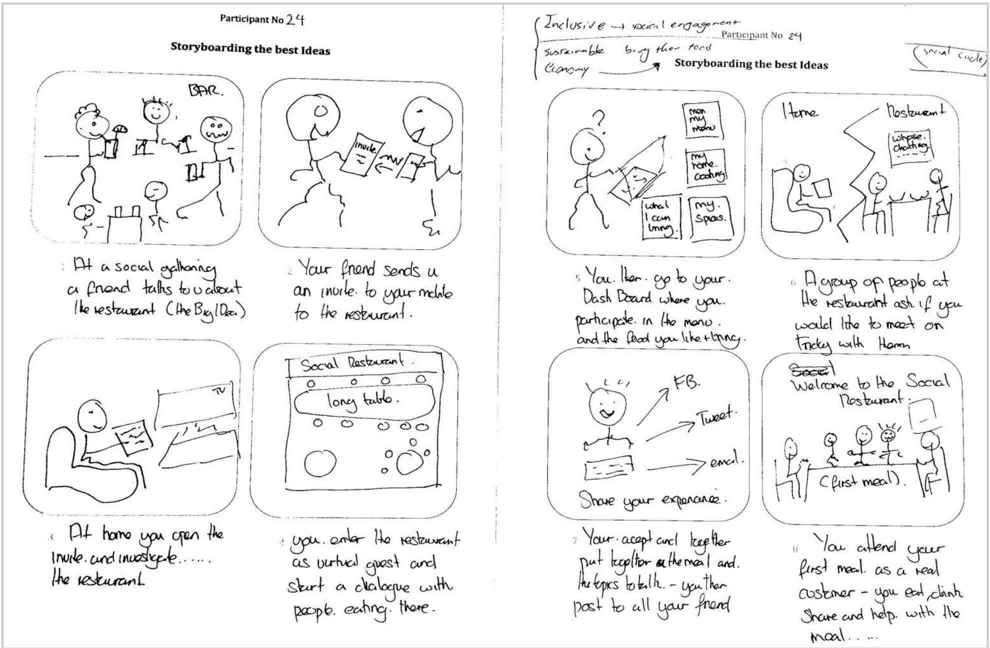


Figure 4.21. Example of a Storyboard as an outcome of convergent creative design task

To test whether the HA and LA spaces influenced the creative outcome in the storyboards, the researcher performed a one-way ANOVA with the spaces as the independent variable (IV) and originality and usefulness as the dependent variables (DV).

IV / DV	ZA space		HA space		LA space	
	Mean	SE	Mean	SE	Mean	SE
Originality	4.13	.295	4.70	.396	4.90	.433
Usefulness	3.75	.559	4.70	.396	3.60	.452

Table 4.6. Means and standard errors (SE) of the originality and usefulness of the storyboard ideas for the ZA, HA and LA spaces

The results showed no significant effects of the environment on the rated originality of the generated ideas, ($F(2, 25)=.98$, $p=.390$, $\eta^2<.072$). Similarly, there were no significant effects of the environments on the rated usefulness of the generated ideas, ($F(2, 25)=1.741$, $p=.196$, $\eta^2<.122$). The environments did not have a direct influence on creativity components in convergent design task.

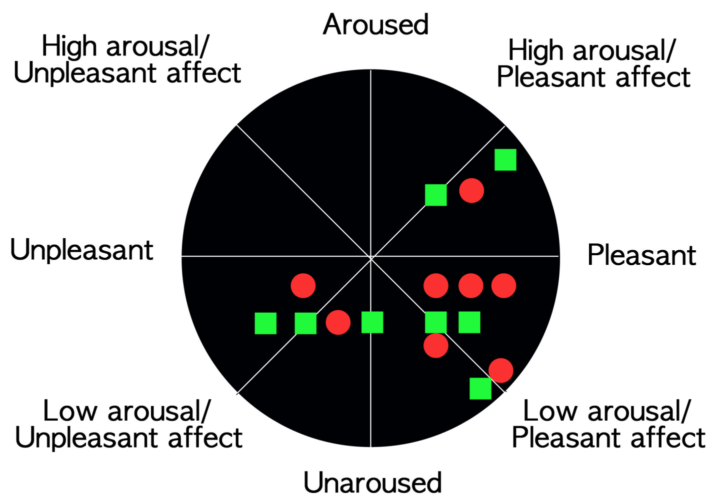
4.2.5.3 Participants’ emotions about the environment based on start-end emotion data

A visual illustration of the results revealed that participants experienced more pleasant and higher arousal in both the low activated (LA) and high-activated (HA) environments compared to zero-activated (ZA) environment. Results for each space also described in Figure 4.22.

ZA environment - there was no specific pattern to the participant’s responses in this environment.

LA environment - at the start point, participants reported pleasant affects and low level of arousal, and at the end, participants reported pleasant and high level of arousal increased and they stated pleasant and high-arousal emotions, see the white arrow in Figure 4.22.

HA environment - at the start point participants reported higher arousal and higher pleasure than in both the ZA and LA environments. However, at the end of the task, the level of arousal dropped, but the participants were still reporting pleasant emotions, see the second white arrow in Figure 4.22.

<table>
<tr><td colspan="2">Participants emotions before task ■ Participants emotions after task ●</td></tr>
<tr><td>Environment</td><td>Arousal-pleasure</td></tr>
<tr><td>Zero-activated (ZA) Non-designed environment</td><td>
</td></tr>
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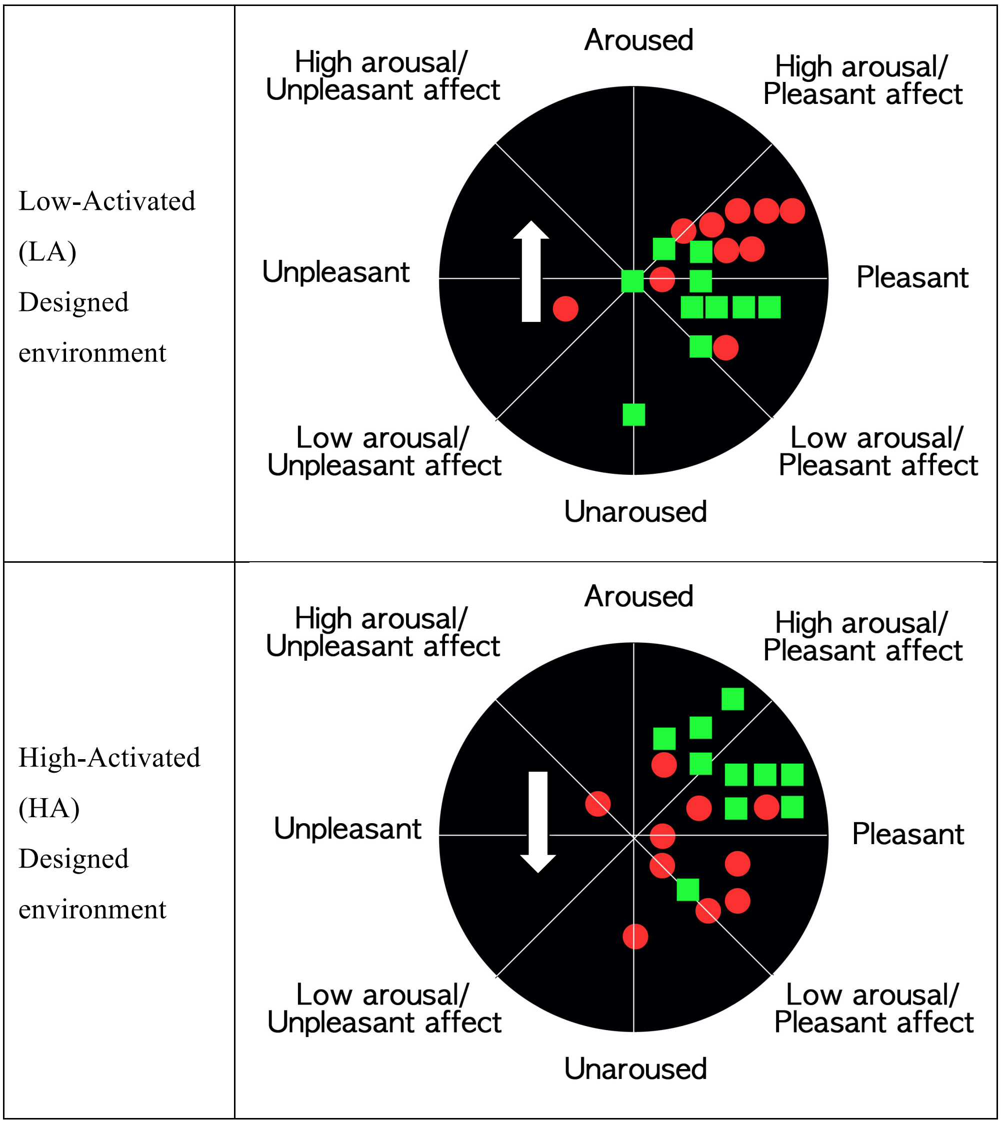


Figure 4.22. Pleasure and arousal changes in 3 different environments before and after task

4.2.5.4 The ANOVA test for initial emotions based on concurrent emotion data

To test whether participants consistently attributed different effective characteristics to the designed environment, an ANOVA test was performed on the effective dimensions acquired with the self-report measures at the beginning of the study. The results showed that participants' initial affect attributions differed significantly among the three environments when described along the pleasure ($F(2, 25)=3.81$, $p=0.036$, $\eta_p^2=0.234$), arousal ($F(2, 25)=9.16$, $p=0.002$, $\eta_p^2=0.423$), and dominance ($F(2, 25)=7.88$, $p=0.001$, $\eta_p^2=0.387$) dimensions. The ZA environment was seen as less pleasant compared to the LA environment, and the LA, which in turn was seen as less pleasant than the HA environment. The ZA environment was associated with less arousal compared to the LA environment, which was associated with less arousal than the HA environment. Lastly, the ZA environment was seen as less controllable than the LA environment but the LA space was seen as slightly more controllable than the HA environment. This result provided evidence that the different designed environments reflect different emotion related characteristics, see Figure 4.23.

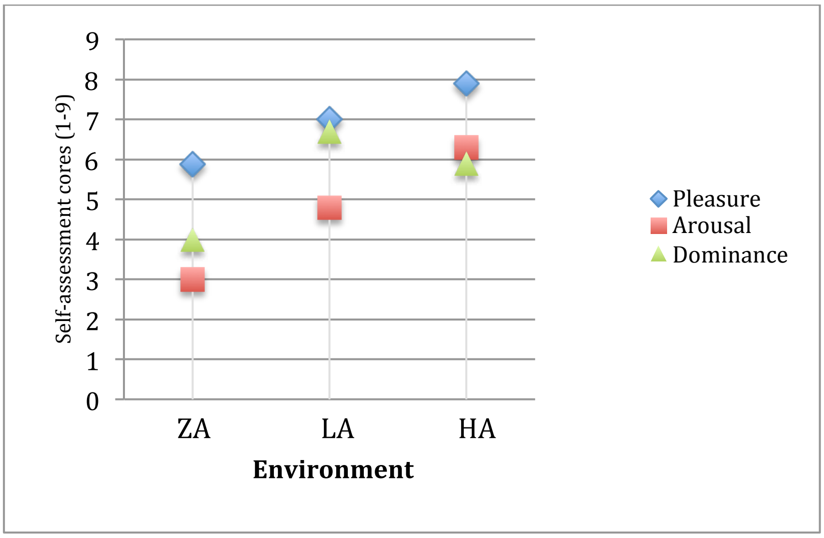


Figure 4.23. Means of beginning pleasure, arousal and dominance in 3 different environments

Analysis of the data of the self reported emotional states of the participants in three spaces, also revealed differences by environment. In the ZA environment, changes in emotions revealed that participants reported more joy, serenity and optimism at the end of the design task, compared to the beginning of the task. In the LA environment participants reported more trust, acceptance and optimism at the beginning of the task, while at the end, they reported more joy and interest. In the HA environment, the level of surprise, amazement and joy that were caused by the high-activated stimuli in the environment, decreased and changed to higher levels of trust and acceptance.

To investigate the start-end emotion data, further, the researcher depicted the basic emotions with the same colour in Pluchik's wheel of emotion for each environment. The inner pie chart showed the emotions before the task and the outer pie chart showed the emotions after doing the task with name and the percentage of each emotion. In the ZA environment, joy was the reported emotion that increased most at the end of the task. Participants reported higher joy about the ZA environment at the end of the task, see Figure 4.24.

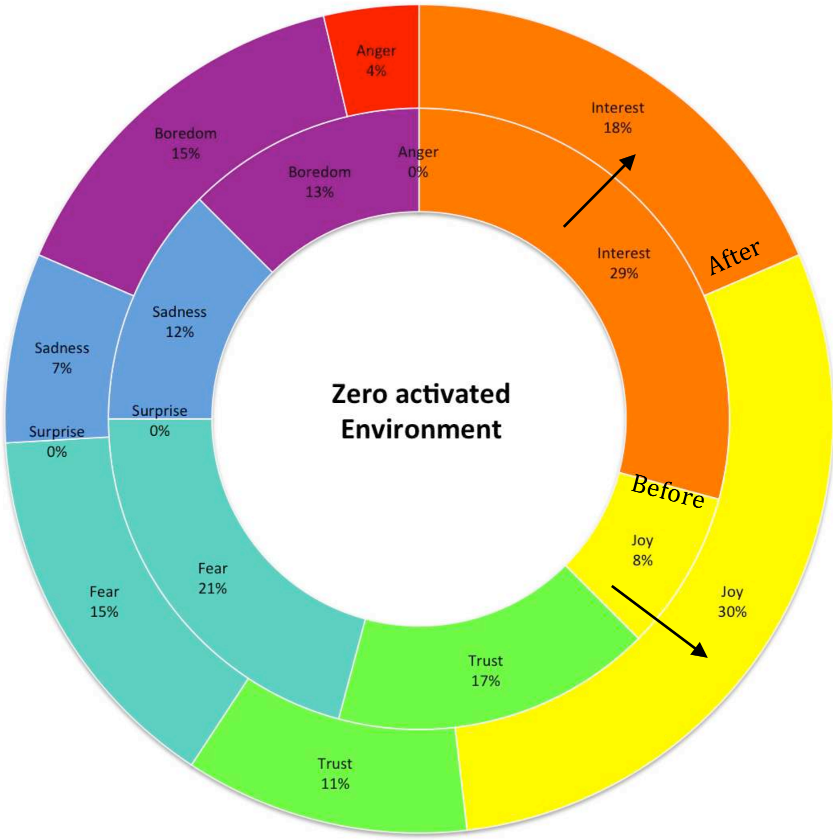


Figure 4.24. Changes of emotions before and after the task in Zero-activated (ZA) environment (inner pie chart illustrates emotions before task and outer pie chart illustrates emotions after the task)

Moreover, in the LA environment, participants reported more joy, interest and trust. However, emotion of trust had decreased at the end of the design task and the designers had higher level of joy and interest, see Figure 4.25.

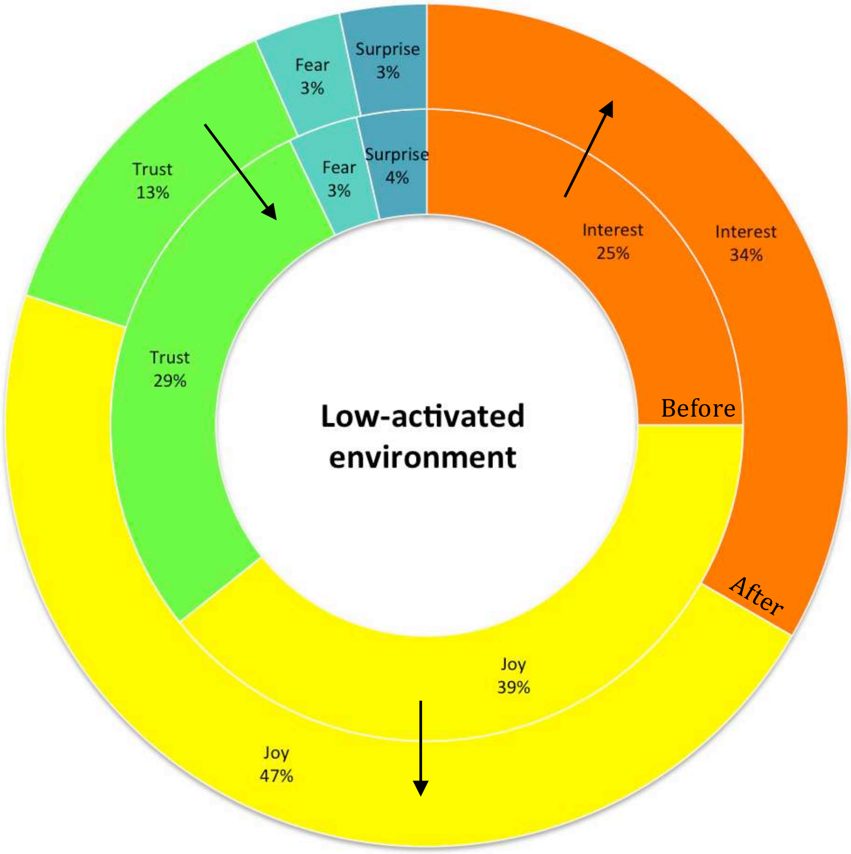


Figure 4.25. Changes of emotions before and after the task in Low-activated (LA) environment (inner pie chart illustrates emotions before task and outer pie chart illustrates emotions after the task)

Finally, in the HA environment the highest levels of joy and surprise were reported at the start of the task, but these emotions decreased by the end of the task. In contrast, trust and interest increased after accomplishing the task as shown in Figure 4.26.

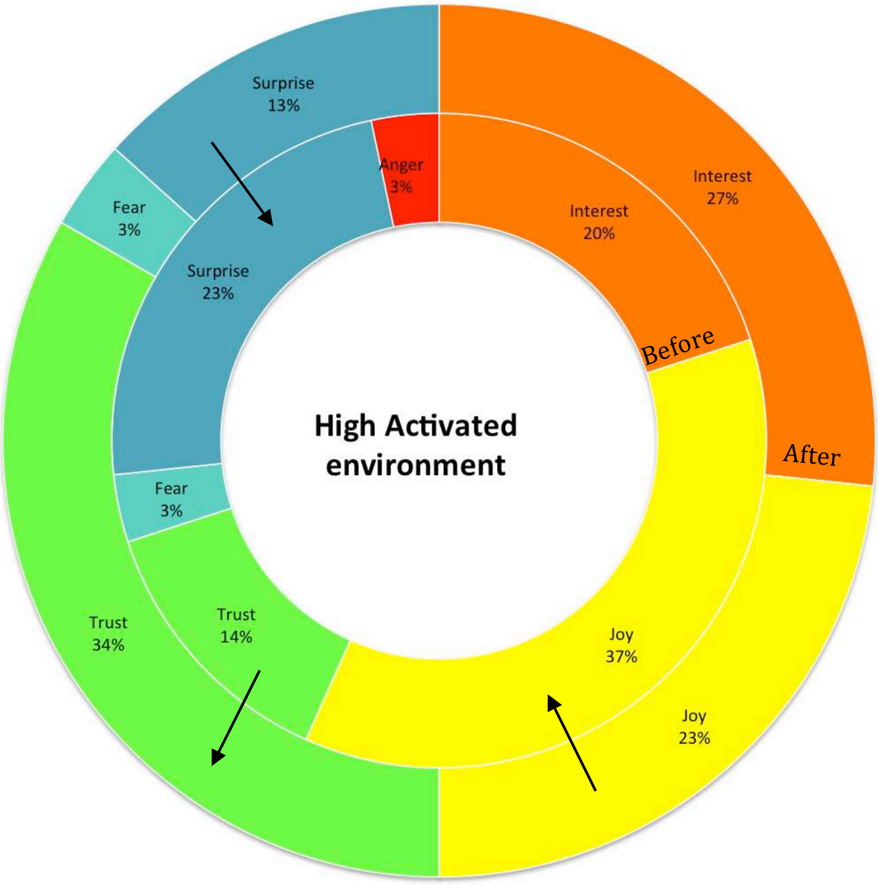


Figure 4.26. Changes of emotions before and after the task in high-activated (HA) environment (inner pie chart illustrates emotions before task and outer pie chart illustrates emotions after the task)

4.2.5.5 Participant's emotional state during the time based on retrospective emotion data

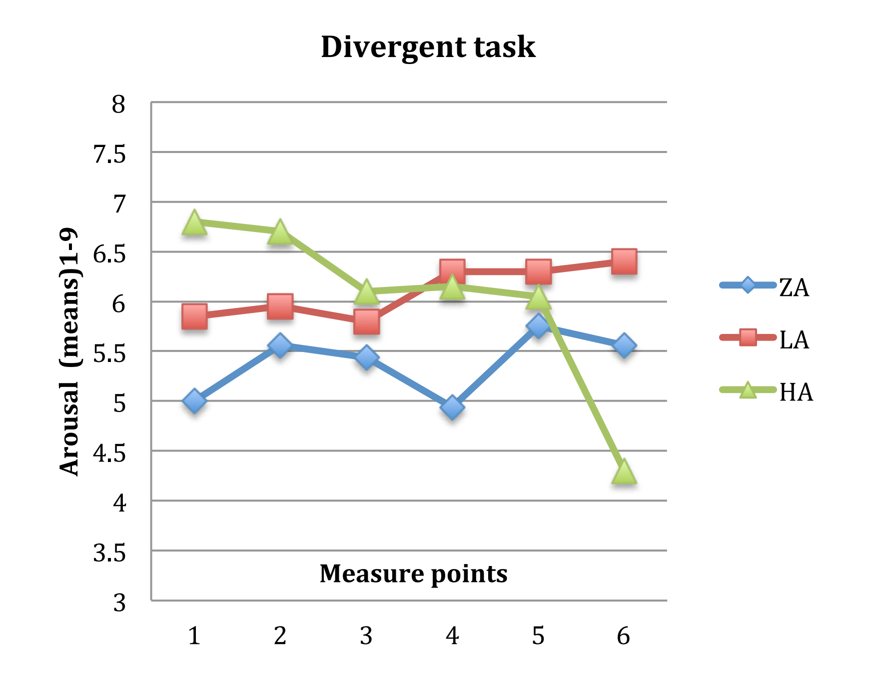
With regard to the influence of the ZA, HA, and LA spaces on the change of emotional arousal over time, tests of within-subject effects showed a significant interaction between the measure points and the spaces ($F(5.86, 73.19)=3.06$, $p=.011$, $\eta 2=.245$), environment stimuli affected emotional arousal while participants were undertaking the design task. Furthermore, the estimated marginal means showed that, during convergent task for six measure points, there was no significant difference between the environments. However, the measure points in the divergent task revealed that, in early stages of the creative task, there was a significant difference between 3 environments. The participants in ZA space self-reported less emotional arousal than those in the LA space, which in turn reported less emotional arousal than those in the HA space, see Table 4.7.

Measure Points in Divergent task \ Spaces	ZA space		LA space		HA space	
	Mean	SE	Mean	SE	Mean	SE
1	5.00	.483	5.85	.432	6.80	.432
2	5.56	.472	5.95	.422	6.70	.422
3	5.44	.511	5.80	.457	6.10	.457
4	4.94	.476	6.30	.426	6.15	.426
5	5.75	.587	6.30	.525	6.05	.525
6	5.56	.818	6.40	.731	4.30	.731

Table 4.7. Estimated marginal means (Mean) and standard errors (SE) of self-reported emotional arousal for the ZA, HA, and LA space, at each of the six measure points during the divergent and the convergent task

However, this pattern changed towards the later stages of the creative task participants in the ZA space and the LA space reported a slight increase in emotional arousal over time. The participants in the HA space reported a strong decline in emotional arousal, especially toward the end of the task. In the last stage of the creative tasks this resulted the lowest level of emotional arousal for the participants in the HA space, and the highest for the participants in the LA space, see Table 4.8.

Arousal measure points in divergent task



Arousal measure points in convergent task

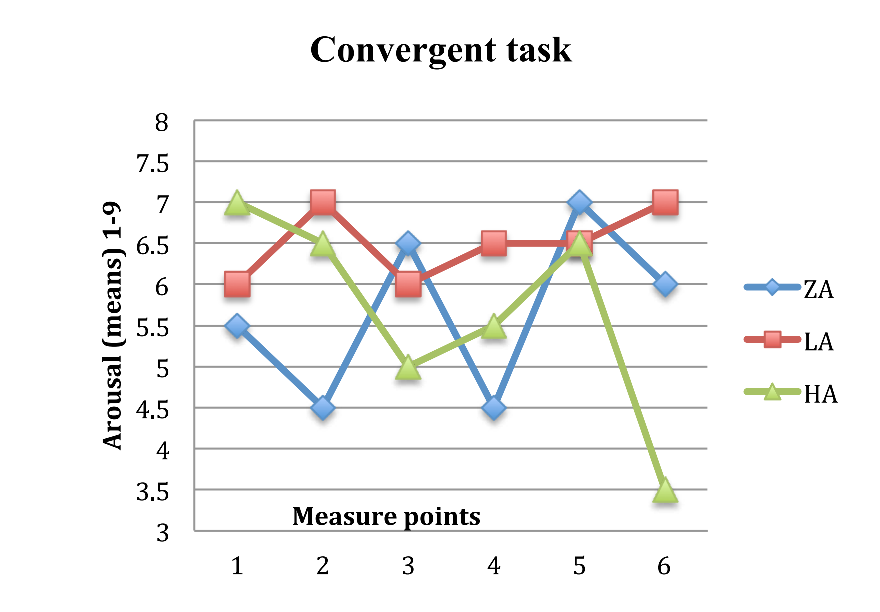


Table 4.8. Comparing the line graphs of the estimated marginal means for emotional arousal reported at the six measure points during the brainstorming (divergent design task) and six measure points during storyboarding (convergent design task) for the ZA (blue line), LA (red line), and the HA (green line)

4.2.6 Conclusion

The results of the creative design outcomes that were rated by experts revealed that the effect of different environments on the creativity of the outcomes were not significant. Application of the design guidelines to the HA and the LA environments had not led to more creative ideas than from the ZA environment, and the results did not provide strong evidence that the stimuli designed for the HA and the LA environment by implementing design guidelines enhanced creativity as opposed to no stimuli.

Furthermore, the findings showed the tests of within-subject effects were significant for emotional arousal (higher emotional arousal associates with higher level of creativity, Section 2.3.10.2), but the test of between-subjects effects showed that the influence of the environments on emotional arousal differed from each other in a temporal manner. The effects at the beginning of each task looked higher, but the effect diminished over time. This is a support for the fact that the effect of the environment or any stimuli is relatively short, and the environment's influence as the stimuli to enhance creativity decreased over the time unless the influence of the environment coming through the creative task that people engaged. This is consistent with research results reported by Lewis et al. (2011), which revealed that positive pictures as a background to a creative task produce some affect on creativity with small affect size. Therefore, the environments to support emotions that affect on higher creative performance need to be designed such a way that environment plays its role within the context of creative task.

Indeed, the different spaces did not consistently showed the differences in emotional arousal throughout the divergent (brainstorm) and the convergent (storyboard) task, that is, participants in the HA environment did not consistently self-report higher emotional arousal than the participants in the LA space. Instead, the arousal was different in the HA and the LA spaces. Participants in the HA space reported higher emotional arousal early in each of the tasks, and lower levels of arousal later in each of the tasks, however the participants in the LA space reported a steady increase in emotional arousal during the tasks.

Even though the spaces exerted an influence on emotional arousal, there was no clear evidence for how this translated into an influence on creativity. Although interpretation is not strong, it is suspected that the elicited emotional arousal influenced creativity if the emotional arousal is part of the creative task. Indeed, previous research has found that the influence of emotion depends on whether that emotion is considered meaningful to the creative task (Gasper, 2003). The result revealed that emotional arousal was not a meaningful part of the creative task; emotional arousal did not influence emotion accordingly.

Moreover, people's personal attitude and interest about the environments were different. The complex design of the HA environment might have suited for some participants more than others. While the simple designed environment for the LA space worked better to increase the level of arousal gradually, participants in the HA environment started with higher level of arousal that had dropped over time. This finding suggested that the environment that support creativity needs to keep designers engaged in the task by using the continual stimuli in the environment to support creativity.

Therefore, for the next study focused be on a simple designed environment that applied the stimuli that increasing arousal throughout the time of design work, and stimuli should be part of the task in action. It causes designers involve in the task in hand and find the change of the environment through the time while achieving the goal of the task. They can experience higher level of flow that leads to higher creativity (Csikszentmihalyi, 1999).

Moreover, before and after the task, participants reported different emotions, while the environment remained the same for each participant during the design task. Changes in the emotions about the same environment may be a consequence of participant's internal emotions that can be caused by how they felt about their own design work. Moreover these emotions might have an impact on how s/he felt in the beginning. For example, participants in the HA environment had the highest level of joy and surprise. In contrast, trust and interest increased after accomplishing the task. It could be discussed that joy and surprise may be the results of higher level of external stimuli in the environment at the beginning of the task, whereas trust and interest are the results of internal stimuli in each participant in accomplishing the design task, and engagement and pleasure and satisfaction of achieving the design task goal at the end of design task. The particular results that outlined to each research questions are:

1. RQ1: Does environment affect individual designers' emotions in order to enhance creativity? Although, there was not a significant difference in emotional changes overall, during the design process performed in different environment, the impact and influence of each environment on creativity and also on emotional state, was most pronounced in the beginning of the task. This provides a marginal positive support for RQ1 of this study, that the environment's influence on arousal can be effective.

2. RQ2: Does high-activated environment (HA) increase designers' emotional arousal and foster divergent creativity? The high-activated space had the positive impact to increase arousal in the beginning and over the time the level of impact decreased. However, originality and usefulness in creativity assessment did not show a strong impact by environment.

3. RQ3: Does low-activated environment (LA) decrease designers' emotional arousal and foster convergent creativity? The low-activated environment created a space for higher focus and had an effect on increasing arousal, gradually. However, the effect of environment on the creative outcomes was not significant.

One possible solution might be to design the environments to provide a continuous influence on emotional arousal to support creativity and divergent thinking in idea generation tasks. Although the results of this study were not significantly extensive, the findings herein make a valid and incremental contribution to creating an improved and constructive working environment for designers.

The CSE framework was evaluated using results from the two studies, mainly about designing the environments for divergent and convergent activity in higher contrast with implementing the stimuli that are involving in the task and throughout the time for divergent activity and in diverse for convergent activity. Next study requires decreasing the constraints of the environment, and limiting the variables of the study, to explore the more practical application for the environments that can support creativity through emotional states.

5 Refined CSE Framework (Creativity Support Environment)

This chapter presents the refined CSE framework generated from the initial CSE framework in Chapter 3 and the empirical results reported in Chapter 4.

5.1 Findings of the first and second studies to develop the CSE framework

The results from first study in Chapter 3 revealed that participants in the high-activated environment were more creative in the divergent task, compared to the participants in low-activated environment, although the effect was short lived. Moreover, changes and unexpected events in the environment appeared to foster creativity, and the effect of the spatial environment decreased over the time. The results revealed that designing the environment with inducing stimuli could trigger designers' emotions in the environment, in order to improve creativity. For example, artefacts that were used as part of the creativity techniques (e.g. colourful Lego bricks and plasticine) enhanced the creative climate in the low-activated environment. The result suggested that artefacts affected the task environment more than the spatial environment. Over time, participants' awareness of surroundings decreased and their attention became more focused on the task than on the environment around them.

The results from the second study showed that a visually high-activated environment increased the fluency (the number of ideas in creativity assessment) compared to the low-activated and neutral environments. These results were consistent with findings reported by other researchers, which revealed that higher emotional arousal could result in higher creative fluency and originality through higher cognitive flexibility (Schei, 2013; De Dreu et al., 2008). The environment with more stimulating visual features in the high-activated space was associated with higher pleasure and activation in the participants. In contrast, the environment with less stimulating visual features in the low-activated space was associated with higher control and lower distraction in the designers, leading to more focus on the task. Moreover, the results showed that the high-activated environment was good for making designer's ideas more original, while the low-activated environment had a positive impact on the practicality of the ideas that designers generated. The level of emotional arousal increased gradually in the low-activated space, while in the high-activated space, arousal was very high at the beginning and decreased quickly afterwards. To conclude, the influences of the environment on designers in different environment were:

1. The design guidelines that applied to generate visual stimuli in the high-activated environment had a strong impact at the beginning of the task but their effect decreased over time. One of the solutions for making the effect of the environment stable appears to be providing continuous stimuli in the environment. Moreover, if the level of arousal stays high over time, while designers engage in a task, it has the potential to make designers more creative. Therefore, stimuli need to involve in the task environment. For example, if a designer undertakes a brainstorming task, the "task environment" contains a table, post it notes, markers, and other artefacts that s/he implements to accomplish the task. One solution for achieving higher arousal in the high-activated space is that the stimuli should be applied in combination with both the spatial and task environments. The spatial environment is a trigger and motivation to elevate the emotional arousal for the beginning of the task, however it is not enough. The space of the task environment is required to provide the stimuli that lead to high arousal in designers that is linked to high motivation in divergent thinking.

2. The design guidelines that were applied in the low-activated environment had a steadily increasing effect on emotional arousal, and designers generated more functional ideas in the low-activated environment.

Based on these results, the research proposed 2 new types of design environments: while designer undertaking a task 1. a spatial environment and 2. a task environment shown in Figure 5.1. The special environment is the whole surrounding space including floor, ceiling, walls, windows, views, furniture and other objects in the environment. The task environment is part of the spatial space that contains all artifacts and objects and facilities designers' work to accomplish the task

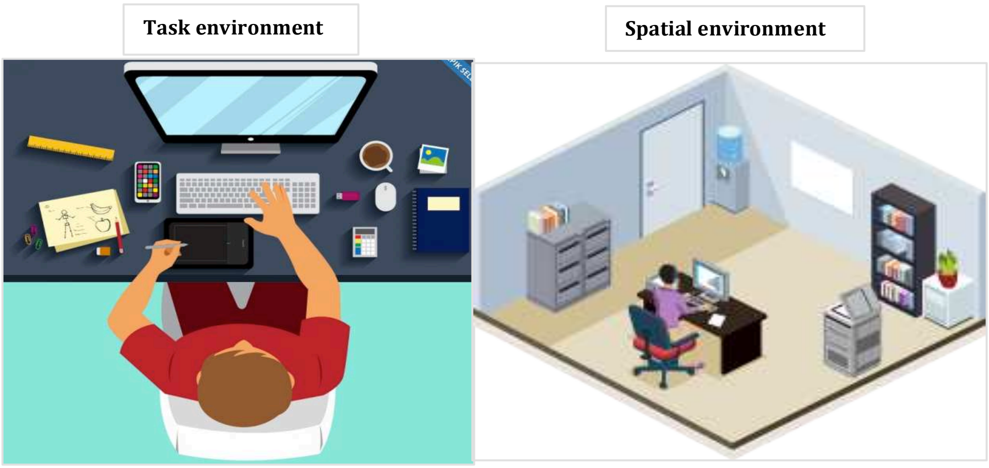


Figure 5.1. A new task environment (left image) vs. a new special environment (right image)

5.1.1 The spatial environment

The spatial environment refers to the surrounding environment and includes the space itself, furniture, accessories, objects and all of the visual features in the environment, as shown in Figure 5.1. It can be designed to fit the type of creative task, by implementing the design guidelines described in chapter 3, for example with on the high activated stimuli for divergent tasks and low activated stimuli for convergent tasks (Figure 5.2).

Figure 5.2. An example of a spatial environment, composed of surrounding environment with furniture, objects, windows and all visual features are in the shape the space

5.1.2 The task environment

To define a task environment, the framework adopts the following definition of a task: “an assigned piece of work often to be finished within a certain time” (Webster, 2003). A design task contains both divergent and convergent thinking, from the ideation stage to the evaluation stage. Therefore, the task environment refers to the all elements of the environment related to the task that designers undertake. Depending on the type of task, the environment might include elements such as artefacts that designers use to accomplish the task. For example, Figure 5.3 shows the *task* environment of a creative design task from the first study in a group work includes Lego bricks, plasticine, post-it, papers, and marker pens. In this example, the level of information from the spatial environment is filtered based on the higher level of focus attention arising from the task. Therefore, when the engagement in the task increases in the task environment, the effect of spatial environmental elements is anticipated to drop.

Figure 5.3. An example of a task environment composed of artefacts that designers undertake the deign task

Designers need to be supported not only in the spatial context, but also in the context of task that enables them to enhance their creative performance in the task environment. To support the particular attributes of divergent and convergent work, the framework was extended with new design guidelines for the task environment, These new guidelines which facilitate creativity design tasks through the right levels of activation that linked to higher creative outcomes.

5.2 Refined CSE framework based on spatial and task environment

The initial CSE framework was refined using these 2 new types of environment to improve and be more inclusive, as described in Figure 5.4. In the refined CSE framework, the concept of environment was divided into *spatial* and *task* environments, the latter, which indicated that an environment could incorporate task elements. The refined CSE framework presents the element of a task environment shown in the environment in Figure 5.4 by considering the time-based effect of the environment that makes a better overview of the space and the time to enhance creativity in different types of creative task.

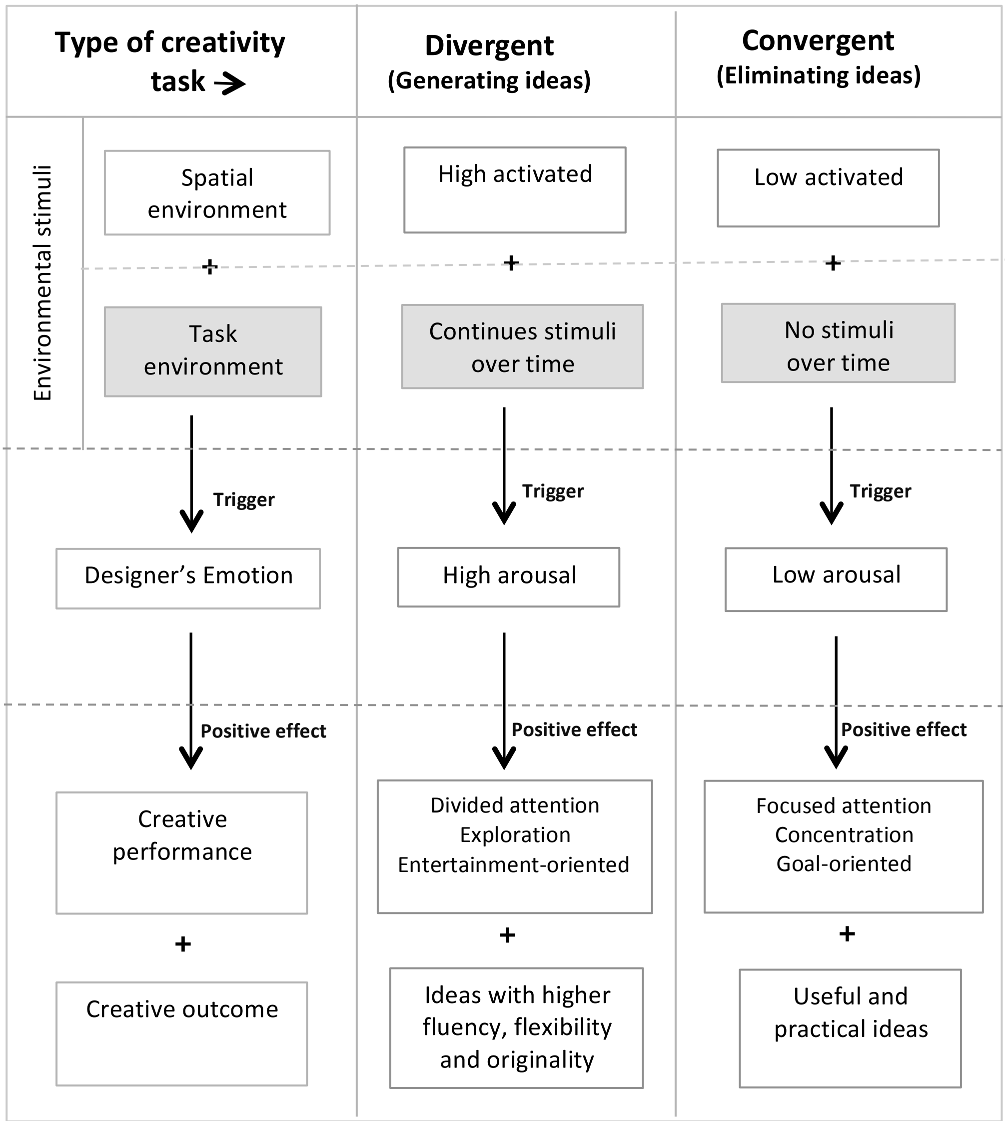


Figure 5.4. The refined CSE framework with hypothesized effects between the design environment, designer emotions and activation levels for divergent and convergent work that effect creative work outcomes (The highlight boxes in the environment stimuli added to the previous CSE framework based on the results of first and second studies from Chapter 4)

5.3 Spatial versus task environments in the high-activated and low-activated spaces

A refined version of CSE framework was proposed to add the environment of the task to the framework. With this time-based element, the *task* environment becomes part of the environment that activates and sustains the higher emotional arousal over time. As a consequence, the effect of stimuli becomes stronger and continuous, in order to create higher emotional arousal and stimulate designers over time.

5.3.1 The ask environment supporting divergent and convergent task

Based on the CSE framework, desirable task environmental stimuli that support the related emotional states for divergent and convergent creativity tasks are:

5.3.1.1 The task environmental stimuli in divergent task

The environment needs to provide continuous stimuli in the task over time, and these stimuli change over time to keep the emotional arousal high in designers, leading to higher creativity in performance and outcomes.

5.3.1.2 The task environmental stimuli in convergent task:

In contrast, there is no need for environment stimuli during the convergent task. The reason is that the higher levels of attention focus and concentration that produce higher emotional arousal in designers can enhance the creative performance in the convergent task. Therefore the environment for the task needs to offer low activation with fewer distractions to prevent higher level of arousal by the environment.

5.3.2 Further design guidelines to support divergent creativity

Based on existing design guidelines with which to design high-activated environments, these environments should have spatial complexity, visual details, high value colours, high contrast colours, use of natural materials and texture, and views of a natural environment in order to improve divergent creative performance (see the guidelines reported in Chapter 3). In addition, new design guidelines for the task environments are needed to seek to activate emotions with a positive tone and improve creative performance measured in terms of the novelty and value of outcomes of design work. The design guidelines were developed to activate emotional arousal in 3 elements classifications that are shown in Table 5.1. In the table there are 3 main categories of guideline: 1. the task environment platform that is a 2- or 3-dimensional surface in which a design task undertaken, 2. visual stimuli that are the visual images which change in slow to moderate speed over time. Visual stimuli categorized to nature, the abstract forms and colours, 3. auditory stimuli, the form of music that is combined with the visual changing stimuli to increase the harmonious and flowing effect of visual stimuli.

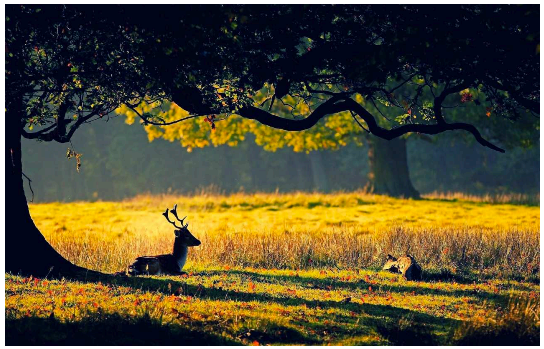
1. Design environment platform	Natural material	
	Flexible size and form	
	Projection: images projected onto the work surface	
2. Visual stimuli	A. Nature	Images of nature
		Natural movement from nature
	B. Abstract form	Minimal and simple form in playful movement
		Complex and in details forms with simple change
	C. Colours	Bright colours
		Contrast colours
3. Auditory stimuli	Music matching visual stimuli in harmonious and flowing ambiance	

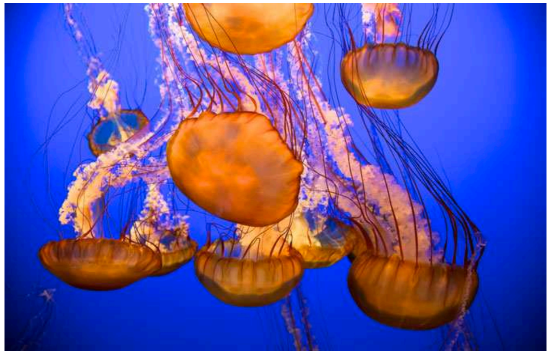
Table 5.1. Elements of design guidelines in high-activated environment

The new design guidelines for the task environment are reported in Table 5.2.

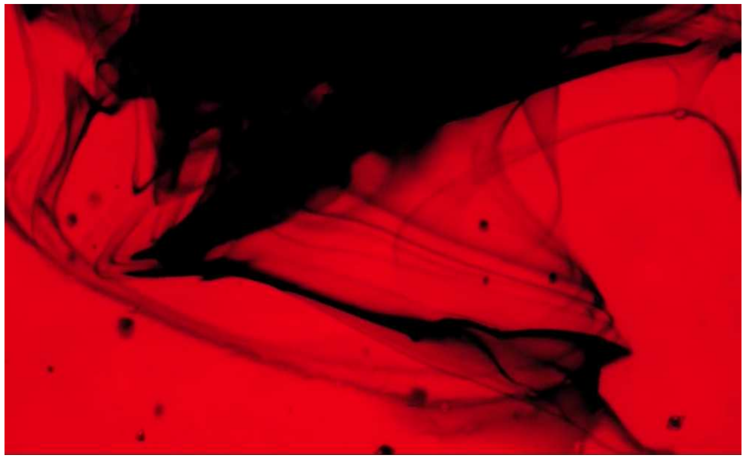
No	Task environment (TE) design guidelines		Description	Image example
TE1	Task environment platform	**Natural materials:** Use natural materials for a task environment	Use natural materials to design the background for the task environment (e.g. the table, desk, wall or floor) (McCoy & Evans, 2002)	
TE2		**Flexible size and form:** Provide the task environment in different sizes and shapes, in order to fit with the design task	Provide the surface platform of a size that is consistent with the design tasks and with considering the ergonomic standards of standing or sitting conditions. (Doorley & Witthoft, 2011) (Groves, 2013)	

TE3		**Visual projection:** Provide a projection system in the task environment	Set the projectors up in a location that can project high quality pictures and videos on the table or wall as part of the task environment. (Based on the results of the studies in Chapter 4)	

TE4	**A. Visual stimuli (nature)**	**Nature**: Provide images of nature and beauty from the natural environment	Show the images that are related to the nature and change through time. These images that are photos of the natural environment change smoothly to create relaxing flow to connect designers to the nature. Because there are some limits to view the real nature, these images can bring that effect of being in the nature that leads to higher creativity. (McCoy & Evans, 2002) (Kaplan, 1989) (Cooper, 2013)	  	Waterfalls and green spaces Lakes, mountains and seasonal beauty Fields and animals

TE5	**A. Visual stimuli (nature)**	**Natural movement:** Show different forms of natural movement from nature using motion videos	Design the motion video to show different types of movement or perception of movement in the nature. The movements and slow changes of natural organic forms provide flow and unexpected changes. (McCoy & Evans, 2002), (Kaplan, 1989), (Cooper, 2013)	  	Birds flying in the sky Smooth natural movement of jellyfishes in the ocean Fish movement swimming in the sea

TE6	**B. Visual stimuli (abstract)**	**Abstract visual forms (minimal and simple):** Use abstract visual forms that transform over time in playful motion	Show minimal abstract forms in playful flowing movements that are unexpected to the designers. (Groves, 2013) (Meyer, 2009)	 A drop of colour in water
		Abstract visual forms (Complex and details): Use abstract visual forms in complex shapes and details with visual texture that change over time	Show complex and detailed visual effects that change over time, for example with fading or blending two images. (McCoy & Evans, 2002)	

TE7	**C. Visual stimuli (colours)**	**Bright colours:** Use bright colours in abstract motion videos	Use bright colours such as red, yellow, green and purple video that change over time to provide unexpected changes to the designers. (McCoy & Evans, 2002), (Stone, 2003) (Gorp, 2012)	
		Contrast colours: Use contrasting colours to project in slow motion video	Use colours that are in contrast, and design the motion video to blend these colours in movements to provide is flowing changes that are unexpected to the designers. (Gorp, 2012)	

TE8	**Auditory stimuli**	**Music:** Play music that match with motion graphics and changes of the same visual stimuli	Play music with 60-70 db. to provide the creative, harmonious and flowing ambient background. (Mehta et al, 2012)	 https://www.youtube.com/watch?v=NF8aQHwcKN0

Table 5.2. Design guidelines for the high-activated environment in the task context to support divergent creativity

In contrast, to support convergent creative performance, the task environment should be designed, without external stimuli, with the aim of not activating the emotional arousal to detract designer attention to the completion of the design task and to create more attention focus and concentration.

