The use of Colour in an Affective Installation for Teenagers

by

Andra Balta

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STUDENT DECLARATION FORM

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I declare that while registered as a candidate for the research degree, I have not been a registered candidate or enrolled student for another award of the University or other academic or professional institution

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Chapter 1

INTRODUCTORY CHAPTER

Introduction

This PhD is in the intersect between teenagers (as users of IT), social interaction (as an activity), and mood (as a driver for concern). It considers teenagers' moods through an interactive colour sharing social product. It builds on studies of colour and colour preference with adults and on the effect of colour on mood and behaviour from interior design and architecture. The aim is to investigate the extent to which, and the context in which, certain colours reflect teenagers' mood and feelings whilst also studying the behaviours of teenagers in communicating their moods with their friends.

The research is framed in the context of transdisciplinary research, where more than one discipline, profession, and field are involved (Klein 2008). Two styles of research are seen in the thesis: science research (Chapter 6) and design research (Chapter 7). Nowadays, research is pressured "to cross disciplinary boundaries" as interdisciplinary research, transdisciplinary research, multidisciplinary research, or cross-disciplinary research (Lyall, Bruce & Tait 2011).

Whilst HCI typically embraces science, design, and engineering, the crossover between science and design is where the present thesis is largely situated (see Figure 1). The terms interdisciplinarity, multidisciplinarity, transdisciplinarity, and cross-disciplinarity are further explored in the subdivision entitled Inter-, multi-, and transdisciplinarity in HCI.

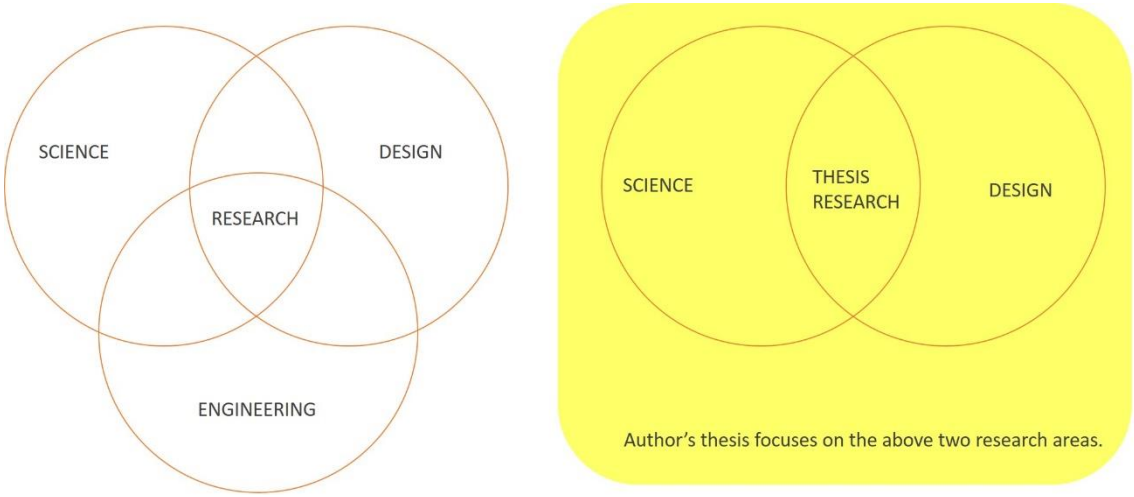


Figure 1. Transdisciplinary research diagram.

In this chapter, the background, the motivation for the research and the existing research gap are each introduced. Furthermore, the research objectives, the research questions, and the relevance of this work to Human Computer Interaction field are outlined.

Aim and objectives

The aim of this research is to explore the relationship between colour and teens' mood in the context of interactive social communication in private spaces. The objectives are as follows:

- To determine what colours teens might associate with certain moods;
- To use observational studies in order to discover how colour affects teens' mood;
- To observe if colour can be used as a tool for expressing their mood;
- To evaluate an interactive installation that applies the findings.

Research questions

The four research questions answered in the thesis are:

1. Is there a relationship between colour and mood? If yes, is there a difference between genders?
2. Do teenagers have a favourite colour?
3. What colours would teenagers choose for their bedroom?
4. How can colour-mood associations be represented into a product? Can such a product be designed?

The first three questions are explored in Chapter 6, and the last one in Chapter 7. During Chapter 5, an online questionnaire is developed so that the three questions in Chapter 6 can be answered, these answers informing the design in Chapter 7. This design development then answers question four (Chapter 7) and an in-the-wild study (Chapter 8) evaluates the product.

Contributions

The contributions of this thesis are specific to the culture in which the work was done and cannot be generalized to other populations. The work associates with populations from England (EU) and New York (USA). The key contributions of the thesis, in order of appearance, are as follows:

- Strong associations between certain colours and certain moods (Chapter 6) which could be applied in the design industry, where those colours might trigger certain moods and maybe unconsciously affect the teen wishing to buy those products. These colour-mood associations could also be used as a way of understanding teenagers' moods, such as in colour therapy, where the counsellor would know that in a painting context with a teen

subject, the use of yellow might suggest happiness, the use of red, irritation, and the use of black, fear (Chapter 6);

- Evidence that vivid colours are preferred by teenagers; this finding can be successfully used in the industry or in teen product adverts where bright colours could play an important role in triggering teens' moods (Chapter 6);
- Development of new methods for use in teenage research such as teens' interpretation of their own results, which proved to be a strong confirmation method (Chapter 6);
- An interactive social installation that allows teenagers to send to, and receive colours from, their friends, allowing them to express their moods in a quick and abstract way, using colour in the context of interactive social communication in private spaces such as bedrooms (Chapter 7). If developed by the industry, this concept could challenge the architectural notion of interior design, adopting technology such as smart textiles and interactive wallpapers or even interactive painting;
- An interactive model used in the context of colour expression but with the possibility to be used in wider areas of interactive research (Chapter 7).

Structure

As mentioned before, the work applies two types of research: scientific research and design research (Figure 2). Research questions are tested by empirical studies that inform the findings, which are then categorized as research findings and design findings. Different insights emerge and they are grouped together in order to form the conclusion of the thesis. The diagram in Figure 3 explains this approach with the aim to clarify how the two styles of research were used. It should be mentioned that in some cases the scientific research methods were interchanged with the design methods and vice versa.

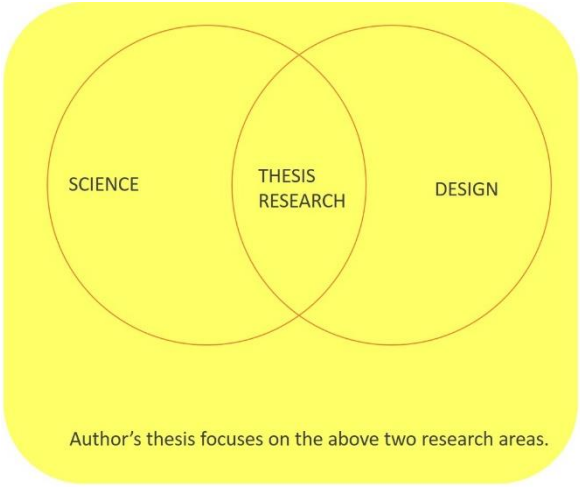


Figure 2. The two research disciplines found in the present thesis.

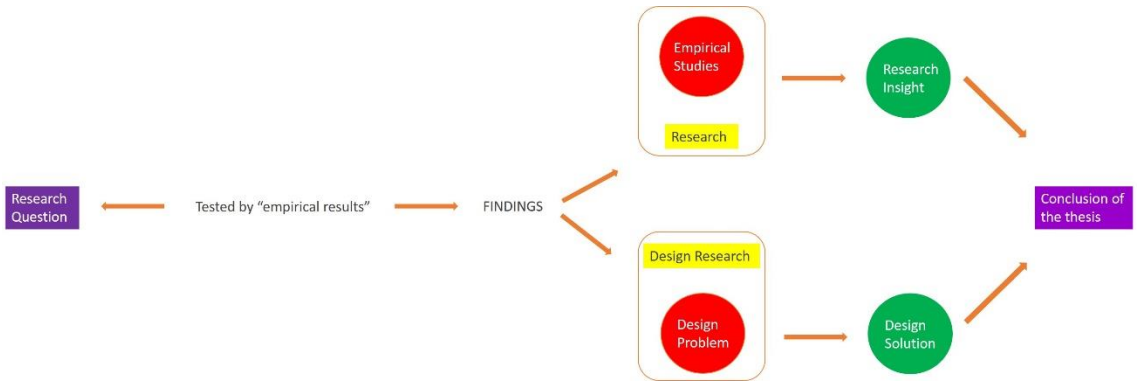


Figure 3. Thesis structure diagram.

Teenagers

There are different views on what a teenager is, and what is the accepted age for a teenager. It is generally accepted that teenagehood is between 13 to 19 years old (Oxford Dictionaires 2016). The term *teenager* is associated with the term *adolescent*, since both terms define a transition between childhood and adulthood (Arnett 2000). Whilst historically, adolescents have been around since the beginning of the human species, they were not a "specifically distinguishable or categorized cohort" (Arnone 2014), until the early twentieth century when Hall (1904) developed the adolescence terminology that defines a slow transition, as opposed to a step change, from childhood to adulthood. The period of adolescence was viewed as a time of "storm and stress" (Hall 1904), when teenagers went through some degree of emotional and behavioural changes (Arnett 2006). Hall (1904) noticed that depressed moods were common during adolescence, reporting that "the curve of despondency starts at eleven, rises steadily and rapidly till fifteen, then falls steadily till twenty-three" (Hall 1904). In one of his articles, Hall (1891) stated that the "adolescent period does not normally end before the age of twenty-four or five" and that "far more conversions take place during the adolescent period than during any other period of equal length" (Hall 1891). Hall's (1904) research on adolescents contains similarities with today's understanding of adolescent psychology (Arnett 2006). The current view of adolescence is that it begins at around 10 and it ends towards 18 years old (Arnett 2000) but neuroscience research shows that the age of adulthood might now extend to 25 years old, because of the late maturation of frontal lobes, which assimilate emotional and cognitive activity in adolescence (Johnson, Blum & Giedd 2009). Nowadays, adolescence is seen as the bridge between childhood and adulthood (Arnone 2014), marking a "time of rapid physical growth and development, including tasks of identity formation, the separation from authority as a means of independence, and seeking conformity with peers" (Christian 1973). Today's experts consider that young people "need quite a considerable amount of support and help" beyond the age of 18 ((Wallis 2013), (Knapton 2016)). Emerging adulthood is a new "concept of development for the period from the late teens through the twenties, with a

focus on ages 18–25. Emerging adults do not see themselves as adolescents, but many of them also do not see themselves entirely as adults" (Arnett 2000).

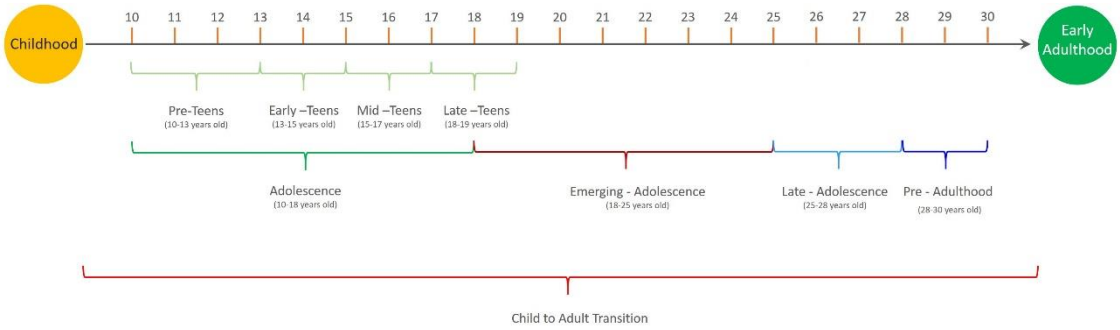


Figure 4. Child to Adult Transition diagram developed by the author of the thesis.

Based on the author's conceptual diagram (Figure 4), a teenager is described in this thesis as someone who is in an early transition from childhood to adulthood, a transition that implies not only physical development, but also emotional, mental, and financial development. In this thesis a teenager is one that is in her/his early-teens (13–15 years old), mid-teens (15–17 years old), or late-teens (17–19 years old) (Figure 4). There are situations where pre-teens (10–13 years old) participated in some pilot studies (Figure 4). Within the HCI literature, both terms *teenager* and *adolescent* are used interchangeably, "the latter being more difficult to define in terms of age-related boundaries" (Bell 2016). Both terms are used interchangeably in the present thesis.

Teenagers' moods quickly vary from one extreme to another in a very short period of time (Larson, Csikszentmihalyi & Graef 1980). Similarly, the exchange of opinions on online social media happens fast. For instance, when one posts a picture on Facebook, there will be immediately comments about it. Therefore, teens' quick mood variation can be associated with the speed of online social communication they are so used to. Teenagers have difficulty in identifying and expressing their moods because "adolescence is a time of behaviour changes" (Giedd 2008) and the emotional part of their brains is not yet developed: the ability to regulate emotions rely on frontal lobe circuitry that "is relatively late maturing" (Giedd 2008). Therefore, teens expose themselves to different risks to understand and discover themselves, looking for different and extreme experiences and friends.

It has long been known that teenagers prefer close friends, rather than adults, as a source for social support (Solberg 1966) and so, teenagers like to belong to a group with whom they can relate or identify. Nowadays teenagers live their lives, with these groups, online as well as offline (Boyd 2014). Lenhart et al. (2015) showed that 92% of American teens report going online daily, of which 24% go online almost constantly. This behaviour is facilitated by "the widespread availability of smartphones"; nearly three quarters of American teens having access to a

smartphone and "91% of teens going online from a mobile device" (Lenhart et al. 2015). The smartphone can be considered to be the most important and personal tool that allows teens to be online anytime and anywhere. Therefore, the smartphone is the most used tool for different purposes, including social media communication. A majority of teens use more than one social network site, such as Facebook, Instagram, and Snapchat (Lenhart et al. 2015). The speed of online communication has increased, and teens tend to get quickly bored when networks become too slow. Ignacio et al. (2013) describe teenagers as being characterized by an emotional vulnerability and by the use and abuse of mobile phones (Ignacio, Pilar, Conesa, Garcia, M. 2013).

Research methods in Teen-CI

In the couple of years preceding publication of this thesis there has been some late attention to Teen Computing Interaction (TCI) research in the area of Human Computer Interaction (HCI) research. The methods for working with teenagers in HCI are a new area of study and are further explored in Chapter 2. Methods used with teenagers have to be engaging, fun, and designs should be visually attractive.

Recent evidence suggests, that for better design in interactive products, there is a need to understand teenager user groups and their worlds ((Read et al. 2013), (Horton et al. 2012), (Fitton et al. 2012a)). Fitton (2012) suggests that "to design engaging technologies for teenagers it is necessary to understand what, specifically, will engage the target users". Read et al. (2013) highlight the need for new research methods that can be used for teenage studies. So far, there is little work and research on designing for and with teenagers. The CCI community has previously proposed specific research methods and tools designed for children such as The Fun Toolkit (Read, MacFarlane 2006), Laddering (Zaman, Abeele 2010), Mission from Mars (Dindler et al. 2005). The CCI methods have been developed because children are both cognitively and physically different from adults ((Read et al. 2013), (Jensen, Skov 2005)). As Read et al. (2013) say, children do not have all the skills adults do, and they are motivated by different things than the adults are. From a neuroscientific point of view, teenagers are different from children (Giedd 2008), but also different from adults (Giedd 2008), and therefore might benefit from adapted or new research methods.

Even though the research in this thesis is not focused on new methods for designing with teenagers, the author believes there are gaps in knowledge about TCI research. For instance, innovative methods are needed for teenagers who should be at the core of TCI design or theory. Teenagers' participation as *young designers* suggests that their opinions on designs matter and their feedback should be taken into consideration. The technology should be considered a tool that helps teens transition from childhood to adulthood.

Colour

In terms of physics, colour is a frequency of the light that our eyes detect (Rupert, Tan & Kelleher 2012). It can also be described as "the property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light" (Oxford Dictionaires 2016). The work here tends towards this second way of looking at colour by focusing on the effect colour has on one's wellbeing and therefore on the relationship between colours and one's moods. The existence of this relationship underlines people's capability to see colour. The author is aware that there are colour-blind people, but the present work is built around the idea that people can see colour even if they may name some colours differently and even though it is known that the quality of one's vision can affect the colour seen. It is accepted, for example, that old people see colours different than young people do, because their vision gets blurry with age, so the colours are not as bright.

When one refers to a colour, there is some complexity (Birren 1970). When one refers to red, s/he must specify a shade as a yellowish red, such as red-orange, is quite different from a bluish red.

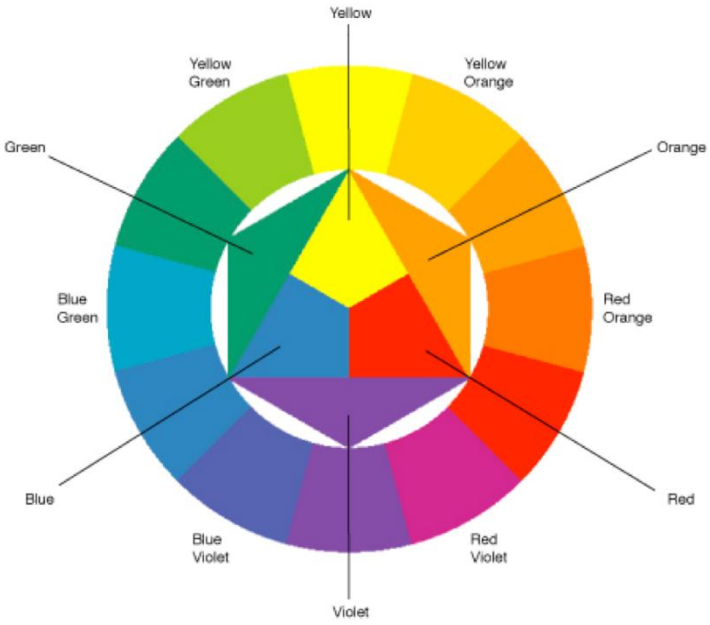


Figure 5. Itten's Colour Wheel.

Similarly to Birren (1970), the author of this thesis describes colours in terms of hues and shades (as represented and defined in the Colour Wheel System Figure 5 (Birren 1970)) where:

- **Hue** refers to the twelve purest and brightest colours which are all found in the Colour Wheel (Figure 5), namely primary colours (yellow, red, blue), secondary colours (yellow, orange, red, violet, blue, green), and tertiary colours (yellow-orange, red-orange, red-violet, blue-violet, blue-green, yellow-green);
- **Shade** refers to any colour with black added, or even the mix of hues and then black is added to that colour mix.

The Colour Wheel system also includes terms such as tints or tones. Tints (or pale colours) are colours that can be lighted up by adding white. Tones are colours to which both black and white are added, and if wanted the hues can be mixed between them too. Different terms are used in

other colour systems such as Munsell Colour system (Munsell Color 2016), where ten hues instead of twelve are used and instead of terms such as shades, tints, and tones, other terms are used such as values and chromas. Value represents the lightness or darkness of a colour, while chroma is the intensity of a colour. The term colour is used by the author when she refers to hues, but, when needed, more precise terms such as shades or colour brightness are used.

A significant body of research finds that colour has an important impact upon human's lives, being especially important for visual communication (Mahovic Poljacek, Cigula & Gojo 2011). The idea that colour could have an effect on psychological processes dates back to the work of Goldstein (Goldstein 1939, Goldstein 1942). It is well accepted that colour can positively influence an individuals' physical and emotional wellbeing (Pinheiro 2008). One of the most widespread views of the relation between colour and arousal is that long-wavelength colours (red, orange, yellow) are arousing and short-wavelength colours (blue, indigo, violet) are relaxing; green spectrum colours are expected to be neutral (Walters, Apter & Svebak 1982).

One of the studies that focused on the relationship between colour and people's feelings was conducted by Spath (2011) who found that a certain shade of pink might relax both civilians and prisoners. The results showed a significant decrease in civilians' blood pressure and a decrease of prisoners' aggressive behaviour when placed in a pink cell rather than a white cell. Because of the social symbolism of pink (association with gay people or female gender) there were individual cases were prisoners would not relax (Spath 2011).

Similarly, Lee (2011) analysed the association between colour lighting and people's emotions showing that coloured lights affect people differently. Dark light made people feel tired and sleepy; dark and blue light made people feel gloomy; coloured lights, as bright light and yellow, brought a fresh feeling to people. Red light was perceived as "warmer, more awakening, agitating, more exciting," but also uncomfortable; blue light, the "most uncomfortable colour lighting", was perceived as masculine, cool, hard, while cyan was considered a calming colour. Yellow light was the most pleasant and comfortable colour lighting, perceived as elegant as cyan. Magenta was perceived as a feminine and soft colour light. Results show that dim light, followed by bright light made people feel calmer, and relaxed (Lee, Sun 2011). According to Lee (2011) people prefer bright colours for their environment and the most preferred were cyan, yellow, and white, which was perceived as pleasant, elegant, and comfortable. Red, blue, and black lighting were perceived as heavy and agitating (Lee, Sun 2011).

In studying how emotions link to colours, the 'shade' of a colour is also known to have an effect. According to Harrington et al. (2008) there are different red shades for positive and negative

emotions. Not all reds stimulate the same emotional response. Harrington et al. (2008) demonstrated that of the nine emotions identified to be linked with red, four negative emotions (aggression, anger, rage, and terror) were linked with dark yellow-reds, while five positive emotions (amazement, ecstasy, joy, love, and passion) were associated with light blue-reds. This indicates that when choosing colours to affect moods more than just primary colours need to be considered. Moreover, the study suggests that designers should carefully choose colours because positive or negative emotions could be triggered (Harrington, Lechner & Simonoff 2008). Whilst red is often associated with excitement and stimulation (Wexner 1954), it has also been suggested that "red is charged with passionate emotion" such as "love, courage, lust, murder, rage and joy" ((Osgood, Suci & Tannenbaum 1957), (Harrington, Lechner & Simonoff 2008)). Whilst it is known that colours can create an emotional response, there is not yet considered to be a clear mapping between one colour and one emotion.

Interactive installations in HCI

There have been several installations in HCI (Human Computer Interaction) and IDC (Interaction Design and Children) that have explored the use of colour and emotion. If it is to define these terms in the context of this work, an installation refers to a large piece of equipment installed for interactive use, where the equipment can be an interactive art exhibit.

Mood Swings is an affective interactive art system which interprets and visualizes the affect expressed by a person by displaying a colour that matches the expressed emotion (Bialoskorski, Westerink, Joyce H. D. M. & van den Broek, Egon L. 2009). *Mood Swings* takes the users' input and then responds with colour. A similar interaction model is found in the *Multimodal Art Installation*, which is part of a theatre production on Galileo that generates projected galaxies that move according to the motion of visitors and change colour depending on the voice of the visitors (Jacucci et al. 2009). *Visual Melodies* is an affective installation aiming to change mood. It is designed for relaxation, and relief of anxiety, of visitors, friends, parents, and children in healthcare settings. Two themes are used: the *Jellyfish* theme is created to calm and relax people using the blue colour of water, and the *Night Sky* theme evokes feelings of peace and dream-like emotions using green and white (Yi-Chun Chen, Bongers & Iedema 2009).

Installations for teenagers using colour to affect mood have not been reported in the HCI literature however an interesting and engaging interactive installation designed for teenagers in heritage matters is described in Iversen et al. (2013) where teenagers simultaneously interact with a museum installation whilst different types of motives occur such as learning and playing (Iversen, Dindler & Smith 2013).

The use of electronic ink technology on an ultrathin, flexible material would extend the range of display applications in various industries. *ShiftWear* (ShiftWear 2015) present their revolutionary sneaker design based on e-paper technology: sneaker's old fabric is replaced by waterproof, flexible e-paper. This material is a flexible display that can be connected to one's smartphone. Innovative personal design can be uploaded onto the shoe "display" similarly to uploading a wallpaper to the smartphone's screen. Another similar work is *mood. Cloud*, an LED light sculpture that changes its colours reflecting moods of people in a public space (Kim et al. 2015).

Inter-, multi-, and transdisciplinarity in HCI

Multidisciplinary research is about doing research with researchers from different disciplines and with different perspectives, involving "low levels of collaboration" (Lyall, Bruce & Tait 2011). On the contrary, interdisciplinary research is about approaching an issue from "a range of disciplinary perspectives" understood by the researchers and therefore allowing the transfer of methods from one discipline to another (Lyall, Bruce & Tait 2011). Transdisciplinary research builds on knowledge production, while multidisciplinary and interdisciplinary research are built on "the knowledge foundations that arise from academic disciplines" (Lyall, Bruce & Tait 2011). However, transdisciplinarity is still not exactly defined, but it is considered to be multidimensional, "transcultural, and transnational" (Klein 2004). The terms transdisciplinarity and interdisciplinarity are often interchanged, because there are few distinct differences between them (Hall et al. 2008). Nowadays cross-disciplinary research is addressed from aspects of one discipline in terms of another but, similarly to Bordons et al. (2005) and Dewulf et al. (2007), this thesis refers to cross-disciplinarity as a more general and descriptive term embracing multi-disciplinarity, inter-disciplinarity and trans-disciplinarity ((Bordons, Morillo & Gómez 2005), (Dewulf et al. 2007)).

Human Computer Interaction, in Blackwell's (2015) point of view, is seen as a field characterized by a strong multidisciplinarity with transversal themes of research collaboration that involves not only researchers, but practitioners too (Blackwell 2015). In HCI it is well known that different disciplines have different priorities and therefore, the author of the thesis believes that transdisciplinarity is encouraged in HCI (Kim 1990). HCI is also seen as an interdisciplinary field ((Kim 1990), (Blackwell 2015)).

One of the key skills of HCI is to have the will to "engage with technical practice and the desire to make interventions" (Blackwell 2015). In this work, the author combines a technical practice (design) with a theoretical practice (research). The design of the thesis is informed by the theory and practice of Human Computer Interaction, which is defined as the interaction between computer science, the behavioural science and design sciences (Plimmer 2006).

In the light of the transdisciplinary nature of HCI research, the present work is an exploration of the relationship between colour and teenagers' mood. When the work of the thesis began, there was found no literature regarding colour being used as a tool for teenagers' mood expression. By the end of the PhD process, the limited idea of a colour-code was replaced by the novel concept of an interactive installation that would help teenagers express their mood using colour, which appeared to offer a new way for communication that had not been explored before. The main purpose was to determine the use of colour for teens' mood expression; to discover how colour affects teenagers' moods; to explore if colour could be used as a tool for expressing mood. Another aim was to design an interactive installation that would help teens express their mood using colour as a tool of communication in private spaces.

Motivation and research gap

This research focuses on mood apps, which are mainly used either for personal daily mood assessment, for sharing moods with friends or for sharing colours with people. Aside from the adult product eMoto (Sundstrom, Stahl & Hook 2005), that uses pre-defined colours to express emotions, there is no app on the market that would allow friends to share their moods using colours and there is nothing specifically designed for teens. The interactive installation presented at the end of the thesis contains an app that would fill the cross-cultural gap, giving teenagers the freedom to express their mood in a close group of friends, by adding a meaning to the colours they share whilst letting them assign any mood they liked to any colour they chose.

An extensive literature survey on colour shows little at all about the relationship between colours and teenagers' moods. Even though it is assumed that teenagers' mood swings happen because parts of the brain that are related to emotions are still developing during the adolescence process, teenagehood is only partially understood, being seen as an unsettled, rebellious, and a risky age. Literature shows a number of research papers focused on understanding, for example, the teenage brain, or teenage depression, but there seem to be no specially designed tools to help teens understand the changes that happen in their brain during this transition, and thus their feelings of confusion. A simple step forward would be to help teens be aware of their emotional state, which according to literature is related to one's mental state. The present research focuses on the absence of work on colour-mood relationship with regard to teenagers in a social communication context. The smartphone is the most important and personal tool used by teens, who are familiar with many types of apps.

The literature review is described in the next three chapters (Chapter 2, Chapter 3, and Chapter 4). Chapter 5 describes different pilot studies in order to try out different methods. The main work

of the thesis is found in Chapter 6 and Chapter 7. As described earlier, the thesis combines research methods from two different fields: science and design. Chapter 6 focuses on scientific research while Chapter 7 describes the design research. Then the prototype developed in Chapter 7 is evaluated in a proof of concept study in Chapter 8. Reflections and conclusions are brought together in Chapter 9, and the thesis ends with Appendices and References sections.

This chapter ends with a list of publications related to the thesis:

- "Colour My Mood: Understanding how to express moods in an Interactive Application." Full paper accepted but withdrawn because the author could not afford to pay the conference's fees.
- "U OK? Txt me the Colour of ur Mood!" Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, 2016.
- "Teenagers' Mood improved by Coloured Lights" International Conference on Architectural Research (ICAR), 2015.
- "Colour Preference in Teenage Boys Bedrooms" Proceedings of the 28th International BCS Human Computer Interaction Conference, 2014.
- "Art, Technology and Interaction in the context of teenagers Digital Age" CHI 2013.
- "Draw Me a Poem: defining and promoting creativity and 'out-of-the-box' thinking" Journal of Interaction Design & Architecture, 2013.

Chapter 2

TEENAGERS

Introduction

This chapter presents the current literature on teenagers' mood and their social activities in the context of private spaces such as bedrooms, and it introduces the link between teenagers and interactive devices, which is explored in the HCI (Human Computer Interaction) research area. The Teens and Mood subdivision debates mood and emotion for teenagers and suggests colour as a possibility to help teenagers convey mood. The second subdivision, Teens, media, and social communication, explores how teens engage in social communication and how this has become altered with the smartphone. This is followed by a Teens and interactive digital art subdivision which exposes what interactive digital art is, and asks about teens and their relationships with art, provoking it as a candidate means for expression for teenagers. The Teens in private spaces section considers where teens hang out, in and outside their homes, and specifically highlights privacy in the context of real and virtual interactions. The final subsection is entitled Research methods and this shows a gap for Teen Computer Interaction (TCI) that is filled with one of the method contributions of the thesis.

Aim

The work from this chapter is presented from a crossover viewpoint between research areas such as psychology, social communication, media, interactive design, and interior design. The aim is to find common grounds from all these research areas in order to have a broader understanding of teenagers' wellbeing and social lifestyle.

Structure

This chapter begins with an introduction to teenage moodiness and emotion from a more general viewpoint and then looks at teens' social communication style, following with a subsection about digital natives in an interactive digital art age, ending up with a short introduction of bedrooms as private spaces for teenagers. The chapter concludes with a discussion of limitations in the literature review, contributions, and design options based on the research found.

Teens and Mood

According to Evans (2003), there is a difference between mood and emotion: moods are considered background states that raise or lower one's predisposition to emotional stimuli; moods last longer than emotions. For instance, happiness is considered to be a mood, while joy, an emotion, because happiness could last from several minutes to several hours while joy, would last only a few seconds, rarely more than a minute. When in a happy mood, one would react joyfully to good news, but when in a sad mood, the same person might react less intense. Someone in a bad mood would be more likely to cry when hearing bad news, while one in a "happy mood might laugh it off" (Evans 2003). Furthermore, people are more easily frightened when in anxious moods, while an irritable mood makes them angrier (Evans 2003).

Moodiness has long been considered a distinctive attribute of teenagers (Larson, Csikszentmihalyi & Graef 1980). Since early times it was thought teenagers were inclined to wide, frequent, and unpredictable mood variations ((Larson, Csikszentmihalyi & Graef 1980), (Hall 1904), (Freud 1937), (Blos 1961)). Recent work has confirmed these observed findings by scanning the brains of teenagers. Several changes, that occur at the time of puberty (Coleman 2011), were noticed: the development of the brain was related with the improvement of information processing (Coleman 2011); only then, the limbic system, responsible for emotions, started developing. Teenage brains were reported to almost re-image themselves, causing risky behaviours but also great creativity (Nature Publishing Group 2006), considered to be related with positive mood ((Baas, De Dreu, C., K., W. & Nijstad 2008), (Davis 2009)). Thoughts (as a cognitive process) and moods are considered to be reciprocally related ((Chermahini, Hommel 2011), (Bar 2009), (Gray 2004), (Gross 2002), (Solberg 1966)), with divergent thinking leading to positive moods and convergent thinking to negative ones (Chermahini, Hommel 2011). Teenagers' sleep patterns have been considered to be related to brain changes; during puberty, levels of melatonin increase later in the day, therefore teenagers feel both sleepy and wakeful later than adults do ((Carskadon, Acebo 2002), (Coleman 2011)). It might be the case that because of these changes, teenagers over-react, have mood-swings and get over-emotional.

Adults, in comparison, show more stable emotional levels, which do not change so quickly (Larson, Csikszentmihalyi & Graef 1980). Bradburn (1969) states that as people get older they report less positive and less negative emotional experiences (Bradburn 1969). Compared to adults' moods, adolescents' high and low moods do not last for long, both their concentration and mood state are fleeting (Larson, Csikszentmihalyi & Graef 1980). Data shows that teenagers' concentration is shorter-lived than their moods (Larson, Csikszentmihalyi & Graef 1980), which are thought to be expressed in a way that only few friends would understand. Because of their 'mood swings',

teenagers experience a different world than adults do, one which is considered unsteady and much less even (Larson, Csikszentmihalyi & Graef 1980).

As teens moods seem to change almost as quickly as their emotions, there might not be a clear difference between teens' moods and emotions. Therefore, in this work, the term 'emotion' (or 'feeling') is sometimes interchanged with 'mood'. Scientists have tried to measure emotions using self-report as well as galvanic measurements. In the case of moods, self-reports preferred as they typically are more durable than emotional feelings which are often fleeting. Galvanic measures might measure the body's reaction to emotions (as impulses to action (Goleman 1996)) but not to moods (which last longer than emotions (Evans 2003)).

According to Gordon et al. (1997), people, activities, and situations in which teenagers find themselves are the three main influences on their moods. Because girls are more "people oriented" than boys, they link their happiness with people (friendships, relationships, family, etc.) while boys feel that their happiness depends on their actions, such as playing sport (Gordon, Grant 1997). Sources for unhappiness for girls are friendships, relationships with people, feeling unconfident; boys feel unhappy when they lose something (e.g. their football team losing) or when they get into trouble (Gordon, Grant 1997). At the age of 15-16, the rate of depression is twice as high among teenage girls as compared with teenage boys (Gordon, Grant 1997). However, there are also similarities regarding teenage emotions, both genders being equally likely to describe themselves as shy, angry, and romantic (Gordon, Grant 1997).

Expressing mood is difficult, language is often not the most effective means and so humans have sought "other technologies of mood that might provide a faster and more secure shortcut to happiness than words alone", with the use of colour being one such technology (Evans 2003). Colour rarely affects our emotions directly but generally influences them indirectly via mood (Evans 2003). Conveying moods through colour might be similar to venting, which was used as a way of using language to "talk about unpleasant emotions in order to make them go away" (Evans 2003). Therefore, colour could be vindicated as a novel tool for conveying moods.

With the possibility to convey mood, colour can also affect mood. Kandinsky (1977), a painter and art theorist, who describes colour from a philosophical point of view, believed the "psychic effect" of colour could affect one's soul: "to a more sensitive soul the effect of colours is deeper and intensely moving. They produce a corresponding spiritual vibration, and it is only as a step towards this spiritual vibration that the elementary physical impression is of importance" (Kandinsky 1977). Kandinsky (1977) was questioning "whether the psychic effect of colour is a direct one, or whether it is the outcome of association". Nevertheless, Kandinsky (1977) acknowledged the relationship

between colour and one's spirit, the latest maybe seen as a form of emotional energy revealed in, or by, a work of art. He also suggested that the effects of colour could be defined by association through other senses. For instance, "one might say that keen yellow looks sour, because it recalls the taste of a lemon" (Kandinsky 1977).

Teens, media, and social communication

Teens engage in social communication and they have always communicated much more with their own kind than with those outside their peer group. They prefer to express their mood in a way that only few friends would understand. It has long been known that teenagers prefer close friends, to adults, as a source for social support (Solberg 1966). Teenagers at-risk feel comfortable to express feelings to their best friends without worrying about reactions or criticism (Solberg 1966).

Teenagers' social communication has become altered by computer technology via mobile phones, social media apps, and online chat systems (Boyd 2014). Nowadays the smartphone is most used tool for different purposes, such as calls, messages, listening to music, listening to the radio, watching videos, taking photos, recording or capturing videos (or audio), playing games, browsing on the Internet, etc. (Ignacio, Pilar, Conesa, Garcia, M. 2013). Teenagers are described as being characterized by an emotional vulnerability and by the use and abuse of mobile phones (Ignacio, Pilar, Conesa, Garcia, M. 2013). This behaviour might have been facilitated by the widespread availability of smartphones (Lenhart et al. 2015). In the last few years, mobile phones, "with their built-in ability of surfing the internet, have taken over a growing portion of the communications pie" (Passig 2014). Lenhart et al. (Lenhart et al. 2015) showed that 92% of American teens report going online daily, of which 24% go online almost constantly. A more positive view on this is that mobile devices suit teenagers' communication styles allowing low effort, easy in and out communication via more than one social network site, such as Facebook, Instagram, and Snapchat (Lenhart et al. 2015).

The embodiment of interactive technology into the social lives of teenagers is reported in the literature. Teenagers at-risk have been shown to prefer to express their social support using instant message (IM) and short-message (SMS) interfaces (Passig 2014). Other studies show a preference for IM ((Lenhart, Rainie & Lewis 2001), (Boneva et al. 2005)). Teenagers are more supportive in social conversation contexts than in emotional ones. When teenagers had conversations with a negative context about a partner they mostly used IM; but preferred an SMS style interface when asking favours or advice or gossiping. Chat interfaces were preferred when they wanted to talk about a relationship partner. These results suggest that at-risk teenagers prefer different interfaces for different topic conversation (Passig 2014).

There are some gender differences in the use of communication media with girls spending considerably more time on mobile devices than boys (number of calls, messages and the general time spent during weekends and weekdays) and with girls having more positive attitudes towards their mobile devices ((Ignacio, Pilar, Conesa, Garcia, M. 2013), (Lenhart et al. 2015)). These distinctions in amount of use may be attributed to the different tasks that the teenagers use the devices for. Teen girls use mobile phones to overcome boredom, manage anxiety or in moments when they are alone or feeling down, teen boys being more likely to use mobile phones for games, internet downloads, and use of electronic devices (Ignacio, Pilar, Conesa, Garcia, M. 2013). The context of these studies is varied: Solberg's (1966) book was published in Jerusalem, Ignacio et al. (2013) run their study in Spain, and Lenhart et al. (2015) in America.

Teens and interactive digital art

Interactive digital art is art that is dynamic, responding to its external stimuli like people moving and speaking (Edmonds, Candy 2011). In this context, the art viewer becomes the art user, as contemporary art becomes more experimental and interactive, using a new sense, touching (Wands 2006), and a digital medium (Paul 2003). Therefore, a work of art is transformed into a "dynamic environment", where viewers become participants in a space with no clear boundaries where action might take place (Lovejoy, Paul & Vesna 2011).

Artist Miriam Backstrom (Backstrom 2013) created an interactive art installation using Philips luminous panels (Figure 6). Sounds and dynamic images were displayed on the panels that were arranged, in an artistic way, in a corner of a room. The artist wrote that "people are sensitive to movement, colour, technique and interaction. That's why these panels have such an interesting

effect" (Philips not specifiedb). Figure 7 shows different displays of the installation showing how it changed changing colours and patterns on a musical background as people interacted with it.

Figure 6. An interactive art installation created from Philips luminous textiles by artist Miriam Backstrom. Source: (Backstrom 2013)

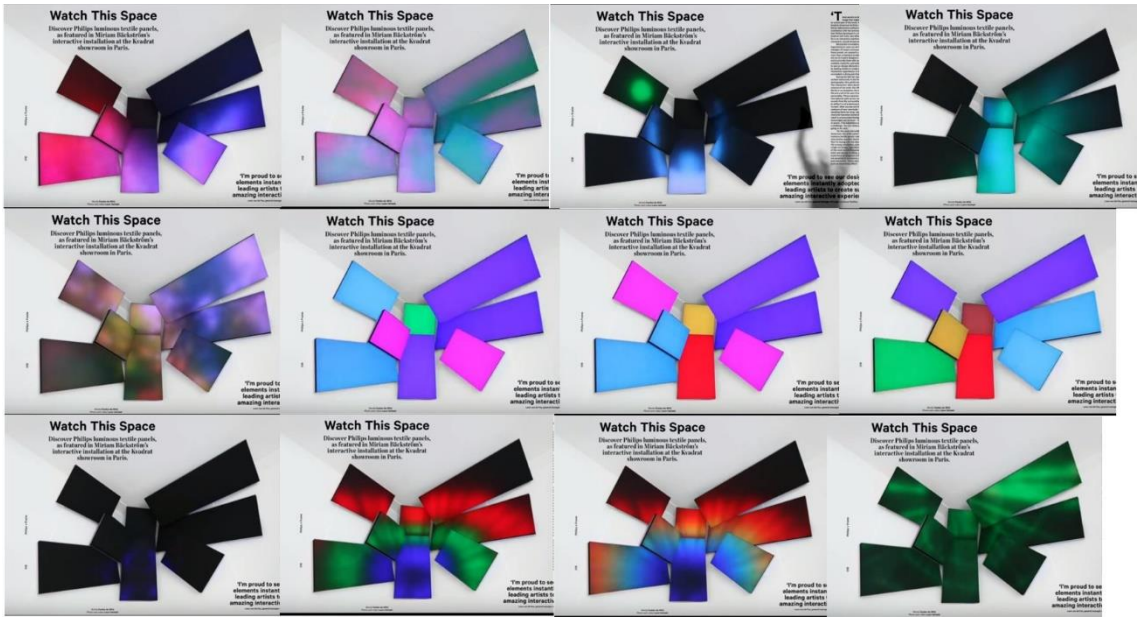


Figure 7. An interactive art installation made out of Philips Luminous Panels by artist Miriam Backstrom. Source: (Philips not specifieda)

Technology plays an important role in digital art (Edmonds, Candy 2011), and the use of digital technologies has vastly increased, especially in teenagers' lives (Paul 2003). Accepting that young adolescents' lives and digital art are linked to technology, teenagers born in a digital world could become the next digital artists as long as digital art exists (Balta 2013). Moreover, more and more artists use digital technology as a new tool for creating their own art (Paul 2003). Future artists might never know how it feels like to draw by hand on a white piece of paper. People's economy,

politics, culture, and even the structure of our family life might be "forever transformed" as art collides with technology (Palfrey, Gasser 2008). Therefore, the author provokes digital interactive art as a candidate means for expression for teenagers.

Teens in private spaces

Teenagers spend most of their leisure time at home, alone (Csikszentmihalyi, Larson 1984), and when outside their homes they tend to 'hang out' in schools or in shopping malls (Anthony 1985). Shopping malls are a third place for teens where they have "a sense of belonging while yet retaining a distinctive personal identity, and an opportunity for spontaneity, surprise, and emotional expression" (Oldenburg, Brissett 1980). When they cannot leave the house, teens look for privacy online, where they connect with friends, socialize, develop social skills, learn how to network, and also relax (Boyd 2014).

Teens' desire for privacy might be an escape from adults' authority (parents, teachers) (Boyd 2014). Social media "introduced a new dimension over private space and personal expression" (Boyd 2014), that is explored by teenagers. There is this idea that teens do not care about online privacy, sharing too much information but today's technology executives argue that "social norms around privacy have changed" and that today's teens are different (Boyd 2014). As one teen points out, "every teenager wants privacy" (Boyd 2014), and private spaces could be virtual as well as real. For instance, teenagers could access virtual private spaces from the real ones like bedrooms.

Teenage bedrooms were considered a "space designed and maintained almost exclusively by teens rather than parents" (Reid 2010). Teenagers' moods might be affected by school or college environments and in their search for privacy, bedrooms could help teens cut off any distractions. The bedroom is a place where teens might feel the most comfortable to reflect on their mood at the end of the day and could be used as a nest during difficult times (Lincoln 2012). Bedrooms are private spaces that are not simple, functional, static spaces ((Lincoln 2012); (Reid 2012)), but spaces where one can authenticate his/her identity, play, and experiment. The contemporary teenage bedroom is not simply a sleeping room anymore; it is also a space for socializing, "acting as an incubator for teen identity and development while also serving as one of the most important sites of teen online consumption" (Reid 2012). Such rooms are key spaces within which young people are able to articulate and represent their social and cultural lives, their transitions, experiences, aspirations, and identities (Lincoln 2013). According to Lincoln (2012) teenagers' bedrooms are full of activities (Lincoln 2012). The bedroom is the space where teenagers start and end their day. It is a space where they sleep, self-maintain, eat, do homework, prepare for important exams, relax, spend time on their own, read magazines, listen to music, play computer

games, watch TV, listen to the radio. In this space teenagers also use their laptops, smart phones, they text, talk on the phone, check social network sites such as Facebook or Twitter (Lincoln 2012). Bedrooms' significance to young people is not stable and the experience of a bedroom is unique to every young person (Lincoln 2012).

Research methods

Engaging with teens in research is a natural consequence of HCI and CCI research. First there was Human Computer Interaction (HCI) that used adults as participants and then Child Computer Interaction (CCI), with research methods focused on children. Some of the work in CCI is pertinent to Teenage Computer Interaction. According to Jensen et al. (2005), there are eight applied research methods and five research purposes in the Children Computer Interaction community (CCI) (Jensen, Skov 2005). The methods are case studies, field studies, action research, lab experiments, survey research, applied research, basic research, and normative writings; the purposes are to understand, engineer, re-engineer, evaluate, and describe (Jensen, Skov 2005). It is imagined that each of these methods could effectively be used with teenagers.

That said, teenagers, unlike children and adults, have not been well studied within the field of interaction design and they fall "into an underexplored space between the Child-Computer Interaction community and mainstream HCI", a space called Teen Computer Interaction (TCI) (Fitton, Read & Horton 2013). Therefore, TCI, as a new sub-discipline, takes some methods from CCI, but also demands some new methods as not all "methodologies developed for child users or adult users may be appropriate or entirely successful when used with teenagers" (Fitton, Read & Horton 2013). Teenagers are different from children, gaining "increasing independence from their parents", often having "access to a wide variety of technologies" and having more spending power than children do (Fitton, Read & Horton 2013). "When working with teens, as opposed to younger children, participants are much more able to understand the context in which they are participating in research and the potential impact of their contribution" (Fitton, Read & Horton 2013). Therefore, even if in CCI there are design methods suitable for TCI, there are cognitive and physical differences between children and adults (Jensen, Skov 2005), and between children and teenagers (Giedd 2008).

Some of the methods and tools that have been developed to involve teenagers in research and design projects include *The Cool Wall* (Fitton et al. 2012b) that was developed to gain insights into teen understandings of 'cool', the use of *specialized personas* (Horton et al. 2012) that have been developed to effectively understand and design for teenagers, and the *Scandinavian PD model* (Iversen, Smith 2012) that was developed to encourage teenagers realize they can play an

important part in the design of future technologies. However, "it is still unclear what techniques should be used/adapted for teens and how" (Fitton, Read & Horton 2013).

In theorising about the need for new methods for working with teenagers in HCI, Read et al. (2016) developed two models and a set of guidelines for TCI research. These models consider the cultural distances between the teenagers and the researchers as well as considering the autonomy of the teens – and these two perspectives are used to discuss the appropriateness of research methods and the choices for interpretation during analysis of results ((Read, Horton 2016), (Schlegel, Barry 1991)). Teenage-adult segregations allow teenage culture to develop on its own, having increased autonomy because of this independence, but this then "create(s) conditions in which the communication path between the adult and teenager become problematic" (Read, Horton 2016). Teenagers' individual lack of autonomy might affect the data collected by researchers, because some tasks require them to be reflective, and low reflection might lead to "data that is not representative of his/her views". The TRALa model (Teenage Reflection/Autonomy Landscape) (Figure 8) highlights four possible situations of which researchers should be aware of. These are as follows:

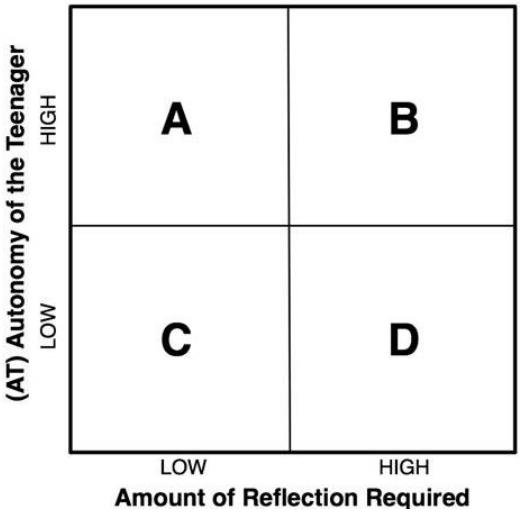


Figure 8: TRALa (Teen Reflection/Autonomy Landscape) model

- Quadrant A is when the teenager as participant has a high degree of autonomy, and the amount of reflection needed for the task is low. The data would be robust in this case;
- Quadrant B is where the level of autonomy remains high and the amount of reflection on the given task is rising, a deeper reflection being needed. The quality of data might depend on teenager's culture, educational maturity, and life experiences;
- Quadrant C indicates a low level of autonomy as well as low amount of reflection. Therefore, the researcher might want to treat the data with caution, as its quality is questionable;
- Quadrant D is where the teenagers have low autonomy and "a complex task to complete", therefore "this is the worst place to be in this matrix" (Read, Horton 2016).

The second model proposed by Read et al. (2016) is the RIDLa (Researcher Interpretation/Distance Landscape) model (Figure 9), which shows four different TCI research positions in terms of data interpretation. Quadrant P here represents the position of a researcher who is having an outsider view ("large cultural distance") on the data that requires a low amount of interpretation. It is

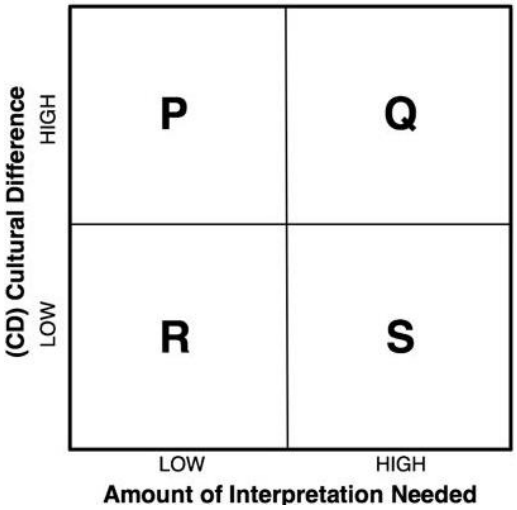


Figure 9: RIDLa (Researcher Interpretation/Distance Landscape) model

suggested by Read et al. (2016) that this is a "safe place for analysis". Quadrant Q represents the position of an outsider researcher that needs to interpret the "meaning of teenage data", a questionable interpretation "without the context and knowledge of teenage culture" (Read, Horton 2016). Quadrant R represents a position of a researcher that has an understanding of the context and knowledge of teenage culture, and the requirement to interpret data that is not too complex. Because of the familiarity with the subject of research, "this person may be seeking for confirmations of ideas but the lack of complexity in the data leaves this as not too concerning arrangement" (Read, Horton 2016). The situation in quadrant S refers to a researcher that has knowledge about the subject and is very good at interpreting data. This position of the researcher might affect the meaning of the data. "The advice for research teams might be to both be aware of one's own position when doing interpretation but also to consider making up teams of analysts, who are not all standing at the same position" (Read, Horton 2016).

For effective research in TCI, there is therefore a need for engaging research methods and novel design, and there is a need of effective ways to interpret data from teenagers. The autonomy of teenagers should be thought about before the study design. For example, if there is low teenage autonomy, then simple tasks should be designed rather than complicated ones. Alternatively, maybe their freedom to express ideas could be limited by the presence of parents/teachers during the study (Read, Horton 2016), so a method that would avoid this influence to happen might give more valid results.

The problems of interpretation can be mitigated against by potentially letting teens interpret their own research. This leads the reader to one of the method contributions of the thesis (Chapter 6) where same teen participants interpreted visual data (their results which were graphically designed), without knowing, around one year after it was first collected. The study in Chapter 6 of this thesis would position the data mainly in the quadrant A of the TRALa model, because the students that participated had high autonomy and the given tasks had little complexity. Regarding the interpretation, there was a mix of cultural distances, the interpretation being pushed towards quadrant Q in the RIDLa model (Read, Horton 2016).

Conclusion

From present literature, it is evident that there is shortage of literature about tools that could help teenagers express, understand, and be aware of their moods during this confusing transition from child to adult. Even though teenage moodiness is temporary, there are three main influences on their emotions, which are people, activities, and situations, in which teenagers find themselves (Gordon, Grant 1997). Moreover, the differences in what make girls and boys happy or unhappy suggest that what triggers emotions might differ because of gender, which implies a difference between gender teenage moods, as emotion is a very quick reaction to a factor (could last for few seconds to few minutes), while mood would last longer (from several hours to a day). Furthermore, there has been little research into teenage area, especially when related to their bedrooms, which is surprising considering that these spaces might be very personal and significant to their lives.

Limitations

The decision to present this chapter from different point of views (psychological, Human-Computer Interaction, Interior design, Social Media) might be seen as unfocused. However, as the thesis is a crossover between different areas of research, this is reflected in the structure of the chapters. Therefore, this chapter might not cover all relevant studies from each research area, as it is focused on the crossover of the areas, underlying several works from relevant areas.

It has not been proven that there is a relation between the brain changes that can be seen on an fMRI (functional magnetic resonance image) and moods and thoughts. However, the present work uses studies that suggest there might be a relationship between moods and parts of the brain. Future research might change these beliefs, but at the moment the author is building her ideas based on present available relevant research, being aware that the present view of the relationship between mood and brain might change in the future because of improved technology and new ground breaking findings.

Contributions

Evans (2003) writes that people might prefer other faster ways than language to release emotional pressure. Therefore, in this thesis, colour is vindicated as a novel tool for conveying moods, as it generally influences emotions indirectly via mood (Evans 2003). From the review of the literature on teenage moods, which has shown that teens' mood could vary in a very short period of time, together with the literature on their online social communication style, which is again fast and prompt, it would seem sensible to suggest that a faster and more flexible way of communication might suit their spontaneous social communication style. Moreover, research has shown that teenage transition is a confusing stage of life, but no solution to help teenagers understand this

process has been suggested. Therefore, it is evident that a quick, prompt, and flexible communication style is needed to help teenagers understand and express their quickly changeable moods.

Chapter 3

INTERACTIVE INSTALLATIONS

Introduction

This chapter presents the current literature on interactive installations and interactive products, including some designed specifically for teenagers. The Mobile apps subdivision explores online apps designed to help users with mood expression. The Colour installations subdivision introduces interactive installations that affect people's wellbeing using colour. Other artistic interactive products that are used to express moods are exposed in the Mood installations subdivision. This is followed by the Architectural installations subsection which considers the use of ambient installations in people's homes.

Aim

To explore the literature on the design of interactive installations and mood reporting applications for teenagers, especially within the context of colour as a communication medium. To inform the design of the proposed application/system.

Structure

This chapter introduces the literature on interactive devices, grouping them in interactive mobile apps, interactive installations that use colour, mood interactive installations and architectural ones.

Interactive devices

Nowadays, because of technology, new types of installations that were never created before are designed, interactive digital art being one such example (Edmonds, Candy 2011). Using new software and a computer, artists can design three-dimensional sculptures rather than creating them in stone, as in the old times (Wands 2006).

The word interactive has different meanings in different contexts. There is, and always has been, on one level an interaction between a viewer and a painting – but this is an interaction at the cerebral layer. A traditional painting does not itself start changing while the viewer is looking at it, neither can the viewer start drawing over the paint, because of the museum's restraints, but the viewer her/himself interacts by thought with the meanings of the static work.

Regarding to digital art, however, interacting with the artwork is the main purpose (Paul 2003) and an action-based interaction is anticipated. The role of the audience as a user is an important new element in interactive art as the expected actions of the audience affect the way interactions are built into the art (Edmonds, Candy 2011). The idea of the audience becoming a user is found in Sheridan's et al. (2008) work, where three categories of audience behaviour are described in the context of live street performance: spectating, participating, and performing. Spectating behaviour relates to people that do not engage in performative interaction. They either interpret the performer's actions (being called witting audience) or they may observe the performer's actions but are not aware that a performance is happening (unwitting bystanders). People from the audience who decide to participate in the performance have to learn how to use the tools given to perform. Thus they are called participants, who could, by practice, become performers. The most engaged group would be the people who participated before in the performance (participants), so they have prior knowledge on how to use the tools given, thus allowing them to express themselves by performing (Sheridan, Bryan-Kinns 2008). It can be seen there is a behavioural audience transition from spectating to performing. There are the spectators who do not engage in a performance, but by choosing to engage, they could become participants. The participant, through practice, could become expert in performing, therefore a performer. According to Sheridan et al. (2008), performers are those who played several times or a longer period of time (such as thirty minutes) with their device, in this case uPoi, an interactive tool that is meant to be used in a performance context in order to induce behavioural change, namely the transition between one as an observer to participator, and finally, performer.

Based on their observation with this interactive prototype in a street performing frame, Sheridan et al. (2008) presented some initial guidelines for designing interactive and movable tools for street performers in the context of Digital Live Art (Sheridan 2006). Digital Live Art (DLA) (Sheridan 2006) is the crossroad between computing, live art and Human Computer Interaction (HCI), and it "brings in question how we design for, and support experimental, improvisational, and fleeting interaction" (Sheridan, Bryan-Kinns 2008). There is little understanding of "how to design for such situations" but the tangible devices designed should be robust, intuitive, unobtrusive yet enticing, portable and flexible (Sheridan, Bryan-Kinns 2008). The key designed requirements for performative tangible interactive systems are as follows:

- Robust – suitable for bad and changeable environmental conditions and different forms of interaction;
- Intuitive – user friendly design that allows people to quickly understand how to interact with the device;

- Unobtrusive – such design that allows public to carry on their normal activities if they choose so;
- Enticing – encouraging spontaneous interaction of any interested person without instruction needed;
- Portable – lightweight, low power, easily transported, set up and taken down;
- Flexible – can be easily adapted to any dynamic environment in which they are displayed.

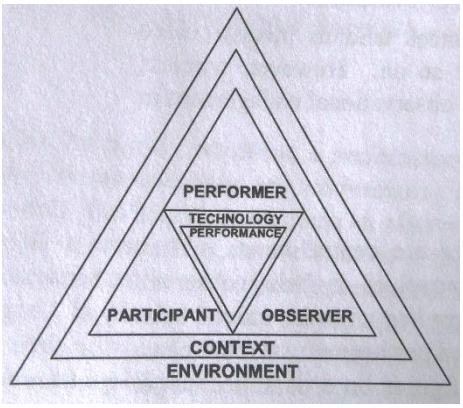


Figure 10. Performance Triad model for the development and analysis of technology-based performance. Source (Sheridan 2006)

The guidelines above might be applicable "in other tangible interaction domains that involve groups of people in real world interaction". Sheridan et al. (2008) question "how the audience and non-performers might understand, respond, and interact with a system" in the context of street art performance. When designing tangible interfaces for the real world, one should understand the "practice, methods, and theories in the field of Live Art" (Sheridan 2006). This way the context of design can be informed. The Performance Triad model (PT) (Figure 10), is "a method for the analysis, deconstruction and understanding for tripartite interaction" (interaction between performers, participants, and observers) in playful arenas (Sheridan 2006). This model allows researchers to investigate the interaction between performers, participants, and observers (tripartite interaction), and explore how context and environment could affect these activities.

A theoretical framework related to interactive installations "as inspirational artistic probes for HCI" was created by Nam et al. (2014) who suggested interactive installations can foster emotional engagement, influence critical thinking, as well as "reference audiences' social and cultural contexts" (Nam, Nitsche 2014). According to these researchers, an interactive installation should be constitutive, epistemic, and critical. A constitutive interactive installation references participants' social and cultural condition. It focuses on the user's self-expression with the interface, referencing participants' individual experiences and influencing "their social and cultural perspectives". An epistemic installation refers to the "full-body interaction that shifts focus to the physical space and embodied experiences". According to Nam et al. (2014), "interactive installations reconfigure spaces, so participants create a shared performance". Interactive installations can be critical because they could reflect and convey social and political roles, as they "often work by positioning the audience in a critical stance in a new socio-political context" (Nam, Nitsche 2014).

The Performance triad model was one of the inspirations for the interactive model that is developed later in the thesis (Chapter 7), together with a mobile app, which will be developed in Chapter 7 and evaluated in Chapter 8. Therefore, the Mobile apps subdivision introduces related work in HCI and other fields.

Mobile apps

Related work in terms of online applications should be mentioned as follows: *We Feel Fine* is a data collection engine that scans blog posts to collect and present data about humans' emotions around the world. The top two hundred feelings were correlated with randomly assigned colours: happy positive feelings were recorded as bright yellow; sad negative feelings, dark blue; angry feelings were red, and calm feelings were green (Kamvar, Harris 2011). *MoodJam* is an "online diary that allows people to express their moods and feelings using patterns of colour" (Li 2012). It keeps hourly, daily, or weekly mood-records using colour strips while one's moods can be shared with anyone. *MobiMood* is a social mobile application that allows groups of friends to share their moods while on-the-move. It includes six predefined colours participants can use, which is perhaps limiting (Church, Hoggan & Oliver 2010). *E-Moto* is a HCI mobile service for sending affective messages to others using colours, shapes, and animations as the background of message (Sundstrom, Stahl & Hook 2005). Figure 11 is an example of e-Moto movement diagram and how the app background could look like.

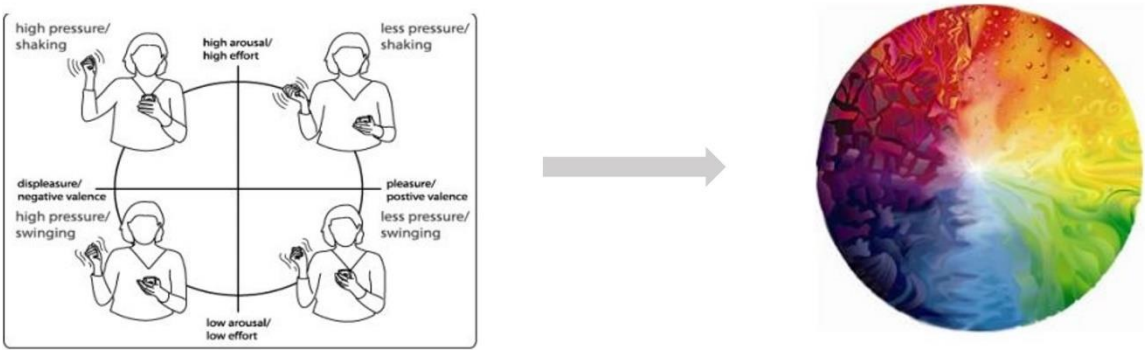


Figure 11. e-Moto movement diagram and an example of how the app background could look like.

Colour installations

Chromosaturation (designboom 2012) is an "interactive manufactured habitat composed of three colour chambers – red, green, and blue" (Figure 12). The chromatic interior spaces alter the perception of their audience by giving the impression of modifying colours of the skin, clothes, or other objects. "As one moves from colour chamber to colour chamber, the reminder of the previous visual saturation shocks the retina" (MFAH 2014). The fascinating results could be seen in the figures below:

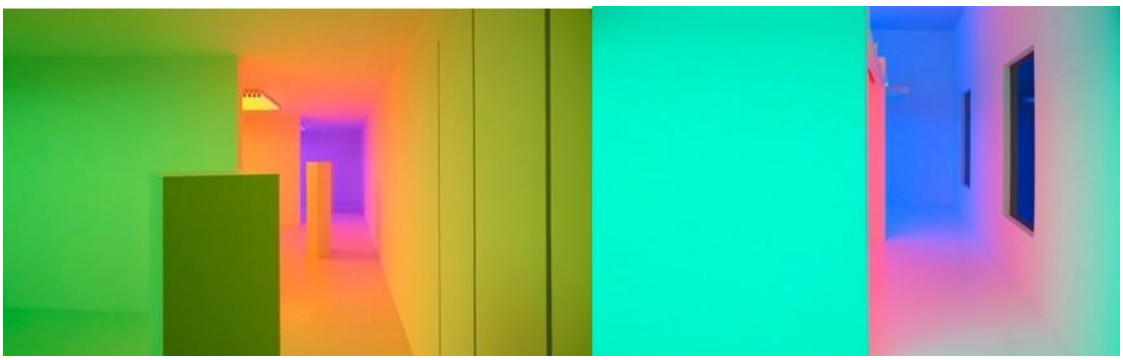


Figure 12. (from left to right): Chromosaturation (source: (designboom 2012); Chromosaturation (source: (designboom 2012).

Plug and Play Installation (Figure 13) is a lighting system created by Philips. The installation is a luminous coloured textile panel, which could be used as a mood wall. According to Philips (2013b) the mood wall installation "can display dynamic content" by integrating the light in an interior in order to create "decorative and ambient effects" (Philips 2013b). The aim is to create a dynamic space, which should "engage and attract, surprise and delight, uplift and inspire" (Philips 2013a). The lighting system integrates multi-coloured LEDs and white or coloured textile panels. This new luminous textile is a new sensory experience that can inspire interior designers and lighting designers. Moreover, because of its texture, it also "helps to dampen noise and soften echoes" (Philips 2013a).

Figure 13. Philips luminous textile combines multi-coloured LEDs seamlessly within beautiful textile panels that also soften sound. Source: (Philips Lighting 2016b).

Philips HUE (Figure 14) is a personal, wireless, interactive lighting system designed for real life that lets the users control their home lighting using an app. It could improve one's mood, as well as keep them informed about the weather or incoming calls (Philips Lighting 2016a).

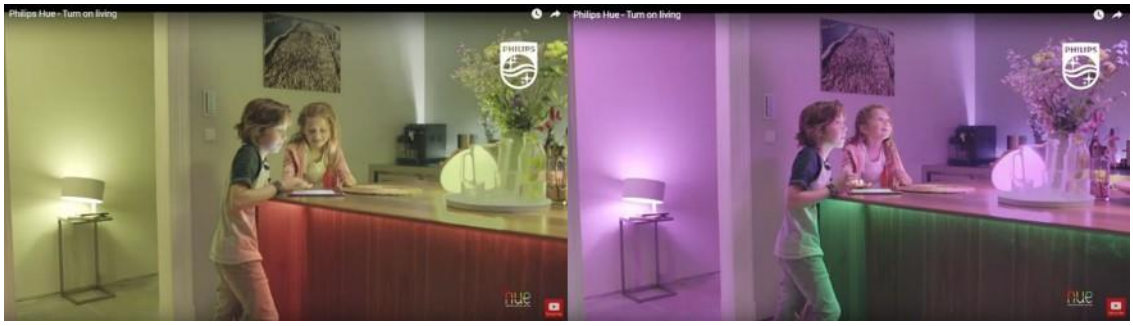


Figure 14. Different light colours of Philips Hue. Source: (Philips Lighting 2016a).