To test the refined CSE framework and the new design guidelines, the researches designed new empirical study that is reported in chapter 6.

6 Study III. A summative evaluation of the effect of environment change on divergent and convergent creative activities in design work

This chapter reports a summative empirical evaluate into the effect of the design environment change on 2 types of creative design task. Although previous research has investigated the effect of environment on creative performance, there has been little research into how it might improve to support creative work that evolves through a sequence of divergent and convergent activities.

The results from the previous studies indicated that the environment during divergent and convergent stages of creative design processes could influence creative performance. In addition higher emotional arousal is not necessary to stimulate all types of creativity. An environment can support divergent or convergent creativity if it is applied correctly. And because past research indicates that emotional arousal has a strong link with creativity (De Dreu et al., 2008; Schei, 2013), the researches focused on emotional arousal in the CSE framework. Therefore, the researches applied high activated and low activated features in the environment to make high arousal and low arousal level of emotions for designers based on design guidelines for the 'task environment' (See Chapter 5). The researches then tested the effect of these conditions on divergent and convergent creativity in designer's creative performance.

Environments that support divergent and convergent creative work have been designed in order to support guidelines for environments following the guidelines of the 'task environment' instead of 'spatial environment'. An environment with multiple visual and audio stimuli that encourage activating emotions with a positive tone can impede as much as support divergent creative work because of divided attention, while an environment without stimuli might not provide designers with the high external emotional arousal that increase attention focus and can support convergent creative work.

Therefore this research drew on these previous findings to generate new hypotheses about the effects of different forms of environment on designer emotional stimulus, attention focus and creative performance during divergent and convergent work, and from these hypotheses with which to guide the development of design environments to maximize activating emotion stimulation during divergent creative work, and to maximize attention focus during convergent creative work by reducing external stimuli. The design guidelines from Chapter 5 informed the construction of the 'task environments' to support divergent and convergent creative design activities. In the study, 41 participants with a formal design education undertook creative divergent and convergent tasks in environments that were constructed in alignment with the design guidelines for each divergent and convergent task, and against the design guidelines.

6.1 Hypotheses

The research hypothesized that a design environment affects both a designer's emotions and activation levels, and designer emotions have a direct effect on the creative outcomes of the design work that is undertaken. Moreover, designer activation levels affect the divergent and convergent creative activities undertaken in a design task differently. The hypothesized effects are depicted graphically in Figure 6.1.

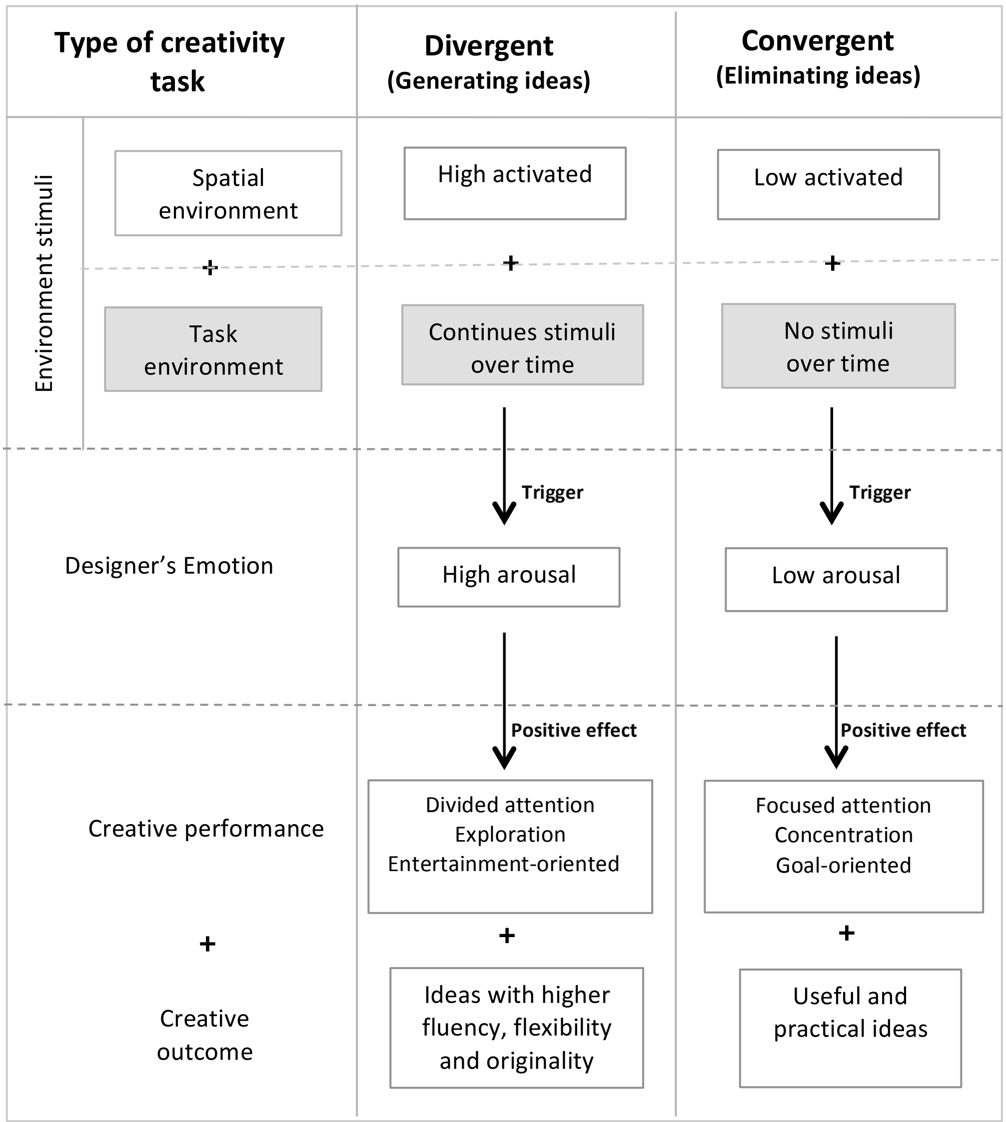


Figure 6.1. The Improved CSE framework hypothesized effects between design environment, designer emotions and activation levels for divergent and convergent work that effect creative work outcomes (The highlight boxes in the environment stimuli added to the previous CSE framework based on the results of first and second study)

H1. The research hypothesized that environments with characteristics that trigger activating emotions with positive tone can improve the creative performance and hence outcomes of designers. In particular, environments with characteristics that have constant stimuli including the spatial complexity, visual details, use natural materials and offer views of a natural environment (see the new design guidelines in Chapter 5) can improve creative performance. Moreover, environments that are designed by following these visual design guidelines and provide ambient noise can also trigger activating emotions with a positive tone and improve creative performance measured in terms of the novelty and value of outcomes of work. Therefore, the researches sought to develop a design environment that is capable of being illuminated with applying the design guidelines for the task context (Figure 6.1) such as complex spatial details and natural forms in selected colours, and animated motion video with moderate levels of ambient noise.

H2. Moreover the research hypothesizes that these higher activating emotions with positive tone in designers result in improved creative performance during divergent design work by increasing designer cognitive flexibility and inclusiveness. From this the researches sought to support divergent creative performance, implement the design guidelines of the task environment with external stimuli that maximize activating emotions with positive tone, such as happiness and elation and surprise.

H3. In contrast the research hypothesized that lower emotional stimulation levels, reduce activating emotions in designers and result in improved creative performance during convergent design work through increased attention focus to complete creative tasks. From the research sought to support convergent creative performance, implement the design environment without external stimuli that might activate positive emotions and detract designer attention from the completion of the design task.

First validation of the correctness or otherwise of these 3 hypotheses during a controlled study of the effect of 2 different environments that were designed using design guidelines in the 'task environment' has examined in this study.

The remainder of this chapter reports the method, results and implications of this empirical study for design guidelines from which the CSE framework were extracted.

6.2 Method

6.2.1 Participants

All study participants were drawn from 2 postgraduate degree courses at City University London – the Masters in innovation, creativity and leadership, and the masters of Science in human-cantered systems. All had received a minimum of one semester of formal education and practice in creative design processes that included brainstorming and visual storyboarding. A total of 65 students on both Masters degrees received an invitation and financial incentive to take part (a £10 Amazon voucher), and offered date/time slots to undertake the study. From this invitation, 41 students from both courses undertook the study.

6.2.2 Design task

All 41 participants were requested to perform the same design task to outline the redesign of a waiting area for outpatients visiting their neighbourhood doctor using the same 2 creative design techniques in the same sequence. The task was presented to each participant in the form of text and picture descriptions of current service problems as shown in Figure 6.2.

Figure 6. 2. Examples of selected images of current doctor reception areas, which were provided to define the design task

6.2.3 Procedure

Each participant was asked to outline the redesign of the service in 25 minutes using 2 creativity techniques:

1. Idea generation with brainstorming – a divergent creativity technique – for a period of 12 minutes, then;
2. Visual storyboarding – a convergent technique – for a second period of 12 minutes.

The use of each creativity technique was kept relatively short based on earlier findings that the effect of environment on creative design performance was also relatively short-lived. Idea generation with brainstorming was selected to support creative divergence because participants were required to explore a space of and generate new design ideas for the outpatient waiting area. Visual storyboarding was selected to encourage combinational creativity with these ideas that converged towards a single, coherent design concept. Each participant was provided with a large number of post-it notes, large sheets of blank white paper and different coloured pens to undertake both tasks.

6.2.4 Change in the creative environments

All participants undertook the design task in the same physical environment - a 4x4m space at City University London in the middle of which was a chair at a simple and large worktable made of natural materials. The design guidelines from Chapter 5 implemented to design the environment with continues change of stimuli to support divergent activity, and also without design stimuli to support concentration in the convergent activity. Digital technologies were then used to generate 2 versions of the environment, with and without the stimuli:

6.2.4.1 An activated space

An activated space was formed on the worktable with slow motion video and dynamic visual and auditory stimuli digitally generated and projected onto the worktable from above as shown in Figure 6.3.

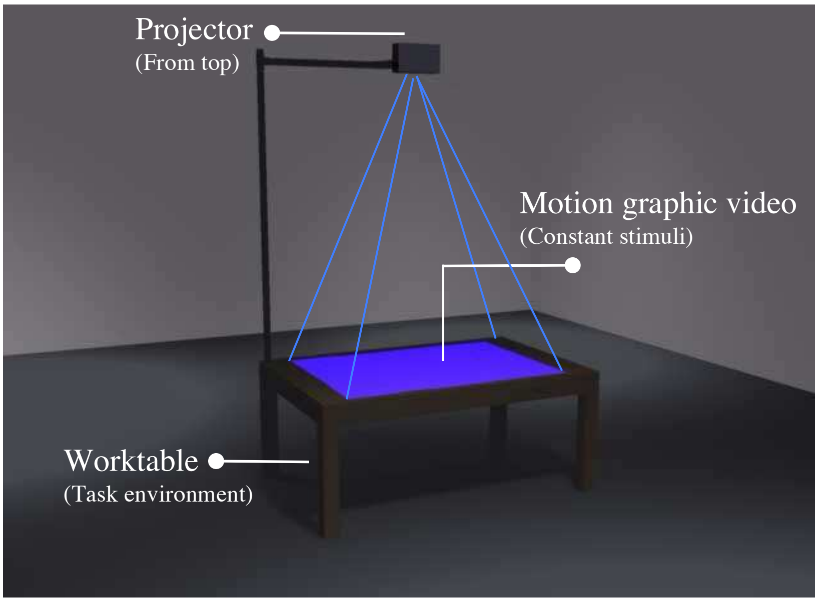


Figure 6.3. The activated task space, worktable with a projection from top with slow motion video to create continues external stimuli

The visual stimuli were natural, complex and abstract shapes that blended and transformed the shapes over time and derived from task environment design guidelines e.g. TE4, TE5, TE6 (see table 5.2). The researches chose not to show concrete objects and images in order to avoid design stimuli that could have been interpreted as deliberate inputs to the design task. The visual stimuli were aligned with music that was played at different rhythms during the task at 60-70 decibels, again consistent with design guidelines e.g. TE8, and did not include loud or sudden sounds. Again the researches chose not to play music with lyrics to avoid design stimuli that could have been interpreted as deliberate inputs to the design task for participants. The integrated visual and auditory stimuli were provided in the space throughout the 12 minutes of each use of the space. Selected images of the visual stimuli projected onto the worktable to generate this activated space are shown in Figure 6.4.

Figure 6.4. Images depicting pilot users undertaking creative design tasks in the activating task environment and in the top is the design work surface with slow motion video

6.2.3.2 A deactivated space

The deactivated space was formed of the same worktable and chair but without any visual or auditory stimuli. Selected images of this deactivated space are shown in Figure 6.4.

Figure 6.5. Images depicting pilot users undertaking creative design tasks in the deactivating task environment

6.3 Material and measurement

6.3.1 Study conditions

To investigate the effect of the 2 creative spaces – *activated* and *deactivated* – on the 2 types of design task - *divergent* and *convergent* – The study was set up with 2 conditions, called the *aligned* space and the *unaligned* space.

6.3.1.1 The aligned space

The creative spaces were aligned with the types of design task – designers undertook the divergent task in the activated space and the convergent task in the deactivated space – i.e. the space was constructed in alignment with the design guidelines of task environment for each divergent and convergent activity (See Chapter 5).

6.3.1.2 The unaligned space

The creative spaces were deliberately unaligned with the types of design task, i.e. the designers undertook the divergent task in the deactivated space and the convergent task in the activated space – i.e. the space was constructed to be unaligned with the design guidelines for divergent and convergent tasks.

Each of the 41 participants was then randomly allocated to one of the 2 conditions – 20 participants undertook the design task in the *aligned* condition and 21 undertook it in the *unaligned* condition.

6.3.2 Measuring participants' emotions

At 3 times during the task - at the start of the divergent task, between the divergent and convergent task, and at the end of the convergent task- participants in each condition was asked to self-assess their primary emotion. They used the same simple measurement tool as used in the second study in Chapter 4 - *affect circumplex* (Gorp & Adams, 2012)- illustrated in Figure 6.6. It was selected to be simple and quick to use, and not interfere with the design task. Sam and affect circumplex questionnaire are different self-assessment tools with the same theory of dimensional emotion, each with specific visual presentation. The Sam questionnaire was used in the second study in chapter 4, and is explained in detail in Section 2.3.8.1. The affect circumplex questionnaire (Section 2.3.4) is a shorter visual version of Sam questionnaire that was used in study 2 in Chapter 4. The reason to choose the affect circumplex visual tool for study 3 was because it illustrated only two dimensions of pleasure and arousal which study 2 revealed that most effective factors of emotion on creativity. In addition the 2-axis in affect circumplex questionnaire helped participants to understand the words easier and pick the emotion faster.

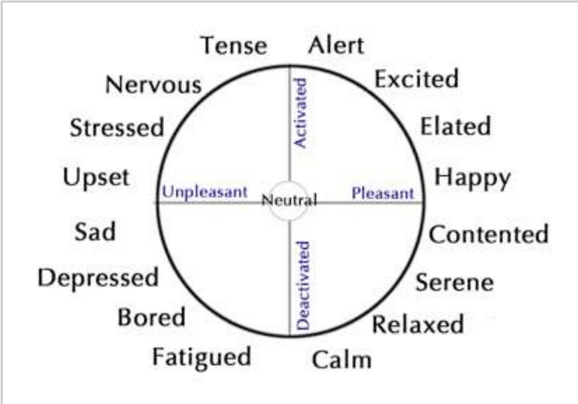


Figure 6.6. The Affect Circumflex tool used to collect evidence of participant primary emotions during the design task (Russel, 1980; Gorp&Adam, 2012)

In addition, at the end of the design task, each participant completed a simple one-page questionnaire to rate the design task experience using 1-7 Likert scales on: 1. performance – how *creative* and how *productive* s/he considered him or herself during the divergent task and the convergent task; 2. overall emotional stimulation –how emotionally stimulated s/he considered him or herself during each of the 2 tasks, and 3. specific emotional stimulation – how in control, relaxed, focused, joyous, motivated and stressed s/he considered him or herself during the divergent task and the convergent task. Finally, at the end of each study, a semi-structured interview was also considered with each participant to elicit qualitative feedback on the perceived differences and effects of the 2 creative spaces on the design task. Each session was video- and audio-recorded to enable data analysis. The overall study design and conditions are summarized in Table 6.1.

Aligned condition	Unaligned condition
Self-assess primary emotion	Self-assess primary emotion
Undertake divergent task in activated space for 12 minutes	Undertake divergent task in deactivated space for 12 minutes
Self-assess primary emotion	Self-assess primary emotion
Undertake convergent task in deactivated space for 12 minutes	Undertake convergent task in activated space for 12 minutes
Self-assess primary emotion	Self-assess primary emotion
Complete questionnaire	Complete questionnaire
Respond to semi-structured interview questions	Respond to semi-structured interview questions

Table 6.1. A summary of the 2-condition study - the designers in both conditions undertook the same design task using the same techniques in the same order, but in 2 different space configurations

To analyse data about participants' self-assessments of their emotions and levels of creativity, a repeated measure ANOVA with 2 independent variables was used– space and task type – and different dependent variables to show within-subject effects and between-subject effects based on the questionnaire ratings. These results, and the responses to the semi-structured interview questions, were used to investigate the validity of the 3 principles. In contrast, this study did not elicit creativity measures of the outcomes, i.e. the visual storyboards that described the outline redesigns because each was sketched rather than fully described, and difficult to assess objectively by domain experts.

6.4 Evaluation Results

All 41 participants completed the design task and produced one visual storyboard for the outpatient waiting service design. Examples of these visual storyboards are depicted in Figure 6.7. All 41 participants also recorded their primary emotion at the start and end of the diverge and converge tasks, rated predefined emotions for both tasks in the questionnaire, and responded to the questions asked in the semi-structured interviews.

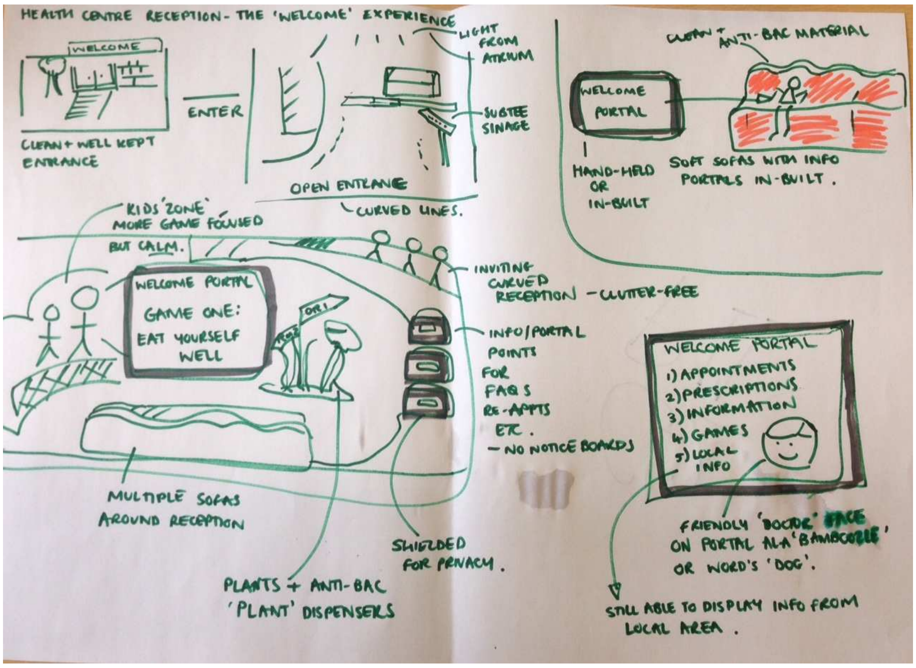


Figure 6.7. Two examples of visual storyboards produced by the participants for the design task

The average ratings of the levels of creativity and productivity, emotional stimulation and emotions reported by all participants in the aligned and unaligned conditions are shown in Table 6.2. Participants in both conditions reported being more creative and productive than not, more emotionally stimulated than not, more in control, relaxed, focused, joyous and motivated than not, more forgetful of the time and the surroundings during the task than not, as well as less stressed than more. These results suggest that the designers used the spaces in both conditions effectively during the design task.

Measure	Aligned condition	Unaligned condition
Creative	5.72	5.04
Productive	5.8	5.54
Stimulation level	5.65	4.88
In control	5.9	5.3
Relaxed	5.15	4.66
Focused	5.97	5.21
Joyous	5.42	4.88
Motivated	6.12	5.54
Forget time	5.42	4.83
Forget surrounding	5.17	4.21
Stressed	2.9	3.26

Table 6.2. Questionnaire means of Likert Scales from 1-7

Correlations between these emotion ratings with increased perceived creativity were investigated using a two-tail Pearson correlation. The perception of increased creativity in the design task correlated most significantly at p<0.01 with increased *forgetting time passing* in the *aligned* (r=0.413, p=0.07) and *unaligned* r=0.504, p=0.01) conditions, with increased joyfulness in the *aligned* (r=0.593, p<0.001) and *unaligned* (r=0.561, p<0.001) conditions, and increased emotional stimulation in both the *aligned* (x=0.625, p=0.001) and *unaligned* (r=0.447, p=0.003) conditions. All of these emotions are commonly associated with creative flow (Csikszentmihalyi, 1990), indicating that the participants in both conditions who reported evidence of flow also exhibited improved perceived creative performance.

The effect of the aligned and unaligned spaces on how participants perceived their creative performance during the design task was investigated using a repeated measure ANOVA 2 (spaces) x 2 (tasks) with participant self-ratings of creative performance reported in the post-task questionnaire as the dependent variable. Tests of between-subjects effects showed a significant difference between ratings made by participants in the aligned space (M=5.74, SD=.18) and unaligned space (M=5.02, SD=.20), $F(1, 39)$=7.70, p=.008, indicating that the participants considered themselves to be more creative in the aligned space than in the unaligned space. Means of the participant creative performance ratings for the divergent and convergent tasks in the aligned and unaligned conditions in Figure 6.8 revealed that designers who worked in the activated space during the divergent task rated themselves to be creative both than when they worked in the deactivated space during the convergent task, and than designers who worked in the activated space for the convergent task.

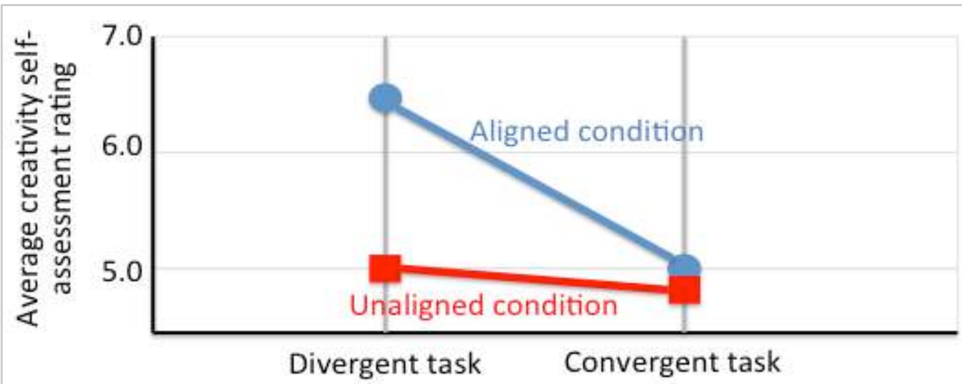


Figure 6.8. Creative performance rating means for participants in divergent and convergent tasks at aligned and unaligned spaces

Moreover, tests of within-subjects effects revealed a significant difference between the divergent (*M*= 5.72, *SD*= 0.20) and convergent (*M*= 5.04, *SD*= 0.20) tasks, *F* (1,39)=7.56, *p*=.009, indicating that participants in both conditions also considered themselves to be more creative during the divergent task than the convergent task.

The effect of use of the aligned and unaligned spaces on how participants perceived their emotional stimulation during the design task was also investigated using a repeated measure ANOVA 2 (spaces) x 2 (tasks) with participant self-ratings of stimulation reported in the post-task questionnaire as the dependent variable. Tests of within-subjects effects revealed no significant difference between the divergent task (*M*=5.31, *SD*=.20) and convergent task (*M*=5.21, *SD*=.21), *F*=. 121, *p*=.729. However, there was an interaction between space and task, *F*=16.61, *p*<.001: in the aligned space participant perceptions of their own stimulation levels decreased between the divergent task (*M*=6.30, *SD*=.30) and the convergent task (*M*=5.00, *SD*=.29), whereas in the unaligned space these perceptions increased between the divergent task (*M*=4.33 , *SD*=.28) and the convergent task (*M*=5.42, *SD*=.29). Means for the participant emotional stimulation ratings for the divergent and convergent tasks in the aligned and unaligned conditions are depicted visually in Figure 6.9.

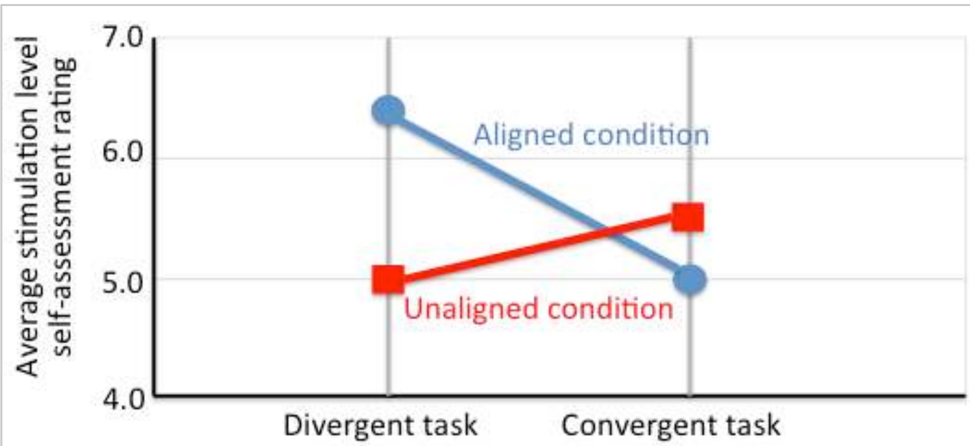


Figure 6.9. Emotional stimulation rating means for participants in divergent and convergent tasks at aligned and unaligned space

Moreover, during the divergent task, perceived stimulation levels were on average higher in the aligned space than in the unaligned space with a between-subject significant difference between the aligned space (*M*=5.65,

SD=.21) and unaligned space (M=4.88, SD=.20), $F(1, 39)=6.85$, p=.013. The results suggest that the participants were more stimulated in the activated space, but especially during the divergent task.

Further investigation showed that the effect of the aligned and unaligned conditions on the primary participant emotion with data collected from the Affect circumflex device. Results from all 41 participants are summarized in Table 6.3. The top row reports results for participants in the aligned space and the bottom row participants in the unaligned space. Most participants in the aligned space moved from a range of positive emotions with different levels of stimulation at the end of the divergent task – notably alert and calm – to more positive emotions at the end of the convergent task – alert, elated and happy, as well as contented. In contrast, the participants in the unaligned space moved from a wider range of positive and negative emotions such as tense and bored at the end of the divergent task, to more positive emotions such as contented, serene, relaxed and calm at the end of the convergent task. The result indicates that designers in the aligned condition reported different primary emotions to designers in the unaligned condition (Table 6.3)

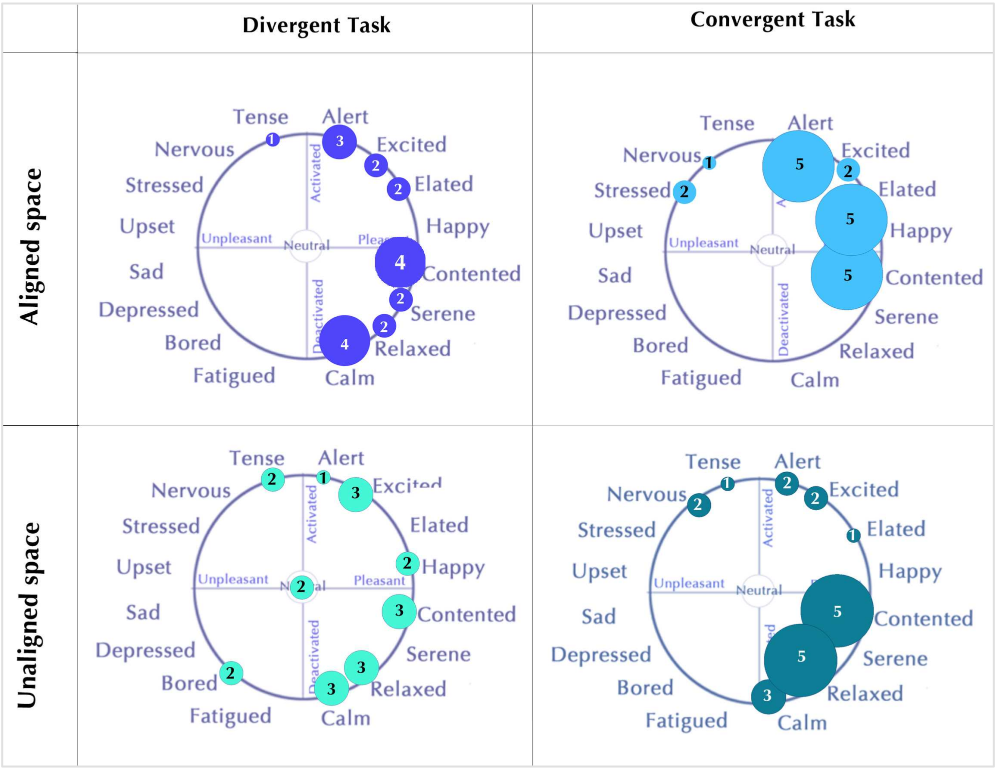


Table 6.3. Participants' emotions at the end of the divergent and convergent tasks in the aligned and unaligned spaces. Numbers in the circles indicate the total number of participants reporting the emotion

In addition the effect of the aligned and unaligned conditions was investigated on specific participant emotions rated in the post-task questionnaire using a repeated measure ANOVA 2 (spaces) x 2 (tasks) with different emotion dependent variables and indicates the emotional states that associate with creativity in the state of flow (Appendix 3.7). Results revealed no significant difference in reported levels of participant's *control*, *relaxation* and *joy* between the aligned and unaligned spaces or between the divergent and convergent tasks, but it did reveal significant between-subjects effects for *focus* and *motivation* - participants reported being more *focused* in the aligned space (M=5.97, SD=.21) than in the unaligned space (M=5.21, SD=.21) , F(1, 39)=6.41, p=.015 and *motivated* in the aligned space (M=6.12, SD=.19) than in the unaligned space (M=5.54, SD=.19) , F(1, 39)=4.31, p=.044.

Responses to the semi-structured interviews with each participant elicited individual designer perceptions of the spaces and how they affected the design task. When asked to identify the spaces that each preferred and enabled them to be more creative, the participants in the aligned and unaligned conditions provided different responses, see Table 3. Whereas most participants in the aligned condition preferred the activated space and found it to be more supportive of creative work, more participants in the unaligned condition both preferred the deactivated space and found it more supportive of creative work. This result would suggest that the activated space for convergent design activities – a space constructed out of alignment with design guideline– was neither preferred nor perceived to be as creative as the other space used for the design task.

Condition	Preferred space		Creative space	
	Activated	Deactivated	Activated	Deactivated
Aligned	18	2	17	2
Unaligned	8	13	7	14

Table 6.4. Totals of participant claims about their preferred space and the space considered most creative (note that 1 participant in the aligned condition was unable to decide the most creative space)

Participant responses to other interview questions provided tentative explanations for this preference. Many of the participants in the *aligned* condition who worked in the activated space for the divergent task reported calmness and flow, although some reported being distracted by the visual stimuli, whereas the same participants reported that the deactivated space for convergent thinking supported focus and concentration, see Table 6.5.

The activated space For divergent thinking	The deactivated space For convergent thinking
P3: “Helped me to relax. The consequence of that was second part that made me focused.”	P5: “I like quiet spaces to work. After relaxing in the first part it was motivational and concentrative.”
P15: “Stimulated and a bit distractive.”	P12: “Much easier to concentrate and loose myself in the task.”
P8: “Enjoyed it and create ideas. Less pressure.”	P22: “I made more connection between my ideas. It was perfect for the task.”
P31: “I felt in flow. First was a bit distractive but I was floating on that. Very inspiring and came up with some ideas in relation to what I saw in the pictures.”	P10: “Was good to focus. But I was more aware of the environment and felt frustrated.”
P27: “Warmed me up.”	P13: “Did not like it. Made me feel like exam pressure with the silent. Made me stressed a bit.”
P2: “More calm. I came up with more ideas.	P5: “Was stressful. I was involved in

Felt better."	the task. The perception of time was different compared to activated space."

Table 6.5. Selected semi-structured interview responses of participants in the aligned condition about the activated and deactivated spaces

In contrast, the participants in the unaligned condition who worked in the deactivated space for the divergent task reported little apart from becoming bored, and then reported negative emotions and unpleasant distractions in the activated space for convergent creative thinking, see Table 6.6.

The deactivated space For divergent thinking	**The activated space For convergent thinking**
P4: "It was Ok."	P15: "Interesting and different. Made me slow down. Changed my thought in a positive way."
P29: "Was Ok."	P27: "Liked it. I was taking a look on animation said nice and my mind coming back to it."
P12: "I do like it. But I prefer to have music."	P3: "It was distracting but I focused on the task and I was not aware of surrounding."
P1: "Too neutral. Boring not inspiring."	P36" Was too much and made me stressed. The pictures were attractive not inspiring. And make my attention out of the task."
P31: "Perfect."	P10: "Did not like it. Horrible especially some lights in animation."
P6: "I liked it but if it was more in time I became bored."	P7: "Distractive."

Table 6.6. Selected semi-structured interview responses of participants in the unaligned condition about the deactivated and activated spaces

Finally, the interview responses also indicated a preference for the audio stimuli in both conditions. Of the 20 participants in the aligned condition who worked in the activating space during the divergent task, all made an explicit statement and/or preference for the audio stimuli over the video, while only 4 reported that the video stimuli were distracting at the beginning of the design task. Prototypical comments about the audio stimuli included: "*Very relaxing, really enjoyed indeed*", "*Likes and prefers to have music (noise) when I work. It stirs up the environment*" and "*Calm and in some part intense. So it helps me to think about task. And it was different*". Prototypical comments about the visual stimuli included: "*Very good. Felt better. No distraction at all. Did not notice them exactly*", "*In the beginning was very abstract and distractive* *in a positive way*" and "*A bit distraction. First was bothering. But interesting*". Likewise, of the 21 participants in the unaligned condition who worked in the activated space during the convergent task, 20 made a positive comment about the audio stimuli while the other reported that s/he did notice the audio stimuli. However 12 of the same participants reported that the visual stimuli were either annoying and/or initially distracting to the task: "*Annoying. Distractive. Lost my focus*" and "*Hate it. Distracting and so annoying*", although this response was temporary for many: "*A little bit annoying. At first more distraction and then I focused in to the task*" and "*Was random and not distracting*". Moreover, some of these 21 participants reported only positive comments about the visual stimuli, for example: "*Very good. Some birds that flied made me distracted and stopped my brain for second and then I started again my ideas*" and "*I liked the visual in the background*".

6.5 Discussion

This study reports the development and evaluation of design guidelines related to the task environment (see Chapter 5) with which to inform the construction of changing design environments that can support divergent and convergent creative activities. The design guidelines of Chapter 5 were developed from a review of environmental factors and cognitive phenomena demonstrated previously to affect creative performance. A controlled study was then undertaken to validate the design guidelines in which designers undertook the same design task with divergent and convergent creativity techniques in environments constructed to align with and not to align with the principles. Results revealed that designers who worked in the environment that was constructed in alignment with the deign guidelines preferred an activated space with continues stimuli that animated with slow motion digital images and music for divergent creative work more than for convergent creative work, and reported that the environment increased both their creative thinking and emotional stimulation compared to the environment constructed not to align with the design guidelines. Therefore, the results provide empirical evidence not only to validate the design guidelines, but also to understand better the roles of motivation, external constant stimuli and emotional stimulation in creative design work. In the remainder of this research, some of these roles are classified.

Designers in the environment constructed in alignment with the design guidelines reported being more motivated and more focused than did designers in the other environment. We conjecture that one reason for these designers to have been more focused was related to deactivated space, in which the lack of external stimuli during the convergent task enabled the designers to focus their attention during it and complete it to their satisfaction. This contrasts with the other space in which the stimuli provided continuously during the convergent task divided their attention and reduced their motivation for the convergent task (Gorp & Adam, 2012). The result would suggest a possible causal association that increased attention focus increases motivation to complete the task. The result provides evidence and additional rationale for deactivated space supported the convergent task in line with H3.

The designers also reported different reactions to the external stimuli in the activated space, depending on whether the space was used for the divergent or the convergent creative activities. Many who received the external stimuli during the convergent task found it distracting and stressful, in part perhaps because the stimuli divided their attention needed to complete the design task, and made it difficult to maintain attention focus. In contrast, the designers who worked in the space for the divergent task reported enjoyment of the stimuli, and appeared more comfortable with divided attention, shifting it quickly from task to stimuli and back again to the divergent creative work. Indeed, this more effective attention shifting might be one reason for the designers in the environment constructed in alignment with the design guidelines to have considered themselves to have been more creative, providing further support for design guidelines of task environment and H2.

Moreover, most of the designers in both experimental conditions expressed a preference for the audio over the visual stimuli to support their creativity in the activated space. Most forms of design work are predominantly visual, and our request to produce visual storyboards of an outline service redesign task that we consider typical of design work. Therefore, one possible explanation for this result is that further visual stimuli sometimes divided designer attention focus (Wickens et al., 1997), whereas the audio stimuli played in a defined decibel range (60-70 db.) more effectively influenced their emotions during the design task. This result suggests that some refinement of the H2 is possible to adapt the external stimuli according to the form of design work being undertaken by the designer.

Another unexpected result was the recorded primary emotions of the designers in both conditions after the divergent and convergent creative activities. Designers in the environment constructed in alignment with design guidelines reported less aroused emotions such as alert and calm at the end of the divergent task in the activated space rather than more aroused emotions such as elated and happy, indicating that the designers were less stimulated than predicted after receiving the visual and audio stimuli. Conversely, the same designers reported more aroused emotions such as alert and elated at the end of the convergent task that was undertaken without the external stimuli, even though most of these designers stated a preference for creative work in the activated space. The result suggests that the activated space in the experiment might have led to only moderate levels of emotional stimulation during and immediately after the divergent task, but designers' emotions increased further at the end of the design task in the less stimulating deactivating space, perhaps because the design task had more completed satisfactorily. It indicates that the relationship between designers' emotions and space is more complex than the design guidelines indicate, requiring some refinement of H1. Designer emotions appear to be, in part, determined by their success or otherwise in completing the design task to their own satisfaction. Results from the other experimental condition support this conclusion. The designers reported less aroused emotions such as serene, relaxed and calm at the end of the convergent task, after undertaking this task in the activated space that many found to be distracting.

Of course, these conclusions are subject to different threats to their validity, some of which are reviewed here. The most obvious threat is to the external validity of the results in the form of conditions that limit our ability to generalize results of the study more widely (Wohlin et al., 2000). The research reports a single study to solve a single design task with one pair of creativity techniques selected to support a diverge-converge creative process undertaken by relatively inexperienced designers. Wider claims for other creative processes can be taken with different types of creativity techniques, design task and experienced designer in different field. In order to mitigate this risk, other researchers require to implement and experiment different design gridlines to create the environments with the aim of improving design performance. Threats to the study's internal validity were the influences that could have affected independent variables related to causality, and of course, the limits of the size of space and environment that might have affected designer emotions and creative performance during the task. However, to mitigate the risk, the 4x4m space was selected because it was typical of a designer's space within a wider interaction design lab environment. Moreover, it remained constant during both conditions of the experiment, and appears not to have influenced results.

In summary the three hypotheses tested in the experiment, had different results. Hypothesis 1, the high-activated environment can positively affect the creative performance was partly proven (Study 3). Not all types of high-activated environment suit with all types of creative tasks. It also affected by people's interest. Hypothesis 2, if the environment triggers high-activated emotion, theses emotions will in turn affect the creative performance, was proven (Study 3). The stimuli based on design guidelines created the high-activated environment that associated to higher creativity. Hypothesis 3, low activated environment creates a different set of low emotional arousal that has a positive effect on convergent task, was proven because convergent task needs higher focus and no distraction (Study 3).

To conclude, the experimental results provide evidence both to validate the design guidelines for the task environment and to evolve the design guidelines to provide better future prescriptive guidance to construct environments that change with designer's activities in order to support their creativity more effectively. The study limited the design guidelines to the guidelines that influence a designer's digital environment rather than a physical one (for example to provide external views of the natural environment) in order to inform the construction of new forms of environment that can use digital technologies to change with the designer's work.

7 Discussion

7.1 Introduction

This doctorates thesis presents a new framework that describes the relationships between the work environment, emotion and creativity. In the previous chapters, the thesis reports related literature and empirical studies in order to investigate new design guidelines and develop a definition of creative press (environment) as part of a CSE framework. The research proposes the links between creative performance of designers and their emotional states in different environments and different type of creativity tasks. The CSE framework suggests a novel approach in the creativity discipline to support creative thinking in design environments.

In this final chapter, the thesis discusses how creative environments can be applied in design organisations. It defines the potential value of the CSE framework and design guidelines to design organisations, and where it might fit within the strategies of the organisations to improve their creative outputs. The researches explored the emerging need for creativity support to be applied more widely in design studios, design academies, and other commercial and industrial organisations. This chapter discusses how the framework for the creative environment might move beyond a theoretical framework into helpful practical attitude by following the design guidelines to benefit both designers and organisations.

The research presented in this thesis has examined the influence that the environment of the workspace has on the creativity of designers while they experience different emotions when undertaking a design task, based on data collected from observations, interviews and empirical studies.

7.2 Why the research matters

This research has significant potential to make a positive influence on people's workspace and well being in two main ways. The first way is to evolve the work environments of designers and architects. The second is though designer that works in these design studios and spaces. The level of creativity in designers has the possibility to increase, by supporting designers' emotions through the process of creative design. Evidence has shown that when organisations support individual and group designers through workspace conditions, creativity in designers is enhanced and leads to higher creative output and performance in the organizations and groups (McCoy, 2005).

People in work environments are often not consciously aware of the effect of environment on their mood and creative performance (Williams, 2013). The question is how this relationship between environment, emotion and creativity can be defined, and how people become more aware of this affect to make useful changes in their own environment, as well as how to create the new workspaces by applying these conceptual relationships between these 3 concepts.

Recently, companies such as Google, Facebook, Lego and Pixar have evolved their understanding of the need for change in everyday workspaces. Those organisations have experienced that adapting the environment design can enhance creativity both individually and in groups to benefit both the people that work there, and the company's creative outputs. However, these company workspaces have been designed without a theoretical framework (Moultrie et al., 2007), and are a mixture of physical and psychological press (Chapter 3), such as play (Meyers et al., 2007) or reflection and communication (Groves, 2010). In contrast, this research, considered emotion to be a key to enhance creative thinking in environments. It has the potential to improve emotions that link to creativity by designing specific workspaces that enable designers to boost their creative capability. A design environment should support the specific emotions at each stage of divergent and convergent thinking needed to improve the creative results in each design task.

It could be argued that positive manipulation in designers' emotions by applying different design guidelines and stimuli in the environment, specifically to enhance creativity, is enough for changing the workspaces to be more creative. But environment on its own is not enough, and the effect is not permanent; the creative environment (press) requires a dynamic changing potential to support different types of task and creative activity for different people. Spatial and task environment are the key concepts to improve such spaces based on the type of creative task.

This thesis, therefore, provides both research-based theories and comprehensive design guidelines for the environment that enables designers and architects to design for optimal creative performance over time, based on different types of tasks in the workspaces. It also enables people that work in the design environment to optimise their creative potential by being in the right environment to achieve the goal of the specific tasks. The interactive CSE framework of environment, emotion and creativity posits that people can make their choices and changes in terms of the both their surrounding and their task environment, and the emotions needed to accomplish the tasks that make a valuable difference in how they perform and the final creative output.

7.3 Empirical and theoretical findings

This section will synthesize the empirical findings to answer the study's three main research questions:

7.3.1 Research question 1

How can an environment affect on designers' creativity by influencing their emotional states in a creative design work?

To answer the first research question the theoretical CSE framework reported in Chapter 3 revealed that a design environment with the right types and amount of stimuli could change people's emotions, to enhance their creative thinking. The results of the first empirical study to examine the initial CSE framework and relationship between environment (physical press), climate (psychological press) and creativity, showed that positive environment had a greater effect on the creative climate, however this effect is short-lived. The results also revealed that the changing in the environment by using different creativity techniques could change the creative climate. The notable point was that the *task* environment became more effective than the *spatial* environment over time. The type of stimuli and the times that stimuli are applied in the environment play a key role to answer the first research question that the relationship between environment, emotion and creativity is not a simple one-way influence, but might be the consequence of unexpected stimuli and interactions between people in the group that also can affect the emotions people experience in the environment.

7.3.2 Research question 2

What kind of emotional states can enhance creativity in a creative design work particularly during the divergent and convergent stages?

Results from the study reported in section 4.2 revealed that environment with high or low stimulation had different impacts on emotion. In divergent tasks, emotional arousal has been increased steadily during the task in environment with lower stimuli. In contrast, in the environment with high stimuli designers' emotional arousal dropped over the time. It is important to note that although the environment influenced emotions, yet the effect of environment on creativity outcomes did not show significant impact. One reason may be that stimuli from the environment had a shorter time effect, and when designer's engagement in the task improves over time, then the effect of spatial environment decrease. Therefore, one implication is that needs to provide continuous stimuli during the task.

Consistent with this finding is the cognitive mechanism in a creative process theorized by Gabora (2010) based on memory patterns. Gabora suggested that creativity is a back and forth process analysing and associates information and thoughts. Higher activation triggers more memory recall that improves divergent thinking. This is in line with Mendelsohn (1976), who reported defocused attention with perceiving more stimuli is associated to divergent creativity, while in contrast, focused attention triggers by lower activation is associated with convergent thinking.

Moreover, the refined CSE framework (Chapter 5) suggested a new approach to this research in terms of higher and lower level of emotional arousal associated with the type of creativity task. Higher arousal is key potential to enhance divergent thinking in a creative process leading to higher originality and flexibility. Therefore, environments implemented with more stimuli that increase emotional arousal to cause defocused attention in designers, leading to higher creative performance. In contrast, convergent thinking needs focused attention with lower arousal that could be designed with simplicity in the environment, in order to improve concentration on the task.