Philips designed an interactive colour changing light wall (Figure 15) for Birmingham Children's Hospital. The interactive wall, which offers interactive scenes and games, "has been designed with a holistic approach in mind to lessen the tension, anxiety and stress young patients typically feel when entering a hospital environment" (Philips 2014).

Figure 15. Philips interactive colour changing light wall.

Triolin AV (Figure 16) is an example of an interactive surface, which has an effect on people's mood by using light and sound in a dark room. When the user presses the surface, visuals start reacting around the pressure point, and music is triggered. Participants can easily change their mood depending on the colour and sound intensity they are playing within the dark room. If the spandex is not being pressed by the user, then the installation does not react. An algorithm created allows the music to speed up and slow down or get louder or softer, based on depth of pressure. The installation is made from rectangular interactive spandex walls (Ionescu 2013).

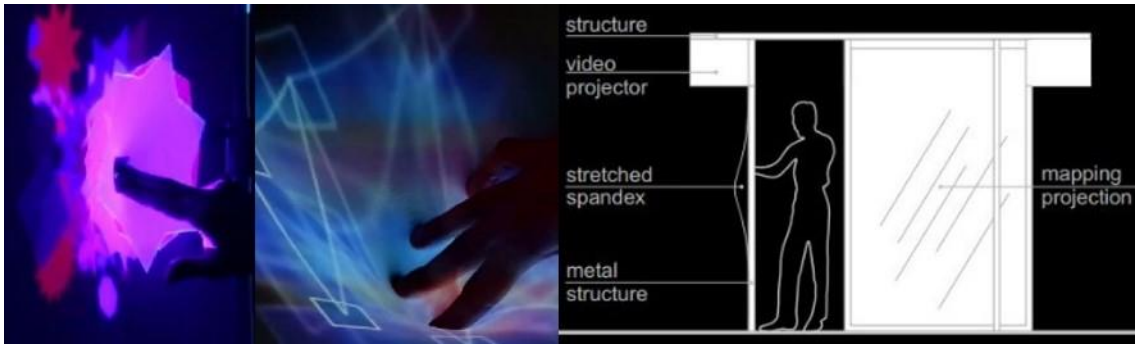


Figure 16: Triolin AV, an interactive installation; prototype and side view [source: (Ionescu 2013)]

Mood installations

The use of artistic interactive products in order to facilitate social communication has had considerable interest in recent years. The *Buddy-Beads* project creates an interactive bracelet that allows teenage females to communicate in groups using codes and signals that they can decide upon (Kikin-Gil 2006). Users in this installation can communicate moods and situations without speaking by pressing different beads on the bracelets (Figure 17). The final design for this technology was used in an exhibition where people reacted positively to it. Three girls stated they like to use the bracelet mainly because they could code it themselves in such way that no one else would understand the meaning of signals they use (visual or tactile), and because it can be used in situations where one cannot use a SMS (Kikin-Gil 2006).

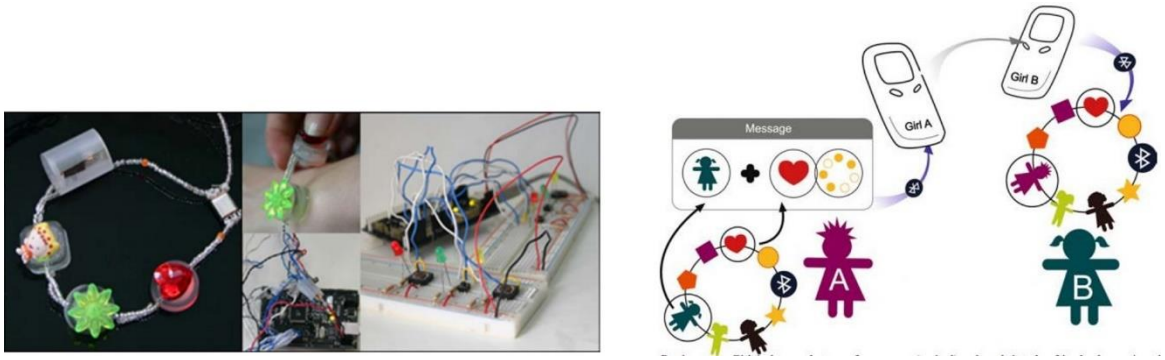


Figure 17. Interactive bracelet that allows teen females to communicate in groups using codes and signals that they can decide upon.

In one study on how to design for teenagers Read et al. (2011) considered how the designs for teens could incorporate cool attributes to ensure their acceptability (Read et al. 2011). Among these cool attributes one design feature was for anti and pro sociality which was to design something that could be understood by the teenagers own social group whilst being not understandable beyond this group. This is clearly an attractive element of the work by (Kikin-Gil 2006) and is an aspect elemental to the thesis work.

Mood Swings (Figure 18), is an interactive mood installation from HCI; it is an interactive room full of little orbs that use tactile interfaces (movement as input and coloured light as output) to visualize one's emotion. Sensors in the orbs measure one's movement, and "deduce the appropriate affective state. Feedback is given by means of different colours of light" (Bialoskorski, Westerink, Joyce H. D. M. & van den Broek, Egon L. 2009).

Figure 18. Left side: the original concept. Right side: people interacting with Mood Swings Luminous Orbs.

Visual Melodies, an affective installation aimed to change mood, was designed for relaxation and relief of anxiety for people in healthcare settings (Yi-Chun Chen, Bongers & Iedema 2009). It has two themes: Jellyfish theme and Night Sky theme (Figure 19).

The Jellyfish theme (left side of Figure 19) is a representation of blue water, created to calm and relax people while they stimulate the water's surface. Jellyfishes could be manipulated under the water in a X and Y axis. The user can change the view, from an under-sea view to a night sky view, with ambient music that sounds like bubbles floating to the water's surface (Yi-Chun Chen, Bongers & Iedema 2009).

The Night Sky (right side of Figure 19) theme is an animation that changes perspectives: from sitting on a tree branch as an owl to being in the grass looking up as several dandelions. To change perspectives, the user has to click on owls, and this is where interaction takes place. Together with the ambient sound, this interaction evokes feelings of peace and dream-like emotions (Yi-Chun Chen, Bongers & Iedema 2009).

Figure 19. Visual Melodies affective interaction and its two themes: Jellyfish theme and Night Sky theme.

Architectural installations

Figure 21. Interior of Photon Pod glass module. Source: {{380 Meinhold, Bridgette 2013}}

Figure 20. Philips Hue

The Photon Project (Figure 21), an all glass house module, is used by researchers to study the effect of light on people's wellbeing ((Meinhold 2013), (Sharman et al. 2013)). Thus, it plays an important role in the research of light effect on people's health, behaviour, and ways of living. The aim is to understand how people feel in different light settings by testing levels of alertness or relaxation (Meinhold 2013). Therefore, they applied designed light *Philips Hue* (Figure 20) in ways that harmonize with natural light (Oliner 2013). According to Sharman et al. (2013), the *Photon Project* will have a profound influence on different disciplines such as architecture, interior design, lighting, philanthropy, healthcare, leisure, therapy and much more. The first prototype *Photon Pod* was launched during the London Design Festival in September 2013, when visitors had the chance to take part in daily sunrise and sunset experiences, where their levels of alertness/relaxation were measured (Sharman et al. 2013).

It is becoming increasingly difficult to ignore the importance of light in interior design, thus another interior lighting solution is *SchoolVision* lighting, designed to "improve pupils' concentration by changing classrooms' lighting conditions" (Philips 2010). A study was run for a year in a classroom where the existing lighting was replaced with *SchoolVision* light that could be changed by teachers according to the classroom's activities or time of day. The aim was to create the right ambience at certain times during the day in order to "bring out the best in pupils". There was a significant positive correlation between lighting and "attention span, concentration and all-round behaviour", reading speed increasing by almost 35%, frequency of errors reducing by almost 45% while hyperactive behaviour was reduced by a massive 76% (Philips 2010).

Conclusion

This chapter has highlighted theories of interaction as well as interactive work that aims to affect one's mood, wellbeing, or mental state by using a combination of colour and light in an interactive context, attention being drawn to the crossroad between interaction, colour, and light, digital art being mentioned as a form of interaction. This literature review has shown the existence of a variety of interactive installations and applications, but few have teenagers as a target group and systems that aim to help them convey mood in a social communication context seem to be inexistent. Therefore, the present research aims to fill this gap, having a futuristic vision in mind: affective computing for teenagers in the context of mood expression.

Limitations

Interactive systems seem to be designed especially for the interaction between an individual and a device, rather than two individuals who would use the device as a tool for expression. Literature review shows that not much work has been done in the area of interaction design for teenage population. For example, most of the mobile mood apps seem to be used for personal daily mood assessment, either for sharing moods with friends or for sharing colours with people. There is a lack of systems that would allow friends to share their moods using a range of colours, only predefined colours being used in most of the sharing mood mobile apps.

Contributions

The design of an interactive system for teenagers, that would help them express their moods, in ways that are to be explored in further chapters of this thesis, seems to be worthwhile as a thesis aim. Such an interactive system will give teenagers the freedom to express their mood within a close group of friends. Similar to the interactive bracelet project by Kikin-Gil (Kikin-Gil 2006), this device would allow teenagers to communicate in such way that no one else would understand the meaning of colours they use. As a solution to the limitations stated above, an interactive system will be designed especially for the communication between two (or more) individuals, colour together with technology being used as a tool for mood expression.

Chapter 4

COLOUR

Introduction

This chapter presents the current literature on colour preference and the first two subsections (Colour and emotions and Colour and arousal) introduce the link between colours and emotions/ mood. The Colour preference subdivision explores people's preferences on colours that might be influenced by cultural variation (Choungourian 1968) or cultural factors ((Oberascher 2008), (Chu, Rahman & Mandal 2011)).The Colour in Interior Design subsection considers the affect of coloured environments on people's wellbeing.

Aim

The purpose of this chapter is to provide an introduction to colour, to describe the importance of colour in one's life, to investigate how colour influences people's wellbeing and to draw awareness of the role colour plays in interior design.

Structure

This chapter begins with an overview of colour and its effects on people's emotions, gathering papers from different periods across Europe and beyond. It continues with a section on colour and arousal, perceived as a psychological state of being awake. Colour preference is further discussed, with examples from studies that used colour samples and studies where preferred coloured mugs or colouring methods were used. Interior design is then briefly explored, underlying the importance of colour in one's surroundings.

Colour and emotions

It is widely assumed, and some research studies corroborate this belief, that colours impact on people's lives with people claiming favourite colours, and suggesting some colours make them feel certain ways. Studies exploring these relationships come from a variety of academic disciplines. In Hemphill's (1996) study, 40 undergraduate students (20 males and 20 females), mainly Caucasian, were presented with ten cardboard rectangles of different colours: white, pink, red, yellow, blue, purple, green, brown, black, and grey. Firstly, they were asked questions about their favourite colour, and the major colour they were wearing. Then they had to choose from the given coloured cardboards the colour that mostly resembled their favourite colour and put it aside.

Then, they had to respond to questions for each colour left from the presented colours. The questions were "what emotional response do you associate with this colour?", "how does this colour make you feel?" and "why do you feel this way?" The coloured cards were shuffled after each use. Results showed that bright colours were mainly associated with positive moods, while dark colours were mainly associated with negative moods. Findings also showed that males tended to respond to dark colours more positively than females did. It was also noticed that colours were chosen because of different reasons. Blue because of its association with the ocean or the sky, green for its association with the environment, such as forest, trees, or nature and yellow because its brightness was associated with the sun. Red was seen as a positive colour because of its warmness while grey was considered the most negative colour because of the association with "rainy days and elicited sad or bored emotional responses" (Hemphill 1996). Hemphill (1996) identified red as being associated with excitement, which supports another study where it was found that children associated red with excitement and happiness (Boyatzis, Varghese 1994).

Boyatzis's et al. (1994) investigated children's emotional associations to colours. Sixty US children (30 girls, 30 boys) aged five to six and a half years old, were asked what their favourite colour was and were then shown nine different colours, "one at a time and in a random order" (Boyatzis, Varghese 1994). For each colour they were asked how did the colour make them feel and why. Girls responded positively to bright colours and negatively to dark ones. Boys also associated bright colours with positive moods, but tended to associate positive emotions to dark colours more than girls did (Boyatzis, Varghese 1994). When all children's responses had been analysed together and not by gender division, then results showed that all of them had positive reactions to bright colours such as pink, blue, red, and negative reactions for dark colours such as brown, black, and grey (Boyatzis, Varghese 1994). Results showed that children colour-emotion associations across all colours were "predominantly positive". The positive emotions mentioned by children were happiness, strength, and excitement and the negative ones were sadness, anger, and boredom. A major finding of this study was that "children revealed distinct emotional reactions to particular colours" (Boyatzis, Varghese 1994), which confirmed earlier work by (Cimbalo, Beck & Sendziak 1978). In this earlier study, Cimbalo et al. (1978) used two different age groups as participants. Eighty children, boys and girls (second and third grade) and 56 college students (males and females). Children and students were separated in 'judges' and 'participants'. The first group (of 24 children and 22 students) had to judge 20 coloured slides as happy or sad using a nine-point scale. Following this, the four coloured slides with the highest positive rating, and the four with the lowest rating were each presented for 15 seconds to the second group, the 'participants' (a group of 56 children and 34 students) who had to associate mood to colours.

Results showed that there was "a strong and reliable association between emotional tone and colour". In a follow-up study, 20 children (first and second grade) and 20 college students were asked to associate the same colours with their own mood interpretations. Results showed that "for both groups, black was associated with night, darkness, and death, whereas yellow was associated with sun, brightness, and warmth".

These studies described above are quite old, highlighting that the relationship between colour and emotions presented interest in the early days of colour research. At the time, Boyatzis et al. (1994) suggested that future work lay around the increase of colour-emotion associations in the context of social experience suggesting that future social experience might rise opportunities for more "sophisticated" colour mood associations (Boyatzis, Varghese 1994). They also hinted that cognitive development might "facilitate increasingly complex conceptualizations" of colour-mood associations (Boyatzis, Varghese 1994).

Cognition is, by definition, the mental action or process of acquiring knowledge and understanding through thought, experience, and senses; perceptions, sensations, ideas, or intuition result from the process of cognition (Oxford Dictionaires 2016). Following this definition, when one, for example, tries to communicate by sending a colour to another person via social media, cognition is involved because a process of thought is needed. Firstly, one has to be aware of the mood s/he is in so that a decision could be made about expressing the mood or not. Afterwards, the way of expression has to be chosen: will the person express the mood through a colour? If the answer is 'yes', then a colour would be associated to the mood, and this implies the decision of what colour would that be in order to correctly express the intended mood. The receiver would have to go through a similar process of mind that implies cognition: meaning making of the colour received. Even if the understanding is in an intuitive way, it still involves cognition according to the definition above. This idea, which will be developed in the thesis, is supported by Boyatzis et al. (1994) research suggestions mentioned above and it involves the use of cognitive development that facilitates the development of colour mood association.

Colour is perceived by the human eye in the form of light (Yildirim, Hidayetoglu & Capanoglu 2011) and it is experienced by all individuals who can perceive it (Lancaster 1996). During the process of perceiving colours, a feeling, referred to as a colour emotion, is induced by the brain (Yildirim, Hidayetoglu & Capanoglu 2011) and this emotion is believed to differ for different colours. According to Hogg (1969) and Sivik (1969) people react to colour in terms of warm and cold ((Hogg 1969b), (Sivik 1969)). Warm colours are red, orange, and yellow while cold colours are blue and green (Harleman, Werner & Billger 2007). In full-scale experiments, it was found that colours "cause a cognitive experience with associations of warmth and coldness" (Harleman,

Werner & Billger 2007). Cool colours such as blue and green together with achromatic colours are associated with calm and peaceful emotions, and spacious and restful feelings. Warm colours such as red and orange are associated with active feelings, being stimulating colours (Yildirim, Hidayetoglu & Capanoglu 2011).

In one study, healthy and depressed people's drawings were examined by grouping them as drawings in colour (chromatic condition) and drawings in black and white (achromatic condition). Jue (2013) found that healthy participants would use colours in their drawings while depressed ones would mainly use black and white. These results might show that colour is strongly connected with emotions and might be an important factor in assessing people (Jue, Kwon 2013). According to Davidoff (1991), the connection between colours and emotions is both innate and a "learned reaction" (Davidoff 1991) maybe because of the colour symbolism that is different in many cultures (Morton 1997).

According to Gelineau (1981), a colour has three essential characteristics these being hue, tone, and chroma (Gelineau 1981). These characteristics are described as "warmth, coolness, and brightness" (Yildirim, Hidayetoglu & Capanoglu 2011). As it is already known, the wavelength determines the colour's hue. The cool colours are associated with short wavelengths, while the warm colours are associated with longer wavelengths. The shortest wavelength is violet, and the longest is red (Yildirim, Hidayetoglu & Capanoglu 2011). Cool colours have low saturation and high brightness while warm colours have high saturation and low brightness (Valdez, Mehrabian 1994). Saturated colours tended to be selected more (Henry, Cheung & Westland 2008), were more arousing, women reacted to them stronger than men did, and were linked with dominance (Valdez, Mehrabian 1994).

Colour and arousal

Arousal is a physical response to a stimulus associated with an increased heart rate and raised blood pressure and a condition of sensory alertness, mobility, and readiness to respond. Walters' et al. (1982) studied how colour affected arousal: suggesting some colours could make one highly aroused. Wilson (1966) showed red as being more arousing than green by measuring physiological arousal with skin conductance responses in reaction to exposure to red and green slides (Wilson 1966). Nourse and Welch (1971) used galvanic skin response physiological measurements on 14 US undergraduate students (6 males and 8 females) for a total period of 6 minutes with 60 seconds alternations from green to violet light (Nourse, Welch 1971). They found that violet was more arousing than green. In other studies, red, blue, and white lights were projected on a diffusing screen (Gerard 1957, Gerard 1958). Physiological measurements were used such as heart rate,

palmar conductance, cortical activation, blood pressure, respiratory movements, and frequency of the eye blink. Results showed that red was arousing and blue relaxing.

Not all studies use physiological measurements, some study affect by seeing how participants perform under different colour conditions and some ask participants how colours make them feel. In Nakshian's (1964) study, 48 US undergraduate and graduate students aged 18 to 30 years old were exposed to a big box (with three walls, ceiling, and floor) illuminated by five lamps in a dark room. This box was situated on a table in such way that the participants could sit down facing it through the fourth inexistent wall. Therefore, only three walls of the box could be seen and they were removable to allow participants to be exposed to three different coloured surrounding walls such as red, green, and grey. Participants had to perform different given tasks into the box while colour conditions changed to red, green, and grey, following six predefined orders. Results gave mild support to the idea that red had higher effects on participants than green (Nakshian 1964). In Schaie's (1961) study, US 44 participants (25 males and 19 females) had to associate ten printed colours with twelve mood-tones, where every mood-tone "was described by two or more adjectives". The printed colours were displayed in groups of two on a grey panel, red always being one of the two. Participants had to grade the level of association between the colours and the mood-tones by dividing 100 points to each member of the pair. Results showed that yellow and orange were associated with excitement and stimulation; blue was associated with secure, comfortable, tender, soothing; blue, white, grey were associated with calm, peaceful, serene (Schaie 1961). Green had no stronger association with any mood. Wexner (1954) explored the association between colours and moods, by asking 94 US students (48 female and 46 male) to select a colour that best go with each mood-tone group. There were eleven groups of mood-tones such as exciting, stimulating; secure, comfortable; calm, peaceful, serene; etc. Eight colours were used: yellow, orange, red, purple, brown, blue, black, and green. They were displayed on pieces of light-grey cardboard that were randomly arranged in a room. Results showed that there were no significant gender differences, and some colours were more often associated with certain mood-tones than others were. For example, red, more than the other colours, was associated with exciting-stimulating group, followed in frequency by yellow and orange. Blue was most associated with secure-comfortable, and tender-soothing, orange with distressed-disturbed-upset, purple with dignified-stately, yellow with cheerful-jovial-joyful and black with powerful-strong-masterful. Most of the same colours (red, brown, blue, black, and purple) were associated with other mood-tones such as protective-defending or calm-peaceful-serene when thinking of only blue and green. One of the participants had expected purple to "go with" powerful, but the shade used in this study was too light for that association to be made (Wexner 1954). Wright and

Rainwater (1962) interviewed 3660 German participants (955 male and 2705 female) aged from 16 to 65 years old, on a door-to-door basis, during a year. Each participant rated only one colour (out of 50) on a pair of polar adjectives rating form (out of 24). Results showed that both age and gender differences were minor regarding colour rating. Researchers noticed a relationship between shades of blue and calmness and between shades of red and greatest warmth and less calmness (Wright, Rainwater 1962). Walters et al. (1982) suggest that all these studies above provide evidence that colour position on the spectrum is correlated with the arousal level: the long-wavelength end of the colour spectrum represents high arousal and the short-wavelength represents low arousal (Walters, Apter & Svebak 1982).

Studies of arousal are difficult as it can seem quite mechanical to simply change colours and measure arousal. In a recent study participants' arousal levels were exposed through coloured ambient light using skin conductivity (Snyder et al. 2015), in other words the arousal delivered as opposed to necessarily was caused by the colour. This way the participants could playfully interact in a single or paired way using light as a coloured symbol of their arousal levels. Snyder et al. (2015) reported an important finding in so far as that the participants were not keen to have the colours fixed to moods – they wanted to use other colours than the given ones: red for high arousal and blue for low arousal. "One participant said she would have preferred a soft green instead of blue-violet at the relaxed end since she considers blue to be sad and dark. Another participant thought the white colour was equally as stressful as red" (Snyder et al. 2015). Even if participants wanted to have customizing colours, none of them questioned if the lights "were accurately representing their internal state" (Snyder et al. 2015). The choosing of colours for mood expression is a key delivery in the work of this thesis.

Colour preference

Colour preference might be influenced by personality traits such as extroversion and neuroticism (Choungourian 1972), as well as cultural variation (Choungourian 1968). Recent evidence suggests that there is a relationship between colour preference and cortical activity of the brain (Nakamura, Harada & Shirokawa 2008). The activities of the anterior prefrontal cortex are thought to "play some roles in determining one's preferred colours" (Nakamura, Harada & Shirokawa 2008). Nakamura et al. (2008) investigated colour preference by using infrared spectroscopy measurements of the anterior prefrontal cortex activities and judgement time. Thirty-seven Chinese volunteers were instructed to choose the most preferred colour from a number of different presented colour pairs which were displayed either on silicon squares, or as coloured objects. The colours used were red, blue, yellow, and green. Blue was the most preferred colour and other

preferences were for saturated and bright colours. The choice of a preferred colour also depended on the kind of object that was presented during the study (Nakamura, Harada & Shirokawa 2008).

The cultural affect of colour preference was studied by Je et al. (2011) who ran a survey using the Psychological Colour Image Scale colour charts of hue and tone. This scale classifies single colours, colour combinations, and adjectives based on three criteria: warm-cool, soft-hard, and clear-greyish. Two hundred forty-eight participants from universities in Korea (150 participants) and Canada (198 participants) had 5 – 6 seconds each to select a colour they liked and then one that they disliked. All the colours, hues, and tones choices were then categorized and analysed. Results showed that there are differences and similarities regarding colour preferences between Korean and Canadian students: both countries liked red, blue, and neutral colours and both disliked yellow. There were different preferences regarding red-blue hues, red hues, grey hues, and white hues. These findings are in accordance with Oberascher's (2008) statement about cultural factors such as "religion, politics, economy, technology, and traditionalism vs. modernism" which influence people's preference for certain colours (Oberascher 2008).

Chu et al. (2011) support Oberascher (2008) position regarding the relationship between colour preference and cultural factors and also confirm that objects matter in stating that individuals prefer certain colours for specific objects, demographics and social situations because of associative learning and that colour preferences and meaning varies across cultures (Chu, Rahman & Mandal 2011). For instance, in the West, white symbolizes purity and black mourning, while in Japan white is associated with mourning and in India black means dullness and stupidity. Similar views are shared by Chang (2011) with regard to colour which is considered the key element that influences consumers' decisions, having different impact on them (Chang, Guan 2011). According to Chang (2011), images in "bright, cool/warm colour mixing" are preferred by participants in older age.

Chu et al. (2011) agreed there are more chances for a customer to buy a product if it is aesthetically pleasant (Chu, Rahman & Mandal 2011) as preference is a "subjective judgment on products in consumers' mind" (Norton 1987). Sharing similar view regarding subjective preference on aesthetically pleasant products, Kwiatkowska (2011) notes that colour could become a brand's identity and it can draw attention to certain products by attracting certain targets (Kwiatkowska-Lubanska 2011). Therefore, there is a need to understand people's colour perception, which is related to colour preference, because "colour preference depends on the colour appearance mode" ((Kwiatkowska-Lubanska 2011), (Tangkijviwat, Khankaew & Thoungsawang 2011)). The relationship between colour preference and perceived colour has shown that high-chroma, brighter and more saturated colours were preferred (Tangkijviwat, Khankaew & Thoungsawang

2011). Moreover, colour preferences were found being related to the "perceived chromaticity, whiteness and blackness" (Tangkijviwat, Khankaew & Thoungsawang 2011).

Gong et al. (2011) studied how colour preference associates with choice. Eighty Chinese participants with average age of 22.3 years old had to arrange eleven coloured patches (red, orange, yellow, green, blue, brown, purple, pink, white, black, and grey) and nine coloured mugs (red, orange, yellow, green, blue, brown, pink, white, and black) in their colour preference order. The results showed the colour preference order between coloured patches and mugs was consistent and the preferred colours were white, black, red, and yellow with the most disliked colour being brown. However, when participants were allowed to take away one of the mugs, they generally took a different coloured mug than the one chosen as the most preferred colour during the experiment. There were two reasons for their choice: firstly, participants considered the colour-shape relation and secondly, they wanted to own a unique coloured mug (Gong, Lee 2011). According to the literature, black and brown are the most disliked colours (Gong, Lee 2011).

With regard to colour preference of children Mahovic et al. (2011) demonstrated there are no particular differences between boys and girls. Children and designers were asked about their preference on three different graphics with blue, red, and yellow backgrounds. Children were exposed to this experiment three times a day (morning, noon, and afternoon) for several days in a row. Each of these graphics was held up for five seconds to provoke emotional reactions. Mahovic et al. (2011) showed that children prefer colours depending on different light surroundings: in the afternoon children chose more blue colours than warm ones. Even though young children are attracted to bright colours, with age they might change their colour preference (Mahovic Poljacek, Cigula & Gojo 2011). Children's colour preference might differ because of their temper, nature or because of factors such as "different lighting and atmospheres during the daylight". One should consider young children have different colour preferences during the day, being sensitive and receptive to colour (Mahovic Poljacek, Cigula & Gojo 2011). Another interesting result was that graphic designers' choice of colour for products was in correlation with children's preferences: red, yellow for girls, and blue for boys: "numerous researchers show that most little girls prefer red, pink, lavender or violet. Little boys like dark colours more than girls do." In a study run by Boyatzis et al. (1994) on children aged five to six and a half years old, boys' favourite colour was blue, followed by red. Girls preferred pink, then purple. Yellow, brown, or grey was not chosen by any of the children (Boyatzis, Varghese 1994). Other studies found that when children heard a happy story they would use yellow crayons for colouring and brown crayons if they have heard a sad story (Lawler, Lawler 1965).

Colour preference for single colours

Guilford et al. (1959) investigated the colour preference of 40 North-American students, 20 men and 20 women. The sampling colours were taken from the Munsell colour system (Munsell Color 2016), which back then had around 600 colours, of which only 316 were used and displayed on a neutral grey background. Participants had to scale the level of pleasantness of the exposed colour using a 0 to 10 scale, 0 being the most unpleasant and 10 the most pleasant. Participants valued a number of 100 colours a day, "with rest pauses after sets of 25". Results showed that green to blue colours were most preferred while yellow and yellow -green were the least, "when brightness and saturation are held constant". Moreover, brightness and saturation were positively related to affective value and blue was the most preferred colour and yellow the least (Guilford, Smith 1959).

Eysenck (1941) carried out two experiments in order to find out what people's general colour preference is, to see if they preferred saturated or unsaturated colours and if there is any difference between genders. For this purpose, 42 gender balanced English university students, professional people, and artists participated during the two experiments. In the first experiment, 12 participants had to rank ten colours in their order of preference. The colours were displayed on paper and they were six saturated hues such as blue, red, green, violet, orange, yellow and five shades: green, red, orange, and yellow. In the second experiment, 30 participants had to rank the same colours in their order of preferences, and men and women's results were calculated separately. Correlations were made and results showed that there were people who preferred saturated colours and others who preferred unsaturated colours. Regarding gender preference, men slightly preferred orange while women had a preference for yellow but other than that their colour preferences do not differ (Eysenck 1941). Similarly, to Eysenck (1941), Ou et al. (2004) 's study revealed no gender difference with regard to colour preference and colour emotion responses (Ou et al. 2004).

Another colour preference study run by Hogg (1969c) showed blue and purple were the most pleasant colours from a set of 30, while yellow and green were the most unpleasant (Hogg 1969b). Similarly, the most preferred colours for Japanese, Korean and Taiwanese participants were vivid blue and white (Saito 1996).

Colour preference for colour combinations

Colours seldom appear alone, they invariably come to us in a combination. Compositions of colour can be visually pleasant or unpleasant (Arnheim 1966). Harmony has been described as that position where there are 'pleasant colour compositions' (Judd, Wyszecki 1967). Understanding what makes a combination harmonic of pleasing is complex. Many see colour harmony as a matter

of choice and personal preference, and not as an universal law ((Granville 1987), (Kuehni 2005)). Others suggest a combination be pleasant because it achieves a purpose in an artistic context or because of the relationships between colours (Wang, Westland & Cheung n.d.).

According to Hogg (1969), the preference for a pair of colours could not be predicted by the component colours in that pair (Hogg 1969a). Guilford (1931) tried to predict preference value for colour pairs but the results showed the method was unaccepted (Guilford 1931). It is also reported that one's preference for certain single colours cannot predict the preference for the combination of those colours (Ou et al. 2004). Observers' perception on colour might differ because colour preference is subjective and it is related to personal taste and cultural background (Ou et al. 2004).

Colour in Interior Design

As it could be seen until now, a significant body of research finds that colour has an important impact upon humans' lives. Therefore, it is becoming increasingly difficult to ignore the value of colour. It could be argued that the use of colour in interior design is less related to the user's personality than it is related to the designer's personal choice. One question that needs to be asked is whether the designer should design for/with the individual, after/during understanding her/him, rather than following a few generally known rules.

Colour research is interdisciplinary and systematic studies of colour appearance in interior design are rare, colour being occasionally mentioned in architectural research literature (Billger 1999). To date there has been little research and agreement, in interior design, on what effects colours have on people's moods. It is already known that blue and green have calming effects and red can increase the blood tension being associated with the characteristics of activity, strength and stimulation, and linked to excitement and arousal (Labrecque, Milne 2012, Labrecque, Milne 2012). Therefore, in interior design, red might be recommended just as a colour accent. On the other hand, blue is seen as a secure colour, being associated with competence, trust, duty and communication (Labrecque, Milne 2012). Recently, researchers have shown an increased interest in other different colours than red, green, and blue. Yildirim et al. (2012) aimed to assess women's perception of a hairdressing salon wall colours by asking 70 Turkish customers (women aged from 18 to 60 years old) to complete a survey evaluating three pictures of the same salon but with three different wall colours using ten bipolar adjectives. The wall colours were digitally manipulated in Photoshop (software program) and they were cream, lilac, and orange. Results showed that lilac walls were perceived more positively than cream or orange walls.

Clifton-Mogg (2001) has drawn attention to the fact that colour is important in interior design and, when thinking of interior decoration, people should create their own colour pallet, choosing

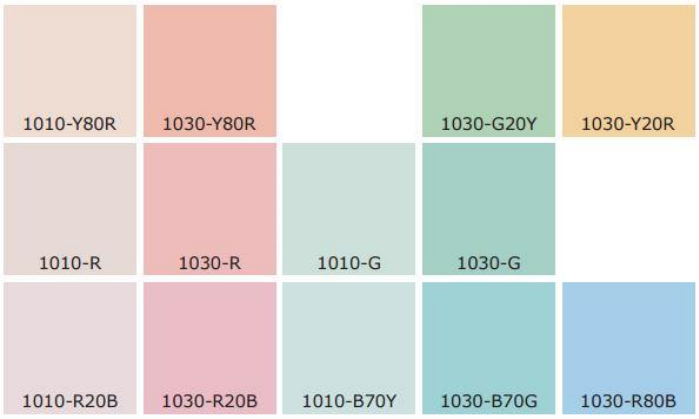


Figure 22. NCS hues used in two identical rooms.

the colours they love the most, despite the thought that it is not fashionable. She argues that people do not think if the colour they choose "would be right for them to live and work with" (Clifton-Mogg 2001), which might be a problem if the affect of colour on one's wellbeing is taken in consideration. Colours are affected by light and surroundings (Clifton-Mogg 2001), and depending on the country and the climate, they are differently chosen. For example, in India, where sunlight is harsh, bright and vivid colours are used while in Europe and North America diluted colours are being used because of a diffused and soften sunlight (Clifton-Mogg 2001). The choice of colour is "deeply rooted in the geographical conditions and culture of the countries", light, climate, vegetation, and landscape having a strong influence on the products' colour preferences (Oberascher 2008). Colour research in interior design has shown that "short wavelength colours are preferred by users, leading to a general association between affective tone and wavelength" (Valdez, Mehrabian 1994).

People's experience of room and colour in a full-scale study on colour appearance in natural daylight was explored by Harleman et al. (2007). Seventy-two participants evaluated and compared two identical rooms, one facing north, and the other one facing south. The subjects were architects, interior designers, and students with knowledge on these subjects. The choice of subjects was made in order to get informed descriptions of the two rooms. No gender or age information was given. As Harleman et al. (2007) state, "each observer gave two complete descriptions of colour appearance, one in each room". Thirteen colours were used based on the Natural Colour System (NCS), which is "a colour notation system based on how humans see colour" (NCS Colour 2016). As it can be seen in Figure 22, six pinkish, five greenish, one yellowish, and one bluish colours were used.

Two different methods were used in order to gather data: verbal description by answering these two guidance notes: "describe your impression of the wall colour" and "describe your impression of the room character". The second method was the use of semantic scales, which in general is a list of opposite adjectives used like a Likert scale. In this study participants had to value (from zero to six, six being the maximum) their experience for sixteen different adjectives that would describe a room based on temperature, emotional tone, spatial quality, and dynamic factor. The

results showed that people had different opinions regarding the same colour. For example, the pinkish rooms were described as "warm, gentle, and stimulating; childish, young, fresh and funny" by some people while others would describe them as "pushy, demanding and glaring; stale, tasteless, vulgar and slovenly". Greenish rooms were perceived as relaxing and calm and were associated with health, being described as clean, pure, peaceful, light-hearted, confident, soothing, and tranquil. Harleman et al. (2007) demonstrated that depending on a room's orientation, different natural lights would affect its colours. A room orientated towards south, will have different colour shades than an identical room, with identical colour, but orientated towards north (Harleman, Werner & Billger 2007). A similar view was that north rooms, being dark, would need more light and "cheerful shades" than south rooms, which would be lighter and therefore might need "darker and richer colours"

As was stated earlier, architects, designers, and other working professionally are obliged to gain their colour knowledge through working experience (Billger 1999). However, learning by taking risks and making errors is usually expensive. Therefore, a major problem with colour in interior design has been the lack of knowledge in research regarding "the way colours actually appear on different spatial and lighting conditions" (Billger 1999). Carrington (1954) drew attention to bedroom lighting, which has always been very important because of its position in the centre of the ceiling, which would not allow one to read in bed, as the eyes would hurt (Carrington 1954). Light is not the only factor that could affect a room's ambiance, but colours too, in the way that they could neutralise each other (Billger 1999). According to Billger (1999) colours affect each other in a room because of contrast effects and reflections between the coloured surfaces. One study focused on the strong effect of dark background on colours, finding that the more darker a background becomes, the more lighter and colourful colours appear (Hunt, R, V, G 1994). Coloured surfaces of a room are separated in depth and at different angles, a light surface lightening up a dark one. Therefore, there is a difference between a room's surface colour combination and sample colour combination (Billger 1999). When two different coloured walls would meet in a corner, the shadow of the room would appear less distinct than if the two walls would have had the same colour. This might be because "contrast effects enhance the difference between the colours involved, whereas reflections make the coloured surfaces blend with each other" (Billger 1999). However, it has been shown that humans' visual system might perceive the colour changes of an object, rather than the colour changes of a whole visual field (Billger 1999, Hurlbert 1986).

The work of Clifton-Mogg (2001) supports the importance of light in affecting colours and it has been found that coloured light changes the appearance of painted surfaces (Cheuvreul 1967).

Cheuvreul (1967) demonstrated there is a difference between the mix of pigments and the mix of coloured light. For example, blue and red pigment mix would become brownish while blue light on a red surface would become violet (Cheuvreul 1967, Billger 1999). In a similar study, Bachmann (1997) demonstrated that coloured light projected on painted panels could create a dark room appearance. On the contrary, coloured light projected on panels coloured by another projected coloured light always become lighter (Bachmann 1997). However, Billger (1999) affirms it cannot be concluded "that a painted surface always becomes darker when it is affected by the reflection of another surface" (Billger 1999). According to Liljefors (1995) the perceived level of light in a room is "more affected by the reflectance of the room surfaces than by the strength of the illumination" (Liljefors 1995).

Conclusion

Chapter 4 focused on colour and mood, and colour in interior design. It has highlighted the impact of colour on people's emotions and wellbeing, and showed colour's importance in interior design. Colour research in human computer interaction (HCI) field is not explored so the author had to research other fields were colour research would be present in order to find an element that could be linked with HCI.

There appear to be studies that show colours seem clearly unfavourable; the effect of colours depends on lighting, objects used to display on and adjoining colours, and also on cultural connections. According to the literature, there is no research in the field of interior design with regard to colour in teenagers' bedrooms. There is a suggestion (Snyder et al. 2015) that for an interactive app some playfulness around associating colours to moods might be fun, participants not being keen to have the colours fixed to moods.

The findings (Table 53 in Appendices) of the literature review showed that there is no colour system used as the only benchmark for studies across the world. The researcher also found a lack of interest on age groups across studies, most of them being run with adults, with fewer studies run with teenagers or children as participants. Therefore, the author believes the research of this thesis is particularly important because it focuses on the effect of colour on a specific age group: teenagers.

There is clearly a case to be made that the methods used need thinking about, especially if studies are to only use a handful of participants. In the literature review, participants were of all ages, between 5 and 65 years old. There were studies that did not mention participants' age, which underlines the lack of focus on an age group. The most common participants were students, young adults, and professionals (Table 50 in Appendices).

The studies took place in different countries from different continents such as Europe, Asia, and the US (Table 51 in Appendices); almost half of the studies were run in the US. In terms of gender, most of the studies equally divided them in male and female. The number of participants varied from 14 to 136, the most common being between 40-50 participants, with two maximums of 348 and 3360 participants.

The ways that colours are presented and talked about is a key consideration for the next few chapters. The literature review has demonstrated that there is a need of a wide range of colour samples when used in studies, as well as different levels of brightness and saturation. A colour system should be used and also referenced, so that when comparing studies, researchers would know if they are comparing similar colours/colour shades or not. This requirement is in accordance with Valdez et al. (1994), which address the weakness of early studies and recommend a wide range of colour samples to be referenced using a standard colour system such as Munsell Colour System ((Valdez, Mehrabian 1994), (Munsell Color 2016)).

Limitations

The discussion in this chapter has focused on various colour studies across continents, with the aim of having a general view and a broad understanding of colour on people's lives. Therefore, the literature review might seem unfocused and too various, but it shows that the age target has to be taken in consideration and be more focused in future colour studies.

Contributions

The thesis fills the gap in the colour literature regarding teenagers the main target group, and encourages the use of colour specifications in studies to demonstrate the shade, saturation, and brightness used in samples.

Chapter 5

DESIGN CONCEPT STAGE 1

Introduction

This chapter describes the initial explorations of the TCI (Teen Computer Interaction) research area by presenting four initial pilot studies that test out different research methods for teenagers, which involve colour as a research focus. Literature has shown that not all colours have been researched, especially their effects on teenagers' moods. This thesis expands research in this area by presenting the findings of several studies seeking to understand how teenagers relate to both printed colour and coloured lighting, and seeking to identify favoured colours in relation to bedroom areas such as walls, ceilings, and floors.

This chapter starts with a general discussion on research approach. Building on three categories of research derived by Christopher Frayling (research into art and design, research through art and design, and research for art and design (Frayling 1993)), Zimmerman et al. (2014) provided a descriptive framework for design research (Zimmerman, Forlizzi 2014):

- research into design, which is the "research into the human activity of design";
- research for design, described as "research intended to advance the practice of design";
- research through design, which focuses on improving the world "by making new things that disrupt, complicate or transform the current state of the world".

Research through design (RtD) is "an approach to conducting scholarly research that employs the methods, practices, and processes of design practice with the intention of generating new knowledge" (Zimmerman, Forlizzi 2014). "RtD can look like design practice" but "it is generally more systematic and more explicitly reflective" and it requires "more detailed documentation of the actions and rationale for actions taken during the design process" (Zimmerman, Forlizzi 2014). Zimmerman et al. (2014) mention three different RtD practices to follow as a design researcher:

- Lab (or Reach Interaction Design): "This approach blends design methods to envision the unimagined and both analytic and experimental methods to evaluate the novel design offerings and to generate frameworks that described how rich interaction works."
- Field (or Participatory Design and User-Centred Design): "Design work was performed by interdisciplinary teams consisting of behavioural scientists, technologists, and designers,

who brought a theoretical understanding of people and work, knowledge about the capabilities of technology, and skills at conceiving an improved future state."

- Showroom (Critical Design): "design researchers make provocative artefacts that force people to think, to notice, and to reconsider some aspect of the world. Knowledge is captured as the designer or design team engages in reflective writing that describes the process, the artefact, and the intended influence".

Based on these theories, the methods in this chapter could be considered a combination of Lab and Field RtD practice.

Points from previous chapters are brought together for investigation in this chapter:

- The literature review on teenage moods (Chapter 2) has shown that teens' mood could vary over a very short period of time and a fast and flexible way of communication might suit their spontaneous social communication style. Therefore, colour as a visual tool that could help teenagers understand and express their quickly changeable moods is explored in four pilot studies;
- Literature in Chapter 3 showed that the design of an interactive device for teenagers, that would help them express their moods seemed to be inexistent. In this chapter, colour is used as a tool for design research in four different pilot studies, exploring the idea of an interactive device that could give teenagers the freedom to express their moods within a close group of friends;
- Chapter 4 showed that in many colour studies, there were conflicting ways to describe colours to demonstrate the shade, saturation, and brightness of the sample colours; many early studies mainly used few hues, with no different levels of brightness or saturation. Therefore, a colour palette is tested in this chapter with a variety of sixteen colours and three levels of brightness.

As shown in Chapter 4, colour has been used to lift mood and change mood in people but until recently colour has been seen as a static element within a room that is not easily changed. With new technologies around lighting and display, it is becoming feasible to have interactive rooms that alter and change, an idea explored in this chapter. This has significant potential in Human Computer Interaction especially when considering the moods of teenagers as, not only are they highly susceptible to mood changes but they are also known to spend considerable time in their bedrooms, as shown in Chapter 2.

Aim

The work in this chapter aims to provide insights into the affect of, and the use of, colour with teenagers as well as bringing method contributions because it is exploring methods for teens from several pilot studies.

Structure

The present chapter presents four different pilot studies, which are listed from A to D, focusing on study description and main results. In each case the study is summarized with key findings, followed by a general discussion, which leads to a subdivision of contributions. The chapter ends with general conclusions driven from all four pilot studies.

A teenager in this thesis is one that is in her/his early-teens (13-15 years old), mid-teens (15-17 years old), or late-teens (17-19 years old). However, pre-teens (10-13 years old) participated in three pilot studies (Study A , Study B, and Study D) because the researcher could not always find participants with an appropriate teenage age. This is a limitation of the studies. However, the author believes the results are still valid in the context of her work, as the pre-teens are considered adolescents, therefore, similarly to teenagers, they are in a transitioning phase from childhood to adulthood (Hall 1891).

The participants of two pilot studies (Study A , Study D) were male only because mixed groups willingly to participate in the studies could not easily be found. This too, is considered to be a limitation. However, the author used both genders in the study run in Chapter 6.

Study A

Seeking to understand how teenage boys relate to colour, a group of 15 teenage boys, 12 to 13 years old, took part in this study where they were instructed to colour in a 2D net of a 3D bedroom model made out of paper (Figure 23). The instructions were to colour only the walls, floor, and ceiling, as other objects such as table, bed, wardrobe etc. were drawn on the model for a narrative feeling. The aim of this study was to start to explore what colours teenagers might prefer to have in their own bedrooms but also to try out the research instrument. Pale and bright colours were given to them for an extensive choice.

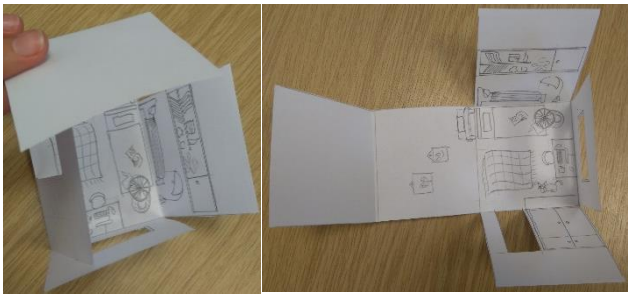


Figure 23. The 3D bedroom model made out of paper that teens had to colour.

The teenagers could choose from 36 different shades of 12 different colours and achromatic colours; these were yellow (Y), orange (O), red (R), magenta (M), violet (V), blue (Bl), green (Gn), beige (Be), brown (Br), umber (U), grey (G), and black (Bk). Each colour group had a number of shades from light to dark. During the study, the white achromatic colour was not offered as a colour choice as the paper used for colouring was white.

The tools used for the study were 12 permanent twin-tip promarkers in pastel colours and 24 permanent markers with bright colours of different shades. The pastel colours were walnut, umber, soft peach, primrose, lemon, arctic blue, cobalt blue, fuchsia pink, cerise, pale pink, almond, sunkissed pink. The bright colours with different shades were yellow, orange, red, magenta, violet, blue, green, beige, brown, umber, grey, and black.

Results

The results of the fifteen different coloured 3D bedroom models can be seen lower down in Figure 30, Figure 31, Figure 32, Figure 33, Figure 34. The resulting 'rooms' are analysed in three different ways. The first analysis focuses on the variety of colours used on the bedrooms' individual faces such as walls, ceiling, and floor, and then all together as a whole (Analysis 1). The second and third analyses focuses on colour schemes.

Analysis 1

The colours used on the walls, in order of preference, were blue (17%), red (15%), yellow (8%), magenta, violet, green, umber (each 7%), and grey (2%) (Table 1). On the floor, blue was chosen by 33%, then followed umber (13%), green, beige, and grey (each 7%). On the ceiling, blue, violet, green, umber, and black were each chosen by 7% of teens. White was the 'apparent' top choice for each surface (walls 32%, ceiling 67%, floor 33%) but it is excluded as a colour choice, the colouring paper being white.

Considering the bedrooms as a whole (Figure 24), there were fifteen bedrooms represented by 90 coloured faces. 38% of the faces were left white. Blue was the most used 'colour' (18%), then red (10%), umber (8%), green (7%), yellow and violet (each 6%), magenta (4%), grey (2%), black and beige (each 1%) (Table 1).

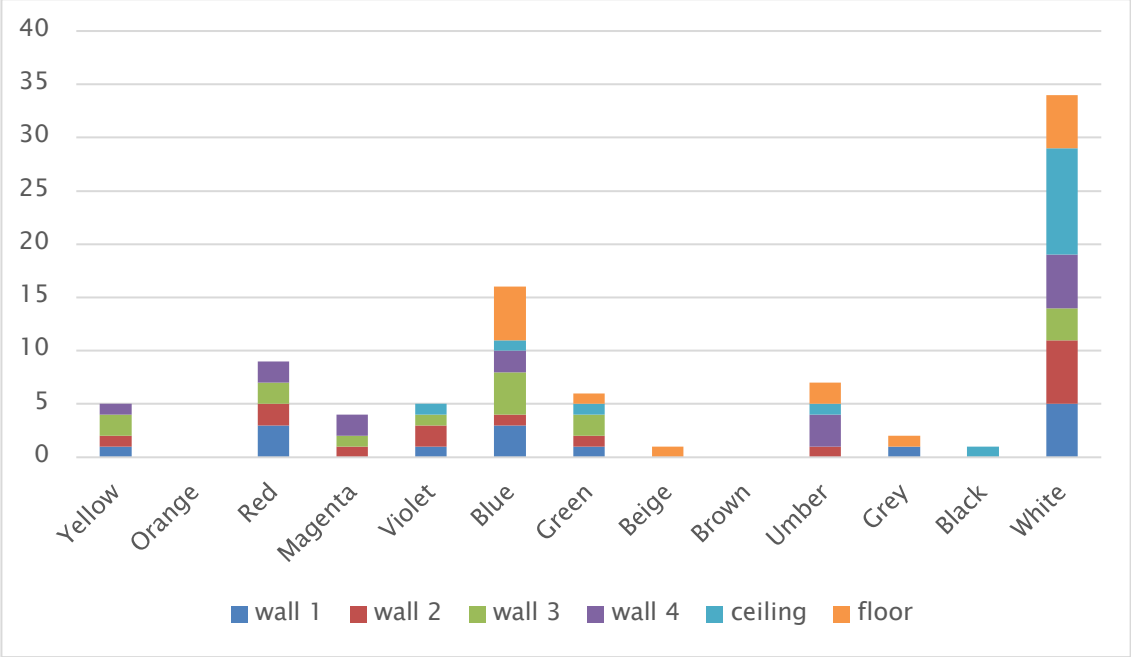


Figure 24. Number of occurrences for each colour.

	Yellow	Orange	Red	Magenta	Violet	Blue	Green	Beige	Brown	Umber	Grey	Black
Walls	8%	0%	15%	7%	7%	17%	7%	0%	0%	7%	2%	0%
Ceiling	0%	0%	0%	0%	7%	7%	7%	0%	0%	7%	0%	7%
Floor	0%	0%	0%	0%	0%	33%	7%	7%	0%	13%	7%	0%
Total	6%	0%	10%	4%	6%	18%	7%	1%	0%	8%	2%	1%

Table 1. Results for bedroom surface colour.

The results are quite inconclusive especially given that many of the faces were left uncoloured. There is a small suggestion that the teen males might prefer strong colours (blue 18% and red 10%). Blue tended to be chosen for floor and wall colours. The apparent popularity of white has to be contested as it was not offered as a colour choice and the paper used for colouring was white. The prevalence of white in the colourings could suggest boredom with colouring, a shortage of time, or could be a conscious choice.

Analysis 2

Figure 25. The Colour Wheel.

The aesthetics of a colour scheme are often considered against norms of colour design that assist in understanding the ideas of contrasting and complimentary colours. Using the 12-hue colour wheel (Figure 25) five popular, and one additional, colour schemes can be described – these being monochromatic, complementary, triad, tetrad, and analogous and then additionally 'accented analogous' ((Stanicek 2010); (Williams 2012); (Birren 1970)). A Monochromatic colour scheme uses various shades of a single colour (Williams 2012). Complementary colour schemes use dyads (pairs) of colours that are diametrically opposed on the

Figure 26. Complementary colours (dyads). Image source (Tiger color 2015).

colour circle, such as red-green, yellow-violet, and blue-orange (Figure 26) (Birren 1970). Triads (Figure 28) use any three colours which are either equidistant on the colour wheel, (forming equilateral triangles), or partially equidistant (forming isosceles triangles) (Birren 1970). Tetrads (Figure 27) refer to any four colours which form a square, a rectangle, or a trapezoid (Birren 1970). Analogous colour schemes (Figure 29) use a group of hues (but more than one colour) that are next to each other on the colour wheel (Tiger color 2015). This scheme creates a monochromatic look with similar colours. For example, yellow-orange, light green-yellow, blue-violet, etc. Accented analogous colour schemes refer to the use of analogous colours with an accent from a complementary colour (Williams 2012).

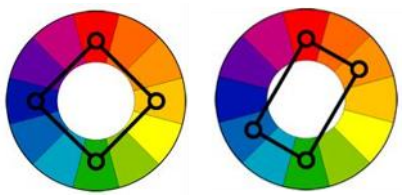


Figure 27. Tetrads (square and rectangle). Image source (Tiger color 2015)

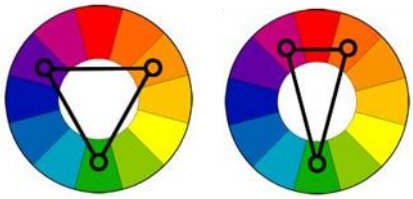


Figure 28. Triads. Image source (Tiger color 2015)

Figure 29. Analogous colours. Image source (Tiger color 2015)

To get a sense of whether the teens had used such traditional colour couplings, each teenager's design was compared to the six schemes described above. A category 'other' was used to describe those designs that failed to 'fit' a scheme.

Of the 15 colour schemes created by the teenagers three were three monochromatic (Figure 34), one analogous and one accented analogous (Figure 33), ten could only be described as other. The 'other' bedrooms were grouped in 'new' schemes: abnormal colours (AC) (Figure 30), opposite colours (OC) (Figure 31) which were associated with tetrad and triad, and similar colours (SC) (Figure 32), associated with monochromatic and analogous, but referring rather to harmonious colours and including a larger range of colours than the analogous colours. There were 4 SC (similar colours, Figure 32), 3 AC (abnormal colours, Figure 30), and 3 OC (opposite colours, Figure 31).

Figure 30. Abnormal colours (AC).

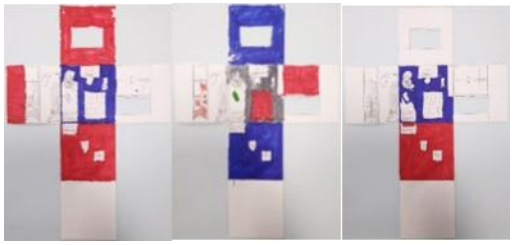


Figure 31. Opposite colours (OC).

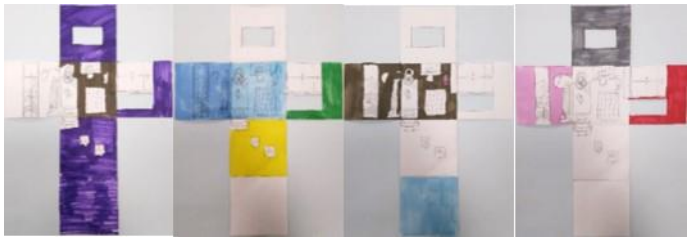


Figure 32. Similar colours (SC).

Figure 33. Analogous colours (left side) and accented analogous colours (right side).

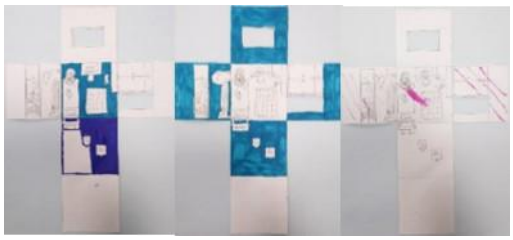


Figure 34. Monochromatic colours.

Analysis 3

Whilst traditional colour schemes are often used to describe colour collections, there is also work from architecture and interior design that concerns how rooms are 'coloured'. Based on three architectural styles (Modern, Georgian, and Art Nouveau) (Whitfield 1984, Whitfield, Slatter 1978), and on the author's interior design experience, this third analysis concerns five room types (Table 2):

- traditional rooms (TR): where all walls are one of these (traditional) colours: blue, yellow, pink, green, red, brown, white; the ceiling is white or similar to the walls; the floor is different from the ceiling and walls and it is brown, beige, or grey;
- modern rooms (MR): three walls are white and one coloured; the ceiling is white or coloured (black, dark grey, yellow, blue, red); the floor is white, brown, or grey;
- futuristic rooms (FR): four walls same colour or shades of it; the ceiling same as the walls, or floor, or white if the floor is the same as the walls; the floor same as the walls or ceiling; or white if the ceiling is the same as the walls; or five surfaces same colour plus one

surface different colour and not traditional; maximum two colours (or shades of two colours) in the room;

- surreal rooms (SR): three or more different colours and not traditional;
- other rooms (OR): what does not fit in the other four types.

Participant	W1	W2	W3	W4	C	F	Room Description
1	Violet	Violet	Violet	White	Violet	Umber	surreal
2	Red	Yellow	Green	Umber	White	White	surreal
3	White	White	Blue	White	White	Blue	other
4	White	White	Red	White	White	Blue	surreal
5	Red	White	Red	Red	White	Blue	surreal
6	Blue	White	Blue	White	White	Grey	surreal
7	White	White	White	Umber	Blue	Umber	modern
8	White	White	White	White	White	White	futuristic
9	Green	Red	Green	Red	Black	Blue	surreal
10	White	Green	Yellow	Blue	White	Blue	surreal
11	Grey	Red	White	Magenta	White	White	surreal
12	Blue	Blue	Blue	Blue	White	White	futuristic
13	Blue	Magenta	Blue	Yellow	White	Beige	surreal
14	Yellow	Umber	Yellow	Umber	Umber	Green	surreal
15	Red	Violet	Magenta	Magenta	Green	White	surreal

Table 2. Room categories.

Surreal rooms were chosen by 73% males, followed by futuristic (13%), modern and other (each 7%), with no rooms aligning to the 'traditional' type.

Given there were so many surreal rooms, it could be that the males were attracted to this as a colour scheme for their rooms or that they struggled to see how the colours might look together.

Key finding from Study A

The majority of teenagers created colour schemes that did not fit 'accepted norms'. It was difficult to learn anything from the designs in terms of colour choices / preferences as there was both a small sample and a lack of certainty as to what extent the teens were thinking about designing a room they might live in.

Methods to analyse the choices were trialled and each found to have limitations. Using room schemes more room choices were able to be categorised usefully than when using colour schemes.

The study was useful to test out the method of colouring in a net. Teens were in many cases actively choosing different or crazy colours for their designs but over a third of the faces were left uncoloured suggesting that the teens may have got bored, or been short of time. It might be the case that teenagers did not see the 3D net design as a room.

The next study aimed to explore if white, when given as a colour choice, would be chosen or not and also aimed to test out a method that allowed a better visualisation of the room once coloured.

Study B

This study sought to reduce the Study A effect of 'not colouring in' and add better context to the activity by using a 3D room. A group of 22 school pupils (14 males and 8 females) aged from 10 to 11 years old participated in this study during a summer school. The pupils were asked to imagine that they were colouring the walls, ceiling, and floor, of their future bedroom, by choosing especially cut sized paper patches from a given colourful pile for each of the six bedroom faces and by sticking them, one by one, inside a transparent box. Once the box had six coloured faces the teens could see inside and view their bedroom (Figure 35), (Figure 36).

Each teenager had a box, thirteen colour choices for each bedroom face, and transparent glue dots to stick the paper faces on the box. The thirteen colours were as follows: three shades of yellow (Y1, Y2, and Y3), two shades each of blue (B1 and B2), and green (Gn1, and Gn2), and one shade of orange (O), red (R), violet (V), pink (P), white (W), and grey (Grey) (Figure 35).

The colours chosen for this study were intended to roughly align with those in Study A whilst also providing some shade choices without having too many colours to select from. Specifically white and grey (but not black) were included as direct choices. Colours were chosen so as to be similar to the ones in the Colour Wheel. Choosing the colours for shade choices was informed from work described in Chapter 4, where yellow was found to be a preferred colour (Cimbalo, Beck & Sendziak 1978), blue was associated with calmness (Wright, Rainwater 1962), and green had no strong association with any mood (Schaie 1961).

Figure 35. Left image, from eft to right: three shades of yellow (Y1, Y2, and Y3), orange (O), red (R), violet (V), pink (P), two shades of blue (B1 and B2), green (Gn1, and Gn2), white (W), and grey (Grey). Right image: all the wall, ceiling, and floor facets us.

Figure 36. The process of adding paper facets to the transparent box (top images). The inside view of a finished bedroom (bottom images).

Results

Below is the raw data of preferred colours for each surface of the bedroom grouped by gender (Table 3, Table 4).

No.	Age	Gender	WallW1	WallW2	WallD3	Wall4	Ceiling	Floor
1	11	m	W	B1	B1	W	V	V
2	10	m	grey	B2	O	V	Y	Gn2
3	11	m	Y2	O	B1	B2	W	Gn2
4	11	m	B2	O	B1	R	V	V
5	11	m	V	B1	B2	V	B1	B2
6	11	m	R	V	R	O	V	R
7	11	m	Y2	V	Gn2	V	Y3	O
8	11	m	B2	B1	B2	B1	B1	B2
9	10	m	R	O	R	Y3	O	B2
10	10	m	Y3	V	Y3	Gn2	B2	O
11	11	m	B2	R	Y3	O	V	Gn2
12	11	m	B2	B2	B2	B2	B2	B1
13	11	m	B2	B2	Y3	Y3	Y3	B2
14	11	m	Gn2	Gn2	R	Gn2	R	R

Table 3. Male colour preference for different bedroom surfaces.

No.	Age	Gender	WallW1	WallW2	WallD3	Wall4	Ceiling	Floor
1	11	f	V	B2	B2	V	V	B1
2	10	f	Gn1	V	Gn1	Gn1	V	V
3	11	f	B2	B2	Y3	B2	B2	B1
4	11	f	B2	Gn2	V	Gn2	Gn1	B1
5	11	f	V	Y2	V	Y1	Y2	Y2
6	11	f	R	B2	O	Gn1	Gn1	V
7	11	f	B2	B2	V	V	B1	Gn2
8	10	f	B2	Gn1	Gn1	Gn1	V	B2

Table 4. Female colour preference for different bedroom surfaces.

Analysis 1

Results are analysed based on gender preference of the variety of colours used in bedrooms (Analysis 1). Different colour shades were used, and every shade is analysed separately and also as a hue. For example, there are three shades of yellow, and each will be analysed on its own (Table 5, Table 6), as well as a yellow group.

Female colour preference

Table 5 shows the colours chosen by the eight females as ratio data. Yellow (11%), blue (35%) and green (22%) accounted for 68% of the chosen colours but, as 54% of the samples on offer were of these three colours thus cannot be seen as a trend. It is worth noting that white was not chosen.

8 Female choices													
Colour	**Y1**	**Y2**	**Y3**	**O**	**R**	**V**	**P**	**B1**	**B2**	**Gn1**	**Gn2**	**W**	**Grey**
4 Walls	3%	3%	3%	3%	3%	25%	0%	0%	31%	22%	6%	0%	0%
Ceiling	0%	13%	0%	0%	0%	38%	0%	13%	13%	25%	0%	0%	0%
Floor	0%	13%	0%	0%	0%	25%	0%	38%	13%	0%	13%	0%	0%
Total	1%	9%	1%	1%	1%	29%	0%	17%	19%	16%	6%	0%	0%

Table 5. Female's colour choices.

Male colour preference

Table 6 shows the same data for the fourteen males. Blue (33%) and violet (18%) accounted for 51% of the chosen colours and, as only 23% of the samples on offer were of these two colours this could be seen as a trend. White was chosen by 4% males.

14 Male choices													
Colour	**Y1**	**Y2**	**Y3**	**O**	**R**	**V**	**P**	**B1**	**B2**	**Gn1**	**Gn2**	**W**	**Grey**
4 Walls	0%	4%	11%	11%	13%	13%	0%	13%	23%	0%	9%	4%	2%
Ceiling	7%	0%	14%	7%	7%	29%	0%	14%	14%	0%	0%	7%	0%
Floor	0%	0%	0%	14%	14%	14%	0%	7%	29%	0%	21%	0%	0%
Total	2%	1%	8%	11%	11%	18%	0%	11%	22%	0%	10%	4%	1%

Table 6. Male's colour choices.

Analysis 2

Considering the rooms as a whole, and following the room analysis as used in Study A (Analysis 3), 86% of the teens designed surreal rooms and 14% futuristic; 88% females designed surreal rooms and 13% futuristic rooms; 86% males designed surreal rooms and 14% futuristic rooms Table 7.

Participants	W1	W2	W3	W4	C	F	Room Description
1	White	Blue	Blue	White	Violet	Violet	surreal
2	grey	Blue	Orange	Violet	Yellow	Green	surreal
3	Yellow	Orange	Blue	Blue	White	Green	surreal
4	Blue	Orange	Blue	Red	Violet	Violet	surreal
5	Violet	Blue	Blue	Violet	Blue	Blue	surreal
6	Red	Violet	Red	Orange	Violet	Red	surreal
7	Yellow	Violet	Green	Violet	Yellow	Orange	surreal
8	Blue	Blue	Blue	Blue	Blue	Blue	futuristic
9	Red	Orange	Red	Yellow	Orange	Blue	surreal
10	Yellow	Violet	Yellow	Green	Blue	Orange	surreal
11	Blue	Red	Yellow	Orange	Violet	Green	surreal
12	Blue	Blue	Blue	Blue	Blue	Blue	futuristic
13	Blue	Blue	Yellow	Yellow	Yellow	Blue	surreal
14	Green	Green	Red	Green	Red	Red	surreal
15	Violet	Blue	Blue	Violet	Violet	Blue	surreal
16	Green	Violet	Green	Green	Violet	Violet	surreal
17	Blue	Blue	Yellow	Blue	Blue	Blue	futuristic
18	Blue	Green	Violet	Green	Green	Blue	surreal
19	Violet	Yellow	Violet	Yellow	Yellow	Yellow	surreal
20	Red	Blue	Orange	Green	Green	Violet	surreal
21	Blue	Blue	Violet	Violet	Blue	Green	surreal
22	Blue	Green	Green	Green	Violet	Blue	surreal

Table 7. Room types.

Compared to Study A the room designs were not dissimilar and so the use of the 3D box did not appear to have an effect on the overall designs but it was easier to use and it was clear that white was not chosen to any great extent.

Key finding from study B

The use of transparent boxes afforded a much less time consuming way to colour the surfaces of the room. It did not appear, from the findings in Analysis 2, that the students chose rooms based on how they might look and so the visualising of the rooms was perhaps underused.