Although many researchers have pointed to the effect of positive emotions on divergent creativity that links with information gathering (Gasper & Zawadzki, 2012), problem finding (Chen et al., 2014), flexibility (Isen, 2002), higher originality (De Rooij, 2014), and higher fluency (Bass et al., 2012), this research is new in that it explores the effect of emotions in other dimension of emotion such as emotional arousal that is recently considers as a key dimension of emotion that link to creativity (De Dreu et al., 2008) and environment.

7.3.3 Research question 3

How can be an environment implemented during the different stages of a creativity design work (in divergent and convergent thinking) to manipulate designers' emotions, with the aim to enhance designers' creativity?

The results of study reported in section 4.2 showed the significant effects of an environment on designer's emotional states such as pleasure, arousal and control. Designers experienced different levels of emotional arousal in low-activated and high-activated environments. High-activated environment lead to higher arousal whereas the low-activated environment was associated with lower level of emotional arousal, however over time the effect of environment diminished. Furthermore, due to the type of creative activity (divergent and convergent), in the divergent task the effect of environment on the creative outcome showed higher number of ideas in high-activated environment, while in the convergent task the effects of environment on creativity outcomes were not significant (Chapter 4).

In addition, the study reported in Chapter 6 aimed to uncover the impact of higher and lower stimulated environments on emotional arousal that could support different types of creative thinking in different stages of a creative design work. The results showed task-environment design guidelines helped the construction of changing design environments that can support divergent and convergent creative activities. Designers in such environments reported being more motivated and more focused. The lack of external stimuli during the convergent task enabled the designers to focus their attention during it and complete it to their satisfaction. The result would suggest a possible causal association that increased focused attention increases motivation to complete the task.

Results also revealed that designers preferred an activated space animated with digital images and music for divergent creative work more than for convergent creative work, and reported that the environment increased both their creative thinking and emotional stimulation compared to the environment constructed without implementing design guidelines. Therefore, the empirical evidence not only validates the CSE framework, but also indicates the roles of motivation, external stimuli and emotional stimulation in creative design work. Many who received the external stimuli during the convergent task found it distracting and stressful, in part perhaps because the stimuli divided their attention needed to complete the design task, and made it difficult to maintain focused attention. In contrast, the designers who worked in the space for the divergent task reported enjoyment of the stimuli, and appeared more comfortable with divided attention, shifting it quickly from task to stimuli and back again to the divergent creative work. Indeed, this more effective attention shifting might be one reason for the designers in the environment constructed with design guidelines considered themselves to have been more creative. It is in line with a recent study reported by Vila-Parrish et al (2015) that revealed that rapid switch between tasks makes people more creative in divergent thinking and they produce more original and flexible ideas. In contrast, forcing people to switch between tasks make them more productive in convergent problem solving which demands higher focused attention. Therefore, the environments need to adjust with the type of tasks and the stage of design.

7.4 Contributions to theoretical and practical knowledge

The primary contributions of this research are the theoretical framework and the practical design guidelines in design environment. The research results contribute to several areas in the creativity and design science and environmental psychology. The research was undertaken to fill the gap in the research to understand the relationship between 3 main areas of knowledge, environment, emotion and creativity. The possible contributions to these different research areas are discussed in the following sections.

First of all, this thesis provides a new understanding of the effects of the environment on emotions that lead effective creative thinking. A creative process that is divided into early idea generation and late idea evaluation in the divergent and convergent stages of design can be influenced by specific environments to enhance creative outcomes by manipulating designers' emotional states. During divergent creativity tasks, an environment can encourage divergent creative activities to challenge environment boundaries and assumptions. The design guidelines support the divergent characteristics such as generating more ideas with higher flexibility and originality. During later design work, the environment can support convergent creative thinking, for example, by focusing attention and concentration on the task to enable designers to be more productive in their creative outcomes. The new CSE framework draws on theories about the links between creativity and emotions to drive further support for the environmental design by creating design guidelines that could be implemented in the workplace. Therefore, this thesis contributes at least 4 forms of knowledge:

7.4.1 The theoretical CSE framework to investigate the relationship between environment, emotion and creativity

This research offers a novel conceptual framework of creativity support environment that explores the relationship between the environment and creativity for designers mediated by (1) emotional states (high and low arousal); (2) the creative design task (divergent and convergent thinking) and (3) the workspace (spatial and task environment). The framework contributes a novel approach to the link between environment, emotion and creativity in order to fill a gap identified in literature review. It can enable designers to use their creative capability better by modifying designer's emotions that are triggered by environments. Previous research explored the effects of emotion on creativity and revealed positive emotions could enhance creativity (Baas et al., 2012). This research is novel in that it extends the research to design tasks.

Moreover, the link between emotion and creativity has been studied in the relationship between emotional arousal and higher creative originality, fluency and flexibility (George & Zhou, 2007; De Dreu et al., 2008). My research is novel because it investigates the same link, but in terms of the physical features of a design environment during a design task. The contribution of this research could be extended by using these theories of the link between emotion and creativity, to make the spaces that cause such emotions for designers to improve creative performance. For example, according to Sas & Zhang (2010), an effective creative design process involves high arousal and positive valence emotions in all stages of Wallace model. According to the CSE framework, a design environment should have features to provide emotions that are positive and activated in order to enhance designer's creativity.

7.4.2 Design environment to enhance creativity

Workspace design is a new trend in large companies, to create workspaces that encourage and retain people to work in the company. The model of environments presented in this thesis has the aim of describing how to achieve higher creativity outcomes through the workspace design. Contributions to the environment that aim to enhance creativity require developing a creative, positive, activated and motivated environments for people to work in (Chronopoulou & Riga, 2012). For example, Williams (2013) suggested a grammar for workplaces with introducing 3 elements of place, properties and affordances to create spaces to identify and codify the elements of physical workspaces that stimulate people's creativity. This thesis also contributes a new approach to present the design suggestions to enhance creativity in workspaces. However, for such spaces, there needs more experimental research to collect the evidence for the effectiveness of the new guidelines.

The proposed approach is novel to the extent that it guides architects and interior designers to better understand the elements of the environment that enhance creativity by using the design guidelines. Furthermore, these design guidelines could be expanded beyond the focus of this research - designers in specific spaces for divergent and convergent thinking- into the broader view of ordinary people without the specific creative skills in the spaces that use for different types of activities to enhance their creative potential. It implies that any environment could be designed to help ordinary people to enhance their own creative capabilities. The results of this future research in an education context could be applied to create specific places to encourage creative behaviour in students in learning spaces.

7.4.3 Design environment that influence emotion

The results of this multidisciplinary research can be explained in different areas of practical science associated with the proposed CSE framework. The framework and design guidelines of new environments that affect on emotions to enhance creativity present the novel applications of environments in different fields of design and creativity. In line with Petermans & Pohlmeyer (2012), the space could influence satisfaction and happiness in people to change their behaviours. The design guidelines can contribute to environmental psychology, in order to create the specific high-stimulated or low-stimulated environments to increase or decrease the level of emotional arousal in designers that leads to different types of creativity. The proposed design guidelines are a novel approach to design and research in using sensory input such as visual and audio stimuli in the environment to create the specific emotions to enhance creativity. For example, one application to implement and expand the guidelines is to use the emotions such as playfulness, happiness and excitement to create the space of the creative process more fun (LIoyd, 2013) or to implement reward theory in the space (Koster et al., 2013).

7.4.4 Design environment that support creativity processes

A creative process can be improved by using the right environment at each stage of the creative process. It happens by engaging designers in the process in a specific environment. For example, idea generation processes can improve by being in the motivating and encouraging environment and by using useful artefacts to provide inspiration. Williams (2013), in her grammar of workplaces, reported, "If people want to engage in a creative behaviour, then they need a supportive physical space in which to do so." Creative thinking in divergent and convergent activities is such creative behaviours, and need to be understood and supported by the top level of design organisations and companies, in order to apply the appropriate solutions for changes in the work environment and creative processes at work for getting the optimum creative results and outcomes. The critical challenge to the use of the theoretical CSE framework in the 'real world' should be the recognizing and supporting the type of creative activity in an environment, and linking each type of task to the related emotional states and creative behaviours in it.

The application of the CSE framework could go beyond the divergent and convergent creativite processes, into other creative processes such as Wallas model of creativity including 4 stages of distinct preparation, incubation, illumination and verification (Lubart, 2001). An environment might be designed by implementing new design guidelines and specific stimuli to support each of these stages of creative thinking based on their characteristic.

For example, in the incubation stage, designers need to become a relaxed in order to rest from the problem and to let the unconscious mind work. The interruption of concentrated effort helps them to solve the problem creatively. Therefore, a specific design environment for an incubation stage can help to facilitate this process by creating the emotions that such spaces provide.

7.5 Test of Validity

The conclusions from this research have a number of restrictions on the validity. The first is the external validity of these results applied to all types of creative tasks in all types of environments for all types of designers. The threat of the results in the form of conditions as an external validity, limited the results of the research to be generalised in wider scope (Wohlin et al, 2000). This research reports 3 different studies that each aimed to solve a single design task with one pair of creativity techniques selected to support a diverge-converge creative process undertaken by relatively inexperienced designers. The study was limited to some specific design task, creativity techniques and designers within a consistent approach. Before making wider claims, it needs the same approach to repeat the empirical studies in other creative processes, combinations of creativity techniques, forms and lengths of design task and levels of designer experience, to see if the emerging guidelines are still valid in a broader context.

Therefore, in order to reduce the risk of generalising on the basis of the reported studies alone, other researchers and designers should implement and experiment with these design guidelines and the CSE framework, in order to develop and evaluate environments with which to seek to improve design performance.

Practical issues that affected the ability to draw correct conclusions about the relations between the treatments, i.e. the activated and deactivated spaces and outcomes reported by the designers, generated threats to conclusion validity. Such issues as the experimental method depending on designers self-reporting their emotions accurately. Thus one validity threat is that the reported designer emotions were influenced by other factors associated with the experimental design, such as completion of the task within the time period.

As for the studies' internal validity, there were influences that could have affected independent variables related to causality: e.g. designers' personal interests; the environment in which the designers undertook the design task. However, to mitigate the risk, the environment remained constant for each study during different conditions of the experiment, and appears not to have influenced results.

7.6 Suggestions for future work

This is a theoretical-empirical thesis, founded in the study of different domains of knowledge in the existing literature review to explore the relationship between environment, emotion and creativity in design activity and researched in observation, suggesting the framework, proposing design guidelines and testing them through empirical studies by designing the compatible environment. There was the strong new link between theory and experimental study that has been investigated in the previous chapters, in the development of the CSE framework and design guidelines of the creative design environment to fill the gap of research in the previous related knowledge and investigate the future of this research area.

There are three main areas suggested for the future evaluation of this research into the CSE framework and the new design guidelines that could be followed by researchers in different fields.

7.6.1 Type of task

Firstly, the CSE framework and design guidelines could be extended beyond their qualitative structure in terms of different creative tasks in creativity science and design field. The research applies the new CSE framework to develop spaces that can be applied for different type of tasks. For example divergent tasks, convergent tasks, individual tasks and collaborative tasks require different levels of focused and defocused attention (Gabora, 2010), lower or higher emotional arousal (Carsten et al, 2008) and lower or higher control. From these theoretical findings, new research can be applied to evolve the practical design guidelines to design spaces in a way to support creative thinking of designers in different types of creative task, further research for all people in different types of activities.

7.6.2 Type of environment: task or spatial environments

The type of environments that applied in the CSE framework were divided to two types: spatial and task environments. The effective environment needs to match tasks in different types of thinking. Some tasks need higher level of focused attention and some tasks needs to involve higher level of defocused attention, with more information in the space. Because the effect of environments was shown to decrease over time, further research of both the task and spatial environments could be expanded apply continuous or sudden stimuli over time to sustain the engagement of designers and keep them in the state of flow and creativity. Task environments can be studied as a personalized workspace for individual designers to enhance creativity. With regards to different likes and dislikes of individual designers, personalised people's environments based on their interests and personalities might influence on their emotions. Other research could therefore focus on the spatial environment to make it flexible and easy to change depends on the type of activity according to the style of creative thinking for individual or group creative works.

Moreover, this research was only evaluated in a university interaction lab and some classrooms in the university. Environments were designed according to the specific needs of the study to make positive versus negative spaces and high- activated versus low-activated spaces. Further research could apply the CSE framework to investigate the difference in built spaces that already contain emotional climate such as offices, cafes, museums, parks and green spaces and trains, which include different natural stimuli for different types of creative thinking in divergent and convergent activities.

7.6.3 Type of stimuli based on 5 human senses

How stimuli interact in the creative process and change designers' emotions to increase creativity was a critical element of this research. The sensory inputs reported in Chapter 3 sensed through the human 5 senses could affect emotions and creativity. In this research the focus was on the visual and audio stimuli. However, further research could be undertaken to study other senses such as taste, smell and touch. There is currently a lack of empirical research to identify effects of such stimulus in the environment on creative thinking. Audio stimuli are very affective stimuli to study because it is the continuous stimuli over time that may create focused attention or defocused attention with highest variety. There are also different types of music that induce different emotions. The research revealed the positive effect of music on work performance because listening to music creates positive mood and enhanced perception of design while people working (Lesiuk, 2014). Further research can be undertaken to explore the environments that provide personalized music for people in different type of tasks and creative thinking activity with their own choices. It is important to note that my interest for future research also would be studying the link between creativity and other types of stimuli in the spaces. For example, different scents are strong stimuli to create specific emotions that lead to higher or lower creativity, and the environment could implement scent to regulate emotions that linked to creative thinking.

7.7 Conclusion

To conclude, the experimental results reported in this thesis provide new evidence both to validate the CSE framework and to evolve the design guidelines to provide better future prescriptive guidance to construct environments that change with designer's activities in order to support their creativity more effectively. The research chose to limit the design guidelines in spatial and task environment separately, that influence a designer's task environment or a physical surrounding environment, in order to inform the construction of new forms of environment that can use either spatial or task environment with digital technologies to change with the designer's work.

This research presented the first steps towards the development of the environment with use of the possible association between emotion and creativity, to help control the emotions that enhance creativity in designers. Future research can extend the applicability of the original framework and implement refined guidelines in design organizations and education systems to free people's potential creativity in any form.

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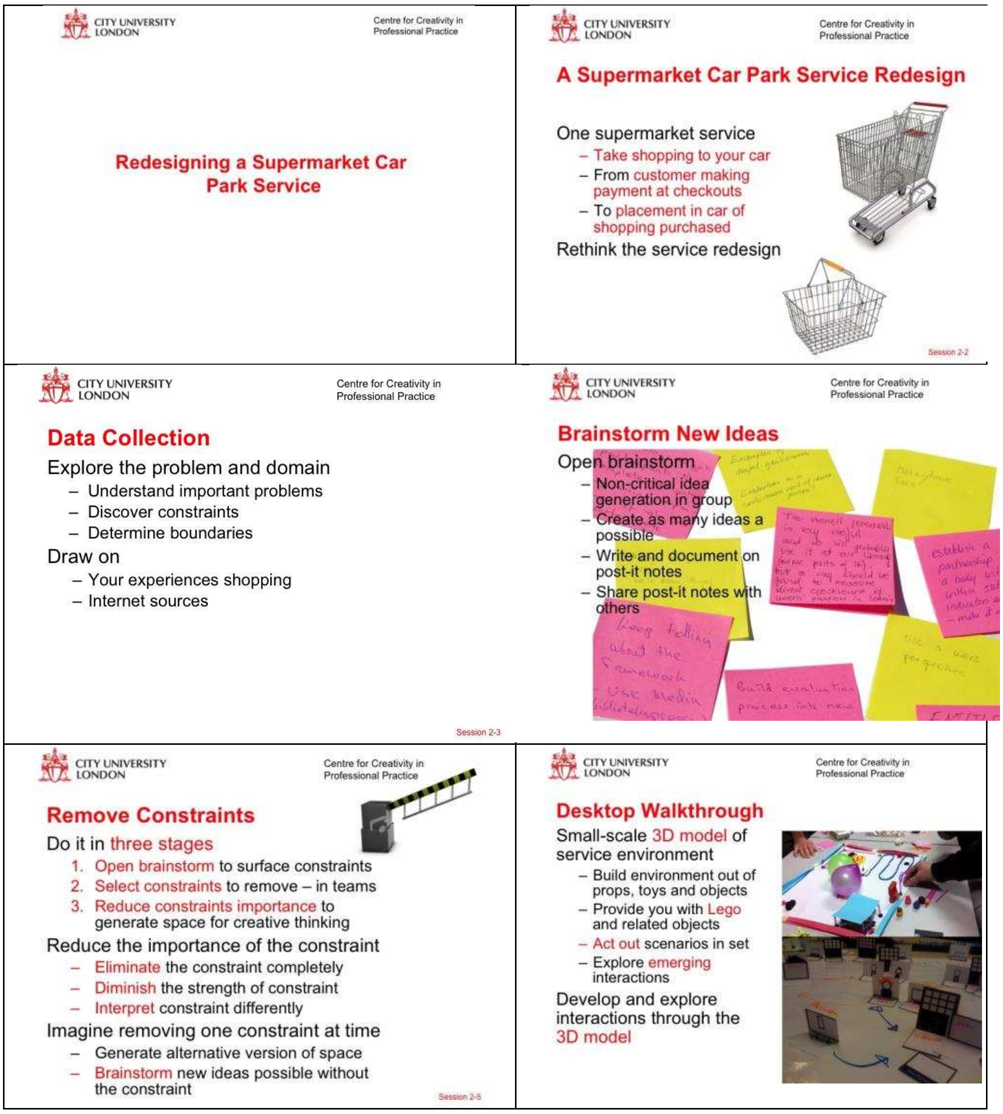
Appendix

Table of Contents

1 Appendix A: Study 1

1.1 Design task



1.2 Result of the creativity design in group

1.2.1 Negative space

1.2.2 Positive space

2 Appendix B: Study 2

2.1 Design task

Design Task: **Designing an experience for a restaurant that encourages social collaboration whilst remaining a pleasant eating experience (by considering economic, sustainable and inclusive constraints)**

1. Brainstorming, 15 min create as many as ideas you can without attention to constraints.

2. Storyboarding the best ideas 15 min with considering the constraints mentioned in the task.

2.2 Participant information sheet

CITY UNIVERSITY LONDON

HCID Department
Centre of creativity in professional practice

Participant Information Sheet (PIS)

Title of Study: ***Creative design experience in different environment***

Mobina Nouri [redacted]

We would like to invite you to take part in a research study. Before you decide whether you would like to take part it is important that you understand why the research is being done and what it would involve for you. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

What is the purpose of the study?
Creative thinking is a critical activity in design work, and it can be influenced by the climate of a space that designers work in, either individually or in groups. Designers experience different emotions during creative design processes, and these emotions can influence their levels of both creativity and productivity, so modifying the environments in which design work is done can impact on creative design outcomes. We aims to have an empirical research that investigates associations between environment, emotion and creative design work undertaken using different creativity and design techniques. This study is part of my PhD research and it will take 1 hour to do a simple design task.

Why have I been invited?
This study invites people with some design expertise. The domain is not important - your design skills can be in software design, product design, service domain or other disciplines To be eligible for this study you must Have design knowledge, be between 21 and 35 years of age, not suffer from any serious medical condition such as cancer or heart disease, and not be taking any medication.

Do I have to take part?
We do hope you will be to find the time to help us, but it is up to you to decide whether or not to take part. If you do decide to take part you will be asked to sign a consent form.
Your participation is completely voluntary and you can withdraw at any stage, or avoid answering questions which are felt to be too personal or intrusive, and an assurance that this will not affect any future treatment (where applicable) or penalized if they choose to withdraw. Taking part in the research will not affect your grades.

What will happen if I take part?

If you would like to take part, then you will need to come to our place in City University London on one session. We explain the study to you in more detail and you will have the opportunity to ask any questions that you may have. We will also ask you to sign a consent form saying that you agree to take part, a copy of which will be given to you to keep for your own records. Providing you are happy to proceed, we will then ask you to complete a short questionnaire about your emotions being in that space. You will do a design task while video recording. Also you wear a wrist band (Q-band) to measuring your electrodermal activity. Then after 30 min we finish the task and we will watch the video record with you and ask some question about how you are feeling while doing the task. At the end you complete a short questionnaire.

Expenses and Payments (if applicable)
You will get 10 Amazon vouchers for 1 hour of your time. This is part of PhD study and supported by HCID department of City University London.

What are the possible disadvantages and risks of taking part?
There is not any risk or disadvantages

What are the possible benefits of taking part?
We do not expect that you will experience any direct benefits from taking part in this study. However, we do hope that our results will tell us a lot about how designer feel and act in various spaces. It could benefit future design education and design society and contributing to knowledge is really valuable.

What will happen when the research study stops?
All the information that is collected about you during the course of the research will be kept strictly confidential. Nobody from outside the research team will be allowed access to any information that might identify you.

Will my taking part in the study be kept confidential?
All the information that is collected about you during the course of the research will be kept strictly confidential. Nobody from outside the research team will be allowed access to any information that might identify you.

What will happen to results of the research study?
We intend to send a summary of the findings to everybody who participates in the research. We also hope to publish the results in a Creativity and design journal.

The University complaints clause:
Participants can complain about the study if they don't like something about it. Please include the following text in your explanatory letter:

If you would like to complain about any aspect of the study, City University London has established a complaints procedure via the Secretary to Senate Research Ethics Committee. To complain about the study, you need to phone [redacted]. You can then ask to speak to the Secretary to Senate Research Ethics Committee and inform them that the name of the project is:
Creative design experience in different environment

You could also write to the Secretary at:
Anna Ramberg
Secretary to Senate Research Ethics Committee
Research Office, E214
City University London
Northampton Square
London

EC1V 0HB
Email: [redacted]

2.3 Expert form for rating creative design results

CITY UNIVERSITY LONDON

HCID Department
Centre of creativity in professional practice

Dear Restaurant Specialist,

Thank you very much for participating in this study.

I am a third-year doctoral student at City University London in the Centre for Creativity in Professional Practice. I research how we can use different environment to foster creativity through people's emotional states.

As part of this research, designers from different sectors have been asked to develop a design for a new restaurant service within a limited time period. We are now seeking people with experience of restaurant design to view and provide a simple rating on each restaurant service design, expressed as a storyboard.

This activity will take about 45-60min of your time. On the pages ahead, you will be asked to rate the ideas produced.

Please follow the instructions on the next page. Return this form when you complete it to my email address given below. Also, if you have any further questions or feedback to share, please do not hesitate to contact me:

Mobina Nouri
Email: [redacted]
Mobile: [redacted]
Office: [redacted]
City University London

www.creativity.city.ac.uk

2.4 Consent form

CITY UNIVERSITY LONDON

HCID Department
Centre of creativity in professional practice

Title of Study: ***Creative design experience in different environment***

I volunteer to participate in a research project conducted by Mobina Nouri as part of PhD study. I understand that the project is designed to gather information about academic work. I will be one of approximately 30 people being applied for this research.

1. I agree to take part in the above City University London research project. I have had the project explained to me, and I have read the participant information sheet, which I may keep for my records.

   I understand this will involve
   - Allow the interview to be videotaped/audiotaped
   - Complete questionnaires asking me about my emotions
   - Make myself available for a further questionnaire should that be required
   - Wear a wrist band (Q-band) to measuring my electrodermal activity

2. This information will be held and processed for the following purpose(s):
   I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be published. The identifiable data will not be shared with any other organisation.
   I consent to the videotapes being shown to other researchers and interested professionals and I consent to the use of sections of the videotapes in publications.

3. I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalized or disadvantaged in any way.

4. I agree to City University London recording and processing this information about me. I understand that this information will be used only for the purpose(s) set out in this statement and my consent is conditional on the University complying with its duties and obligations under the Data Protection Act 1998.

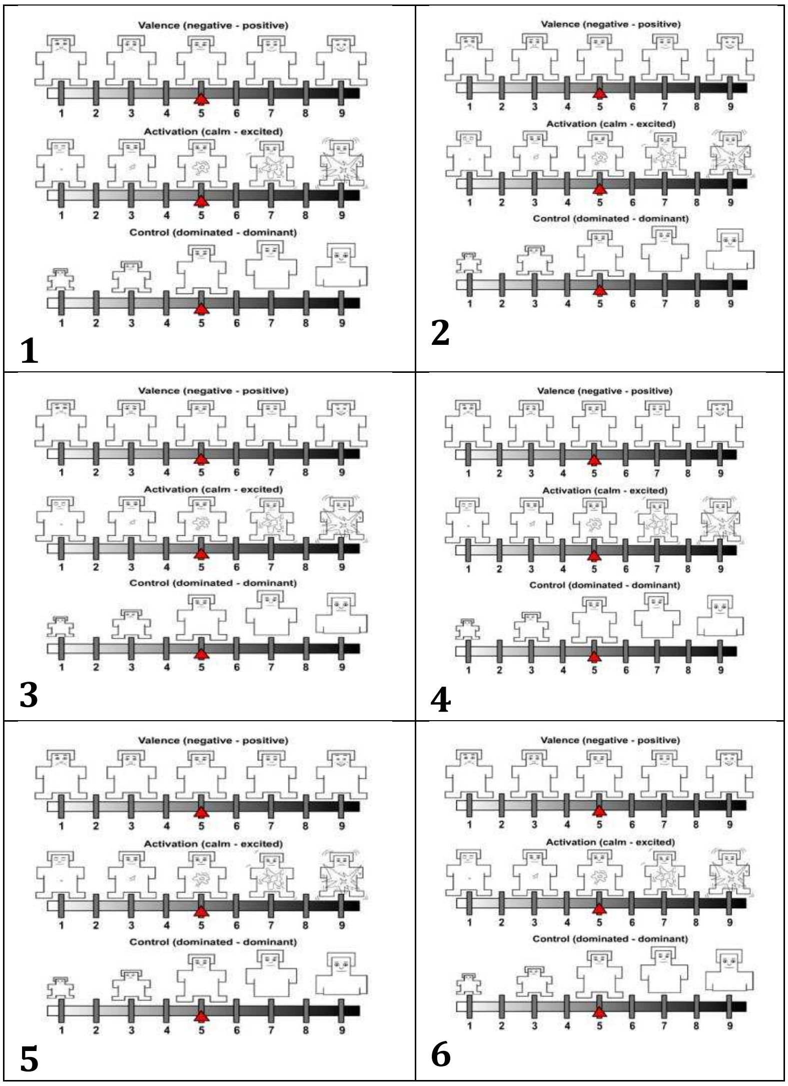
5. I agree to take part in the above study.

____________________ ____________________________ _____________

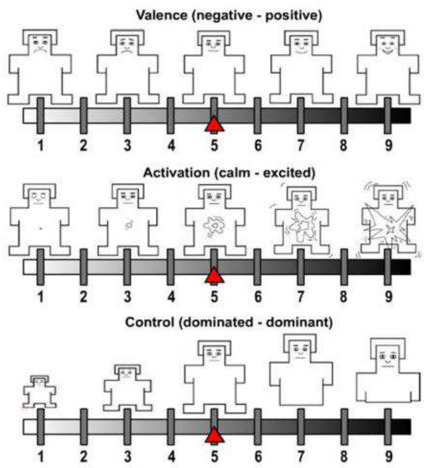
Name of Participant Signature Date

If you have any question about this study please contact Mobina Nouri by Phone: [redacted] or Email [redacted] or her supervisor Neil Maiden ([redacted].

2.5 Emotion self assessment questionnaire in each measure point

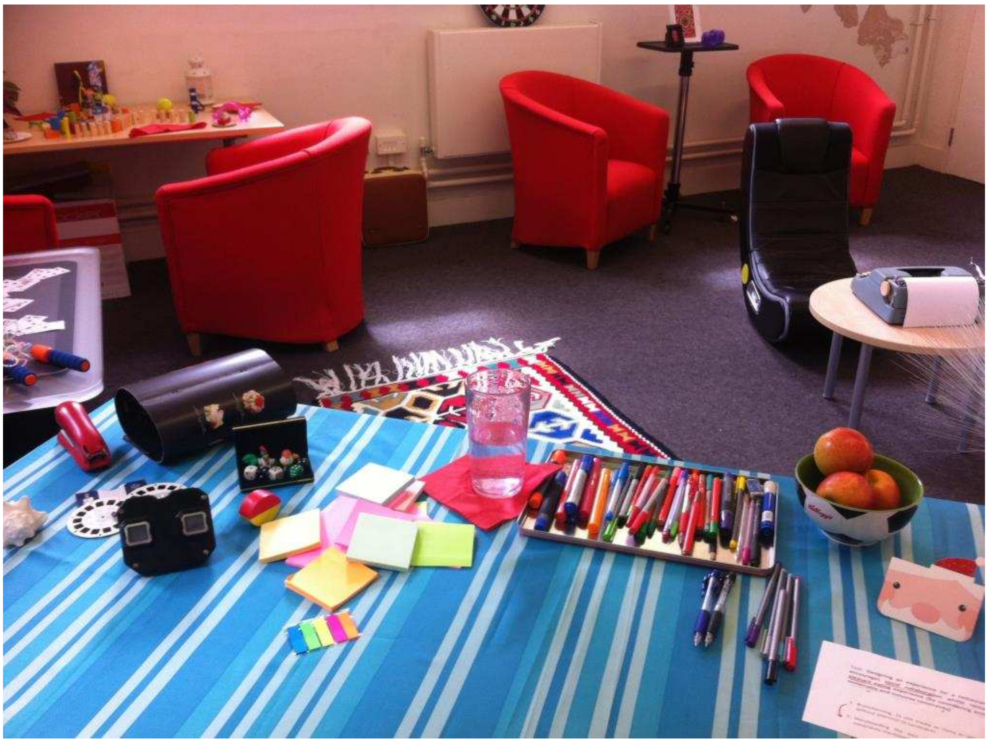


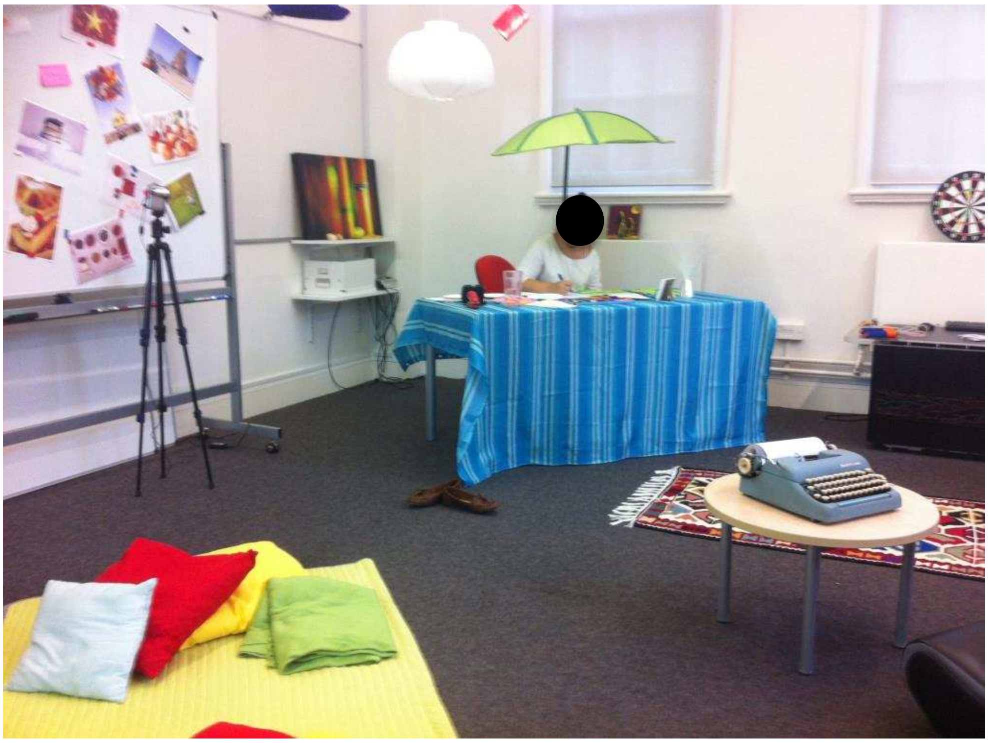
2.6 Emotion self assessment questionnaire before and after task

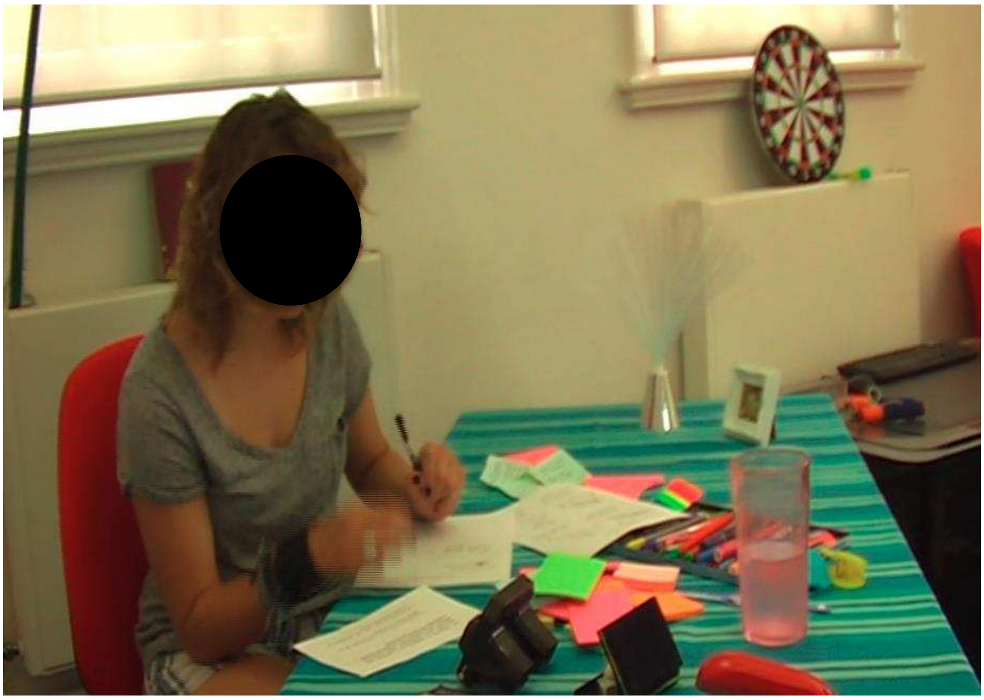


PARTICIPANT NO.