In terms of colours chosen and preferences and gender choices little was discovered. One finding of note was that white was no more used than other colours. There was a slight tendency to favour blue with 35% and 33% of the walls being coloured blue (on average this would have been expected to be around 15%) by the females and males respectively. Given that there were two shades of blue offered, this may have influenced the choice to go for blue as it allowed the use of shades within the rooms (almost half of the teenagers used two shades of blue in their rooms) but that does not explain why it was so much more popular than yellow (which had three shades yet was only chosen for 12% of the faces overall).

Little could be said about gender differences in this study except that shades seemed to be preferred by females and hues by males.

In designing this study it had been assumed that being able to look inside the box may have given the teenagers a sense of how the room might look. Given that most of the room designs were categorised as 'surreal' using the author's room classification method it did appear that the teenagers were not very focused on how the room would look.

To consider how mood might be affected by colour, one choice would be to present Perspex boxes for students to look into – another was to wash a room with colour. This latter choice was taken given that light could be controlled and given that it might help the teenagers feel immersed in a colour.

Study C

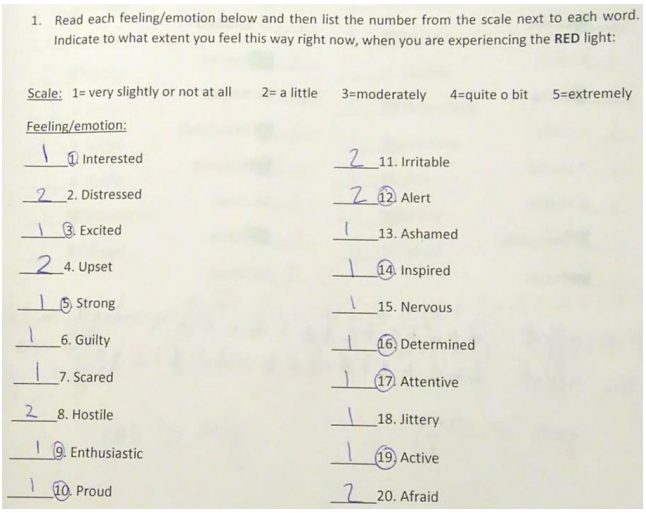
This study was a coloured light study in a living environment, seeking to understand how different coloured lights might affect teenagers' moods and also aiming to test out a means to measure moods. Twenty-two British teenagers, aged 13-14 years old (12 male, 9 female, 1 unknown) participated in this 'Coloured Lights in my Bedroom' study which was held in a room with no windows so that the artificial lighting would not mix with natural lighting. During the study, participants were instructed to complete the PANAS Questionnaire (a mood scale that measures both positive and negative affect) under eight different coloured lights: red, light-green, green, light-blue, blue, pink, yellow, and white (Figure 37). Two LED lights were put up on two adjacent corners of the room (Figure 38).

Figure 37. The study room under different lights: red, green blue, pink, yellow, and white.

Figure 38. The way the two LED lights were arranged in the room in order to create ambient lights.

The PANAS Questionnaire is a "scale which consists of a number of words that describe different feelings and emotions" (Watson, Clark L. & Tellegan 1988). It measures state emotions (changeable aspects of emotions) in terms of both positive and negative affect at the same time. Research shows that people can feel both positive and negative emotions simultaneously ((Emmons, Diener 1985);(Diener, Emmons 1984)).

The score from PANAS scale can be either positive or negative. To calculate the positive affect score, one adds the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. To calculate the negative affect score, one adds the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Scores can range from 10–50, with higher scores representing higher levels of positive affect and lower scores representing lower effects of negative affect. So, for example, in the completed survey shown in Figure 39, the score would be 11 for positive affect and 15 for negative affect.



1. Read each feeling/emotion below and then list the number from the scale next to each word. Indicate to what extent you feel this way right now, when you are experiencing the **RED** light:

Scale: 1= very slightly or not at all 2= a little 3=moderately 4=quite o bit 5=extremely

Feeling/emotion:

1 (1) Interested	2 11. Irritable
2 2. Distressed	2 (12) Alert
1 (3) Excited	1 13. Ashamed
2 4. Upset	1 (14) Inspired
1 (5) Strong	1 15. Nervous
1 6. Guilty	1 (16) Determined
1 7. Scared	1 (17) Attentive
2 8. Hostile	1 18. Jittery
1 (9) Enthusiastic	1 (19) Active
1 (10) Proud	2 20. Afraid

Figure 39. The PANAS Questionnaire.

In the study teenagers had to indicate how they felt in the moment when the study room was full of each of the 8 different coloured lights (for max 3 min each) choosing from 20 adjectives and scaling them from 1 to 5 (Figure 39). Two other questions were added to the questionnaire used for this study which were: "did the coloured lights affect your mood?" (Y/N/ Cannot tell) and "would you like to have a similar system at home?" (Y/N/ Cannot tell).

Results

The results are shown in Table 8. The scores given are the total scores from the addition of points as described above, for positive and negative affects for each of the eight colours.

The average numbers at the foot of Table 8 are calculated by dividing the totals by 22. The differences (shown in the last row) represent the gap between the average positive and negative affect scores. Where this is large it suggests that the colour was more mood affecting than where it was small. Light-green had the highest score (25) for positive affect, followed by light-blue, blue, pink (with scores of 24) and red (23). Red had the highest negative affect score (15), followed by green, white (same score 14) and light-green, light-blue, blue, and pink (same score 13). The largest differences was for light green suggesting that is overall had a positive affect on the teenagers' moods.

No. of teens	Red		Light-Green		Green		Light-Blue		Blue		Pink		Yellow		White	
	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative
1	11	15	12	10	13	11	17	10	12	10	15	10	14	10	10	10
2	17	16	25	10	22	10	28	10	26	10	31	10	16	10	10	10
3	24	10	31	10	26	11	16	13	21	12	25	11	39	12	24	12
4	16	19	15	12	15	15	14	15	14	13	15	13	14	13	13	14
5	21	11	28	10	10	12	17	13	17	27	23	10	19	10	23	10
6	31	23	30	18	23	10	27	11	23	11	30	10	27	10	10	10
7	17	11	18	10	22	10	21	10	21	12	21	15	30	12	27	11
8	13	20	24	10	22	12	15	12	14	16	26	13	20	17	18	16
9	36	18	38	14	36	13	44	18	40	16	22	31	26	24	17	20
10	35	17	44	24	20	29	26	27	28	24	33	34	19	12	37	19
11	21	13	21	12	18	11	20	10	16	10	17	10	10	12	14	10
12	20	14	16	14	17	13	21	13	30	14	17	11	16	10	20	11
13	18	14	16	17	16	13	15	10	22	10	13	11	10	10	15	10
14	33	12	23	14	13	13	25	10	26	13	12	11	15	10	18	10
15	38	14	31	14	24	36	25	32	38	12	41	9	31	15	19	28
16	29	17	35	14	22	25	22	19	37	13	24	19	40	11	16	16
17	12	16	23	11	20	10	22	10	21	9	31	10	34	10	33	10
18	22	10	22	10	27	10	28	10	14	15	26	10	26	10	25	10
19	26	10	27	13	32	20	35	10	36	10	34	10	18	10	34	19
20	14	15	27	11	10	10	27	10	10	10	27	10	10	10	11	19
21	19	12	20	11	21	11	21	10	18	10	15	10	21	10	14	14
22	31	24	32	10	21	12	32	11	37	13	36	17	38	12	20	10
average	23	15	25	13	20	14	24	13	24	13	24	13	22	12	19	14
difference		8		13		6		10		11		11		11		6

Table 8. Table of results for each colour and affect.

In asking the teenagers the last two questions, 21 of the 22 felt the lights altered their moods and 19 would be interested to have a similar system at home.

Key finding from Study C

All colours had a more positive than negative affect on teens' mood, with light-green, light-blue, blue, and pink (13, 10, 11, 11) showing the biggest difference between negative and positive scores and with each having an average or above score (≥23) for positive affect. Red was the only shade with an average and above score for positive affect (23) and negative affect (15) suggesting it provokes variable responses. This study seems to suggest that 'lighter' colours are more beneficial to teenage moods than stronger and darker colours.

It is still unknown how colour might affect pupils' mood, and what colour they prefer to have in their bedrooms. Therefore, what can be next discovered is if there is any relationship between teenagers' colour preferences and mood and what are their bedroom choices in terms of colours. These conclusions lead to the following pilot study, Study D, where one of the aims is to explore how colour might affect mood.

Study D

The main aim of Study D was to validate a method for Chapter 6. The methods tested in Study B proved time consuming and costly. Another aim was to further understand what colours teenagers might prefer to have in their own bedrooms whilst also exploring their stated favourite colours and additionally explore how such colours might affect moods. Moreover, this study was seeking to understand how teenage boys relate to colour, other questions being asked in order to understand teenager's opinion about colour and mood relationship, to see if they would like or

not to be in control of their bedroom walls' colour, and how various they would like a colour pallet to be. The author acknowledges teens' mood could have had an effect on their colour preference, and participants' mood was gathered in a proposed questionnaire in Chapter 6. This study was to pilot questions for the proposed online questionnaire (described in Chapter 6) and thus it was testing out an instrument (Horton 2013).

The author adapted the pilot questionnaire based on insights about survey design with children. Read et al. (2006) recommended to use short and simply worded questionnaires, with limited writing, and the language should be piloted; questionnaires should be fun (for instance by printing questions in colour) (Read, MacFarlane 2006). Horton (2013) recommended to use open-ended or closed questions depending on the context, to ensure the sample is representative, to pre-test the survey, to use simple questions where possible, to "avoid negatively worded questions, double barrelled questions and to keep the length of the question to a minimum" (Horton 2013). The author used a higher number of closed questions because for the participant they were "much easier to answer" ((Horton 2013), (de Vaus 1994), (Oppenheim 2005)). An opt out option such as "not sure" was introduced to almost each question of the present questionnaire so that the participants could choose this response when the options presented were not acceptable ((Horton 2013), (de Vaus 1994)). Horton (2013) advises to "ensure that children understand exactly what a question is trying to ask" and to "keep surveys as short as possible" because of children's short attention span, which, in author's view, is still present in teenagers. The questions used in this study are "nominal questions such as yes/no questions" because they are" the easiest for children to answer" and "responses are kept to 3 or 4" (Horton 2013). However, some questions might be found ambiguous, and this is a limitation of Study D, but the aim was to pretest the questions to avoid ambiguity in the final questionnaire by piloting with sample (Horton 2013) teenagers and pre-teenagers.

A group of 16 teenage boys aged 12 to 13 years old completed the questionnaire. The indications were to answer 15 questions about colour preference, mood, future colour devices, and colour assistance. For the purposes of this study, seven questions are analysed as follows:

1. What colour from those below would you prefer to have on your bedroom's walls/floor/ceiling? Notice that in your bedroom there are 4 walls – here recorded as A, B, C, D – one ceiling, and one floor. Please write the number of your chosen colours on the space line below. Choose any colour you like as many times you can.

Wall A___ Wall B___ Wall C___ Wall D___ Ceiling___ Floor___

2. If you have a favourite colour write it below otherwise leave it blank.

3. Do you think certain colours affect your mood (e.g. help you feel happy or sad)?

Yes___ No___ Not sure____

4. Do you think it is possible to cheer up or feel happy by changing the light's colour in your bedroom?

Yes___ No___ Not sure___

5. If you could change your bedroom's colour to any colour you like, do you think you will be happy with the changed colour?

Yes___ No___ Not sure___

6. Would you like your walls to be able to suggest what colour you should use if you are feeling sad, depressed, happy, too energetic, etc.?

Yes___ No___ Not sure___

7. If you could change the wall/ceiling/floor colours in your bedroom, how many colours would you like to pick from (0-5, 6-10, or more than 10)?

In the questionnaire, vivid, mid-bright, pale colours and achromatic colours were all printed as an extensive choice for question 1 above. The choice of colours was inspired by Itten's Colour Wheel (Fletcher 2014) (Figure 40). In addition to those colours, shades of achromatic colours, white, grey, and black were included as shades of white and grey are the most common used in interior design and as black is sometimes used as a strong accent, but not that often in bedrooms. Brown was not included because it is considered to be one of the most disliked colours (Gong, Lee 2011).

Figure 40. Itten's Colour Wheel (source: (Fletcher 2014)).

For the first question teenagers had to choose between 45 different shades of 15 different colours and achromatic colours to imagine colouring the walls, ceiling, and floor of their bedroom; these printed colours and achromatic colours were different hues of: yellow, yellow-orange, orange, red-orange, red, red-violet, violet, blue-violet, blue, blue-green, green, yellow-green, white, grey, and black. For the other questions teenagers had to simply answer with no extra tools needed.

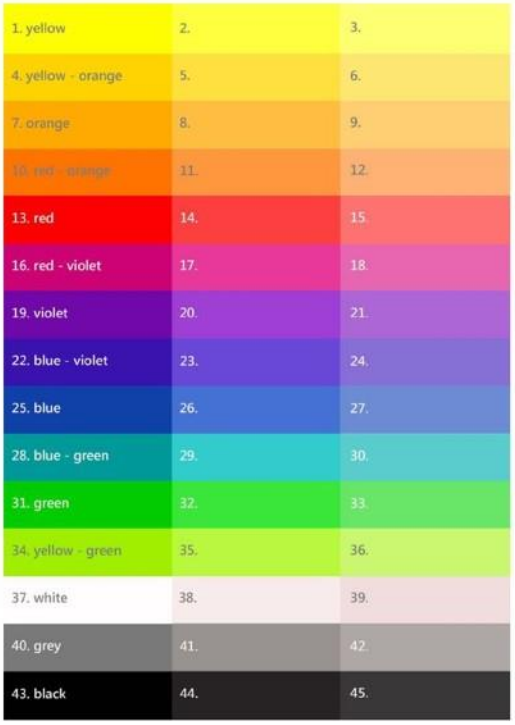


Figure 41. The colour palette used with 45 colours and achromatic colours (source: the author).

The colours and achromatic colours (see Figure 41) were grouped in group colours such as yellow (Y), orange (O), red (R), violet (V), blue (B), green (Gn), white (W), grey (G), and black (Bk). (O) includes orange, yellow-orange and red-orange, (V) includes violet and red-violet, (B) includes blue, blue-violet, blue-green, and (Gn) includes green and yellow green. For each colour and achromatic colour, there are three different brightness levels, which can be seen as three different columns in Figure 41, which are, from left to right: vivid, mid-bright, and pale.

The tools used for the study were the questionnaire and pens to complete it.

Results

All seven questions were analysed and the results are discussed in the following three sections (Analysis 1, Analysis 2, Analysis 3). The first analysis focuses on preferred colours on walls, ceiling and floor and categorizes rooms in four types, focusing on the chosen hues and their shades. The second analysis focuses on personal favourite colours and the third analysis answers all the other questions, seeking to understand if teenagers were aware of any relationship between colour and mood, if they would like to be in control of their wall colours, and aiming to find out how many colours teens would like to pick from when completing a similar questionnaire. For the first two analyses, 14 answers were analysed instead of 16, because two could not be coded. For the third analysis, all 16 answers were taken in consideration.

Analysis 1

Teenagers were behaving as in Study A mixing all sorts of crazy or immersive colours. The author analysed the rooms using the room styles method trialled in Study B defining five styles as shown here:

- traditional rooms (TR): where all walls are one of these (traditional) colours: blue, yellow, pink, green, red, brown, white; the ceiling is white or similar to the walls; the floor is different from the ceiling and walls and it is brown, beige, or grey;
- modern rooms (MR): three walls are white and one coloured; the ceiling is white or coloured (black, dark grey, yellow, blue, red); the floor is white, brown, or grey;

- futuristic rooms (FR): four walls same colour or shades of it; the ceiling same as the walls, or floor, or white if the floor is the same as the walls; the floor same as the walls or ceiling; or white if the ceiling is the same as the walls; or five surfaces same colour plus one surface different colour and not traditional; maximum two colours (or shades of two colours) in the room;
- surreal rooms (SR): three or more different colours and not traditional;
- other rooms (OR): what does not fit in the other four types.

In this study, surreal rooms were created by 50% of the teens, 36% created futuristic rooms and 14% modern rooms. Once again there were no traditional rooms 'designed'.

Participant	W1	W2	W3	W4	C	F	Room description
1	red	green	black	green	white	white	surreal
2	violet	violet	violet	violet	violet	grey	futuristic
3	blue	blue	blue	blue	blue	blue	futuristic
4	white	white	white	red	white	grey	modern
5	red	yellow	black	blue	grey	blue	surreal
6	blue	red	violet	blue	white	blue	surreal
7	blue	yellow	green	green	white	blue	surreal
8	black	black	black	black	black	black	futuristic
9	blue	white	blue	white	white	black	surreal
10	white	white	white	white	white	white	futuristic
11	white	blue	white	white	grey	white	modern
12	green	blue	black	red	white	black	surreal
13	green	blue	orange	yellow	white	white	surreal
14	blue	blue	blue	blue	white	white	futuristic

Table 9. The results of 14 teen participants.

Colours chosen for each bedroom surface are in Table 10. Blue (30%) was favoured for walls and white for ceiling (64%), and floor (36%). In terms of colour brightness, there was a preference for vivid colours for each wall surface (walls, ceiling, floor).

	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black
Walls	5%	2%	9%	9%	30%	11%	21%	0%	13%
Ceiling	0%	0%	0%	7%	7%	0%	64%	14%	7%
Floor	0%	0%	0%	0%	29%	0%	36%	14%	21%

Table 10. Chosen colours for walls, ceiling, and floor.

Analysis 2

The second question considered teenagers' favourite colours and in this case, red and blue were each preferred 3 times, followed by white (2). Purple and green were preferred once. Four teenagers did not have a favourite colour.

Analysis 3

Table 11 summarises the answers from the last five questions on the survey. These results were not especially helpful except that they highlighted that the teenagers did not seem to have a strong view about mood and colour and it also seemed that some of the design concepts would be difficult for them to understand when expressed in this way. There seemed to be some neutrality in terms of the affect colour might have on mood.

Question	**No. of "yes" answers**	**No. of "not sure" answers**	**No. of "no" answers**
3.Do you think certain colours affect your mood?	7	5	4
4.Do you think is it possible to cheer up or feel happy by changing the light's colour in your bedroom?	5	5	6
5.If you could change your bedroom's colour to any colour you like, do you think you will be happy with the changed colour?	9	2	5
6.Would you like your walls to be able to suggest what colour you should use if you are feeling sad, depressed, happy, too energetic, etc.?	2	5	9
	0-5 colours	**6-10 colours**	**More than 10 colours**
7.If you could change the wall/ceiling/floor colours in your bedroom, how many colours would you like to pick from (0-5), (6-10) or (more than 10)?	5	3	8

Table 11. Answers for Analysis 3.

Key finding from Study D

Analysis 1 seemed to suggest that vivid colours were predominantly chosen for bedroom design although this study only included male teenagers so these findings have to be taken with some caution. White was a top choice for the bedroom ceiling and floor. Considering the bedrooms as a whole, white was the most chosen colour, followed by blue and black. However, it seems that 79% of male teens preferred coloured rooms with unusual (surreal) colour harmony. The popular choice of blue aligns with the findings in Study B and does suggest some preference towards that colour.

Analysis 2 considered teens' favourite colours but given so few teenagers nothing can really be gleaned from these results. Results in Study D contradict the earlier results with regard to the colour white but this could be an effect of the different ways of presenting the colour palette. This is discussed in the next section.

Discussion of the four studies

Colour can be differently experienced in varied cultural contexts, as colours have multiple cultural associations, thus context may play a large role in which associations are activated in memory (Labrecque, Milne 2012). "Crosscultural differences of colour perception may cause a problem" (Jacobs et al. 1991). Even if "some colours appear to have universal meaning and association", this is not always the case. "Like language, marketers in a particular nation often take colour for granted, having experienced certain colour associations all their lives, and do not even question whether other associations may exist in different societies" (Jacobs et al. 1991). "Standardised marketing may be risky with respect to colour perceptions. As an example, the Chinese associate the colour brown with a soft drink label, and perceive brown as good-tasting; South Koreans and Japanese associate the colour yellow with a soft drink label, and likewise perceive it as good-tasting; and, finally, the US respondents associate the colour red with a soft drink label and with being good-tasting" (Jacobs et al. 1991). This mindset can be narrowed down to local colour associations in any country, such as the colour of a favourite football team that could influence one's colour choice. According to Derbaix et al. (2011) football supporters prefer the colours of their own team and reject of the colours of rival teams: "we exhibit our colour and try to attract attention with that colour. We are the "mauves" and the others are dressed in another colour. It allows us to recognise one another" (says supporter Albert, Anderlecht) (Derbaix, Decrop 2011). "Colours clearly play an identification and distinction function that may lead to the will/refusal of wearing clothes of particular colours in everyday life" (Derbaix, Decrop 2011). Following this line of thoughts, assuming Study D was run in Preston (which was not), then teens may have refused

to pick orange as this is the colour of Blackpool football team. The influence of cultural aspects on colour choices being mentioned, the findings and methods of the four studies were briefly summarized.

Findings

There was some evidence from Study C that some colours (e.g. light green, yellow, pink, blue, light blue) tended to evoke more positive mood associations than others and this is therefore worth further exploration. There was some suggestion from Study B that teen females had a more harmonious sense of colour than teen males did. Study D seemed to confirm this suggestion given the designs that they made. This was also seen in Study A , where male teens were in many cases actively choosing different quite crazy colours for their bedroom designs. They appeared to prefer bright colours to pale ones. The prevalence of blue as a choice seemed to be identified in Study B and then confirmed in Study D but both of these studies were male orientated.

Throughout the studies there was evidence that the teenagers were maybe struggling to think about how colour might be used/appear in their bedrooms. From Study D it seemed that the teenagers were not all that clear about how to associate colour and mood and the close results from Study C seem to support this idea that there is not a strong colour – mood association.

Methods

Different methods and tools were used in the four studies. In Study A , a 2D room net model was used and teenagers used a pseudo survey method to fill in the nets. The use of transparent boxes in Study B was intended to add context. Coloured lighting in a dark room was used in Study C, with the PANAS questionnaire and a paper based questionnaire was used in Study D. There was a limitation regarding the gender of participants which was not constant throughout the four studies: males only were used in Study A and Study D, while Study B and Study C had both genders. Testing out different methods and tools will have impacted the results and, together with the gender inconsistency, exposed contradictions around the choice and use of white.

Because of the limitations that Study A has showed with respect to white not being a colour choice, Study B aimed to establish whether white was a conscious choice or not. The method used a transparent box, which allowed teenagers to choose the colour of each surface (including white). Moreover, because in Study A all teenagers were males, Study B brought a mixed group of both male and female teenagers, in order to have more balanced colour choices. Compared to Study A, where teenagers participated during the study on unfamiliar grounds, Study B was run in teenagers' familiar environment, that being their classroom. Maybe because of this environment where they had to behave, teenagers seemed more concentrated on their task. They might have

been also been motivated to engage with the study, as it would have escaped them from the usual class activity. Therefore, it could be suggested that teenagers might be more motivated and less distracted when participating in a study run in their familiar environment and in certain context where they would use participation to a research study as an escape, this being their motivation. The method chosen for Study B proved to be an improvement of the first method, allowing teenagers to have a broad colour choice, including white. They were better able to look inside the 'bedroom' to see how the colours worked together.

Because teenagers did not perhaps 'feel' their coloured choices' consequences, the method used in Study C focused on creating a real coloured environment to see if and how it affected teens' mood. As a result, teenagers experienced the effect of colours on their mood in a real room, where they immersed themselves in coloured light. The lighting colours used in Study C might not have been identical with the ones from other studies with which they were compared in the discussion section above. This leads to the possibility of less precise comparisons between results from different studies. Therefore, in order to compare similar results between different studies, the method should be improved by, for example, specifying what colour systems were used, be them light systems or printed colour systems. This methodology limitation was also acknowledged by Valdez et al. (1994), who addressed the need of improved methods, such as the use of colour systems (Valdez, Mehrabian 1994). The small number of participants was another limitation of this study, a larger number of participants being needed for future studies.

The method chosen in Study D was a good start to examine teenagers' colour choices, even though teenagers (boys only) did not have to live in the consequences after choosing colours and brightness levels for the walls, ceiling, and floor of an imaginative bedroom. The results might not be representative because of the small number of participants of one gender only (16 teenage boys) and so further research needs to be done with a larger number of teenagers, both female and male.

A common limitation seen across all four pilot studies was the small number of participants and the unequal gender division. The age of teenagers was not stable, varying from 10 years old to 15 years old, this being acknowledged as another limitation, because 10 to 11 years old is the beginning of adolescence process, while 15 years old is a different stage of it. Teenagers seemed to respond well when asked to associate large bedroom areas with colours, as well as when asked what their favourite colours were or any other related questions. They seemed excited when surrounded by coloured light in a dark room, and were enthusiastic about having similar light options in their bedrooms. Thus, it could be suggested they acted promising at the use of colour as a tool for research.

Another limitation is related to the colour order. Research says that colour schema of a product might influence package choice order (Bagchi, Davis 2012), or that colour presentation mode played an important role in altering the perceptions of faces (Stepanova, Strube 2009). Therefore, the order lights were presented in Study C, and the ordering effect of the colour palette in Study D might have affected the results. However, the author thinks that results could have been affected even if another colour order would have been chosen.

Design implications

Different levels of colour brightness could be used in studies that focus on the affect of colour on teenagers' wellbeing because the author thinks that colour brightness could make the colour-mood association easier. The methods tested in this chapter have shown that colour could be used by teens as a tool for TCI design research because overall, the use of colour seemed to engage them during the pilot studies. Teenagers thought certain colours could affect their mood (Study D), they seemed to enjoy designing 3D bedroom models using colour (Study A ,Study B), and they enjoyed being immersed in a dark room while the colour light changed (Study C).

During the pilot studies, some teenagers quickly got bored, distracting others from their task. Therefore, ways of keeping up their motivation need to be found. Moreover, some teenagers might not understand the task even if it is explained several times, and it might be the case that their colleagues' explanation has more success. For example, some teens had problems in understanding what a 3D model was, and at the beginning of the study, they could not imagine it as a bedroom. One teenager thought the floor was the ceiling and coloured it black, and a few of them were confused by the drawn furniture, that would have not make sense until folding the model to become a cube. Therefore, when working with teenagers in a group, tasks have to be simple and clear, and ideally groups should be formed in such way that no more than one 'disturber' should be included. During the studies, it was noticed that it was important for teens to understand why they were doing the tasks. If they understand that their work as participants is valuable, and if they are engaged with the idea, they might not only complete the task, but also come up with valuable feedback.

Another point to consider about the results of the studies is that coloured light used as a tool for assessing teens' mood might have a higher affect than the use of printed colours. These studies contribute to existing knowledge regarding colour in TCI research by providing new understanding of teenagers' colour preference in their personal spaces.

Conclusion

This section tried out different methods for validation for a bigger study in Chapter 6. The 'effort' of colouring in a net (Study A) and designing transparent boxes (Study B) showed that these might be a challenge as design methods. Study A and Study B methods proved to be unrealistic because teenagers were not feeling the consequences of living in vivid colour schemes. This limitation lead to a different method that implied the use of coloured lights (Study C), which showed that participants have only experienced positive moods under each different colour. Study D suggested that vivid colours were predominantly chosen for bedroom design. Teenagers also thought certain colours could affect their mood, they preferred a variety of colours to pick from if given a colour palette, they thought the option to change their bedroom colour would make them happy and they did not like the idea of a wall to suggest what colour they should use based on their mood.

Thus, the idea of colour as a tool used by teenagers to control their bedrooms' wall appearance will be further developed. The small number of participants, as well as the unequal gender division, were found general limitations across all studies in this chapter. This leads to a future study with a large number of participants, both male and female.

Early Design Idea

One of the main limitation of all four pilot studies was the small number of participants. As shown in Chapter 2, teenagers are great users of the Internet, which is a quick way to gather a large amount of participants is online media. The questionnaire tested during the pilot studies proved to be a good way of gathering teenagers' opinions and colour preferences. Therefore, an improved questionnaire will be used online in order to reach as many teenagers as possible. Colour preference might be influenced by cultural context, so the online questionnaire was intended to be spread in different countries. Thus, this chapter led to the idea of designing a questionnaire that could be easily spread to a high number of participants. It also inspired the initial concept of a device that would allow teenagers to control coloured lighting in their bedrooms.

Chapter 6

DESIGN CONCEPT STAGE 2

Introduction

Following the preliminary work in Chapter 5, a survey study was designed to answer the following questions:

1. Is there a relationship between colour and mood? If yes, is there a difference between genders?
2. Do teenagers have a favourite colour?
3. What colours would teenagers choose for their bedroom?

The aim of the study was to further explore the relationship between colour and mood (Question 2 – Associations between Colour and Mood) but also to eventually guide the design of an interactive mood app for teenagers. Other relationships were also explored: teenagers' favourite colours (Question 1 – Favourite Colours), their bedroom coloured light preferences (Question 3 – Bedroom coloured lighting), and their colour associations with different bedroom surfaces (Question 4 – Bedroom surfaces colour). A side objective was to explore the use of an online survey as a method. A validation exercise is included in this chapter to see if the data in CMV2 study would match the first study results (CMV1).

This chapter contains two connected studies where data from the first study is later analysed by individuals who contributed the data. The first study of Chapter 6 is Colour me Mood version 1 (CMV1) and the second study is Colour me Mood version 2 (CMV2).

Aim

The aim of Chapter 6 is to explore colour-mood relationships, to see if there is a) any gender difference regarding colour-mood associations; b) any preferences regarding the colours of a bedroom's large surfaces and a bedroom's coloured light, and if there are, are there any gender differences?

Structure

Chapter 6 describes two studies, the first being Colour me Mood Version 1 (CMV1, the green area in Figure 42) and the second being Colour me Mood version 2 (CMV2, the blue area in Figure 42). The data from CMV1 was firstly analysed by adults; the resulted data (Data 1 in Figure 42) was

then packaged for use in the CMV2 study, which was run with the same participants from CMV1 (Figure 42). In other words, a set of teenagers from the CMV1 survey interpreted their own data in CMV2 study (Figure 42). From this interpretation, another data resulted (Data 2 in Figure 42), which was again analysed by the same researcher that analysed it in CMV1 (the author of this thesis). Therefore, there are two types of analysis such as adult analysis and teen analysis on the same data (Figure 43) and two types of findings (Figure 42). The contribution of this chapter is to answer the research questions while also describing a method innovation where data was analysed by adults as researchers and then by teens (Figure 43).

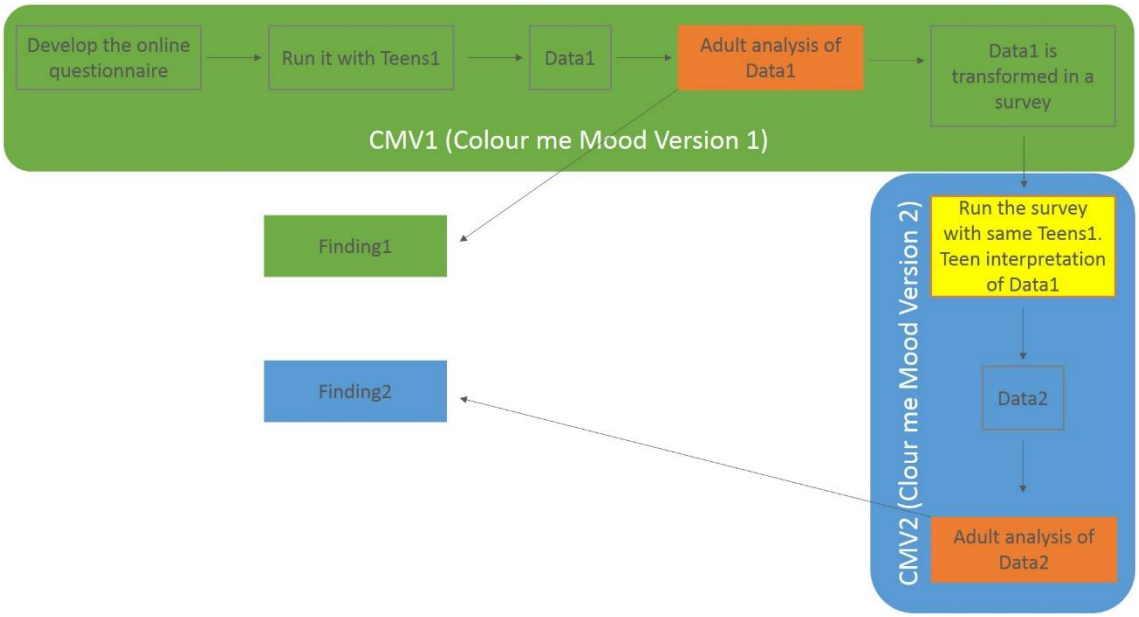


Figure 42. Phases of two different analysis stages in Chapter 6.

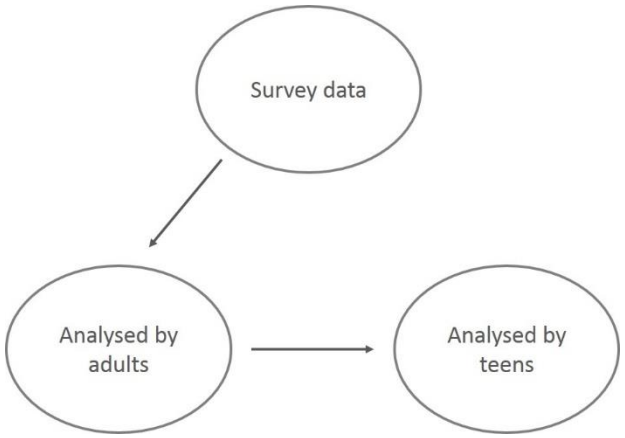


Figure 43. Diagram of the analysis stages seen as a contribution of this chapter.

Colour me Mood version 1 (CMV1)

This study explores the relationship between teens' colour preference and mood, the three main research questions being:

4. Is there a relationship between colour and mood? If yes, is there a difference between genders?
5. Do teenagers have a favourite colour?
6. What colours would teenagers choose for their bedroom?

In order to explore the relation between colour and mood, if there is any, an online questionnaire was designed in Chapter 5. Concern over cultural context resulted in the initial questionnaire being distributed in four countries (UK, Denmark, Romania, and United States). However, for logistical reasons relating to the thesis focus, the research analysed here is from a single country, and one high-school in Rochester (New York), as there was a very large cohort completing the survey from that location and there was the possibility of going back to the representatives of the target group so that they could look over the data analysed by an adult researcher. Thus, in this chapter, the research is focused on the American culture.

As well as answering research questions, the online questionnaire was designed to influence and inform the design of the final interactive product. The author and an expert in the field of CCI followed several steps (Stone 1993) to create the questionnaire: deciding what data was needed, selecting items for inclusion, designed individual questions (open and closed questions (Horton 2013)), composed wording, designed layout, thought about coding, prepared drafts and pretested, piloted and evaluated (Horton 2013), polished and pretested the final draft (Horton 2013) and finally, performed the survey. Short, simple, and precise sentences were mostly used, negativity being avoided (Leung 2001). Content validity was used by "having the questions of the survey judged by an expert in the field" (Horton 2013). Questions that seemed reliable in pilot tests were used in the final version where they might have increased the reliability of the online questionnaire (Horton 2013).

The aim was to explore what teenagers' colour preferences were, what their favourite colours might be for their bedroom walls, ceiling and floor, what colours they would associate to different moods and what colours would suit large, medium and small display spaces. In the questionnaire, the teenagers had to answer a set of answer selection questions as well as some open questions about their bedrooms' appearance and their understanding of colour meaning (in the culture of their own families and in terms of their gender). For the purpose of Colour me Mood version 1 (CMV1) study, only four questions were analysed:

1. "What is your favourite colour?" (described in Question 1 – Favourite Colours subdivision);
2. "What colours from the image below you would like to use for the following 10 moods?" (described in Question 2 – Associations between Colour and Mood subdivision);
3. "What colour light would you like in your bedroom?" (described in Question 3 – Bedroom coloured lighting subdivision);
4. The following six questions have been analysed as one: "What colours would you choose for the large areas of your bedroom (walls, ceiling, and floor)?" (described in Question 4 – Bedroom surfaces colour). The form presented in the questionnaire is the following:
    - What colour you would choose for the first bedroom wall?
    - What colour you would choose for the second bedroom wall?
    - What colour you would choose for the third bedroom wall?
    - What colour you would choose for the fourth bedroom wall?
    - What colour you would choose for your bedroom ceiling?
    - What colour you would choose for your bedroom floor?

Chapter 5 contains early forms of the second and third questions which were piloted and evaluated in Study D. The first question was tested in the second and third version of the questionnaire, which are described later in this chapter. Question 4 – Bedroom surfaces colour – was piloted in previous versions of the online questionnaire (Study D in Chapter 5). As suggested by Horton (2013), all questions above were circulated to a small circle of people, both teenagers and adults, before the online survey was performed (as part of the final online questionnaire draft).

To answer question 2, 3, and 4, participants were given a colour palette (Version 4, Figure 47) that was developed from the printed versions used in Chapter 5 (Version 1–3, Figure 47).

Method

Many different data collection methods exist that are suited to teenagers and young adults including the use of technology and the internet as a tool for gathering data (e-mail, tablets, online surveys, etc.) as well as surveys and focus groups (Flanagan et al. 2015). In order to connect with teenagers, the author chose two of these methods: digital technologies and questionnaires. The use of digital technologies for data gathering provides anonymity, does not exclude marginalized young people, and can be accessed anytime and especially at a time when it suits the teenager's context. Questionnaires can be completed in privacy, can be sent to a large number of participants, and they are good for quantitative data collection (Flanagan et al. 2015).

These two methods were combined in order to create an online questionnaire, which included quantitative as well as qualitative questions that allowed teenagers to express their preferences and thoughts.

Questionnaire design

The questionnaire used in this study was developed iteratively. Initially, a design was made (Figure 44) with a colour palette of seven colours (red, orange, yellow, green, blue, indigo, and violet) and three achromatic colours (white, grey, and black) (Figure 44, left side) from which teenagers had to choose colours in order to complete an unfolded view of a bedroom (Figure 44, right side). When piloted, teenagers asked for more colours and so a second colour palette was created (Figure 45), together with a second version of the questionnaire (Figure 45). This second version was piloted in the study reported earlier in (Chapter 5) and the results from that pilot informed the third version of the questionnaire (Figure 46). This version had forty-eight colours with different brightness (based on both the pilot study's results and on the finding that few people prefer saturated colours, while other prefer desaturated colours (Eysenck 1941).

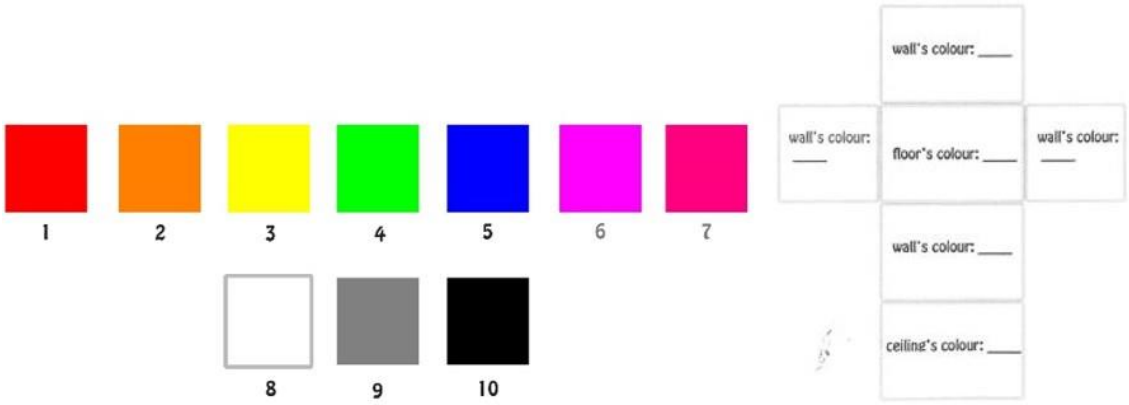


Figure 44. First version of the questionnaire and colour palette. Left side image: Seven colours and three achromatic colours used for the questionnaire (from left to right: red, orange, yellow, green, blue, indigo, violet, white, grey, and black). Right side image: the unfolded bedroom view that teens had to complete.

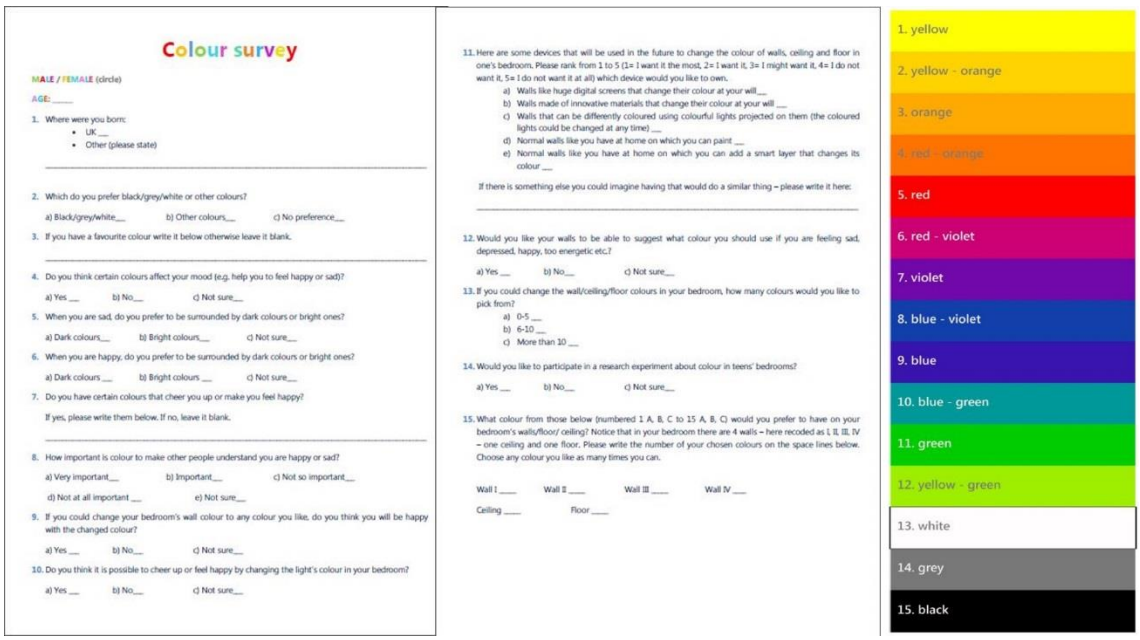


Figure 45. Second version of the questionnaire (left side and middle) and the colour palette (right side).

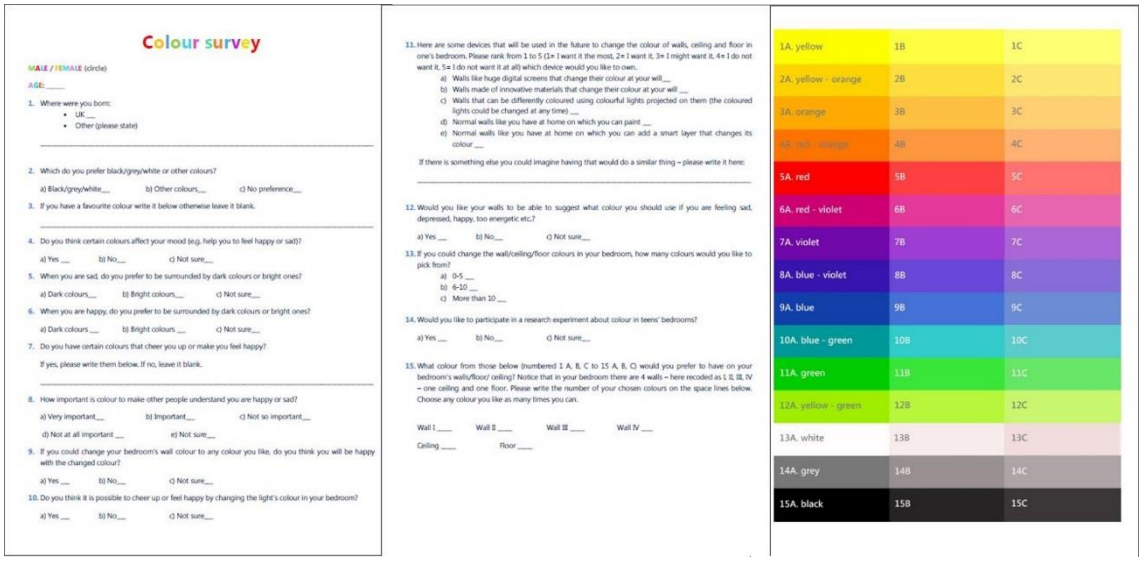


Figure 46. Third version of the questionnaire (left side and middle) with the colour palette (right side).

The images below represent the iterative evolutions of both the colour palette (Figure 47) and the questionnaire (Figure 48). Figure 47 shows the four versions of the colour palette design development, from the first version (Version 1) to the final one (Version 4). The difference between Version 1 and Version 2 is the display of colours, as well as the number of colours. In Version 3 two more shades were added for each colour and in the final version (Version 4) three shades of brown were added and the colour names were removed from the palette.

Figure 47. Colour palette evolution from version 1 to the final version.

All four versions of the questionnaire, including the final one (Version 4), are displayed in Figure 48. Letting aside the differences between the colour palettes, the first version of the questionnaire (Version 1) requested an association of given colours to the surfaces of an unfolded bedroom plan. Version 2 was added questions such as favourite colours, the association of colours with moods, as well as a likeliness ranking of an interactive wall idea. Version 3 was the same as version 2 but simply with a different palette but additional questions were added to the final version (Version 4) to gather information meant to inform the design stage (Chapter 7).

In terms of delivery, the first three versions were delivered to small groups in a paper format. The final version (Version 4) was delivered to allow it to be accessed by a wider audience.

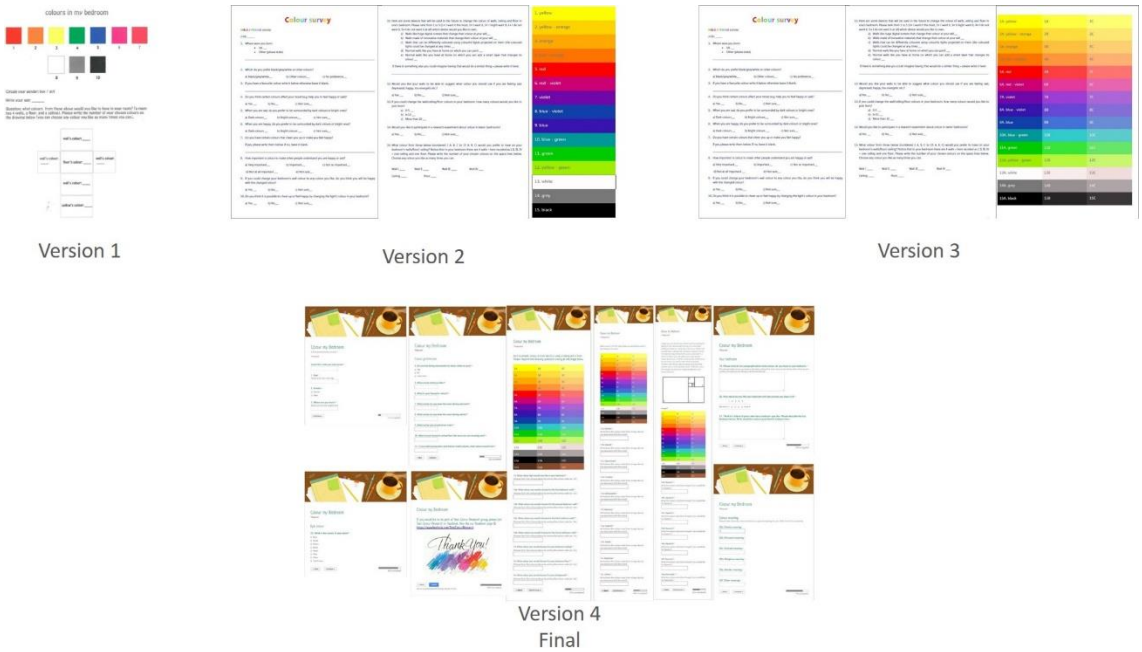


Figure 48. The evolution of the questionnaire from version 1 to the final version.

Figure 49 shows a collage of all the screen-shots of the online questionnaire final version.

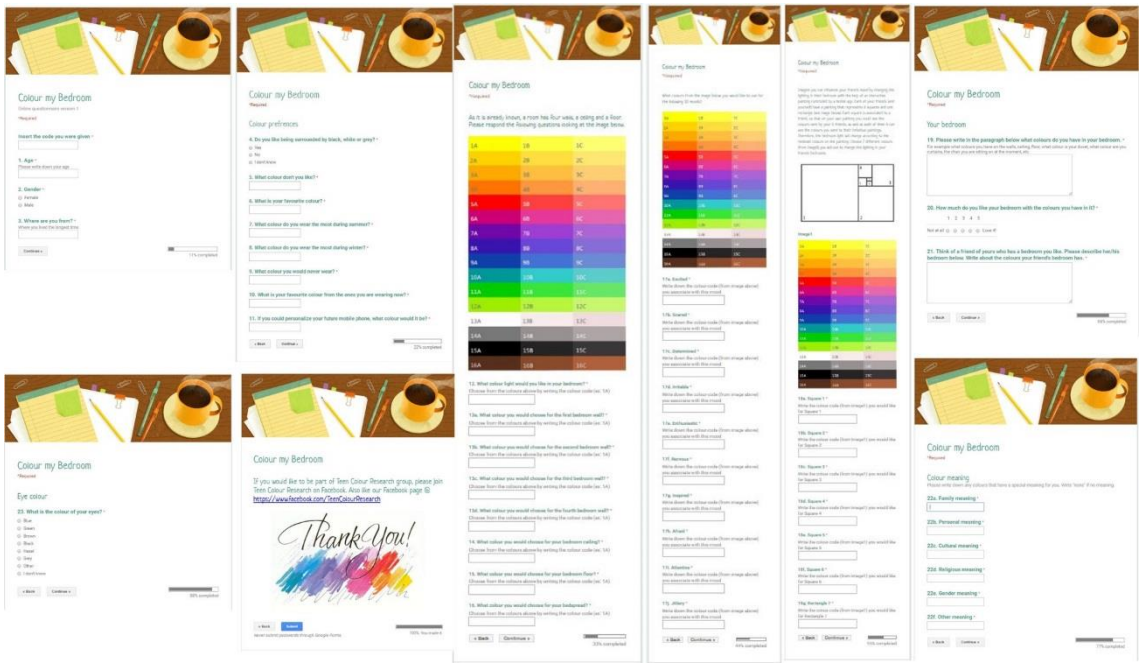


Figure 49. Images of all the online questionnaire 'pages'.

The final version of the questionnaire (Figure 49) was built using Google Forms. The questions were grouped in categories ‘Colour preferences’, ‘Colour meaning’ or ‘Your bedroom’ to simplify the completing process. Each category was displayed on one page. Once all the questions in one category were answered the ‘Continue’ button (Figure 50) could be clicked – this took the participant to the next page. The questionnaire finished with a ‘Submit’ button (Figure 50) that sent the data into the Google Form responses file (Figure 51). Teenagers answered by giving limited answers (for example only one name of their preferred colours or a code from a given colour palette) or by giving open answers such as descriptions of their bedrooms.

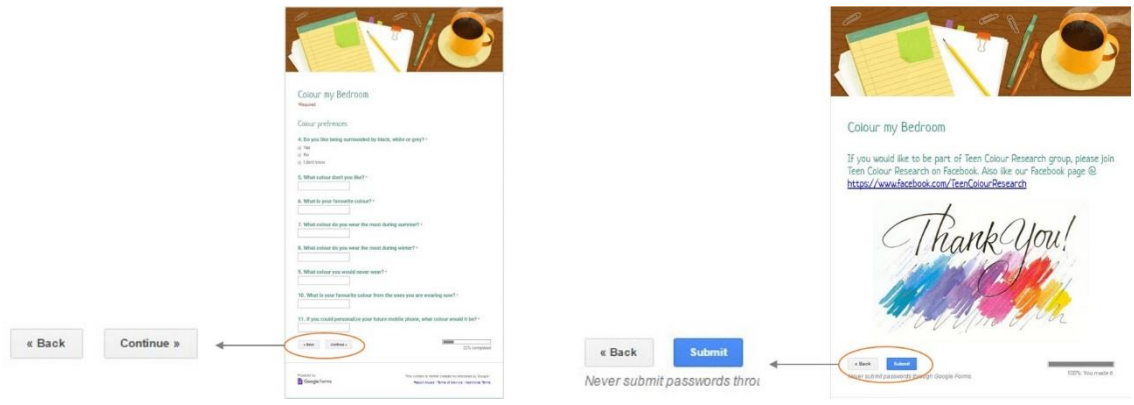


Figure 50. 'Continue' and 'Submit' buttons.

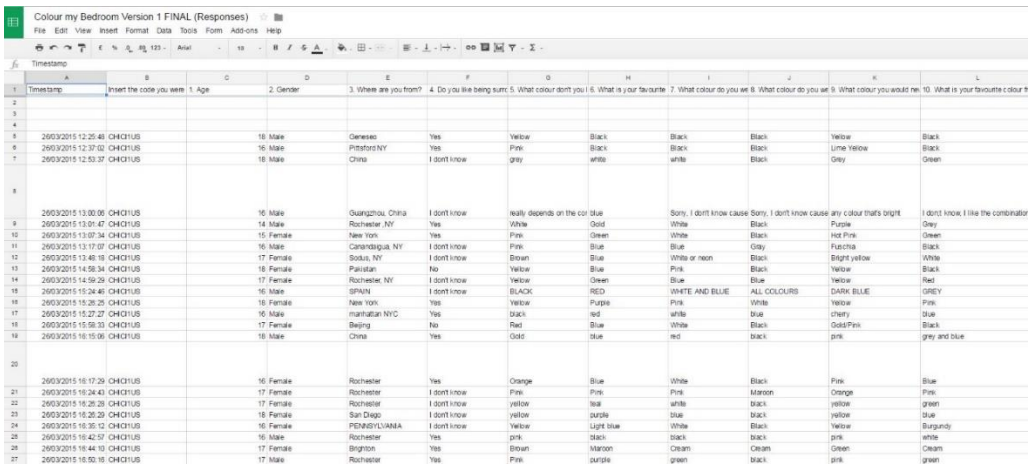


Figure 51. Screen-shot of Google Form responses file where the online questionnaire responses would automatically be sent after clicking the 'Submit' button.

Figure 52. Screen-shot from the online questionnaire

A teacher from a high-school in New York, was recruited to advertise the questionnaire to her pupils. She distributed the URL of the questionnaire to the teenage participants who then completed the survey from the school computers. The completion time was around 20 minutes.

Analysis

Analysis was based on exploring the research questions and thus focussed on the questions about favourite colours, associations between colours and moods, and bedroom design choices.

The questions considered are briefly described here:

Question 1 – Favourite Colours

"What is your favourite colour?"

This question can be seen in Figure 53 below. The expectation was that a single 'name' of a colour would be given. For analysis, if more colour names were given, only the first answer would be taken in consideration. This was a free form answer, the colours were not expected to be chosen from the colour palette included in the online questionnaire.

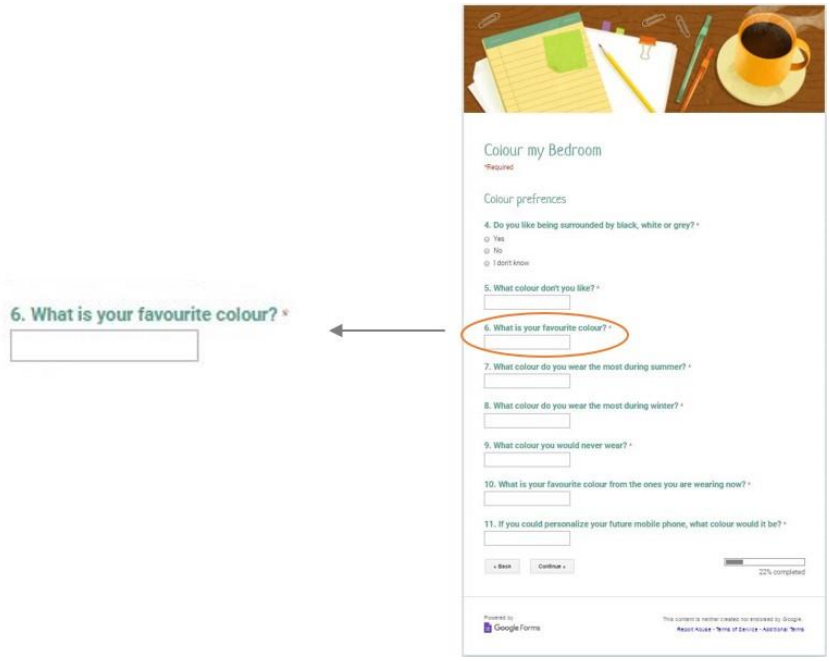


Figure 53. Favourite colours question.

Question 2 – Associations between Colour and Mood

"What colours from the image below you would like to use for the following 10 moods?"

Teenagers were asked to associate a colour from the final colour palette (Figure 52) with ten different moods: five positive (inspired, attentive, excited, determined, enthusiastic), and five negative (nervous, afraid, jittery, scared, irritable), taken from the PANAS questionnaire (Chapter 5) (Watson, Clark L. & Tellegan 1988). The PANAS scale was used because it measures state emotions (changeable aspects of emotions) and does so in terms of both positive and negative affect at the same time. Research shows that people can feel both positive and negative emotions simultaneously ((Diener, Emmons 1984); (Emmons, Diener 1985)) and the pilot study in Chapter 5 showed that teenagers could use the scale. The original PANAS questionnaire has 20 moods, but for the questionnaire only 10 were selected in order to reduce boredom and to focus on emotions teenagers might relate to.

In the survey, underneath each mood, there was a foot-note that said "Write down the colour-code (from image above) you associate with this mood". Figure 54 shows a zoomed-in caption of that, as well as the steps taken to answer. For example, in order to associate a colour to a mood (such as 'excited' in Figure 54), one had to write a code from the colour palette into the answer box. If the answer inputted was not a code from those given in the colour palette such as 1A, 7B, 12C, then a message would appear that would ask for a valid code. Participants could write only one colour code from the colour pallet into each moods' answer box (Figure 52, Figure 54). After

the last insertion on this page, they would click 'Continue' and be taken to the next group of questions.

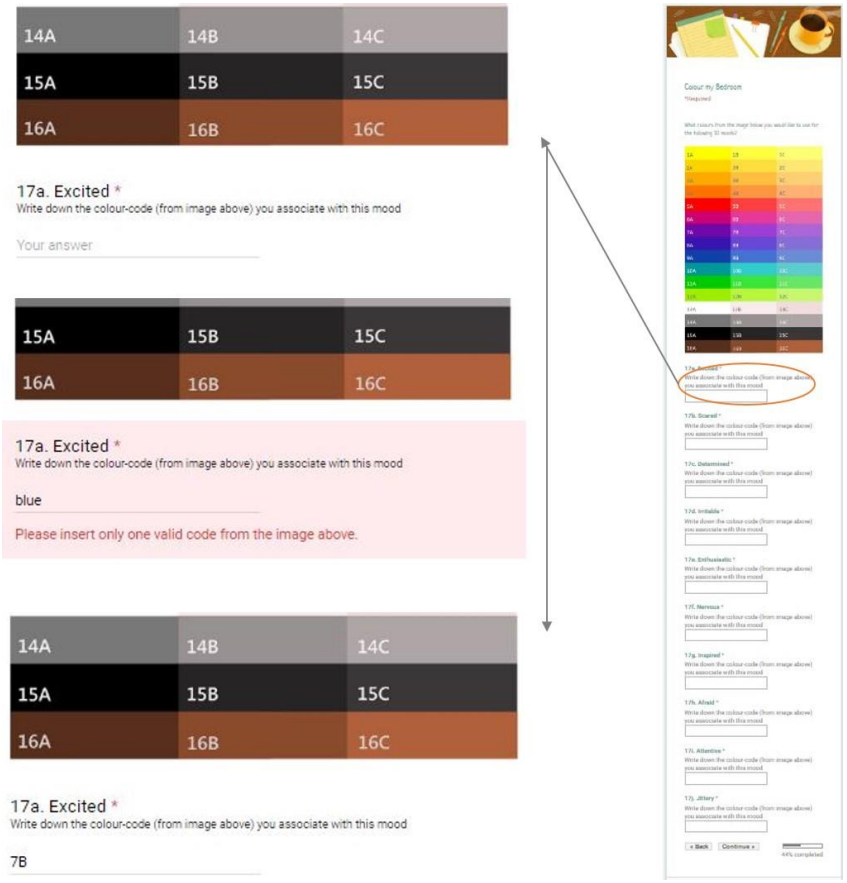


Figure 54. Caption example of the question analysed in CMV1. Right side: the online form of the question. Left side (top to bottom): the steps taken to answer the question and the message that appears if another answer than the requested one is given.

Question 3 – Bedroom coloured lighting

"What colour light would you like in your bedroom?"

As it can be seen in Figure 55, participants had to choose a single colour from the colour palette and write its code into the answering box. Instructions were given beneath the question.

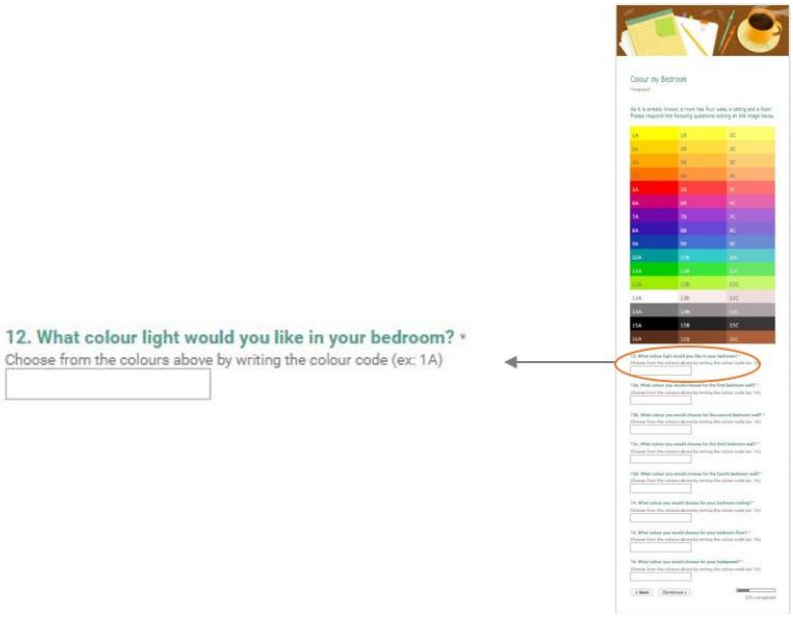


Figure 55. The third question analysed from CMV1 survey.

Question 4 – Bedroom surfaces colour

"What colours would you choose for the large areas of your bedroom?"

This question was presented as six different sub-questions (Figure 56):

1. What colour you would choose for the first bedroom wall?
2. What colour you would choose for the second bedroom wall?
3. What colour you would choose for the third bedroom wall?
4. What colour you would choose for the fourth bedroom wall?
5. What colour you would choose for your bedroom ceiling?
6. What colour you would choose for your bedroom floor?

Participants were asked to associate a colour from the colour palette with six bedroom large surfaces such as walls, ceiling, and floor. They had to write the colour code into the answering box for each question.

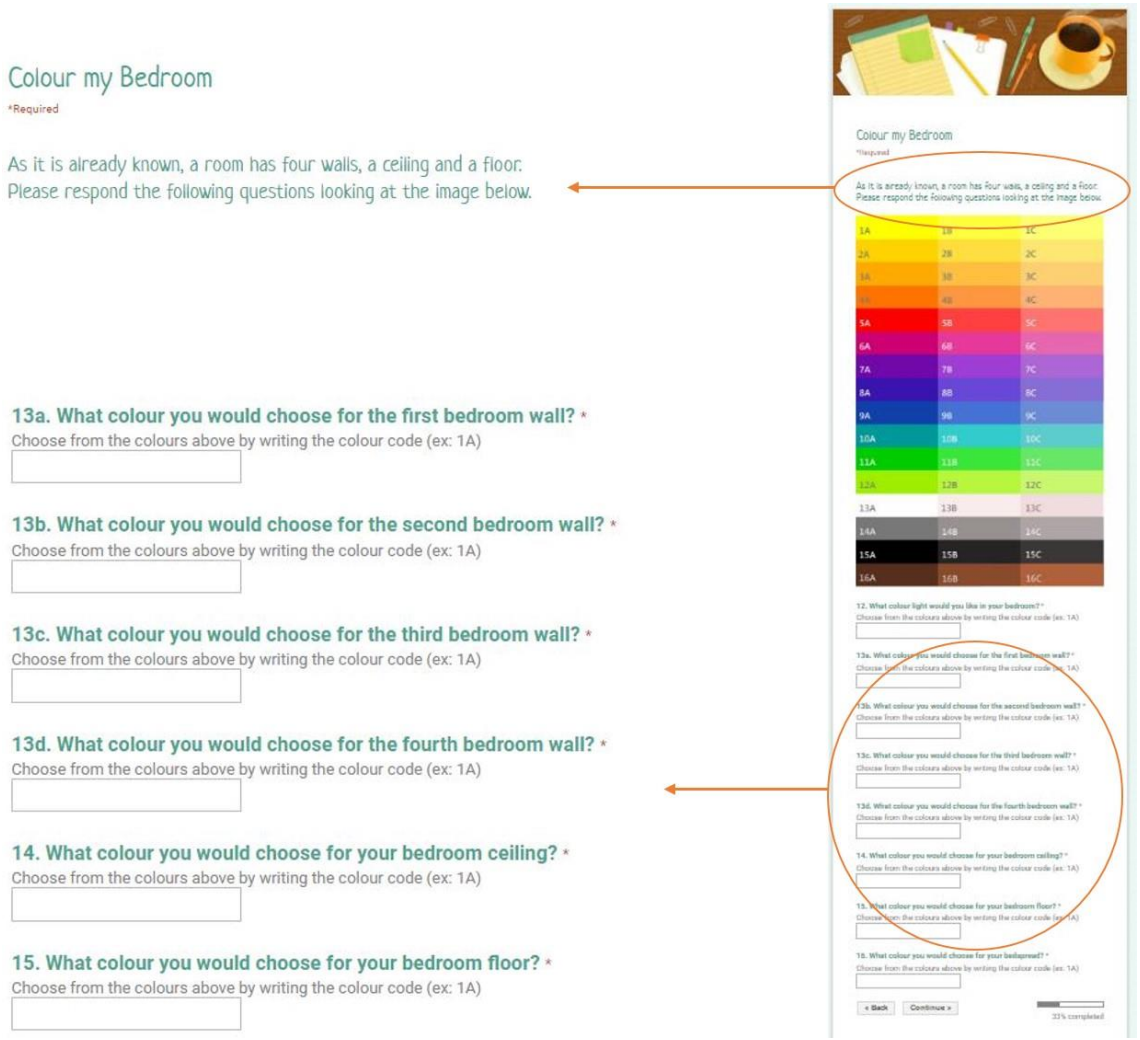


Figure 56. The six questions about bedroom colour later analysed as one.