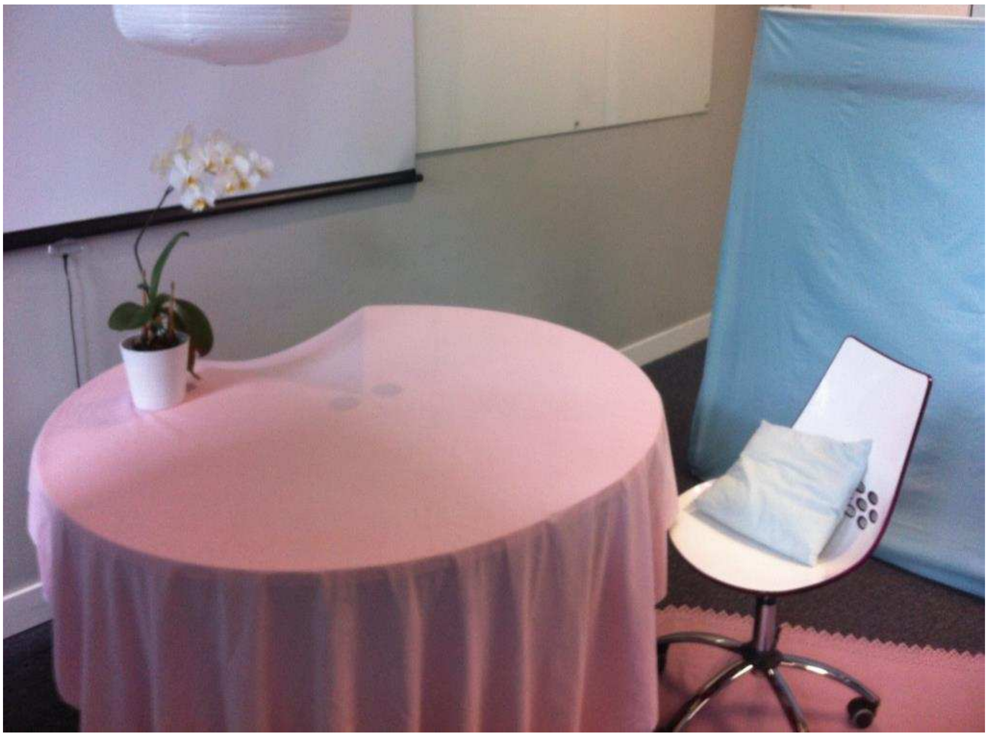
2.7 Designed high-activated space

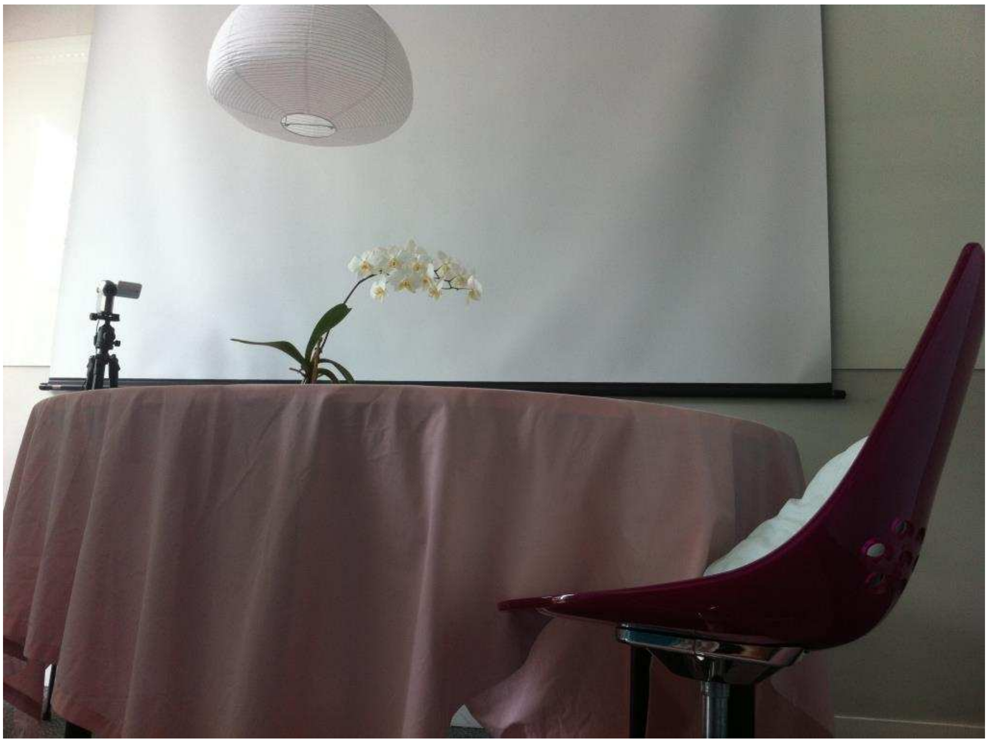


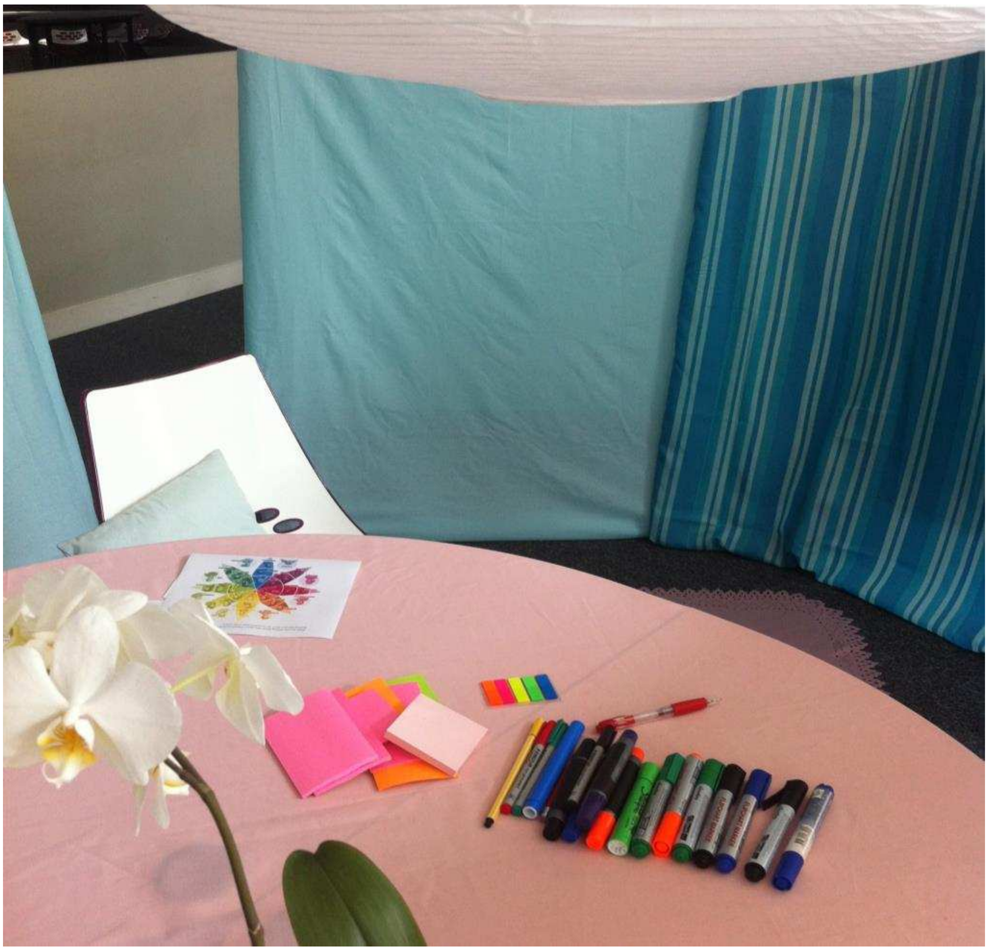


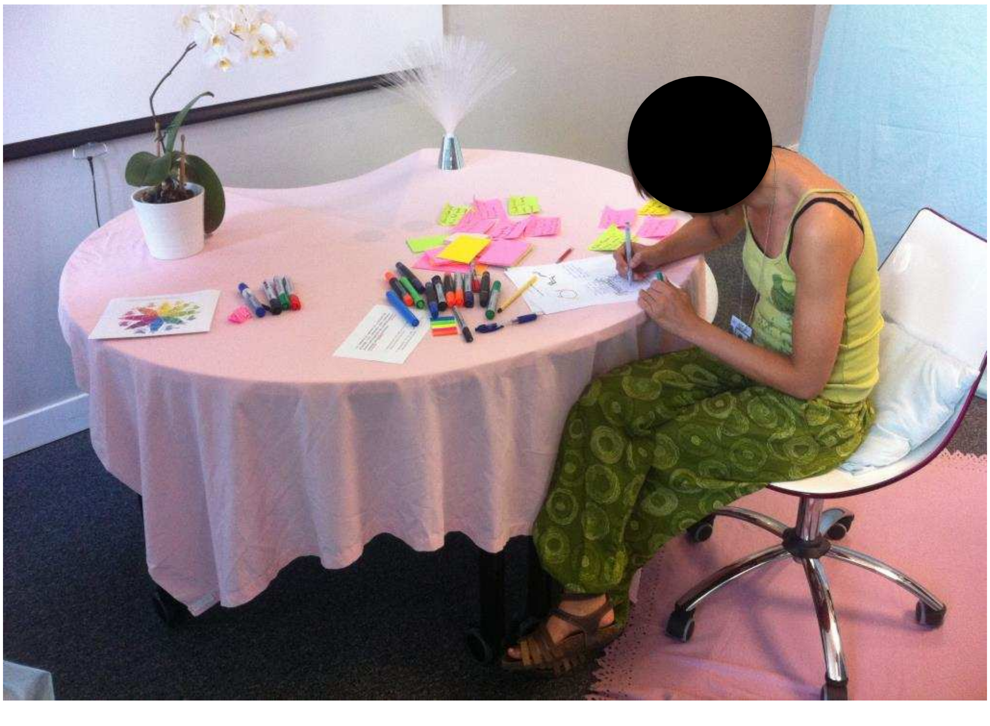


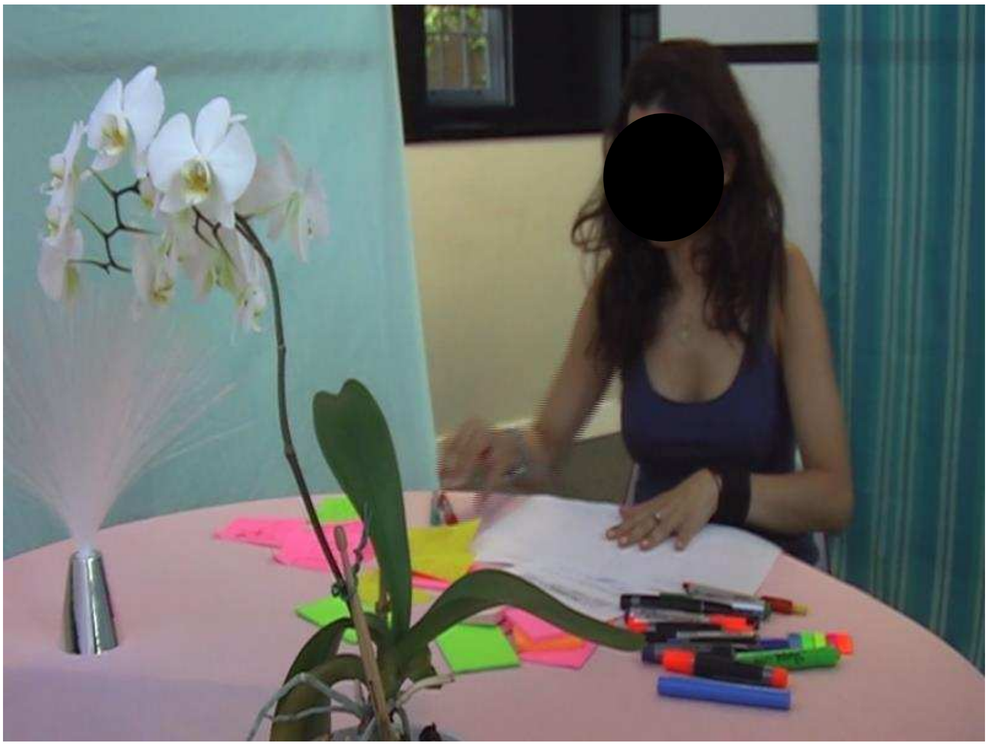
2.8 Designed low-activated space



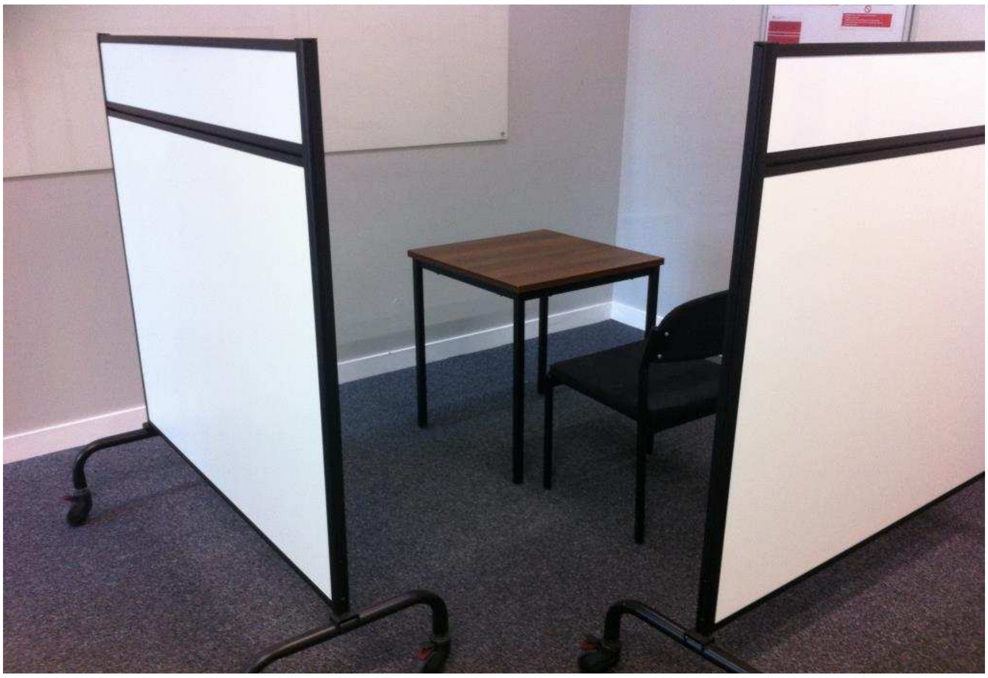


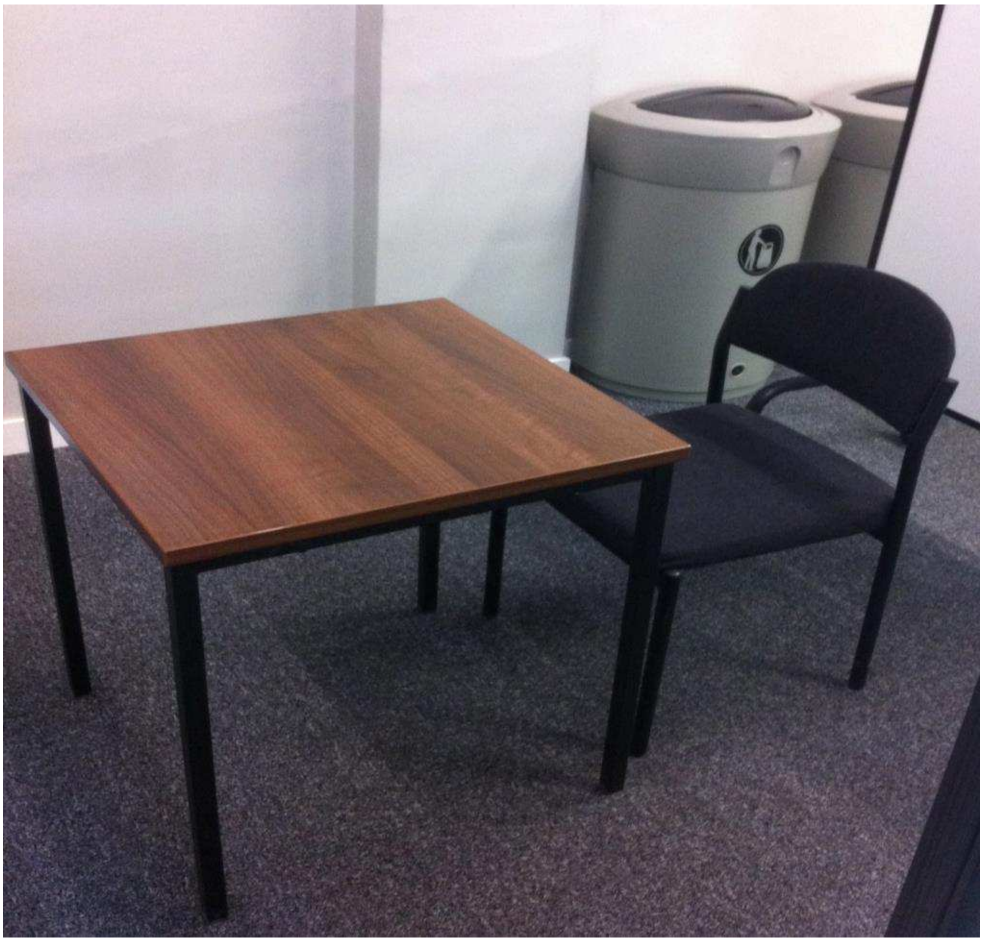


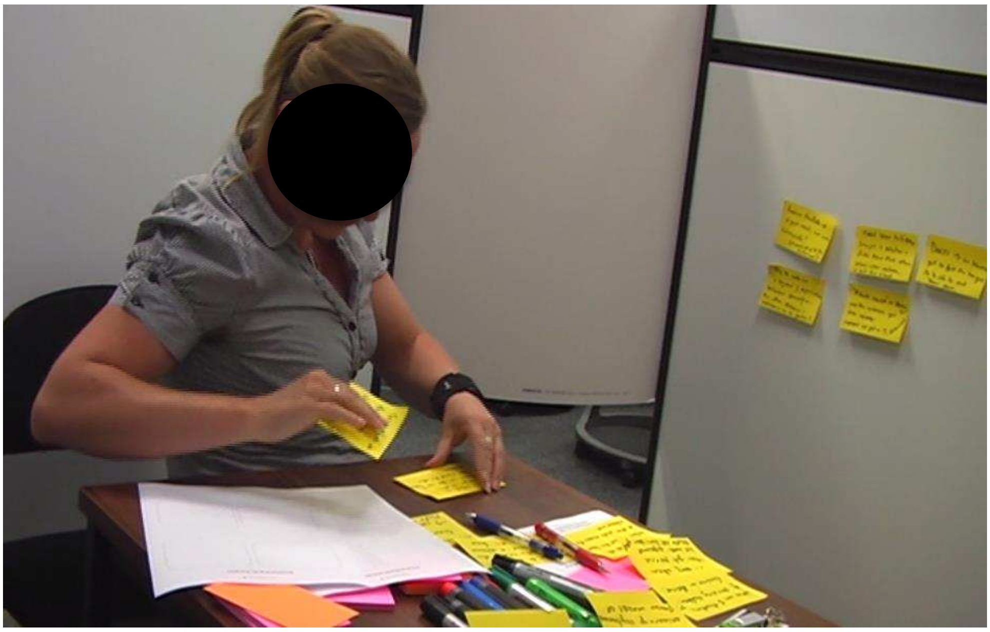


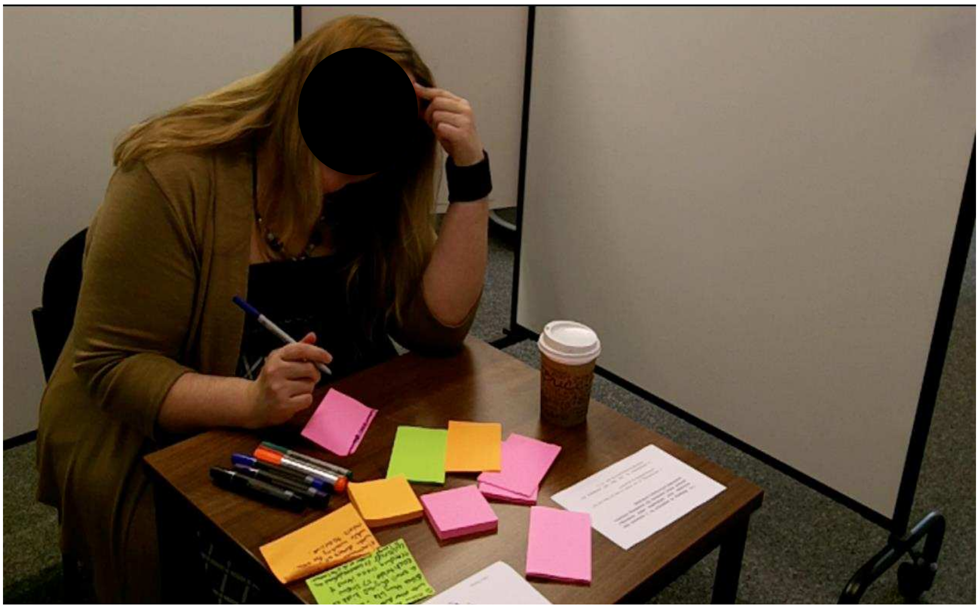


2.9 Environment for the control condition

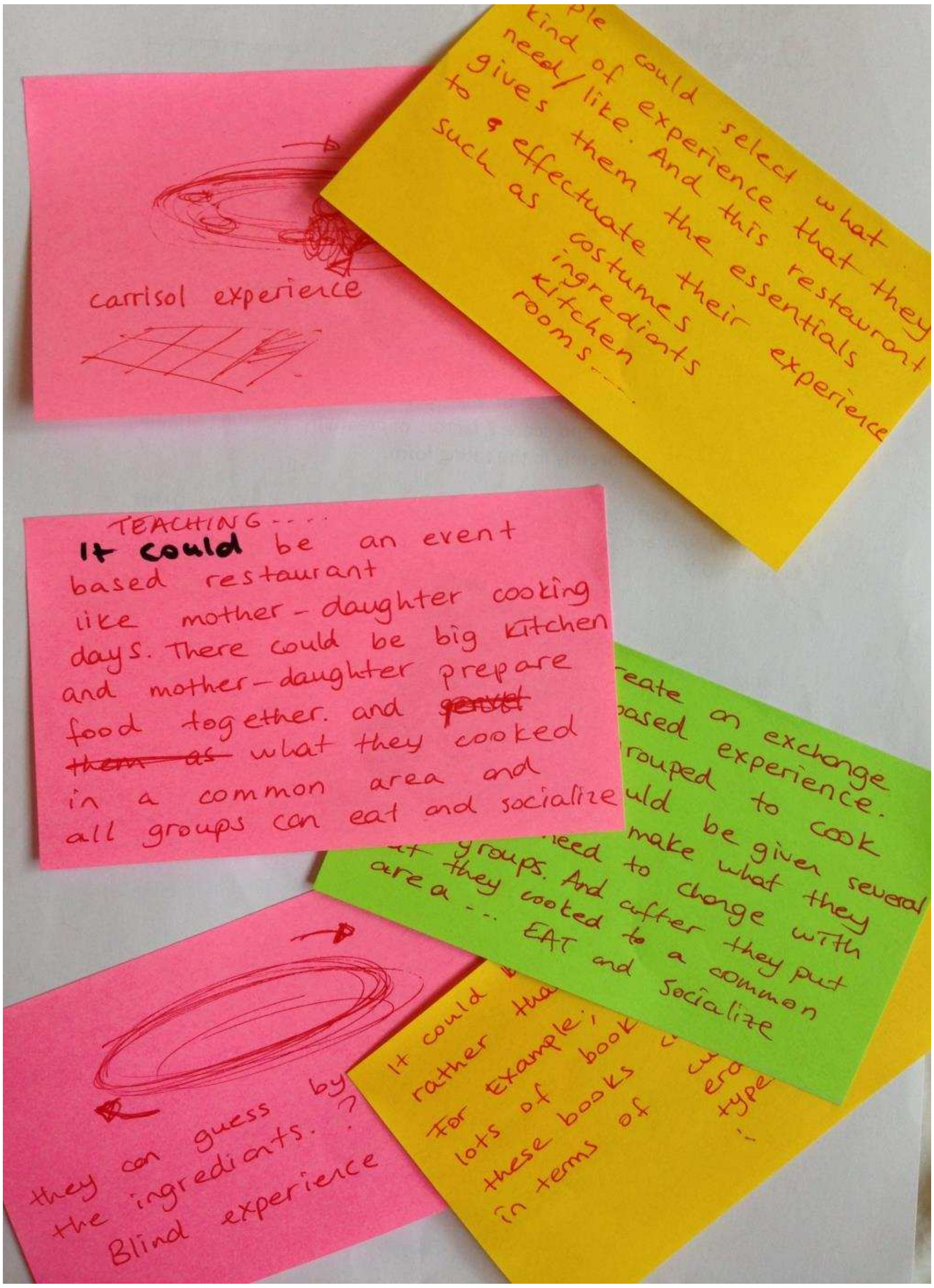


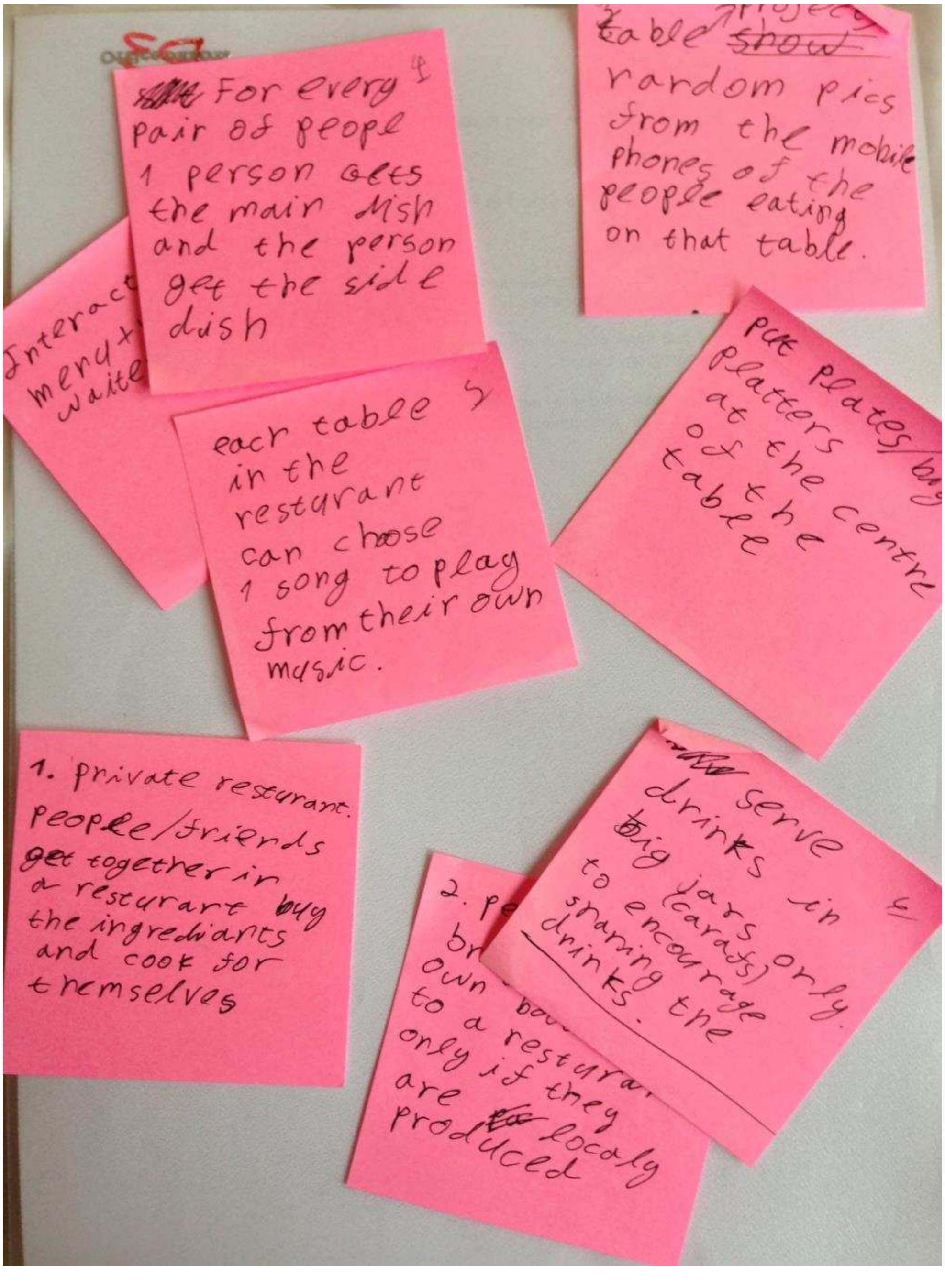


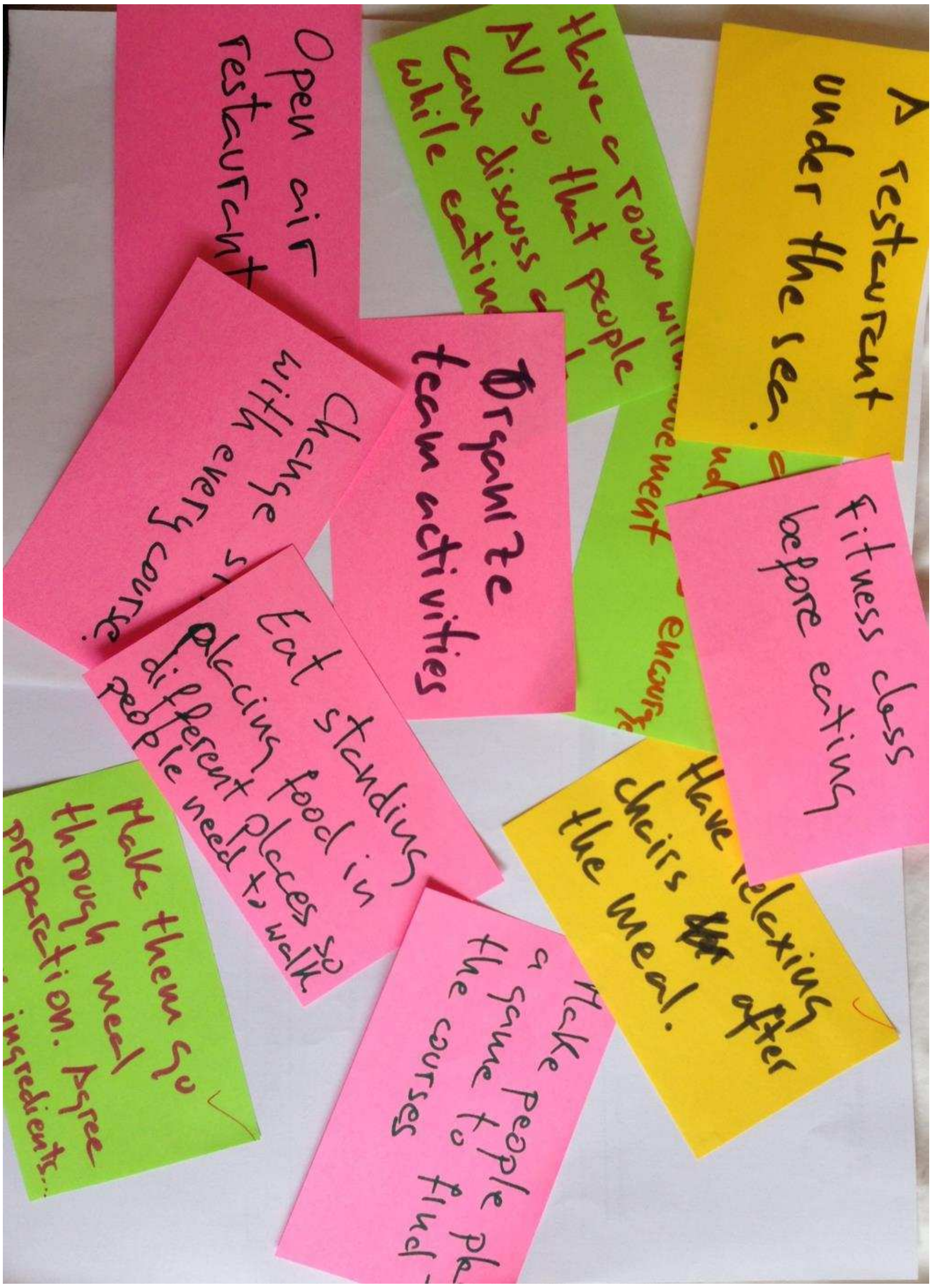




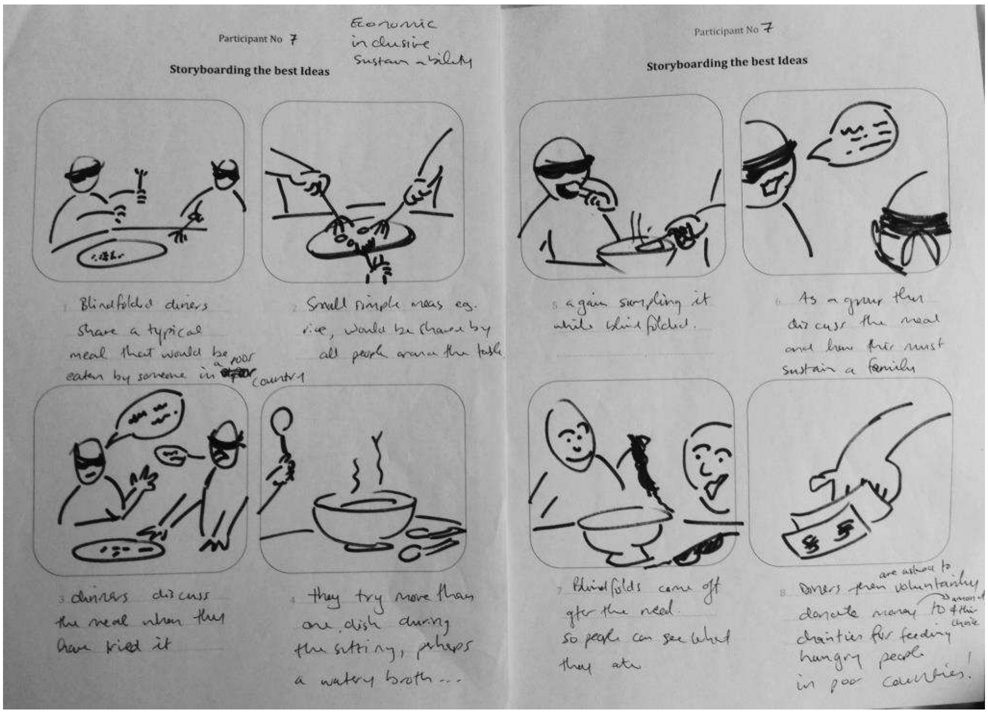
2.10 Ideas of participant's brainstorming (divergent task)

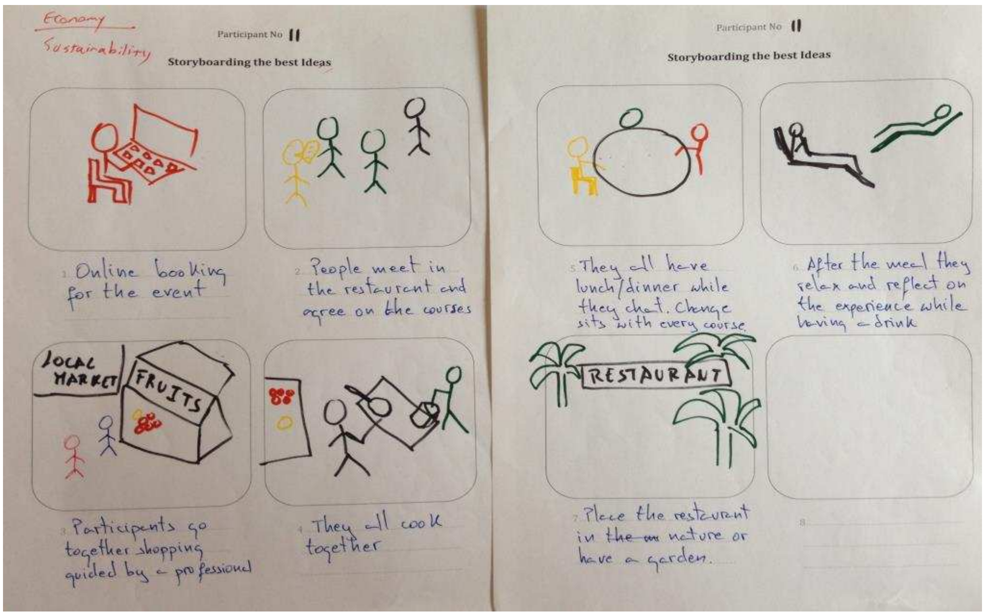

carrisol experience
kind of experience that they need/like. And this restaurant gives them the essentials to effectuate their experience such as costumes ingredients kitchen rooms...
TEACHING....
It could be an event based restaurant like mother-daughter cooking days. There could be big kitchen and mother-daughter prepare food together. and what they cooked in a common area and all groups can eat and socialize
groups. And after they put what they cooked to a common area... EAT and Socialize
they can guess by the ingredients. ?
Blind experience

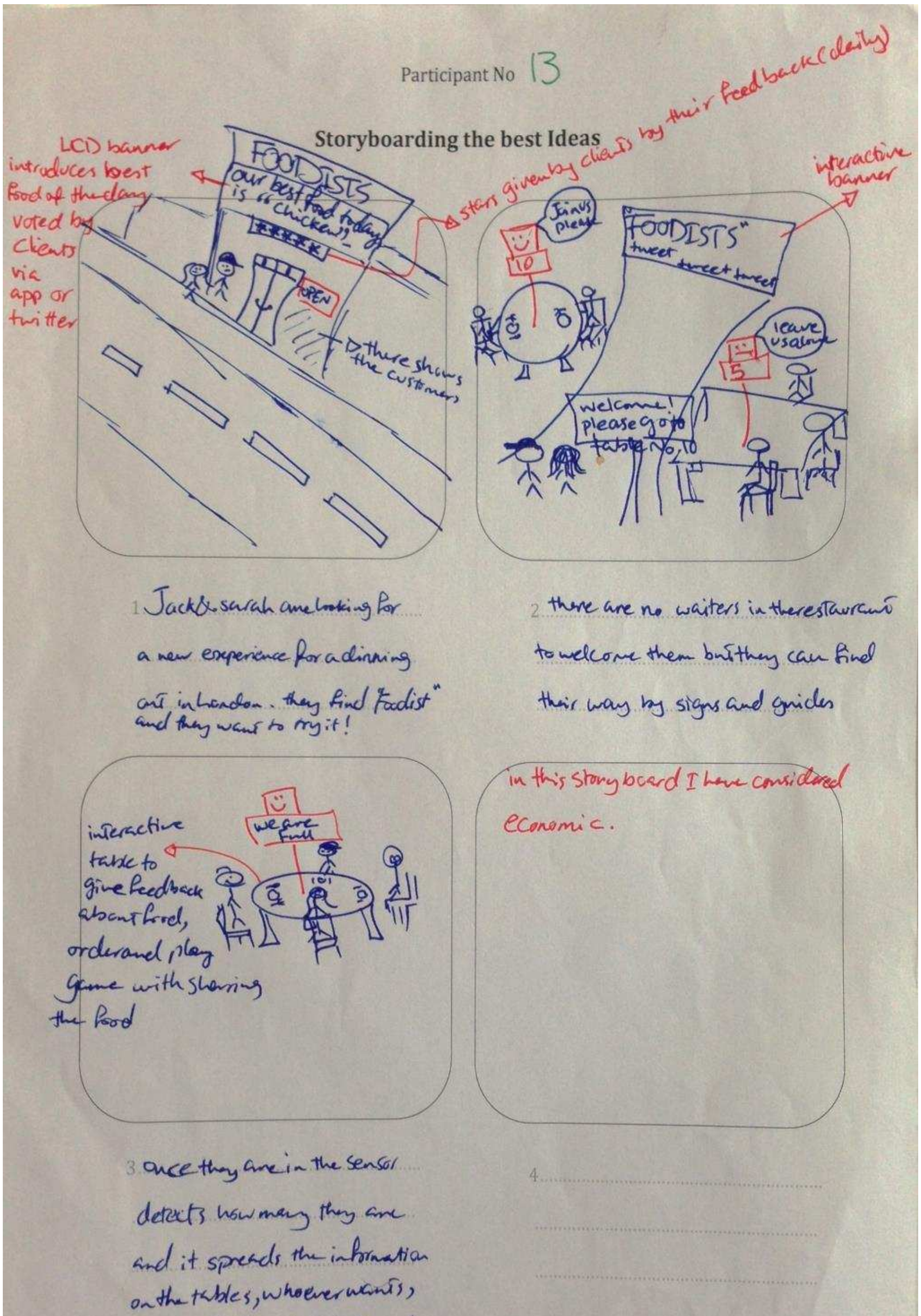

For every pair of people 1 person gets the main dish and the person get the side dish
table random pics from the mobile phones of the people eating on that table.
each table in the resturant can choose 1 song to play from their own music.
put plates/big platters at the centre of the table
1. private resturant. people/friends get together in a resturant buy the ingrediants and cook for themselves
serve drinks in big jars only (carafs) to encourage sharing the drinks.
to a restura
only if they are produced localy


A restaurant under the sea.
Open air restaurant
Fitness class before eating
Organize team activities
Eat standing placing food in different places so people need to walk
Have relaxing chairs after the meal.
Make them go through meal preparation.

2.11 Ideas of participant's storyboards (Convergent task)







Participant No 13

Storyboarding the best Ideas

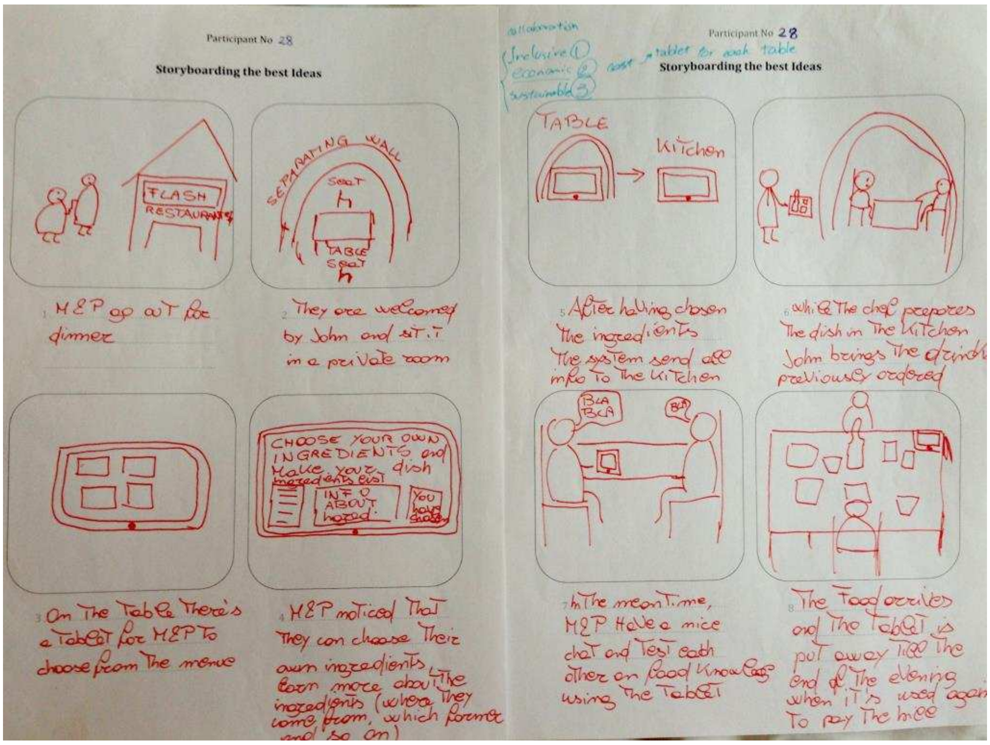
1 Jack & sarah are looking for a new experience for a dinning out in London. they find "Foodist" and they want to try it!

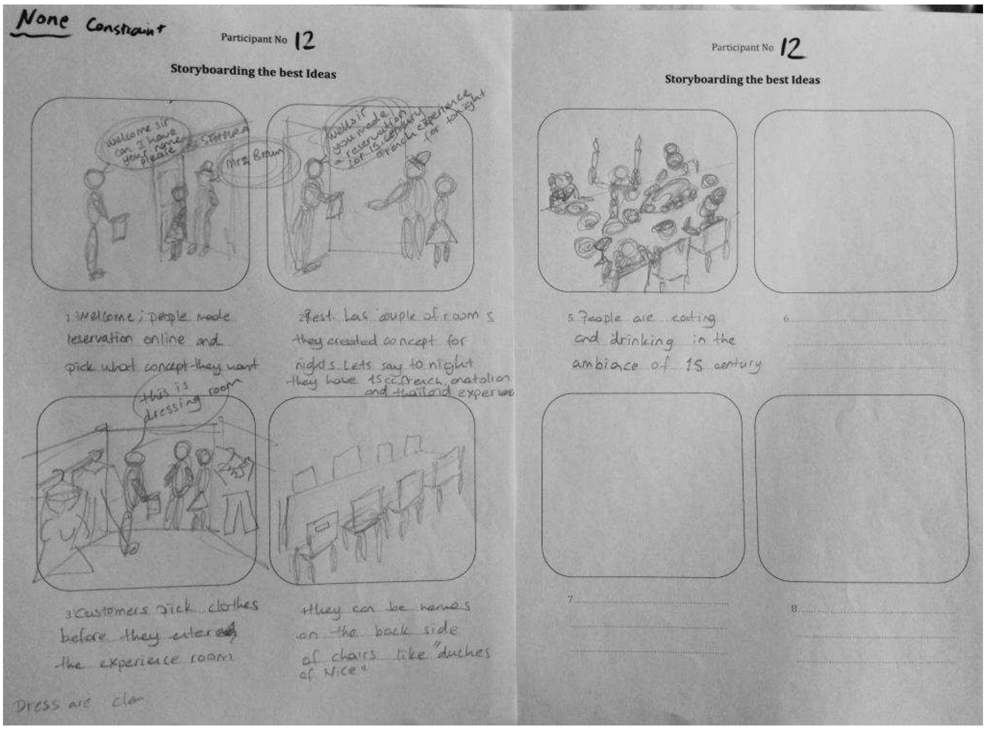
2 there are no waiters in the restaurant to welcome them but they can find their way by signs and guides

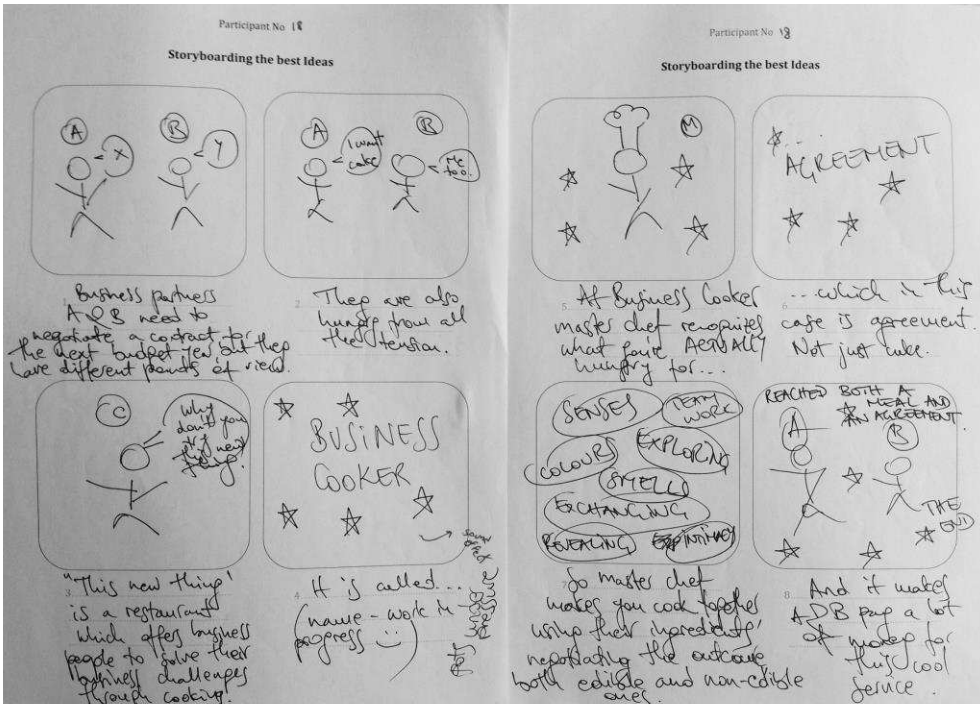
in this storyboard I have considered economic.

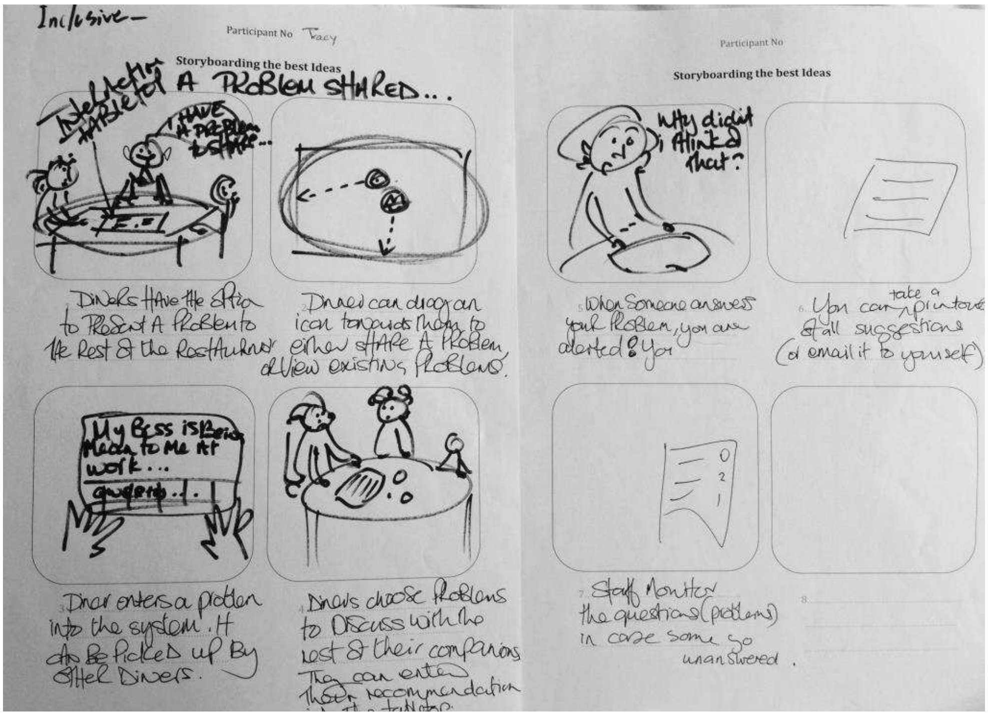
3 once they are in the sensor detects how many they are and it spreads the information on the tables, whoever wants, can invite them to join them by a sign that says "come and join us, we have 2 seats available"

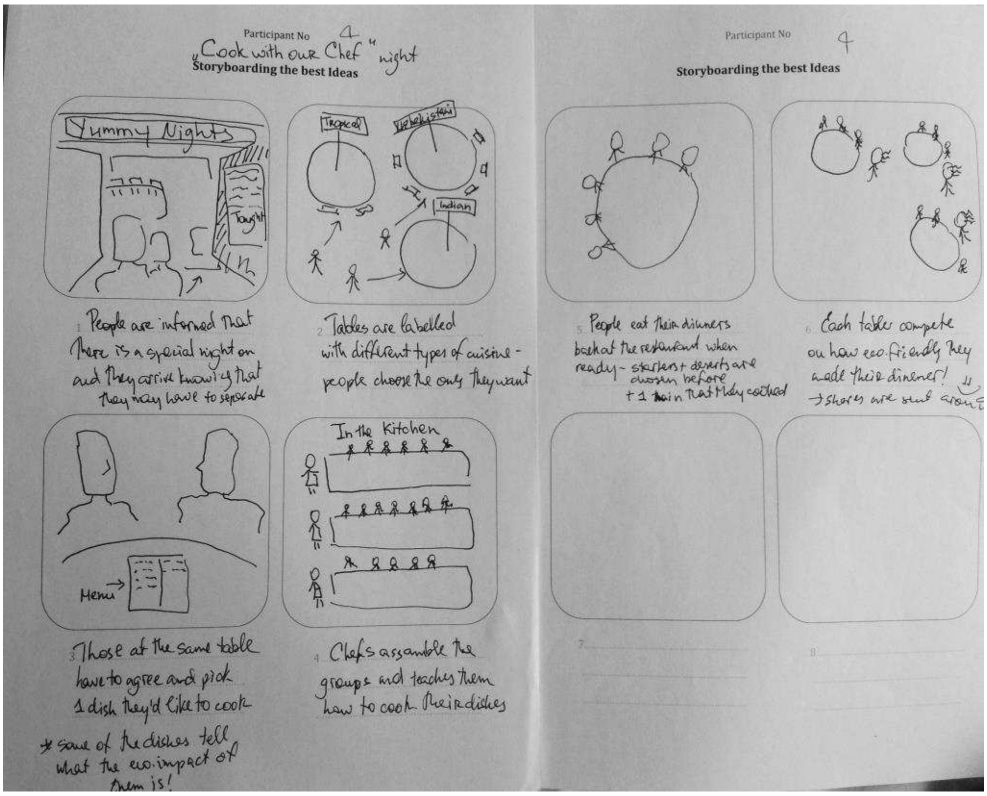
4

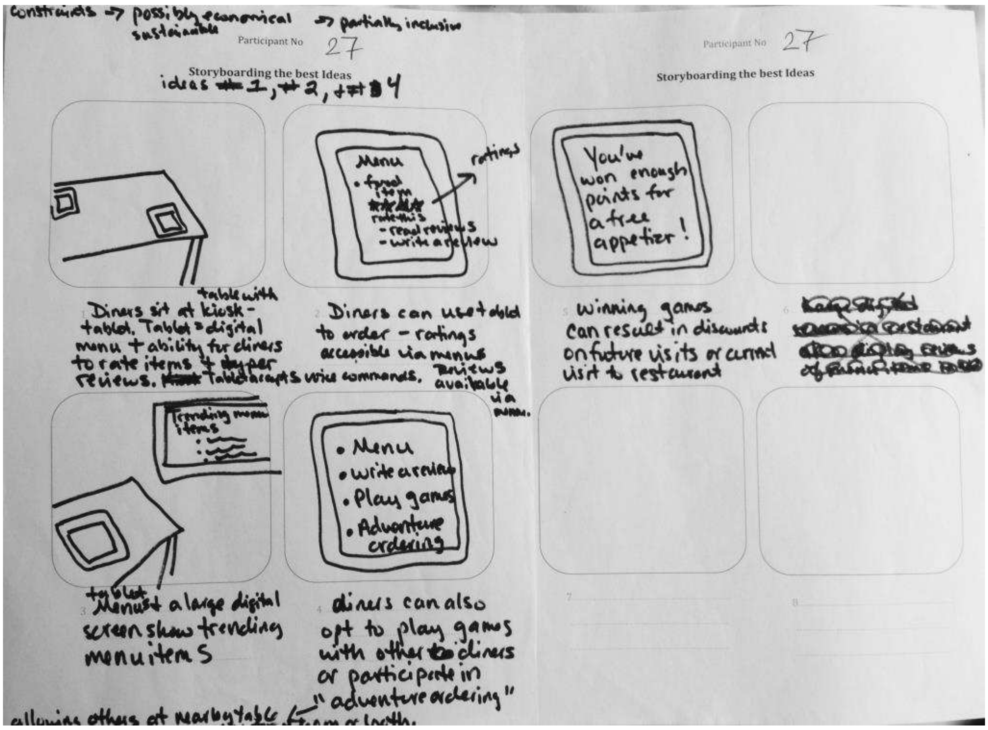


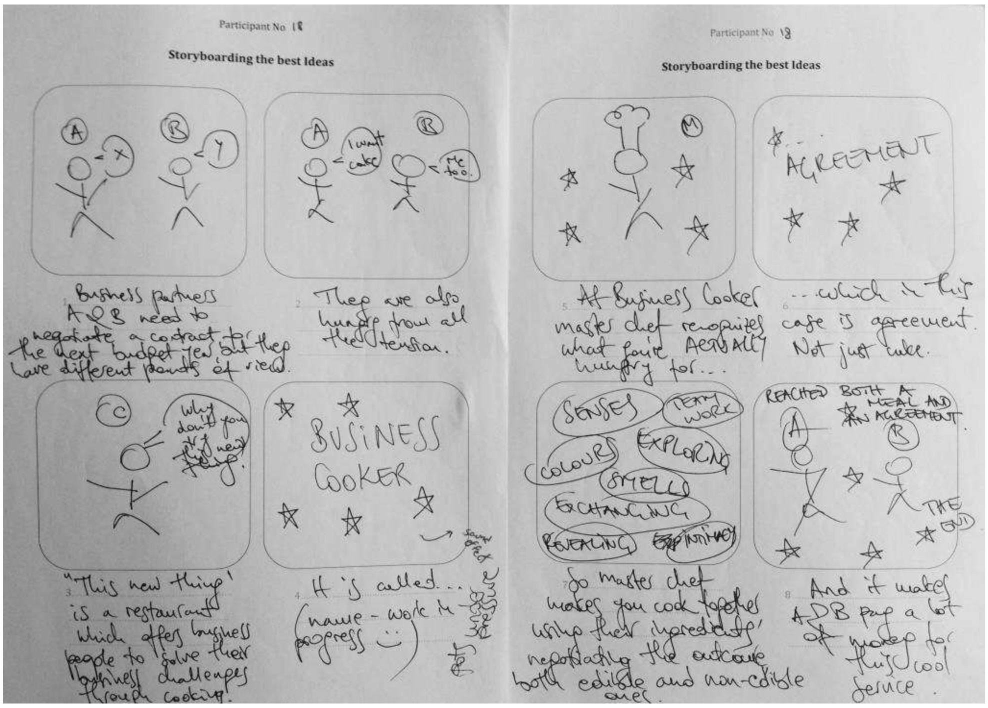


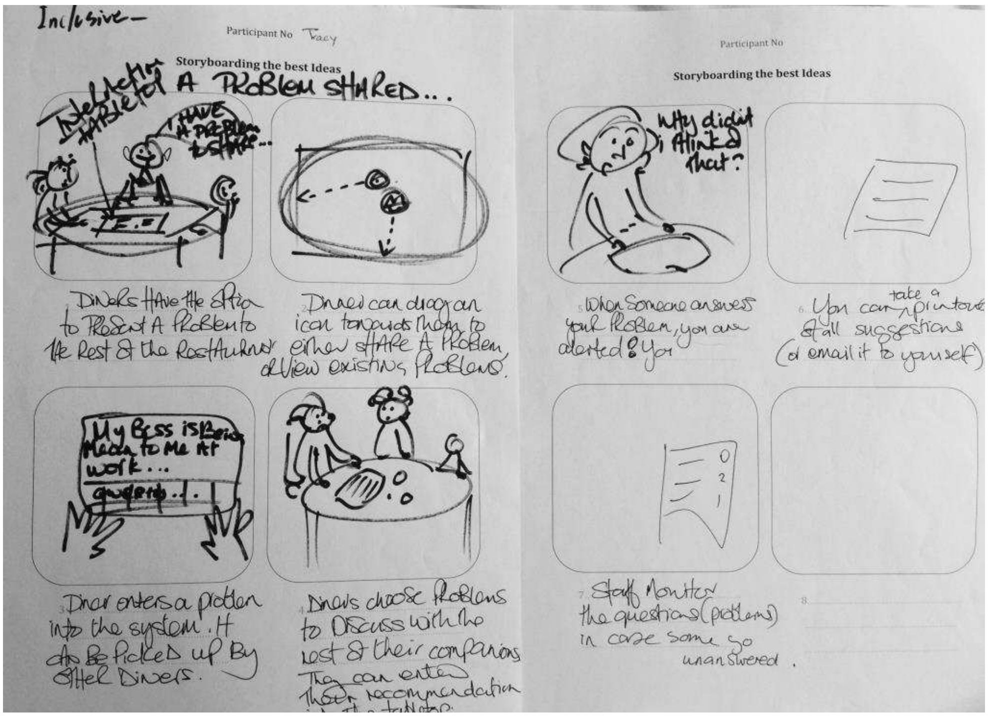

Participant No 18
Storyboarding the best Ideas
Participant No 18
Storyboarding the best Ideas
AGREEMENT
BUSINESS COOKER
Business partners A & B need to negotiate a contract for the next budget year but they have different points of view.
They are also hungry from all the tension.
At Business Cooker master chef recognizes what you're ACTUALLY hungry for...
... which in this case is agreement. Not just cake.
"This new thing" is a restaurant which offers business people to solve their business challenges through cooking.
It is called...
So master chef makes you cook together using their ingredients, negotiating the outcome both edible and non-edible ones.
And it makes A & B pay a lot of money for this cool service.