Participants

One hundred twenty-three teenagers from a New York State high school initially participated in the Colour me Mood version 1 (CMV1) study. They were aged 14 to 19 years old, 68 were female and 55 were male. The method of recruitment was direct recruitment by an enrichment specialist who offered to help with participants after the researcher's paper presentation during a conference, where part of the concept was presented. After considerable thought about the American colour culture (which might not be much different from the UK one (Aslam 2005)) it was decided to run the study with participants from the school in New York, US.

Age	No. of females	No. of males
14	7	5
15	15	14
16	16	14
17	20	14
18	10	8
19	0	1

Table 12. Details of how many females and males of 14 to 19 years old participated in CMV1 study.

Not all of the participants were of American origin. Ninety-four participants were from US, 17 from China, and the others from Europe (three from England, one from Czech Republic, one from France, one from Spain, and one from Serbia). Another five were each from Ecuador, Africa, Pakistan, and Korea. One participant failed to properly answer this question, writing "my home". With regard to participants' ability to answer the questions, the cultural background might have been an important factor, influencing participants' answers maybe because of the different colour meaning across countries and continents. As most of the US was settled by Europeans, the colour cultural differences between the two continents was assumed to not be too problematic. Thinking back to participants' abilities to answer the online questionnaire questions, all the questions were designed to be easy to understand and simple to answer. As high-school subjects, it was assumed that they have the capacity to understand and process questions related to colour preferences.

In the analysis that follows, there are variations in the number of students' responses that are considered. This was a result of incomplete or poorly completed submissions. Table 13 summarises how many participants were in each analysis and the reasons for which any were included or excluded.

Question	**No. participants**	**Why**
Q1	113	They were expected to give one-word answer, not a number of words that would represent different colours. Eleven responses were excluded.
Q2 – Analysis 1	121	1 inappropriate answer and 2 repetitive answers
Q2 – Analysis 2	123	1 inappropriate answer
Q3	122	1 inappropriate answers and one repetitive answers
Q4	120	2 inappropriate answers and 2 repetitive answers

Table 13. A summary of how many participants were in each analysis and the reasons for which three of them were wither included or excluded.

Results

Question 1 – Favourite Colours

The answers to this question are listed in the Appendices (Figure 174). In the analysis that follows, 113 answers were analysed (60 females, 53 males).

The table below (Table 14) shows teens' preferences for twelve hues which were picked by them by free choice. It can be seen that blue was by far the most chosen colour by both genders (35%), where females (38%) slightly preferred blue more than males did (32%). Green (13%), purple (12%), and black (12%) were the next three choices for both genders.

	Yellow	Orange	Red	Pink	Purple	Blue	Green	Gold	Brown	White	Grey	Black
F%	2%	2%	7%	5%	12%	38%	13%	2%	2%	7%	2%	10%
M%	4%	9%	4%	0%	11%	32%	13%	2%	2%	4%	4%	15%
F+M%	3%	5%	5%	3%	12%	35%	13%	2%	2%	5%	3%	12%

Table 14. Teens' colour preference in percentages for each hue from teen females (F), males (M), and both genders altogether (F+M).

This question had a free form answer so teenagers did not have a colour palette to choose from as they did in the other three questions therefore, the colours were categorized in 12 hues, while only 10 hues were used for the other three questions' analyses. The lack of a colour palette was a limitation, because the colours were expressed in words and teenagers might have thought of shades rather than hues. For example, teens made 28 blue choices (13 by females, 15 by males), which differed in terms of shades, brightness, or saturation. Twelve teenagers (10 females and 2 males) specified what shade of blue they liked. The same happened with other colours such as green, red, or brown.

The answer to the research question is that colour preference can be sought but there is considerable variety. There did not, in this study, appear to be a gender difference. Blue was a top choice for both genders (38% females and 32% males), other colours were favoured too.

Question 2 – Associations between Colour and Mood

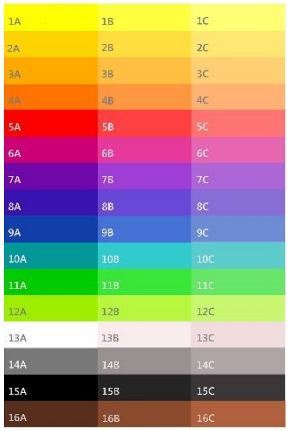


Figure 57. Final colour palette used in the online questionnaire.

This question explored teenagers' colour associations with different moods. They associated colours from a palette of 48 different colours (Figure 57), with ten moods: excited, determined, enthusiastic, inspired, attentive, scared, irritable, nervous, afraid, and jittery. These moods were chosen from the PANAS questionnaire mentioned in Chapter 5.

The teenagers' answers are listed in the Appendices (Figure 176, Figure 177, Figure 178, and Figure 179). As explained earlier, the answers of 121 teenagers are considered for Analysis 1 and Analysis 3, and the answers of 123 teenagers are considered for Analysis 2.

Analysis 1

This analysis focused on colour associations to moods and Table 15 and Table 16 show the number and percentage of each colour chosen for each mood. It can be seen that there was no clear colour match to mood but some favoured colours for each mood seemed to appear. The bold numbers in the table represent scores that are at least 25% more likely to have occurred than others along the horizontal or vertical axis and this appear to suggest some relationship. Thus: yellow ⇔ excited, red ⇔ irritable, scared ⇨ black, afraid ⇨ black, determined ⇨ blue, inspired ⇨ blue, and grey ⇨ nervous.

	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
excited	**37**	16	20	11	8	18	5	1	4	1
determined	5	9	13	12	**39**	10	9	6	15	3
enthusiastic	24	17	13	12	20	24	4	0	6	1
inspired	14	12	5	19	**32**	19	13	0	7	0
attentive	9	19	7	8	22	22	16	5	9	4
scared	3	9	14	8	15	3	7	9	**49**	4
irritable	5	22	**49**	7	4	3	4	5	14	8
nervous	7	19	6	13	23	11	16	**12**	7	7
afraid	1	9	25	14	10	4	7	7	**39**	5
jittery	19	15	9	16	14	22	8	3	8	7

Table 15. The number of each colour chosen for each mood.

	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
excited	31%	13%	17%	9%	7%	15%	4%	1%	3%	1%
determined	4%	7%	11%	10%	32%	8%	7%	5%	12%	2%
enthusiastic	20%	14%	11%	10%	17%	20%	3%	0%	5%	1%
inspired	12%	10%	4%	16%	26%	16%	11%	0%	6%	0%
attentive	7%	16%	6%	7%	18%	18%	13%	4%	7%	3%
scared	2%	7%	12%	7%	12%	2%	6%	7%	40%	3%
irritable	4%	18%	40%	6%	3%	2%	3%	4%	12%	7%
nervous	6%	16%	5%	11%	19%	9%	13%	10%	6%	6%
afraid	1%	7%	21%	12%	8%	3%	6%	6%	32%	4%
jittery	16%	12%	7%	13%	12%	18%	7%	2%	7%	6%

Table 16. The percentage for each colour chosen for each mood.

Where a colour appears to associate strongly with two moods it is worth noting that in most cases these moods are quite similar. Black was mapped to the negative moods of scared and afraid, red to negative moods of irritable and afraid, blue to the positive moods of determined and inspired, and yellow to the positive moods of excitement and enthusiasm.

The positive aspects of yellow are recorded in similar work by Wexner (1954) that showed that yellow was often associated with cheerful–jovial–joyful moods. The positive feelings around blue are also recorded in Wexner's (1954) results, who found an association between blue and secure–comfortable or tender–soothing moods. The negative connotations with black and red contradict Wexner's (1954) results, where black represented powerful–strong–masterful moods and where he found that red was more often associated with exciting–stimulating moods (Wexner 1954).

The differences between Wexner's (1954) results and those here might underline the changes of colour–mood association over the generations. It is not known if Wexner's (1954) participants were teenagers because the age was not mentioned. Therefore, it is only assumed that they might have been young adults.

Thinking of individual choices, two candidates (female and male) were randomly selected by using a random number generator (Number Generator). Figure 58 is an example of their colour choices for each of the ten moods used in Table 15 and Table 16. Both candidates associated blue with nervousness and orange with jitteriness while the other moods had different colour associations.

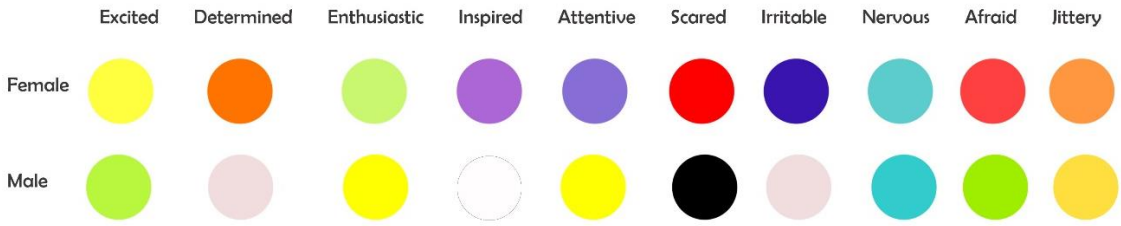


Figure 58. Example of female and male individual colour-mood associations.

Given the variability across the colours when associated to moods, one way to visualise the results was to arrange, for each mood, a list of the colours chosen and to consider those in terms of warm and cold colours. To do this there was a need to choose a way to arrange the colours so they could be looked at in this way. The results in Table 15 and Table 16 informed the creation of the ten mood-strips as seen in Figure 59. A mood strip represented the 121 colour associations, by the set of teens, to a single mood. Each mood-strip was numbered from 1 to 10 (Figure 59), such that the first five represented positive moods (excitement (1), determination (2), enthusiasm (3), inspiration (4), attentive (5)) and the second five represented negative moods (scared (6), irritation (7), nervousness (8), afraid (9), and jitteriness (10)). Every coloured circle represented a colour or a shade that was associated to the associated mood. The colour shades were aligned following the Colour Wheel system order: yellow, orange, red, violet, blue, green. Achromatic colours such as white, grey, and black were added, ending with the brown colour. In Figure 59 the last strip is a reference strip that shows how the colours would align if each were equally likely to be chosen for a single mood.

The last strip is a colour-strip used as a benchmark and it contains all 48 colours from the colour palette; each colour was chosen several times to add up to a total number of 123 choices. This benchmark will appear in figures where all ten mood-strips are presented. The reason to use mood strips was to have a visual representation of the (results) colours associated to each mood to further use them as part of the analysis.

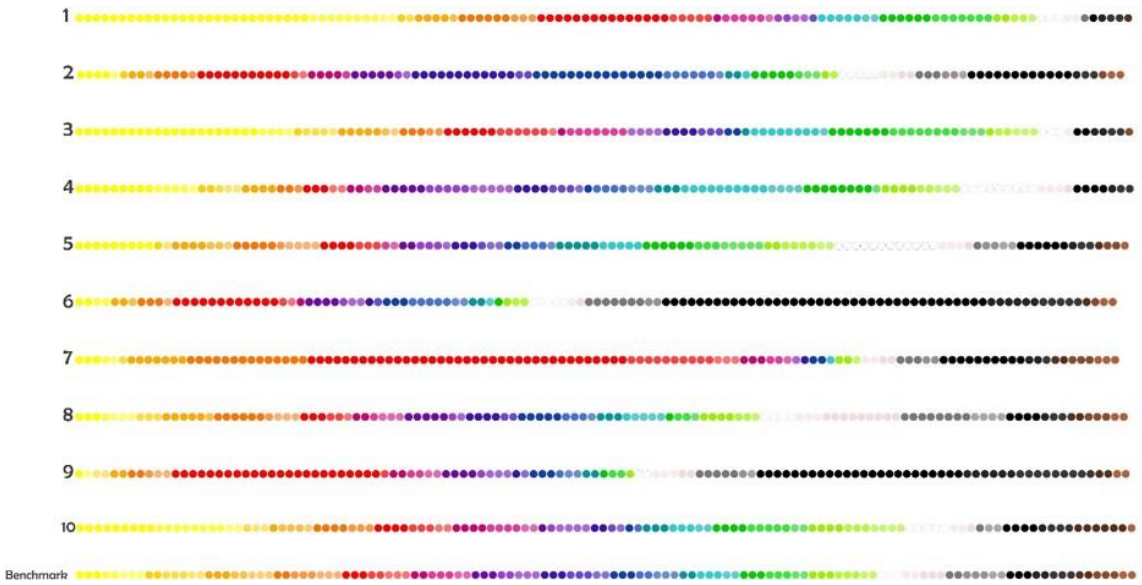


Figure 59. The ten strips that represent colour associations of 121 teenagers for each mood: excitement (1), determination (2), enthusiasm (3), inspiration (4), attentive (5), scared (6), irritation (7), nervousness (8), afraid (9), and jitteriness (10).

Visual inspection of these strips suggested similarities and differences could be interesting to consider. These similarities and differences are discussed in the following sections. An additional judge was used for validation as subjective interpretation of the results by the individual researcher could have been a limitation.

Similar sets

As it can be seen in Figure 60, strip 1 seemed quite similar with strip 3 because of the amount of yellow and warm colours (yellow, orange, and red) present in both strips. In these two strips the length of colours is longer than the one of non-colours (white, grey, and black are considered non-colours). It turns out that these strips represent excited (strip 1) and enthusiastic (strip 3) and these are similar in meaning and are positive moods.

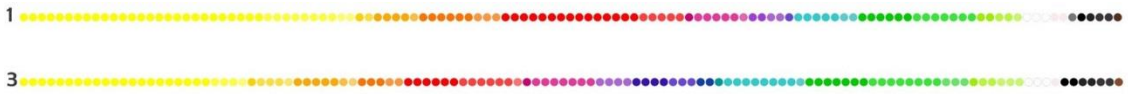


Figure 60. Strip 1 and strip 3 or 1-3 similar set (excited - enthusiastic).

Figure 61 shows 6-9 set that also appear quite similar due to their lengthy 'non-colour' parts. These strips represent scared and afraid and so again, the similarities are unsurprising. Fear, as a primal emotion (Davidson et al. 2003), is common for both moods, and might be represented by the black non-colour, which dominates each strip.

Figure 61. Strip 6 and strip 9 or 6-9 similar set (scared - afraid).

Strip 1 and strip 7 in Figure 62 can seem similar if thinking of the amount of warm colours that dominate each strip: yellow, orange, and red. An explanation of the visual similarity between strip 1 (excited) and strip 7 (irritable) might be that in some circumstances a negative mood could be associated with a positive one (Watson, Clark L. & Tellegan 1988). It could be that two moods which usually show different affects could be similar in terms of colour warmness.

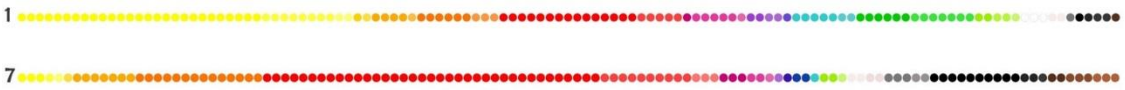


Figure 62. Strip 1 and strip 7 or 1-7 similar set (excited - irritable).

In a similar way, strips 2-4 seem similar when considering the amount of cold colours that define them such as violet and blue (Figure 63). Determination (strip 2) is making firm decisions and not changing them while inspiration (strip 4) is defined as displaying a creative impulse (Oxford Dictionaires 2016). Determined and inspired are both active moods.

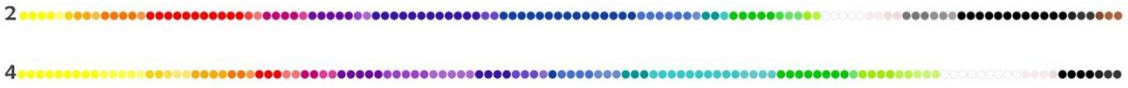


Figure 63. Strip 2 and strip 4 or 2-4 similar set (determined - inspired).

Opposite sets

6-7 set in Figure 64 could be considered an opposite set as can the 1-6 set (Figure 65) because of the strong colour contrast between them: black-red and black-yellow. The meanings of each strip in these two sets are opposite too: scared – irritated and scared – excited.

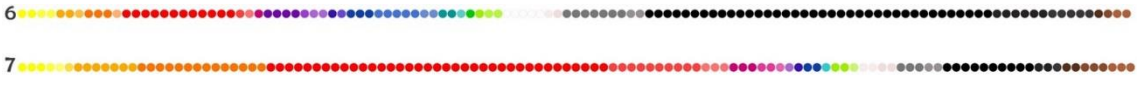


Figure 64. Strip 6 and strip 7 or 6-7 opposite set (scared - irritable).

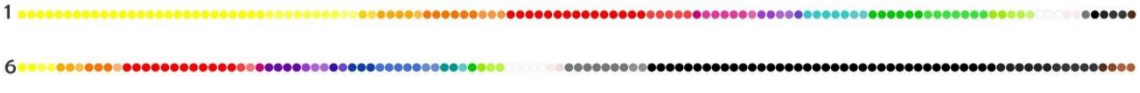


Figure 65. Strip 1 and strip 6 or 1-6 opposite set (excited - scared).

Aligning strips in this way suggests that there is a consistency across individual teens completing the survey. It is arguable that the aligned yellow dots in these strips may be from opposite teenagers. To check this, a sanity check on the similar sets was added (Figure 66) by randomly selecting twelve candidate strips using a random number generator and then aligning these in

teenager fixed strips. The chosen numbers were (7, 16, 24, 33, 52, 62, 76, 84, 92, 96, 99, 133). In terms of consistency, it can be seen that between 30% and 40% of the teenagers mapped a 'same' colour to all but three of the moods (44% yellow for excited, 44% blue for determined, 55% green to enthusiastic, 60% blue/purple to inspired, 55% black to scared, 50% red/pink for irritable, 40% yellow to jittery) to the same colour. Despite the individual colour differences, when the 12 candidate strips were categorized by 10 moods, few colours seemed to stand out for certain moods: yellow for excited, green for enthusiastic, blue for determination, black for scared.

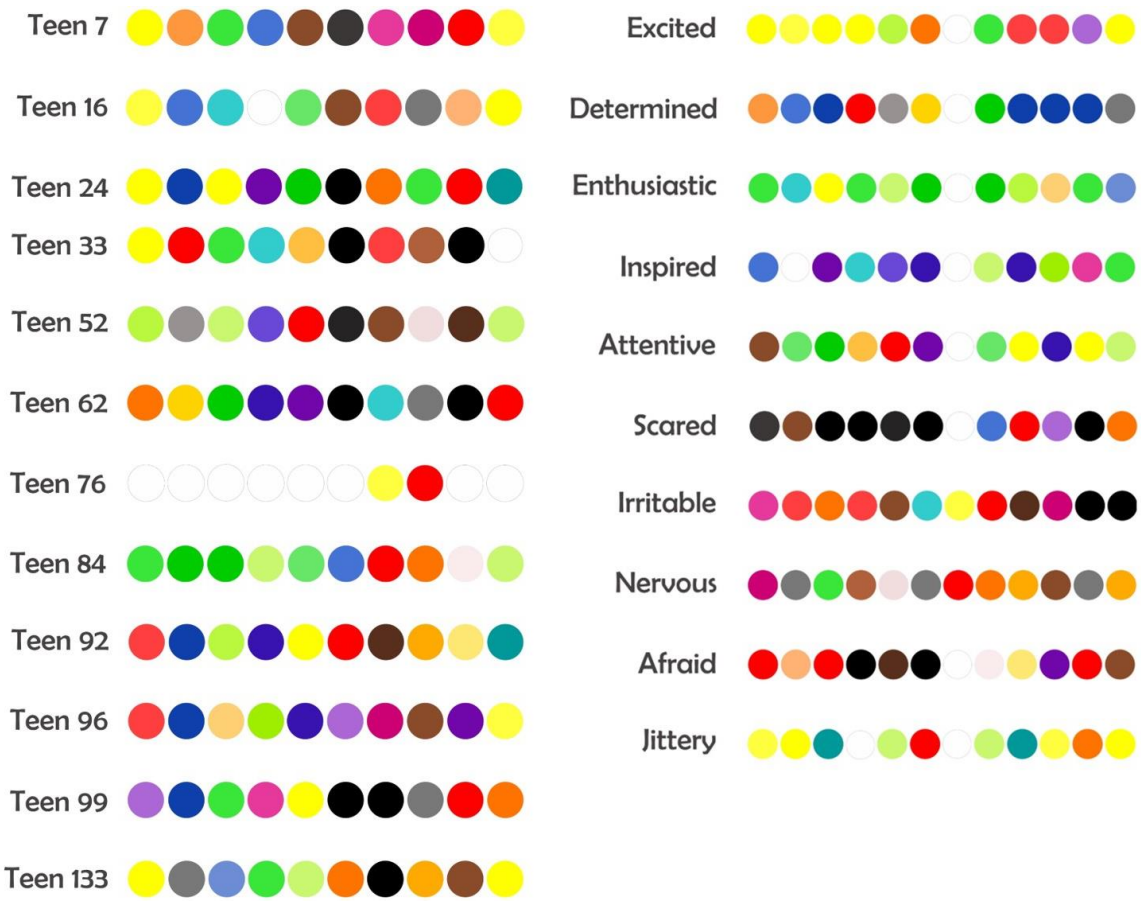


Figure 66. Twelve individual strips later categorized in ten mood strips.

Summary

This analysis showed there is no clear colour match to mood but that some moods may indicate some colours and some colours may indicate some moods. The strongest associations are between yellow and excited and red and irritable. Yellow was mainly related to happy moods such as excited and enthusiastic; black was mainly associated with fear (scared and afraid); red colour was strongly associated with irritation, while blue colour with determination and inspiration. In analysing the colour strips it could be seen that grouping the strips based on colour similarities or differences seemed to correlate with the similarity or difference of the associated moods (Table 17).

Strip number	Strip meaning	Dominant colours	Types of sets
1-3	Excited-enthusiastic	Yellow-yellow	Similar
6-9	Scared-afraid	Black-black	
1-7	Excited-irritable	Yellow-red	
2-4	Determination-inspiration	Blue-blue	
6-7	Scared-irritable	Black-red	Opposite
1-6	Excited-scared	Yellow-black	

Table 17. Similar and opposite sets.

Analysis 2

The same ten strips were analysed again but this time taking account of gender, answering the research question: "Does gender matter when thinking of colour-mood associations?" Each strip was redesigned as, for example, female - [Excited (F)] and male - [Excited (M)] choices (Figure 67, Figure 68).

Figure 67. An example of dividing strip 1 in male and female genders (excited).

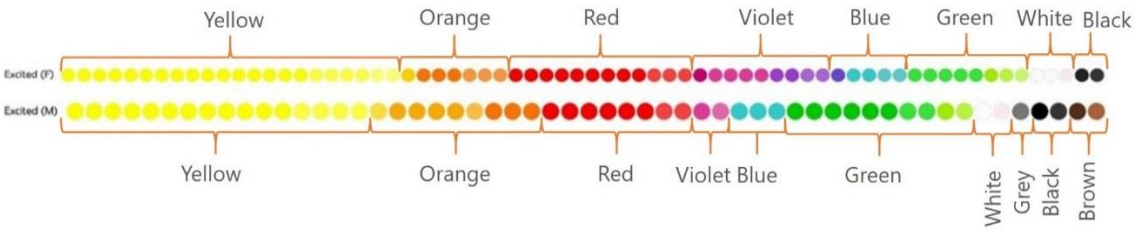


Figure 68. Example of grouping colour shades in hues for excited gender-strip.

The colours grouped in hues were then arranged in tables that were displayed and analysed in the following subsections, where the gender comparison for all ten moods was discussed: Excited, Determined, Enthusiastic, Inspired, Attentive, Scared, Irritable, Nervous, Afraid, and Jittery.

Excited

Both females and males primarily associated excitement with yellow (Table 18, Figure 69). The most popular second colour choice was red for females and green for males. Warm colours were chosen by 60% females and 60% males, while cool colours were chosen by 32% females and 27% males. Achromatic colours (white, grey, and black) were chosen by 7% females and 9% males, while brown colour was chosen twice only by 4% males. Warm colours were preferred by both genders.

Excited	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	32%	10%	18%	13%	7%	12%	4%	0%	3%	0%
Male	29%	16%	15%	4%	5%	18%	4%	2%	4%	4%

Table 18. Raw data of gender colour associations for excited mood.

Figure 69. Colour choices by gender for excited mood.

These results confirmed other findings where yellow and orange were associated with excitement and stimulation ((Schaie 1961);(Wexner 1954)). Maybe teens associated yellow with excitement because they unconsciously related happiness with sunny summer days. This suggestion could be backed up by the finding that showed "people like colours strongly associated with objects they like (e.g., blues with clear skies and clean water) and dislike colours strongly associated with objects they dislike (e.g., browns with faeces and rotten food)" (Palmer, Schloss 2010).

Determined

The determined mood was strongly associated with blue by both genders, with a higher number of choices from females (37%) than males (25%) (Table 19, Figure 70). Teen females (56%) seemed to associate cool colours (blue, violet, and green) with determination. Both female and male teens associated determination with a similar (low) amount of warm colours (females 19%, males 25%), and achromatic colours (females 22%, males 29%). Teen females tended to choose from the blue-violet-red spectrum while teen males chose from blue-red spectrum.

Determined	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	4%	4%	10%	12%	37%	7%	6%	4%	12%	3%
Male	4%	11%	11%	7%	25%	9%	9%	7%	13%	4%

Table 19. Raw data of gender colour associations for determined mood.

Figure 70. Colour choices by gender for determined mood.

Enthusiastic

The first three colours females associated with enthusiasm were green (24%), yellow (21%), and blue (16%). The first three colours associated by males with enthusiasm were yellow (20%), orange (18%), and blue (16%) (Table 20, Figure 71). Warm colours were chosen by 44% females and 45% males; cool colours were chosen by 49% females and 42% males.

Enthusiastic	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	21%	10%	13%	9%	16%	24%	1%	0%	4%	1%
Male	20%	18%	7%	11%	16%	15%	5%	0%	5%	2%

Table 20. Raw data of gender colour associations for enthusiastic mood.

Figure 71. Colour choices by gender for enthusiastic mood.

Teen females' choices of green as a first choice contradicts Schaie's (1961) findings about green having no strong association with any mood. Females might have had a slight preference for cold colours males for warm ones. Assuming that enthusiasm is a high-arousal mood, teen females' preference for cold colours contradicts the widespread views of the relationship between high-arousal moods and warm colours (Walters, 1982); on the contrary, teen males' preference for warm colours seemed to confirm same colour-arousal view.

Inspired

Females seemed to choose blue (31%) and violet (21%) while males chose blue (22%) and green (18%) (Table 21, Figure 72). The association of blue with inspiration contradicts other studies where blue was associated with moods such as secure, comfortable, tender, soothing, and calm ((Schaie 1961); (Wright, Rainwater 1962)). It can be suggested that female teens preferred to associate this mood with cooler colours than male teens did.

Inspired	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	7%	9%	4%	21%	31%	13%	10%	0%	4%	0%
Male	16%	11%	4%	9%	22%	18%	11%	0%	7%	2%

Table 21. Raw data of gender colour associations for inspired mood.

Figure 72. Colour choices by gender for inspired mood.

Attentive

Similar to the previous mood, it can be seen teen females preferred to associate attentiveness with blue (24%), while teen males chose green (22%) (Table 22 and Figure 73). This could suggest that teens associate different colours for the same mood based on their gender. The number of achromatic colour choices (white, grey, and black) was quite high for this mood: 21% females and 27% males.

Attentive	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	7%	15%	6%	6%	24%	16%	16%	3%	3%	4%
Male	7%	16%	5%	7%	11%	22%	9%	5%	13%	4%

Table 22. Raw data of gender colour associations for attentive mood.

Figure 73. Colour choices by gender for attentive mood.

These findings about teen females associating blue to attentiveness and teen males associating green to it, contradict other findings where blue was chosen for moods like secure, comfortable, tender, soothing, and calm ((Schaie 1961); (Wright, Rainwater 1962)) and green had no stronger association with any mood (Schaie 1961).

Scared

The black colour dominance is visible in both female (41%) and male (38%) choices (Table 23, Figure 74). Teen females preferred to associate fear with black and grey colours more than teen males did. The idea of teen females being scared by black more than teen males would, might be imposed by the society's unwritten norms: dark places suggest more danger for females than they do for males. Therefore, teen females might respond to black more emotionally than males would because of negative emotional context associated with darkness (Cohen et al. 2016).

Scared	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	3%	9%	10%	7%	12%	1%	3%	10%	41%	3%
Male	2%	5%	13%	5%	13%	5%	9%	4%	38%	5%

Table 23. Raw data of gender colour associations for scared mood.

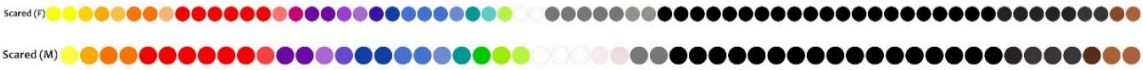


Figure 74. Colour choices by gender for scared mood.

Irritable

For the irritable mood colours such as red and orange dominate, as it can be seen in Figure 75 and Table 24. Teen females had slightly more red (43%) and orange (22%) choices than teen males (38% and 13% respectively). The association of red with irritation contradicts studies where red was found arousing ((Gerard 1957); (Gerard 1958)), or where it was associated with excitement and stimulation (Wexner 1954). The amount of achromatic colours is quite similar in both gender choices: 16% females and 22% males.

Irritable	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	3%	22%	43%	3%	4%	1%	0%	4%	12%	7%
Male	5%	13%	38%	9%	2%	4%	7%	4%	11%	7%

Table 24. Raw data of gender colour associations for irritable mood.

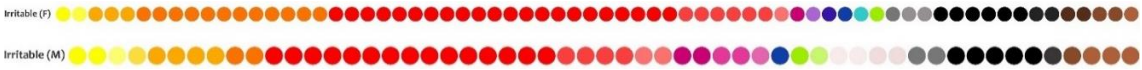


Figure 75. Colour choices by gender for irritable mood.

Nervous

Blue (22%) played an important role in teen females' colour-mood association as they chose it to express different feelings such as determined, inspired, attentive, and nervous. Contrary to teen females, teen males preferred to associate violet (18%) and white (18%) with the same mood. The colour contrast might show how subjective colour mood association is among the same gender. (Table 25, Figure 76). Teens previously chose orange as a colour association to irritation, and choosing same colour to associate it with nervousness might show a relation between the two moods. Irritated and nervous moods might be both linked to a high level of negative sensitiveness such as when one could slightly be annoyed (Oxford Dictionaires 2016).

Nervous	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	7%	16%	7%	4%	22%	12%	9%	16%	3%	3%
Male	4%	16%	2%	18%	15%	5%	18%	2%	9%	11%

Table 25. Raw data of gender colour associations for nervous mood.

Figure 76. Colour choices by gender for inspired mood.

Afraid

Teen females mainly associated this mood with red (25%) and black (26%), while teen males with black (38%) (Figure 77, Table 26). The author considers the afraid mood as being a more complex mood than scared because it involves anxiety (Oxford Dictionaires 2016). As it was seen above, teen females associated red with irritation and black with fear and nervousness. Therefore, when analysing teen females' colour choices for afraid mood, it could be suggested that they expressed a more complex feeling that involves fear, irritation, and nervousness. The author believes this is an interesting analysis of red and black responses for afraid. It could be assumed this complex feeling could be anxiety associated with a similar amount of red and black colour choices. On the contrary, teen males might seem to feel a more basic kind of fear, as it is mostly black colour choices.

Afraid	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	1%	9%	25%	10%	7%	1%	3%	9%	26%	7%
Male	2%	5%	15%	13%	9%	5%	9%	2%	38%	2%

Table 26.Raw data of gender colour associations for afraid mood.

Figure 77. Colour choices by gender for afraid mood.

Jittery

Green was females' (26%) first choice for jitteriness, while males (18%) chose yellow, which was selected by both genders (15% females, 18% males) (Table 27, Figure 78). The choice of such a bright light colour showed that teens allocated to this mood positive affect rather than negative as expected. In other studies, yellow was found to be associated with excitement (Schaie 1961) and stimulation (Wexner 1954). This colour-mood association might suggest that teens thought of jitteriness as a positive feeling.

Jittery	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	15%	9%	9%	10%	10%	26%	4%	4%	7%	4%
Male	18%	16%	5%	16%	13%	7%	9%	0%	5%	9%

Table 27. Raw data of gender colour associations for jittery mood.

Figure 78. Colour choices by gender for jittery mood.

Summary

The top three colour choices for all ten moods are listed in Table 28. Both genders made similar colour-mood associations (Table 28) for irritable and afraid and similar colour-mood associations were given for excited, determined, inspired, and scared when thinking of genders' first colour choices. All gender alike answers are highlighted in blue (Table 28). This finding could show a possible colour-mood association for excited-yellow, determined-blue, inspired-blue, scared-black. A fairly strong colour-mood association was evident for irritable-red-orange-black and afraid-black-red-violet.

Mood	Females			Males		
	1st	2nd	3rd	1st	2nd	3rd
Excited	yellow	red	violet	yellow	green	orange
Determined	Blue	Violet/black	red	Blue	Black	Orange/red
Enthusiastic	Green	Yellow	Blue	Yellow	Orange	Blue
Inspired	Blue	Violet	Green	Blue	Green	yellow
Attentive	Blue	Green/white	Orange	Green	Orange	Black
Scared	Black	Blue	Red	Black	Red/blue	White
Irritable	Red	Orange	Black	Red	Orange	Black
Nervous	Blue	Orange/grey	Green	Violet/white	Orange	Blue
Afraid	Black	Red	Violet	Black	Red	Violet
Jittery	Green	Yellow	Blue/violet	Yellow	Orange/violet	Blue

Table 28. Key findings of Analysis 2.

Table 29 represents a total of each colour choices made by each gender. Females chose opposite colours to associate their mood with such as blue (17%) and red (15%). Males chose blue (13%) too but mostly warm colours like orange (13%), green (11%), reds (11%), yellow (11%).

	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Total Female	10%	11%	15%	10%	17%	11%	6%	5%	12%	3%
Total Male	11%	13%	11%	10%	13%	11%	9%	3%	14%	5%
Both genders	10%	12%	13%	10%	15%	11%	7%	4%	13%	4%

Table 29. Total of each colour chosen by each gender.

Analysis 3

The purpose of this analysis is to examine how, and if at all, different levels of brightness predict positive or negative moods. This section focuses on 121 teenage choices of three levels of colour brightness: vivid, mid-bright, and pale. These were the levels teenagers had to choose from when completing the online questionnaire. All three levels of brightness can be seen in Figure 79: vivid colours are the ones in the left column, mid-bright colours are the ones in the mid column, and pale colours are in the right column. The order of colours in Figure 79, as any other possible colour combinations, might affect teenagers' colour choices. Table 30 below shows teens' colour brightness choices for positive emotions, while Table 31 represents teens colour brightness choices for negative emotions.

Figure 79. The online colour palette with three levels of colour brightness: vivid (left column), mid-bright (middle column), pale (right column).

Positive moods

When analysing both genders together, vivid colours were the most associated with each positive emotion. For example, inspired mood had 60 choices for vivid colours, attentive mood had 62 choices, excited mood had 68 choices, determined mood had 87 choices, and enthusiastic mood had 56 choices. Mid-bright colours were in second place in terms of teens' positive affect regarding levels of colour brightness and pale colours were the least preferred (Table 30). This data could be seen in Table 30 below, where the first column on the left represents five positive emotions such as inspired, attentive, excited, determined, and enthusiastic. The 'Female' column represents the number of females' choices for vivid, mid-bright, and pale colours related to the total number of females as participants. For example, for inspired mood, 27 females out of 68 chose vivid colours, 25 females out of 68 chose mid-bright colours, and 16 females out of 68 chose pale colours. Similarly, if it is to move to males' choices for inspired mood then 33 males out of a total of 53 male participants chose vivid colours, 11 males out of 53 chose mid-bright colours, while 9 males out of 53 chose pale colours.

Based on the data in Table 30, the female group preferred vivid colours for all positive emotions except enthusiasm where they favoured mid-bright colours. Similarly, teenage males preferred vivid colours with a greater tendency to choose vivid colours than the girls thus demonstrating a stronger preference (Table 30). Pale colours were the least preferred by both genders.

Positive Emotion	Brightness	Females	Males	Both genders
Inspired	Vivid	27/68	33/53	60/121
	Mid-bright	25/68	11/53	36/121
	Pale	16/68	9/53	25/121
Attentive	Vivid	35/68	27/53	62/121
	Mid-bright	17/68	17/53	34/121
	Pale	16/68	9/53	25/121
Excited	Vivid	33/68	35/53	68/121
	Mid-bright	27/68	16/53	43/121
	Pale	8/68	2/53	10/121
Determined	Vivid	48/68	39/53	87/121
	Mid-bright	12/68	9/53	21/121
	Pale	8/68	5/53	13/121
Enthusiastic	Vivid	26/68	30/53	56/121
	Mid-bright	28/68	19/53	47/121
	Pale	14/68	4/53	18/121

Table 30. Girls' and boys' positive preferences for colour brightness.

Negative moods

The five negative moods from the study – nervous, afraid, jittery scared, and irritable were similarly analysed. In the same way as in Table 30, these five negative moods are shown in Table 31.

Considering both genders together, the preferences for vivid colours were ahead of mid-bright and pale. There were 60 vivid choices for nervous mood, 75 choices for afraid mood, jittery mood was chosen 53 times, scared mood was chosen 85 times, and irritable mood 84 times. In contrast with the choices for positive emotions, where pale colours were always chosen last, the choices for negative moods showed two cases of high pale colour associations with nervous and scared mood. When considered individually as males and females, the two groups mirrored the collective responses showing few differences.

Negative Emotion	Brightness	Females	Males	Both genders
Nervous	Vivid	38/68	22/53	60/121
	Mid-bright	12/68	14/53	26/121
	Pale	18/68	17/53	35/121
Afraid	Vivid	37/68	38/53	75/121
	Mid-bright	10/68	9/53	19/121
	Pale	21/68	6/53	27/121
Jittery	Vivid	30/68	23/53	53/121

Negative Emotion	Brightness	Females	Males	Both genders
	Mid-bright	20/68	19/53	39/121
	Pale	18/68	11/53	29/121
Scared	Vivid	46/68	39/53	85/121
	Mid-bright	14/68	7/53	21/121
	Pale	8/68	7/53	15/121
Irritable	Vivid	51/68	33/53	84/121
	Mid-bright	14/68	10/53	24/121
	Pale	3/68	10/53	13/121

Table 31. Girls' and boys' negative preferences for colour brightness.

Teenagers therefore seemed to prefer vivid colours for both positive and negative emotions. Female teens preferred vivid colours for all positive emotions except enthusiasm where there was a roughly equal split with mid-bright colours. When thinking of positive emotions, teenage males had a stronger preference for vivid colours than teenage females. In contrast with the positive emotions, there were some second choices for pale colours for the negative emotions of nervousness and fear.

When considered individually as males and females, the two groups mirrored the collective responses showing few differences. Across the two sets of results, it appears that the negative emotions are less gender influenced than positive emotions and it also suggests that girls might be more polarized in their colour choices in terms of them representing emotions.

To answer the research question for Analysis 3 ("Does brightness predict positive or negative moods?"), it could be concluded that:

- There seems to be an overall preference for vivid colours;
- Warm colours appear to be more positive than cold colours;
- The negative emotions are less gender influenced than positive emotions;
- Girls might be more polarized in their colour choices in terms of them representing emotions.

These findings contradict Hemphill's (1996) work on colour emotion association of undergraduate students where the results showed that bright colours were mainly associated with positive moods while dark colours were mainly associated with negative moods. The present findings of teenage males' stronger preference of vivid colour contradict Hemphill's (1996) results of women positively responding to bright colours more than man did.

Conclusion

The answer to the research question is that there are some associations between certain colours and certain moods (yellow – happiness, red – irritation, black – fear, and blue – determination), but a generalization cannot be made. As a small overall conclusion for Question 2 – Associations between Colour and Mood analysis, it should be remembered that Walters' et al. (1982) work showed that participants' colour preference might provide a form of mood indicator because it indicates arousal preference. Walters et al. (1982) suggest that a colour chosen at a given moment may represent a temporary state. Based on the literature about teens mood swings (Chapter 2), it could be assumed that teens' colour preferences change as often as their mood does. Clearly, colour-mood associations might be temporary but some did seem to stand up over time as in the Colour me Mood version 2 (CMV2) study, results showed that some of the participants' colour mood associations remained the same: yellow – happiness, red – irritation, black – fear, and blue – determination. Therefore, the author's findings partially challenge Walters' et al. (1982) results: as some colour-mood relationships remained stable over a long period (couple of months at least).

Similarly to Walters et al. (1982) teens chose high-arousal colours (yellow, orange and red) to indicate excitement, enthusiasm, jitteriness, irritation, and fear. Low-arousal colours (blue, violet) were chosen to express determination, inspiration, attentiveness, and nervousness.

Reversal theory suggests that there are two levels of preferred arousal toward opposite ends of the felt arousal dimension (Walters, Apter & Svebak 1982). Reversal theory is closely associated with telic-paratelic system which are two different states of mind that motivate the individual to either achieve a pursued goal (telic – goal minded) or orientate toward an ongoing activity (paratelic – ongoing activity minded). In terms of emotions and mood, telic state is associated with low-arousal while paratelic state is associated with high-arousal (Walters, Apter & Svebak 1982). As low-arousal is associated with cool colours, then cool colours could be associated with telic state. Similarly, warm colours could be associated with paratelic state. In Walters' et al. (1982) study, when high-arousal colours were preferred, participants tended to be in a playful, spontaneous, excited, or even bored state of mind (paratelic state – warm colours).

Based on this, the author developed the Colour-Arousal diagram (Figure 80): cool colours, associated with low-arousal, short wavelengths, and telic state of mind are on the left side of the diagram; warm colours associated with high-arousal, long wavelengths, and paratelic state of mind are on the right side of the diagram.

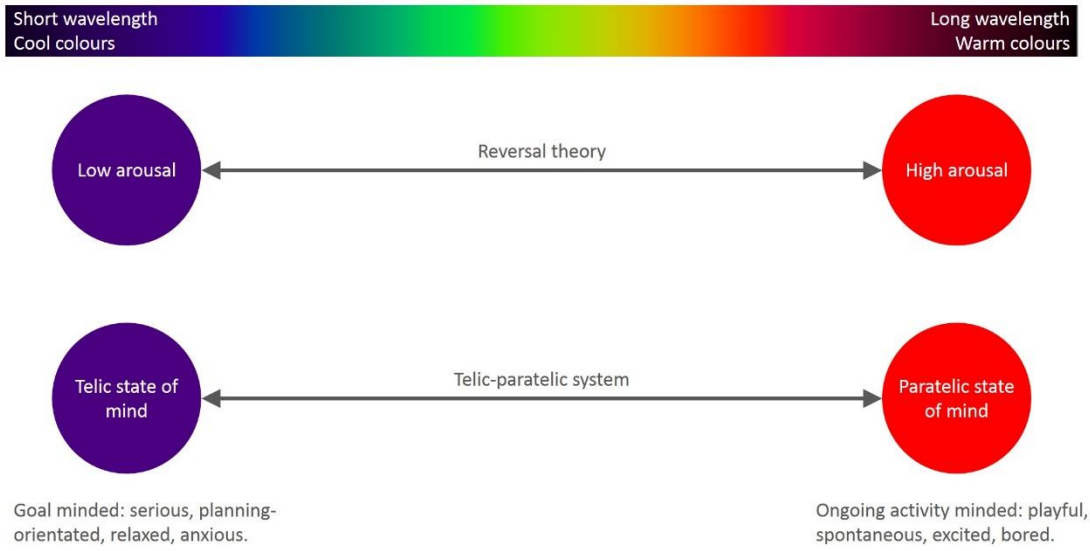


Figure 80. Colour-Arousal diagram.

The present analysis found colour-mood associations such as yellow – excitement/enthusiasm, red – irritation, black – fear, and blue- determination. If it is to discuss these results based on the Colour-Arousal diagram (Figure 80), then it could be said that:

- Yellow is a warm colour and it is positioned on the long wavelength spectrum side. The moods that yellow was associated with in the present study were excited and enthusiastic. Theory supports the author's findings, the association between a warm colour (yellow) and high-arousal (excited) being underlined;
- Red is a warm colour and it is positioned on the long wavelength spectrum side. The mood that red is associated with in the present study is irritated, which, according to the reversal theory, it is a high-arousal mood. Therefore, the author's findings are supported by the theory because red, as a warm colour, was found to be strongly associated with irritation, considered a high-arousal mood and a paratelic state of mind;
- Blue is a cool colour and it is situated on the short wavelength spectrum side. Blue was associated with determination, considered by the reversal theory and telic-paratelic system a low-arousal mood and a telic state of mind. The theory behind the association of blue with a goal minded state such as determination supports the author's findings;
- Black is not represented in the colour spectrum because it does not have a specific wavelength, as it is the absence of visible light. The author found an association between black and fear, but as black is not represented by a specific wavelength, the theory cannot support the author's finding. However, based on the telic-paratelic system, it can be said that fear is a high-arousal mood, triggering a paratelic state of mind. This might suggest that black, even if it is not a warm colour, has an association with a high-arousal mood.

Question 3 – Bedroom coloured lighting

This section considers the research question: "What colour light would teenagers like in their bedroom?" Out of 123 participants, 122 (68 females and 54 males) answers are analysed (see the Appendices (Figure 175)). One answer was removed from the analysis as previously stated. Teenagers had to choose only one colour from the colour palette (Figure 81) and insert the code that represented the colour into the answer box.

Figure 81. The colour palette used for the online questionnaire.

The results can be seen in Table 32 where teens used the colours from the colour palette (Figure 81) and different shades of colours were grouped in ten hues. White light seemed to be preferred by both female and male teens. Yellow, orange, violet, and blue were all favoured by a reasonable proportion of the girls and similar proportions of males chose blue, orange, and yellow. Teens' choice of white (36%), blue (16%), and orange (14%) as coloured lights might have been a consequence of these colours available. It is unlikely that they would have had a similar experience to participants in Pilot Study C (Chapter 5), where after immersing themselves in a colourful room, results showed a positive affect under red, green, blue, pink, yellow, and white. Violet light seemed to be the only 'gendered' colour choice with all other colours being similarly chosen or being chosen by too few teenagers to make any comparison.

	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
F%	13%	13%	3%	13%	10%	3%	41%	1%	0%	1%
M%	13%	15%	6%	2%	22%	6%	30%	2%	6%	0%
F+M%	13%	14%	4%	8%	16%	4%	36%	2%	2%	1%

Table 32. Gender colour preference.

Table 33 showed females and males' preferences for the three levels of brightness; vivid, mid-bright, and pale. It can be seen that both genders preferred vivid colours, while females had a slight preference towards paler rather than mid-bright colours.

	Vivid	Mid-bright	Pale
F%	40%	25%	35%
M%	50%	28%	22%
F+M%	44%	26%	30%

Table 33. Genders' preferences for levels of brightness.

The answer to this research question is that teens chose white (36%), blue (16%), and orange (14%) as bedroom coloured lights and they preferred vivid colours.

Question 4 – Bedroom surfaces colour

The question for this analysis was "What colours would you choose for the large areas of your bedroom?" One hundred twenty-three teenagers answered the following questions using the colour palette as shown in Figure 81.

- What colour you would choose for the first bedroom wall?
- What colour you would choose for the second bedroom wall?
- What colour you would choose for the third bedroom wall?
- What colour you would choose for the fourth bedroom wall?
- What colour you would choose for your bedroom ceiling?
- What colour you would choose for your bedroom floor?

Their answers are listed in the Appendices (Figure 180). Out of 123 participants, 120 answers (68 females and 52 males) were analysed. Three answers were removed from the analysis as previously mentioned.

Analysis 1

The results in Table 34 were analysed as they were in Study D (Chapter 5) using the room scheme with the five choices of traditional, modern, futuristic, surreal, and other. The descriptions of this scheme can be found in Appendices, Room types section.

Participant	W1	W2	W3	W4	C	F	Room types	Gender
1	black	black	black	black	black	black	futuristic	Male
2	black	black	black	black	grey	grey	futuristic	Male
3	blue	brown	blue	brown	white	white	surreal	Male
4	blue	blue	blue	blue	white	white	futuristic	Male
5	orange	red	violet	orange	violet	orange	surreal	Male
6	black	white	green	blue	white	black	surreal	Female
7	blue	blue	brown	blue	grey	orange	surreal	Male
8	blue	blue	blue	grey	blue	brown	surreal	Female
9	orange	red	blue	red	blue	black	surreal	Female
10	blue	blue	blue	blue	white	grey	surreal	Female
11	red	yellow	green	blue	brown	brown	surreal	Male
12	blue	blue	blue	blue	blue	white	futuristic	Female
13	white	white	white	grey	blue	grey	modern	Male
14	blue	blue	blue	blue	white	brown	traditional	Female
15	red	orange	white	red	green	brown	surreal	Male
16	white	white	white	white	white	brown	traditional	Female

Participant	W1	W2	W3	W4	C	F	Room types	Gender
17	violet	violet	violet	violet	white	white	futuristic	Female
18	white	white	white	white	white	brown	traditional	Female
19	white	white	white	white	white	brown	traditional	Female
20	white	white	white	white	white	grey	traditional	Female
21	black	black	black	black	black	black	futuristic	Male
22	white	white	violet	violet	yellow	orange	surreal	Female
23	blue	blue	blue	blue	white	black	surreal	Male
24	black	green	white	violet	black	yellow	surreal	Female
25	blue	blue	blue	blue	white	brown	traditional	Male
26	green	green	white	orange	white	white	surreal	Female
27	red	black	red	black	red	violet	surreal	Female
28	white	white	white	white	white	white	futuristic	Female
29	blue	blue	blue	blue	white	grey	traditional	Female
30	violet	violet	orange	violet	white	black	surreal	Female
31	green	red	yellow	green	red	yellow	surreal	Male
32	blue	blue	blue	blue	white	brown	traditional	Male
33	blue	white	white	white	white	white	modern	Male
34	white	white	white	white	blue	blue	futuristic	Female
35	white	orange	orange	orange	white	black	surreal	Male
36	orange	orange	orange	red	violet	blue	surreal	Female
37	green	green	green	green	green	green	futuristic	Male
38	orange	grey	blue	green	white	grey	surreal	Male
39	white	white	white	white	white	white	futuristic	Female
40	orange	orange	orange	orange	orange	brown	traditional	Female
41	black	black	black	black	black	brown	surreal	Male
42	blue	yellow	violet	blue	orange	red	surreal	Male
43	grey	grey	grey	grey	black	black	futuristic	Female
44	black	black	black	black	grey	black	surreal	Female
45	violet	violet	violet	violet	violet	violet	futuristic	Female
46	brown	brown	brown	brown	brown	brown	futuristic	Male
47	white	white	white	white	white	white	futuristic	Female
48	orange	orange	orange	orange	blue	blue	futuristic	Male
49	orange	orange	orange	orange	orange	orange	futuristic	Male
50	orange	orange	orange	orange	white	white	futuristic	Female
51	blue	blue	yellow	violet	blue	white	surreal	Female
52	green	blue	orange	red	white	brown	surreal	Female
53	blue	blue	blue	blue	white	brown	traditional	Male
54	blue	blue	blue	blue	blue	blue	futuristic	Male
55	black	white	white	grey	black	brown	surreal	Male
56	white	white	white	white	white	brown	traditional	Male
57	white	white	white	grey	white	brown	traditional	Female

Participant	W1	W2	W3	W4	C	F	Room types	Gender
58	blue	blue	blue	blue	white	brown	traditional	Female
59	white	white	white	white	white	white	futuristic	Female
60	violet	violet	violet	violet	white	brown	traditional	Female
61	violet	violet	violet	violet	white	black	surreal	Female
62	white	white	grey	white	white	black	surreal	Female
63	orange	orange	orange	orange	blue	blue	other	Female
64	green	blue	green	blue	blue	blue	other	Female
65	green	blue	blue	green	blue	brown	surreal	Female
66	black	black	black	black	black	black	futuristic	Male
67	white	white	white	white	white	blue	futuristic	Female
68	white	orange	orange	orange	orange	grey	surreal	Female
69	white	white	white	white	white	white	futuristic	Male
70	blue	blue	blue	blue	white	brown	traditional	Female
71	violet	black	grey	white	white	black	surreal	Female
72	blue	violet	orange	green	green	blue	surreal	Male
73	orange	orange	orange	orange	white	yellow	other	Female
74	blue	blue	blue	blue	blue	white	futuristic	Male
75	white	white	white	white	white	white	futuristic	Female
76	blue	green	orange	red	white	orange	surreal	Female
77	blue	red	white	blue	white	brown	surreal	Female
78	blue	blue	blue	blue	white	white	futuristic	Female
79	white	white	blue	white	blue	white	modern	Male
80	blue	blue	blue	blue	white	brown	traditional	Male
81	blue	blue	blue	violet	white	white	surreal	Male
82	brown	brown	brown	brown	white	brown	futuristic	Male
83	white	white	white	white	white	brown	traditional	Male
84	black	black	black	black	blue	brown	surreal	Female
85	white	white	white	white	white	white	futuristic	Female
86	white	brown	white	blue	white	brown	surreal	Male
87	white	white	white	white	white	white	futuristic	Female
88	red	red	white	blue	black	grey	surreal	Male
89	blue	blue	blue	blue	white	blue	futuristic	Female
90	black	black	black	black	black	brown	futuristic	Male
91	grey	white	black	black	white	grey	surreal	Female
92	violet	blue	orange	blue	blue	white	surreal	Female
93	blue	blue	blue	blue	white	brown	traditional	Male
94	blue	black	black	black	black	blue	other	Female
95	grey	grey	grey	grey	grey	brown	futuristic	Male
96	white	white	white	white	white	grey	traditional	Female
97	violet	violet	violet	violet	violet	black	futuristic	Male
98	orange	black	orange	orange	black	brown	surreal	Female

Participant	W1	W2	W3	W4	C	F	Room types	Gender
99	blue	blue	blue	blue	white	white	futuristic	Female
100	blue	blue	blue	blue	blue	blue	futuristic	Female
101	white	white	white	white	white	blue	futuristic	Female
102	black	black	black	black	white	brown	surreal	Male
103	blue	violet	green	yellow	black	violet	surreal	Female
104	violet	blue	blue	blue	white	blue	surreal	Female
105	violet	grey	grey	grey	white	black	surreal	Female
106	blue	blue	blue	blue	white	brown	traditional	Female
107	red	white	white	white	white	brown	modern	Female
108	green	white	green	white	white	brown	surreal	Female
109	blue	blue	blue	blue	white	blue	futuristic	Male
110	white	white	white	white	white	brown	traditional	Male
111	yellow	yellow	yellow	yellow	white	brown	traditional	Male
112	violet	green	violet	violet	white	white	surreal	Female
113	green	blue	green	blue	white	white	surreal	Male
114	blue	blue	blue	blue	white	white	futuristic	Male
115	red	red	red	red	white	white	futuristic	Male
116	orange	orange	orange	orange	white	brown	traditional	Male
117	white	white	white	white	brown	grey	surreal	Male
118	violet	violet	orange	yellow	orange	violet	surreal	Female
119	orange	orange	orange	orange	black	black	futuristic	Male
120	grey	grey	blue	blue	white	brown	surreal	Female

Table 34. Teens colour preferences for six bedroom surfaces.

As seen in Table 34 and Table 35, the teens' bedrooms were mainly coded to surreal (42%) and futuristic (33%) suggesting that 75% of the teens chose colourful rooms, with uncommon colour combinations.

	Traditional	Modern	Futuristic	Surreal	Other
F	19%	1%	28%	46%	6%
M	19%	6%	38%	37%	0%
F+M	19%	3%	33%	42%	3%

Table 35. Teens preference for the five room types.

Analysis 2

This analysis shows the percentages of ten colours preferred by teenagers in their bedrooms. Blue (27%) and white (24%) were preferred as wall colours, white (58%) was the most preferred as a ceiling colour, and brown (33%) as a floor colour (Table 36, Table 37, Table 38). When thinking of all six bedroom faces, white (29%) was the most preferred, followed by blue (22%). Teen females seemed to prefer white (34%), while male equally favoured white (23%) and blue (23%) (Table 39).

Walls	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	1%	12%	3%	12%	25%	5%	29%	5%	7%	0%
Male	3%	12%	5%	4%	30%	5%	17%	3%	14%	6%
Total	2%	12%	4%	9%	27%	5%	24%	4%	10%	3%

Table 36. Teens' colour preferences on bedroom's walls.

Ceiling	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	1%	4%	1%	3%	16%	0%	65%	1%	7%	0%
Male	0%	4%	2%	4%	10%	6%	48%	6%	15%	6%
Total	1%	4%	2%	3%	13%	3%	58%	3%	11%	3%

Table 37. Teens' colour preferences on bedroom's ceiling.

Floor	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	3%	3%	0%	6%	15%	0%	24%	9%	13%	28%
Male	2%	6%	2%	0%	8%	2%	19%	10%	13%	38%
Total	3%	4%	1%	3%	12%	1%	22%	9%	13%	33%

Table 38. Teens' colour preferences on bedroom's floor.

Bedroom faces	Yellow	Orange	Red	Violet	Blue	Green	White	Grey	Black	Brown
Female	1%	9%	2%	10%	22%	3%	34%	5%	8%	5%
Male	3%	9%	4%	3%	23%	5%	23%	5%	14%	11%
Total	2%	9%	3%	7%	22%	4%	29%	5%	11%	8%

Table 39. Teens' colour preferences on bedroom's surfaces.

To answer the research question, it seemed that white and blue were preferred when thinking of single colours, but when thinking of colour combinations, teens seemed to prefer unusual and maybe "hard" to live in colour combinations in their bedrooms. Even if teens mainly chose aesthetically nice colours (white, blue), the colour combinations were strong, surreal, and futuristic.

Conclusion of Colour me Mood version 1 (CMV1)

The following conclusions are situated within the culture of the study and so may not be generalizable:

- Colour preference is subjective so a generalization of teens' favourite colour cannot be made. Even if blue was a top choice for both genders (38% females and 32% males), other colours were favoured too (Question 1 – Favourite Colours);
- Associations of certain moods with certain colours were found (excited– yellow, irritated–red, fear–black, determined–blue) (Question 2 – Associations between Colour and Mood);
- There is not a strong gender difference regarding certain colour mood associations (Question 2 – Associations between Colour and Mood);

- Teenagers preferred vivid colours for both positive and negative affect (Question 2 – Associations between Colour and Mood), as well as vivid coloured lighting for their bedrooms (Question 3 – Bedroom coloured lighting);
- The top bedroom colours were aesthetically nice (white, blue), but the bedroom colour combinations were strong, surreal, and futuristic so maybe unusual to live in (Question 4 – Bedroom surfaces colour);

These findings bring the following contributions:

- Sales in design industry could increase by triggering certain moods with certain colours (Question 2 – Associations between Colour and Mood);
- Gender colour stereotyping (in industry) could be diminished (Question 2 – Associations between Colour and Mood);
- Teenage interior design norms could be challenged by using strong and unusual colour combinations (Question 4 – Bedroom surfaces colour).

This section ends with three acknowledged limitations. Firstly, the limitation of lining up colours in strips is acknowledged by the author, but the large number of participants makes it less problematic. The author thinks it is a limitation because, if it is to compare two strips which are half yellow and half red, it might be the case that five participants chose yellow colour in strip one and red colour in the second strip. In other words, the strips could be opposites and not aligned. However, this would be highly unlikely given the large number of participants. Secondly, the order of the colours in the strips might impact the results, as well as any other order. This order followed Itten's Colour Wheel system (Birren 1970), starting with the lightest colour (yellow). Thirdly, judgements were made by only the researcher and her supervisor.

Colour me Mood version 2 (CMV2)

Introduction

Cultural context matters especially when understanding teens as the relationships between adolescent and adult subcultures differ from culture to culture (Read, Horton 2016).

In considering this study alongside the TRALa model (Read, Horton 2016), it situates in Quadrant A where teens that participated had high autonomy and the given tasks had little complexity. Regarding the interpretation, when adults interpreted the data (as in CMV1), this was towards Quadrant A where researchers needed to interpret the "meaning of the data" (Read, Horton 2016). To gain validity for the thesis work, but also to examine if, given colours, a mood could be implied (a necessary idea for the ultimate design of the interactive product), the CMV2 study aimed to have teenagers as interpreters of data thus reducing the interpretation distance.

Having insight from a small population from the same group of teenagers who contributed data to CMV1, 45 participants (15 to 19 years old) interpreted the data that was previously gathered. The data examined consisted of the ten coloured strips (Figure 82), where each strip represented a different mood, and with each mood-strip being the data of the 121 teens. The aim of the CMV2 study was to examine to what extent a mood being sent as a colour by one teen might have some meaning to a receiver from a similar background.

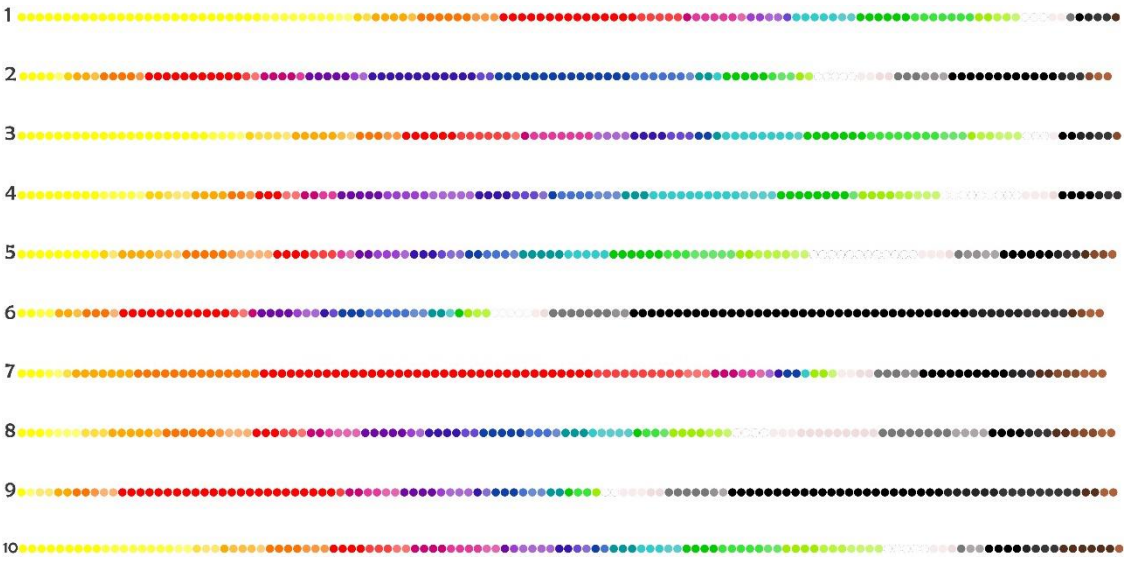


Figure 82: The ten strips used by teenagers to answer few questions.

In the present study, the ten strips (numbered 1 to 10) shown in Figure 82 were used. Teens were asked to:

- Q1: “Arrange the strips in an order that appeals to you – list the order here in the boxes and then explain why you ordered them in that way”;
- Q2: “Find pairs that are similar or opposite. The same strip can be chosen in more than one pair”;
- Q3: “Select no more than 2 strips that you think represent each of the moods below: afraid, scared, irritable, determined, happy”.

“Appeals to you” in Q1 invited teens to order the coloured strips based on what triggered them, be it colours, shades, lightness or darkness of a colour, colour order, etc. For clarification, teens were asked to explain their choices.

Participants

Forty-five teens aged between 15 and 19 years old participated in the study. Nineteen were females, nineteen male, seven did not mentioned their gender. In this study, the forty-five participants are referred to as teen 1, teen 2, teen 20, teen 45.

Method

The main aim was to see if the colour-mood-strip choices of the current participants would match the previous study results. Thus, this study explored the following:

- Teens’ choices of arranging strips in an appealing order to them to encourage the students to examine the strips and see that the colours may have a meaning (Analysis 1);
- Teens’ choices of similar or opposite pairs of strips to confirm / dispute the interpretation of the research team (Analysis 2);
- Relationships between the strips and the five different moods that were previously found to have reasonably strong associations with colours (afraid, scared, irritable, determined, and happy) to identify if any ‘meaning’ of the colour strips would match the way they were constructed in the other way around so that sent colours could be useful to convey meaning. Note that happiness was added instead of excitement to combine both enthusiasm and excitement. Scared and afraid mood were both previously used and the author thinks there might be a difference of mood intensity between them, which is why, for this study, both were used (Analysis 3).

Results

The results are presented and analysed as follows: Analysis 1 considers the way the teens organised their strips, Analysis 2 is concerned with opposites and similarities and Analysis 3 focuses on moods.

Analysis 1

Teens had to order the ten strips as they wanted, and each of them had to write down the order of their choices. One teenager in Figure 83 chose the following order because, in his own words, "shows increasing order of yellow": 9, 6, 2, 7, 8, 5, 4, 10, 3, and 1.

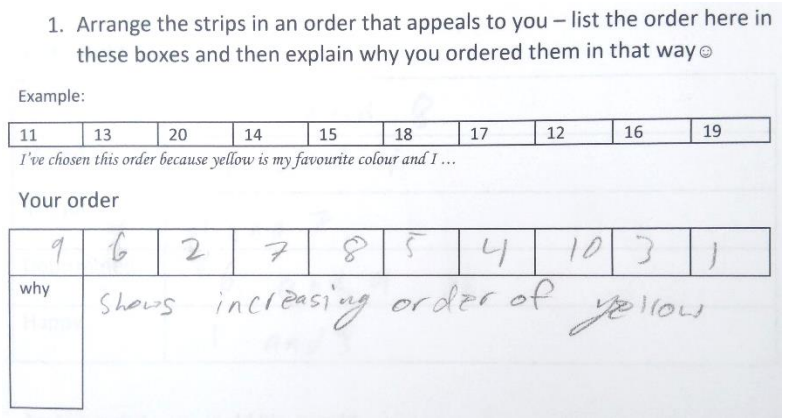


Figure 83. Teen 1's answer as a raw data example.

For analysis, each teen's responses were diagrammed as shown in (Figure 84, left side). Teen 1's choice order started from strip 9, went to strip 6, then 2, 7, 8, 5, 4, 10, 3, and finished at 1. Figure 84 (right side) shows the strips order chosen by Teen 1 and Figure 84 (left side) shows the same strips order arranged by the author in a diagram. Teen 1's explanation of why he chose to put the strips in that order is written under the diagram: "Teen 1: shows increasing order of yellow".

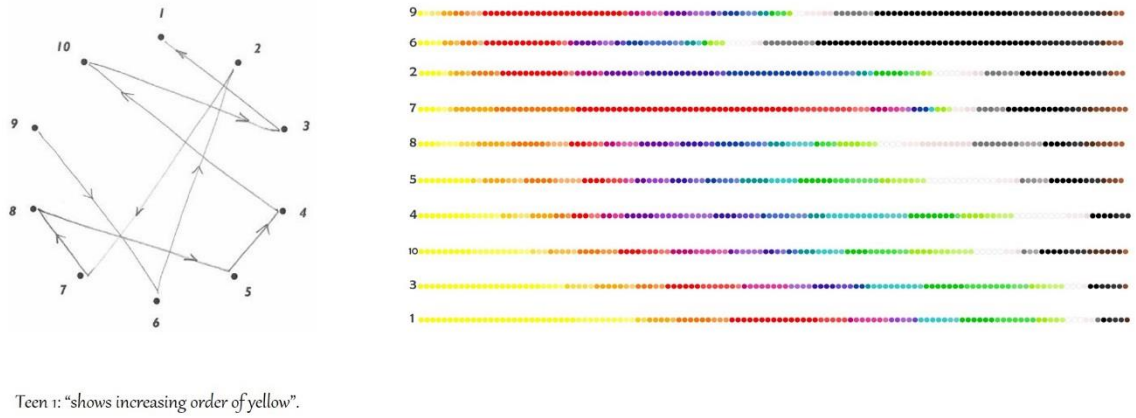


Figure 84. A diagram example, which shows teens' order preference of 10 colour strips.

The same graphical analysis was repeated for all 45 participants. Separately, all 45 diagrams (without the strips and teens' explanations, such as shown in Figure 85) were grouped by similar shapes, in order to see if there are any similarities between the answers in each group. Eleven groups were formed, numerated from A to K (see Appendices), the aim being to see if there were any patterns in the teens' decisions. Figure 86 is an overview of Group A, where the strips are ordered based on an increasing or decreasing amount of yellow. The other groups follow a similar categorization.

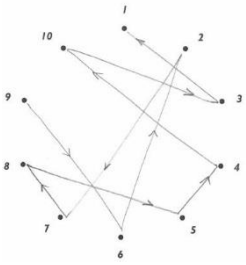


Figure 85. Teen 1's diagram without the strips order and teen's explanation.

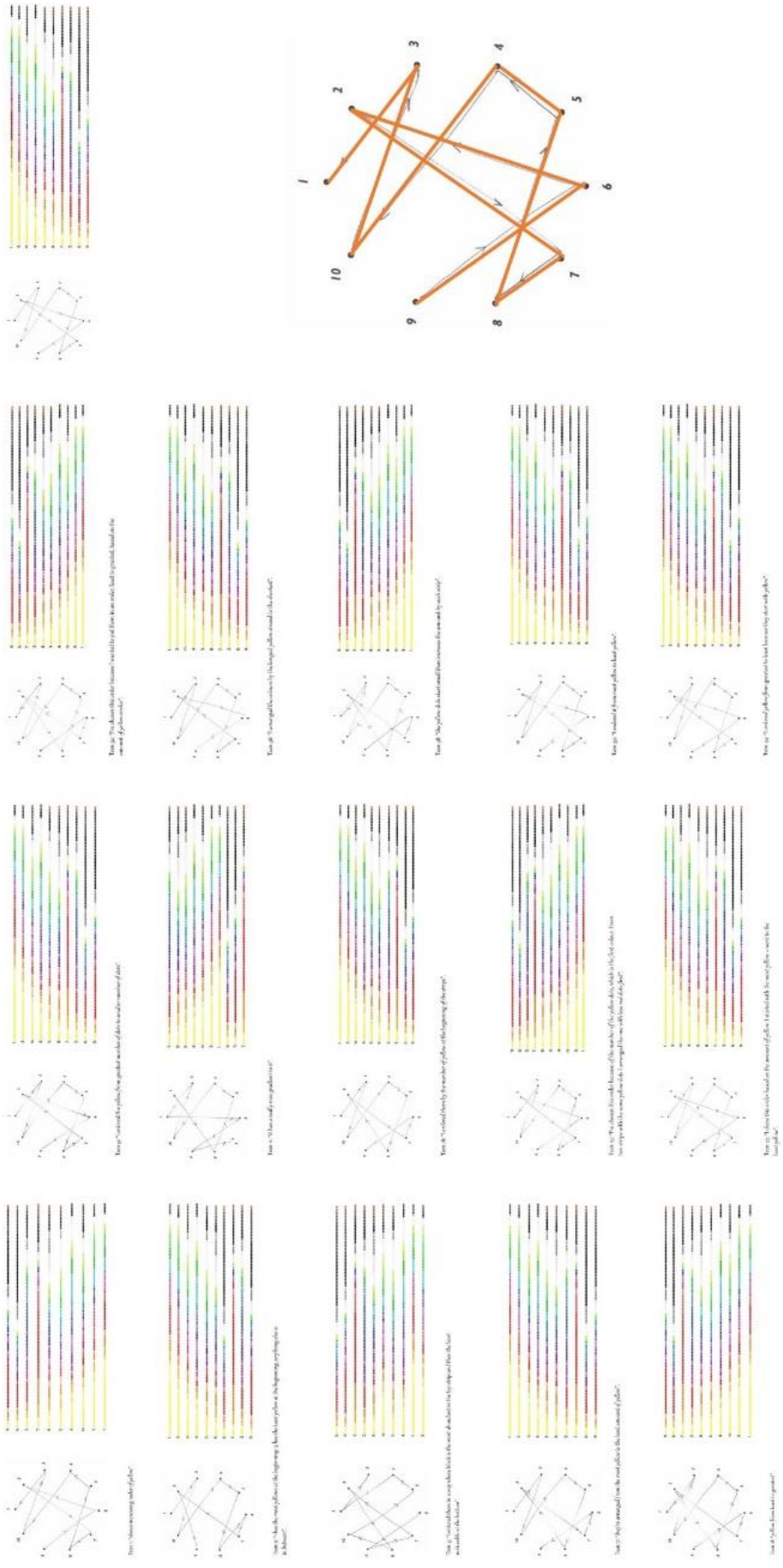


Figure 86. Group A is consisted of sixteen identical or very similar diagrams.

Summary of Analysis 1

Teens generally focused on the increase/decrease of yellow/black. In the context of earlier findings, where yellow was associated with excitement and black with fear, teens might have ordered the strips based on a positive or negative mood. Or, as teens said, they chose yellow because it was a favourite colour, because all strips started with yellow or because a nice gradient was created. Some teens also ordered the strips judging by the decreasing of 'happy' colours and increasing "dark, sad" colours or by choosing black and grey as a starting point. Two teens arranged the strips based on numerical order from 1 to 10 and they did not consider arranging strips by colours. This was a warm up exercise to see how teens would sort out the strips and it seemed that it was based on the colours situated at the beginning/end of the strips.

Analysis 2

Having taken some time to look at the coloured strips, teenagers were then asked to group four similar and four opposite pairs of strips from the same ten mood strips used until now: "Find pairs that are similar. The same strips can be chosen in more than one pair". Figure 87 is an example of a teenager pairing similar and opposite strips. In the representation below, each pairing is then shown by aligning the coloured strips thus adding clarity. For example, the teenager in Figure 87 paired 6-2 strips as being similar, and the 6-2 strips are shown alongside. The same process applied for the rest of the pairs so that teenagers' written choices on the left would correspond to the image of the strip pairs on the right (Figure 87).

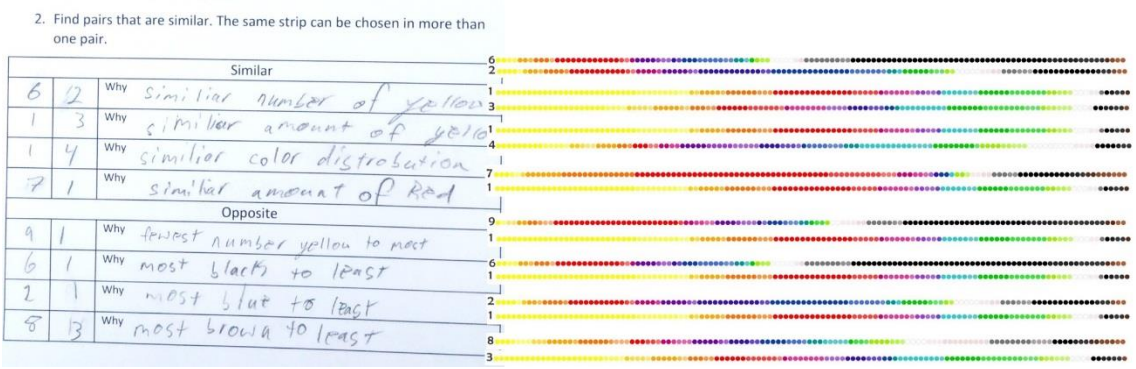


Figure 87. An example of similar and opposite pairs of strips made by one of the teens.

Not all of the participants gave eight answers (4 for similar pairs and 4 for opposite pairs). All the answers can be seen in Table 40, representing both similar and opposite answers. The horizontal and vertical numeration represent all pairing possibilities of the ten strips, such as 1-1 pair, or 1-6, or 2-9, or 7-10, etc. The first numbers in every pair example are from the vertical column while the second are from the horizontal row. The 'X' diagonal separates the similar answers from the opposite answers. The similar answers are below the 'X' diagonal, while opposite answers are

above it. The numbers in each box represent how many times that strip was chosen. For example, strip 1-1 (first number from the vertical column and second from the horizontal row) has no choices, strip 2-7 has been chosen five times, strip 9-6 was chosen twenty-eight times. Strips such as 9-6 or 6-9 are considered similar and their choice is added into the same box.

There was a total of 144 answers regarding similar pairs and 101 answers regarding opposite pairs. The most chosen similar pairs were pair 1-3 (excited-enthusiastic) with 24 choices and pair 6-9 (scared-afraid) with 28 choices (Figure 88). The most chosen opposite pairs were 1-6 (excited-scared) with 20 choices and 1-9 (excited-afraid) with 14 choices (Figure 89).

Figure 88. Most chosen similar pairs.

Figure 89. Most chosen opposite pairs.

101 answers - OPPOSITE

	1	2	3	4	5	6	7	8	9	10
1	x	6	1	2	1	**20**	0	1	**14**	0
2	0	x	0	0	0	0	5	0	1	1
3	**24**	0	x	1	0	1	3	4	3	0
4	5	6	0	x	0	2	9	0	1	1
5	1	4	2	3	x	2	3	1	4	0
6	1	2	0	0	0	x	8	0	0	0
7	9	7	2	0	1	2	x	3	0	1
8	0	4	0	3	9	1	1	x	1	0
9	1	1	1	0	2	**28**	2	1	x	1
10	0	1	11	3	2	0	0	4	0	x

SIMILAR - 144 answers

Total of 45 teens

Table 40. Similar and opposite results analysis.

The fact that teens were able to associate strips with meanings that were implied from CMV1 (excited-enthusiastic 1-3 and scared-afraid 6-9) suggests that in some instances colour could be used as a tool of judgement. Similarly, a good number of the strips grouped by teens as opposite were indeed representing opposite feelings such as excited-scared (1-6) and excited-afraid (1-

9). It is thought that the amount of yellow, black, and the colour contrast between the strips (light-dark) played an important role in teens' colour-mood associations. The order of yellow and black (first, last) in the strips could have also influenced teens' choices.

Teens' answers to the question "why" they paired the strips this way are shown in Table 52 (with similar answers) and Table 53 (with opposite answers) in Appendices.

Sixteen females paired 1-3 as similar because of the similar number of colours and similar colour pattern. Seventeen males described their choice of 1-3 strips as being similar mainly because of the amount of yellow. Therefore, in terms of similarity between strip 1 and strip 3, females focused on the number of similar colours or on the pattern of the colours while males focused on the number of yellow strips displayed. Regarding 6-9 strips, both females and males paired them because of the amount of black each strip had. It could be suggested that both genders associated black with fear, as they paired strip 6 (scared) and strip 9 (afraid) because of the high amount of black. The teens' answers match the adult ones (CMV1) with yellow associated to excited and enthusiastic and black being mainly associated with scared and afraid.

Analysis 3

The third activity in Colour me Mood version 2 (CMV2) was to associate strips with five given moods: afraid, scared, irritable, determined, and happy. Teens were asked to select no more than two strips that they thought represented each of the five moods. An example of one teen's association of strips with moods can be seen in Figure 90, where afraid was associated with strips 10 and 8, scared with strips 2 and 4, irritable with strips 1 and 7, determined with strips 6 and 9, and happy with strips 1 and 3. The pairs of strips are here displayed along each answer in order to help the reader visualise teen's choices. All 45 teenagers completed a similar table with the one in Figure 90.

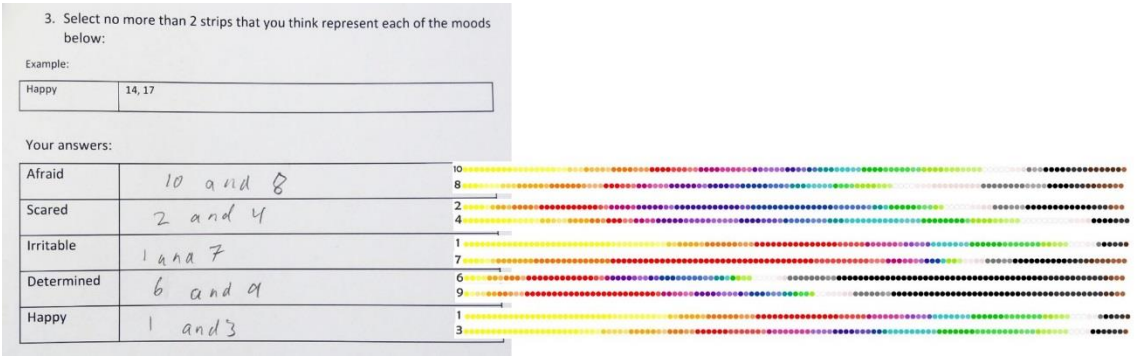


Figure 90. An example of a teen's answer to this request.

The results of the teenagers' answers are gathered in Table 41. All five moods are displayed in the column on the left, and all ten strips are numerated on the first row. The vertical lines in each box

represent the number of choices for each strip. For example, for the afraid mood, there were no choices for strip 1 (afraid-strip 1). There were three choices in afraid-strip 3, five choices in afraid-strip 8. For happy mood, there were five choices in happy-strip 2, and one choice in happy-strip 6.

	Strip 1	Strip 2	Strip 3	Strip 4	Strip 5	Strip 6	Strip 7	Strip 8	Strip 9	Strip 10
Afraid	0	11	3	8	5	**21**	6	5	12	4
Scared	2	7	4	4	4	**17**	5	4	**22**	3
Irritable	12	4	7	4	6	9	**22**	4	8	2
Determined	4	9	6	**11**	7	7	10	7	8	4
Happy	**23**	5	**19**	8	9	1	6	3	0	4

Table 41. Results of strip-mood associations.

Results showed that afraid matched quite strongly with strip 6 and that irritable was strongly associated with strip 7. Happy and scared each seemed to associate quite favourably with two different strips (9 and 6 for scared and 1 and 3 for happy). There was no strong choice for determined.

Figure 92 represents the meanings of the strips as determined in the CMV1study. It can be seen that in CMV2 (Figure 91) the teens associated 6 and 9 with scared and 6 with afraid. These align well. Chosen by the teens strip 7 aligned with irritable and strips 1 and 3, chosen by the teens as happy, associated well with the stated meanings of excited and enthusiastic.

Figure 91. Results of the strip-mood associations.

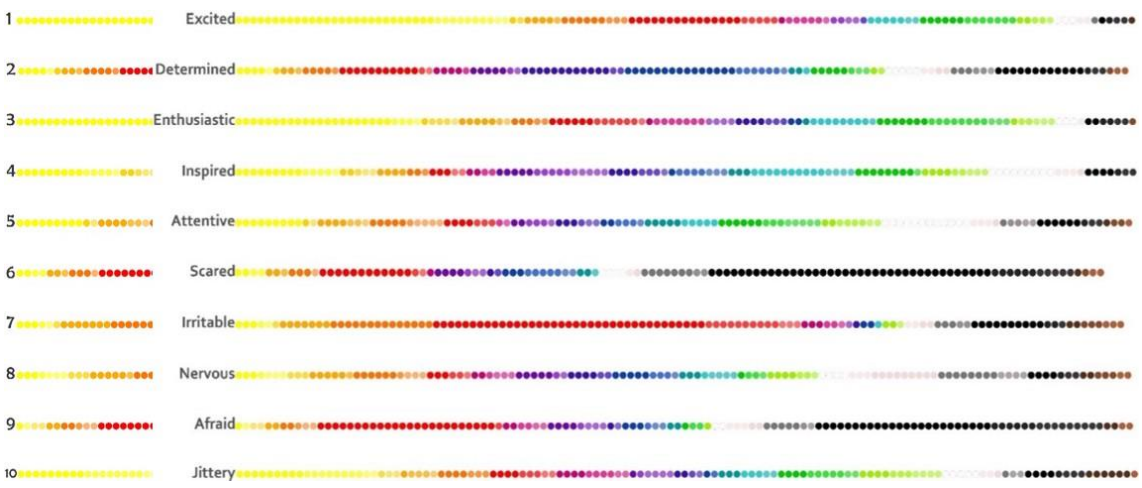


Figure 92. The ten mood strips and their numeration.

Teens' interpretation of fear for two strips with black dominant colour was as expected. This finding confirms the strong connection between fear and the dominant black colour found in Colour me Mood version 1 (CMV1). However, this finding contradicts Boyatzis et al. (1994) results as well as Wexner's (1954). Boyatzis et al. (1994) results showed black and brown induced positive emotions in half of the children's responses even though it was the least associated with positive emotions. The age difference between teenagers from the present study and Boyatzis et al. (1994) study might be a factor regarding the results difference: present results showed that for teenagers, black has a strong connection with fear while Boyatzis et al. (1994) study found that for children, black has a positive connection. Another age difference is between the thesis teen participants and Wexner's (1954) participants, which were students. Wexner's results showed that black colour was associated with power, strength, and masterfulness, which again, it is a different result than black being associated with fear. However, Wexner (1954) suggested, and this is borne out by this thesis work, that certain colour-mood associations were more real than others, black being fairly well associated with "despondent, dejected, unhappy, melancholy, protective, and defending" (Wexner 1954). In this research, black has been found to have strong associations with fear.

Despite claims about red being previously associated with anger or sadness ((Birren 1978), (Cimbalo, Beck & Sendziak 1978), (Sharpe 1974)), Boyatzis's et al. (1994) results with children suggested red to be associated with excitement and happiness. One explanation of the apparent differences between these results might be the possible use of different shades of red, another might be that children have different views about colours due to different exposures to them.

In this study, without knowing the meaning of the strips, and judging only by the dominant colour, it appears that teens' mood association of four strips were, in the main, quite similar to the strips' hidden meaning. Strip 1 (excited) was associated with happiness (maybe because of yellow colour); strip 7 (irritated) was associated with irritation (maybe because of red colour); strips 6 (scared)

and 9 (afraid) were associated with afraid, respectively scared mood (maybe because of the amount of black). The small number of participants might be a limitation and it should not encourage for general claims, but it is believed that these results confirm previous suggestion that there might be an innate colour mood association, even if only for certain moods and colours.

Conclusion of Colour me Mood version 2 (CMV2)

The key findings of Colour me Mood version 2 (CMV2) analysis are described in this subdivision, where every analysis focused on the 45 participants, which were part of the participants in Colour me Mood version 1 (CMV1).

The author is aware that the following conclusions are situated in a specific culture and in a specific time. Even though, the colour culture in Europe might be quite similar to the North American one, this is a supposition which could be investigated in further research studies that are not part of the present thesis. It is certainly the case that the local cultural context such as favourite football team colours (red, blue, etc.) might have an impact on teenagers' colour preferences or choices.

The main conclusions that resulted from Colour me Mood version 2 (CMV2) are as follows:

- In Analysis 1, most of the strips were arranged aesthetically based on increasing or decreasing amount of certain colours such as yellow, black, purple, light pink, warm light colours, or dark colours. Yellow and black were the two colours most described as reasons for ordering strips in different ways. It may be that this was because these two colours have strong associations to moods (yellow to excitement mood and black to afraid) but it is more likely that this was because the strips started and ended with yellow and black and that these are strong colours. The main purpose of the first activity was to have the teenagers start to look at the strips and note their differences and similarities ahead of the next two actions and given that most created an order dissimilar to the order given this aim was achieved;
- When colour was used as a visual tool for pairing similar or opposite strips, some pairs were chosen by many of the teenagers suggesting some strong similarities. These were 1-3 and 6-9 as similar (yellow/yellow for excited/enthusiastic; black-black for scared/afraid) and 1-6, 1-9 for opposite (yellow/black for both excited scared and excited/afraid). This finding could be used as a contribution where the amount of yellow and black could be used as colour tools for identifying similar and opposite moods;
- When teenagers had to associate coloured strips (with hidden meaning) to five different moods, their mood association of four coloured strips, especially in terms of the dominant colour, was very similar to the strips' hidden meaning: yellow-happy, red-irritable, black-

scared, and black-afraid. This confirms that there are some quite strong relationships between certain moods and certain colours such as yellow-excited, red-irritable, and black-fear as previous findings have shown in Colour me Mood version 1 (CMV1) (Analysis 3);

- The method used in Colour me Mood version 2 (CMV2) regarding teens' interpretation of their own results proved to be a strong confirmation method (Analysis 1and Analysis 3).

The findings from this study confirm previous findings (Colour me Mood version 1 (CMV1)) that there is a relationship between certain colours and certain moods such as black-fear, red-irritation, and yellow-happiness. Teens were able to unconsciously give meaning to some of the strips that aligned with the earlier analysis.

Conclusion

The main conclusions and contributions of both Colour me Mood version 1 (CMV1) and Colour me Mood version 2 (CMV2) are brought together in this subdivision.

Findings of this thesis showed associations of certain colours with certain moods such as yellow-excited, red-irritated, and black-fear. Findings also showed associations of blue colour with determined mood. These associations were confirmed by findings in Colour me Mood version 2 (CMV2), where teenagers had to associate data from Colour me Mood version 1 (CMV1) which was in the form of ten coloured strips with hidden meanings, with five different moods. The 45 teenagers in Colour me Mood version 2 (CMV2) were a subset of the previous 123 participants in Colour me Mood version 1 (CMV1), so they interpreted their initial colour-mood associations without knowing. Results showed that their mood associations with four coloured strips in Colour me Mood version 2 (CMV2) were similar with the previous colour-mood associations in Colour me Mood version 1 (CMV1): yellow-happy, red-irritable, black-scared, and black-afraid. This finding confirms relationships between certain moods and certain colours such as yellow-excited, red-irritable, and black-fear as previous findings have shown in Colour me Mood version 1 (CMV1) (Analysis 3 in Colour me Mood version 2 (CMV2)).

This finding regarding associations between certain colours and certain moods might be brought in the design industry where it might be used, for instance, to create new objects designed with these certain colours that might trigger certain moods for teenagers.

Similarities between females and males colour associations with moods such as irritated and afraid were found. There were no differences in terms of colour-mood associations for excited, determined, inspired, and scared.

Blue was the single colour most preferred by both genders, but clearly colour preference is highly subjective and will depend on context of use. Generally teen females tended to choose more shades of the same colour than males did. Females associated blue with different moods such as determined, inspired, attentive, and nervous which could contribute to the challenges of colour stereotyping in design where it is still considered that blue should be used for male design and pink for female design.

As a bedroom colour light, both genders preferred white, while blue was a second choice. These bedroom light choices (surrounding colours) were mostly different from favourite colour choices (self-colours), which might show that what one chooses to wear (self-colour) is not similar with what one wants to be surrounded by (surrounding colour).

Vivid colours tended to be preferred by both females and males; with regard to large bedroom surfaces (walls, ceiling, floor), teens mainly chose aesthetically nice colours (white, blue) as single colour options, but the bedroom colour combinations were strong, and "unrealistic" by todays' interior design norms, and therefore maybe hard to live in. These findings are supported by the work of Carruthers et al. (2010) that showed "people tend to pick different colours to describe different moods, and they pick yet other colours as their favourites, regardless the mood they are in".

Carruthers' et al. (2010) work is interesting as a point of comparison, whilst situated in psychology and with a larger sample, the Carruthers' et al. (2010) study used a printed rather than an onscreen palette as shown in Figure 93. This difference might affect the way human eye perceives colours, as screen colours are different than printed ones. Carruthers' et al. (2010) results showed that healthy participants tended to choose saturated colours while depressed ones chose desaturated colours (Carruthers et al. 2010). These findings support the thesis results where vivid (saturated) colours were by far mostly preferred by teenagers than the pale ones (desaturated).

The Colour Palette (Figure 93 left side) of the present thesis used forty-eight colours displayed in a rectangular shape, Carruthers et al. (2010) used a Colour Wheel (Figure 93 right side), where only thirty-eight colours were used. The Colour Palette used three levels of brightness, while the Colour Wheel used four, so the numbers are quite equal.

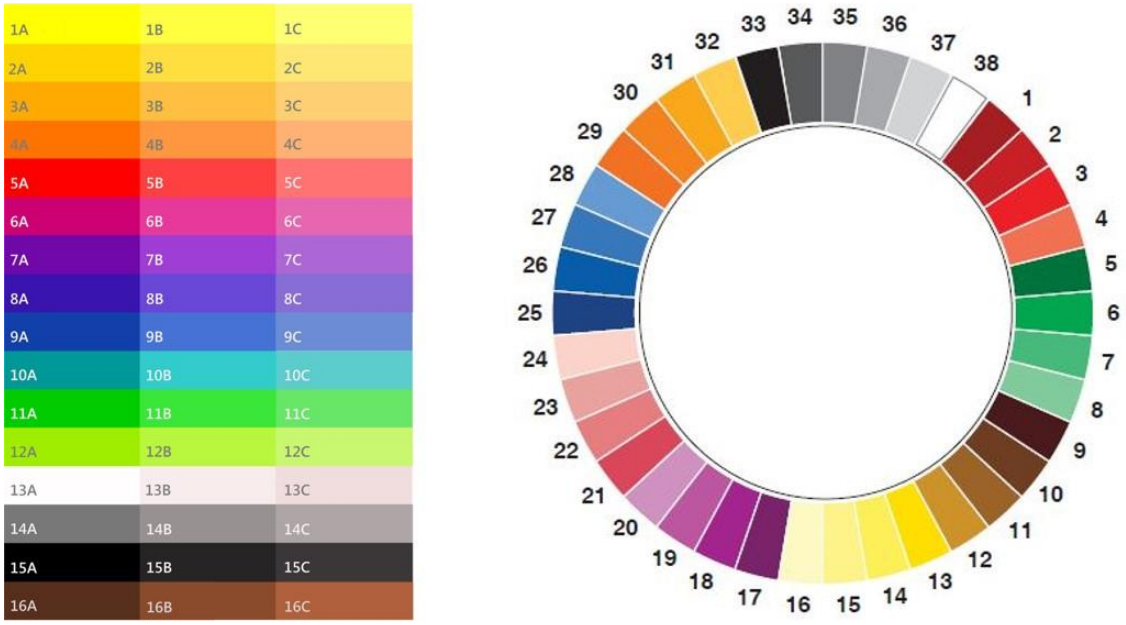


Figure 93. The Colour Palette (left side) used in the present thesis studies on teenagers versus the Colour Wheel (right side) used in Carruthers et al. (2010) study on healthy, anxious, and depressed individuals.

Regarding colour choices associated with one's mood, Carruthers' et al. (2010) findings suggested that anxious and depressed individuals were "more likely to connect their mood with a colour" and in their study 7% of anxious individuals associated 'Red 3' to anger, stress, and frustration, while most of the anxious and depressed people associated their mood with different shades of grey such as 'Grey 35', 'Grey 36', and 'Grey 37'. In the present thesis, red was found to be associated by teens with irritation, black was related to fear while yellow was associated with moods such as excitement, and enthusiasm. In Carruthers et al. (2010) study, yellow was most preferred by healthy people. Blue was one of the most preferred colour in both studies, with differences in shade preferences. In the present thesis it is suggested that different shades of blue are associated with moods such as determination, attention, nervousness, or even inspiration. Carruthers et al. (2010) also found a difference in shades of favourite colours between healthy, anxious, and depressed individuals. Healthy and anxious participants preferred Blue 28 as a favourite colour. Depressed people preferred Blue 27, but this was closely followed by Blue 28.

According to Carruthers et al. (2010), anxious and depressed people were more inclined to associate a colour to their mood than healthy people. Thinking back to teenagers' moodiness and how extreme and variable their emotions are (Chapter 2), it could be suggested that teens could be more drawn to associate colours to their mood because of their emotional roller-coaster. One of the thesis findings suggests that colour shades could be used as a tool to help teenagers recognize and express their mood. Therefore, the interactive installation concept (described in Chapter 7) might help teenagers express their moods using colours, as they might be more drawn to colour-mood association because of their extreme mood swings.

A question about teenagers' current mood could have been added, however reference says that teens' moods are highly volatile (Ballou 2002) and given that the teens at the time were filling the questionnaire, they were focusing on the given task. Data shows that teenagers' concentration is shorter-lived than their moods (Larson, Csikszentmihalyi & Graef 1980) that could quickly vary (Chapter 2). Therefore, completing the questionnaire might have already affected their mood, so the author did not focus on their current mood.

Further work

This subdivision presents design options from the chapters to date. A new, fast, spontaneous communication style for teenagers was suggested in Chapter 2 to help them express and understand their moods. To support teenagers' quick changeable moods, the use of technology is needed, such technology that would allow fast way of use. To create a communication context, there is a need of a communication tool and device. Colour has been shown previously to affect people's emotions (Chapter 3), therefore it would be chosen as a communication tool for teenagers to convey mood. Teenagers' preferences of mobile phones have been shown in Chapter 2, thus a mobile phone will be used as a device for communication.

Having in mind the idea of designing an interactive installation by the end of this thesis, some of Sheridan's et al. (2004, 2008) design requirements suggested in Chapter 3 could be adapted for the interactive installation that is going to be described in Chapter 7, even though there is no performative interaction. For instance, the Performance Triad model might apply to this present research, but with the focus on interaction and not performance. Both the relation between human, technological, contextual, and environmental elements (Sheridan et al. 2004), as well as the transition from spectator to performer (Sheridan, Bryan-Kinns 2008), are used in thesis design concepts in Chapter 7 as suggested below:

- The spectating-participant-performer transition (in a performance context) might be adapted to the idea of interaction between individuals (in an interaction context). Therefore, in an interaction context, there would be the person who initiates the interaction (performer), and the person who would react to it (spectator). The difference is that both initiator and respondent could become performers, and they are both participating in the interaction, gaining similar experience. However, the loop that is being created, initiator-respondent, the latest becoming initiator, is similar with the loop proposed by Sheridan et al. (2008), in the way that there is the possibility of transiting between the roles: spectator becomes performer, but could go back to being spectator, as well as an initiator could become a respondent;

- The relationship between people (as observers, participants, and performers), technology (as a performance tool), and environment (as a context) could be adapted for a possible initiator-responded model. To be noticed that in both initiator-responded model and in Performance Triad model, there is need of interaction, which, in both models, is considered to happen between individuals, and with the help of technology. Moreover, interaction has to happen in a place, within a context. Therefore, at the core of people-technology-context relationship is interaction (between people), and both models could not exist without it.

The conclusions from Chapter 4 underlined the need of a range of various colours with different shades, from pale to vivid. The Early Design Idea in Chapter 5 suggested a device that allows teens to control coloured lighting in their bedrooms.

When bringing together all design options from Chapter 3, Chapter 4, Chapter 5, and Chapter 6, the design of a mood conveying social application was considered because just as mood changes very quickly, and can vary in a short time, so too can lighting. Therefore, the manipulation of lighting in terms of colour became a good candidate solution. In order to express their rapid and extreme mood swings, teenagers would benefit from an environment that would quickly adapt to their own moods, projecting those moods beyond the teenagers' inner world. This interactive application would then allow teenagers to communicate their moods to friends in an easy, fast, and expressive way. Colour in the form of light was thus chosen as a main tool for the study, as light can be quickly changed.

Similarly to Gaver et al. (1999) the goal is to provide opportunities for teenagers to discover new pleasures and new forms of sociability (Gaver, Dunne & Pacenti 1999). The author is trying to allow the expression of teenagers' moods in relation to colour in a social context. To enable this exploration and playfulness, and given that only a few moods had strong colour associations, the first idea of creating a colour-code for teens' colour preferences is dropped as a design requirement and a variety of colours and colour shades will be given to teenagers to express their moods. The author considers this is a very sound conclusion and design decision to reach. Therefore, the concept of the interactive installation will be further described in Chapter 7.

Chapter 7

NEW DESIGN CONCEPT

This chapter considers the research questions: "How can colour-mood associations be represented into a product?" and "Can such a product be designed?"

A design concept, *Colour me Mood*, is developed to support teenagers express and communicate their moods in ways that are aligned to their ways of making meaning. In use, this interactive installation uses colours, both sent and received to reflect mood. The *Colour me Mood* concept draws from theories of interaction, ambiguity, and self-disclosure, and uses inspiration from art and the natural world. This chapter describes the evolution of *Colour me Mood* from early concepts to early prototypes.

Introduction

This chapter presents the design concept of an interactive installation that is built in order to help teens express, interpret, and reflect on their emotions. The interactive installation consists of a mobile app connected to a wall display, and the system is originally conceived to be used by teenagers from their bedrooms. The design concept is based on an interaction model defined by the author and built upon theories such as self-disclosure theory (Greene, 2007), ambiguity in design (Gaver, 2003), and interactional view on design for emotional communication (Hook et al. 2008), (Boehner et al. 2007). The design concept is inspired by research in Chapter 6 and also by the Fibonacci spiral, a shape found in art, architecture, nature, and human body. The design research approach comes from the cultural probes research direction: "we approach research into new technologies from the traditions of artist-designers rather than the more typical science and engineering – based approaches" (Gaver, Dunne & Pacenti 1999).

Aim

The aim is to deliver this chapter with a designed prototype that will be then evaluated in a proof of concept study. The aim of this interactive device is to provide teenagers an innovative way of communicating their moods that might prevent anxiety or depression. The use of the device aims to have an impact on interior design too, in the sense that it could capture industry's attention to design tools that have an impact on teenagers' private environment using colour as a medium for both ambient and communication.

Structure

Chapter 7 starts with an introduction into design methods (Possible Design Methods), then it presents supportive theories of self-disclosure, ambiguity, affective interaction, and other related work (Theory subdivision). The next section (Design) investigates the design of the proposed interactive installation, starting with early design ideas (Early ideas), and exploring the design concept (Wall design). The chapter ends with the Conclusion section.

Possible Design Methods

"Interpretation has always been a key issue in HCI" (Sengers, Gaver 2006) so the term 'design' is differently defined in HCI and design communities (Zimmerman, Forlizzi & Evenson 2007). In HCI a designer might be an interaction designer, a usability engineer, a software architect, a software developer, while in the design community the term designer refers to "someone who has had training or extensive practical experience in a discipline such as architecture, product design, graphic design, or interaction design" (Zimmerman, Forlizzi & Evenson 2007). However, there is a potential for HCI to consider "multiple, co-existing interpretations" (Sengers, Gaver 2006), but it should be highlighted that "approaching design in the engineering disciplines" is different than in art (Fallman 2003).

Design research, as an activity separate from design practice is rather poorly understood by both designers and HCI researches (Zimmerman, Forlizzi & Evenson 2007). One reason for a lack of clarity is that "design researchers often 'borrow' conceptual perspectives from other disciplines and discuss their applicability for design" (Gaver 2012). In the literature there appear to be different categories of design research:

- research into and about design: historical research that evaluates and interprets art (Milton, Rodgers 2013);
- research as design: research in design that creates innovative design methods (Milton, Rodgers 2013);
- research through design: focuses on improving the world "by making new things that disrupt, complicate or transform the current state of the world" (Zimmerman, Forlizzi 2014, Frayling 1993); it is more an experimental practice, "often interdisciplinary in nature and can range from an idea or concept to a new material or process" (Milton, Rodgers 2013);
- research into design: the "research into the human activity of design" (Zimmerman, Forlizzi 2014, Frayling 1993);

- research for design: "research intended to advance the practice of design" (Zimmerman, Forlizzi 2014, Frayling 1993).

There are differences between 'scientific research' and 'design research', research being a systematic investigation into knowledge that is applied "in order to provide scientific information and theories to explain the nature and world around us" (Milton, Rodgers 2013). On the other hand, *design research* focuses on creating "things that do not exist", by focusing on what could be created. *Scientific research* might be "concerned with universal truth" while design research aims to produce knowledge that seeks to improve the design world.

It is suggested that "the design research community should be wary of impulses towards convergence and standardisation, and instead take pride in its aptitude for exploring and speculating, particularising and diversifying, and – especially – its ability to manifest" (Gaver 2012). Therefore, the thesis borrows methods from both design (IDEO 2016) and design research communities.

A *research though design method* was used in this chapter. Research through Design (RtD) is seen as a method for interaction design research in HCI (Zimmerman, Forlizzi & Evenson 2007); it can look like design practice, but its process is more systematic and reflective (Zimmerman, Forlizzi 2014), employing "methods and processes from design practice" (Zimmerman, Forlizzi 2008). RtD can be carried out following five steps (select, design, evaluate, reflect and disseminate, and repeat (Zimmerman, Forlizzi 2014) or six interconnected phases (define, discover, synthesize, generate, refine, reflect (Zimmerman, Forlizzi 2008). Therefore, "designers move iteratively between phases, developing sketches, models, and prototypes along the way" ((Zimmerman, Evenson & Forlizzi 2004), (Fallman 2003)).

Examples of design methods used in the thesis

This section presents various design methods, places the work in a research through design context, and it highlights methods used in Chapter 7 and Chapter 8. There are three accounts of what design is: conservative, romantic, and pragmatic (Fallman 2003). Conservative account sees design as a science, following a systematic, rational, and controlled process. The romantic account considers design as functional art, where creativity and imagination rule methodology. The pragmatic account sees design as a reflective practice, being "engaged directly in a specific design situation" (Fallman 2003). This chapter presents design from both the romantic and conservative account: the aim is to create a functional product of art through a creative process where imagination and drawings are used (romantic account), together with methods from design practice (romantic account) and research design methods (conservative account).

To provide the reader with context about the methods chosen, brief examples of design methods in HCI follow. The construction of personas (Cooper 1999) and contextual inquiry (Beyer, Holtzblatt 1998) are user-centred design approaches applied in HCI and are viewed as design practices (Forlizzi, Zimmerman & Evenson 2008). Cultural probes is an experimental design method that provokes inspirational responses by giving participants kits of cameras, postcards and other materials (Gaver, Dunne & Pacenti 1999). Bodystorming and experience prototyping (Buchena, Suri 2000) intend to "increase empathy between designers and users" (Forlizzi, Zimmerman & Evenson 2008). Interaction relabelling (Djajadiningrat, Gaver & Fres 2000) and transfer scenarios (Ljungblad, Holmquist 2007) are methods that intend to "extend the creative ability of designers" (Forlizzi, Zimmerman & Evenson 2008). Paper-based diaries in HCI (Tomitsch, Singh & Javadian 2010) are used to evaluate usability and user experience aspects of novel interactive products (Lichtner et al. 2009). Focus groups, not necessarily a design method, are "individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research" ((Powell, Single 1996), (Jordan 2000)). Other design methods include design prototyping techniques such as storyboards (Vertelney, Curtis 1990), scenarios (Verplank et al. 1993), and sketches (Wong 1992).

The design approach in Chapter 7 (as well as in Chapter 5 and Chapter 8) uses methods from design practice, design research, and scientific research:

- **Cultural probes**: a kit (package of photo cameras, diaries, and other materials) was given to teenagers to record their experience with an interactive mobile app ((Gaver, Dunne & Pacenti 1999), (Milton, Rodgers 2013), (Chapter 8);
- **Experience (or paper-based) diaries**: teenagers recorded their experience with a product in pre-designed diaries (IDEO 2016, (Tomitsch, Singh & Javadian 2010), (Lichtner et al. 2009), (Jordan 2000)), (Chapter 8);
- **Product analysis**: The author went to Philips company in Eindhoven (The Netherlands) to analyse the Luminous Textile panel which was similar with her own product concept. She took photos as a method of product analysis (Design, Chapter 7), as she could not break down the panel in pieces to analyse it (IDEO 2016, (Milton, Rodgers 2013);
- **Competitor product analysis**: research about competitors which found that Philips Luminous Textile panel was the main one, as Philips research focuses on how to trigger people's mood using light (IDEO 2016), (Design, Chapter 7);
- **Sketching**: used throughout the design development process in order to develop ideas (IDEO 2016, (Milton, Rodgers 2013), (Wong 1992)), (Design, Chapter 7);

- **Focus group**: at the end of the pilot study, the participants were gathered in a focus group so that the researcher would have open talks about the installation concept ((Powell, Single 1996), (Jordan 2000), (Milton, Rodgers 2013)), Chapter 7) ;
- **Try it yourself**: individually logging in as different users in order to see how the app works (IDEO 2016, (Milton, Rodgers 2013)), (Design, Chapter 8);
- **Paper prototyping**: models made out or paper and used by participants for a fast feedback on designs ((Snyder 2003), (Milton, Rodgers 2013)), (Design, Chapter 7);
- **Quick-and-dirty prototypes**: prototypes created with any available materials: the transparent boxes (IDEO 2016, (Milton, Rodgers 2013)), (Chapter 5);
- **Experience prototype**: "a form of prototyping that enables design team members, users and clients to gain first-hand appreciation of existing or future conditions through active engagement with prototypes" (Buchena, Suri 2000); useful for revealing "unanticipated issues or needs, as well as evaluating ideas" (IDEO 2016), (Chapter 5);
- **Expert appraisal**: where the product design decisions are taken by an expert. In design practice one experts' opinion is sometimes enough as design methods do not have to be scientifically validated (Frayling 1993). This method was used by the author to evaluate the final prototype (Jordan 2000), (Chapter 8);
- **Intuition** is another an evaluative design practice method used by designers who, based on their training and experience, would generally be able to make valid aesthetic judgments towards a product (Milton, Rodgers 2013), (Chapter 8);

Building on RtD work ((Zimmerman, Forlizzi 2008), (Zimmerman, Evenson & Forlizzi 2004), (Fallman 2003)), Table 42 shows how design methods interconnect in the design phases of the thesis.

Phase	Activity	Method	Chapter
Define	Select focus	Literature review, Sketching	1-4, 7
Discover	Develop Collect data	Questionnaire, Paper prototype, Quick-and-dirty prototypes, Experience prototype.	5
Synthesize	Create Extract Define	Online Questionnaire, Sketching (the colour-mood strips), Reinterpreting visual data (contribution method).	6
Generate	Sketch Critique Prototype Evaluate	Sketching, Product autopsy, Competitor product analysis, Focus group, Paper prototyping, Quick-and-dirty prototypes.	7

Phase	Activity	Method	Chapter
Refine	Select Make Describe	Cultural probes, Experience diaries, Expert appraisal, Intuition, Try it yourself.	8
Reflect	Reflect	Reflect	1-8

Table 42. Phases of the design process commonly employed in RtD in HCI developed after (Zimmerman, Evenson & Forlizzi 2004).

Theory

Supportive theories and Related work

Three theories underpin the initial design concept: self-disclosure theory (Greene, 2007), ambiguity in design (Gaver, 2003), and interactional view on design for emotional communication (Hook et al. 2008), (Boehner et al. 2007). In this section, these theories and their applicability to the design space are presented and these are followed with examples of interactive devices similar to the author's interactive installation that aims to be designed in this chapter.

Self-disclosure theory

When people interact, emotional processing is essential to figure out their own emotional reactions and to interpret the emotions of others. This requires interpretation and meaning-making (Hook et al. 2008). Self-disclosure is a form of emotional process, and it associates with any communicative act that reveals something about the self (Greene, Derlega & Mathews 2006). Self-disclosure is defined as an interaction between two people "where one intends to deliberately divulge something personal" to the other (Derlega et al. 1993).

According to Greene et al. (2006), there are four reasons for self-disclosure in personal relationships: self-focused reasons (when the person expresses feelings for his/her own benefit), other-focused reasons (duty to inform, a desire to educate), relationship-focused reasons (having a close, trusted relationship with one's partner, having something in common, or a desire to increase intimacy), and situational-environmental reasons (availability of the target person when the other asked for disclosure). Greene et al. (2006) apply these reasons also to non-disclosure, in the following way: self-focused reasons (fear of rejection, fear of possible loss of privacy), other-focused reasons (protecting the other for being hurt, upset, or a perception that the other would not be helpful), relationship-focused reasons (losing the relationship, superficial relationship, or the info to be disclosed is not relevant for the relationship), situational-environmental reasons (unavailable possible disclosure target, or the person already knows the

information). Even though all the reasons above are related to self-disclosure in personal relationships, the author of the thesis and other researchers believe the model can be adapted for friendship relationships (Greene, Derlega & Mathews 2006). In terms of teenage design, there is clearly something to be concerned with in regards to self-disclosure when building a concept that communicates emotions.

Greene et al. (2006) also describe three modes of disclosure: face-to-face, non-face-to-face, and third-party. Face-to-face is when people are talking in person and non-face-to-face is when people are communicating through emails, telephones, and letters (and nowadays through social media). In a typical non-face-to-face situation, the listener learns less and has fewer non-verbal cues but individuals disclosing something might feel freer to openly talk than in face-to-face mode. Third-party mode is when more than two people are communicating (Greene, Derlega & Mathews 2006).

It has been postulated that where people interact may influence how much and what people disclose (Werner, Altman & Brown 1992). For example, locating interaction in private spaces, such as bedrooms, which are very personal, might enable individuals to feel more comfortable and thus be freer to communicate their feelings than in other places. A caveat to this, however, is that what one person perceives as a private setting for disclosing personal information may be perceived by another person as inappropriate (Greene, Derlega & Mathews 2006). In placing the author's design concept in children's bedrooms, it is assumed that there may be some resistance from, say parents, to teenagers closing themselves away in their own rooms to talk about how they feel. It is the author's view that the advantages of the bedroom as a personal space outweigh the disadvantages.

Disclosure of feelings is considered beneficial in the main. Hiding personal information such as moods, thoughts, actions is considered to be quite stressful (Pennebaker, O'Heeron 1984) and "suppressing thoughts and feelings via nondisclosure is believed to result in negative cognitive consequences" (Greene, Derlega & Mathews 2006). Letting negative feelings and thoughts out may reduce the negative effects of disguise (Greene, Derlega & Mathews 2006), help individuals understand and find meaning in their experiences and reduce the emotional impact of experiences (Lepore, Ragan & Jones 2000). This supports the author's design concept of giving users the freedom to let out their moods and thoughts in a direct or indirect interaction.

Ambiguity in design

According to Gaver et al. (2003) ambiguity is an attribute of people's own interpretation of things and situations. The ambiguous scene can be set by the artefact/situation, but only a person would make the ambiguous artefact/situation comprehensible. Therefore, ambiguity requires people to interpret, and make, meaning. This process can be pleasurable for participating individuals and can lead to a closer, deeper relationship with the artefact that is supporting the ambiguity – thus it has implications for long-term use of products and may encourage individuals to build relationships with ambiguous artefacts. Because ambiguity creates some mystery, it forces people to interpret situations or things for themselves. In this way, ambiguity encourages people to start interacting with the artefact in conceptual ways. As ambiguity is seen in everyday life, and as people deal with ambiguity on a daily basis, ambiguity in a user interface is reasonably easy to navigate (Gaver, Beaver & Benford 2003).

Gaver et al. (2003) described three types of ambiguity pertinent to computer systems: ambiguity of information, ambiguity of context, and ambiguity of relationship. Ambiguity of information is when ambiguity arises in the way that information is presented. Ambiguity of context is when things might be perceived differently, or have different meanings, in different contexts. For instance, a product could have several interpretations depending on the context so users are obliged to make a meaning of the object in different contexts. Ambiguity of relationship refers to the situation when ambiguity arises from the viewer's personal relationship with the artefact. For example there are products that make people imagine how they would use them and they end up speculating: "we form intellectual, aesthetic, emotional, and moral judgements that can become available for self-reflection" (Gaver, Beaver & Benford 2003).

Ambiguous design focuses on multiple interpretations of the relationship between people and artefacts (Gaver, Beaver & Benford 2003). In an ambiguous situation, involved people might be forced to "decide upon their own interpretation of what is happening" ((Hook et al. 2008); (Gaver, Beaver & Benford 2003)).

Ambiguity therefore is a 'desirable' interaction element for a system that would be used by teenagers to communicate moods. It may encourage teenagers to visit the application, provide conceptual integration and allow flexibility of use.

Interactional approach – affect as interaction

The interactional approach sees emotions as social and cultural products experienced through people's interactions. It supports individuals to understand and experience their own emotions, making emotional experiences available for reflection (Boehner et al. 2007). Emotion is seen as being related to culture, dynamically experienced, and constructed in action and interaction. In this interpretation, emotion cannot be separated from what happens in one's life such as social context, experiences, friendships, work, and life in general (Hook et al. 2008). From an interactional perspective, emotion communication implies a combination of sensual and intellectual experiences of a variety of emotions, called affective loop experiences (Hook et al. 2008). This affective loop can happen in real time with immediate feedback and little reflection or the process might need longer time and a deeper reflection (Hook et al. 2008).

Building upon Hook's et al. (2008) interactional design view, privacy, autonomy, and ambiguity are three advantages of designing a product based on their interactive model. Taking Hook's et al. (2008) idea further, the author refers to privacy as a dynamic process between people from different cultures who are negotiating finding a common ground in their interaction. Autonomy in affective computing refers to users' independent choice to express emotions without letting the system interfere, even if it, as a tool, fits their needs and ideas (Hook et al. 2008). Moreover, users' own interpretation might make their experience more real (Hook et al. 2008).

Related work that implements the approaches above is presented in the following section.

Interactive devices

The use of interactive products in order to facilitate social communication has had considerable interest in recent years.

Affector (Sengers et al. 2008) is a video window between two offices that is intended to enable people to reflect on the emotional presence of the other. It collects real time video and then distorts this; the distorted view of what happens in office B is seen in office A, and vice versa. *Affector* was designed to be experienced in a conversational way. This system is emotionally expressive even though the emotions are not captured within the window (Boehner et al. 2007).

Affective Diary is a personal diary that "captures some of the physical, bodily aspects of experiences and emotions" of the users and uploads them via users' mobile phone, in order to form ambiguous, abstract colourful body shapes which are made available to the user. Combining other materials from the mobile phone such as text or photographs, the diary is "designed to invite reflection and to allow the user to piece together their own stories" (Lindström et al. 2006).

The *e-Moto* mobile app ((Sundstrom, Stahl & Hook 2005), (Hook et al. 2008)) and the *Buddy Beads* project (Kikin-Gil 2006), both described in Chapter 3, let users express their emotions, thus underlying the interactional view on communication between friends.

The interactive approach from the examples above supports people to understand, experience, and reflect upon their own emotions (Boehner et al. 2007). This approach is expected to be useful for understanding how people construct and experience their emotions and can lead to new designs that will encourage awareness of, and reflection on, emotions (Boehner et al. 2007).

Colour-affective interaction and supportive theories

The author presents a model (Figure 94) showing how the three theories cooperate to support the design concept. This early diagram expresses the interaction between two teenagers when using the *Colour me Mood* interactive installation, designed by the author in this thesis. Having in mind the context of communication by sending and receiving colours on a friend's personal interactive wall display while using a mobile app, one teenager would be the sender of a colour, and the other the receiver (Figure 94). Therefore, when sending a colour to the receiver, the sender would associate moods to the sent colour, thus sharing emotions with the receiver. The receiver would make a meaning of the colour-mood message, reflect upon it, and then respond back (interact) by sending a colour with a mood associated to it. Once the sender would receive the colour-mood message, s/he would reflect on it, making a meaning out of it and interact by sending a colour back, but s/he can also choose not to interact by sending nothing in return. Based on the theories that would follow in this subdivision, a more advanced interaction model will be presented in Chapter 8.

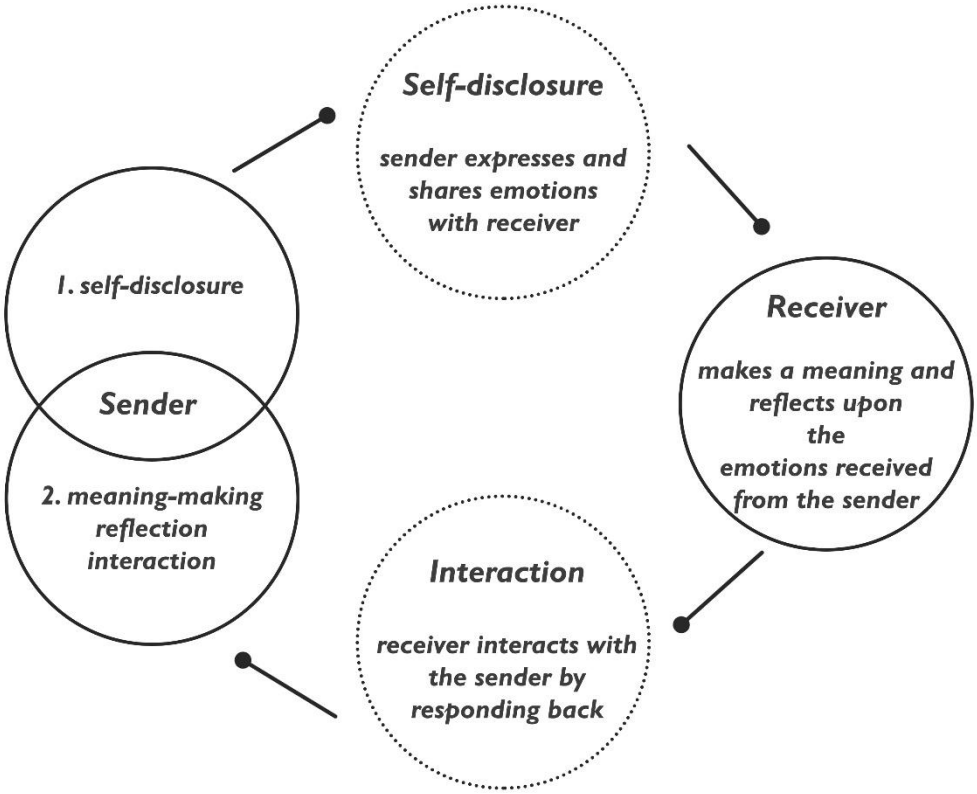


Figure 94. The affective loop model created from a mix of three theories: affective loop (Hook, 2008), affective approach (Boehmer, 2007), and self-disclosure theory (Greene, 2006).

Having in mind her communication concept of sending and receiving colours in a social context, the author created three ways of interaction between users (Figure 95):

- SI: secret interaction,
- AI: ambiguous interaction,
- DI: direct interaction.

The author assumes secret interaction (SI) might happen when two or more users communicate using a secret colour-mood code established by themselves. The ambiguous interaction (AI) represents the expressing of mood using colour only, without having previously agreed, as a pair, or as a group, what meaning is associated with such colours and without adding any meaning, to the colour, as it is sent. Within this, the three types of ambiguity are present (ACE, ACC, ACR). Direct interaction (DI) is considered when users will use text and colour to communicate.

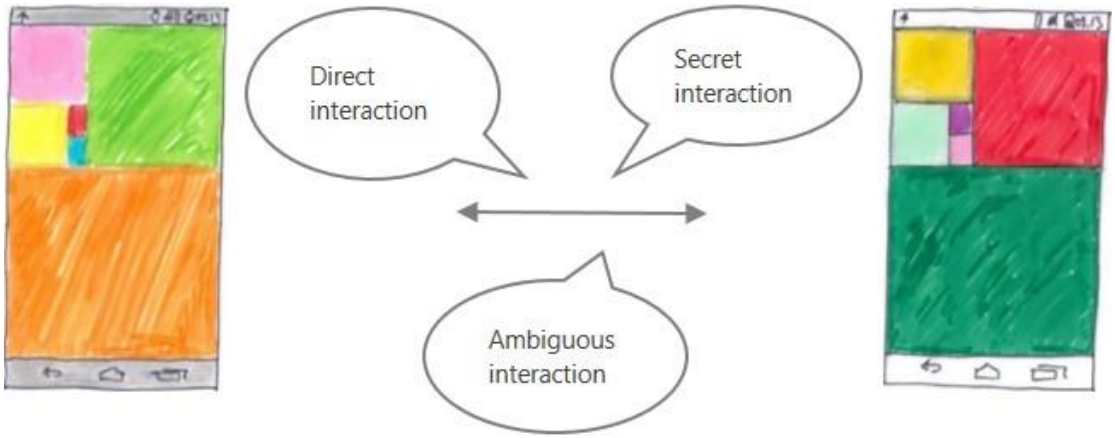


Figure 95. The interaction mood-colour model concept: three types of interaction thoughts teens might have when using this app.

Building upon Greene's (2006) reasons for self-disclosure, the author has created four models of colour-disclosure that are supporting the concept of the app:

- SFCD: self-focused colour disclosure,
- OFCD other-focused colour disclosure,
- RFCD relationship-focused colour disclosure,
- PFCD: place-focused colour disclosure.

Each of these disclosure models will be described with the thought that they are adjusted for author's design purposes. Self-focused colour disclosure (SFCD) occurs when teens would only send colours, creating an ambiguous meaning for their receiver. This is an ambiguous interaction. Other-focused colour disclosure (OFCD) occurs when teens send colours with meaning, so that the receiver would understand their mood expression. This could lead to secret interactions because after that point, for example if then only that colour is sent, no one but the receiver/s would understand what the sender expressed. Relationship-focused colour disclosure (RFCD) refers to colour-mood communication in a closed, trusted, relationship where there is a desire to increase intimacy or closeness. This could also support secret interactions. Direct interaction can be present in all situations if teens decide to only text. Place-focused colour disclosure (PFCD) occurs when the place influences one's mood. The author considers all these models to be symbolic disclosures, because colour is a symbolic form, meant in this case to be used by users to express moods, feelings, thoughts, etc. The self-disclosure could be spontaneous or reflective when using this app.

Besides the above theories, the design of the interactive installation also uses the concept of colour-mood communication. A following study (see Pilot study -paper prototype), found that the

hidden meanings of the conveyed colours was one of the most attractive aspects of the proposed design (Balta, Read 2016).

Along with these hidden meanings, the author further explored the idea of ambiguity as a resource in design (Gaver, Beaver & Benford 2003) and based on Gaver's et al. (2003) types of ambiguity mentioned earlier, the author described her own ambiguities types, as follows:

- ACE: ambiguity of colour expression,
- ACC: ambiguity of colour context,
- ACR: ambiguity of colour relationship.

These three ambiguity types support the author's colour communication concept using colours as a form of ambiguity when necessary.

In the design concept, the ambiguity of colour expression (ACE) would happen when a colour with no meaning is received on the installation's wall display. The imprecise representation of a colour would emphasize uncertainty, and would encourage speculation and interpretation (Gaver, Beaver & Benford 2003). Moreover, if the wall display seems mysterious and attractive to the users, as Gaver et al. (2003) say, the teens will be tempted to join in, make sense of the colours received, and interact. Therefore, the author's installation exploits the ambiguity of colour meaning through the use of a display in order to create an air of enigma. This type of ambiguity also opens a space of possible interpretations such as the choice of a colour based on culture, religion, or gender preferences. Therefore, this type of colour ambiguity creates a space for interpretation.

Ambiguity of colour context (ACC), which is the second type, would be considered when colours might have different meanings in different cultures or contexts.

According to Gaver et al. (2003), ambiguity of relationship (ACR) can lead people to consider new beliefs, values, and attitudes. It refers to the situation when ambiguity arises from the viewer's personal relationship with the artefact, creating a personal projection and adding personal values to the design. Gaver et al. (2003) say this personal condition "can allow products to become psychological mirrors for people, allowing them to try on new identities or to question their values and activities". Therefore, the author's wall display will allow teens to question their friends' moods that will be represented by colours thus supporting ambiguity of colour relationship (ACR). Moreover, the mobile app will allow users to see their own mood-colours on a similar but smaller screen concept. Therefore, teens would be able to question their own mood and reflect upon it.

Design

The *Colour me Mood* design concept is based on the idea of designing an interactive installation to help teens express their mood using colours in a social communication context. The *Colour me Mood* installation embraces affective design, while the concept draws inspiration from art and design, being explored early via design sketches (Early ideas subdivision) that lead to a later design concept (Wall design subdivision), its development (Design Development of the Interactive Installation section) and early prototypes (Mobile app prototype subdivision).

Early ideas

During this very early design stage, the author tried to find connections between four different areas such as teenagers (Chapter 2), colour (Chapter 4), technology (Chapter 3) and design (Chapter 7). These connections informed the design concept, which is described in this chapter. Figure 96 was one of the first sketches informing the early design ideas that focused around the crossover between colour, teenagers, technology, interaction design, and interior design, and it lead to the diagrams in Figure 97. Interaction became a very important element, such as a bridge between all the other areas.

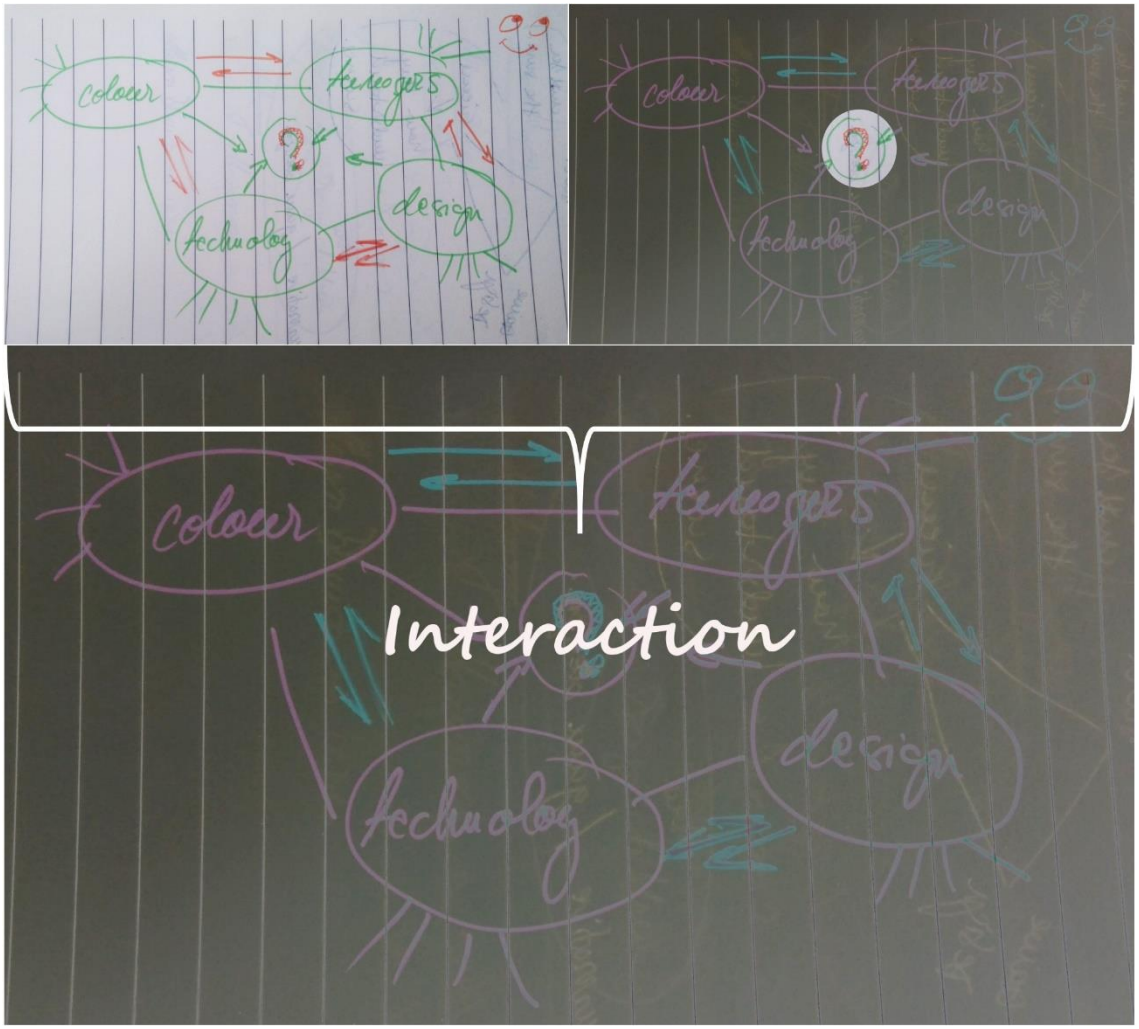


Figure 96. Early sketches that informed the design of an interactive installation.

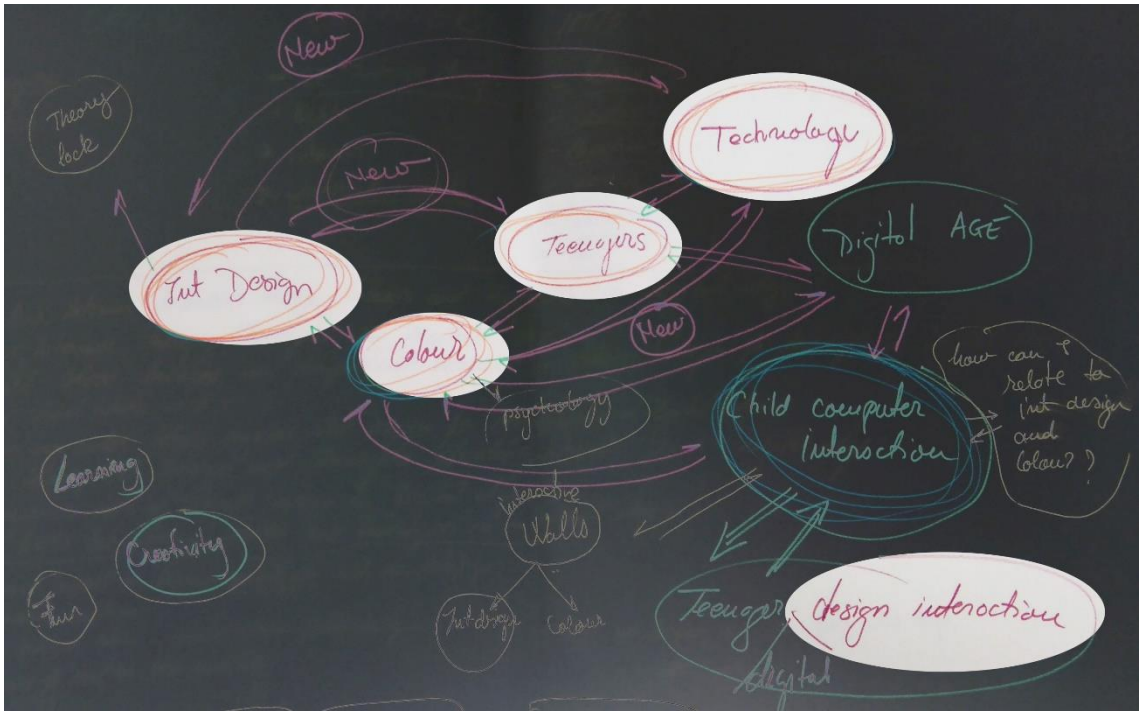


Figure 97. One of the first sketches informing the early design ideas.