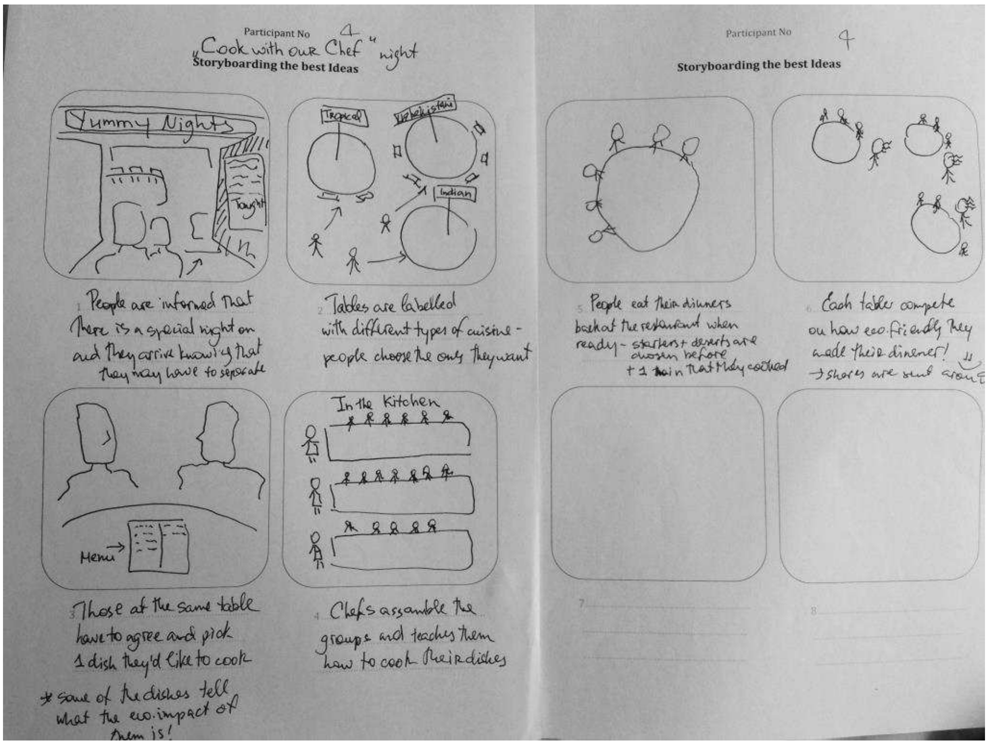

Inclusive –
Participant No Tracy
Storyboarding the best Ideas
Participant No
Storyboarding the best Ideas
A PROBLEM SHARED...
Why didn't I think of that?
Diners can drag an icon towards them to either SHARE A PROBLEM or view existing problems.
When someone answers your problem, you are alerted
You can take a printout of all suggestions (or email it to yourself)
Diner enters a problem into the system. It can be picked up by other diners.
Diners choose problems to discuss with the rest of their companions
Staff monitor the questions (problems) in case some go unanswered.

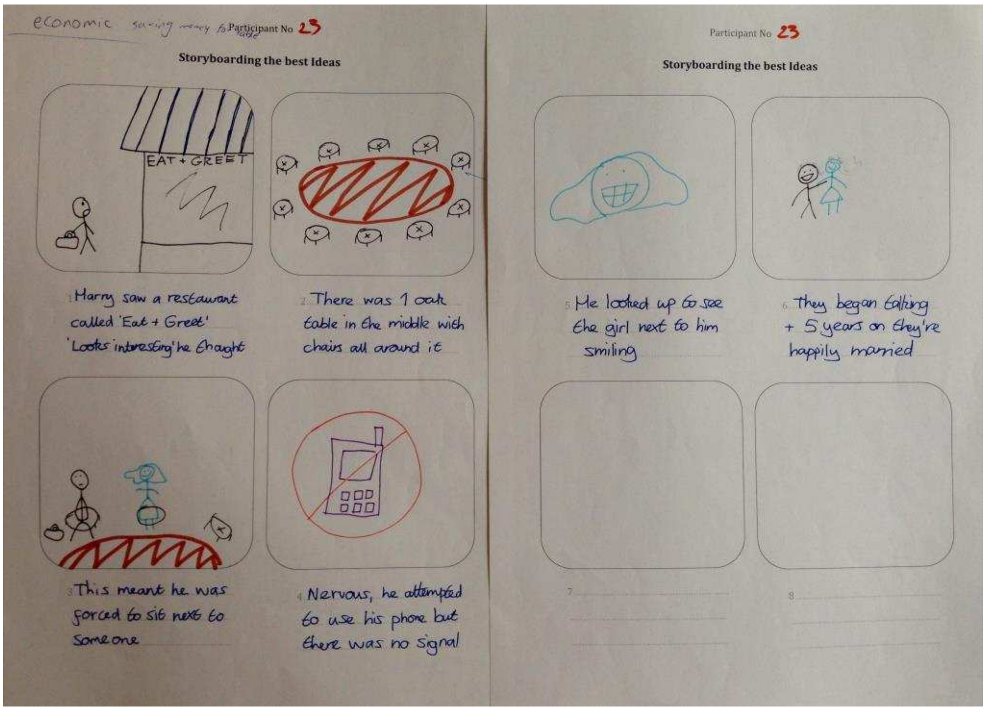

Participant No 4
"Cook with our Chef" night
Storyboarding the best Ideas
Yummy Nights
Tropical
Vegetarian
Indian
1 People are informed that there is a special night on and they arrive knowing that they may have to separate
2 Tables are labelled with different types of cuisine - people choose the one they want
Menu
3 Those at the same table have to agree and pick 1 dish they'd like to cook
* some of the dishes tell what the eco-impact of them is!
In the Kitchen
4 Chefs assemble the groups and teaches them how to cook their dishes
Participant No 4
Storyboarding the best Ideas
5 People eat their dinners back at the restaurant when ready - starters + deserts are chosen before + 1 main that they cooked
6 Each table compete on how eco-friendly they made their dinner!


constraints → possibly economical sustainable → partially inclusive
Participant No 27
Storyboarding the best Ideas
ideas 1, 2, 4
Menu
ratings
You've won enough points for a free appetizer!
1 Diners sit at kiosk-table with tablet. Tablet = digital menu + ability for diners to rate items + write reviews.
2 Diners can use tablet to order - ratings accessible via menus. Reviews available via menu.
5 winning games can result in discounts on future visits or current visit to restaurant
Trending menu items
Menu
Write a review
Play games
Adventure ordering
3 Menu at a large digital screen show trending menu items
4 diners can also opt to play games with other diners or participate in "adventure ordering"
Participant No 27


Participant No 18
Storyboarding the best Ideas
Business partners A & B need to negotiate a contract for the next budget year but they have different points of view.
They are also hungry from all the tension.
"This new thing" is a restaurant which offers business people to solve their business challenges through cooking.
It is called... (name - work in progress)
BUSINESS COOKER
Participant No 18
Storyboarding the best Ideas
At Business Cooker master chef recognizes what you're ACTUALLY hungry for...
...which in this case is agreement. Not just cake.
SENSES
TEAM WORK
COLOURS
EXPLORING
SMELL
EXCHANGING
REVEALING
INTIMACY
REACHED BOTH A MEAL AND AN AGREEMENT.
THE END
And it makes A & B pay a lot of money for this cool service.

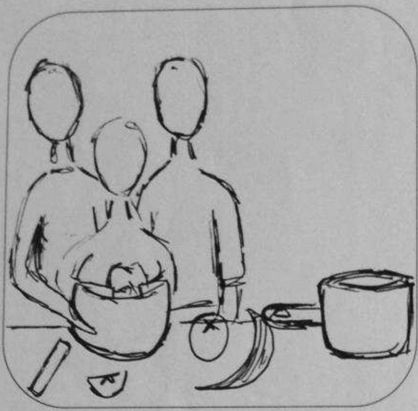

Inclusive
Participant No Tracy
Storyboarding the best Ideas
A PROBLEM SHARED...
Diners have the option to present a problem to the rest of the restaurant.
Diners enter a problem into the system. It can be picked up by other diners.
Diners choose problems to discuss with the rest & their companions.
Participant No
Storyboarding the best Ideas
Why didn't I think of that?
When someone answers your problem, you are alerted
You can take a printout of all suggestions (or email it to yourself)
Staff monitor the questions (problems) in case some go unanswered.


Participant No 4
"Cook with our Chef" night
Storyboarding the best Ideas
Yummy Nights
1. People are informed that there is a special night on and they arrive knowing that they may have to separate
2. Tables are labelled with different types of cuisine - people choose the ones they want
Tropical
Indian
In the Kitchen
Menu
3. Those at the same table have to agree and pick 1 dish they'd like to cook
* some of the dishes tell what the eco-impact of them is!
4. Chefs assemble the groups and teaches them how to cook their dishes
Participant No 4
Storyboarding the best Ideas
5. People eat their dinners back at the restaurant when ready - starters + deserts are chosen before + 1 main that they cooked
6. Each table compete on how eco-friendly they made their dinner!
7.
8.


economic
Participant No 23
Storyboarding the best Ideas
EAT + GREET
1. Harry saw a restaurant called 'Eat + Greet' 'Looks interesting' he thought
2. There was 1 oak table in the middle with chairs all around it
3. This meant he was forced to sit next to someone
4. Nervous, he attempted to use his phone but there was no signal
Participant No 23
Storyboarding the best Ideas
5. He looked up to see the girl next to him smiling
6. They began talking + 5 years on they're happily married
7.
8.

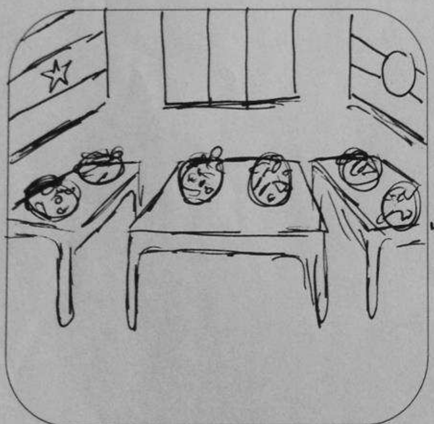
Participant No 6

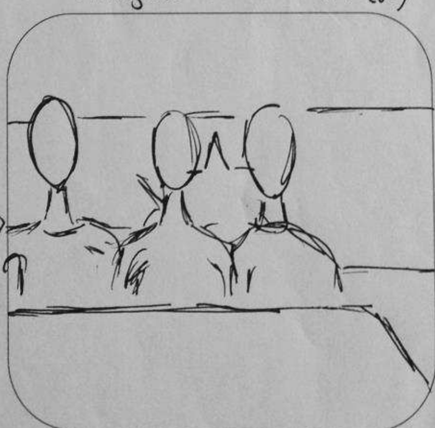
Storyboarding the best Ideas



1 COOKING WORKSHOPS
e.g. once a month for families/ groups. Expert chefs ↳ ticket fee

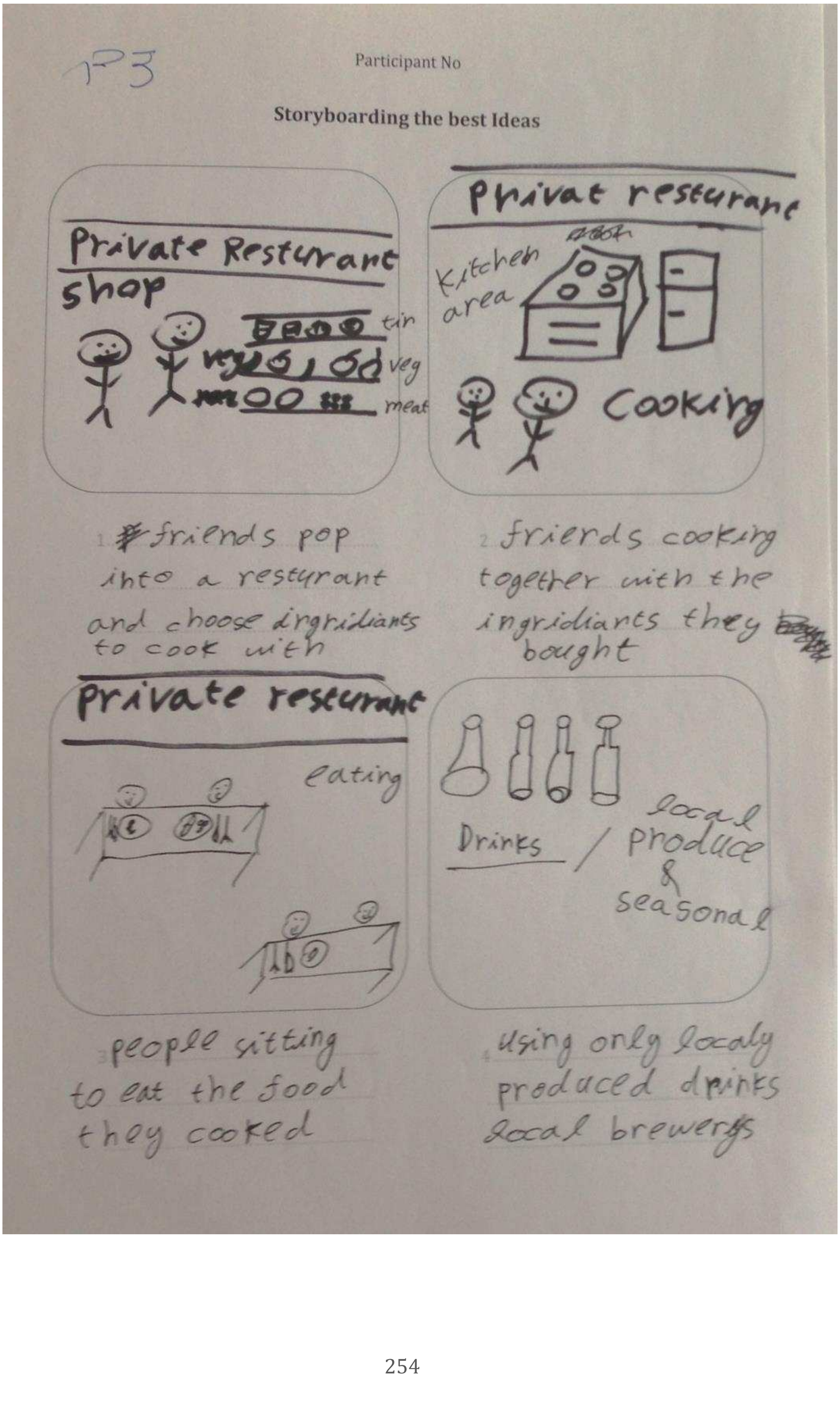
2 TALKS/ LIVE SESSIONS
Chefs/health experts teach people about food, healthy eating etc. once a month (£)

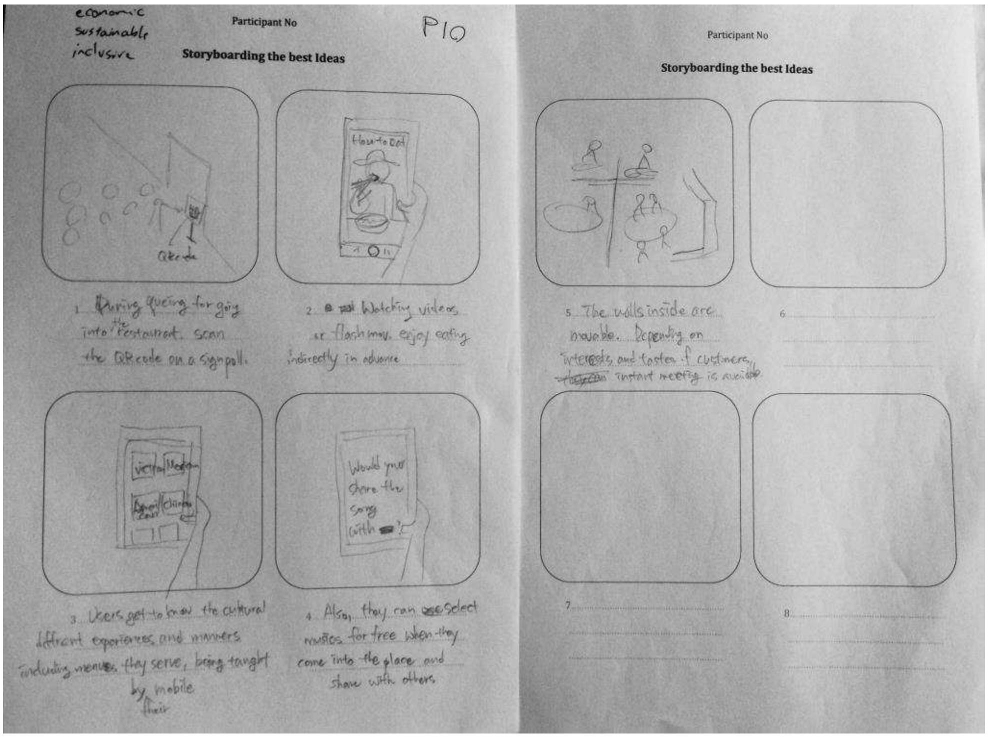


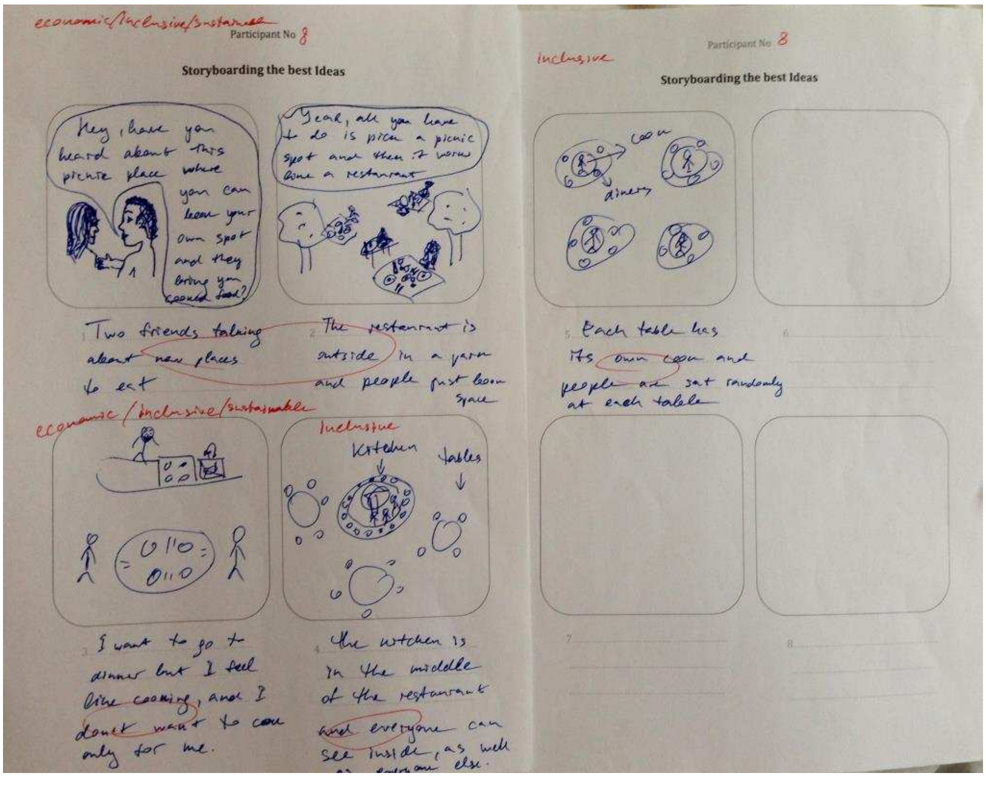


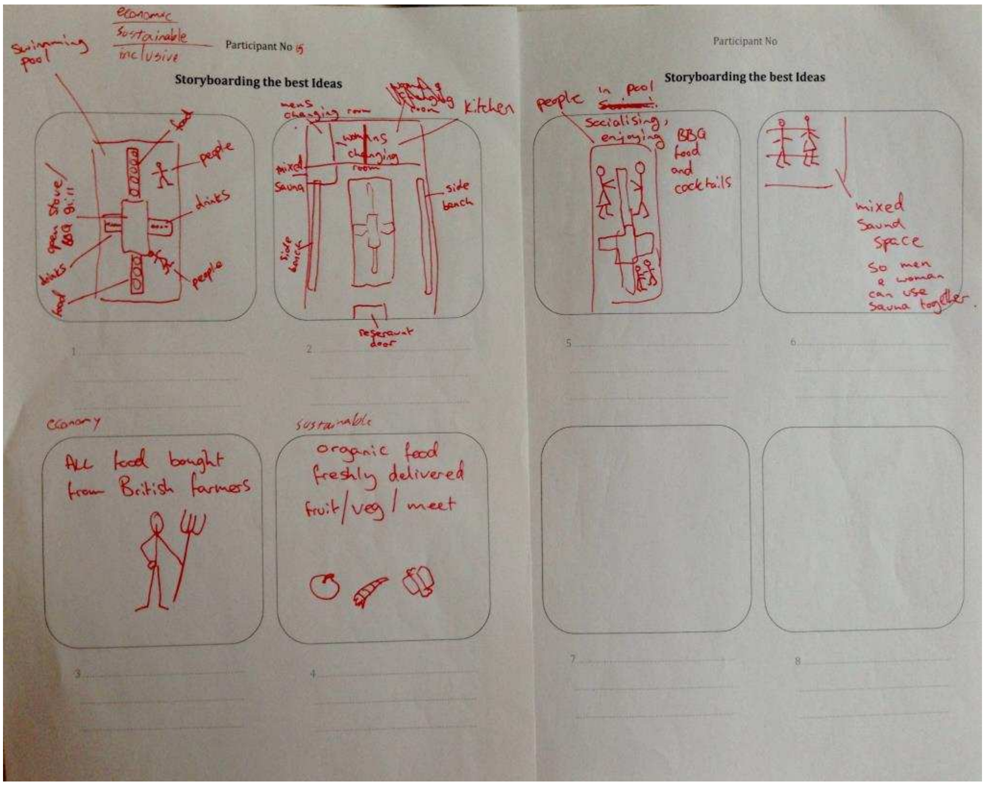
3 ~~FOODS~~ FOOD FROM AROUND THE WORLD
Restaurant does 'international' day e.g. Japanese food, African cuisine etc.

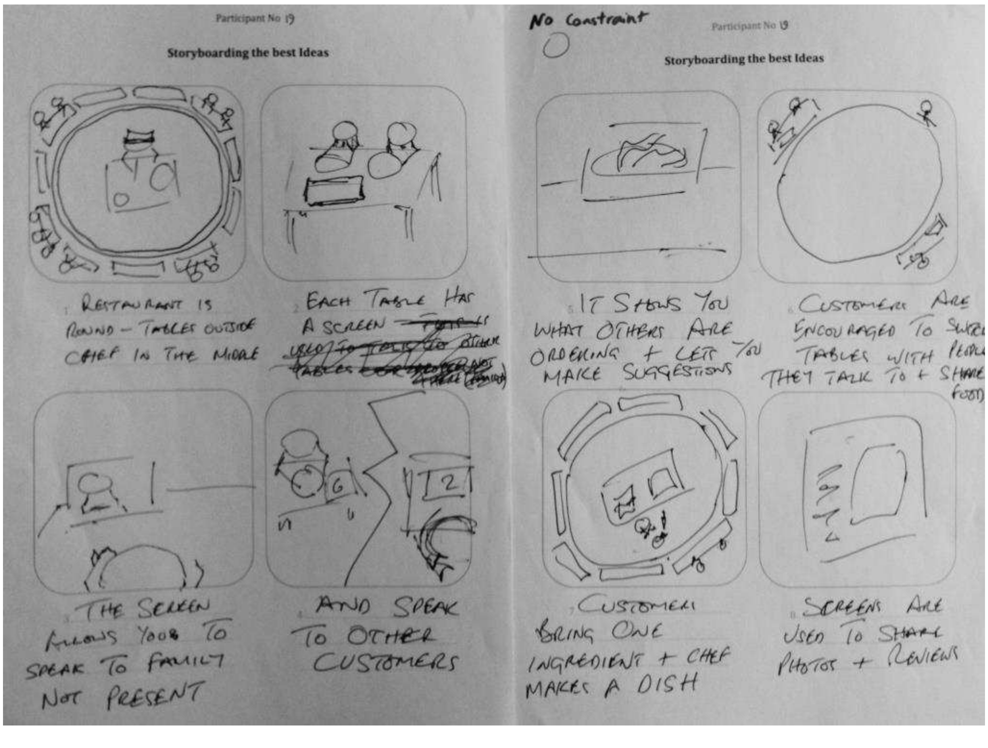
4

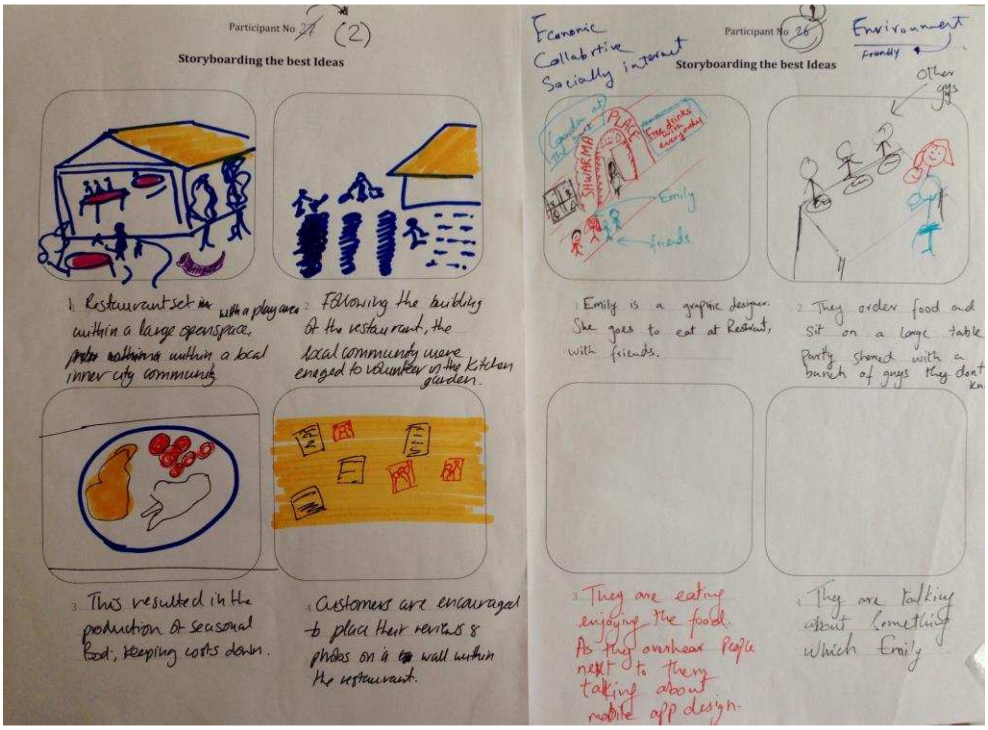

P3
Participant No
Storyboarding the best Ideas
Private Resturant
shop
tin
veg
meat
Privat resturant
Kitchen area
Cooking
1. friends pop into a resturant and choose ingridiants to cook with
2. friends cooking together with the ingridiants they bought
private resturant
eating
Drinks / local produce & seasonal
3. people sitting to eat the food they cooked
4. using only localy produced drinks local brewerys

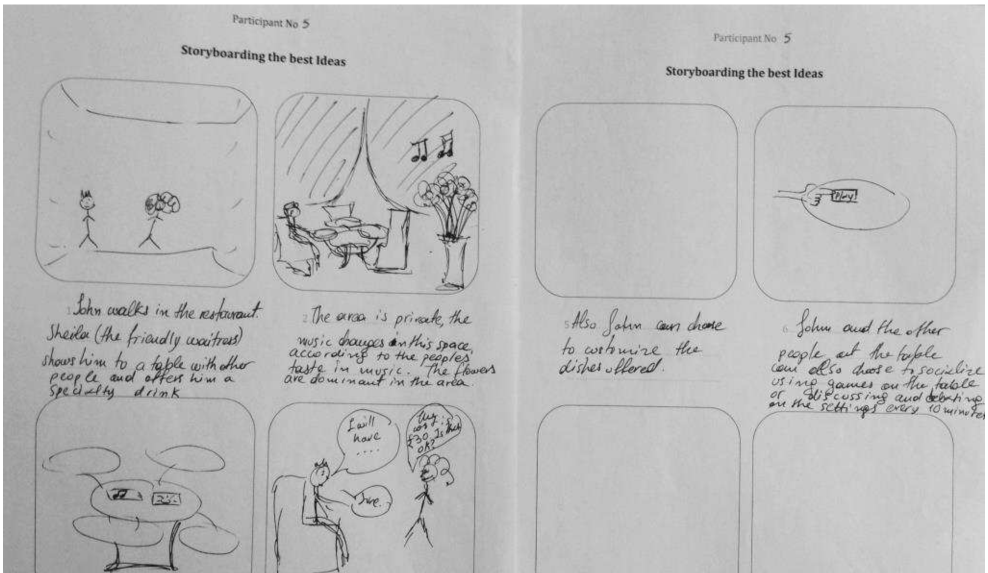

economic
sustainable
inclusive
Participant No
P10
Storyboarding the best Ideas
QRcode
How to eat
1. During queuing for going into the restaurant, scan the QRcode on a signpoll.
2. Watching videos or flash mov, enjoy eating indirectly in advance
Would you share the song with
3. Users get to know the cultural different experiences and manners including menus they serve, being taught by mobile
4. Also, they can select musics for free when they come into the place and share with others
Participant No
Storyboarding the best Ideas
5. The walls inside are movable. Depending on interests and tastes of customers, instant meeting is avaible.
6.
7.
8.


economic/inclusive/sustainable
Participant No 8
Storyboarding the best Ideas
Hey, have you heard about this picnic place where you can have your own spot and they bring you cooked food?
Yeah, all you have to do is pick a picnic spot and then it works like a restaurant
1. Two friends talking about new places to eat
2. The restaurant is outside in a park and people just book space
economic/inclusive/sustainable
Inclusive
Kitchen
tables
3. I want to go to dinner but I feel like cooking, and I don't want to cook only for me.
4. The kitchen is in the middle of the restaurant and everyone can see inside, as well as everyone else.
inclusive
Participant No 8
Storyboarding the best Ideas
cook
diners
5. Each table has its own cook and people are sat randomly at each table
6.
7.
8.


economic
sustainable
inclusive
Participant No 15
Storyboarding the best Ideas
Swimming pool
food
people
drinks
open stove / BBQ grill
kitchen
mixed sauna
side bench
restaurant door
Participant No
Storyboarding the best Ideas
people in pool socialising, enjoying
BBQ food and cocktails
mixed sauna space so men & woman can use sauna together.
economy
ALL food bought from British farmers
sustainable
organic food freshly delivered fruit/veg/meet


Participant No 19
Storyboarding the best Ideas
1. RESTAURANT IS ROUND – TABLES OUTSIDE CHEF IN THE MIDDLE
2. EACH TABLE HAS A SCREEN
3. THE SCREEN ALLOWS YOU TO SPEAK TO FAMILY NOT PRESENT
4. AND SPEAK TO OTHER CUSTOMERS
No Constraint
Participant No 19
Storyboarding the best Ideas
5. IT SHOWS YOU WHAT OTHERS ARE ORDERING + LETS YOU MAKE SUGGESTIONS
6. CUSTOMERS ARE ENCOURAGED TO SWITCH TABLES WITH PEOPLE THEY TALK TO + SHARE FOOD
7. CUSTOMERS BRING ONE INGREDIENT + CHEF MAKES A DISH
8. SCREENS ARE USED TO SHARE PHOTOS + REVIEWS

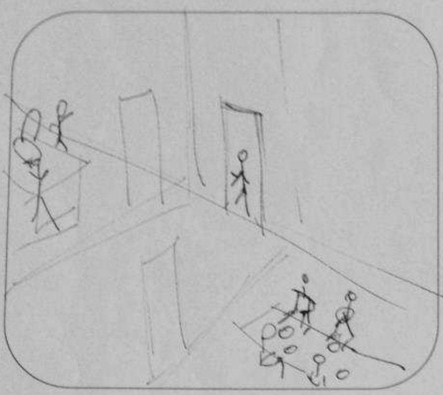

Participant No (2)
Storyboarding the best Ideas
1. Restaurant set with a play area within a large openspace, within a local inner city community
2. Following the building of the restaurant, the local community were enaged to volunteer in the kitchen garden.
3. This resulted in the production of seasonal food, keeping costs down.
4. Customers are encouraged to place their reviews & photos on a wall within the restaurant.
Economic
Collabortive
Socially interact
Participant No 26
Environment
Friendly
Storyboarding the best Ideas
Emily
friends
Other guys
1. Emily is a graphic designer. She goes to eat at Restaurant, with friends.
2. They order food and sit on a large table party shared with a bunch of guys they don't know
3. They are eating enjoying the food. As they overhear people next to them talking about mobile app design.
4. They are talking about something which Emily

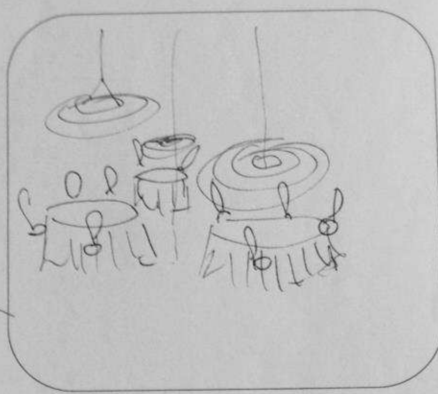

Participant No 5
Storyboarding the best Ideas
1. John walks in the restaurant. Sheila (the friendly waitress) shows him to a table with other people and offers him a speciality drink
2. The area is private, the music changes in this space, according to the peoples taste in music. The flowers are dominant in the area.
3. The table consists of a big table and other smaller surfaces. The big table is used to select the music and the lighting of the space (all the people at the table manipulate it. The smaller surfaces are used for dining purposes
4. John orders dinner and before the order is sent to the kitchen, Sheila informs him about the total cost of his meal.
I will have ...
Sure.
Participant No 5
Storyboarding the best Ideas
5. Also John can chose to customize the dishes offered.
6. John and the other people at the table can also chose to socialize using games on the table or discussing and voting on the settings every 10 minutes
7
8

economic
sustainale
inclusive

Participant No P20

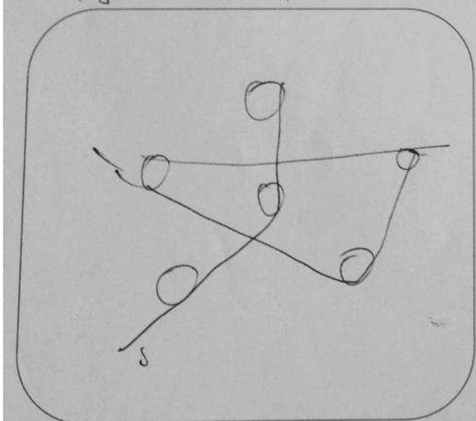
Storyboarding the best Ideas

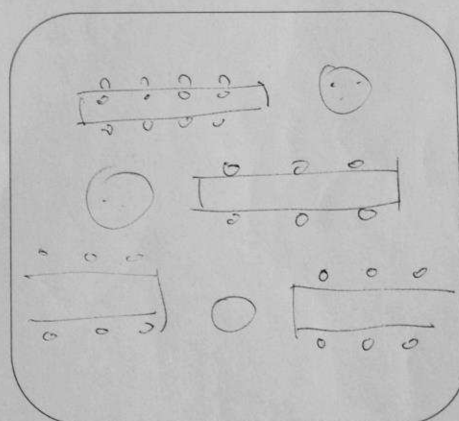




1. Visitors should have a chance to participate in making the meals, deciding about the menu (or) they could skip this, and just have a meal

2. The place should have a story (~~sence of~~) atmosphere (all the senses are of importance)



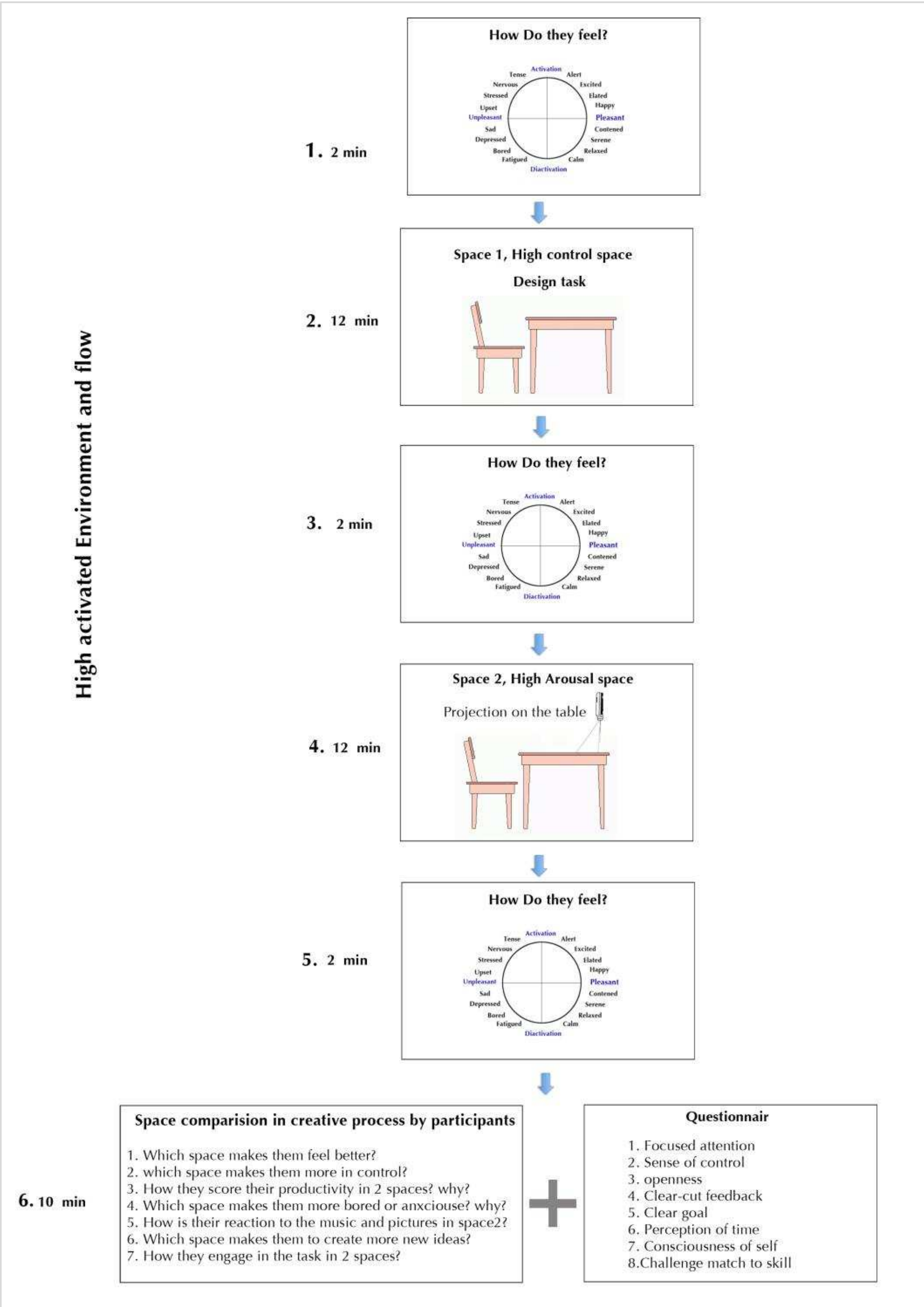


3. The eating could be organized around different thematic nodes, ~~for example~~ so that different tastes of food could be achieved visiting different nodes.

4. Tables with different foods could be dispersed in space so that visitors would have to walk around, looking for specific ones.

3 Appendix c: Study 3

3.1 Designing the Study based on time, task and questionnaires



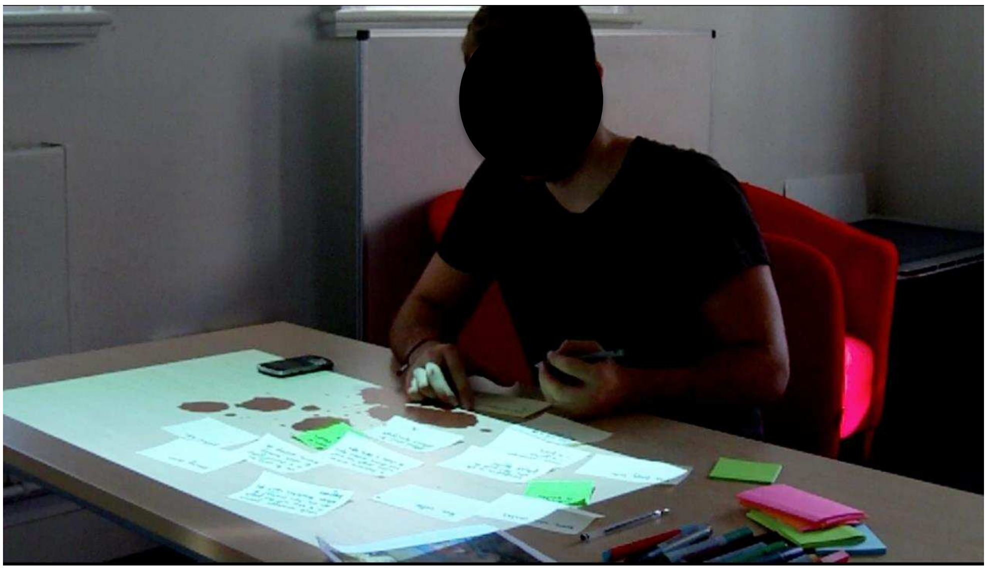
3.2 Design task

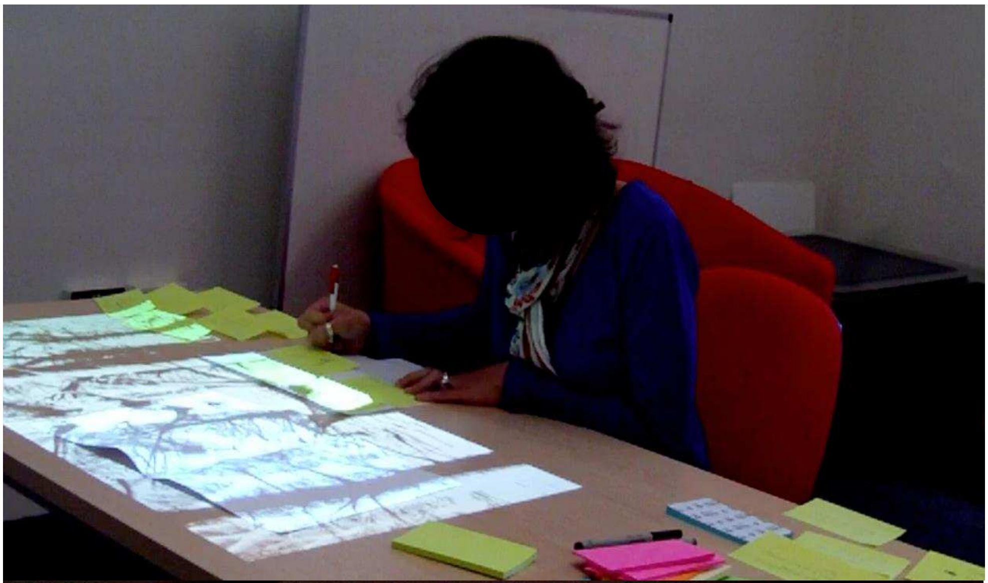
Centre for Creativity in
Professional Practice

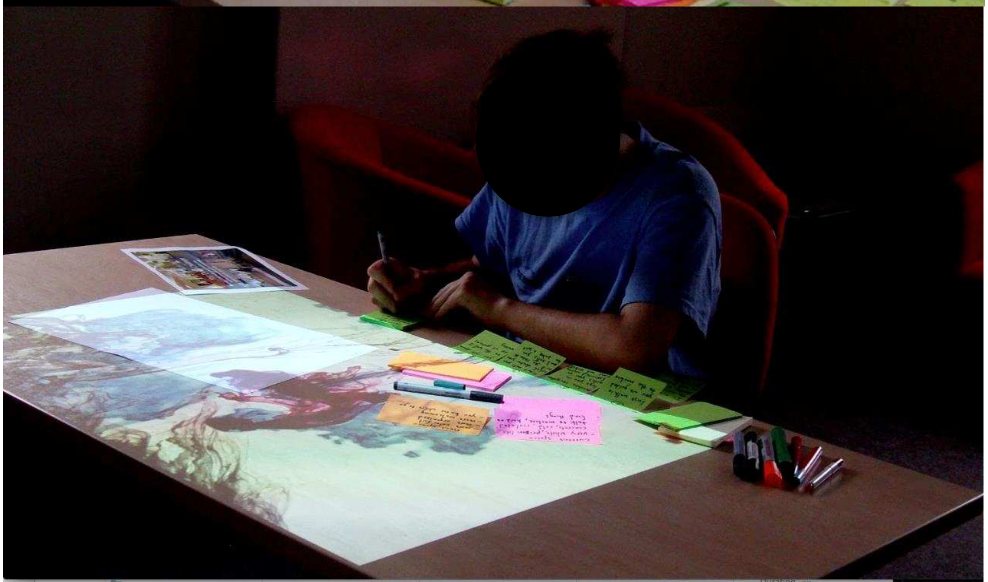
Design problem: The reception areas of NHS health center in many areas of London are not a pleasant space for patients. Receptions make the first impression of the health center environment. Therefore to improve the patient experience, we need to improve them functionally and aesthetically.

Design Task: Redesign a NHS health center reception area to improve the patient experience. Design could propose a new service, system and physical components of the space to create more pleasant experience for the patients.

3.3 Activated task environment with Continuous stimuli

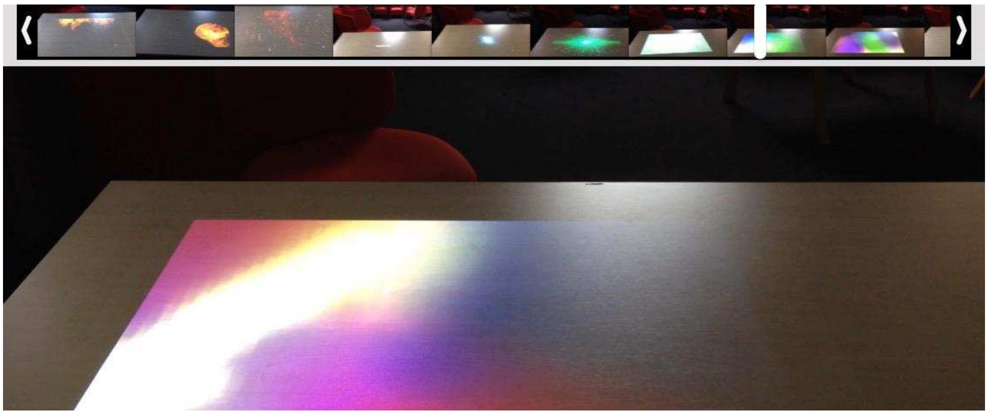






3.4 Deactivated task environment without stimuli

3.5 Animation (visual stimuli) projected over the table in the activated space



3.6 Consent form

CITY UNIVERSITY LONDON

HCID Department
Centre of creativity in professional practice

Title of Study: ***Creative design experience in the environment***

I volunteer to participate in a research project conducted by Mobina Nouri as part of PhD study. I understand that the project is designed to gather information about academic work. I will be one of approximately 40 people being applied for this research.

1. I agree to take part in the above City University London research project. I have had the project explained to me, and I have read the participant information sheet, which I may keep for my records.