Interaction would happen in private spaces such as bedrooms, because it was an area that was not explored before in the context of interior design research. As already shown in Chapter 2, teenagers are known to need their own privacy and in the family home, the teenagers' bedroom is their space to escape. Bringing the use of interaction into such private spaces became an idea that started to be further explored. Colour was shown to have an effect on people's moods (Chapter 4) and certain colours were found to have strong colour-mood associations among teenagers (Chapter 6). Therefore, more sketches were drawn around the idea of using interactive design in teenagers' bedroom that would use colour as a tool for creating an interactive ambient design.

The author started from the idea of two people sending colours between them while relaxing (top left image of Figure 98), then thought of parts of the bedroom (curtains, ceiling, walls, and bed duvets) that could be used as a display area (bottom right image of Figure 98), drew sketches of different digital wall shapes (bottom left image of Figure 98), and thought of materials to be used on the wall (digital screens, digital wallpaper, wash-up lights, or other smart materials) (top right image of Figure 98).

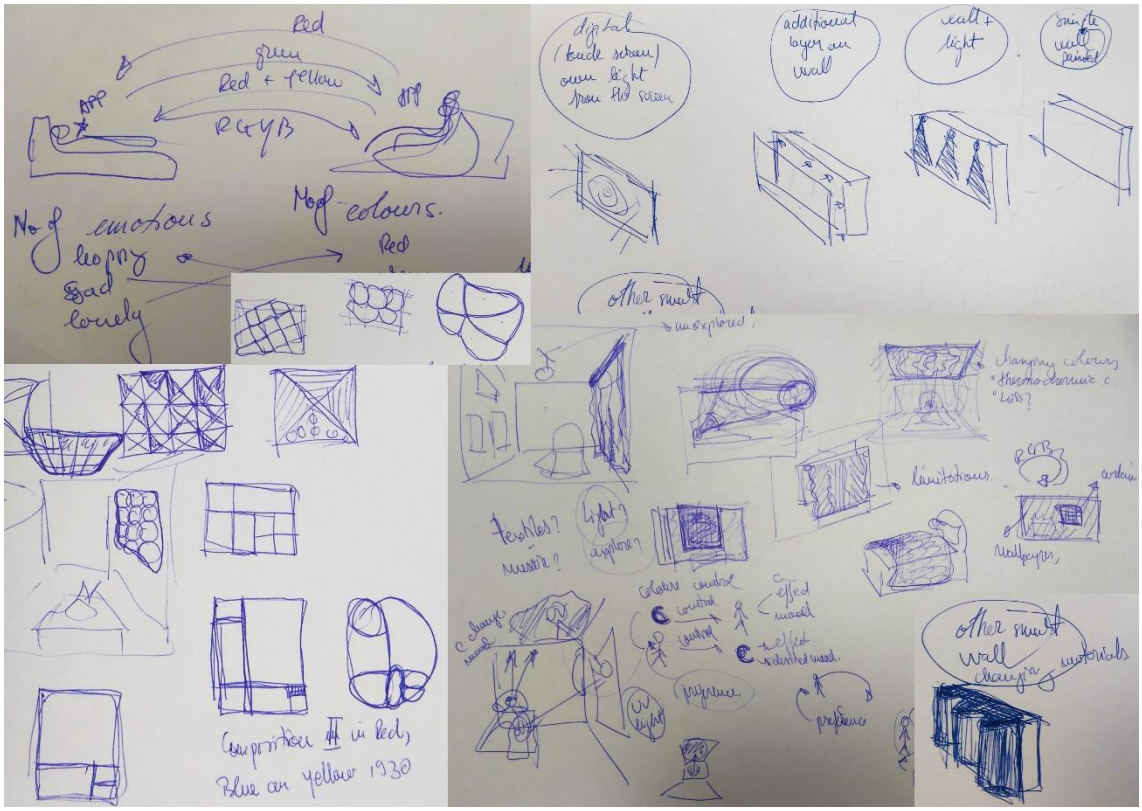


Figure 98. Stages of wall design concepts.

Being part of the Child Computer Interaction research group as a PhD student, the author chose teenagers as her design target, because designing with and for teenagers is a research area not so well explored. Therefore, at this stage, the author had a clearer idea of her future design concept (Figure 99). Teenagers would be given a device (designed in this section) that would allow them to control the colour of their bedroom interactive walls in order to have a new experience such as playing, or creating something that might change the primary function of a bedroom as an intimate space for sleep. The focus was on physical interaction between the teenager as a user and the bedroom wall.

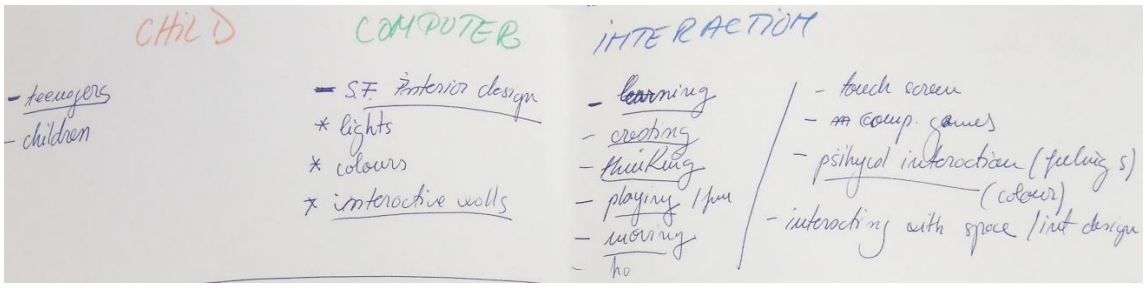


Figure 99. Early design concept ideas.

The early design process above, where sketches were used and questions were raised to create new design ideas, lead both to an articulation of the scientific research questions and also to a more developed design concept that will be described in the following subdivision.

Wall design

The sketches above inspired the author to use the golden rectangle (Figure 100) as a design concept for the wall display. The golden rectangle ratio associates with the Fibonacci spiral, which is present everywhere such as in nature, architecture, art, cosmos, human and animal body, and even in anatomical cells (Figure 101) ((Aygar 2013), (Merrick 2014)). One's eye/brain can unconsciously recognize it and find visual pleasure because of its ideal proportions, which are based on a precise mathematical calculus (Merrick 2014).

Figure 100. Sketches of the design steps taken to use of golden rectangle as a design concept.

Figure 101. Examples of the Fibonacci spiral in architecture, art, animals, and nature.

The golden rectangle concept was transformed into a design concept, where it could be used as a display for teenagers' sent and received colours. Figure 102 shows the transition between the

initial sketch of two people sharing moods and colours and a more developed sketch idea representing two teenagers sharing colour on a golden rectangle display. For example, the girl on the left side sent yellow to the girl on the right side, who replayed with red. At this early stage, the idea of having their faces appear on the display was born, such as when one's profile picture is on the display, that meant the person is active, and when the profile picture disappeared, that meant the person was inactive (Figure 103). This idea lead to more detailed sketches such as Figure 104, where teenagers would each have a golden rectangle display in their bedrooms and they could send colours between each other.

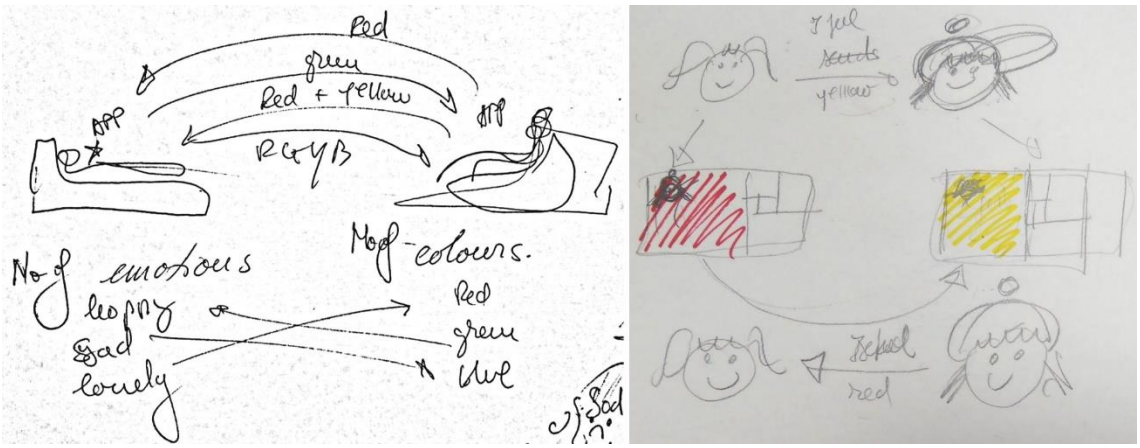


Figure 102. Transition from early sketching ideas to new ones.

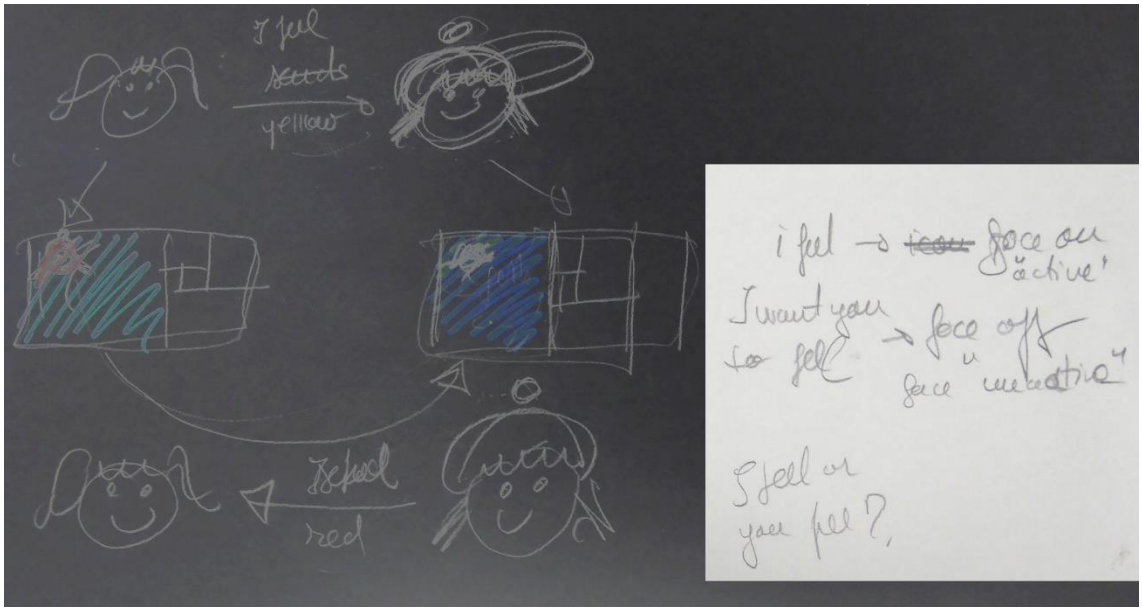


Figure 103. The first idea of having users' faces appearing on the display.

Drilling down the design it was determined only seven rectangles would be used for the first prototype (six squares and one rectangle) to build an eventual display that could, theoretically, but not practically, be infinitely expanded. Controlling the number of squares gave the author

(designer) the advantage of controlling the number of teenagers that would use the interactive installation.

In this design, each square is associated to a friend, so that one would see the colours sent by the other six friends, and each of those friends could see the colours sent by the others to their individual wall displays (Figure 104, left side image). Therefore, the ambient bedroom appearance would constantly change in one's room because of the colours received from friends. Sent colours are intended to be associated to a mood so that users would communicate using colours (Figure 104, right side image). If it is to think at the shape of a spiral, it never ends, so another reason for which the author decided to use the golden rectangle as a design concept was that the wall size could be adjusted by adding/removing squares to/from it.

Below are early sketches (Figure 104) of the way the author imagined how two or more friends would communicate their feelings on a wall 'screen' using colours while sitting in their own different bedrooms. When only two teens interact, the display is not fully coloured (Figure 104, left side), but when more than two teens interact, more colours are displayed on the 'screen' (Figure 104, right side).

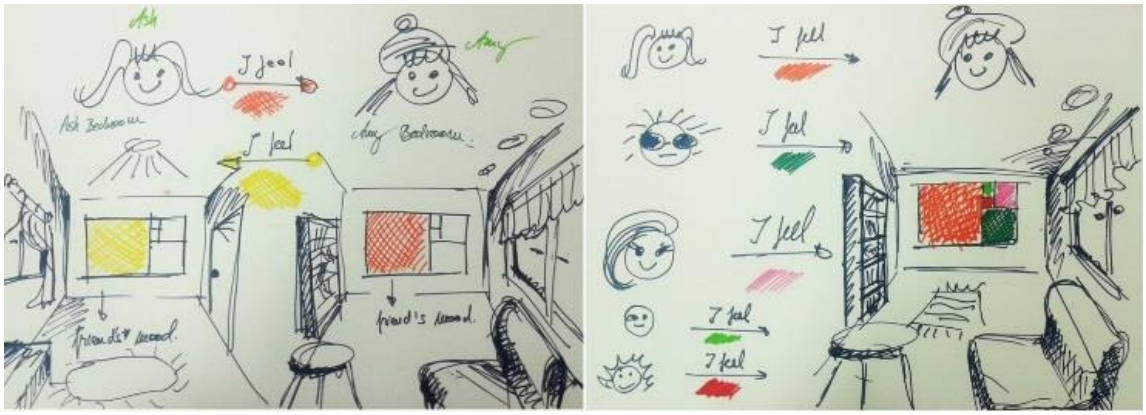


Figure 104. Sketches of the colour-mood device and how it might be used by two teenage friends.

A scenario of how the installation works is as follows. Imagine two teenagers, living in two different houses, in their different bedrooms, being able to communicate their moods using colours. Each of them would have a display on their bedroom wall, which would be connected to their mobile phones. Teen A can send a colour to Teen B's display using a smartphone. Teen B can respond back by sending a different colour to Teen A's display. Moreover, they would both have the freedom to let the receiver know the meaning of the sent colour by associating a textually described mood to it (Figure 105). The text would be a description of participant's mood, and the idea came from the colour-mood association explored in Chapter 6. The wall display would have a series of squares of different sizes thus allowing the colour moods of multiple friends to be seen

at any time (Figure 105, right side image). The display and mobile phone are tools used to express one's mood with friends allowing for an affective interaction between the two friends: Teen A chooses to disclose her/his emotions to Teen B by using a type of expression that contains different levels of ambiguity which have to be interpreted by Teen B in order to create an interaction. For example, a received colour with no meaning would be harder for the receiver to interpret than a colour with a meaning: plain *red* versus *red-I love you*, or plain *green* versus *green-I am excited* (Figure 105, right side image).

Figure 105. Left side: visual colour-mood communication example between two teenagers (the two yellow faces) living in two different houses. Right side: the wall display concept; each square is associated to a friend.

Therefore, the author's concept underlines the affective interaction between two or more individuals, by giving them a tool to choose with which they would be able to express, communicate, and reflect on their emotions. The tool was intended to be a wall interactive installation connected to a mobile app that used colour for expressing moods so research on smart textiles followed.

Smart textiles

During design research, the author found that Philips were having similar design and research interests, while designing a similar product, called the *Luminous Textiles acoustic panel* (Philips Lighting 2016b), which is a panel that combines multi-coloured LEDs seamlessly within textile panels that also soften sound (Figure 106). The author went to a workshop in Eindhoven where she had the possibility to see and analyse these panels, as well as similar products made by Philips. Both Figure 106 and Figure 107 are examples of such panels. These panels are made from an aluminium frame, along with two layers of textiles and an underlying LED lighting system. The displayed images are dynamic, the light resolution is low, and colour, light intensity, and image can be personalized as it can be seen in Figure 107 and Figure 108, where different patterns and colours appear on the screens. Figure 108 shows how patterns change when detecting movement.

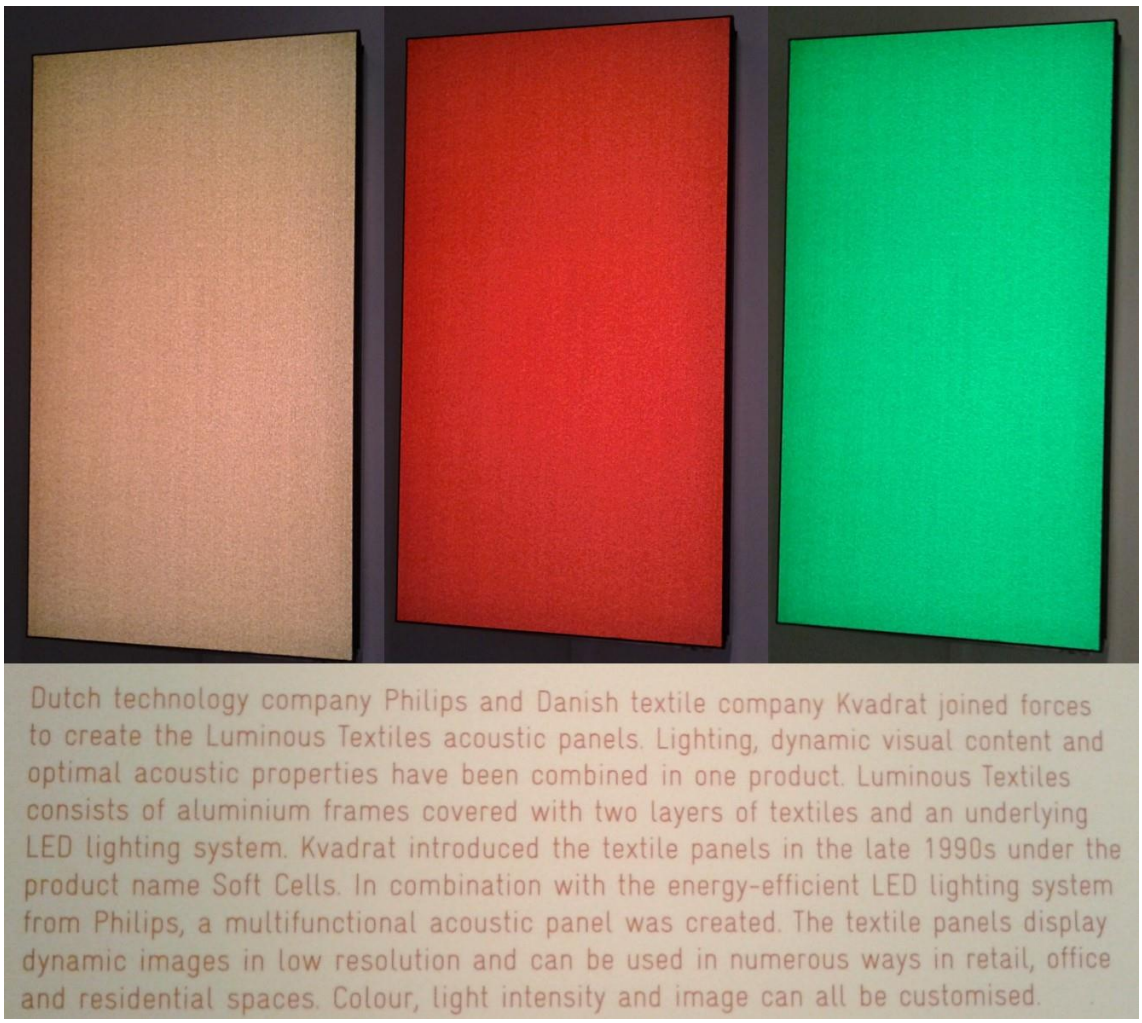


Figure 106. Luminous Philips Textile Panels. Source: pictures taken by the author.

Figure 107. Different pattern examples of Philips Luminous Textile panel. Source: pictures taken by the author.

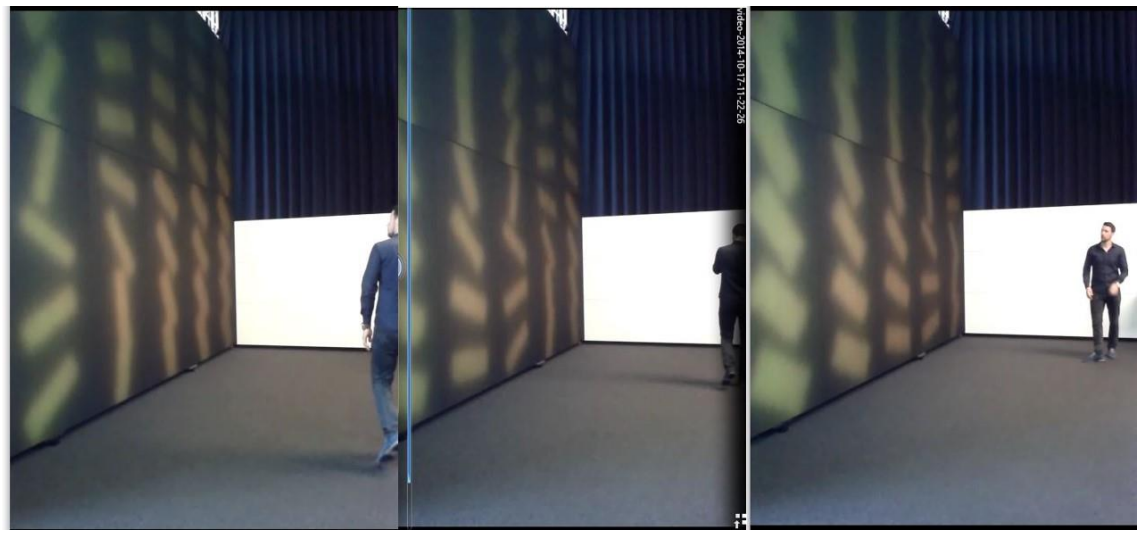


Figure 108. Motion of patterns can be created while one is walking by the panels. Source: pictures taken by the author.

A small sample of the Philips Luminous textile panel can be seen in Figure 109: the textile is black and firm, the weight is not heavy, and maybe all the technology is built inside the aluminium frames which are quite wide for the shapes' size. The author could not get more technical details apart from the general ones that Philip give away.

Figure 109. Details of Luminous Textile panel. Source: pictures taken by the author.

During the conference in Eindhoven, the author had the chance to play with *Philips Hue* (Philips Lighting 2016a), a personal, wireless, interactive lighting system, that allows the user to control their home lighting. The LED bulbs in the house are wirelessly connected and controlled by an app on one's smartphone or tablet, allowing users to personalize their home lighting, as shown in Figure 110, where the author is changing the lighting from green to violet and back to green just

by touching a control digital screen. One of Philips aims is to make “home lighting as personal as our home interiors”(Figure 110).

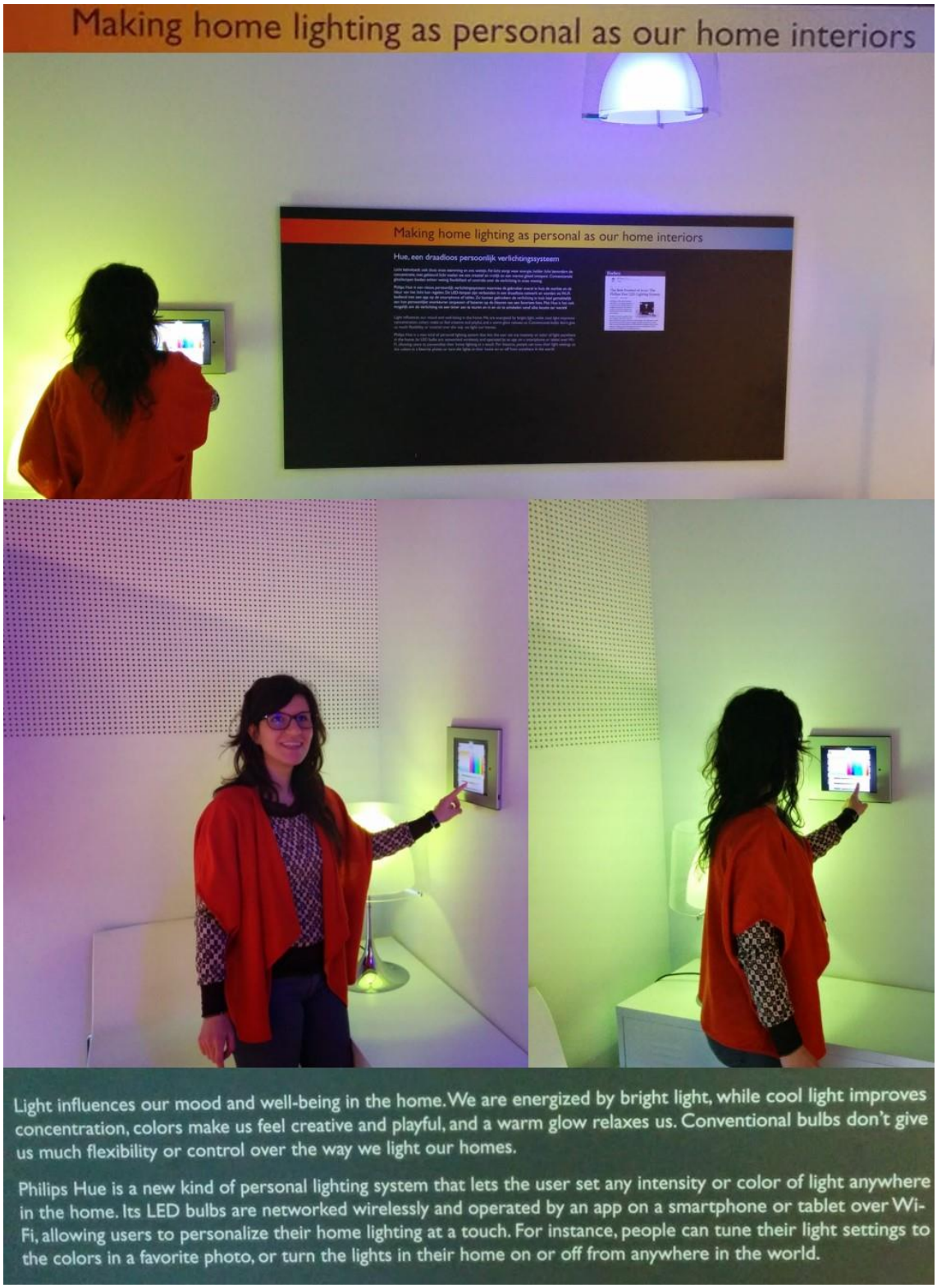


Figure 110. The author playing with Philips Hue. Credits to Silviu Melnic.

Figure 111. Living Ambiance table lamp, Philips. Source: picture taken by the author.

An early product of Philips that resembles a similar idea is the *Living Ambiance* table lamp (Figure 111), designed in 2010, that can be found at Philips museum in Eindhoven, Holland. It works with LED bulbs and, as it says on its museum product description, it "can create a million of colours including white light. The intuitive remote can store favourite lighting scenes, change colours and dim or adjust intensity of light".

Below are few images of companies that embraced textile panels in their interior design (Large Luminous Surfaces n.d.):

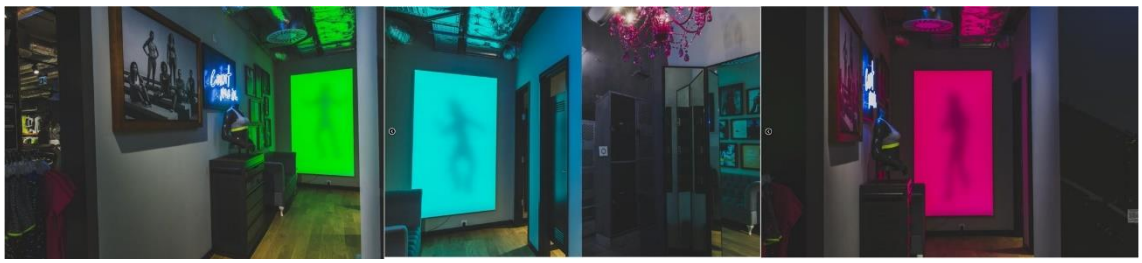


Figure 112. Philips Project: Nike ForPro store, Warsaw, Poland.

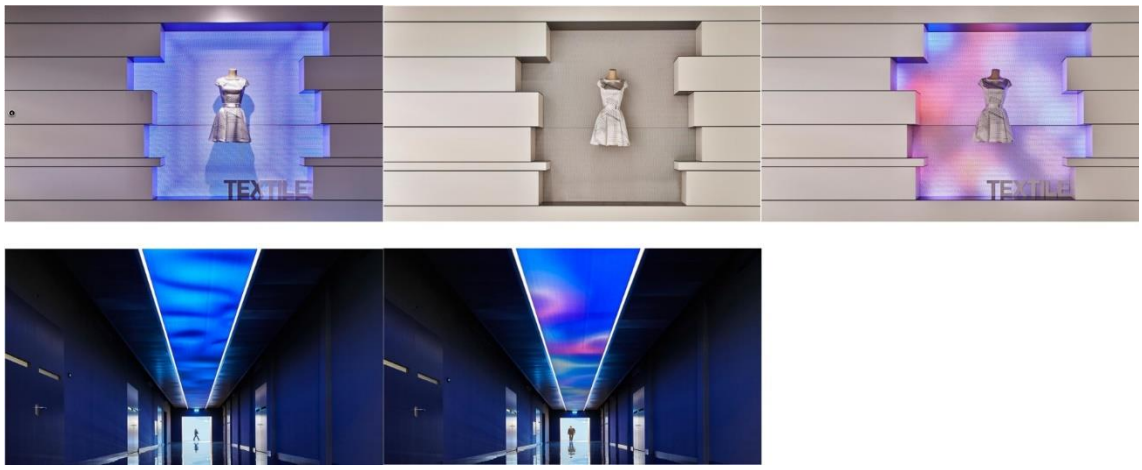


Figure 113. Philips Project: Lighting Application Centre, Eindhoven, The Netherlands.

Figure 114. Philips Project: Marriot International, Maryland, USA.

Figure 115. Philips Project: Nordsjaellands Hospital, Denmark.

ArcInTex Network is a "network where Architecture, Interaction Design and Textiles join forces in developing ideas, techniques, methods and programs for new perspectives on design for building, dwelling and living" (Anderson, Dumitrescu n.d.). In a visit to Tilburg Museum, as an ArcInTex network event, the author saw a design of a luminous carpet, that combined Philips lighting technology and Desso carpet technology. As described in the museum description note (right side picture of Figure 116), Desso is a textile company which developed a translucent carpet by modifying the backing. This is where Philips brought in their ultra-thin LED panels, that are mounted underneath the carpet. These carpets could be used as route guides of exits floor signs in crowded areas such as airports. Logos and decorative flooring could be used with the luminous carpet. Figure 116 shows how patterns can take different shapes, from rectangular shapes (top left image) to more wavy shapes (bottom left image).

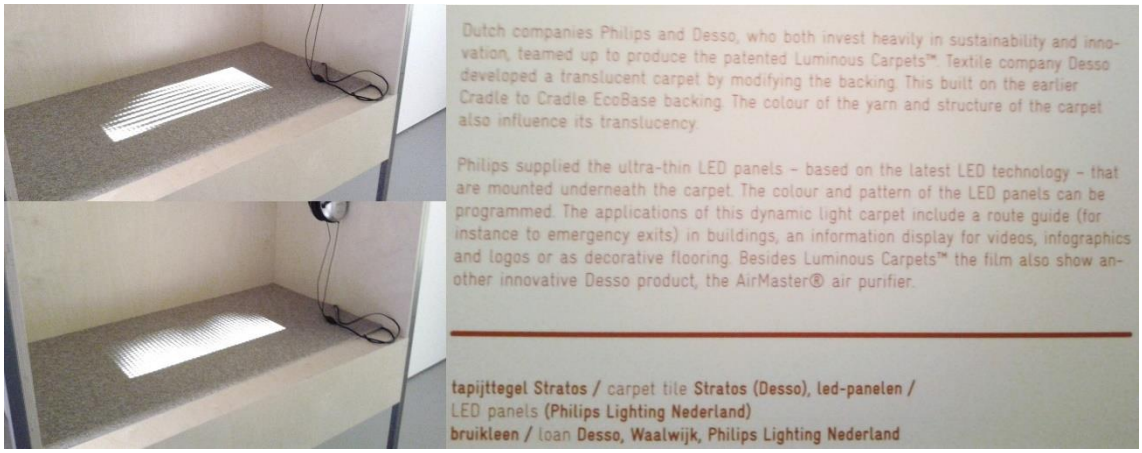


Figure 116. Luminous Carpet by Philips and Desso.

Figure 117 shows two different examples of how the *Luminous Carpet* can be used: as information floor signs (breakfast that way), or cloud connection sign (bottom right picture). The layers of the carpet are also shown in the top right image of Figure 117.

Figure 117. Examples of how the Luminous Carpet can be used such as information floor signs (breakfast that way), or cloud connection floor sign. The layers of the carpet are also shown. Source: (Philips, Desso 2016)

Other luminous textiles displayed in Tilburg Museum included:

- *Light Skin* (Figure 118), an "interactive skin that converts pressure and vibration from embedded silicone lenses into light", as it was written on the museum product description note. The material was initially developed for car industry use, but designers think it could also be used as interactive displays in hoses and schools;
- *Philips Woven Light* (Figure 119), a special light prototype that is considered a media screen and it is connected to the customized Philips Hue mobile app, which has a dual-mode control: nature driven and user driven. As stated on the product museum

description (bottom left image in Figure 119), this installation is part of a PhD project and only "part of its interactive performances were demonstrated".

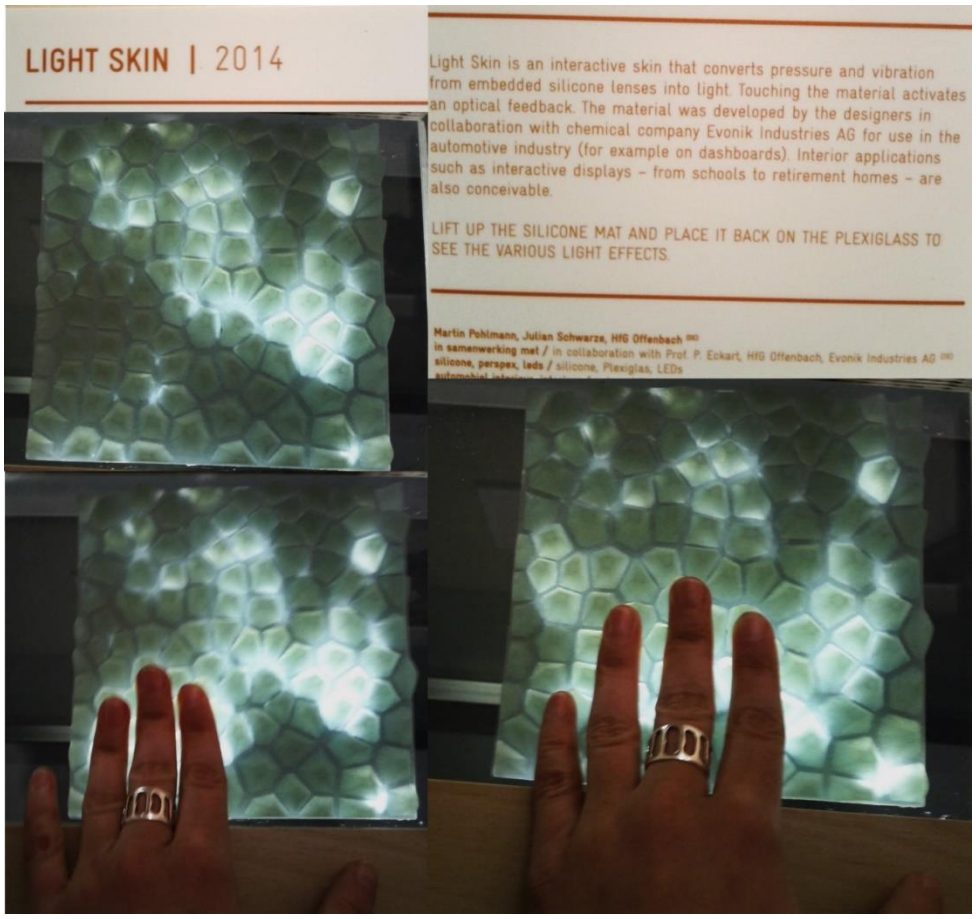


Figure 118. Light Skin. Pictures taken by the author.

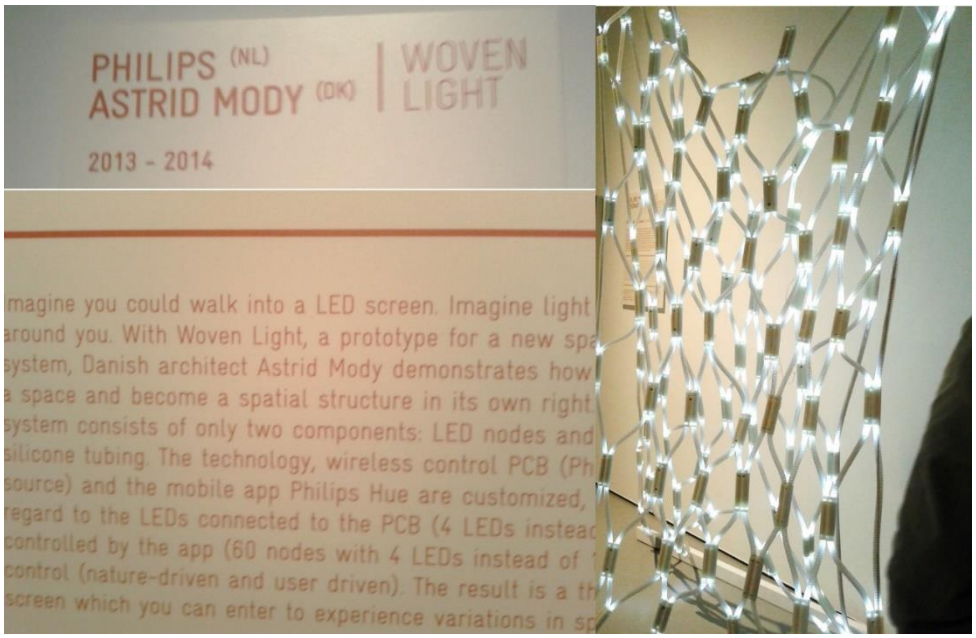


Figure 119. Philips Woven Light. Pictures taken by the author.

Moreover, Philips (2009) created an electronic-skin technology that looks like a thin plastic "wrapping" which is "ultra-low-power, lightweight, and full-colour technology" which is ideal for displaying colours, patterns and simple graphics (Figure 120). According to Philips (2009), the e-skin technology could be easily integrated into wallpapers in order to "create lighting and environmental controls that 'magically' appear when you want them, and then fade back into the wall". Individuals could "personalize their phone with the touch of a button, changing its colour to match their outfit, mood or environment – even using different colours to tell them who is calling", as shown in one of the sketches in Figure 120. The e-skin technology could be also used in product design, such as kettles that could change their colours when temperature rises (Figure 120) (Philips Research 2009).

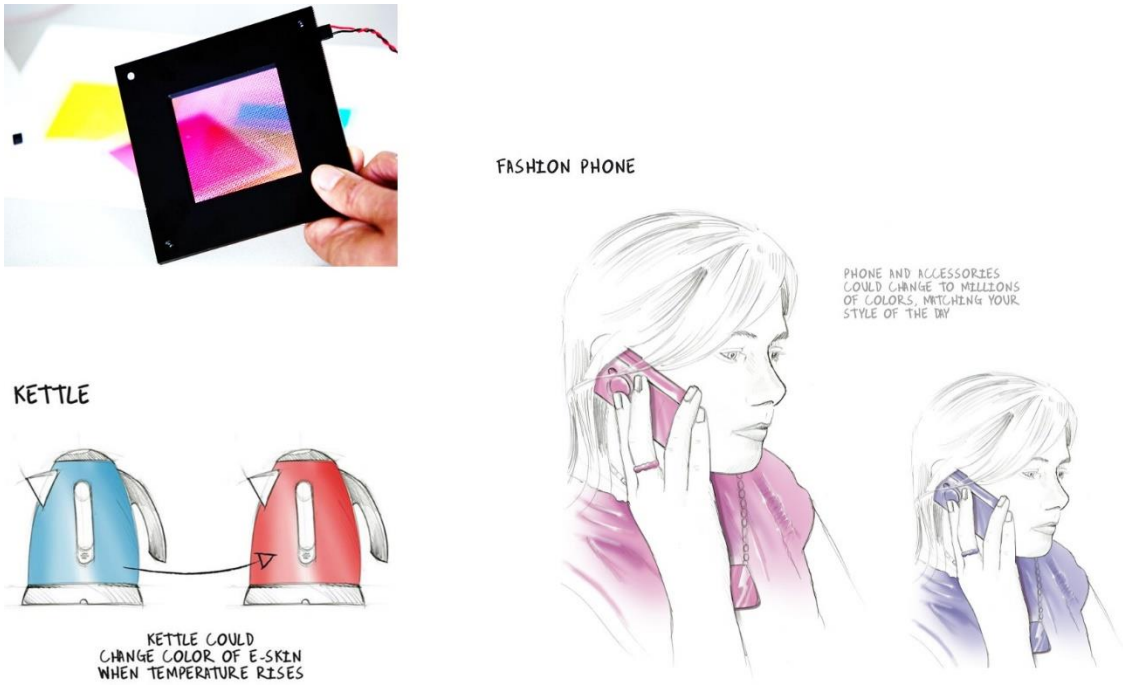


Figure 120. E-skin made by Philips and examples of its applications in fashion and product design (Philips Research 2015).

The use of electronic ink technology on an ultrathin, flexible material would extend the range of display application in various industries. *ShiftWear* present their revolutionary sneaker design based on e-paper technology: the sneaker's fabric is replaced by waterproof, flexible e-paper (Figure 121). This material is a flexible display that can be connected to one's smartphone. Innovative personal design can be uploaded onto the shoe "display" similarly to uploading a wallpaper to the smartphone's screen (ShiftWear 2015).

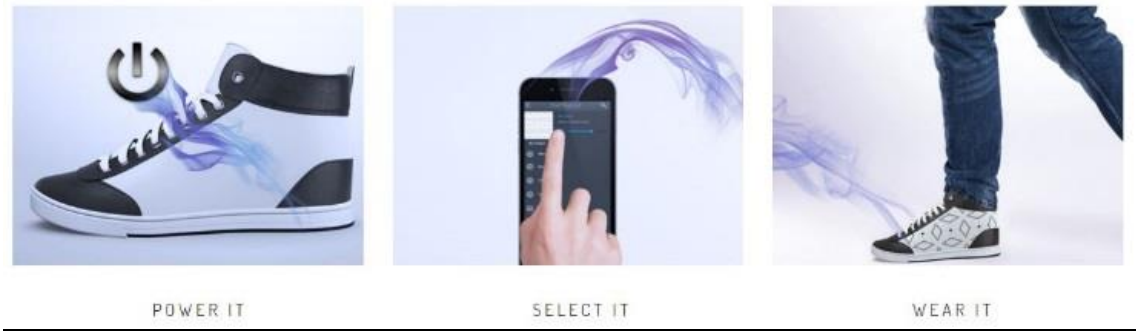


Figure 121. E-paper shoe concept by ShiftWear (ShiftWear 2015)

The use of smart textiles implies a reaction of the material when the user is interacting with it. For example, the *Light Skin* (Figure 118) would light under pressure, the *E-skin* (Figure 120) would change its colour under different factors such as high temperature or the control of a mobile app connected to one's accessories, and the *E-paper* (Figure 121) would change its pattern when the user uploads a pattern to her/his shoe material. All these material colour changes imply interaction, a subject discussed earlier in the Theory subdivision.

Design Development of the Interactive Installation

This section presents a study that tests out the interactive installation, but teens' feedback made the wall prototype fail, only the mobile app being further explored.

Pilot study -paper prototype

This study is run to test out a paper prototype, observe teenagers as users of it, get feedback from them and it explores teenagers' experience and understandability of the interaction process while using the paper device.

Paper prototypes are intended to be "sketchy representations of a product's interface" and they are used as a design research method as a "quick way to visualize, organise, and articulate basic design concepts" (Milton, Rodgers 2013). Using a paper prototype helps the designer to detect possible problems in the interface, and would allow it to be refined based on participants' feedback (Milton, Rodgers 2013).

This study aimed to introduce the use of a new social communication interactive product for teenagers, to help them communicate their moods using colours. Paper prototypes were used to test the concept of an interactive installation as described earlier in this chapter. Teenagers' feedback was gathered to see if they understood and liked the concept. The author's hypothesis was that teens would like to express their mood in a quick, effortless, private, personal, coded, and abstract way.

This study describes a low-tech exploration of the mobile phone and wall display installation. The exploration was with 22 teenagers who 'played' the installation using paper prototypes and then answered questions. The study found that the hidden meanings of the conveyed colours was one of the most attractive aspects for the proposed design and the wall display one of the least attractive items. The study concludes with design pointers for the installation.

Method

The aim of this study was to gather teenagers' feedback and opinions on the concept in order to inform or/and confirm the interactive installation design mentioned above. Therefore, a pilot study was run to observe how teenagers would use and understand this interactive device. The study consisted of two stages: stage 1 was designed for teenagers to understand how to use the device, represented by paper prototypes; stage two was an open discussion where predefined questions were asked. Both stages are discussed below after the Research Question subtitle.

Research Question

The goal was to have an open discussion with teenagers about how/when/with whom they would like to use the interactive installation. Nine research questions were used – these are shown as subtitles in the results section (example: "Do you like to communicate using colours or not? Why?").

Study Design

This study consisted of two parts. The first part was designed in order to help the teenagers understand how to use the device. The second part was designed in order to observe if teens understood the concept of the device, and knew how to use it. This second part ended with a discussion where teens answered the research questions in order to gain feedback that would be used to inform and/or confirm the installation design. Teenagers' answers are shown in the Results section and analysed in the Discussion section. Props were used to facilitate the study; cardboard mobile phones (Figure 122, Figure 123), a cardboard screen (Figure 124), an A4 printed colour palette paper (Figure 126), code cards (Figure 125) and blue tack in order to stick pieces.

Participants

Twenty-two teenagers (10 females, 12 male) from an UK school aged 11 to 13 years old participated in the study. Three group sessions were run – one after another – of around thirty minutes each. The groups were made up of eight, eight, and six participants respectively. For each session teenagers were anonymized by taking codes from T1 to T8 from eight different cards randomly faced down (see Figure 125). The cardboard mobile phones and screen were two-sided because there were to be two colour interchanges between phone owners and screen owners. On

Figure 122. The seven cardboard mobile phones with the side on which is written "Send this colour to T1".

Figure 123. The seven cardboard mobile phones with the side on which is written "You received this colour from T1".

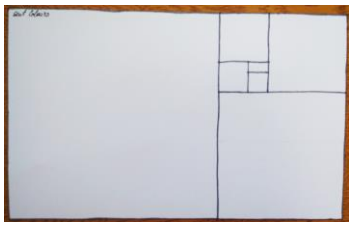


Figure 124. The cardboard screen divided in 7 shapes (6 squares and 1 rectangle).

one side of the phone was written "Send this colour to T1" (Figure 122) and on the other side was written "You received this colour from T1" (Figure 123). Similarly, on one side of the cardboard screen was written "Sent colours" (Figure 124), and on the other identical side "Received colours".

Procedure

The group of teenagers sat around the table in a classroom and were given seven cardboard mobile phones and one cardboard screen. One teen of the group held the screen. Each of the other teens held the cardboard mobile phones and sent a colour to the one who held the screen. Then the screen holder replied back by sending a colour to the other teens. Teenage holders had to imagine the cardboard screen and mobile phones changed colour. An open discussion followed after this procedure.

Results

After interacting with the paper prototype, all teenagers formed one group and answered nine research questions in an open discussion. The researcher asked each question and took notes while teens were answering. Each of the nine research questions are analysed below.

"Do you like communicating using colours or not? Why?"

The majority of teenagers said they would like communicating using colours, "because it is colours". They liked the idea of associating colours with emotions because it is different and faster. It is easier to pick a colour than texting, one boy said. Teenagers who answered "no" had various reasons: one girl did not understand what she had to do and one boy was colour blind. He could not see red and green. But he was engaged in the discussion, came up with ideas and he seemed enthusiastic about the process.

"Do you want your friend to know the meaning of the colour you sent or not?"

All teenagers thought it is important to add a meaning to colours so that it would make sense what one is trying to communicate. They agreed that it is important to know friends' emotions. One group thought colour choices are related to mood and colour preference can quickly change.

One girl suggested this device can help deaf people communicate their feelings. Therefore, all three groups of teenagers would like their friends to know the meaning of received colours.

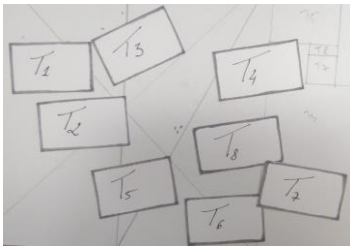


Figure 125. The cards were designed for being used by teenagers as a code name instead of their real names.

"WHERE WOULD YOU USE THIS KIND OF COMMUNICATION?"

Several teenagers said they would use it in bedroom, during boring hours, at school, at home, outside or anywhere. They really liked the secret code of it, the fact that no one would know what a colour meant unless they wanted to convey it. One boy came with the idea to make sentences using colour: one colour would be one letter, another colour another letter. Another argued one could play with the device as it is.

Figure 126. The colour palette from which teens had to choose colours. Each of them 8 teens were given a printed sheet with a coloured palette on it.

"WILL YOU USE IT TO COMMUNICATE ONLY BETWEEN YOUR FRIENDS OR WITH ADULTS TOO (FAMILY FOR EX.)?"

The majority said only friends, but some said they would communicate with family too. One girl did not want to communicate with family because she did not want her family to know the meaning of her colours.

"WILL YOUR BEST FRIEND HAVE THE BIGGER SIZE OF THE SQUARE? ON WHAT BASIS YOU WOULD ASSOCIATE THE SQUARE SIZE WITH YOUR FRIENDS?"

All teenagers said the association between square size and friends was not important. One teenager, when associating squares with codes (T2-T8) wrote them randomly. One said that it does matter, but then changed his mind when others said no.

"WHAT DO YOU THINK ABOUT THIS APP I WILL BUILD?"

Answers varied from decent to ok, good, one said boring. Few of them did not seem very enthusiastic about the device while others were really excited. They liked it because it is different, amazing, easy way to tell parents what you feel than face to face.

"HOW AND WHY WILL YOU USE THIS APP?"

They will use it every day, everywhere, for communicating while hiding feelings, or expressing feelings in a better way. One boy said he would use it when expressing his emotions because it is easier than texting. One girl said she could use it when going to see a concert, and send a white colour to friends to communicate her concert mood. Another boy said he would use it when feeling sick, so that parents would know how he feels.

"WHAT DO YOU THINK ABOUT THIS DEVICE I WANT TO BUILD?"

Some teenagers did not like the use of the LCD screen. They would only like to use the app on their personal mobile phones. One girl said she would not like to use the screen because everyone that might enter her bedroom could see it so it would not be personal anymore. Other teens liked the idea of the screen because of quickly changing colours. One said the colour mood communication device would be good for people who cannot spell, or are dyslexic, because they would send colours and would not have to write. It seemed they liked the idea of communicating using colours as hidden messages.

"HOW AND WHY WILL YOU USE THIS DEVICE?"

Several teenagers said they would use the device if bored. One group asked if this app actually exists. They were very enthusiastic when they were told it is going to be built. They were given serious, honest answers, maybe because they have understood their role and that their opinions matter.

Discussion

The concept of the author's interactive installation was supported by teenagers' feedback: most participants wanted to be able express their moods with friends and family using colours because it was a quick, different, nice, and easy way. Another reason was that it is easier to pick colours than texting. As the author assumed, teens thought it is important to add a meaning to colours so that it would make sense what one was trying to communicate. They liked having the freedom to give meaning to colours or not. Teens seemed to enjoy the possibility of using a hidden coloured coded language between them without others knowing. Teenagers' intuition about the relation between colours and moods was in accordance with author's hypothesis that colours preferences do change according to one's mood.

A few of the teenagers were not so keen on using the LCD wall screen, because of confidentiality reasons. They liked the idea of using the app only, because it was more personal. However, other

teens liked the screen idea, because it can quickly change colours on a wall. A precise number of how many teens liked or did not like the idea of using a LCD wall screen was not recorded, as the researcher took notes of teens' opinions in an open group discussion at the end of the study.

Contrary to the author's expectations, teens would like to use the app everywhere, not only in their bedrooms. Moreover, they said the association between square sizes and friends was not relevant to them.

This device could give teenagers the possibility of expressing moods in a quicker and easier way, the freedom of choosing if their colour message should have a meaning or not, the advantage of sharing emotions in a coloured coded way (if wanted). It could ease the teens-parent interaction by helping teens express their mood to parents in a faster and easy way.

Thinking of the work contributions, the colour-mood interactive installation could be used by: patients living in same hospitals rooms, helping them share their mood while suffering from similar problems; old people in care environments so it would be easy for the caregiver to be aware of their mood (or between elderlies to share emotions while being in their own room as it might be hard for them to speak because of old age); people with movement problems for which it is hard to speak or write; and in classrooms between teacher and scholars so that the first one would know how topics affect pupils.

To conclude, the design concept of the interactive installation (Figure 127) started with a wall design and a mobile app design, the relationship between them being that the wall displays what is shown in the app. In the end, the wall prototype failed and so the relationship between the wall prototype and the app prototype are not further explored (Figure 127) but the mobile app was further developed and described in the Mobile app prototype section. There were three mobile app versions and the third became the final prototype that was evaluated in Chapter 8.

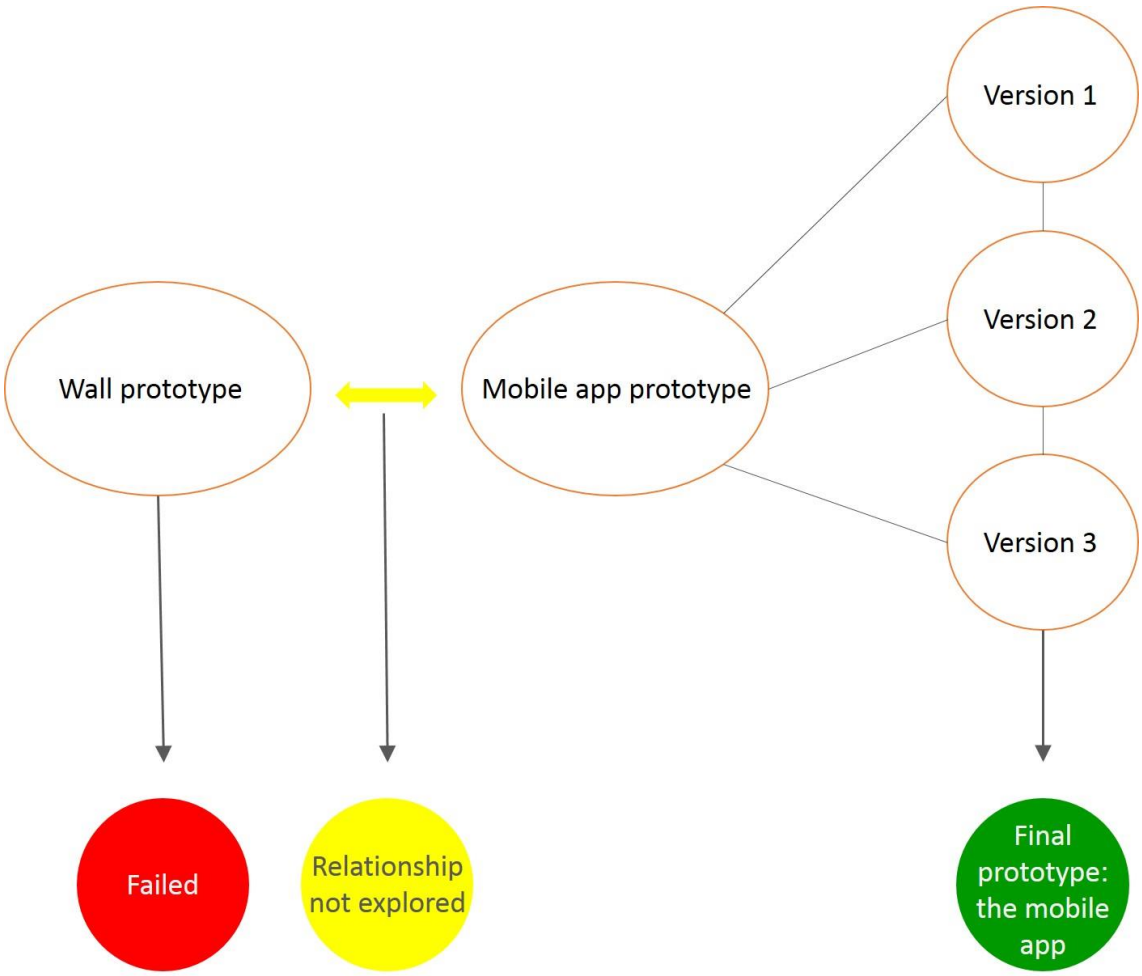


Figure 127. The diagram of the interactive installation design process.

Mobile app prototype

Version 1

The pictures below show the first sketches for the app design concept and also the first prototype. The initial idea was that a group of six teenagers would each have a display that was connected to their mobile phones. Figure 128 shows that one mobile is connected with five different displays and that one display is connected with five different mobile phones. Using a specially design app on their mobile phones, teenagers could control the lights of the other five displays. The first sketches lead to the first prototype of the app, that included six friends, therefore 6 geometrical shapes of different sizes (Figure 129). Designing the display into the app, was included at this stage. The circles in Figure 130 on green and blue backgrounds represented 20 different moods, that teenagers would choose from when sending colours to their friends. The design of the app was to be suited not only for mobile phones, but for tablets or computers too, in the idea that these devices could be connected to the display. The background colours in top left image of Figure 130 would represent the colours sent to those friends, and the background colours in the

bottom line of Figure 130 represent the last colours received from a certain friend, when the user would visit their personal profile. These ideas were the initial concept ideas.

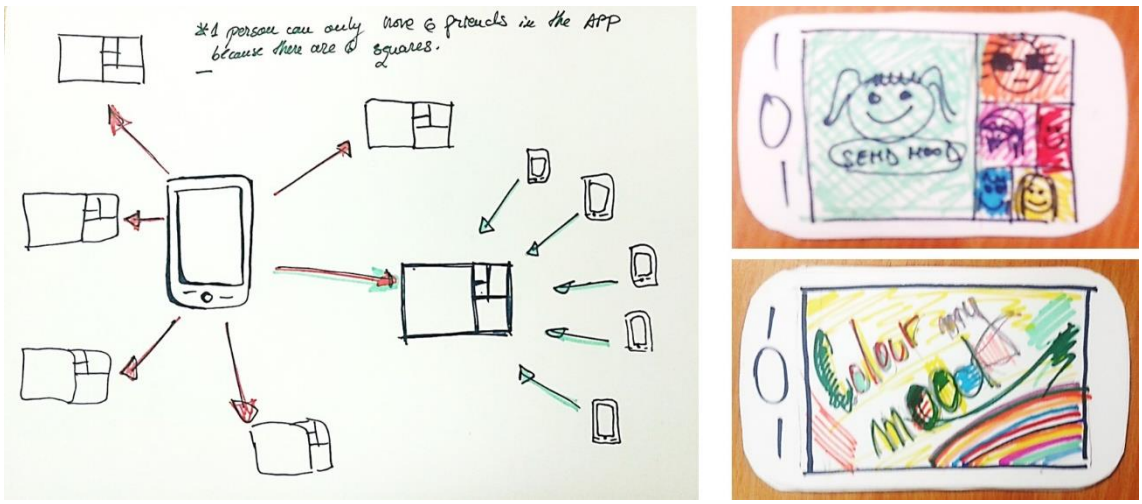


Figure 128. First sketches for the mobile app.

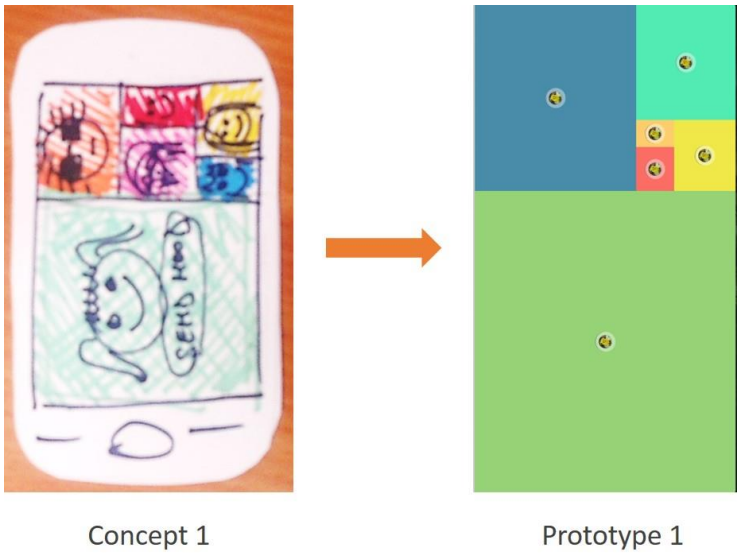


Figure 129. The app concept transferred into the first mobile app prototype.

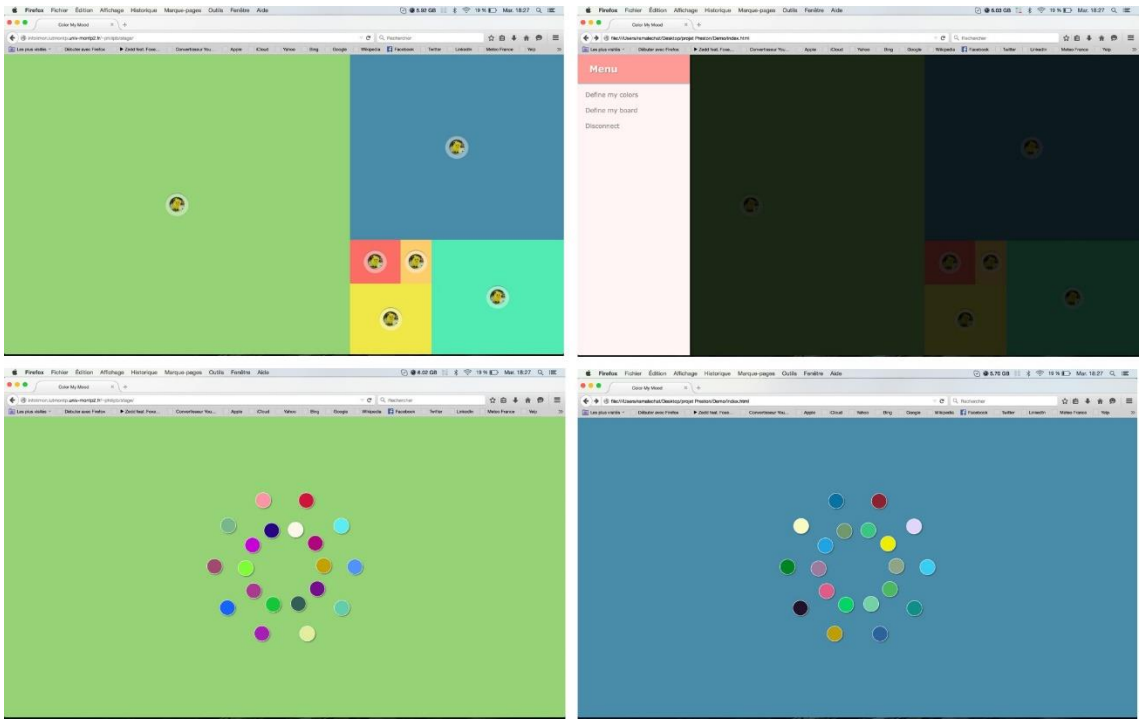


Figure 130. Screen shots of the development of the first mobile app prototype.

Design Critiques study

This design study aimed to inform the second mobile app version by analysing ten different mobile apps from Google Play, using a research for design method (Frayling 1993, Zimmerman, Forlizzi 2014). This research method intended "to advance the practice of design" (Zimmerman, Forlizzi 2014) where "the thinking is embodied in the artefact", where the goal is to visually communicate knowledge, where expressive tradition is concerned (Frayling 1993). The author analysed the design of ten different mood apps from this point of view. The mood apps were "Colouring", "Mandala Colouring Pages", "Moodlytics", "Moodtrack Diary", "How are you feeling", "MoodMeter", and other four mobile apps that were either not recorded back then or cannot be found on Google Play anymore. These ten different mobile apps were analysed in order to find inspiration for the design of author's *Colour me Mood* app.

Method

The author inspired her design from several mobile app interfaces, and the lenses she was looking through were those of a designer. Therefore, it could be said that a research for design method (Frayling 1993, Zimmerman, Forlizzi 2014) was used in this small study aimed to review and comment on apps that were already on the market from two points of view: visceral design and behavioural design. Visceral design is related to the appearance of a product, while behavioural design focuses on usability and functionality, or in other words on the pleasure and effectiveness to use a product (Norman 2004).

Ten mobile app images (Figure 131, Figure 132, Figure 133) were analysed by the author, who found design elements that could be taken forward to her own design, or design elements that should be avoided.

Figure 131. Mobile app design inspiration.

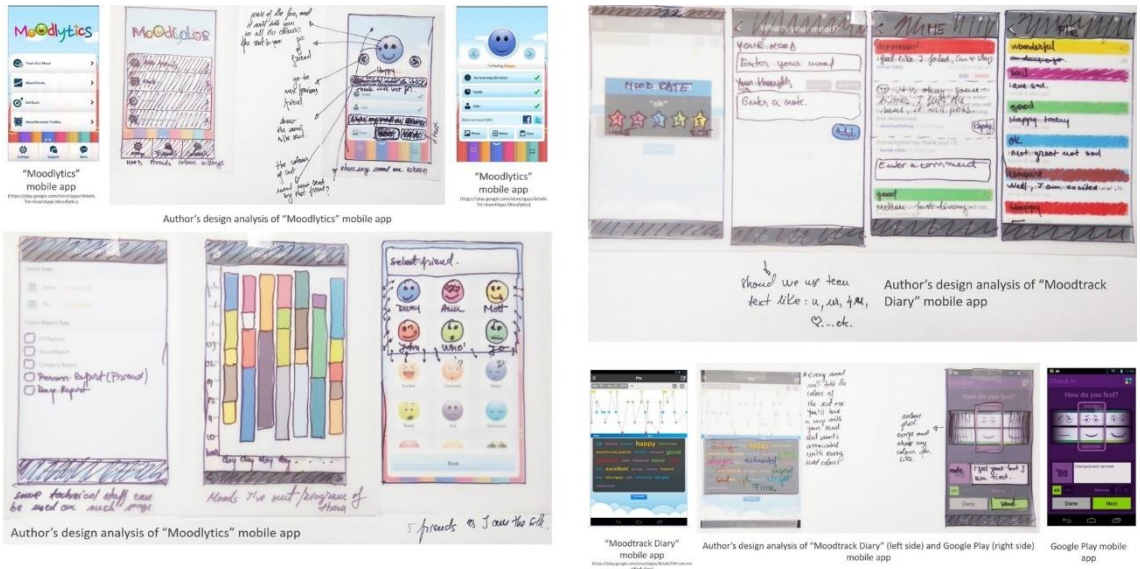


Figure 132. Mobile app design inspiration.