   I understand this will involve
   - Allow the task and interview to be videotaped/audiotaped
   - Complete questionnaires asking me about my emotions
   - Make myself available for a further questionnaire that should be required

2. This information will be held and processed for the following purpose(s):
   I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party. No identifiable personal data will be published. The identifiable data will not be shared with any other organisation.
   I consent to the videotapes being shown to other researchers and interested professionals and I consent to the use of sections of the videotapes in publications.

3. I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalized or disadvantaged in any

way.

4. I agree to City University London recording and processing this information about me. I understand that this information will be used only for the purpose(s) set out in this statement and my consent is conditional on the University complying with its duties and obligations under the Data Protection Act 1998.

5. I agree to take part in the above study.

______________________ ______________________________

Name of Participant Signature Date

If you have any question about this study please contact Mobina Nouri by Phone: [redacted] or Email [redacted] or her supervisor Neil Maiden [redacted]).

3.7 Questionnaire at the end of the task

1. I was so involved in the task and I did not see **time** passing during it.

First Part	1	2	3	4	5	6	7
Second part	1	2	3	4	5	6	7

2. I was so involved in the task and I did not notice my **surroundings**.

First Part	1	2	3	4	5	6	7
Second part	1	2	3	4	5	6	7

3. During the task I **felt**:

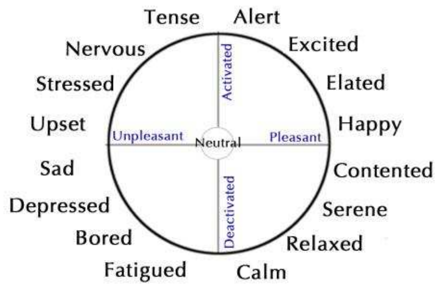
First part (brainstorming)								
	1	2	3	4	5	6	7	
Not in Control	○	○	○	○	○	○	○	In Control
Unrelaxed	○	○	○	○	○	○	○	Relaxed
Unstimulated	○	○	○	○	○	○	○	Stimulated
Unfocused	○	○	○	○	○	○	○	Focused
Not joyful	○	○	○	○	○	○	○	Joyful
Not motivated	○	○	○	○	○	○	○	Motivated
Uncreative	○	○	○	○	○	○	○	Creative
Unproductive	○	○	○	○	○	○	○	Productive
Not stressed	○	○	○	○	○	○	○	Stressed

Second Part (storyboarding)								
	1	2	3	4	5	6	7	
Not in Control	○	○	○	○	○	○	○	In Control
Unrelaxed	○	○	○	○	○	○	○	Relaxed
Unstimulated	○	○	○	○	○	○	○	Stimulated
Unfocused	○	○	○	○	○	○	○	Focused
Not joyful	○	○	○	○	○	○	○	Joyful
Not motivated	○	○	○	○	○	○	○	Motivated
Uncreative	○	○	○	○	○	○	○	Creative
Unproductive	○	○	○	○	○	○	○	Productive
Not stressed	○	○	○	○	○	○	○	Stressed

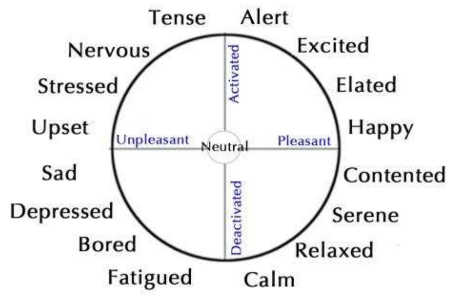
3.8 Questionnaire during the study

1. **Emotion self-assessment questionnaire before starting**
2. **Emotion self-assessment questionnaire after divergent task**
3. **Emotion self-assessment questionnaire after convergent task**

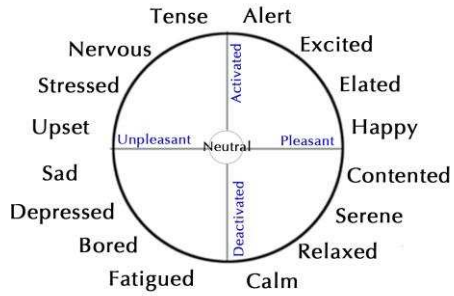
1
How do you feel now?
Please select one of the emotions around the circle that is closer to yours.



2
How do you feel now?
Please select one of the emotions around the circle that is closer to yours.



3
How do you feel now?
Please select one of the emotions around the circle that is closer to yours.



3.8 Designer's comments after finishing the task

Group1- Aligned: Start by activated and then follows by deactivation space

Group2- Unaligned: Start by deactivation and then follows by activated space

Participants Comment						
Aligned space						
ID	**Animation**	**Music**	**Activated Space**	**Deactivated space**	**Preferred Space**	**Creative space**
8	Made me relaxed. No distraction. Sometimes take a look and coming back to the task.	Very relaxing. Really Enjoyed indeed.	Helped me to relax. The consequence of that was second part that made me focused.	I like quiet spaces to work. After relaxing in the first part it was motivational and concentrative.	Activated	Activated
10	Very good. Felt better. No distraction at all. Did not notice them exactly.	Very nice and calm.	Good. The animation and music made the space warm and fresh enough to work.	Not good.	Activated	None
12	Very Nice. I enjoyed.	Liked it. Made me more focused.	Good. Music and animation made a wall to feel I m in my private space.	Was good. Made me more focused and I need more concentration for storyboarding.	Activated	Activated
14	Distracting.	Less affective than visual. Calming.	Stimulated and a bit distractive.	Much easier to concentrate and loose myself in the task.	Deactivated	Activated
13	Did not pay attention. Consciously not involving in the animation.	Likes and prefers to have music (noise) when I work. It stirs up the environment.	Warmed me up.	Did not like it. Made me feel like exam pressure with the silent. Made me stressed a bit.	Activated	Activated
15	I was aware but not distracting.	Was not distracting. Comfortable and nice. I focused more.	Enjoyed it and create ideas. Less pressure.	I made more connection between my ideas. It was perfect for the task.	Activated	Activated
17	I did not affect too much. (A few of them distracted me).	Relaxing	More calm. I came up with more ideas. Felt better.	Was stressful. I was involved in the task. The perception of time was different compared to activated space.	Activated	Activated
19	No distraction. I liked them.	Good	Informal. Stimulated and relaxed. I felt different.	Good. I could focus more.	Activated	Activated
21	I stayed more focus on the task.	I noticed that.	I liked it and felt different.	I Was more concentrated.	Activated	Activated
23	I was pleasantly distracted but still focus on the task.	Very good to drown in the task.	Good.	Liked it.	Activated	Activated
25	In the beginning was very abstract and distractive in a positive way.	Calm and in some part intense. So it helps me to think about task. And it was different.	I felt in flow. First was a bit distractive but I was floating on that. Very inspiring and came up with some ideas in relation	Was good to focus. But I was more aware of the environment and felt frustrated.	Activated	Activated

			to what I saw in the pictures.			
27	Stimulating. No distraction. Focused more on the task.	Calm	Good and prefer it.	More distracting. Silent is a distraction for me.	Activated	Activated
28	Unexpected. I did not notice.	Was alright and relaxing.	Was in the flow.	In a short time is ok. I felt more focused.	Activated	Deactivated
29	A bit distraction. First was bothering. But interesting	Nice and relaxing music	Interesting and different	Was really good for focusing.	Activated	Activated
7	In the beginning was a bit distracting but I used to the space and I only see the post it notes.	Was different. I was listening to the music and it influenced on my work. (Slow and fast rhythms)	It was good. It depends the task.	It was good for 10 mins but after that I become bored.	Activated	Activated
5	Cloud was good. Some animation was annoying.	Very relaxing. Loved it.	Very good for idea generation. More relaxed.	Was ok. I had to act on my.	Activated	Activated
33	Some animation was distractive just for a second.	Reminds me of a video game .I liked it. Let my mind goes.	Nice I prefer it.	Concentrate more. Time was faster. Was good.	Activated	Deactivated
32	I did not perceive the animation. Then I saw them but it was not distractive.	Liked it.	It gave me the flow and I liked it by the time.	More private. It was Ok.	Activated	Activated
38	At First a bit distraction but in a positive way.	Liked it. Gave me the location and focus attention.	It can help me to spread my thoughts.	In general I liked it. I was able to focus and do the task.	Deactivated	Activated
37	I knew it was there and I ignored it. No distraction at all.	Relaxing.	Was good.	Was Ok. I m familiar to focus on the task in a quiet space.	Activated	Activated

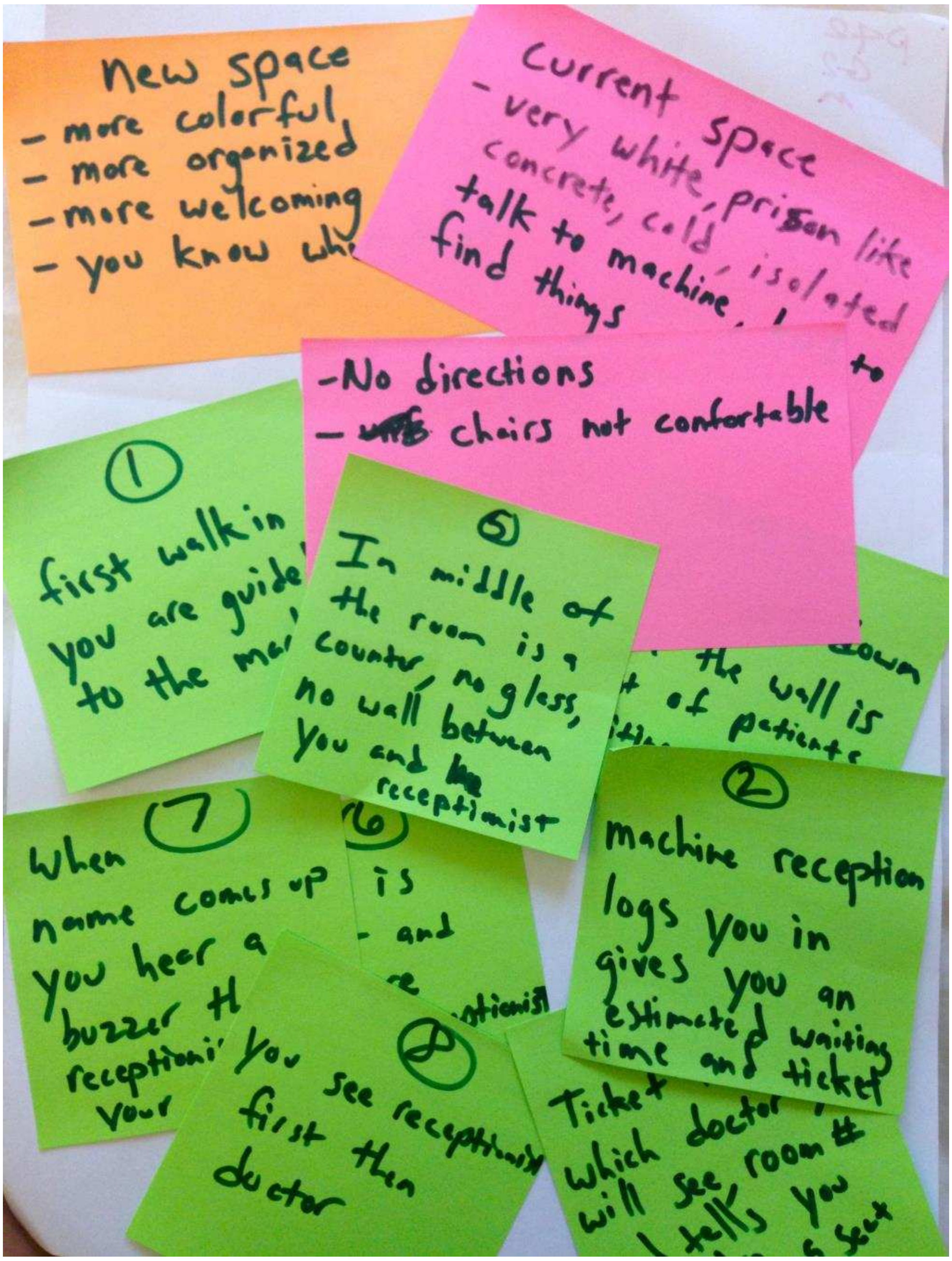
Unaligned space

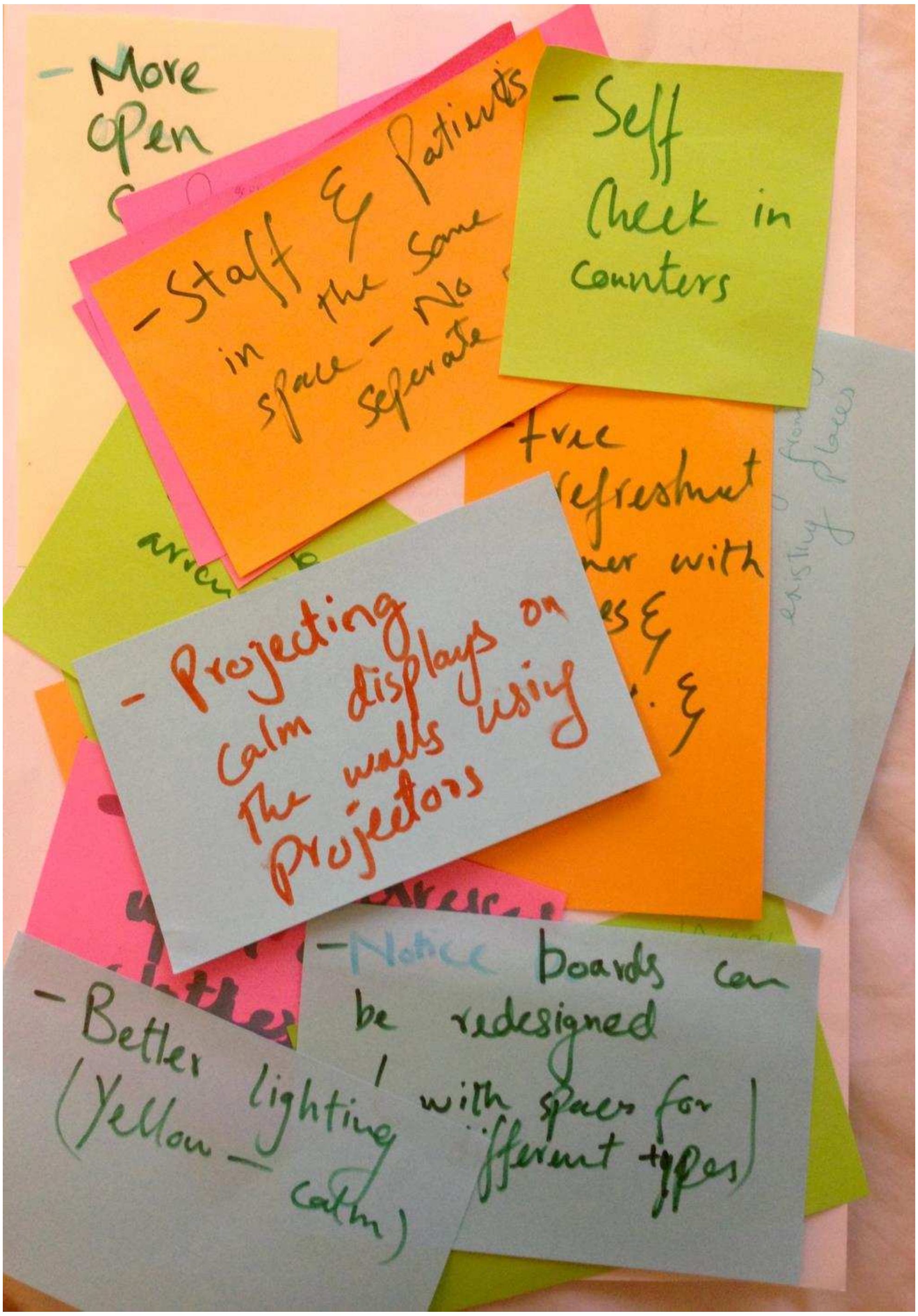
ID	Animation	Music	Activated Space	Deactivated Space	Preferred Space	Creative space
11	I could not see them cause I was immersed in the task.	Suiting and calm.	Nice background for work.	I don't mind. When I m in to the task, silence is useful.	Activated	Activated
12	Made me think about nature as a metaphor to use in some of my ideas.	Different and Unfamiliar music made me think about new things.	Interesting and different. Made me slow down. Changed my thought in a positive way.	It was Ok.	Activated	Activated
14	Did not like the animation.	Helped me to focus and relax. I liked it however was not my music style.	It was distracting but I focused on the task and I was not aware of surrounding.	I do like it. But I prefer to have music.	Activated	Activated
16	Very distractive. I could not focus. The images	Good without animation.	Was too much and made me stressed. The pictures were attractive not inspiring. And make my attention out of the task.	Too neutral. Boring not inspiring.	Activated	Deactivated
18	Distractive. I was aware of them.	Was Ok.	More relaxing	Was Ok. Could focus more.	Activated	Activated
20	Hate it.	Did not notice the	Did not like it.	Perfect.	Activated	Activated

	Distracting and so annoying.	music.	Horrible especially some lights in animation.			
22	Was a distraction when it comes to my paper.	Liked it. I felt like I am in the competition to win.	Distractive.	I liked it but if it was more in time I became bored.	Deactivated	Deactivated
24	A little bit annoying. At first more distraction and then I focused in to the task.	Calming.	Distractive.	I used to quite space. I do like it.	Deactivated	Deactivated
26	A little distraction. But I forgot it by time and I focused more on the task.	Was nice with variety.	Very nice and different.	Boring and dry for me.	Activated	Deactivated
30	A bit distraction. I liked that distraction.	I really Loved it. Made me concentrated.	My focus was only on task even if I take a look on the pictures.	Just normal. Felt in flow.	Activated	Activated
31	Some of them were distractive. Overall I liked them.	Was very suiting. Good and made me focused. It makes a wall around me to concentrate.	Liked it. I was taking a look on animation said nice and my mind coming back to it.	Was Ok.	Deactivated	Activated
9	Was random and not distracting.	Very relaxing. Good	When I looked at animation It was a little bit distraction.	Very good	Deactivated	Deactivated
6	It was not related to the task, a bit distractive. I ignored it and didn't pay attention	Nice music. Less distractive.	I tried to focus. At first was a bit distracting but nice when I used to it. In one moment I distracted but come back to the task again. Pleasant.	Was Ok.	Deactivated	Deactivated
34	I really appreciate it. No distraction.	Helped me to focus in the task. Was relaxing in a positive way.	I enjoyed because it helps me to focus and motivate to create a micro space for me. And makes the space more isolated in a positive way.	I focused and thought. I was in the flow.	Deactivated	Deactivated
39	Very good. Some birds that flied made me distracted and stopped my brain for second and then I started again my ideas.	I liked it.	My brain was stimulated.	Made me feel anxious and worried.	Deactivated	Deactivated
36	I was alone with my ideas. Change in animation makes me to think of linked ideas animation.	Really liked it. It added a narrative drama to my storyboard. Interactive to my feelings.	I was aware of environment.	Movement distraction helped me to calm down, and keep me going and drowning into the task.	Deactivated	Deactivated
35	Was distractive and surprising. It made me more serene and I was ignoring it and was ok.	Was Ok. Relaxing.	A little bit distracting. I used to work in Silent.	Very strange, specially in the beginning Interesting when animation changed. But I ignored it.	Deactivated	Deactivated
43	Annoying. Distractive. Lost	Was good	Was more focused on the task with pressure	Good.	Deactivated	Deactivated

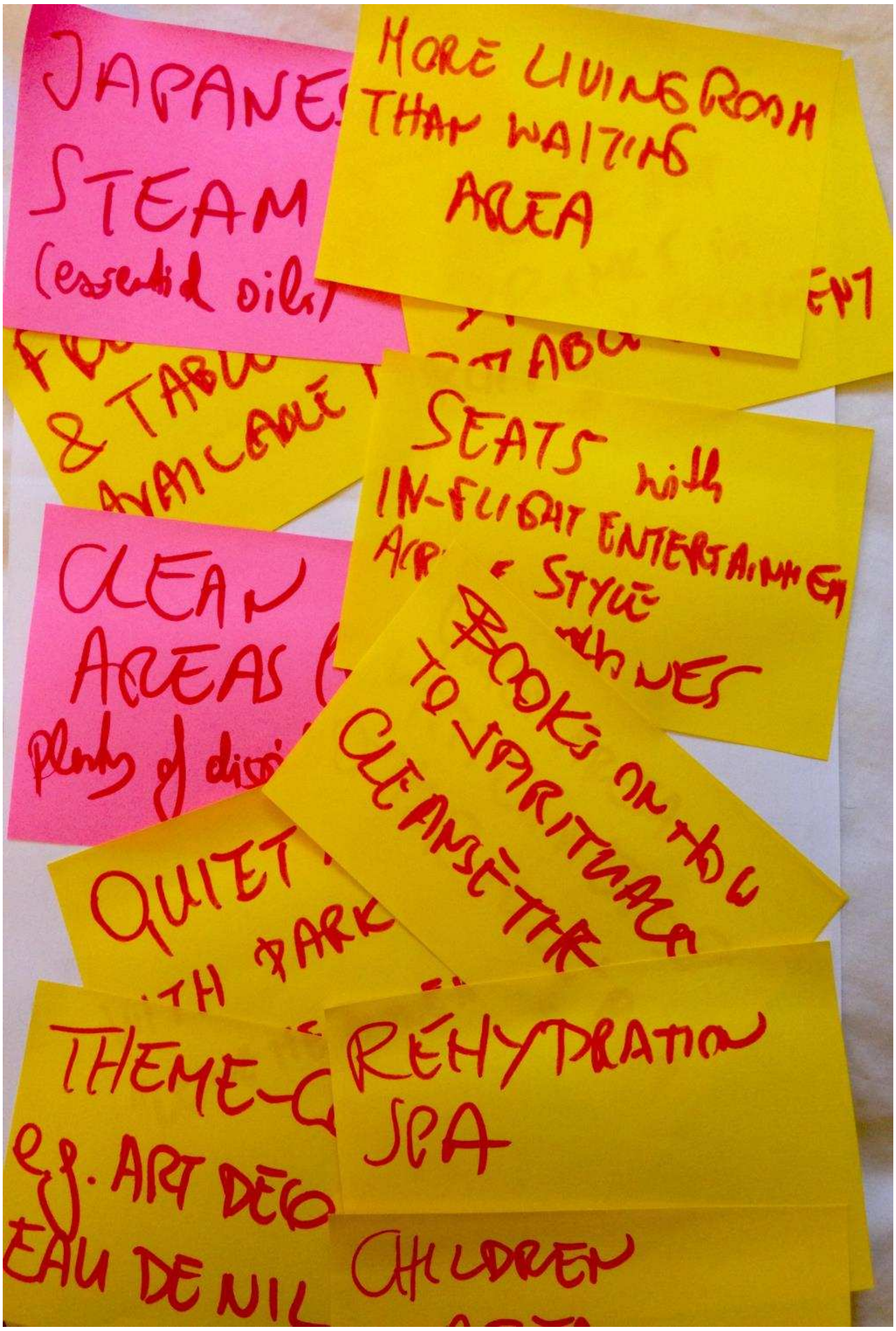
	my focus.		of time.			
42	Just noticed them at the end.	Good and made some difference and helped me to relax.	Was very focused in the task.	Very good. Inspiring. Silence and freedom.	Deactivated	Deactivated
41	I liked the visual in the background.	Was Kind of distraction but I loved it.	Liked the visual in the background.	My favorite.	Deactivated	Deactivated
40	In the beginning was distractive. Then I used to it and ignored it.	Calming. It kept me in the same level.	Was ok.	Was Fine.	Deactivated	Deactivated

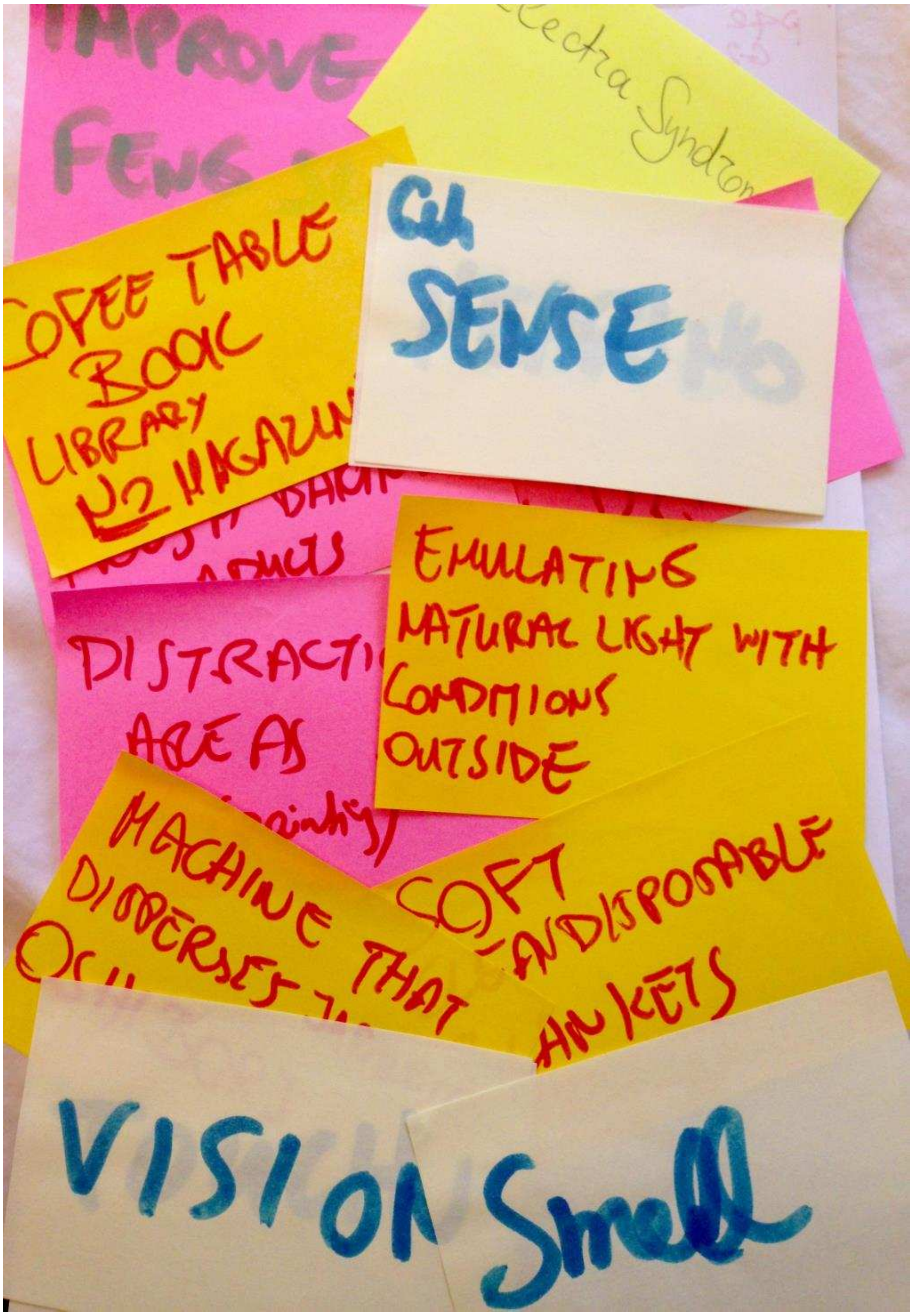
3.9 Participants' Brainstorming



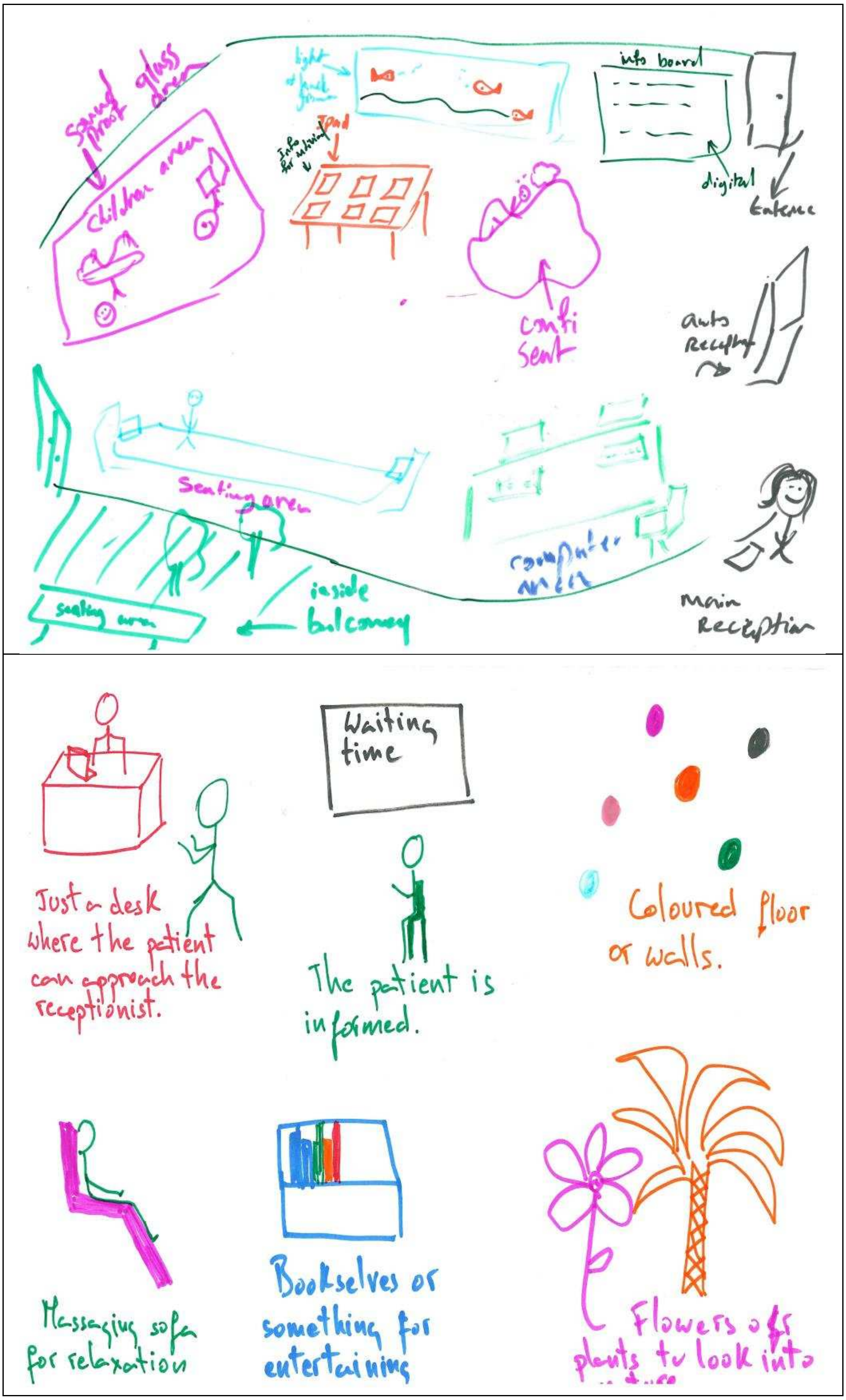


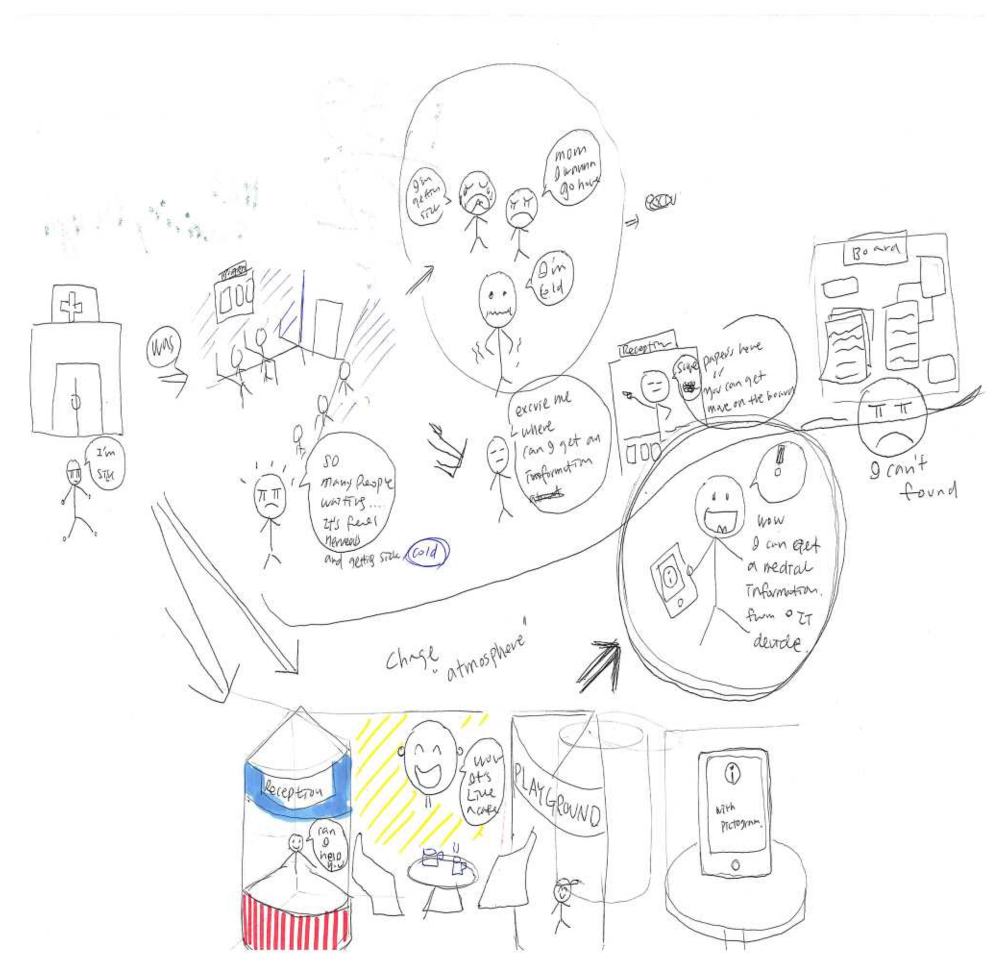
- More Open
- Staff & Patients in the same space - No seperate
- Self check in counters
- Free refreshment
- Projecting calm displays on the walls using projectors
- Notice boards can be redesigned with spaces for different types)
- Better lighting (Yellow - calm)

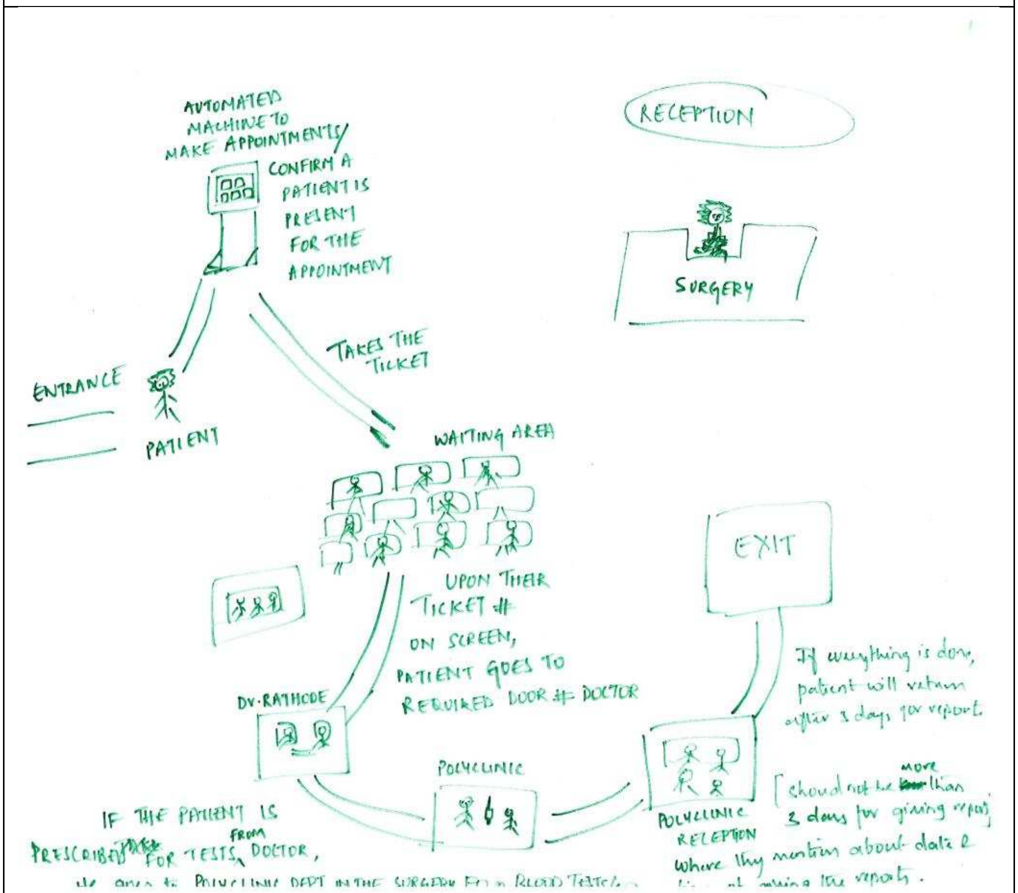

JAPANES
STEAM
(essential oils)
MORE LIVING ROOM THAN WAITING AREA
SEATS with
IN-FLIGHT ENTERTAINMENT
STYLE
CLEAN
AREAS
QUIET
THEME-
e.g. ART DECO
EAU DE NIL
REHYDRATION SPA
CHILDREN

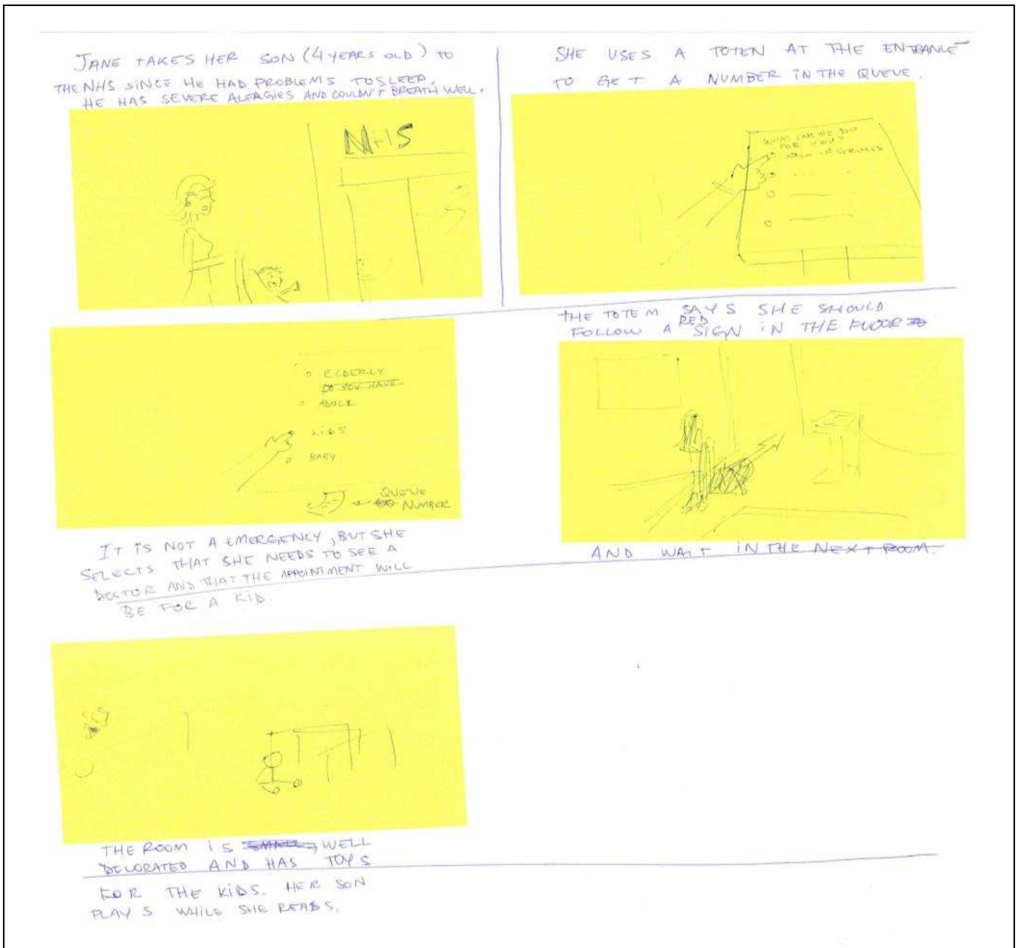

IMPROVE
FENG
Electra Syndrom
COFEE TABLE
BOOK
LIBRARY
MAGAZINE
SENSE
EMULATING
NATURAL LIGHT WITH
CONDITIONS
OUTSIDE
DISTRACTI
AREAS
MACHINE THAT
DISPERSES
SOFT
AND DISPOSABLE
BLANKETS
VISION
Smell

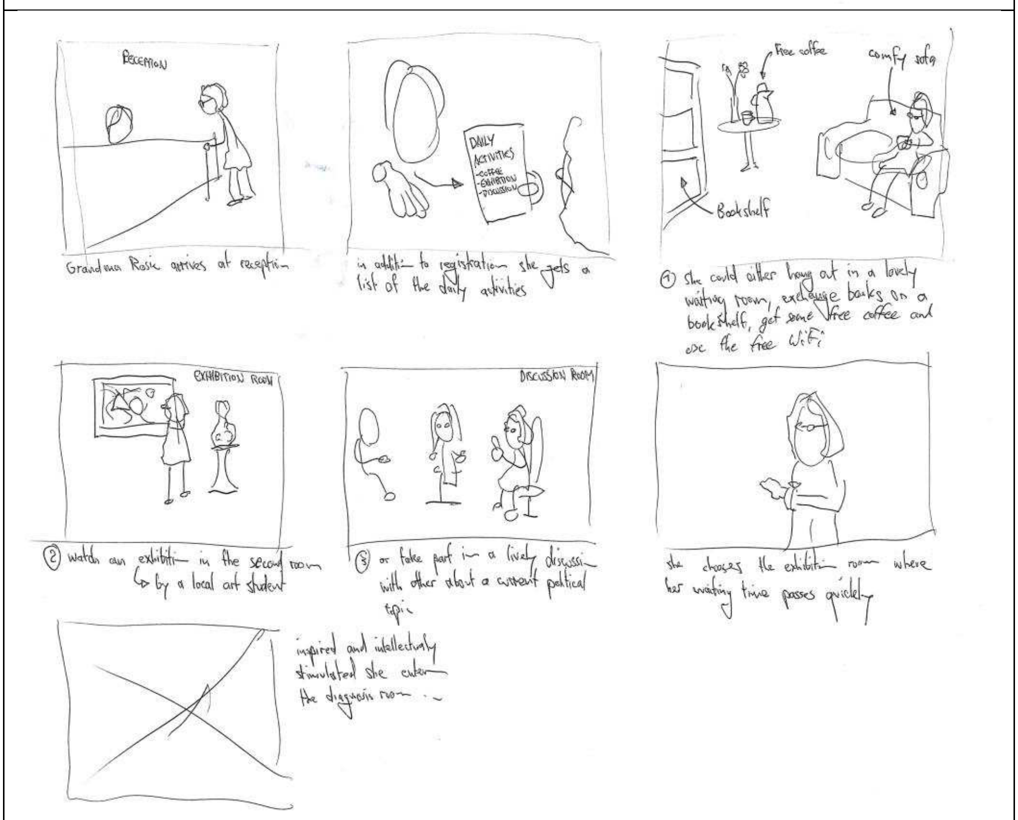
3.10 Participants' Storyboards




I'm sick
Was
So many people waiting... It's feel nervous and getting sick
cold
mom I wanna go home
I'm cold
excuse me where can I get an information
Reception
papers here or you can get more on the board
Board
I can't found
wow I can get a medical information from IT device
Change "atmosphere"
Reception
Can I help you
wow it's like a cafe
PLAYGROUND
with pictogram


AUTOMATED MACHINE TO MAKE APPOINTMENTS/
CONFIRM A PATIENT IS PRESENT FOR THE APPOINTMENT
RECEPTION
SURGERY
ENTRANCE
PATIENT
TAKES THE TICKET
WAITING AREA
EXIT
UPON THEIR TICKET # ON SCREEN, PATIENT GOES TO REQUIRED DOOR # DOCTOR
If everything is done, patient will return after 3 days for report.
Dr. RATHODE
POLYCLINIC
POLYCLINIC RECEPTION
[should not be more than 3 days for giving report]
where they mention about date & time of giving the reports.
IF THE PATIENT IS PRESCRIBED FOR TESTS, FROM DOCTOR,

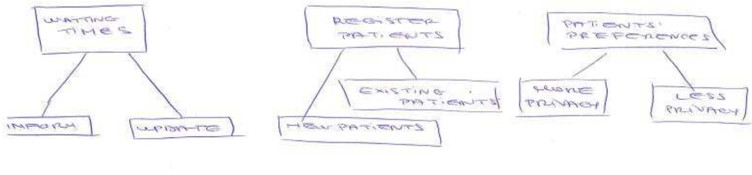

JANE TAKES HER SON (4 YEARS OLD) TO THE NHS SINCE HE HAD PROBLEMS TO SLEEP, HE HAS SEVERE ALERGIES AND COULDN'T BREATH WELL.
NHS
SHE USES A TOTEN AT THE ENTRANCE TO GET A NUMBER IN THE QUEUE.
ELDERLY
~~DO YOU HAVE~~
ADULT
KIDS
BABY
QUEUE NUMBER
IT IS NOT A EMERGENCY, BUT SHE SELECTS THAT SHE NEEDS TO SEE A DOCTOR AND THAT THE APPOINTMENT WILL BE FOR A KID.
THE TOTEM SAYS SHE SHOULD FOLLOW A RED SIGN IN THE FLOOR
AND WAIT IN THE NEXT ROOM.
THE ROOM IS ~~SMALL~~, WELL DECORATED AND HAS TOYS FOR THE KIDS. HER SON PLAYS WHILE SHE READS.


RECEPTION
Grandma Rosie arrives at reception
DAILY ACTIVITIES
-COFFEE
-EXHIBITION
-DISCUSSION
in addition to registration she gets a list of the daily activities
Free coffee
comfy sofa
Bookshelf
① She could either hang out in a lovely waiting room, exchange books on a bookshelf, get some free coffee and use the free WiFi
EXHIBITION ROOM
② watch an exhibition in the second room
by a local art student
DISCUSSION ROOM
③ or take part in a lively discussion with other about a current political topic
she chooses the exhibition room where her waiting time passes quickly
inspired and intellectualy stimulated she enters the diagnosis room ...