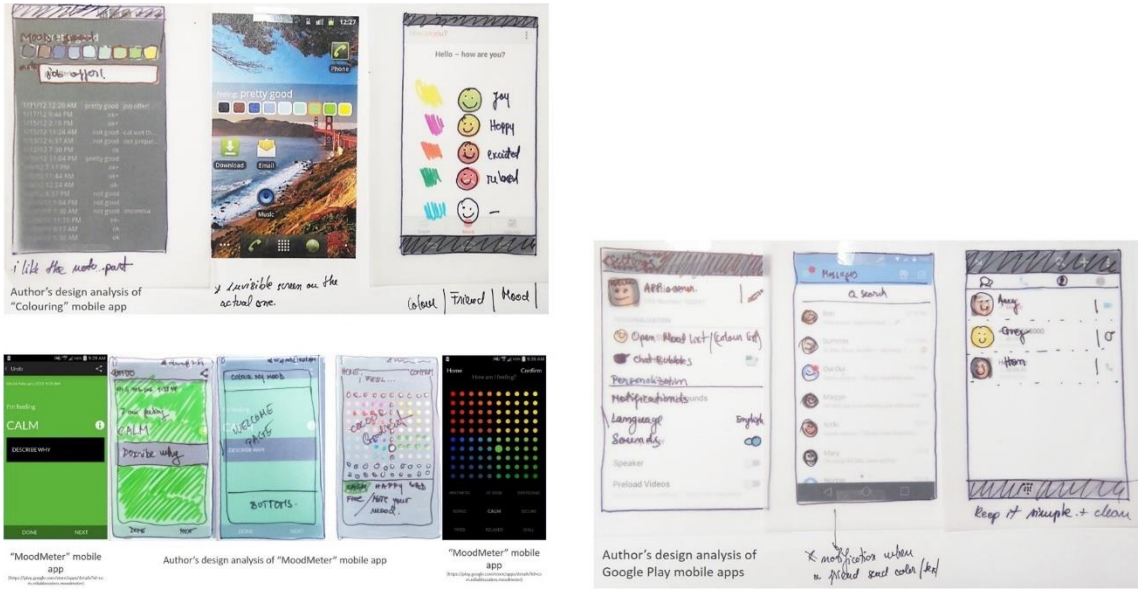


Figure 133. Mobile app design inspiration.

Conclusion

For this study a set of design critiques (Table 43) lead the author towards design version two for the *Colour me Mood* app. These design critiques were general conclusions about aesthetical design (visceral design) and functional design (behavioural design) of ten different mobile apps.

Visceral Design		**Behavioural Design**	
Pros	**Cons**	**Pros**	**Cons**
Clear, nice empty screen area for sharing images.	Too heavy design such as too many colourful elements for the home screen, and because of that not too easy to find buttons as they do not stand out.	The use of a colour picker with big icons is very handy.	More buttons appeared when in landscape mode.
Simple, few buttons, large colouring area, simple design and intuitive to use.	The icons/buttons are hidden in the drawing.	The use of a colour picker in form of a 'swipe and pick' tool.	
The use of bright colours attracts the user's eye.	In one of the apps the colour-mood association is by default, with red representing the lowest moods and yellow the happiest.	Users would have a map with their recent sent moods associated with every used colour.	
The app interface is very simple and nicely designed, allowing the chosen colour and mood to stand out.		Mood track apps where the user could keep a track of her/his mood seem to be a common use.	

Visceral Design		Behavioural Design	
Pros	**Cons**	**Pros**	**Cons**
Free space of the screen where images could be shown.		The presence of different colour picker designs.	
The use of few buttons to create a simple and intuitive design.		The use of text boxes where one could write their mood and maybe say why they are feeling in a certain way.	

Table 43. General aesthetical (visceral design) and functional (behavioural design) conclusions after analysing ten different mobile apps.

Therefore, based on the general conclusions in Table 43, the author decided that her future mobile app would mirror the following design principles:

- The use of bright colours;
- The app interface should be simple and nicely designed, allowing the chosen colour and mood to stand out in order to create an easy-friendly and intuitive user experience;
- The screen area is needed to be easily visible for sharing colours;
- Fewer buttons should be used in order to create a simple and intuitive design;
- Users could have a map with their recent sent moods associated with every sent colour;
- An innovative colour picker design should be used, as picking colours would be one of the main activities users would do with this app;
- The use of text boxes where one could write their mood.

Version 2

Version two of the app focusses on how the app could be used and how teenagers would communicate between them by sending both colours and moods, as well as receiving both colours and moods. This second concept, where design aesthetics were a fundamental element, is described in the next section.

Concept

The mobile sketches below are an example of the author's second design idea.

The first figure on the left (Figure 134) shows a teen sending a yellow colour to his/her friend, Janet, and associating a 'happy' mood to this colour. The following three figures represent Janet's screen and her choices of replying with a colour or a text. It can be seen she texts 'keep up the mood' without associating a colour to the message.

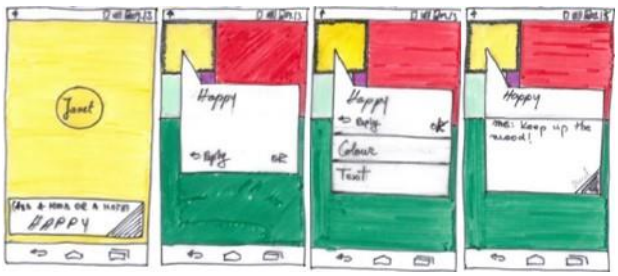


Figure 134. An example of two concept screens when communicating with colours.

The following steps and images will give the reader a broad view of the author's app concept regarding both aesthetics and how it should be used.

Step 1 (Figure 135): Imagine this is Andra's home page when she opens the app. There are six rectangular shapes and each friend of Andra is associated with one of those squares/rectangles. In order to check one of her friend's mood, Andra will press on one of the six colourful rectangles. Each rectangle is associated to one of the six friends that are using the app.

Step 2 (Figure 135): When Andra presses the green rectangle, the friend's name will appear on that specific rectangle. The colour of each rectangle is the last colour sent to Andra by that friend. In this case, the last colour that Janet sent is green.

Step 3 (Figure 135): Andra would press again on the friend's name and it will take her to this screen where she can choose a colour that she wants to send to Janet. First Andra has to choose from the primary and secondary colours (the ones in the image: yellow, orange, red, violet, blue, green) or from the non-colours (white, grey, black). In this example, Andra chooses yellow colour. A black circle appears around the yellow colour showing it was selected. If Andra presses again on the yellow colour, next screen will appear where Andra can choose a certain shade of yellow.

Step 4 (Figure 135): On screen 4 Andra can choose from all shades of yellow. In order to "rotate the wheel" Andra has to scroll up and down to see all shades options. When she would choose a shade, she would select it (a black circle would appear around the selected shade). If Andra presses again on the same colour shade, the app. would take her to the following screen, because she has decided on the colour. The circle that surrounds Janet's name will become the colour selected by Andra: a certain shade of yellow (step 5 in Figure 136).

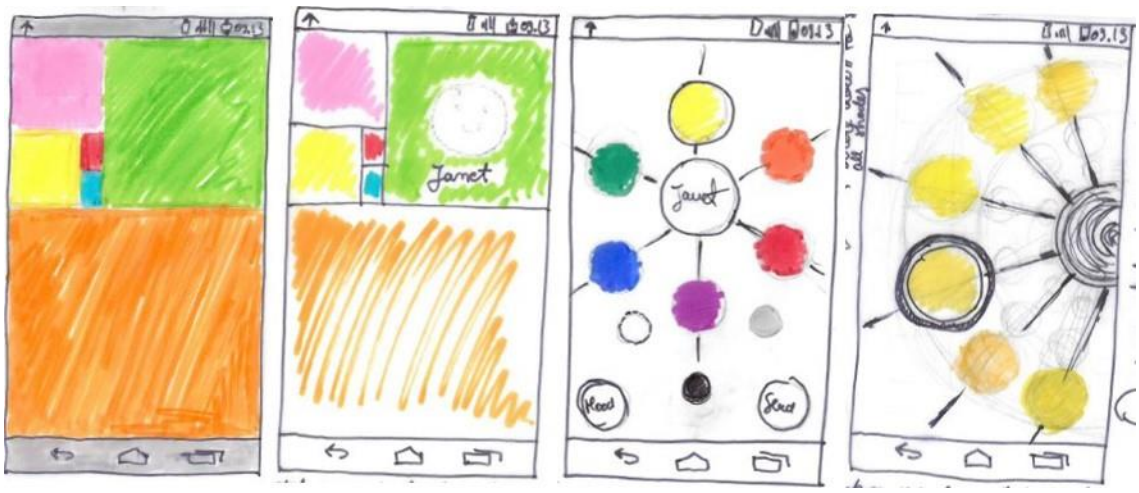


Figure 135. Steps 1, 2, 3, and 4 (from right to left).

Step 5 (Figure 136): After Andra selected a colour that is to be sent to Janet, all the other buttons disappear so that the screen is all filled with the selected colour that is to be sent. If Andra decides to change the colour, then she would press on the circle with Janet's name on it and this would take her to screen no. 3, where she can choose another colour or shade. If Andra is happy with the yellow colour on the image collated to this text, then she can send it by pressing the "send" button. If Andra wants to add a meaning to the colour that is to be sent, then she can press "mood" button to add a mood for the colour. After deciding on the mood, Andra gets back to this same screen and sends both mood and colour to Janet.

Step 5.01 (Figure 136): This image shows that Andra pressed "mood" button to add a mood to the colour she would send. A text box appears that allows Andra to write her mood or message. A maxim number of characters is allowed to write a message. The black triangle on the corner of the text box is an "ok" button. Once Andra presses "ok", screen 5.02 will appear and Andra can send the colour and mood to Janet.

Step 5.02 (Figure 136): Andra chose a mood for yellow colour and now both can be sent to Janet by pressing the "send" button.

Step 5' (Figure 136): This image represents Janet's screen. If Andra presses the "send" button the yellow colour will appear on Janet's screen in the rectangle allocated to Andra. Received colours can change once they are received, without any notification. If the yellow square has a black contour around it that means the colour that has been sent has been associated with a mood. If there is no black contour around the yellow square at all, then it means Andra sent only a colour, without a message.

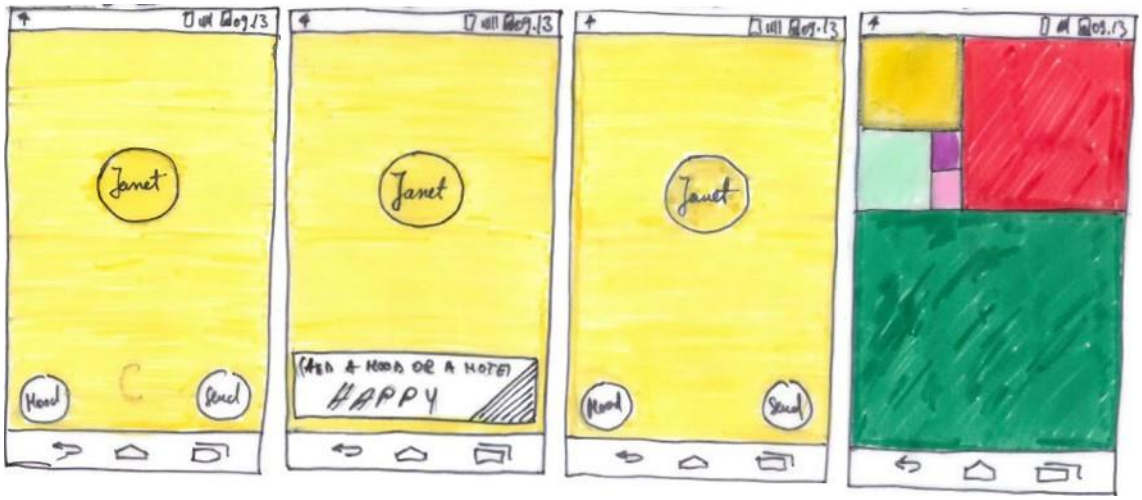


Figure 136. Steps 5, 5.01, 5.02, and 5' (from left to right).

Step 5.1 (Figure 137): This image represents how Janet's screen would look like when Andra sends a yellow colour to Janet. The yellow square (allocated to Andra) gets thick black margins in order to let Janet know she received a colour with a meaning from Andra. The colour changes when friends send another colour. However, when the colour has a message too, black margins appear as a notification for Janet.

Step 5.2 (Figure 137): When Janet presses once the yellow square, Andra's name will appear (an icon, picture of face might mislead the real mood). If Janet presses again on Andra's name of the yellow square, then screen 5.3 appears as a text box. In this case, because the yellow square has a black margin around it, that means a mood/message has been attached to the colour received by Janet. If Janet wants to read the message, she has to tap on the yellow square or Andra's name.

Step 5.3 (Figure 137): This image shows the textbox that appears when Janet presses Andra's square that has black edges. On the text box Andra's message appears. Janet can see it and press "ok" or reply. If Janet selects the "ok" button, the text box disappears. If Janet presses the "reply" button, then go to step 5.4.

Step 5.4 (Figure 137): If Janet presses "reply" button, then other two buttons appear in the same text box: the "colour" button if Janet wants to respond by sending a colour or the "text" button if Janet wants to respond only by text. An option regarding reply time could be available in settings, where the user could set their own time limit for responses. However, there is no reply time in the final prototype. For example, Janet opted for responding once to the received colour, as her focus is on the momentary responses. Therefore, Janet could respond in a period of several hours. If she does not respond, then she would not be able to respond to that particular message. Therefore, the responding time could be set by the user, as everyone is different, in such way that one might

need time to reflect on the colour received, or one might be too busy during day-time, while other might prefer an immediate response.

Figure 137. Steps 5.1, 5.2, 5.3, and 5.4 (from left to right).

Step 5.5 (Figure 138): If pressing the "text" button, then Janet would be able to only text Andra (not sending colours too), as seen in the image on the left side. The dark triangle in the right corner of the text box is the "send" button.

Step 5.6 (Figure 138): If pressing the "colour" button, it will take Janet to this screen on the left side. Here, Janet can choose any colour she wants to send back to Andra. If Janet changes her mind about adding a mood/message to the colour, she can press the "mood" button and add a message to the colour.

Step 5.7 (Figure 138): Janet selects green to send Andra a shade of it. When green is selected, a black circle appears around it. If Janet presses again on the same selected shade it would take her to the next screen, 5.8. The design of the interface builds on the creative flair that any designer brings in a design process; it was designed to be visually appealing and different to other colour selecting UIs to trigger visceral design (Norman 2004) in one's mind.

Step 5.8 (Figure 138): During this stage Janet, would select a shade of green. It can be seen in the image that the first shade of green was selected. Even if Janet has selected a shade of green, she can still "rotate" the wheel (scroll up and down) to see all the available shades. If no other shade besides the first choice interests her, then Janet can press the black half circle button that would take her to the previous selected colour choice. When Janet taps again the selected colour it would take her to screen 5.9 in Figure 139.

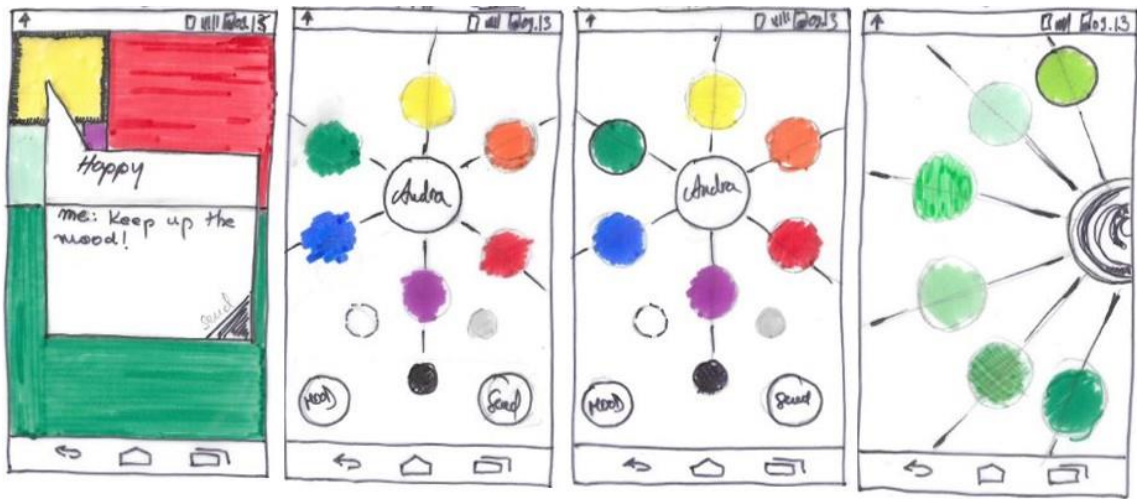


Figure 138. Steps 5.5, 5.6, 5.7, and 5.8 (from left to right).

Step 5.9 (Figure 139): Once Janet selected a colour shade to be sent to Andra, the screen becomes that colour and most of the other buttons disappear as it can be seen in the image on the left side. At this point Janet can add a mood/message to the colour by pressing the "mood" button or send the colour as it is by pressing the "send" button.

Step 5.9.1(Figure 139): Janet sent a colour to Andra with no meaning. The first column, from left to right, represents the colours Janet send to her friends. The middle column represents the people (which are Janet's friends) to whom Janet sent those colours. Last column represents the moods Janet associated with each sent colour. If there is a line towards one mood, then it means Janet did not send any mood associated with the sent colours to her friends. The "home" button takes Janet to the home page (screen 5' in Figure 136).

Step 5.9.2 (Figure 139): If Janet pressed the "mood" button, then a text box appears where Janet can write her mood to Andra. Once the message is written, Janet can press the "ok" button which is the dark triangle on the right side of the text box.

Step 5.10 (Figure 139): After Janet writes up her mood or message to Andra, then she gets to this screen where she can tap the "send" button. Both colour and mood will be sent to Andra.

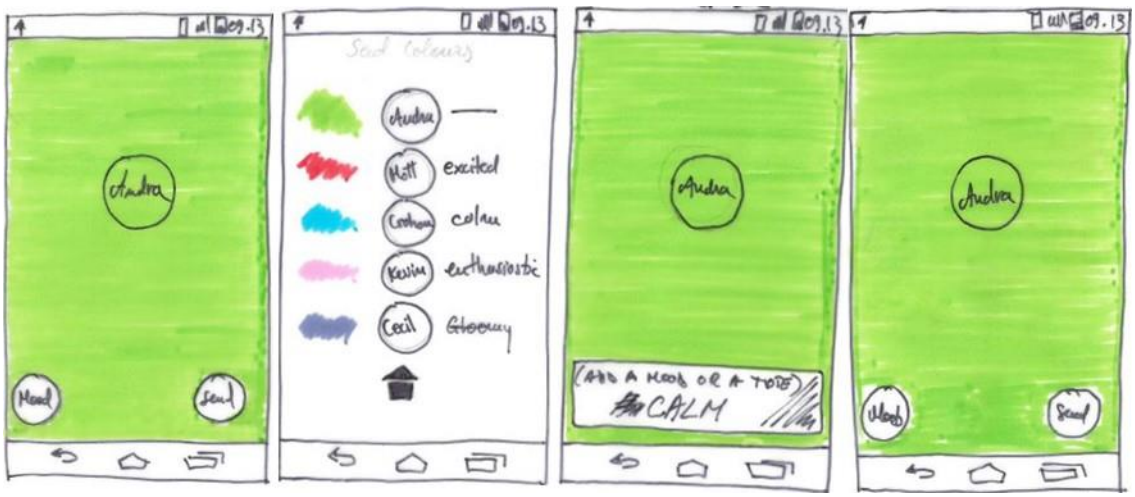


Figure 139. Steps 5.9, 5.9.1, 5.9.2, and 5.10 (from left to right).

Step 6 (Figure 140): After the text is added to the colour, Andra can press the "send" button to send both colour and text to Janet. When pressing the "send" button, the colour message is sent, and screen 7 appears. If Andra wants to send only a mood with no colour selected, then she has to press the "mood" button and she would not select any colour (for screen 3).

Step 7 (Figure 140): Screen 7 shows Andra's friends with the colours she sent to each of them and the sent messages if any. The colour's column is on the left, the friends' names in the middle and the sent mood/text on the right. If no text has been sent, then no text will appear. The black arrow that points to the left side of the screen should be replaced by a home icon so it can take Andra to screen 1 which is the home screen.

Step 8 (Figure 140): Screen 8 is actually screen 1, the home page which would remain active in such way that colours would change each time friends send to Andra different colours.

Step 9 (Figure 140): In order to go to the "settings" page Andra has to go to the home page and swipe to the left. A new screen appears where she can find settings and more (step 10).

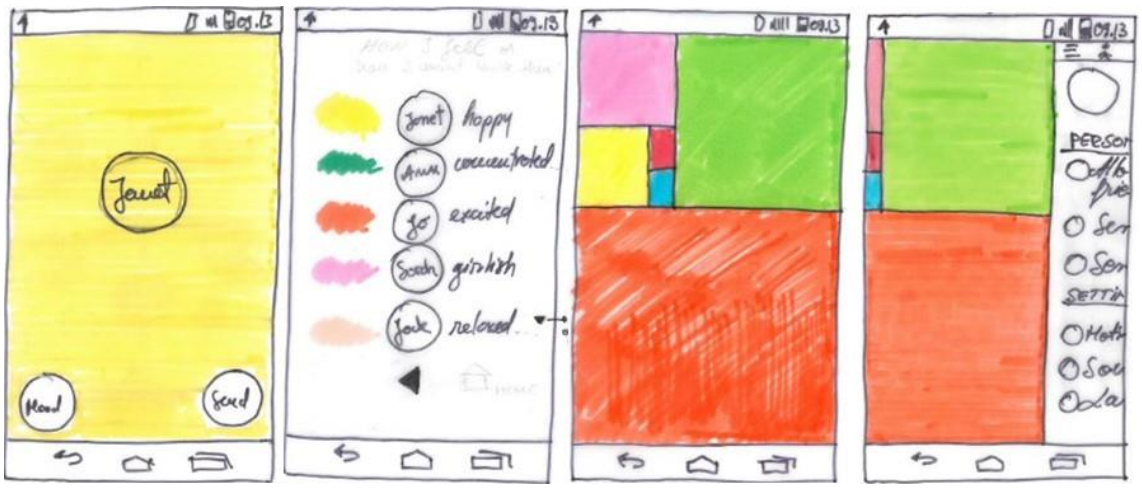


Figure 140. Steps 6, 7, 8, and 9 (from left to right).

Step 10 (Figure 141): Screen 10 represents a first concept of what settings and other pages the app should contain. If "allocate squares to friends" button is pressed, it takes Andra to a new screen where she is able to allocate squares to each of her friends from the app. If pressing the "send colours" button, Andra sees the colours she sent to her friends. If pressing the "sent moods" button, Andra sees the moods or texts she sent to her friends.

Step 11(Figure 141): When Andra presses the "allocate squares to friends" button the screen in the image appears. Andra has to tap each square where each time a list of her friends' names appears. She has to choose one friend from that list until there is no friend left to be associated with any square.

Step 12 (Figure 141): For example, let us imagine that in the previous step Andra tapped on a square. The image on the left appears (or a similar one) where Andra could pick one of her five friends which at the moment is the maximum number of friends allowed. For future improvements however, there will be an "add new friend" button as it can be seen in the image on the left side. Imagine Andra picks Janet so Andra taps on Janet's item and Janet is allocated to that specific square (see next screen on step 13). After the selection is done, the "ok" button sends Janet to that square and takes Andra to the previous screen, screen 11.

Step 13 (Figure 141): As it can be seen in the image, Andra allocated Janet to a specific square. Andra repeats the same procedure until all of her friends are allocated to a square from the app. The friend-square allocation could be changed at any time. In order to add colours to the squares, Andra has to receive colours from her friends. In this case, Janet sent Andra a pink colour. Once the first colour is received, the name of the sender disappears from the square as shown in steep 14 in Figure 142.

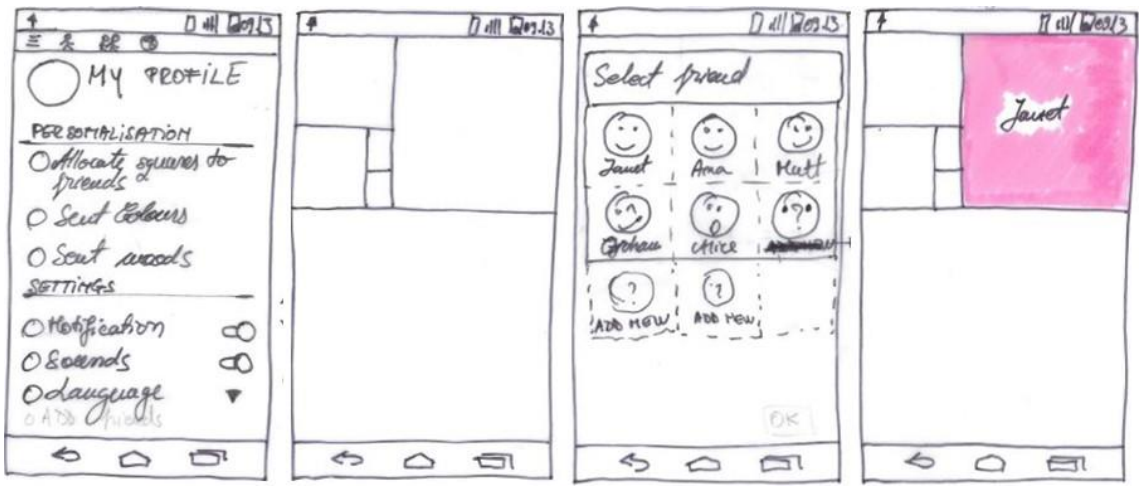


Figure 141. Steps 10, 11, 12, and 13 (from left to right).

Step 14 (Figure 142): This is an example of Andra's screen (at the very beginning stage) when she waits for her friends to send her colours in order to have a colourful screen. The colourful squares and rectangles are the ones where friends sent colours. The white ones with names on them have not been "activated" yet as those friends did not send any colour.

Step 15 (Figure 142): If Andra wants to associate a different rectangle to a friend, then she would go to "my profile", "allocate squares to friends", tap on the square she wants to move her friend to and then "select friend" button will appear. Andra selects Janet and the new square is allocated to Janet. The colour does not disappear or change because of this movement, it sticks to the square. In this case Janet and her pink colour moved together to the bigger sized square while Ana moved to the other one (see image on the left side).

Step 16 (Figure 142): Going back to step 10, if Andra selects the "sent colours" button from "my profile" then she is able to see the last colours she sent to her friends, as it can be seen in the image on the left. The screen is similar with the home page one, but the difference is that these colours are the colours sent by Andra to her friends, and not the ones she received from them.

Step 17 (Figure 142): If Andra wants to keep track of the colours she sent to each of her friends, then she can tap on any rectangle and a text box appears like in the image on the left side. In this text box Andra can see all the colours she sent to Ana. Andra could scroll down to see more colours. If Andra wants to see the moods associated to each colour, she would click on a colour from the colour rows in the text message and a mood/message would pop out like it is shown in the left-side image.

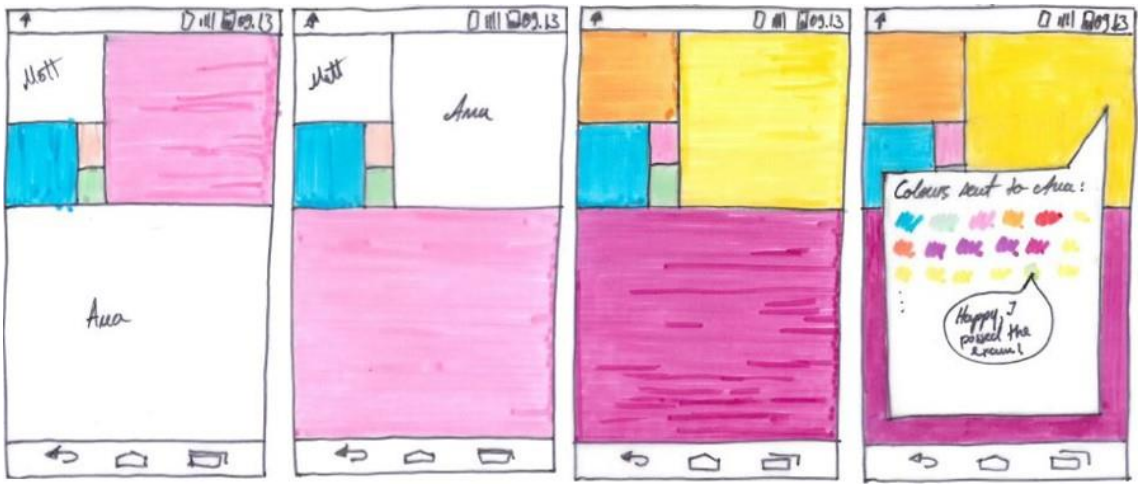


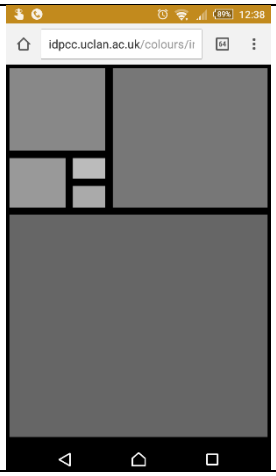
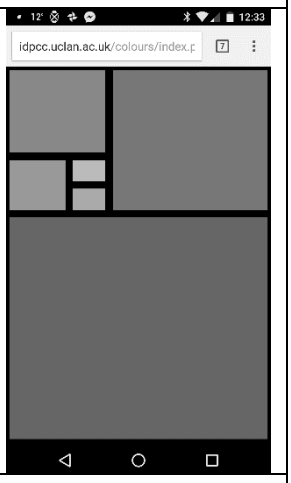
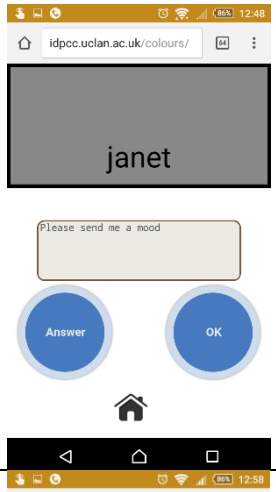
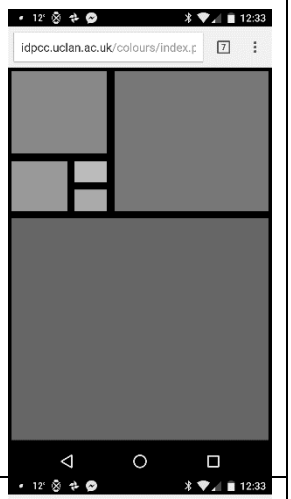
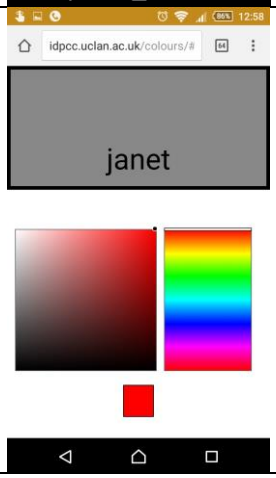
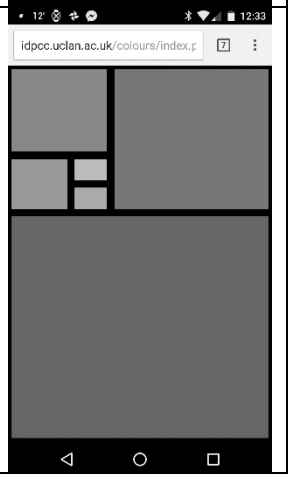
Figure 142. Steps 14, 15, 16, and 17 (from left to right).

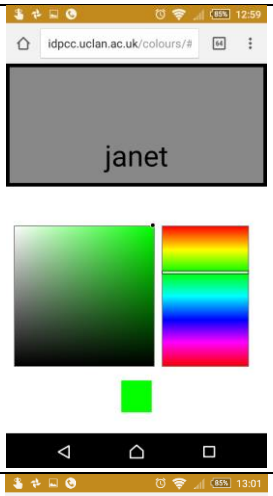
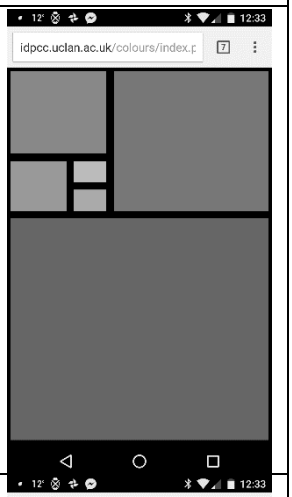
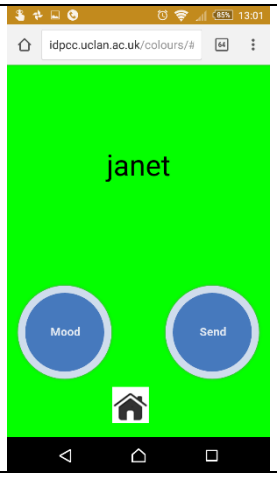
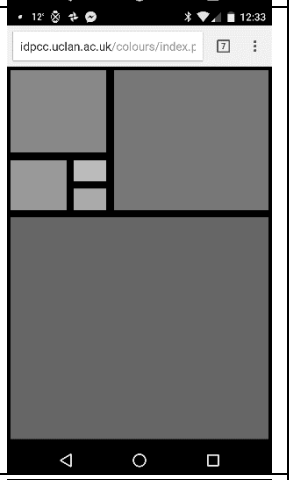
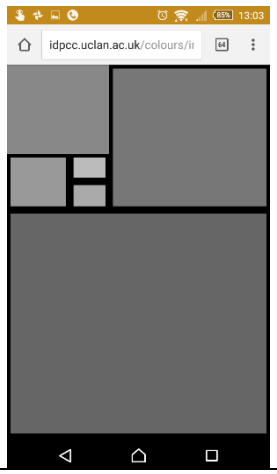
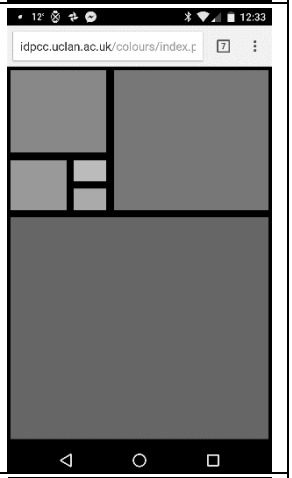
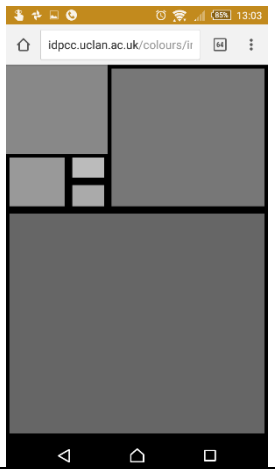
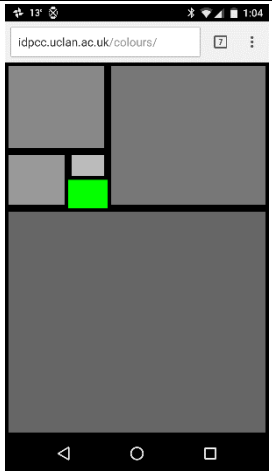
Version 3

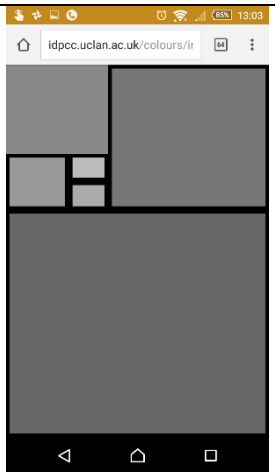
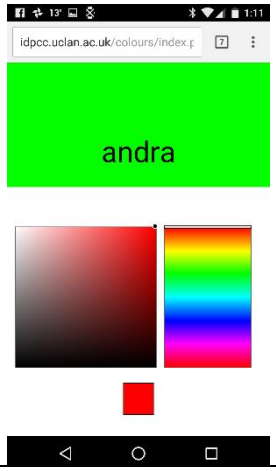
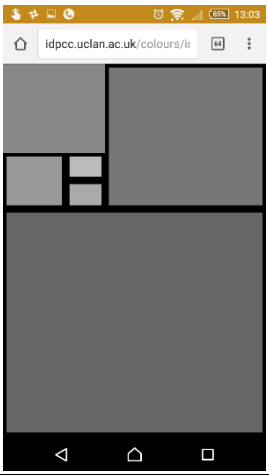
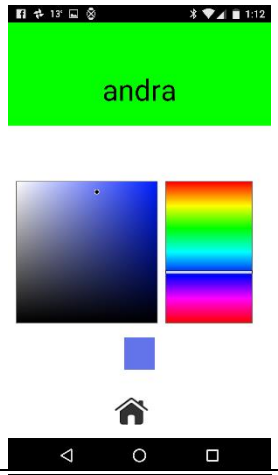
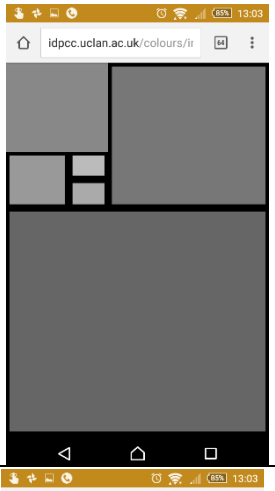
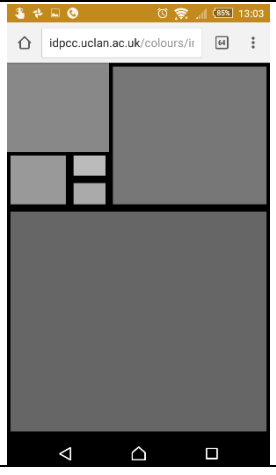
The design concept above could not be built as planned (for example there are no circles and lines for selecting colours in the final prototype) because of time restrictions. However, the design concept was partly implemented in a mobile app prototype that included the basics of the concept (self-disclosure, ambiguity, and interaction between groups of friends in a mobile colour mood application).The application was a web application running on a Linux, Apache Server, MySQL, PHP (LAMP) Stack. Client side scripting used the JQuery framework. The app allowed teens to associate a text to the sent colour if they wanted that. Table 44 is a detailed example of how the mobile app could be used between two users, who will be called Andra and Janet. The first left side column of the table ("Actions" column) represents the actions taken when both Andra and Janet use their app. Images of Andra's screen and Janet's screen are displayed in two columns.

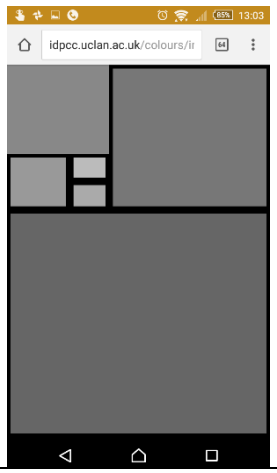
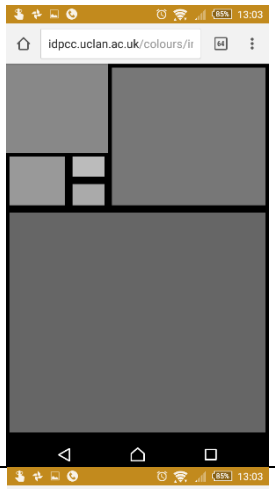
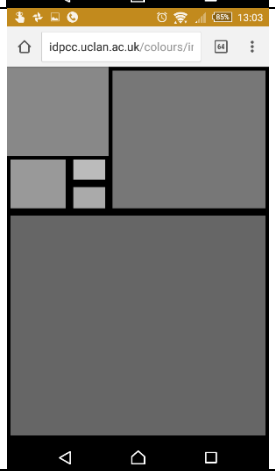
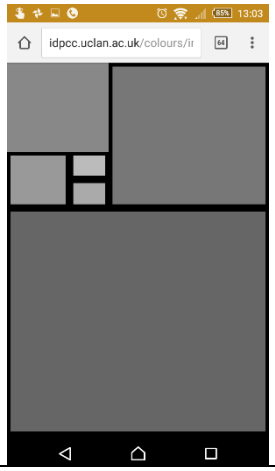
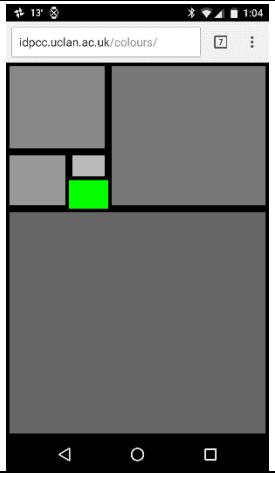
When an action has been taken, it is written in the "Actions" columns, and the result of it is shown as an image in the other two columns. For instance, when Andra taps the "Answer" button (A2 in Table 44), then image A3 in Table 44 appears as a response to that action. Andra then picks a green shade to send to Janet (A4 in Table 44), and when that shade is selected then A5 image in Table 44 appears as result of Andra's selection. Janet's screen remains the same (J1) until green colour is sent by Andra (A6). At this point, Janet's screen changes (J2), a green colour appearing in the square associated to Andra. That green colour is the colour Andra sent to Janet. Janet would then have the option to respond to Andra, by sending a colour, a colour associated with a mood, or only a mood. In this example, Janet picks a shade of blue colour to respond to Andra (J4), then she associates a mood to that colour by tapping the "Mood" button (J6), writes a message into the text box (J8), and sends the message. This action takes her back to the previous screen (J2). Andra receives the colour with its associated message (A8), and can either answer by tapping on the "Answer" button or she can ignore the message by tapping on the "OK" button. In this case Andra

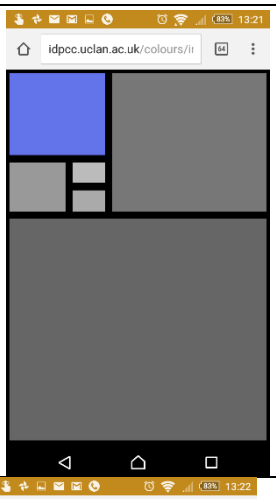
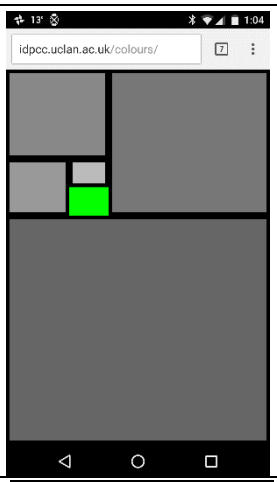
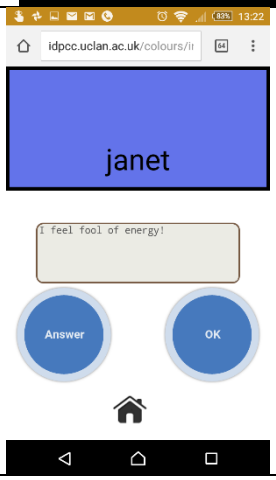
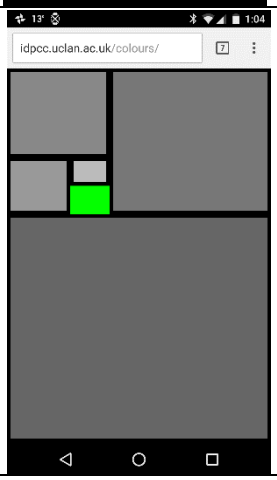
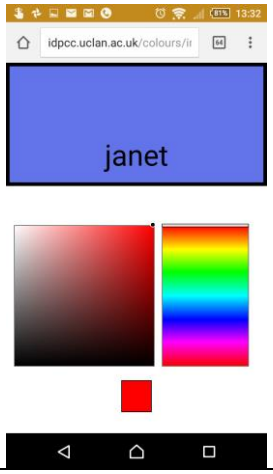
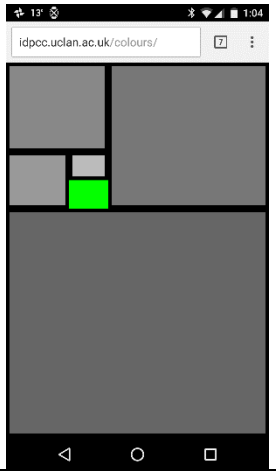
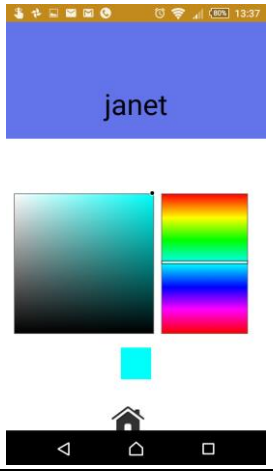
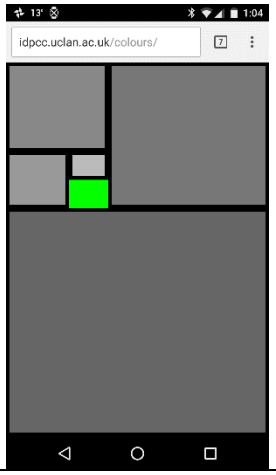
intends to answer by choosing a pale blue colour associated with a "happy" mood (A13), but then she changes the mood into a text: "happy and full of joy" (A16). Andra sends the blue colour associated with the test (A18) and Janet receives it (J10).

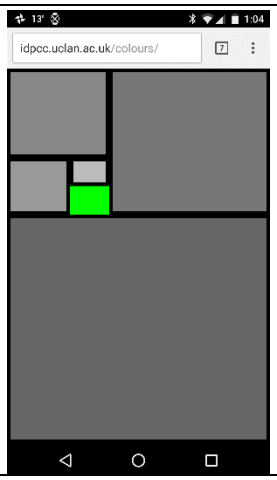
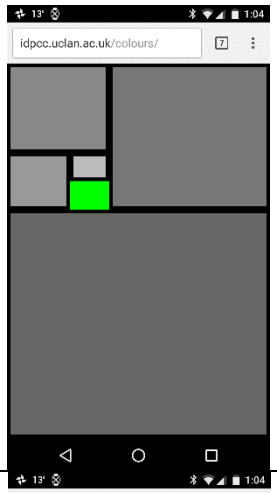
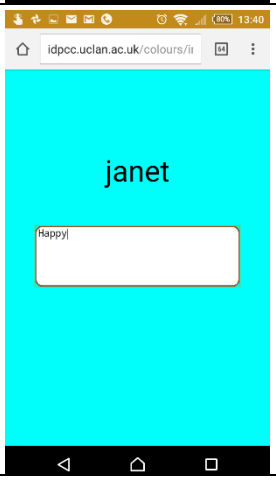
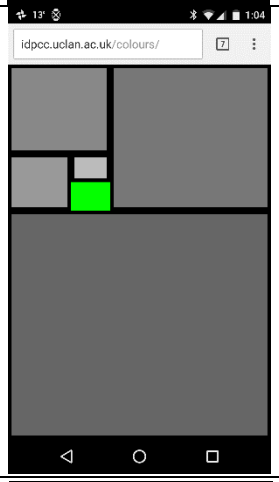
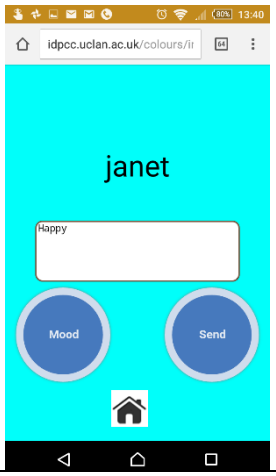
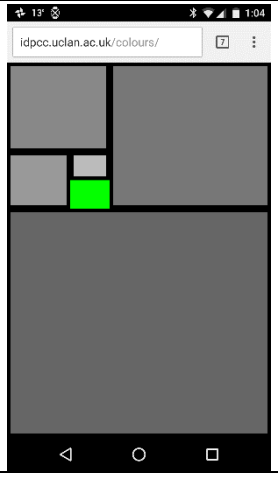
Actions	Andra's screen	Janet's screen
How the screen looks before receiving colours from friends.	A1 	J1 
Andra decides what to send to Janet	A2 	J1 
Andra taps the "Answer" button	A3 	J1 

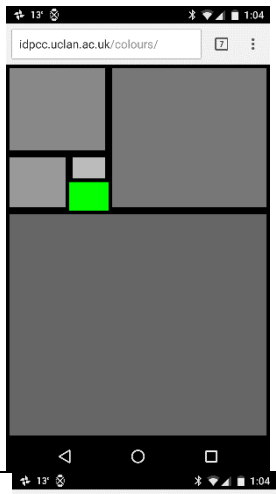
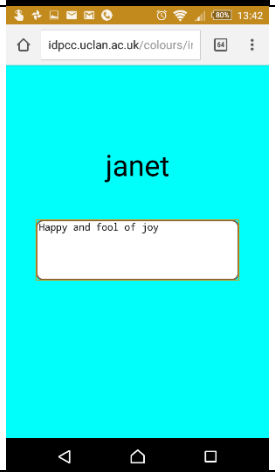
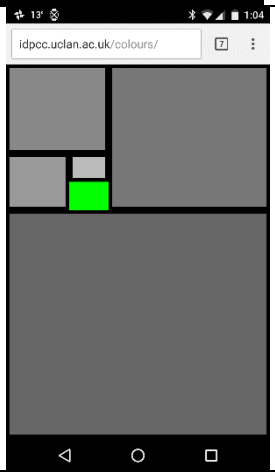
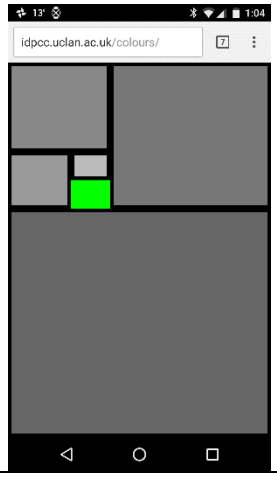
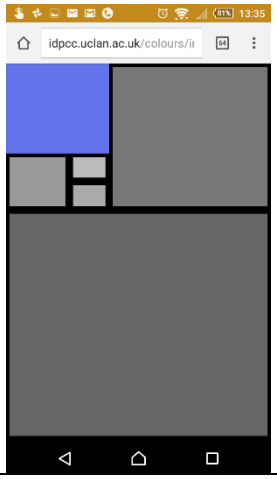
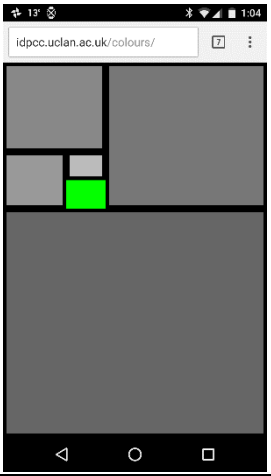
Actions	Andra's screen	Janet's screen
Andra picks a green shade to send to Janet	A4 	J1 
Andra selected the green shade to send to Janet	A5 	J1 
Andra sent green to Janet	A6 	J1 
Janet refreshes her screen	A6 	J2 

Actions	Andra's screen	Janet's screen
Janet selects the associated square to Andra	A6 	J3 
Janet picks a shade of blue colour to respond to Andra	A6 	J4 
Janet selects the chosen blue colour	A6 	J5 
Janet taps the "Mood" button	A6 	J6 

Actions	Andra's screen	Janet's screen
Janet taps on the text box	A6 	J7 
Janet writes a mood into the text box (Janet associates a mood to the blue colour)	A6 	J8 
Janet tapped out of the texts box	A6 	J9 
Janet taps the "Send" button	A6 	J2 

Actions	Andra's screen	Janet's screen
Andra refreshes her screen	A7 	J2 
Andra selects the associated square to Janet (taps on it)	A8 	J2 
Andra answers by tapping the "Answer" button	A9 	J2 
Andra chose a pale blue shade	A10 	J2 

Actions	Andra's screen	Janet's screen
Andra taps on the chosen pale blue colour	A11 	J2 
Andra chose "Mood" button	A12 	J2 
Andra writes a mood in the text box ("happy")	A13 	J2 
Andra taps outside the text box	A14 	J2 

Actions	Andra's screen	Janet's screen
Andra changes the first mood choice by double tapping on the "Mood" button again	A15 	J2 
Andra writes her second mood in the text box ("happy and full of joy")	A16 	J2 
Andra taps outside the text box	A 17 	J2 
Andra taps the "Send" button	A 18 	J2 

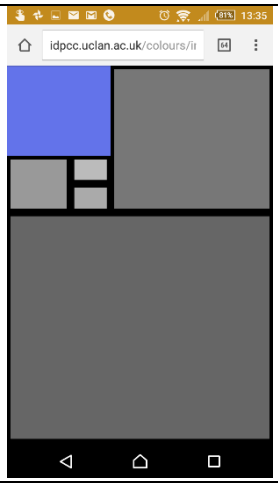
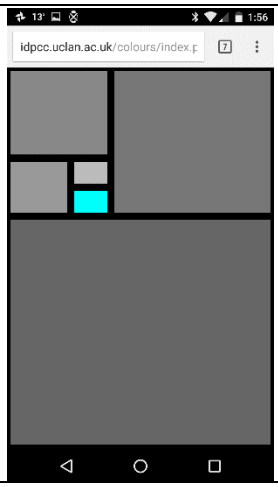
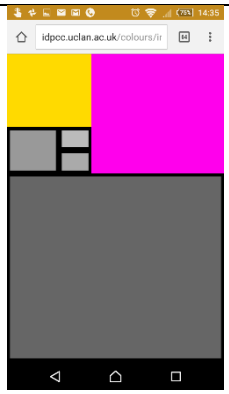
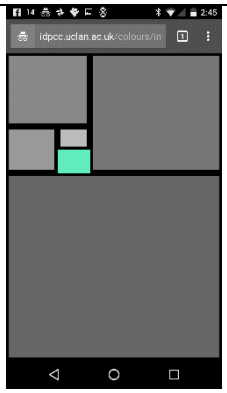
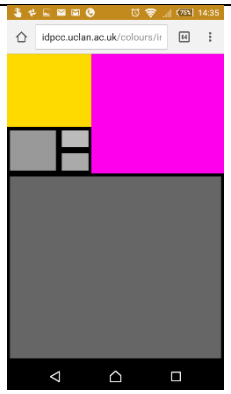
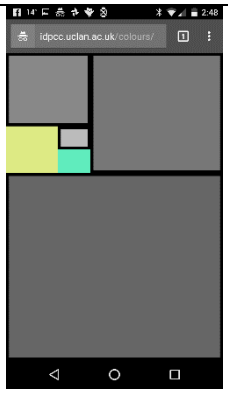
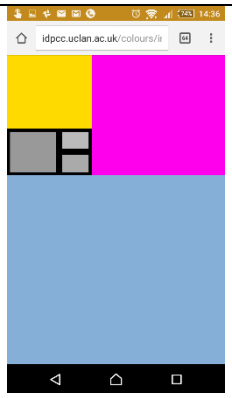
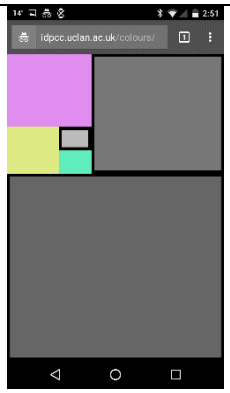
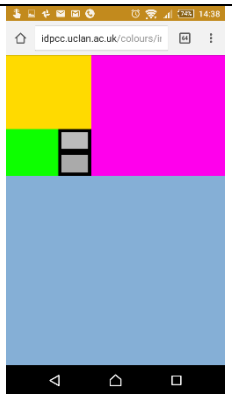
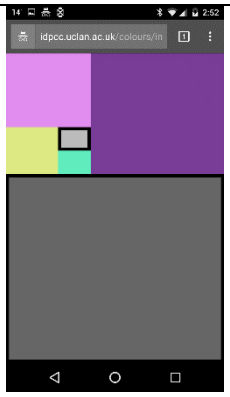
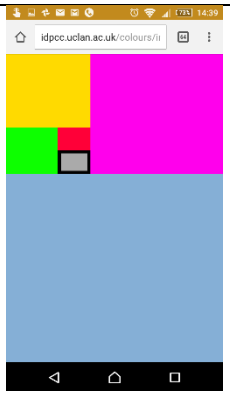
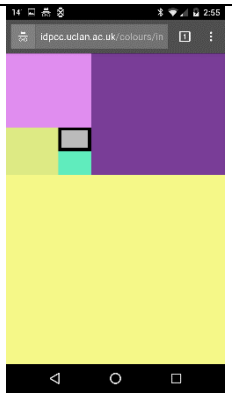
Actions	Andra's screen	Janet's screen
Janet refreshes her screen	A18 	J10 

Table 44. A detailed example of how the app is being used between two users.

Table 45 shows a detailed comparison between Andra's screen when she receives colours from her friends and Janet's screen in a similar situation. The two middle columns of Table 45 represent Andra's and Janet's mobile screens when they are sent colours by their friends. Each square is associated to a friend, so the more colours Andra and Janet receive, the more colourful their screens become. For instance, Janet sent to Andra yellow colour, and Matt send to Andra pink colour. This process could be seen in the first two rows of "Andra's screen" column and "Colours sent to Andra by her friends". Similarly, Andra sent to Janet pale green, while Dan sent to Janet pale yellow. This process can be seen in the first two rows of "Janet's screen" column and "Colours sent to Janet by her friends". If, for example, one friend would have decided not to send a colour, then the square associated to her/him would have remained grey and would have had a black thick edge around it. Once a colour is received, the black thick edge disappears, but another black edge functions as a notification for the recently received colours.

Colours sent to Andra by her friends	Andra's screen	Janet's screen	Colours sent to Janet by her friends
Janet to Andra: yellow			Andra to Janet: pale green

Colours sent to Andra by her friends	Andra's screen	Janet's screen	Colours sent to Janet by her friends
Matt to Andra: pink			Dan to Janet: pale yellow
Graham to Andra: pale blue			Gavin to Janet: pale pink
Gavin to Andra: electric green			Matt to Janet: violet
John to Andra: red			Graham to Janet: light pale yellow

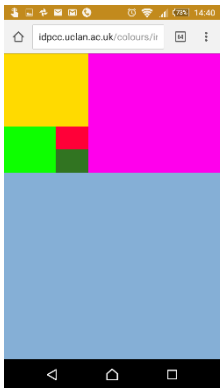
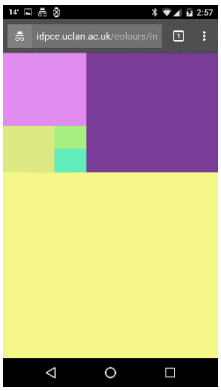
Colours sent to Andra by her friends	Andra's screen	Janet's screen	Colours sent to Janet by her friends
Dan to Andra: dark green			John to Janet: pale green

Table 45. A detailed comparison between Andra's screen when she receives colours from her friends and Janet's screen in a similar situation.

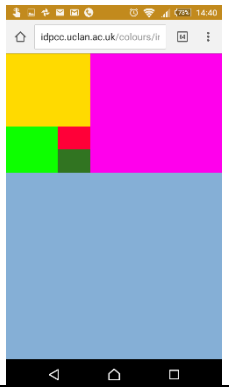
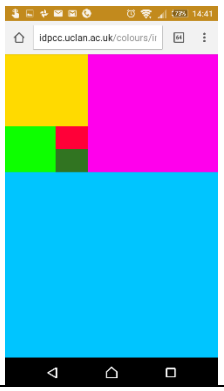
Graham to Andra: pale blue			Graham to Andra: bright blue

Table 46. Graham could send a different colour or shade of colour to Andra if he changes his mind.

Table 46 shows that Graham could send different colours or shades of colours to Andra if he changes his mind. Graham sent pale blue (left side image of Table 46), but then changed his mind and sent bright blue (right side image of Table 46). Like Graham, all users could send any colour or shades if they change their mind about the first sent colours.

Detailed simulations were explained in Table 44, Table 45, and Table 46, in order to:

- Highlight the interaction between two users, Andra and Janet (Table 44);
- Mark out the interaction between each user and their friends when Andra and Janet would receive colours from them (Table 45);
- Accentuate that one could receive different colours or colour shades from same friend (Table 46).

Conclusion

Chapter 7 answered the research question "How can colour-mood associations be represented into a product?" by designing the *Colour me Mood* interactive installation, as there seemed to be a need for a tool that allows teens to easily associate any colours (or shades) with moods based on their personal preference.

The initial concept was to have a smart textile wallpaper connected to an interactive mobile app but this concept could not be built because of different constraints. Moreover, some teenagers did not like the idea of displaying colours on a large surface in their bedroom, because it would be visible to their parents and they felt uncomfortable and vulnerable (Pilot study -paper prototype in Chapter 7). Therefore, a downside of this chapter was that the interactive installation was reduced to the prototype of an interactive mobile app which is evaluated in Chapter 8.

Chapter 8

Proof of concept study

Introduction

Whilst it could have been that the work of this thesis ended with a proof of concept and the research findings, having put much effort into thinking about the design elements, it seemed appropriate to try to evaluate a prototype in order to validate some of the ideas of the work. Specifically there were questions about whether the design was attractive, usable and well fitted to the context as well as questions about how teenagers would appropriate the different aspects of the app and indeed, what the market for such an app could be.

A two stage evaluation was designed to carry out this evaluation with an author self-reflection and an in-the-wild study with teenagers.

Aim

The aim of this chapter is to evaluate the *Colour me Mood* concept for its fit to the context of colour mood association for teenagers. Two types of evaluation are presented: the author's evaluation and the teenagers' evaluation.

Structure

The chapter is in three parts. The first is the Author's evaluation, this is then followed by an account of an in-the-wild study with teenagers and then the chapter concludes with some thoughts on the methods of evaluation and the evaluation findings.

Author's evaluation

The concept was evaluated based on the reflective design aspect developed by Norman (2004) and earlier described in Chapter 7. Reflective design is one's rationalization and intellectualization of a product and it is related to self-image, personal satisfaction, and memories. Reflective design is when someone reflects about a product, moving through its visceral level (product attractiveness) and behavioural level (functionality). As Norman (2004) notes, this brings "many factors into play and where the deficiencies of one aspect can be outweighed by the strengths of another", as retrospective memory and reassessment are triggered.

The *Colour-Affective Interaction model* (Figure 143) was used to highlight the reflective level an individual should go through when using the app. Teenagers pass through several stages including

self-disclosure, interaction, ambiguity, interpretation of ambiguity, meaning-making, and again, interaction. This model is designed by the author based on the theories developed in Chapter 7.

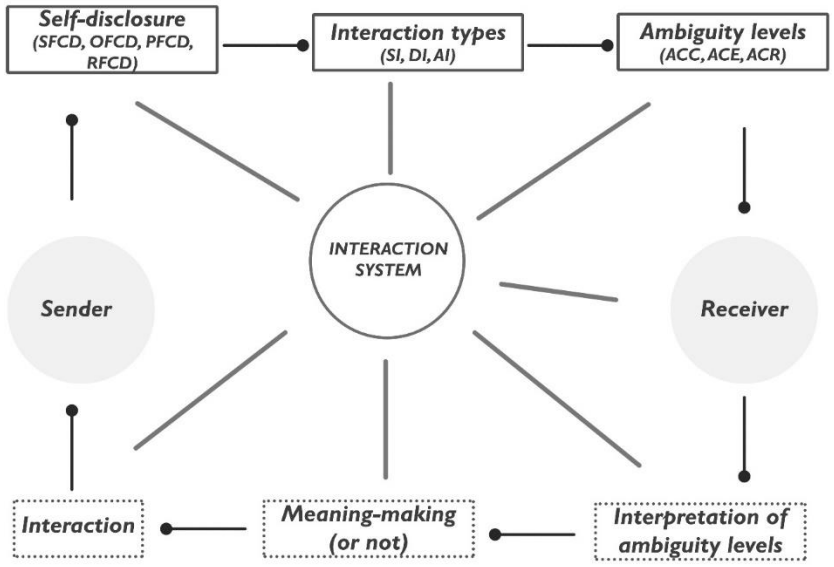


Figure 143. The Colour-Affective Interaction model.

When the sender makes the decision to express feelings, s/he would use one of the four self-disclosure types (Figure 143): SFCD: self-focused colour disclosure, OFCD: other-focused colour disclosure, RFCD: relationship-focused colour disclosure, PFCD: place-focused colour disclosure. Once the self-disclosure type is chosen, the sender would choose an interaction type: SI: secret interaction, AI: ambiguous interaction, DI: direct interaction. Once the interaction type is chosen, the sender would choose the level of ambiguity that would depend on the type of interaction: ACE: ambiguity of colour expression, ACC: ambiguity of colour context, ACR: ambiguity of colour relationship.

Acknowledging that ambiguity involves interpretation, the receiver would have to interpret the received message, make a meaning out of it, and then interact with the sender by choosing one of the four self-disclosure types. By this time the receiver becomes the sender and the interactive loop continues.

Therefore, when sending a colour associated to a mood, the teenagers have to be aware of their moods, to make a choice of how they would like to disclose their moods using one of the four self-disclosing types. Then they would have to choose how they would want to interact with their friends, by choosing a type of interaction (direct, secret, or ambiguous). If they choose an ambiguous interaction, then they have to decide what kind of ambiguity they would use (ambiguity of colour expression, ambiguity of colour context, or ambiguity of colour relationship). The Colour-Affective Interaction model informed a reflective designed product, which needs time to

be explored, and time is needed to reflect upon both the product and the user experience. Moreover, the installation's ambiguous meaning is left in the hands of the users, allowing for privacy and autonomy, which are two advantages suggested by Hook et al. (2008) to be used for any interaction design.

Diary study

To evaluate the built mobile app, a group of six teenagers were recruited to use the app on their homes for a period of one week while recording their experiences. They were given a cultural probe kit that included an instant camera, seven diaries (a diary for each day of the week), a product pleasurability questionnaire that measures how pleasant or unpleasant a product is (Jordan 2000), and other stationaries (see Apparatus section for more info about the kit contents). Teenagers completed the diaries with their reflections and comments on the app, using the instant camera to immortalize moments of their experience with the app that were significant to them. They were advised to stick instant pictures in their diaries, adding more comments about the reasons for which they took the pictures. They were advised to be creative when writing their feedback, using tools from the given kit.