1
Marie goes to her first NHS appointment
NHS
2 She is from France and recently moved to London. She speaks English well but is happy to see that she can interact with the board in French.
Welcome
Bienvenue
Bienvenido
She can also talk to the receptionist, who is behind a desk but not in a cubicle
But it is clear from the sign that she needs to confirm her appointment
3
Marie selects French. She is asked to enter her DOB to confirm appointment
The screen tells her she has done so successfully.
She needs to wait now.
4 She sees the seating area on her right.
(Table)
She is pleased by the colour of the seats, there are other patients waiting
5

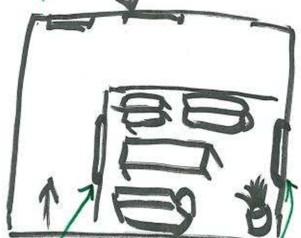
Assistant (front-~~desk~~) — keep waiting times updated (if not done manually by system)

- inform patients of their remaining waiting time
- register/sign-up patients
- ask patients if they would like to take a seat in the more private or in the common waiting area
- provide patient with
  - a personal waiting time (in the form of a ticket with numbers OR in the form of a personal code that will display info about the waiting time)
  - a general waiting time (display system)
- inform patient when it's their turn to be seen by a doctor (send message through phone app containing room number or doctor's name)



Patient arrives at health centre
Can check in using touchscreen display
- enter name + appointment time

staff at reception desk to assist when necessary

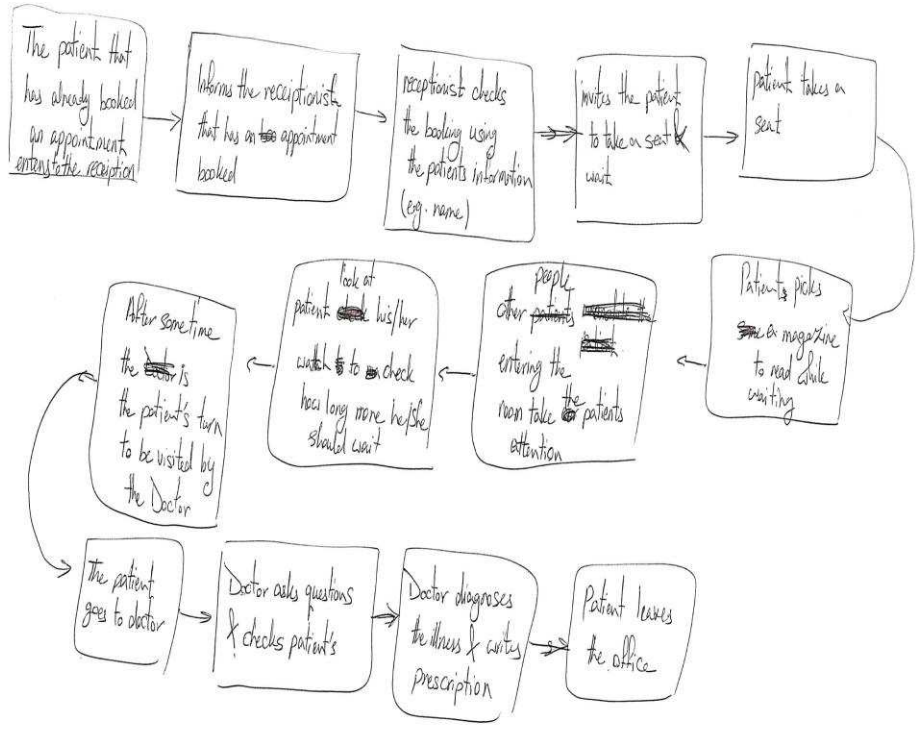


Multiple display boards show patients who have checked-in ~~when~~ order of appointments

PATIENT	DOCTOR
SMITH	~~~
JONES	- ~

comfortable fabric chairs + small sofas instead of plastic chairs

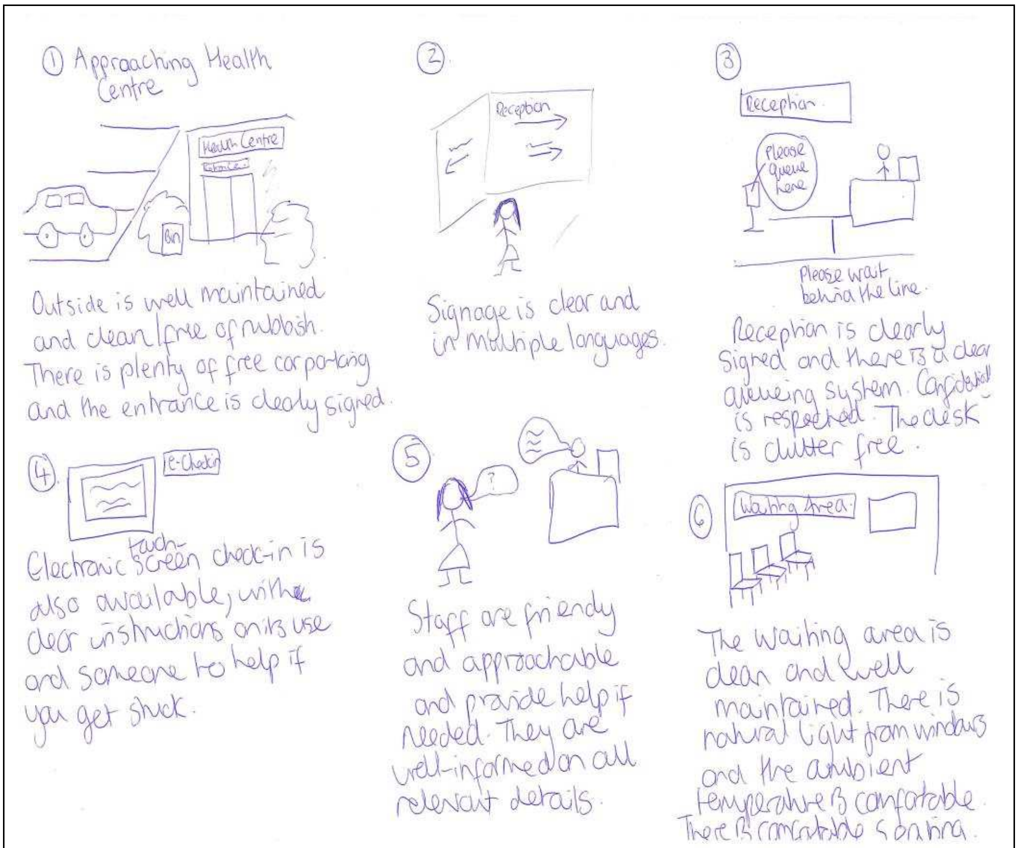
Patients know number of patients ahead of them
Displayed both sides of seating

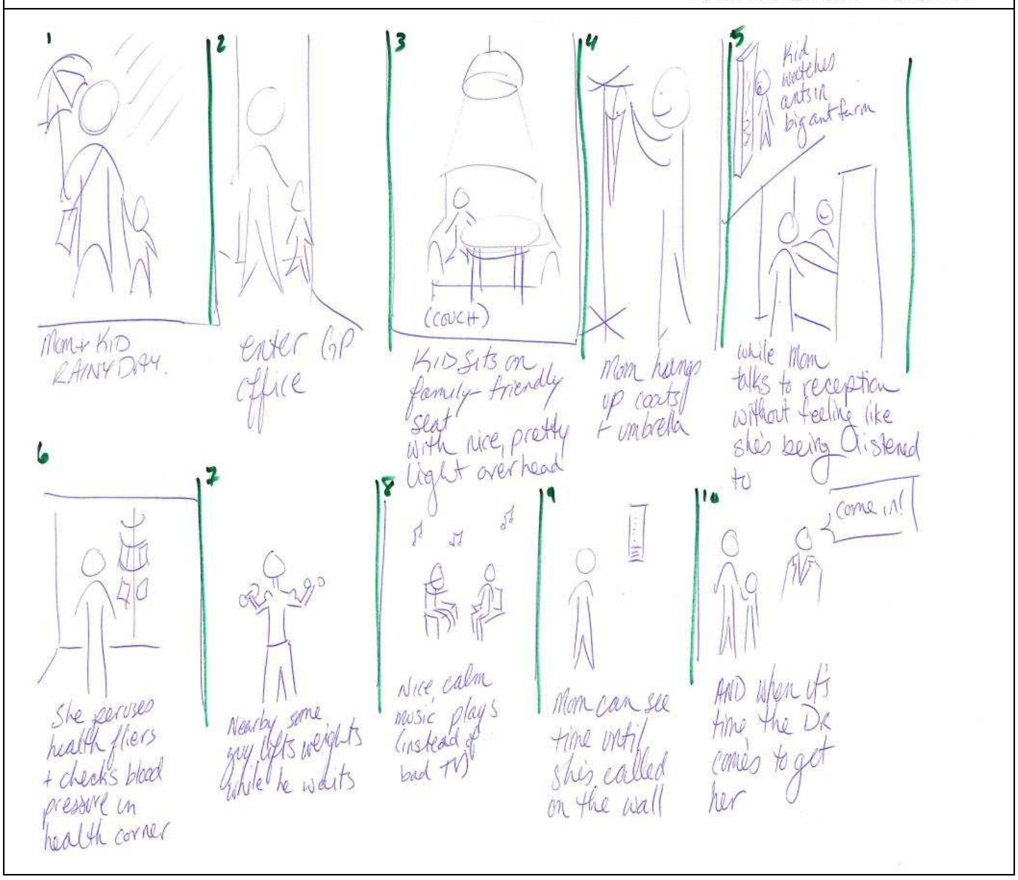


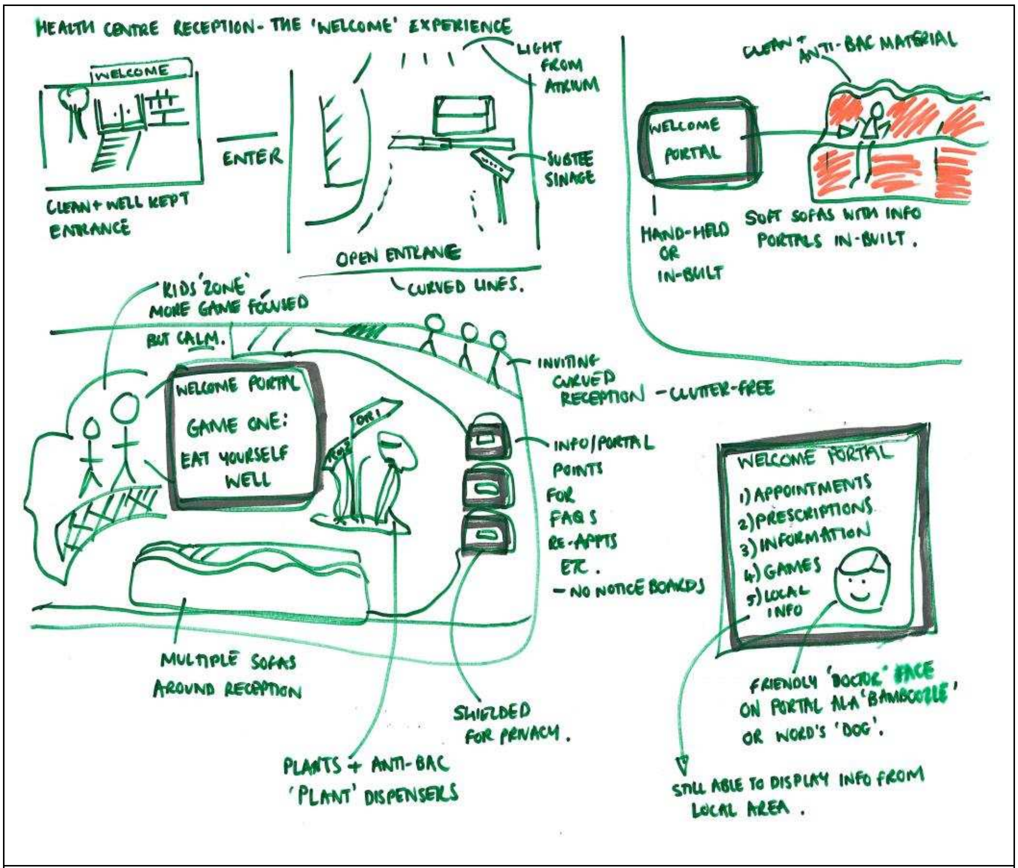
JOHN AND HIS CHILD GO TO A NHS HEALTHY CENTER TO VERIFY AN SKIN ALLERGY. AS THEY ENTER, THERE IS A OPEN SPACE TO PATIENS MAKE A QUICK LINE. THE RECEPTIONIST CALL ACCORDING TO THE ORDER OR URGENCY, AS WRITEN IN AN AD. MEANWHILE THEY NOTICED THE PLAYGROUND AND TOYS FOR CHILDREN. THE KID IS HAPPY NOW!

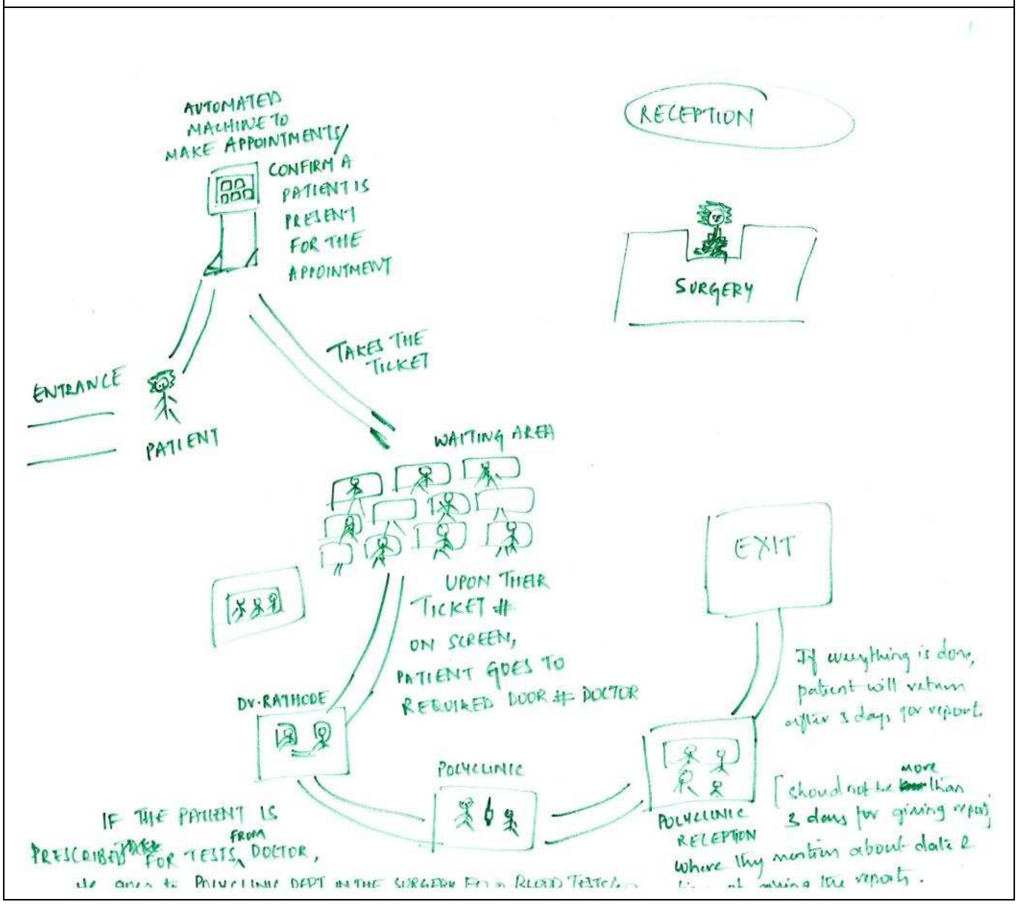
JOHN COME TO THE TABLE AND THE RECEPTIONIST IS SMILING. HE HAS HIS APPOINTMENT. WHILE WAINTING, HE REALIZES A PATIENT THAT ~~COULD~~ SEEMS TO BE WITH A CONTAGIOUS PATOLOGY IS IN HEADED TO ANOTHER ROOM.

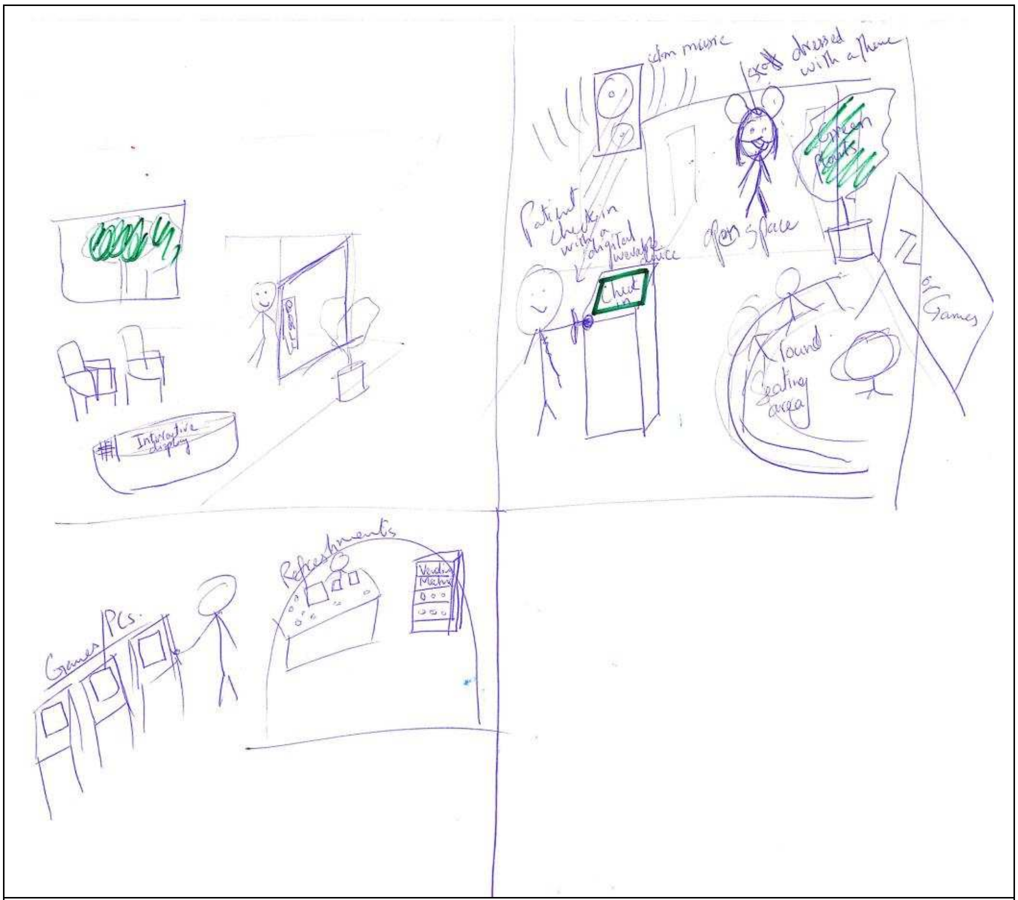
JOHN CHOSES A SUDOKU GAME TO SPEND HIS TIME UNTIL THE APPOINTMENT. THE KID IS STILL PLAYING IN THE PLAYGROUND

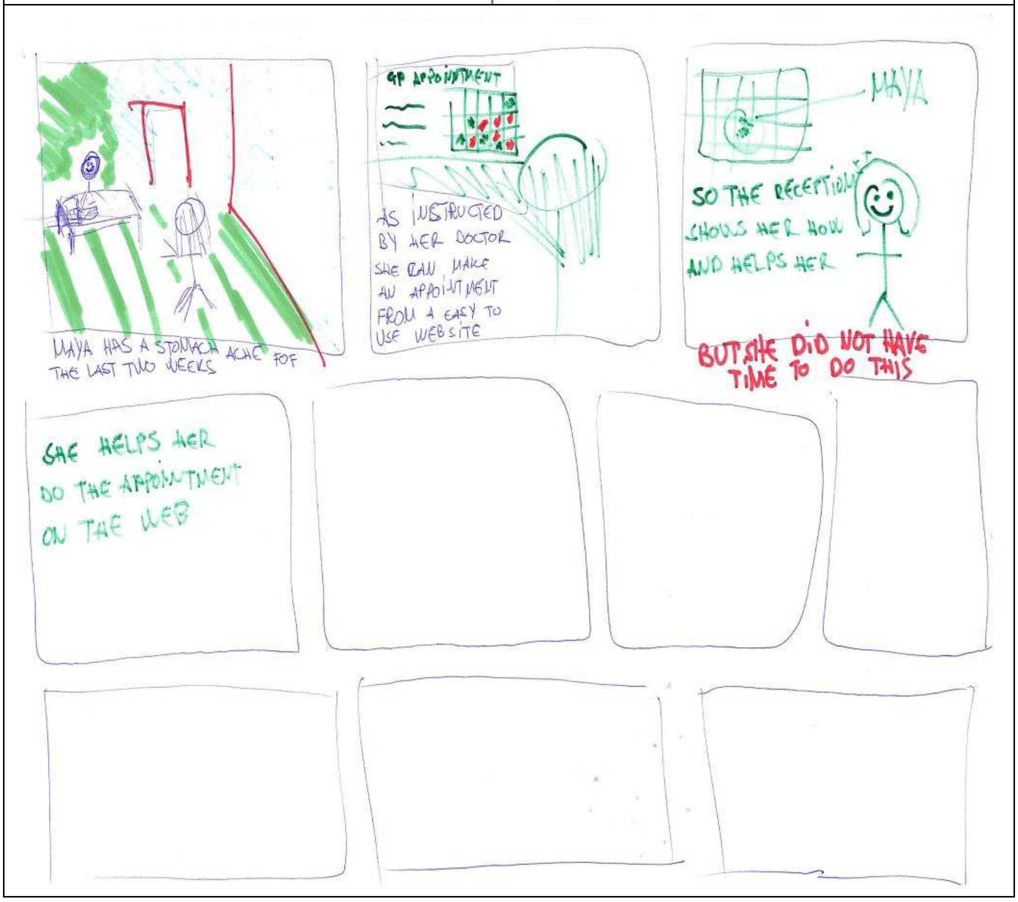

1 Approaching Health Centre
Health Centre
Outside is well maintained and clean/free of rubbish. There is plenty of free car parking and the entrance is clearly signed.
2
Reception
Signage is clear and in multiple languages.
3
Reception
Please queue here
Please wait behind the line.
Reception is clearly signed and there is a clear queueing system. Confidentiality is respected. The desk is clutter free.
4
E-Check in
Electronic touch-screen check-in is also available, with clear instructions on its use and someone to help if you get stuck.
5
Staff are friendly and approachable and provide help if needed. They are well-informed on all relevant details.
6
Waiting Area
The waiting area is clean and well maintained. There is natural light from windows and the ambient temperature is comfortable. There is comfortable seating.

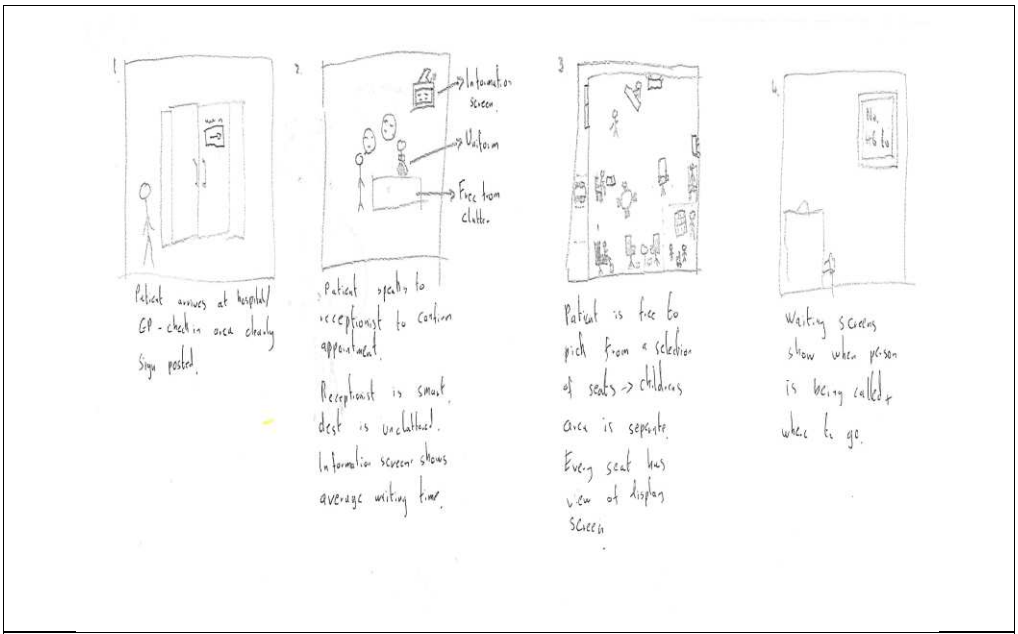

1
Mom + Kid RAINY DAY.
2
enter GP office
3
(COUCH)
KID sits on family-friendly seat with nice, pretty light overhead
4
Mom hangs up coats + umbrella
5
Kid watches ants in big ant farm
while Mom talks to reception without feeling like she's being listened to
6
She peruses health fliers + checks blood pressure in health corner
7
Nearby some guy lifts weights while he waits
8
Nice, calm music plays (instead of bad TV)
9
Mom can see time until she's called on the wall
10
Come in!
AND when it's time the DR comes to get her


HEALTH CENTRE RECEPTION - THE 'WELCOME' EXPERIENCE
WELCOME
CLEAN + WELL KEPT ENTRANCE
ENTER
LIGHT FROM ATRIUM
SUBTLE SINAGE
OPEN ENTRANCE
CURVED LINES.
WELCOME PORTAL
HAND-HELD OR IN-BUILT
ANTI-BAC MATERIAL
SOFT SOFAS WITH INFO PORTALS IN-BUILT.
KIDS 'ZONE' MORE GAME FOCUSED BUT CALM.
INVITING CURVED RECEPTION - CLUTTER-FREE
WELCOME PORTAL
GAME ONE:
EAT YOURSELF WELL
INFO/PORTAL POINTS FOR FAQS RE-APPTS ETC.
- NO NOTICE BOARDS
WELCOME PORTAL
1) APPOINTMENTS
2) PRESCRIPTIONS
3) INFORMATION
4) GAMES
5) LOCAL INFO
MULTIPLE SOFAS AROUND RECEPTION
SHIELDED FOR PRIVACY.
PLANTS + ANTI-BAC 'PLANT' DISPENSERS
FRIENDLY 'DOCTOR' FACE ON PORTAL ALA 'BAMBOOZLE' OR WORD'S 'DOG'.
STILL ABLE TO DISPLAY INFO FROM LOCAL AREA.

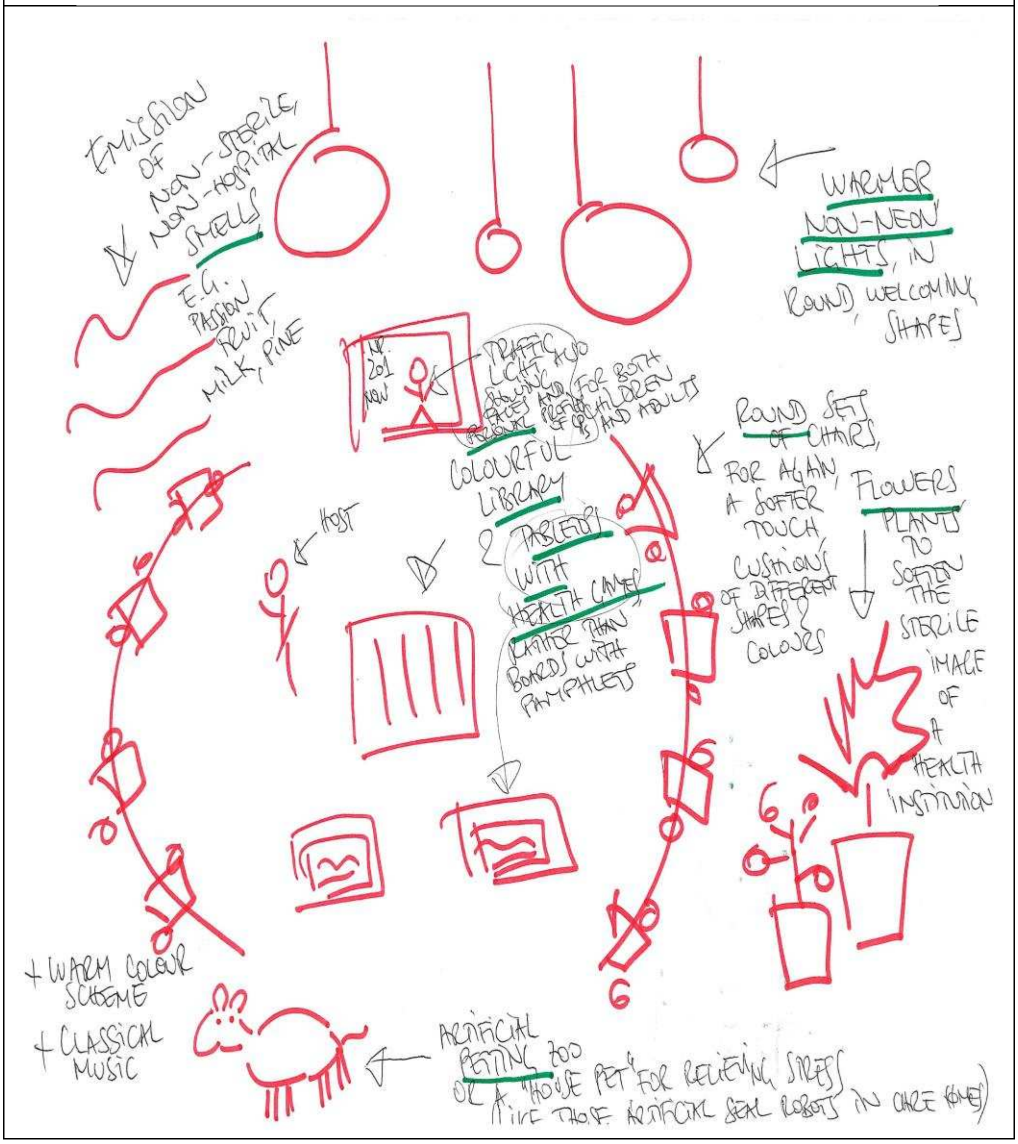

AUTOMATED MACHINE TO MAKE APPOINTMENTS/
CONFIRM A PATIENT IS PRESENT FOR THE APPOINTMENT
RECEPTION
SURGERY
ENTRANCE
PATIENT
TAKES THE TICKET
WAITING AREA
EXIT
UPON THEIR TICKET # ON SCREEN, PATIENT GOES TO REQUIRED DOOR # DOCTOR
If everything is done, patient will return after 3 days for report.
DR. RATHODE
POLYCLINIC
POLYCLINIC RECEPTION
[should not be more than 3 days for giving report]
IF THE PATIENT IS PRESCRIBED FOR TESTS, FROM DOCTOR,
where they mention about date &


calm music
staff dressed with a theme
Patient check-in with a digital wearable device
open space
Chat
TV or Games
round seating area
Interactive display
Games PCs
Refreshments
Vending Machine

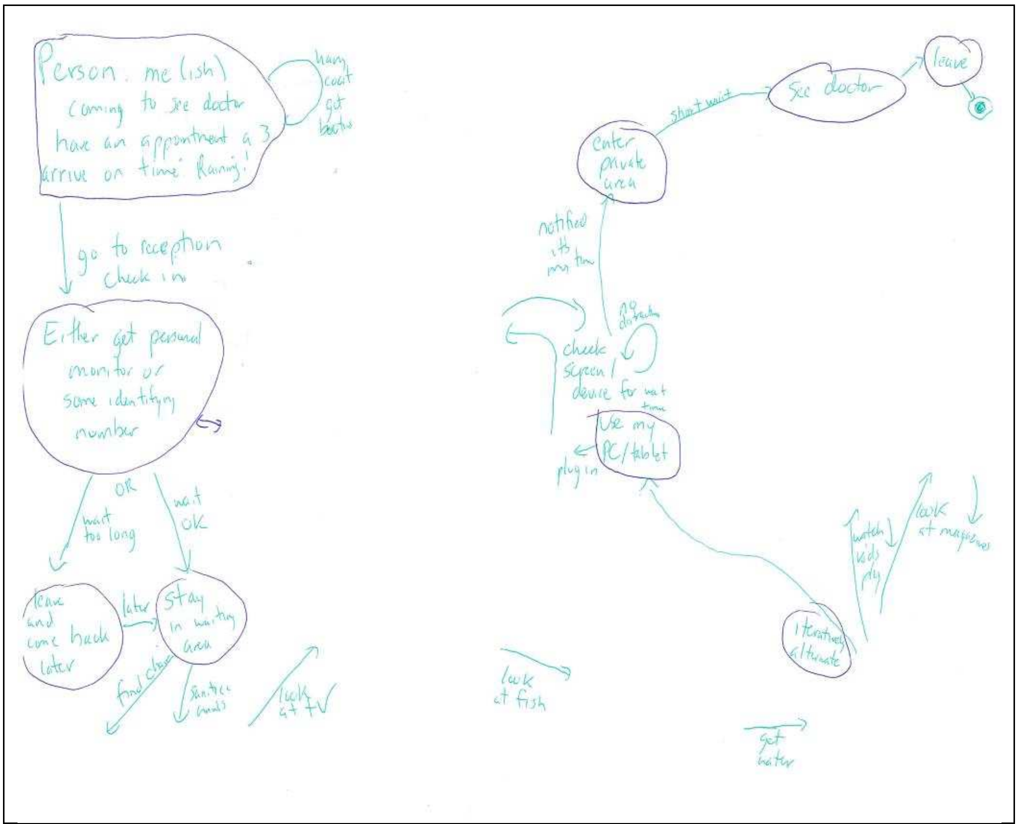

MAYA HAS A STOMACH ACHE FOF THE LAST TWO WEEKS
GP APPOINTMENT
AS INSTRUCTED BY HER DOCTOR SHE CAN MAKE AN APPOINTMENT FROM A EASY TO USE WEBSITE
MAYA
BUT SHE DID NOT HAVE TIME TO DO THIS
SO THE RECEPTIONIST SHOWS HER HOW AND HELPS HER
SHE HELPS HER DO THE APPOINTMENT ON THE WEB

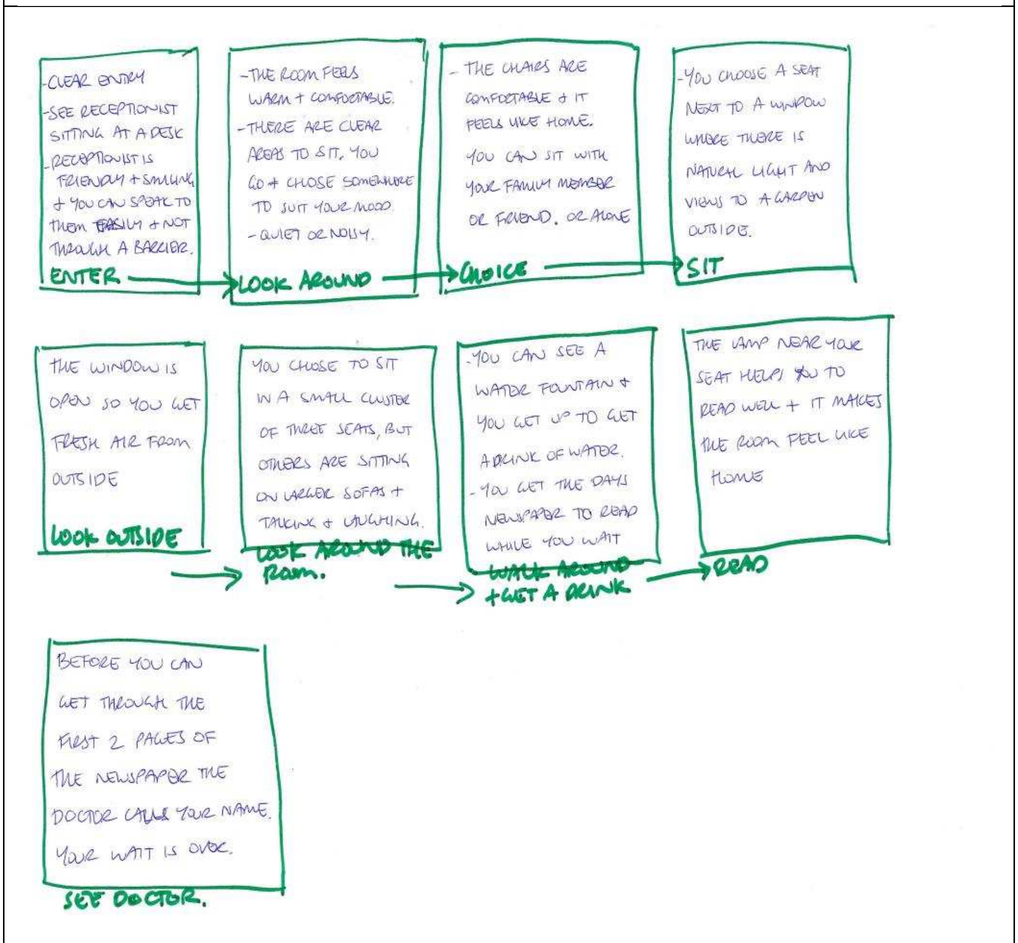


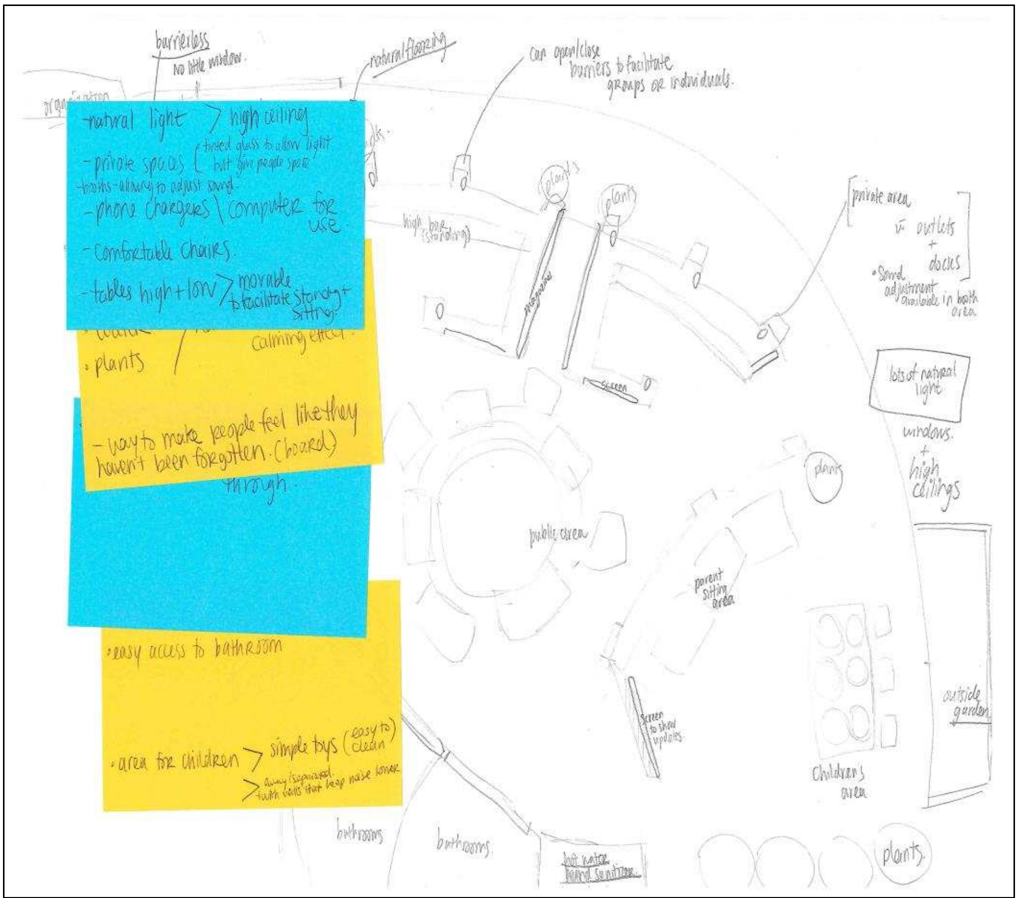
1
Patient arrives at hospital/ GP - check in area clearly signs posted.
2
Information screen.
Uniform
Free from clutter.
Patient speaks to receptionist to confirm appointment.
Receptionist is smart, desk is uncluttered. Information screen shows average waiting time.
3
Patient is free to pick from a selection of seats -> childrens area is separate. Every seat has view of display screen
4
Waiting screens show when person is being called + where to go.

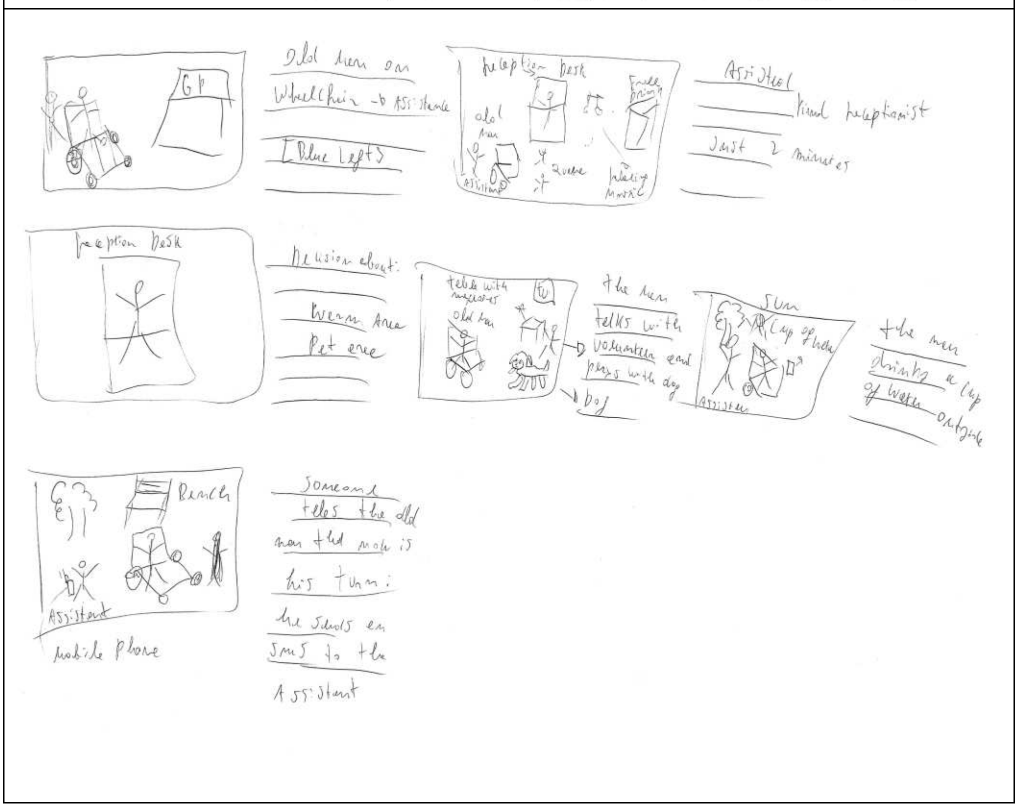


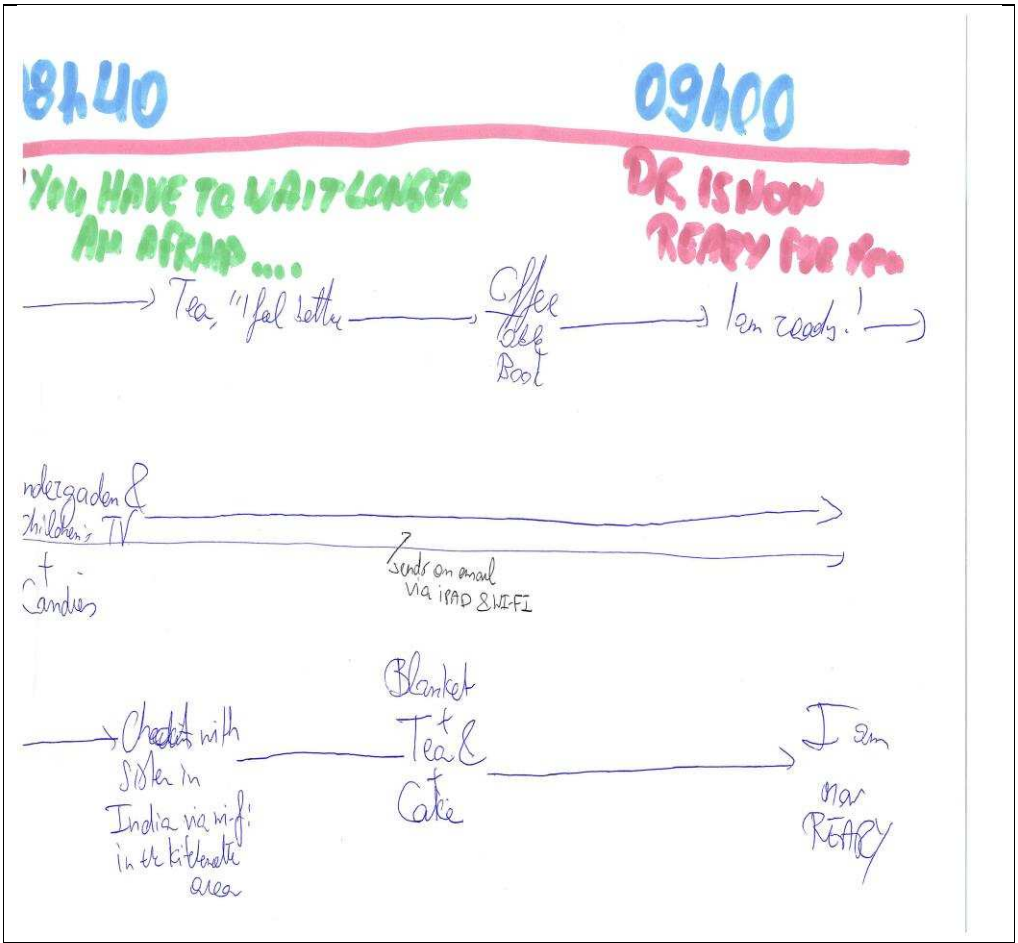
EMISSION OF NON-STERILE, NON-HOSPITAL SMELLS
E.G. PASSION FRUIT, MILK, PINE
WARMER NON-NEON LIGHTS, IN ROUND, WELCOMING SHAPES
NO. 201 NOW
COLOURFUL LIBRARY
HOST
TABLETS WITH HEALTH GAMES RATHER THAN BOARDS WITH PAMPHLETS
ROUND SET OF CHAIRS, FOR AGAIN A SOFTER TOUCH
CUSHIONS OF DIFFERENT SHAPES & COLOURS
FLOWERS PLANTS TO SOFTEN THE STERILE IMAGE OF A HEALTH INSTITUTION
+ WARM COLOUR SCHEME
+ CLASSICAL MUSIC
ARTIFICIAL PETTING ZOO OR A 'HOUSE PET' FOR RELIEVING STRESS (LIKE THOSE ARTIFICIAL SEAL ROBOTS IN CARE HOMES)

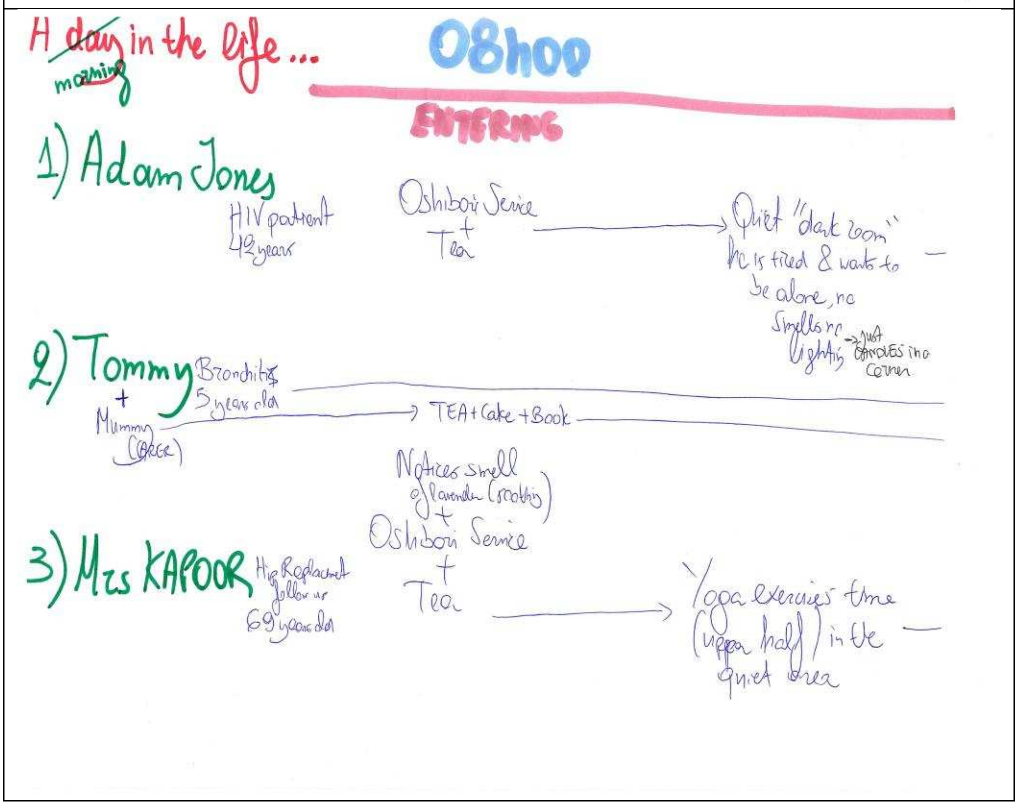

Person: me (ish)
coming to see doctor
have an appointment @ 3
arrive on time! Raining!
go to reception
check in
Either get personal monitor or some identifying number
OR
wait too long
wait OK
leave and come back later
later
stay in waiting area
find chair
sanitise hands
look at TV
look at fish
get water
Iterations alternate
watch kids play
look at magazines
check screen / device for wait time
no distraction
Use my PC/tablet
plug in
notified it's my time
enter private area
short wait
see doctor
leave


-CLEAR ENTRY
-SEE RECEPTIONIST SITTING AT A DESK
-RECEPTIONIST IS FRIENDLY + SMILING + YOU CAN SPEAK TO THEM EASILY + NOT THROUGH A BARRIER.
ENTER
-THE ROOM FEELS WARM + COMFORTABLE.
-THERE ARE CLEAR AREAS TO SIT, YOU GO + CHOSE SOMEWHERE TO SUIT YOUR MOOD - QUIET OR NOISY.
LOOK AROUND
- THE CHAIRS ARE COMFORTABLE + IT FEELS LIKE HOME. YOU CAN SIT WITH YOUR FAMILY MEMBER OR FRIEND, OR ALONE
CHOICE
-YOU CHOOSE A SEAT NEXT TO A WINDOW WHERE THERE IS NATURAL LIGHT AND VIEWS TO A GARDEN OUTSIDE.
SIT
THE WINDOW IS OPEN SO YOU GET FRESH AIR FROM OUTSIDE
LOOK OUTSIDE
YOU CHOSE TO SIT IN A SMALL CLUSTER OF THREE SEATS, BUT OTHERS ARE SITTING ON LARGER SOFAS + TALKING + LAUGHING.
LOOK AROUND THE ROOM.
-YOU CAN SEE A WATER FOUNTAIN + YOU GET UP TO GET A DRINK OF WATER.
- YOU GET THE DAYS NEWSPAPER TO READ WHILE YOU WAIT
WALK AROUND + GET A DRINK
THE LAMP NEAR YOUR SEAT HELPS YOU TO READ WELL + IT MAKES THE ROOM FEEL LIKE HOME
READ
BEFORE YOU CAN GET THROUGH THE FIRST 2 PAGES OF THE NEWSPAPER THE DOCTOR CALLS YOUR NAME. YOUR WAIT IS OVER.
SEE DOCTOR.


barrierless
no little window.
natural flooring
can open/close barriers to facilitate groups or individuals.
-natural light > high ceiling
-private spaces
-phone chargers \ computer for use
-comfortable chairs.
-tables high+low > movable to facilitate standing+ sitting
calming effect
plants
- way to make people feel like they haven't been forgotten. (board)
through.
easy access to bathroom
area for children > simple toys (easy to clean)
private area
outlets + docks
lots of natural light
windows + high ceilings
plants
public area
parent sitting area
screen
outside garden
Childrens area
bathrooms
bathrooms
plants


GP
Old man on
Wheelchair -> Assistance
[Blue Light]
Reception Desk
Assisted
Kind Receptionist
Just 2 minutes
Reception Desk
Warm Area
Pet area
Sun
Cup of water
Bench
Assistant
mobile Phone
Someone tells the old man that now is his turn:
he sends an SMS to the Assistant


08h40
09h00
'YOU HAVE TO WAIT LONGER
AM AFRAID...
Tea, "I feel better
Coffee
Book
I am ready!
DR. IS NOW
READY FOR YOU
Kindergarden &
Children's TV
+
Candies
sends an email
via iPAD & WIFI
Checks with
Sister in
India via wifi
in the kitchenette
area
Blanket
+
Tea &
+
Cake
I am
now
READY


A ~~day~~ morning in the life...
08h00
ENTERING
1) Adam Jones
HIV patient
42 years
Oshibori Service
+
Tea
Quiet "dark room"
he is tired & wants to
be alone, no
smells no
lighting → just
candles in a
corner
2) Tommy
Bronchitis
5 years old
+
Mummy
(CARER)
TEA + Cake + Book
3) Mrs KAPOOR
Hip Replacement
follow up
69 years old
Notices smell
of lavender (soothing)
+
Oshibori Service
+
Tea
Yoga exercises time
(upper half) in the
quiet area

- John is a 32 years old father, who takes his 5 years old daughter to doctor

- As reception, he first welcomed by the receptionist. After explaining his daughters illness, he will be given a simple form to complete.

- He then return the form to the receptionist, who will run the NHS system as well as the ids that John as provided to retrieve the necessary information.

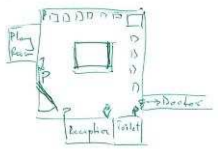
- John will then be given a ~~numbering~~ ticket with a number, explaining the waiting time, as well as a leaflet with some useful inf

- There is an electronic board which shows updates info about the time he has to wait, as a feedback to him.

- There is also a nice area for children to play with some toys. John take his daughter to the play area.

- He then go to the next room, which is a quiet room, with nice and comfortable seats, a TV in silent mode with subtitles, books, magazines & newspapers. ~~There ... the seats~~ He sits there to read the leaflet. He can also see his daughter playing, as the wall is ~~...~~ made of glass.

~~Then~~ After a while a doctor comes after him & his daughter, guiding them to the visiting room.



P = Plants

① Family of 4 walks in with two children of age 2 and 8. Mother is ill with a fever.
- Leave the little child in play room.
- The older child picks up a ~~book~~ toy & plays with it while watching TV.
- Father brings water for mother, and gets himself a soda from the vending machine.

② Father brings teenage daughter with fever.
- Daughter sits and watches TV. Takes a nap in between.
- Father sits down with a newspaper.

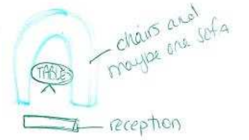
③ An elderly couple come for a checkup.
- They really don't do much other than sit around and occasionally say something to each other.
- The man picks up a copy of the bible (or whatever is appropriate for his religion) and skims through it.

- Father picks up sports magazine.

- ~~Everyone~~ People uses the loo from time to time.
- The receptionist calls the patient when its their turn.
- Everyone first reports to the receptionist to confirm their appointment.

① patient comes into GP waiting area and has easy access to reception

② The waiting room is spacious and all the seats are arranged in a horse-shoe formation around reception desk



③ if the patient has a child - he or she can entertain him/her with the small table of children's books/toys

④ the patient will feel more at home b/c the GP waiting area will have plants and wall ART. It will also have various plants. The lighting will be soft - NOT TOO bright and no LED lights

⑤ the patient can also feel relaxed/comfortable because there will be Large windows - allowing natural light. The paint colors will also be calming - light neutral → creams, blues (Robin's egg)

⑥ The place should be clean and the floor should be wood or wood-like

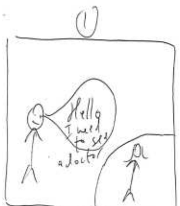
⑦ The patient will have easy access to reception b/c the seating all faces in a direction towards the reception desk except for the desk. Also, the desk will not be too high so he/she can see and make eye contact with the reception

⑧ during the patients wait, he/she will have the option to look at magazines, books or information ~~[illegible]~~ packets. If he/she finds a packet useful - ~~[illegible]~~ he/she can take it home for further use

Also, the way the seats are positioned makes it easier to see/hear reception

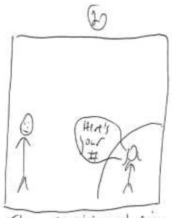
⑨ when the patient is called to see the GP - he/she will hear clearly / because there is nothing blocking off reception from the patients

①



A Patient comes to the GP clinic and is greeted by receptionist

②



The receptionist gives him a number after he identifies himself

③

The patient makes himself a cup of coffee ~~and~~

④

The patient sits down with his coffee in a comfortable chair

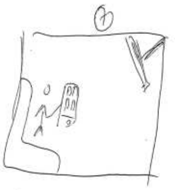
⑤

He's enjoying his coffee and looking through some magazines

⑥

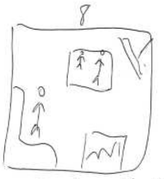
He decides to logon to his gmail account using the GP WiFi connection and check some emails

⑦

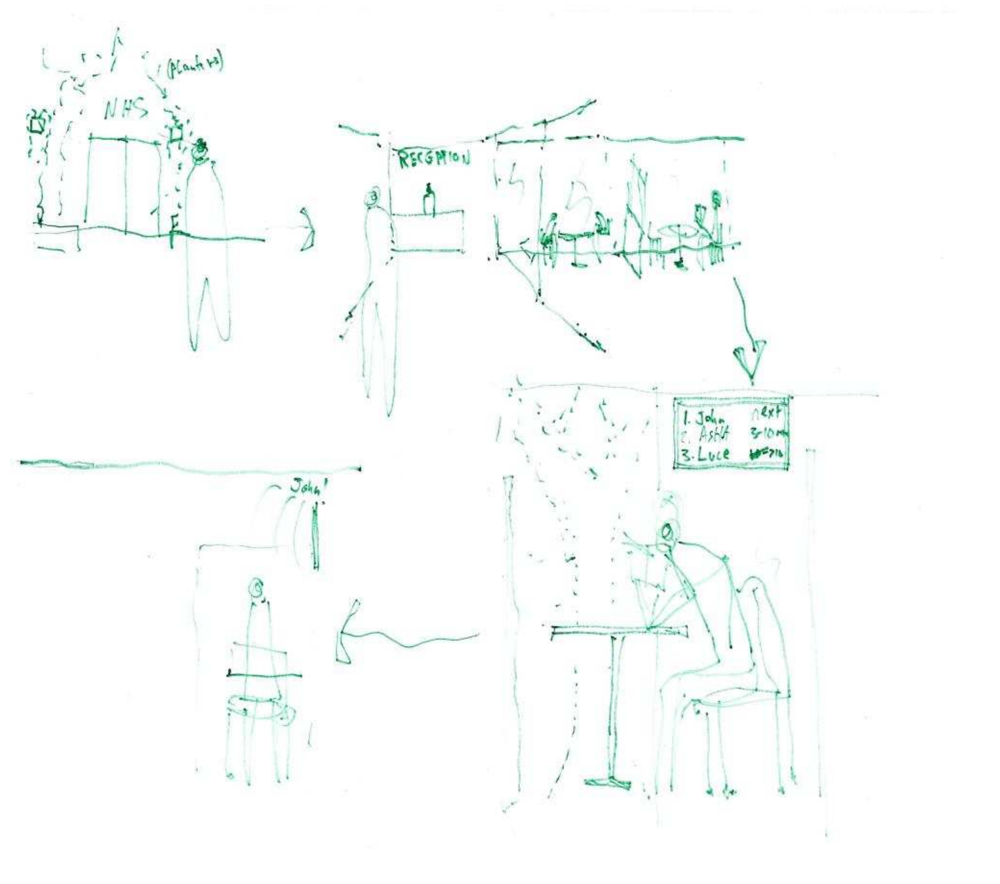


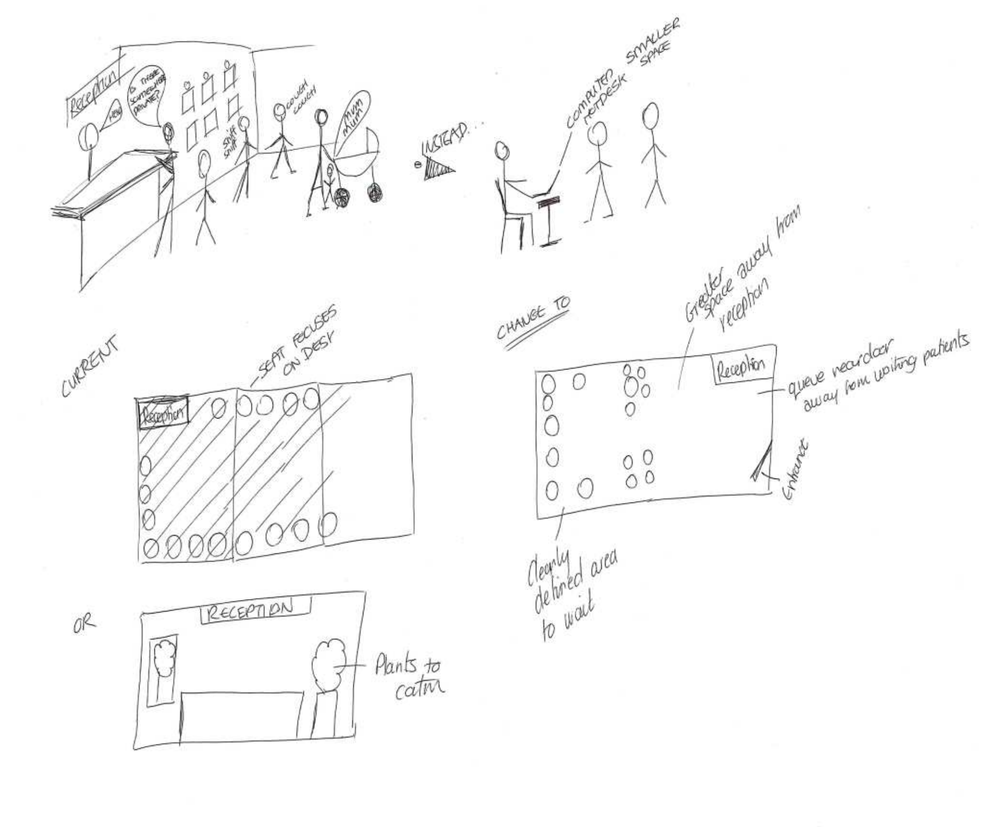
He can see on the screen that he still has 2 patients ahead of him in the queue

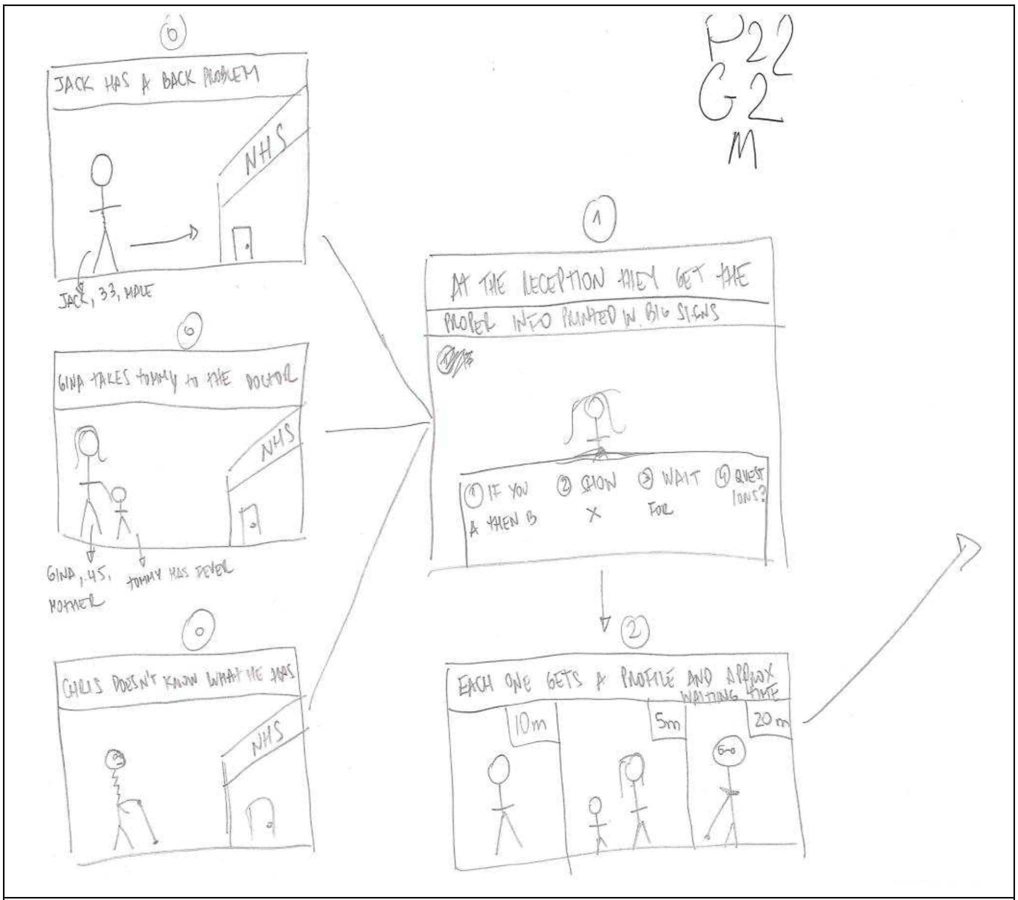
8

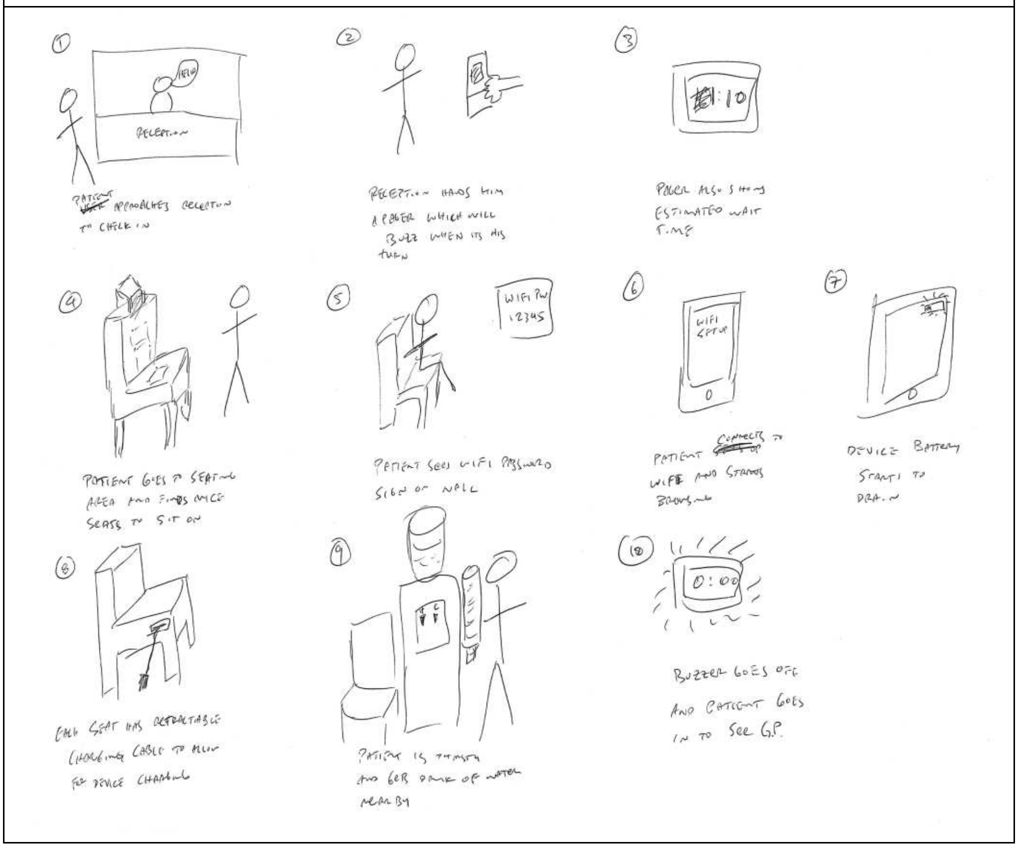


in the far side of the room there is a small play area for people with children


NHS
RECEPTION
1. John next
3. Luce
John!

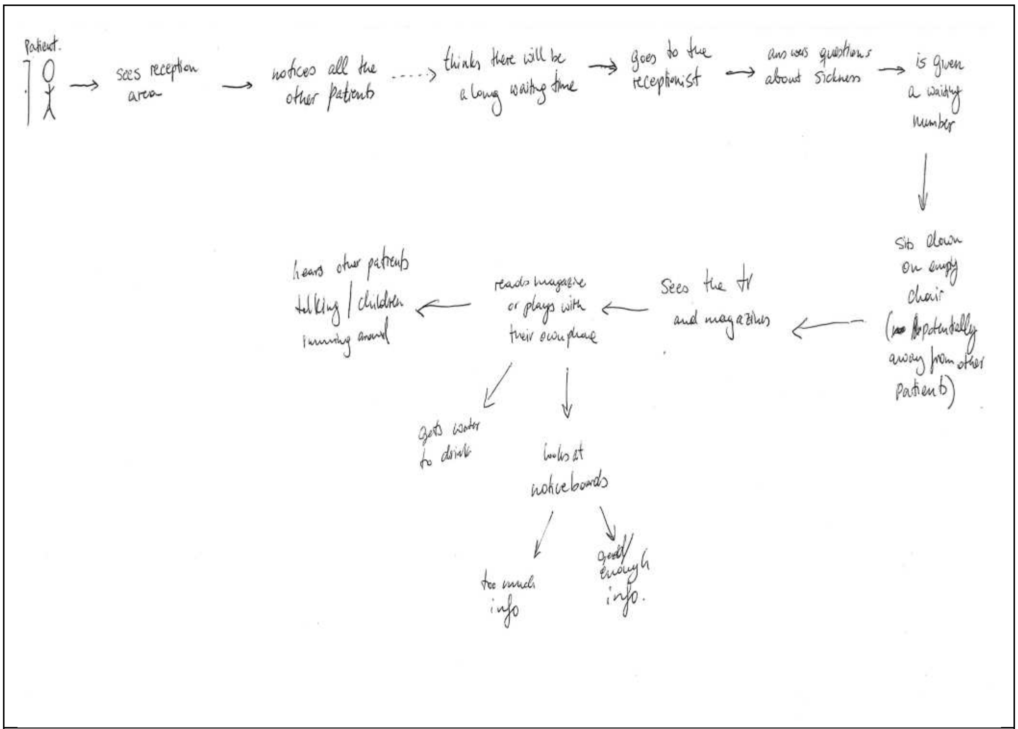

Reception
INSTEAD...
COMPUTER AT DESK
SMALLER SPACE
CURRENT
SEAT FOCUSES ON DESK
Reception
CHANGE TO
Greater space away from reception
Reception
queue near door away from waiting patients
Entrance
clearly defined area to wait
OR
RECEPTION
Plants to calm

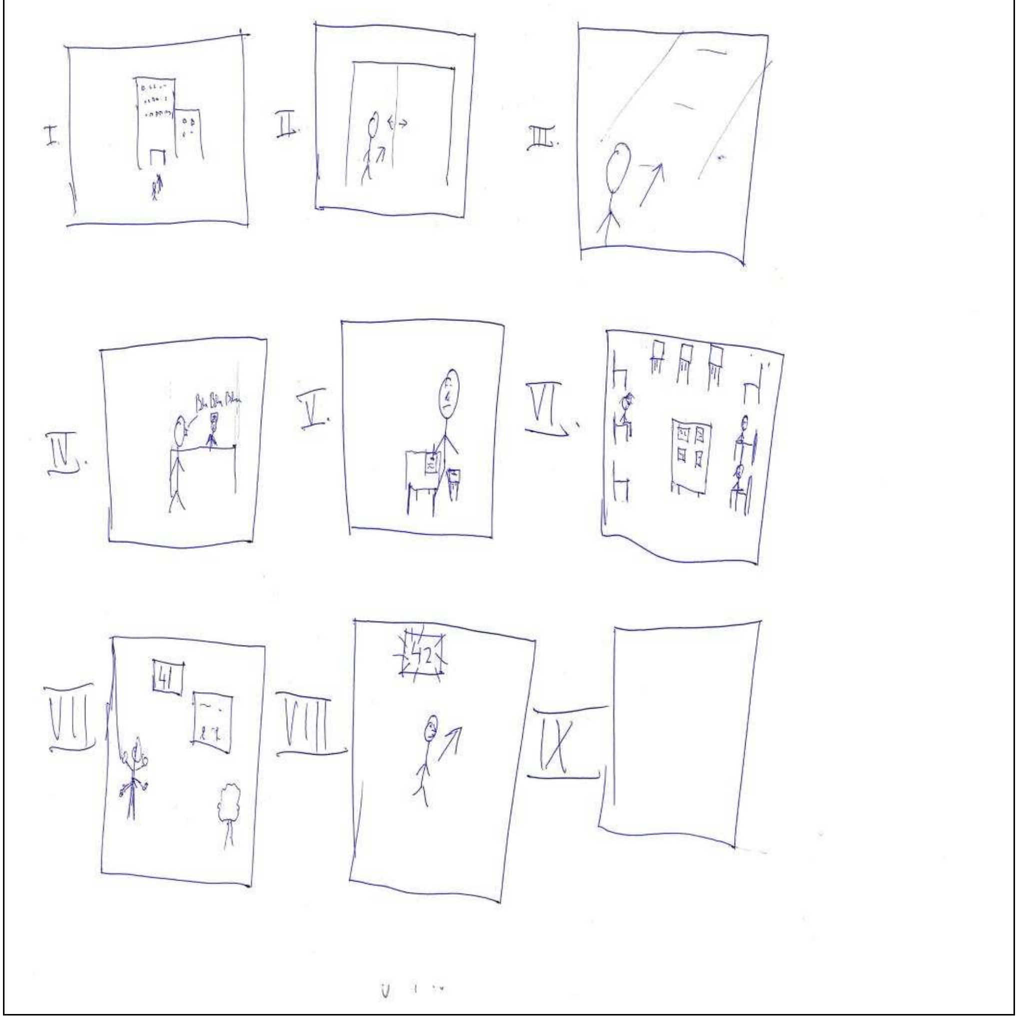

P22
G2
M
JACK HAS A BACK PROBLEM
NHS
JACK, 33, MALE
GINA TAKES TOMMY TO THE DOCTOR
NHS
GINA, 45, MOTHER
TOMMY HAS FEVER
CHRIS DOESN'T KNOW WHAT HE HAS
NHS
AT THE RECEPTION THEY GET THE PROPER INFO PRINTED IN BIG SIGNS
① IF YOU A THEN B
② SHOW X
③ WAIT FOR
④ QUESTIONS?
EACH ONE GETS A PROFILE AND APPROX WAITING TIME
10m
5m
20m


RECEPTION
HELLO
PATIENT APPROACHES RECEPTION TO CHECK IN
RECEPTION HANDS HIM A PAGER WHICH WILL BUZZ WHEN ITS HIS TURN
PAGER ALSO SHOWS ESTIMATED WAIT TIME
PATIENT GOES TO SEATING AREA AND FINDS NICE SEATS TO SIT ON
WIFI PW 12345
PATIENT SEES WIFI PASSWORD SIGN ON WALL
WIFI SETUP
PATIENT CONNECTS TO WIFI AND STARTS BROWSING
DEVICE BATTERY STARTS TO DRAIN
EACH SEAT HAS RETRACTABLE CHARGING CABLE TO ALLOW FOR DEVICE CHARGING
PATIENT IS THIRSTY AND GETS DRINK OF WATER NEARBY
0:00
BUZZER GOES OFF AND PATIENT GOES IN TO SEE G.P.

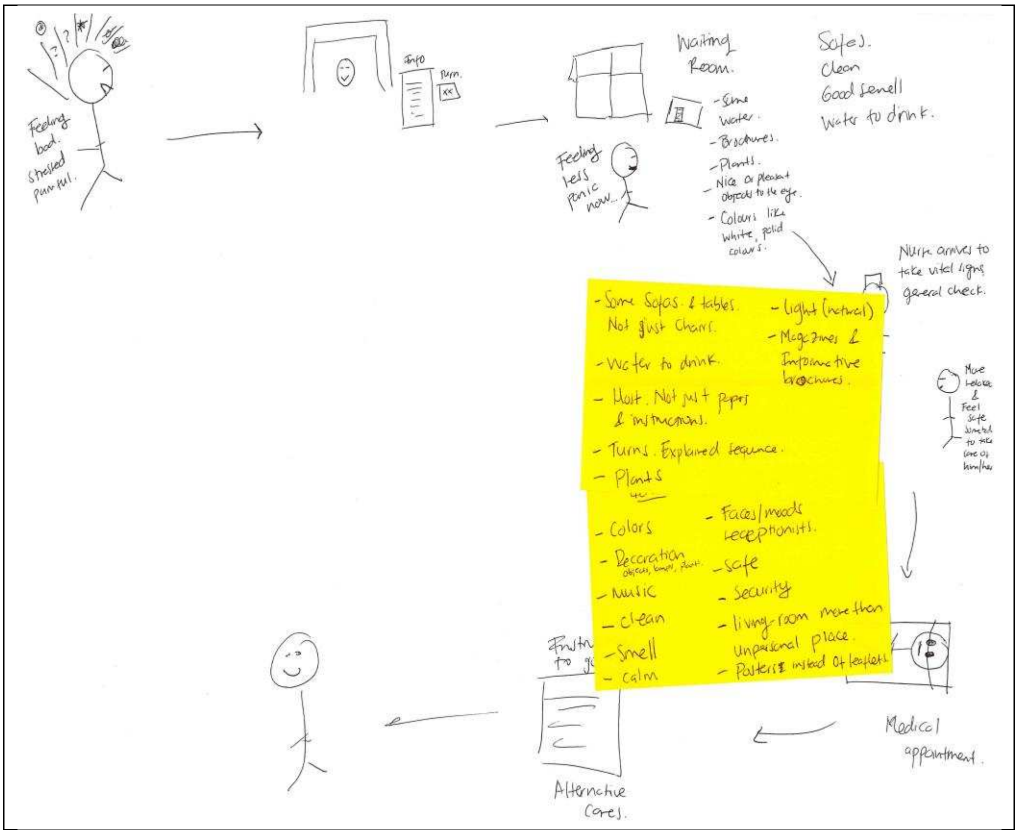

RECEPTION
TOYS
MAG
MAG

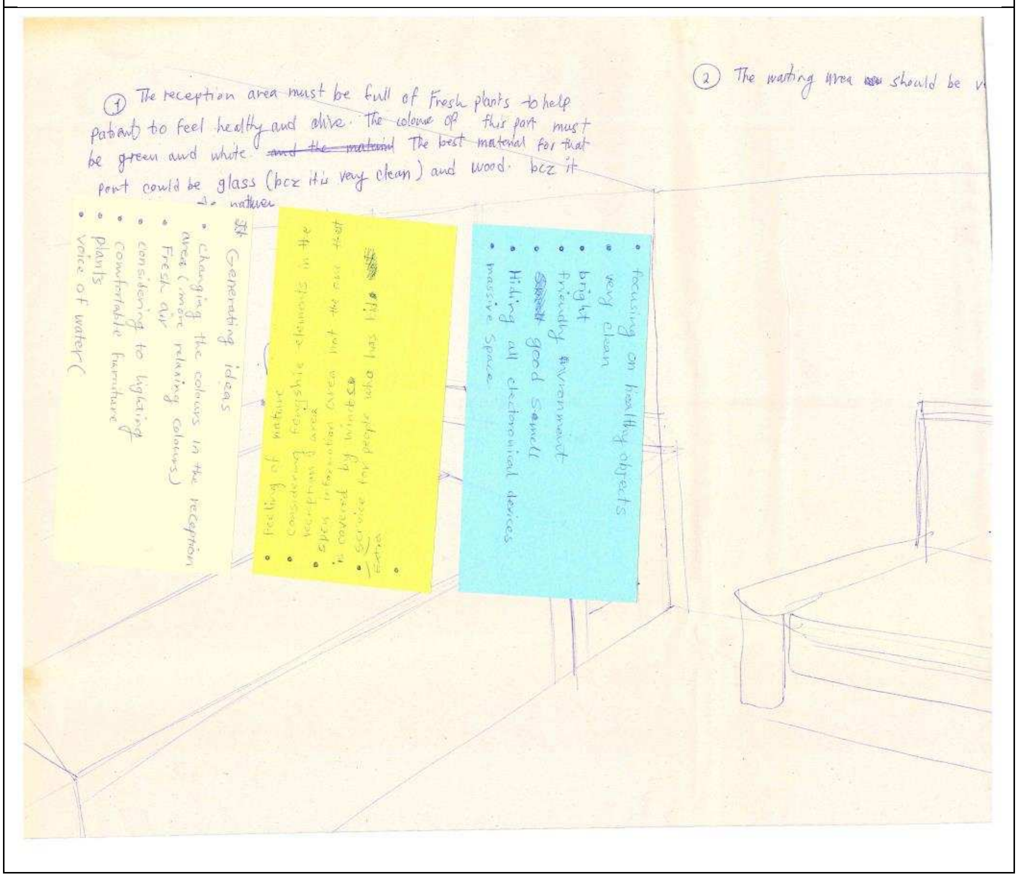

CHILDRENS AREA
RECEPTION
JUICE
MAG
MAG

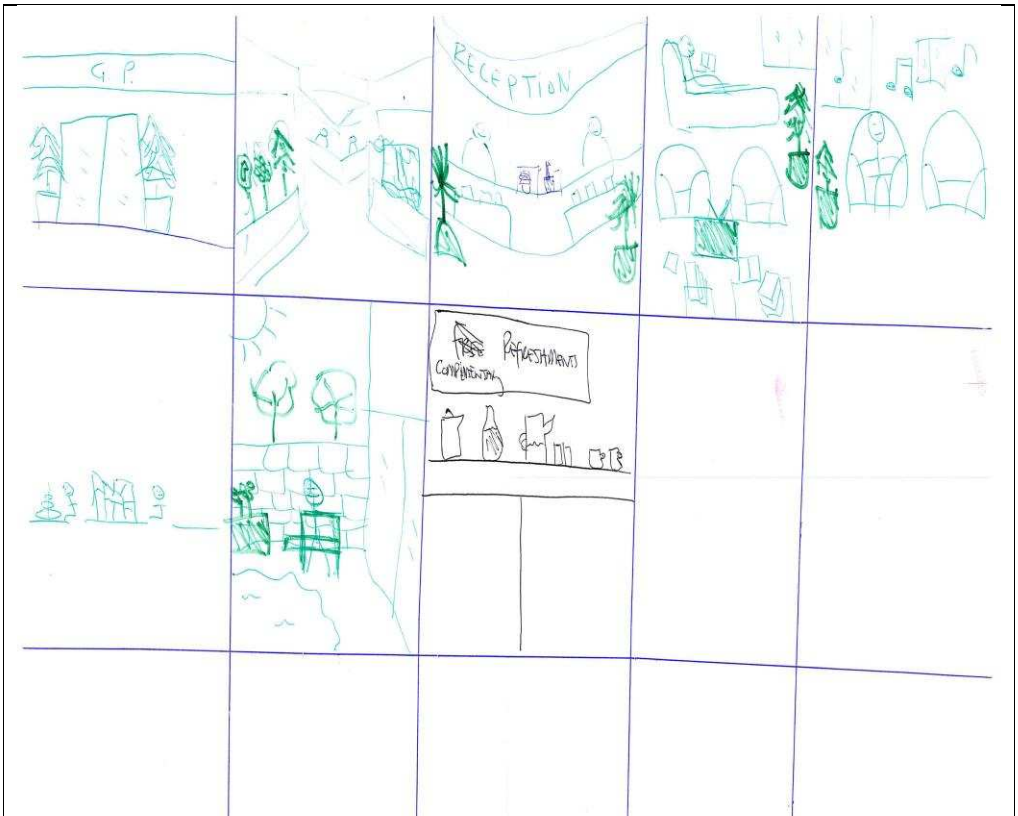

Patient.
sees reception area
notices all the other patients
thinks there will be a long waiting time
goes to the receptionist
answers questions about sickness
is given a waiting number
sits down on empty chair (potentially away from other patients)
sees the tv and magazines
reads magazine or plays with their own phone
hears other patients talking / children running around
gets water to drink
looks at noticeboards
too much info
good enough info.

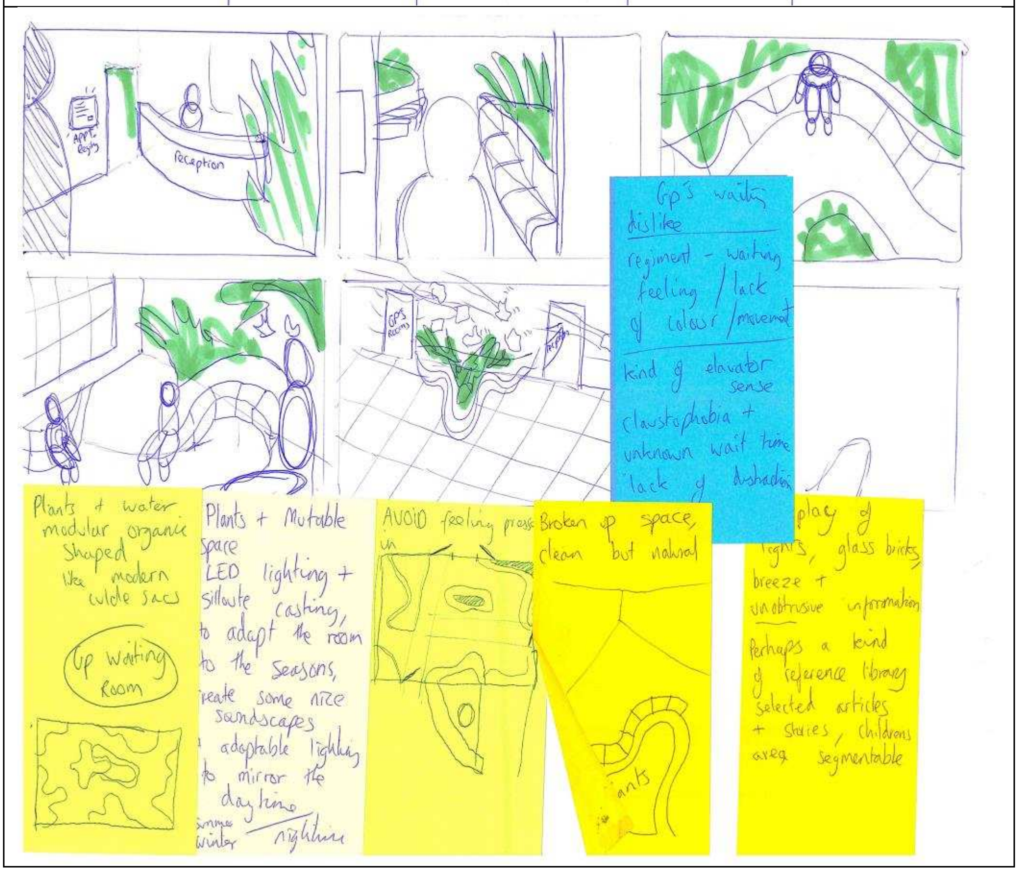

I.
II.
III.
IV.
V.
VI.
VII
VIII
IX
41
42


@home
DR
Patient
DR
IN OFFICE
How DID THAT HAPPEN?
Patient is comfortable
WELL DR...
Appointment is booked for Specialist
Need
Patient shares data from monitor
Session finishes early
OK Goodbye
DR sees records of next patient
No germs are spread between patients

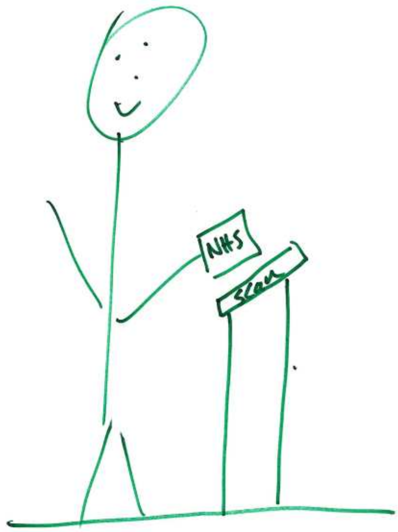

Feeling bad. Stressed painful.
Info
Waiting Room.
- Some water.
- Brochures.
- Plants.
- Nice or pleasant objects to the eye.
- Colours like white, solid colours.
Sofas.
Clean
Good smell
Water to drink.
Feeling less panic now.
Nurse arrives to take vital signs general check.
- Some Sofas & tables. Not just Chairs.
- Water to drink.
- Host. Not just papers & instructions.
- Turns. Explained sequence.
- Plants
- Light (natural)
- Magazines & Informative brochures.
- Colors
- Decoration
- Music
- Clean
- Smell
- Calm
- Faces/moods receptionists.
- Safe
- Security
- living-room more than unpersonal place.
- Posters instead of leaflets.
Medical appointment.
Alternative Cares.


① The reception area must be full of Fresh plants to help patients to feel healthy and alive. The colour of this part must be green and white. The best material for that part could be glass (bcz it's very clean) and wood. bcz it's natural
② The waiting area should be
Generating ideas
• changing the colours in the reception area (more relaxing colours)
• Fresh air
• considering to lighting
• comfortable furniture
• plants
• voice of water
• focusing on healthy objects
• very clean
• bright
• friendly environment
• good smell
• Hiding all electronical devices
• massive space

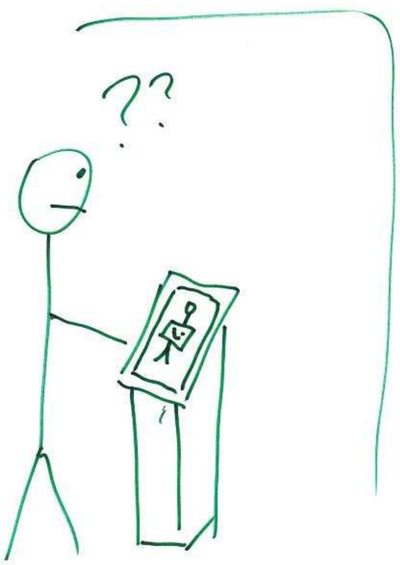

G.P.
RECEPTION
COMPLIMENTARY REFRESHMENTS


Reception
GP's waiting
dislike
regiment - waiting feeling / lack of colour / movement
kind of elevator sense
claustrophobia + unknown wait time
lack of distraction
Plants + water
modular organic shaped
like modern cuide sacs
Gp waiting Room
Plants + Mutable space
LED lighting + sillouette casting, to adapt the room to the seasons,
create some nice soundscapes
adaptable lighting to mirror the daytime
summer winter nighttime
AVOID feeling press in
Broken up space, clean but natural
play of lights, glass bricks, breeze +
unobtrusive information
Perhaps a kind of reference library
selected articles + stories, childrens area segmentable

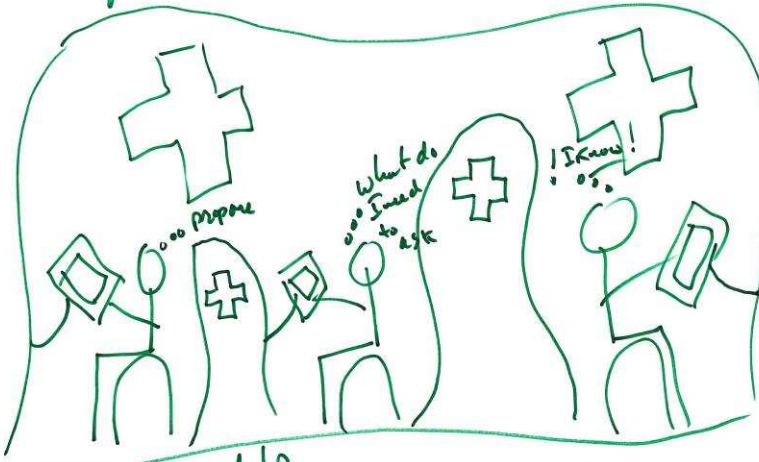
① You enter the room, you scan in. No receptionist needed.



② If there are questions. Ask the interactive program



(3) You find your seat, which offers privacy, And the technology you need to prepare for your visit.



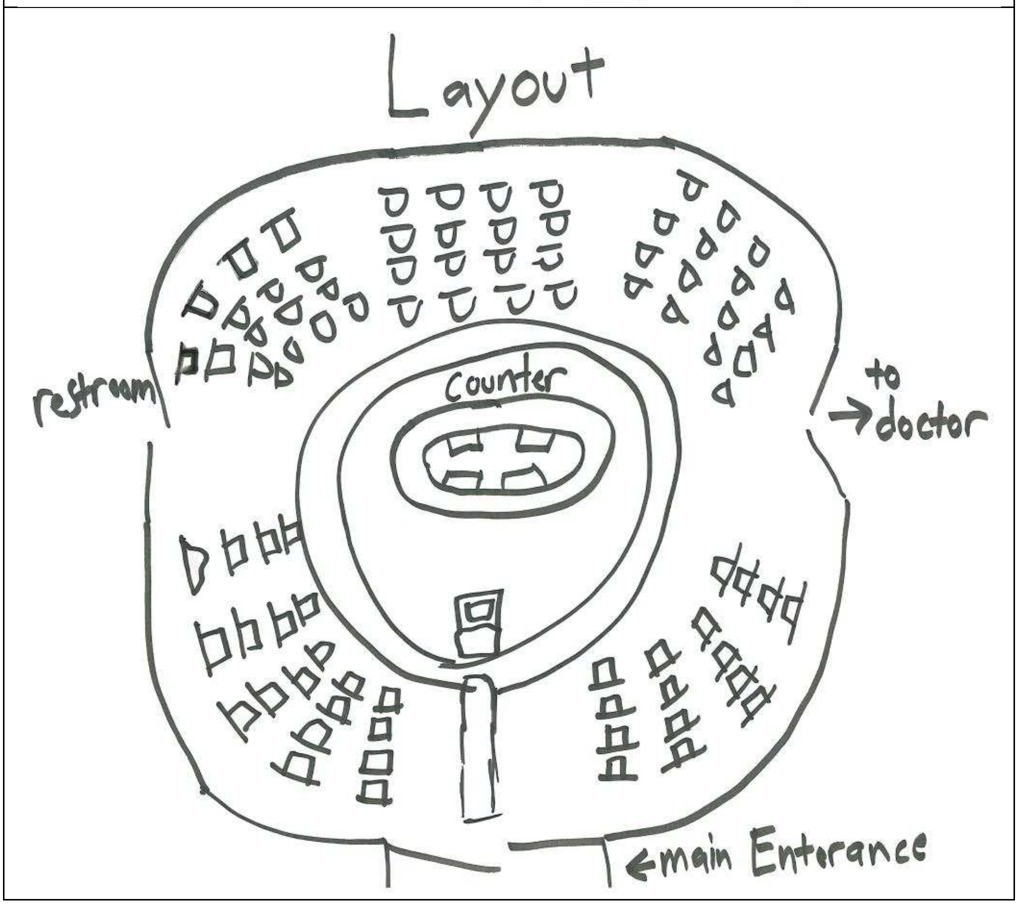
Organic designs help ease stress symptoms

(4) AFTER you are prepared, you are called in for your visit.

The latest "Hygiene-materials" are used in all architecture + objects. Ensuring Cleanliness everywhere!

If needed, a little Bot leads the way. Or can pull your wheelchair.


1
3
2.
ticket
Welcome John!
Waiting time is
2 hours!
Please take a seat.
3
Dr. Bill
Rm#3
4
5
Bill lye......ready
Angel Lee.....
Bob .....
6
7
Mr John!
8
Doctor
John...
kate...


Layout
restroom
Counter
to
doctor
main Entorance