Research Aims

The research aims were to gather insights on how the teenagers used the app in a semi-structured, but unsupervised, study. The structuring was provided by the use of diaries. Of interest was to find out if the teenagers consciously used the app for mood conveyance, to examine any associations between colour and mood and to unearth design insights for future iterations of the product.

Method

Teenagers were given the web app to use and a diary study as well as logged data was used to evaluate their usage and their experience of it. The teens' main task was to complete seven daily diaries designed for them to gather their feelings and thoughts about the app. More details can be found in the subsections below.

Participants

Given the social nature of the app, it was essential to recruit a set of friends for the in-the-wild study. A single teenager was asked by a third party recruiter if she could recruit friends to the study. When she confirmed she could, she was given the task of gathering their consent, setting them up with the app, explaining the study, and distributing and collecting in the diaries. She also allocated nicknames to each participant (and herself) in such a way that only she and her participating friends would know, and not the research team, who each person was. The result

was that a convenience sample (people easy to reach) of six English female teenage friends, aged between 15 and 17 years old, participated in the evaluation study.

Teenagers could not be identified because of the use of predefined nicknames (usernames) and passwords. No real name or any other personal data was of interest, except age and gender. The app logged what was sent to whom. This data, on a password-protected site, consisted of usernames, colours they sent and received, textual mood data, and input times. Teenagers could withdraw their consent at any time; they could have chosen at any point to not participate. They were told at the end of the study that they did not need to hand in their diaries if they did not want to.

Apparatus

The same mobile app, as described in the previous chapter, was made available to the participants. Participants could send colours to each other and associate moods with the sent colours. Figure 144 is a screen app example of one user before and after receiving colours. Before receiving colours, the screen is grey, and after the colours are received the screen becomes colourful. The difference between the two-coloured screen interfaces in Figure 144 is the number of coloured squares and rectangles. The right-side image has one grey rectangle with a thick black edge, which means that friend did not send a colour yet. Because in the present study there were only six participants, and space on the app for seven, the upper small rectangle did not change its colour. The grey colour was changed to white, so that the colour contrast would not be too high between the "static" rectangle and the colour changeable ones.

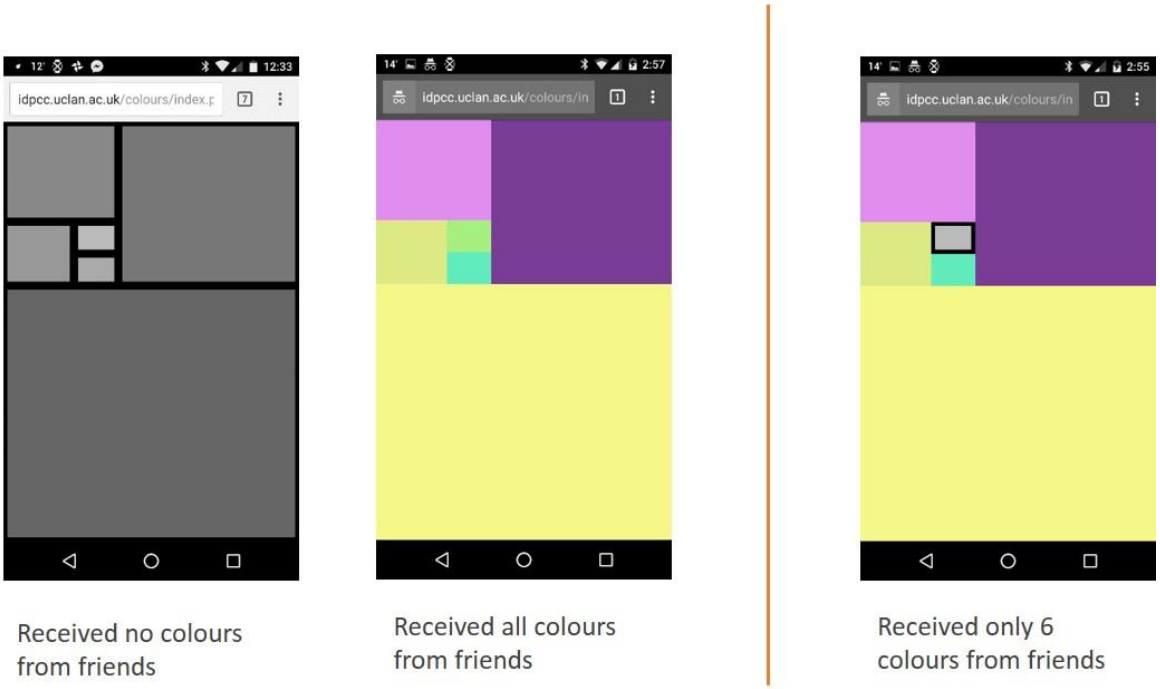


Figure 144. Screen app example before and after receiving colours from friends.

Teenagers were given diaries as well as a set of materials to assist in diary completion in a single pack. The pack contained:

- Seven daily diaries (Figure 145);
- Product Pleasurability evaluation form;
- Ten design pads with different patterns;
- One black pen;
- One set of 12 mini colouring pencils;
- Sixty foam face stickers of two different sizes;
- Eight self-adhesive labels;
- Approx. eighty sticky notes;
- Two card size wooden frames;
- Twenty-five double sided adhesive patches;
- One glue stick;
- One instant camera: Fujifilm instax mini 8 with 40 shots.

Figure 145. Cultural probe kit.

Figure 146. An example of the inside of a daily diary.

Figure 145 shows the materials that were given to the participants and Figure 146 is an example of the inside of a daily diary. The cultural probe kit was used as a design method to provoke creative responses. Teens' answers to the predesigned questions in the diaries gave an insight of teenagers' experience with the mobile app.

Diary design evolution

In designing the experience diaries for the study, ideas for form and content were iterated. Initially it was desired that a circular diary be produced as shown in Figure 147. The intention would be that each pupil would have seven of these diaries, one for each day of the week, and that each would have slightly different content in order to move the students along from structured to more

unstructured reporting. The images below explain the different stages of the first ideas for the diaries.

Days 1 and 2: As it can be seen in Figure 147, the first ten pages of the first two diaries each have a (different) question written on them. The diary has a number of empty pages at the end for extra notes.

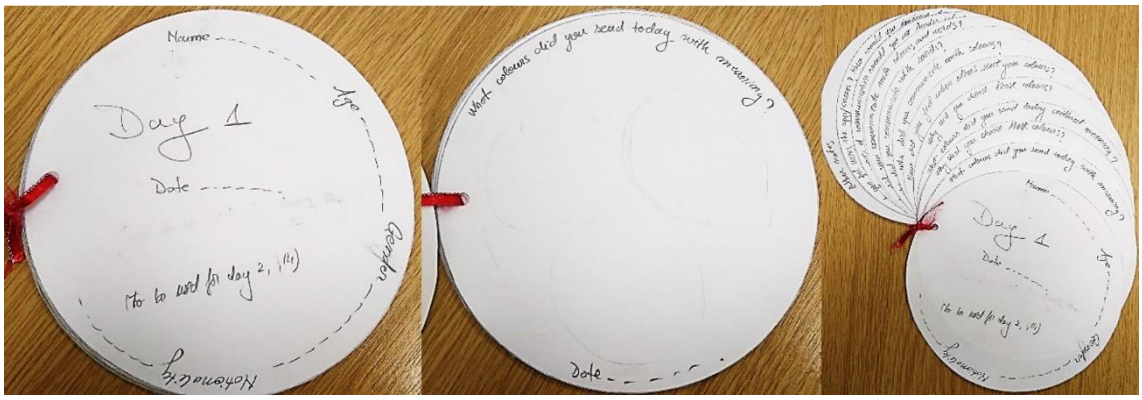


Figure 147. Day 1 diary entry.

Day 3: At this stage, only six of the pages have questions on them.

Day 4: On day 4, teens would have to complete only four diary entries with questions on them but doodles on the pages would be used to prepare them for the next stages, where they would have freedom to determine what they wanted to write.

Days 5 – 7: This last stage of the diary completion would give participants the freedom of expressing their thought about their experience by freely writing and without prompts. It was assumed some would follow the order and slightly align to the earlier questions.

Having created the prototype of the diaries in this way, the version that was used in the study took the ideas of reducing questions and increasing freedom but used a rectangular booklet format instead of the circles. This format provided more space to the participants, was easier to print and assemble and allowed for easy 'booklet' shaping thus keeping pages in order.

Examples of each diary's cover, introductory pages, plus other two 'look inside' pages, can be seen in the following images: Day 1 in Figure 148, Day 2 in Figure 149, Day 3 in Figure 150, Day 4 in Figure 151, Day 5 in Figure 152, Day 6 in Figure 153, and Day 7 in Figure 154. Day 1 and Day 2 diaries have identical questions, as well as Day 4 and Day 6, and Day 3 and Day 7. Diary 5 has only one question to answer, and gives to the participant more freedom for feedback. Every diary starts with an instruction on how to complete it and a space to enter the date of completion, age, and gender of participants.

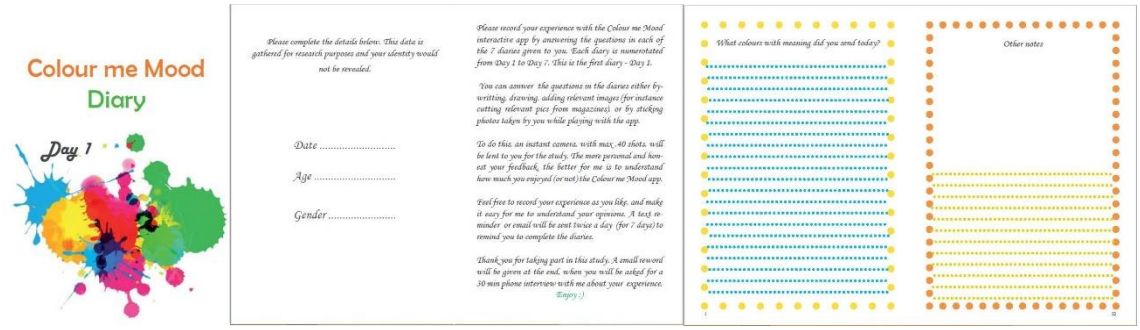


Figure 148. Inside view of the *Colour me Mood* Day 1 diary.

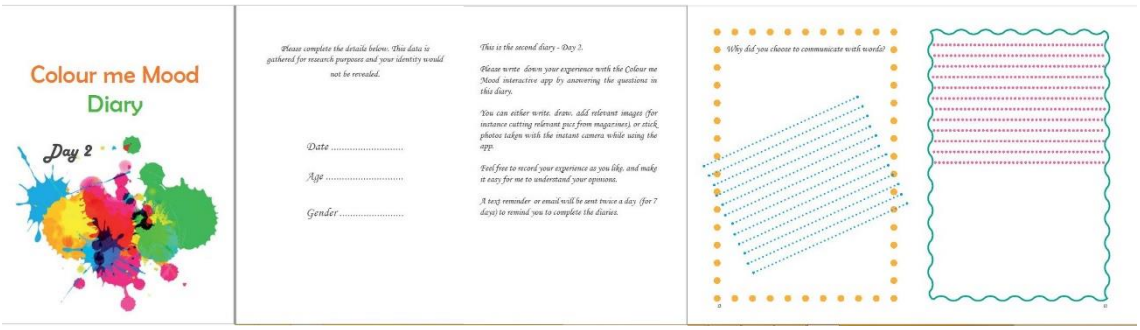


Figure 149. Inside view of the *Colour me Mood* Day 2 diary.

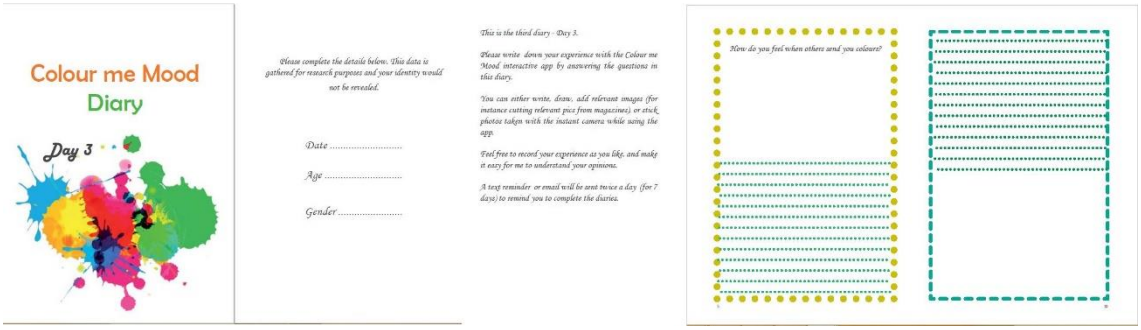


Figure 150. Inside view of the *Colour me Mood* Day 3 diary.

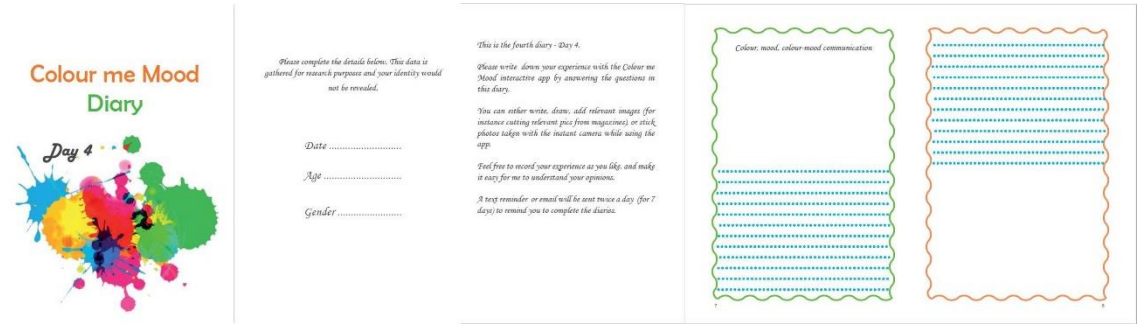


Figure 151. Inside view of the Colour me Mood Day 4 diary.

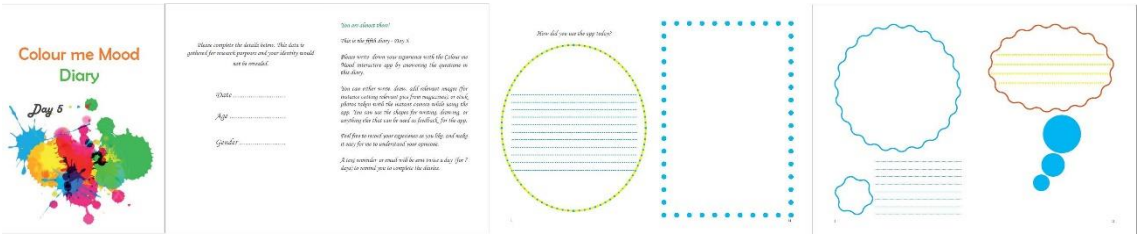


Figure 152. Inside view of the Colour me Mood Day 5 diary.

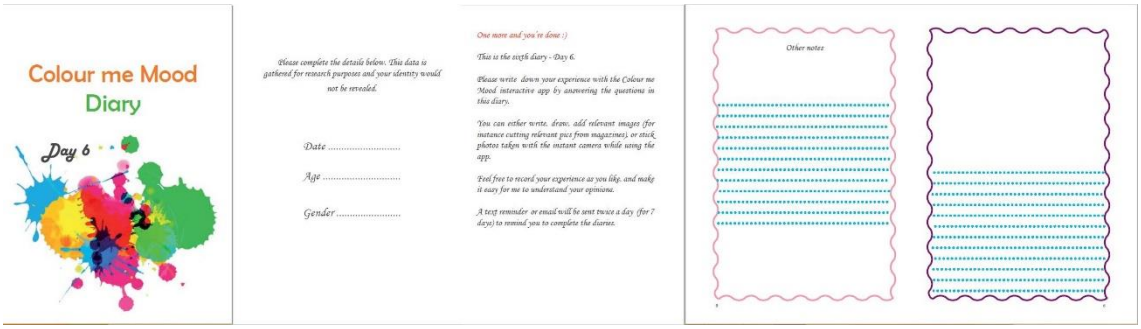


Figure 153. Inside view of the Colour me Mood Day 6 diary.

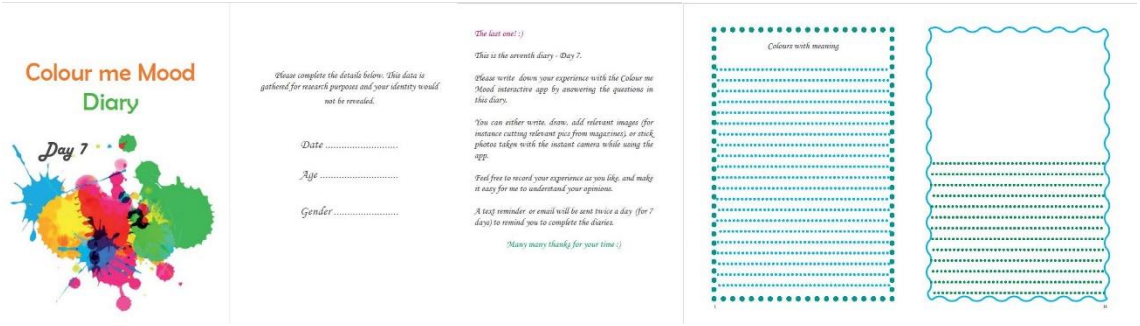


Figure 154. Inside view of the *Colour me Mood* Day 7 diary.

Table 47 shows how many questions each diary had. The number of questions decreases from 10 questions in Day 1 to 1 question in Day 5 so that the user has gradual freedom for her/his feedback, while understanding what the researcher in looking for in terms of feedback. The questions increase then back to 10, because at this stage the participants would ideally have more experience using the app prototype and they would have formed a general opinion about it.

The diary design aligns in a novel way to the Norman's (2004) three aspects of design:

- **Visceral design** deals with the **appearance of a product**;
- **Behavioural design** is focused on the **pleasure and effectiveness to use a product**;
- **Reflective design** is one's **rationalization** and **intellectualization** of a product and it is related to self-image, personal satisfaction, and memories.

Teenagers might unconsciously analyse the app prototype along these lines having an initial visceral opinion about the appearance of the app, then analysing how pleasurable and easy to use it is before eventually reflecting on their experience with the app, coming with a conclusion about

it. That is why the questions in the diaries: Day 7, Day 6. Day 2 diary repeat the Day 1 questions to encourage teens to focus on the app analysis and on their experience with it. The structure of the diaries based on Norman's (2004) research could, with further analysis and extension, be a contribution in TCI.

Diary number	Number of questions	Similarities
Diary 1 and Diary 2	10	Identical questions
Diary 3 and Diary 7	6	Identical questions
Diary 4 and Diary 6	4	Identical questions
Diary 5	1	One question

Table 47. The similarities and number of questions for each diary.

Procedure

Prior to the study beginning, the lead teenager had the study and app explained to her. This teenager then instructed the others and each could also contact the research team in an anonymous way to check for anything they were unsure about. The teens had the data collection explained and were made clear about consent and how it could be withdrawn.

Each teenager interacted in the study using a nickname. Seven nicknames (Foxy, Kitty, Turtle, Pony, Monkey, Mermaid, and Rabbit) were set up as usernames and each was associated to one of the app's seven squares or rectangles in Figure 144. In the event, only six of the squares/rectangle were active, because there were only six participants (Pony not being used). Each nickname had a pre-set password that was chosen by allocating to each of them a word from the phrase: "The quick brown fox jumps over the lazy dog" ("the" was not considered a word).

During the seven days' study, the teenagers sent colours and messages to one another and completed the seven diaries daily. They recorded how they used the app, as well as any insights and any thoughts about the app and their experience with it. This was mainly freeform reporting but it was scaffolded in the early pages of the diary just to help them express their feelings and thoughts.

Besides the seven diaries, the cultural probe kit contained a product pleasurability evaluation sheet that measures how pleasant or unpleasant a product is (Jordan 2000).

At the end of the week, the teenage research lead collected in the diaries, wrote the nicknames on each diary and delivered them to the research team.

Results

Only one product pleasurability evaluation sheet was completed out of seven, so it was excluded from the analysis. The reason for teenagers not completing the evaluation sheets is not known (the forms were returned in the pack and there was no discussion with the teens after the study). All the diaries were returned and they had all been completed. The data from the diaries was analysed in a qualitative way and was also triangulated with the logged data.

All six participants took part in the study, but there were different levels of involvement. For instance, Rabbit did not use the app, but she had diary entries reporting how she 'used' the app. Two others (Turtle and Foxy) sent very few colours. During the 7 days' study, Rabbit sent no colours, Foxy sent one colour, Kitty sent 19 colours, Mermaid sent 20 colours, Monkey sent 10 colours, and Turtle sent 4.

The diary results contradicted the database results as there is inconsistency between logged in colours and reported diary colours. Kitty's diary results were consistent with the logged data, Mermaid's results were sometimes consistent, but the other participants' results were not. Foxy sent only one colour during the study, but in her diaries she reported that she sent colours daily, associated some with moods. Similarly, Rabbit sent no app colours but she reported daily sent colours in the diaries (most of them being associated with moods). Turtle used the app only to send four colours which she recorded in the diary, but she also recorded other colours daily that were not in the logged data. Monkey sent 10 colours with the app but only four of them matched with the diary data. These inconsistencies are discussed in the conclusions to this section.

Colour – mood associations

Given the interest in colour-mood associations, the first analysis of the data was focused on understanding if the teenagers used colour-mood associations when using the app, or when writing in the diaries. Diary and database colour-mood associations were put aside in six individual tables representing each participant's results (see the Appendices).

The logged data showed that only one teenager (Kitty) associated moods to colours and she was inconsistent. However, the diary data showed many confirmations of earlier results in so far as most of the six tagged yellow with excitement, red with being stressed or angry and blue with positive feelings. Black was used to express depression and anger. In addition, there were cultural references, one could suggest, with the attachment of green and red to 'festive' (the studies were

bring done towards Christmas). Associating colours with how they 'look' in nature was also seen with references to dark blue for freezing and light blue for calm (seas and skies).

Thus, while the app itself did not shed light on colour-mood association, the diaries did and to that extent there was some confirmation of earlier findings.

Conversations

As the app was intended to be social, a second analysis looked at how the teenagers used the app. Table 60 (see Appendices) shows how many database and diary colours each participant sent (or claimed to have sent) on a daily basis; the totals over the seven days and the six teenagers were – *logged* – 40 colours sent with no mood associated, 14 colours with mood and *dairy* – 116 colours with no mood and 166 colours with moods. Thus there appear that there were over 250 interactions 'planned' by the teenagers even if these were not effected through the app – this shows an intention to communicate even if not an action. Figure 155 is a communication dyad and it represents whom sent colours to whom based on the database results.

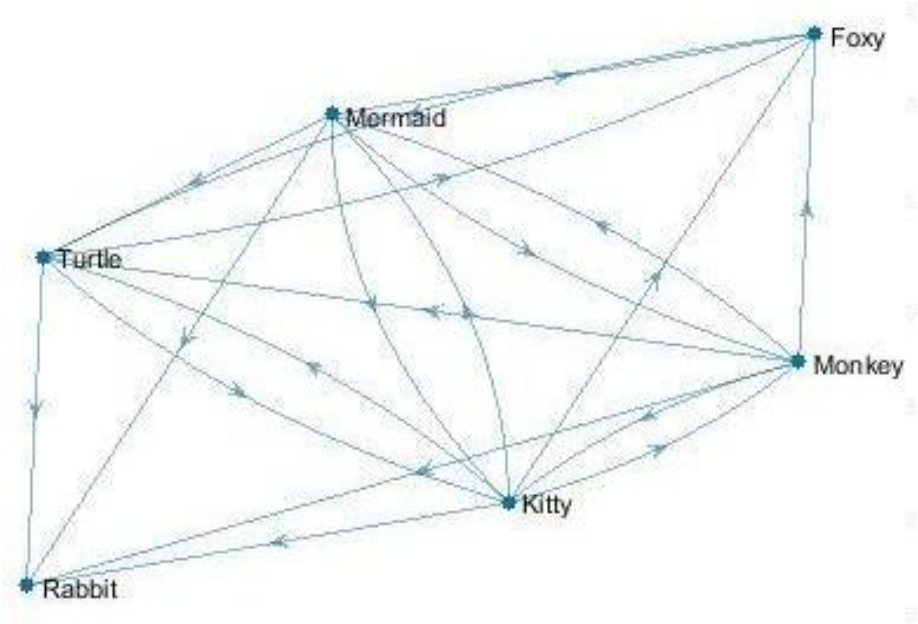


Figure 155. Database communication dyad

A diary communication dyad cannot be designed because participants did not say whom they sent/received the colours to/from. In the diaries, the teens generally referred to 'everyone' when sending or receiving colours. Mermaid does not specify the sender/receiver when writing: "I was happy to receive a few colours today as I know now that they are feeling somewhat emotion", "today I sent a few more colours without meaning as I thought I try and connect with the others and see if I'd get colours back", "I feel happy when people send colours to me'. Monkey similarly writes: "I enjoy communicating with my friends", "excited that people share (colours) with me, happy that we are able to talk", "I am communicating with my friends", "I sent colours and moods

to my friends to express my emotions", "it has made me talk to my friends more about personal issues". Turtle "did not bother" when others sent her colours, stating that "I don't know how to know if someone has sent me colours". Rabbit said she was "very confused" when others sent her colours.

There is a contradiction between the 'chatter' teens put in their journals and what the database showed. This is returned to in the conclusion where the contradicting stories are critiqued.

Diary vs App engagement

This analysis considers the engagement of individuals with the two products. Table 48 is based on the data in Appendices (Table 60) and shows engagement scores for each participant. The diary engagement was calculated by dividing the total number of pages completed by each participant during the study by the total number of pages possible. The app engagement was calculated by dividing the total number of individuals' sent colours to by the total numbers colours used by of all six participants during the study.

Engagement	Foxy	Kitty	Mermaid	Monkey	Turtle	Rabbit
Diary	10%	22%	44%	22%	13%	20%
App	2%	35%	37%	19%	7%	0%

Table 48. App vs diary engagement.

Mermaid and Monkey seemed quite consistent with the use of both app and diaries, and Kitty was more active with the app then the diary. Foxy, Turtle, and Rabbit used the app less than they recorded in the diaries.

Insights from the diaries

All teens submitted the seven daily diaries, and so for each an individual story was created by the author based on teens' diary recordings. The author aimed to pick up teen's significant experiences while using the app. Photographs of teens' diary recordings are displayed alongside where possible.

Kitty

Kitty, 15, preferred words over colours, but enjoyed the colour-mood app, because "*it made you think about how you actually felt*" when associating moods to colours. She was the only participant who associated moods to colours. Kitty thought "*it was better to communicate with words because then the person knows what you are talking about*". She was confused when receiving colours with no meaning from her friends, because she "*had to try and figure out why they sent it and what they were trying to convey*". Kitty thought that the receiver of a colour "*might not associate the same colour with the same emotions*" as the sender did. It is possible that Kitty was expecting that

her friends would chose words over colours too: *"it is good that the app doesn't have set colours for set moods because everyone thinks differently about colours. But it would be easier to understand what others are thinking if there was set colours for certain moods"*.

Kitty sent some colours without meaning because she was experiencing with the app, at other times she associated moods to colours with some consistency. She sent red because "*it felt like Christmas*" when she was in town for Christmas shopping and looking at Christmas decorations. She also sent a hot pink during her car drive to town when she was excited because they drove with the roof down (Figure 156).

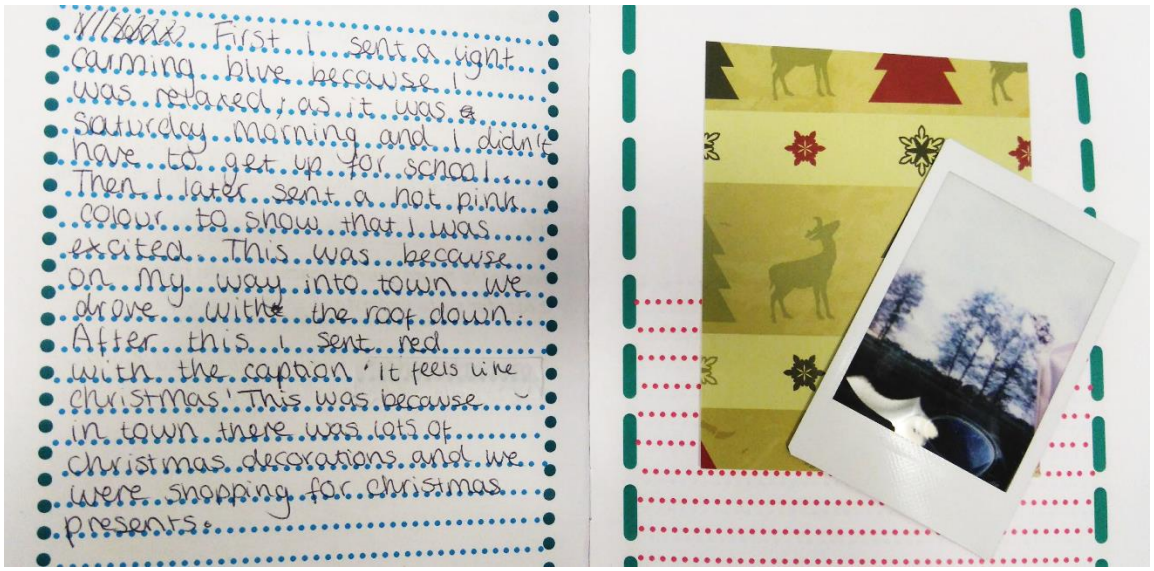


Figure 156. Kitty's diary entries.

Kitty started to use given coloured smiley faces to associate them with moods: blue-relaxed, orange-excited, pink-excited about Christmas. On one day, she associated blue with chilled and relaxed moods, and she made a picture with a cat, saying that she "*was chilled and curled up with a cat*" (Figure 157).

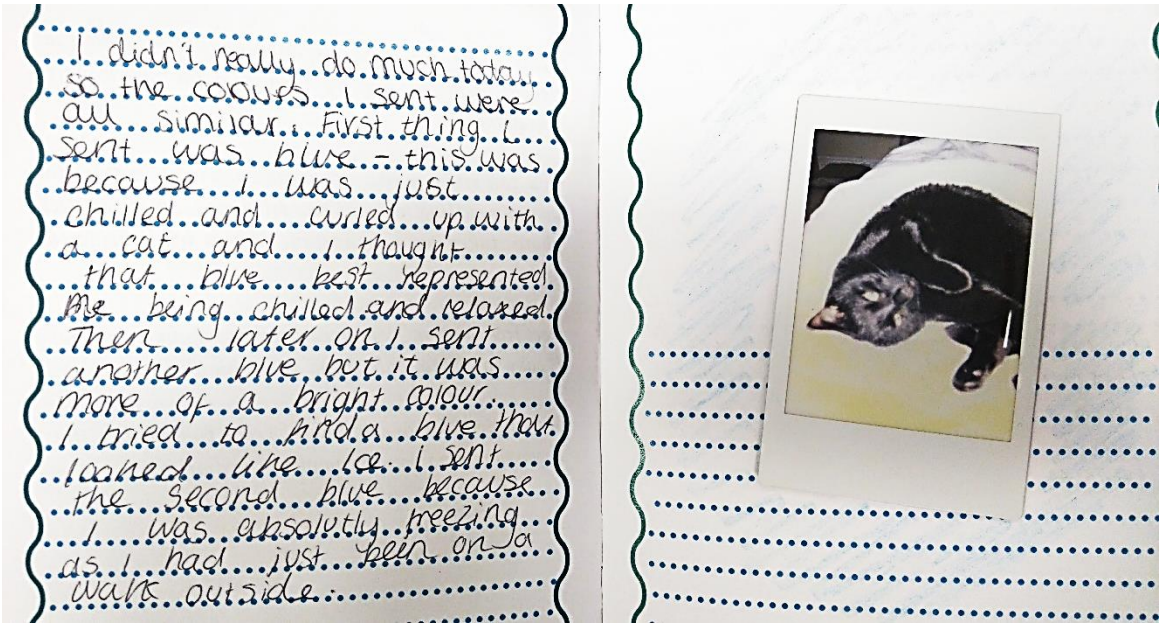


Figure 157. Kitty's diary entries.

One-day Kitty felt really tired and associated a clock to that mood (Figure 158). Another day she was stressed about exams and associated oranges and reds while making a drawing of herself dreaming about exams (Figure 159). She kept recording her strong feelings about school exams (red colour) and personal experiences such as going to the orthodontist to have her braces tightened. She was in a lot of pain after that so she sent a grey colour. During her diary records, Kitty seemed to easily associate moods to colours.

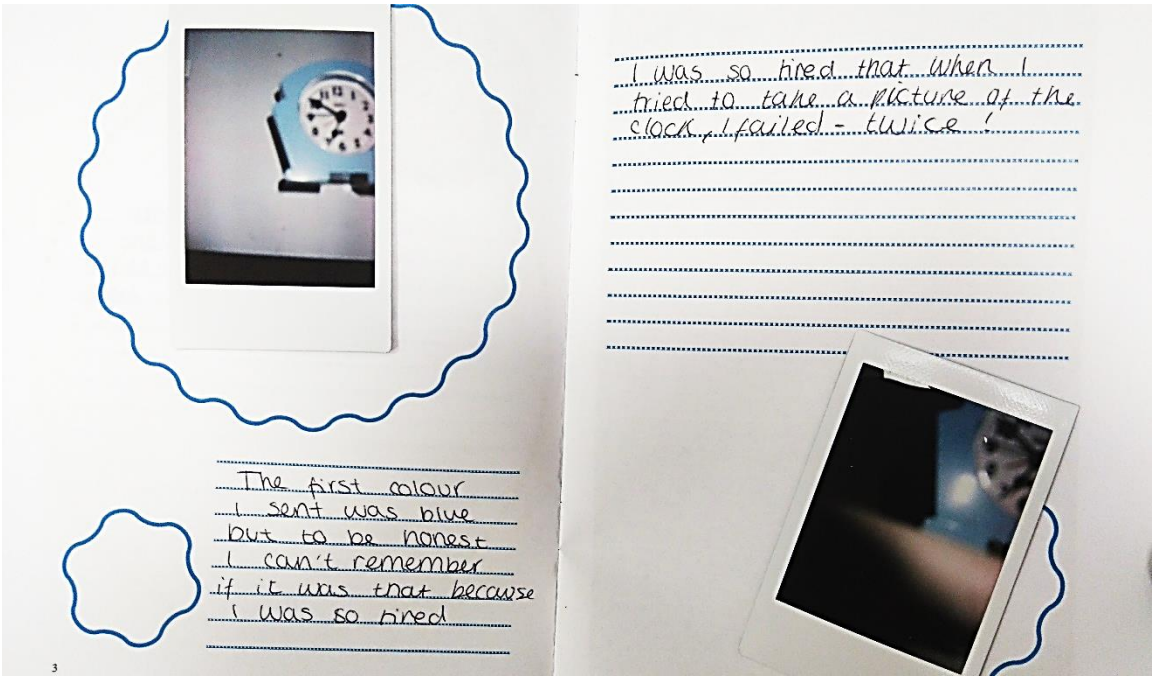


Figure 158. Kitty's diary entries.

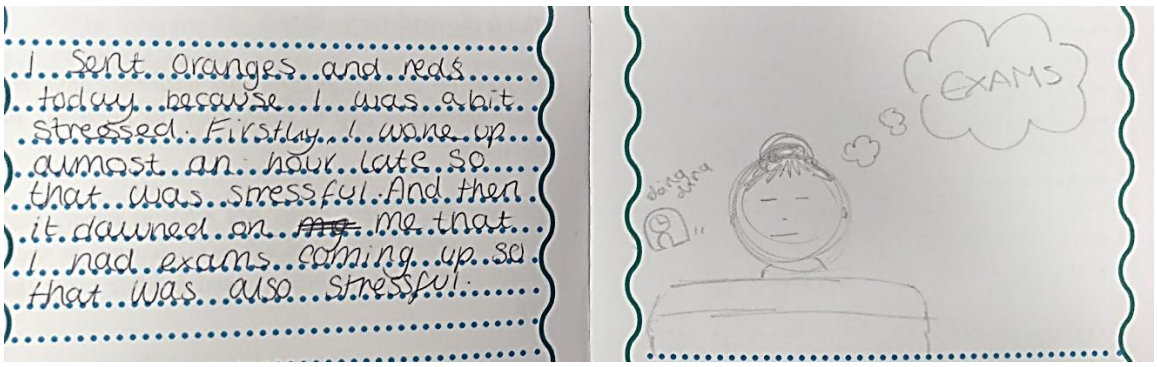


Figure 159. Kitty's diary entries.

Kitty experienced some problems with the app, which "*didn't seem to be working properly today as I couldn't see anyone else's boxes. So it was difficult to select a certain box so I couldn't see if anyone sent me a colour"*. The app had no notifications (the author considers this a limitation) and the participants had to constantly check if they received any colours. Kitty asked for an improvement of this limitation.

Kitty thought that the app "*is a good way of showing others your emotions*". She enjoyed using it because it makes one think about her mood and "*it would be a good way to calm yourself down – if you were the type of person to get angry or stressed a lot*". After four days of using the app, Kitty suggested an improvement: "*it would be better if you could see the colours that you had sent on that day. This would be good because you could track how your mood changed and maybe it would help you to create a stress-free lifestyle*". She acknowledged there is relationship between colour and mood and she wanted to be able to track the sent colours so that she could track her own mood. It might be the case that Kitty found the use of colour in the app both useful and easy for tracking her emotions. Another improvement suggested by Kitty was that she "*would allow more people to be on it so you could include all of your friends or maybe less of your friends as well*".

Because she was the only one to associate mood to colours, she thought it would be better to have words that explain the meaning of the sent colours: "*Two people sent me dark blue today and I have no idea why. To improve on this, I think the person who is receiving the colour should be able to see the caption that the sender gave to the colour*". She draws an example in Figure 160 and explains it again, using different words.

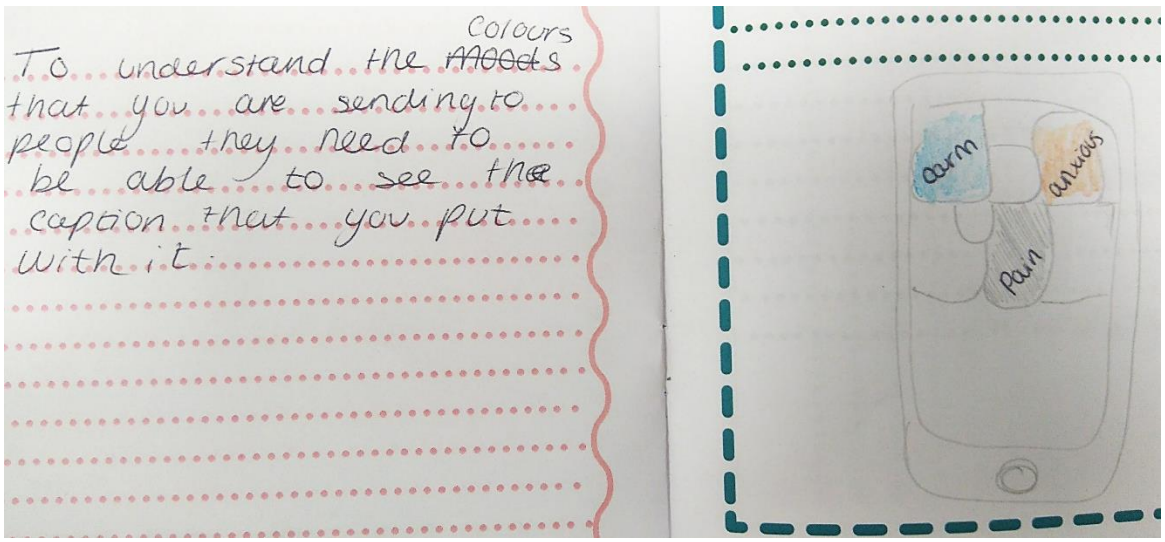


Figure 160. Kitty's diary entries.

Mermaid

Mermaid, 17, started this study by preferring word over colours but by the end of the study she "*preferred to use colours so it makes people think and actually work out what I am feeling*". Mermaid decided to use colours as a way of communication because "*it made people think more about how you were feeling*" and also because "*it was more mysterious, making people realize what colours mean to you*". She felt more relieved telling people how she felt without them knowing who she is or how was she feeling (Figure 161).

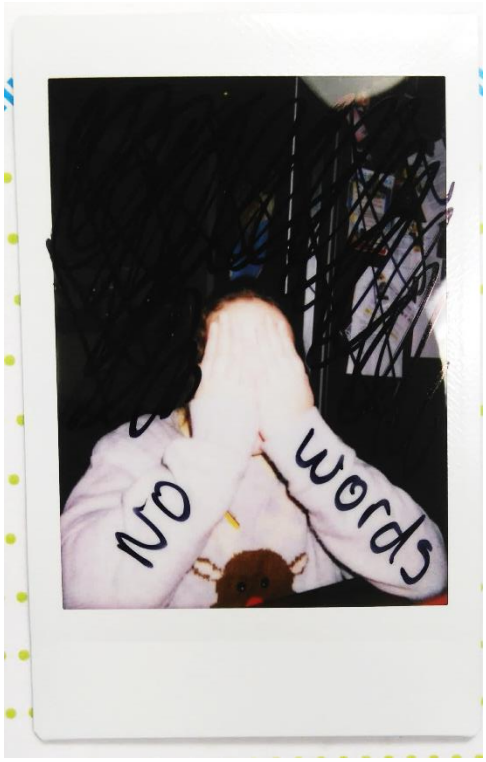


Figure 161. Mermaid diary entries.

This provoked the author to consider the possible scenario of the Colour-Affective Interaction Model, where the sender could choose to express moods in an ambiguous way. Mermaid's diary entry could support the author's scenario, where the sender could feel happy expressing her moods in an ambiguous way. Mermaid tried to make the others' guess her mood, by sending colours with no meaning: "*today I chose not to communicate with words and just colours. This was to see if anyone knew how I felt or thought they knew how I felt*".

Mermaid felt happy and excited when receiving colours from her friends, as she could try and figure out "*what they were feeling and why they were feeling*" that way (Figure 163).

She mentioned a few times that "*it is exciting to see how everyone is feeling at the moment and how they are feeling is sweet*". To be mentioned that she noticed the importance of the "*moment*". It might be possible that Mermaid acknowledged a relationship between colours and moods as, on receiving colours green and turquoise, she associated them with "*envy or hungry*", and she created a collage that might represent her uncertainty about the true meanings of the received colours (Figure 162).

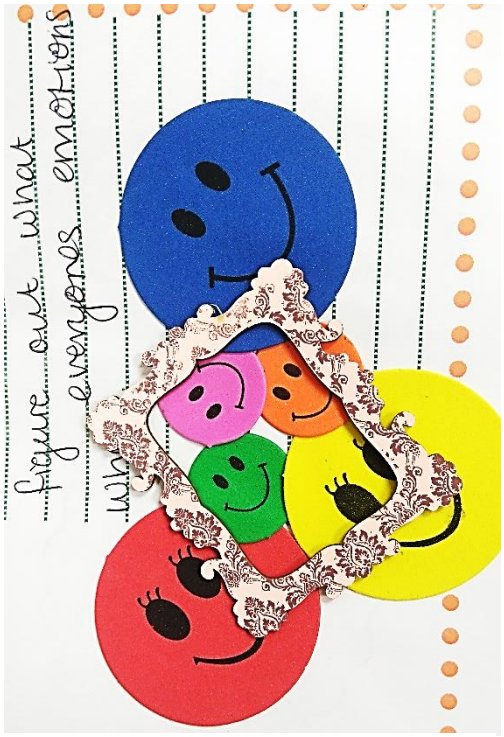


Figure 163. Mermaid diary entries.

Figure 162. Mermaid diary entries.

Mermaid preferred to use colours over words: "*I was expressing my views and making people really think how others are thinking. As with words it's more blunt than colours*"; "*I didn't communicate with words as I thought it was more obvious to people what you were feeling and I'd rather someone figure it out*"; "*I do prefer colours though makes it look more effective and better than words*"; "*I feel like the colour communication is fun as it shows what everyone is feeling but at different times and different opinions on different colours*".

One day, Mermaid used purple because she was relieved and relaxed to have tidied up her room and brought all her Christmas presents (Figure 167). When she got an eye palette, Mermaid was really excited and sent the yellow colour, but she also recorded the shades from the palette and their names. She was sad that she spent too much money on Christmas presents but happy that she bought useful presents so for these feelings she sent orange colour (Figure 167). There was a whole day when Mermaid felt excited and for that day she mainly used yellow to express her moods. She tried to connect with others by sending colours and waiting to see if she would receive a colour response. Mermaid was excited about colouring her hair pink so she recorded this mood by sticking a picture and sending yellow (Figure 167). Other days she sent yellow colour because she was feeling happy and excited due to

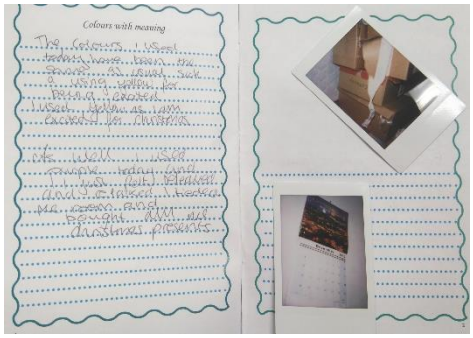


Figure 167. Mermaid diary entries.

Figure 167. Mermaid diary entries.

Figure 167. Mermaid diary entries.

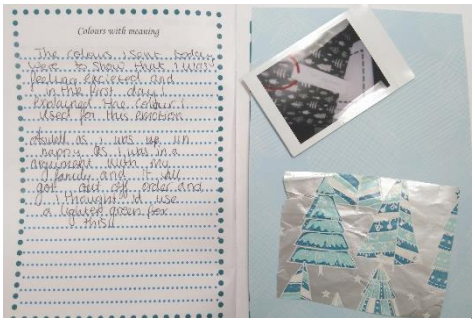


Figure 167. Mermaid diary entries.

the Christmas decorations in her house. She associated a "*musky green*" with jealousy and being upset because she did not get any school awards. Mermaid associated red with feeling neutral and normal, red being her favourite colour. One day, Mermaid associated bright pink with happiness and blue with "*hungry and sad*", and she stick a dark violet chocolate wrapper. She also sent colours without meaning, to experiment with the app. Another day, she had an argument with her family and used "*a lighter green*" to show she was unhappy (Figure 167).

As well as Kitty, Mermaid suggested the use of a colour code "*that everyone makes for their own colours*". The author thought that teens would naturally create their own colour code in their group of friends. It is therefore a limitation of the app that these two friends felt this need but none of them took action to create such colour code.

Mermaid mentioned she would like to be able to "upload pictures of stuff" to express her "*emotions*", as she "*likes to draw and take pictures*". She felt that it is useful to hint at people how one feels without saying.

Mermaid liked the app, and she would improve it by uploading pictures and a daily "*story from each member*" of the app, making the app be "*more of a diary where you can see the past and show your improvement of emotions*". Similar to Kitty, Mermaid felt the need of tracking her moods using colours.

Turtle

Turtle, 15, was struggling at the beginning to understand how to use the app: "*I'm still figuring out how to use the programme so I'm not sure if anyone has sent me any [colours]*". At the beginning, she was sending colours because she was "*figuring out how to use the app properly*". On the fourth day, she was still struggling to figure out how the app works. She was not sure if

certain colours (blue, yellow, and green) were the ones she received. Turtle said she *"wasn't really bothered"* when others sent her colours because *"I don't know how to know if someone has sent me colours"*.

Figure 168. Turtle's diary entries.

At the beginning of the study Turtle sent colours just because she liked them (pink or green). Later, Turtle sent pink, yellow, red, blue, and purple but she did not state their meaning. At a later stage, she started to associate moods to the colours sent such as red, green, and yellow for festive, red for annoyed and angry, blue for cold. Turtle sent red because she had *"lots of revision to do"* so she was *"quite annoyed/angry about that*" (Figure 168). Turtle did choose colours over words because she thought "*colours made a message look more bright and nicer to open*", and also because she thought "*it's unique and different*". Turtle would improve the app by "*make it a bit less complicated by having more instructions on how to use it*". She also felt to "*add more to it as there is not much to do*".

Monkey

From the first day, Monkey, 16, associated meanings to the colours she sent: purple for hungry, black for stressed, light blue for her "*cheeky mood*", dark blue for sadness, white for tired from school, grey for cold from the "*wintery weather*", light blue for relieved "*because my mocks are over*", yellow for excited to go away for the weekend, lilac for relaxed after a bath (Figure 169). She also sent colours without meaning from the first day, because it caught her eye "*while looking at the colour chart*". Monkey felt excited and happy on her cousin's wedding, and she recorded her feelings by taking photos of her high heels shoes and what appears to be a blue heart (Figure 170): "*dark for a disco, shiny for a special occasion*". Monkey chose to communicate with colours to *"represent my mood and what I went through during the day"* but also because *"Christmas is joyful and is associated with colours"*. Monkey sent green, red, and blue because she *"felt Christmassy"*, and when others sent her colours, she felt "*festive*". She found the app experience *"expressive and self-representing"* because *"sometimes it can give you a way of expressing yourself when you don't know what to say"*. Monkey sent colours and moods to her friends *"to express my emotions"*. Others sending her colours cheered her up and made her laugh, stating that she felt *"excited that people share theirs (colours) with me, happy*


Figure 169. Monkey's diary entries.

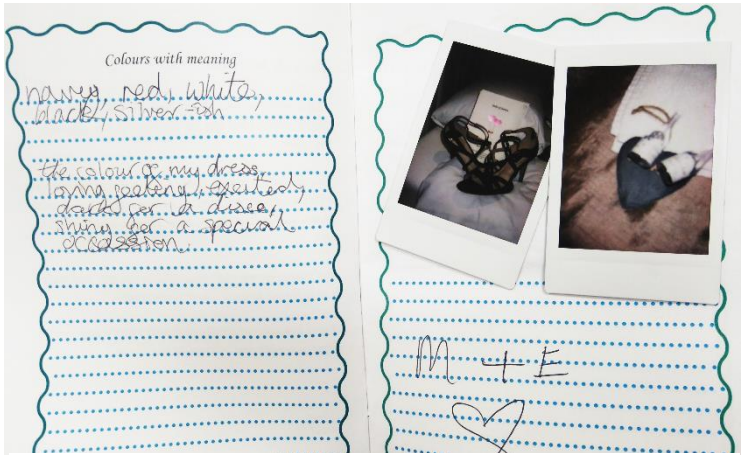


Figure 170. Monkey's diary entries.

that we are able to talk". Monkey wanted to improve the app by adding *"more than just colour"*. However, she enjoyed the app because *"of the ease of self-expression"*, because *"it has made me talk to my friends more about personal issues"* and also because it was *"almost a sense of relief that I've got someone to talk to about how I'm feeling"*. Monkey enjoyed the colour-mood association because she saw it as "*a creative way of thinking*". She enjoyed to communicate with colours more because "*it leaves some mystery and perhaps makes a game of a quite serious topic*". However, Monkey believes that associating moods to colour "*works the best as it is most explicit*". This is another statement which shows the user feels encouraged by the app to express her moods.

Rabbit

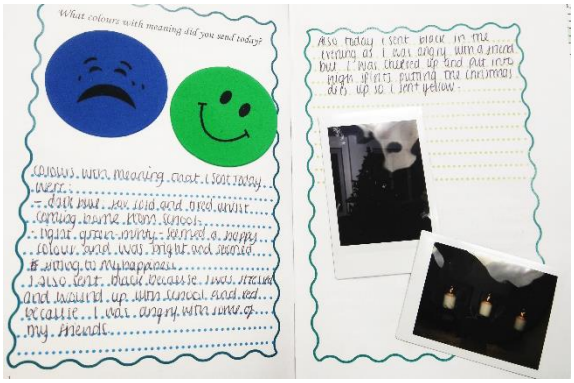


Figure 171. Rabbit's diary entries.

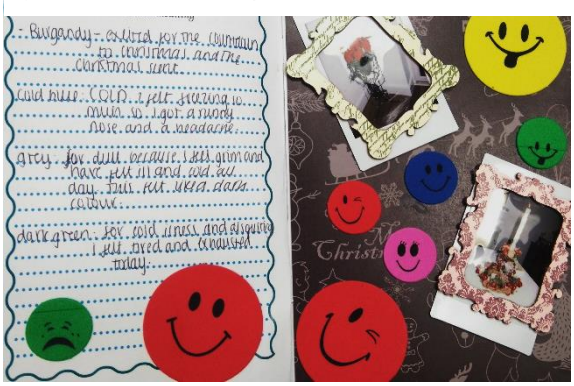


Figure 172. Rabbit's diary entries.

From the beginning of the study, Rabbit, 15, sent colours without meaning to experiment with the app, but she also sent colours with meaning. Rabbit sent light green for happiness (she did something that she loved), red for being angry, dark blue "*for cold and tired whilst coming home from school*", light green-minty for happiness, black for "*stressed and wound up with school*", red and black for being angry with some of her friends, orange for a "*festivity colour that makes me think about Christmas and happy times*", black for "*tired after work*", dark blue for feeling "*cold and miserable with the thought of low sun and cold air*", dark red for "*excitement for Christmas walking into the house with the decorations up*", grotty green for illness, burgundy because she felt "*excited for the countdown to Christmas and Christmas scent*", cold blue for freezing, grey for dull, grim, and ill.

Rabbit tried her best to choose colours that would perfectly describe her mood. Rabbit chose to communicate with colours because she could relate her moods and feelings a lot better: "*it seemed a lot easier and using words might've changed my perspective on the colour*". Figure 171 and Figure 172 show two different diary entries where Rabbit talks about her Christmassy moods.

At the beginning of the study, Rabbit felt confused when others sent her colours because she did not fully understand the app. However, on the fourth day she was trying to guess the meaning of the received colours: "*light green – maybe happiness?*", "*light pink – happiness*", "*dark blue – made me think of the cold*", "*minty green – freezing*". She chose to communicate with colours because she "*did not realize at first that words could be sent*". When she received colours from her friends, she "*was interested to know why they were what they said their mood was and what made them feel like that or what is going on to make them in that mood*". As a receiver of colours, Rabbit also felt like comparing herself to "*everyone else's feelings*" and she also "*feels inquisitive as to why they feel that way*". To be noticed that this is another statement that shows the app makes the user think of her and others' emotions. The user admits that she is introspecting herself and she is also questioning about her friends' feelings. Once again, it is showed the app triggers introspection and reflection on self and others' moods. Rabbit states that the app made her "*feel happy and confident with using colours*": "*I chose to communicate with colours because I could get a better understanding of the link between colour of emotion. I felt as though I could pick a colour and it would relate to myself feelings*". Therefore, Rabbit seemed to acknowledge the existence of a relationship between colours and moods. She used text to help her friends understand her moods. On day seven she even wondered if *"I should've sent some (colours) without words to see if the others felt the same as I do when receiving blank colours"*.

During the second day of the study Rabbit still had some problems with understanding how to type words in the app: "*I cannot use the words because I don't know how to type them*". On day three she felt more confident with the app and felt that she could understand her emotions against her colours. As an improvement for the app, Rabbit suggested to have "*instructions on the app whilst you're using it*" and *"diaries could be filled out online".*

Foxy

Foxy, 15, sent grey because the "*weather was cold and bleak*" and it affected her mood (Figure 173). "*Blue, grey, pink, or light blue*" were colours with no meaning that Foxy sent because they expressed how she felt and she liked them. Pink, blue, orange, green, and yellow were sent because "*all my exams are finished so I am happy and grateful".* One day Foxy picked blue because it was *"bright and colourful so made me happy"*, and another day because *"the sky looked good"*. She sent pink to say *"stay positive because I think that's what some people need to remember"* and she sent grey because she felt *"moody"*. On day 2 Foxy felt *"rejected"* because the others did not send her colours. When others sent her colours, Foxy felt "*happy because it lets you know why others are feeling the way they are and what they are feeling*" or *"happy because others have thought of me"*. Foxy chose to communicate with colours "*so that people can try and guess how you are feeling without words*" and also because *"they can influence others good moods"*. Foxy chose to communicate with words because *"then people know the literal meaning of how you feel"*. It seems like she liked the ambiguity of colour expression the app allowed her to choose. Foxy also acknowledges the importance of word associations to moods, so that people would be aware of one's feelings without having to guess. Foxy would improve the app by uploading it on the app store "*to make it easier to complete the colours*" and she would like to see *"notifications when someone has sent you a message"*.

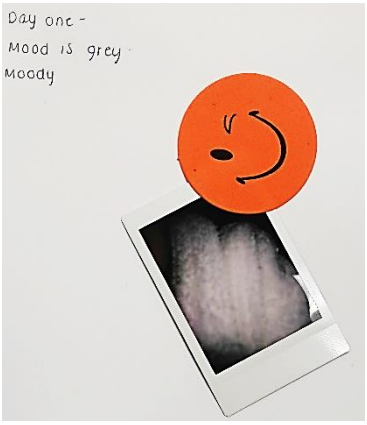


Figure 173. Foxy's diary entries.

Conclusion

This chapter evaluated the concept and the mobile app in two ways, firstly in a reflection with a group of six teenage females, and secondly in an in-the-wild study.

Of particular interest was the way the teenagers engaged quite substantially with the diaries, intended as a cultural probe study, and much less with the app. It could be argued that on reflection the app became a technology probe and the main findings came from the diaries in which the teenagers reported, and maybe imagined, their interactions around mood and colour. The most likely explanations for the inconsistencies are that a) the app was difficult to use and b) the lack of notifications broke the teenagers' engagement with the app. Additionally, the study group being all female might have indicated that they would like the creative space of the diaries over the rather clunky technology of the app. In either event, the study validated findings about the usefulness of colour-mood associations, it validated the ambiguity in the design and it validated the findings from earlier studies that strong colours had partially predictable colour-

mood associations. There was a willingness within the study group to share data and colour-mood data with friends and their narratives in the diaries provide rich data from which additional lessons can be learned.

The data, both logged and from the diaries was quite variable with teenagers using the app with different levels of enthusiasm and understanding. The app was not used only in the bedrooms, as the author anticipated, but in other places including in the car. It does appear from the logged data that some teenagers did not understand how to use it from the beginning, it is fair to say that this situation was not anticipated by the author.

Those that engaged reported that the app helped them talk about their moods, made them aware of their friends' moods and of the affect colour has on their mood. The diary data seemed to show the app triggered some introspection, reflection, and mood conveyance, inspiring chatter outside it. These interactions, introspections, and reflections support the Colour-Affective Interaction model, where ambiguity used these transactions to make meaning out of colours, and supported interaction with the sender by self-disclosure.

The poor visceral design of the app might have been contributed to teens' struggle with it. The behavioural design was poor as well, because teens encountered app glitches: Kitty could not see her boxes and she could not send colours. Some users did not intuitively find where they could write messages to associate them with colours. A limitation of the app was the lack of notifications, so teens had to refresh the link to see if they received any colours. Another limitation suggested by the users was that the app was not "an actual app on app store", but a web application.

In conclusion, the small study showed promising insights of the relationship between colours and moods and identified how this relationship could be designed for to encourage teenagers express themselves. Further work for the app is exploring the inclusion of an online diary, notifications, and a more user friendly design.

Chapter 9

Conclusion

This chapter discusses the contributions and methods of the thesis and answers the research questions:

1. Is there a relationship between colour and mood? If yes, is there a difference between genders?
2. Do teenagers have a favourite colour?
3. What colours would teenagers choose for their bedroom?
4. How can colour-mood associations be represented into a product? Can such a product be designed?

Research Questions

To answer the **first research question**, the novelty of this work's findings is that there was a potential relationship but only for some colours and moods (yellow-excited, black-fear, and red-irritated) and this aligns with other studies' findings:

- Yellow was associated with excitement, stimulation (Schaie 1961), cheerfulness, jovialness, joyfulness (Wexner 1954), happiness (Lawler, Lawler 1965), with sun, brightness, and warmth (Cimbalo, Beck & Sendziak 1978);
- Black was associated with night, darkness, and death (Cimbalo, Beck & Sendziak 1978), and with powerful, strong, masterful (Wexner 1954);
- Red was seen as a positive (Hemphill 1996), warm (Wright, Rainwater 1962) arousing (Gerard 1957, Gerard 1958), exciting and stimulating (Wexner 1954) colour, it was associated with anger or sadness ((Birren 1978), (Cimbalo, Beck & Sendziak 1978), (Sharpe 1974)), or with excitement and happiness (Boyatzis, Varghese 1994).

Yellow and black were shown to have strong associations to moods in the study in Chapter 6 but there was a confound in the way the strips started and ended with yellow and black. That said, the strips started this way as these were strong colours and it could be that strong colours do associate well with moods. It could also be that black and yellow were 'good for mood associations' for different reasons, reversal theory suggesting warm colours (yellow, red) associate with high-arousal and a paratelic state of mind; black, whilst not warm, also associates with high-arousal. In the literature, red was seen both as positive and negative, but this work's findings associate it

more with negative moods, possibly because of participants' age (where red is used to mark work etc.). These observations around strong colours were also seen in the diary study in Chapter 8.

To answer the **second research question**, teens did each suggest favourite colours for themselves, but no colour stood out. Nonetheless, blue, well known as a favourite colour (Nakamura, Harada & Shirokawa 2008) was a top choice. The word 'favourite' in itself was problematic and hard to answer, so the author triangulated some questions (bedroom colour, bedroom light, favourite colour), but one favourite colour was not found, which might show that what one chooses to wear (self-colour) is not similar with what one wants to be surrounded by (surrounding colour). There did not appear to be a gender difference.

Different techniques (nets, 3D box, questionnaire, lighting) were used to answer the **third research question** and from all studies put together, one of the interesting things was the extent to which teens can visualize the bedrooms. Their surreal bedroom designs seemed hard to live in maybe because it was difficult to see their designs. This problem could be improved by using models in virtual reality. The area of teens' bedroom colours has not been studied before. If teens actually prefer 'hard' to live in colours, then this could challenge the interior design colour pallet, which is not as bright and strong as teens preferred.

A product was designed as an answer for the **fourth research question**. It was built on theories such as self-disclosure theory (Greene, 2007), ambiguity in design (Gaver, 2003), and an interactional view on design for emotional communication ((Hook et al. 2008), (Boehner et al. 2007)). An interaction model was built based on these theories. The concept design was iterative, and it went a lot further than the developed product. The developed mobile app was tested in-the-wild and the findings were that teens sent colours far more then moods using the app but associated many moods to colours using dairies. It can be hypothesised that deficiencies in the built app contributed to this and the concept design would have mitigated against these discrepancies. The findings supported the earlier idea that it is important to let teenagers decide for themselves how to match colours. This product is different than the *eMoto* mobile app (Sundstrom, Stahl & Hook 2005) because it does not use predefined colours, or shapes and animations as the background of a message (Sundstrom, Stahl & Hook 2005). The focus of *Colour me Mood* app is to communicate with colours after a process of introspection, self-disclosure, and reflection.

Contributions

The main contribution of the work is the concept design for *Colour me Mood*. This is a design built for ambiguity, interaction and interpretation based on the social interaction of teenagers. Other contributions include the large amount of data on teenage colour mood associations and the innovations around methods for TCI.

Methods in TCI

Two main innovations on methods are claimed, the first was the use of teenagers to interpret their own data in Chapter 6. Redesigning data into visuals that were then subject to interpretation might be used as a method in TCI research, as it proved to be a strong confirmation method. The reinterpretation method supported the thesis findings about strong relationships between certain colours and certain moods such as yellow-happy/excited, black-fear, and red-irritation.

The diary study also assisted in developing insights into methods for TCI. The teens interacted in different ways and the diaries exposed different things. The diary design, based on a transition through evaluations, was quite novel and in the in-the-wild study this was shown to be reasonably effective (although not formally assessed as such given the low numbers participating).

While the results of the study showed inconsistency between the logged data and the diary data (Chapter 8), this is not necessarily a failure of either the diary or the app but rather could be evidence of the two instruments working together in a way unimagined by the author. The app, due to its immaturity and clunky design had some 'technical failings' which put the emphasis onto the diaries which instead of supporting the app use became the main instrument with the app supporting the diaries. In this way the app became a technology probe to support the research that came from the diaries.

Teenagers used the app only for the designed purpose, but it was understood from the diary reports that the app made them talk about personal issues maybe out of the app context, introspections being triggered by the app, which fills a gap in the TCI literature about interactive installations specially designed for teenagers. The method of having one teen recruit and train her fiends was positive for the validity of the work as being in-the-wild but it did result in possibly some misunderstandings with some of the teenagers.

Limitations

There were many limitations to this work caused in the main by recruitment and technical constraints. The online survey in Chapter 6 would ideally have been distributed to more children in the other countries so some cultural comparisons could have been made. More would have been

made of the transparent boxes and the washed bedrooms as described in Chapter 5 to better understand and study how bedrooms looked and to support the teenagers in thinking about how the spaces around them influence mood. The technical build of the app was not possible without huge expense and a lot of time and so a partially functional and rather 'clunky' app was built. The app was not in an app store but was a web app and so it was tricky to attend to. This probably limited the teens interactions with the app.

Further work

At the outset the aim was to help teenagers express their moods and in the final study, using diaries, the teenagers did that. Further work would be to bring the concept app to the marketplace as a product that teenagers could use. Other work that is envisaged is to replicate the study in Chapter 8 with teenage boys in order to provide a gendered context to the use of the app.

In terms of colour-mood associations, there is the possibility to use some of these associations in the design of spaces for teenagers. Certainly the more negative colour associations need to be further studied especially as they apply to the mental health of teenagers. More needs to be done to understood colours that are 'looked at' and colours that are 'self-reflections' and in this discussion it would be good to help teenagers themselves to understand how some colours will affect mood as it may be that they do not fully understand the differences between sent and received colours and how they translate. This could be studied with further use of the app with larger numbers of teenagers.

Closing Remarks

There are challenges that appear at the crossover between design and research, as one could annihilate the one (the creative process could be killed because of the analytical research process), in total favour of the other (the design process has a higher meaning when it is backed-up by research). With a background in Interior Architecture and Art and Design, the author found the design approach easier than the analytical one and it was extremely important to end the research with a final product with a good visceral design. The scientific research approach required by a PhD level contradicted her design thinking and throughout the whole PhD process, there was a continuous struggle and contradiction between the designer and the researcher within the author.

The designer's perspective (DP) was to find the problem, get inspired, design, test, and built the final product, and then put it on the market as a free app. The researcher's perspective (RP) was to find a gap, find a suitable methodology, run the studies, analyse the data, and then (maybe) bring a contribution. Design and research seem to be two different cultures (Fallman 2007) that

typically coexist where research is used to propel a new design (research-oriented design => that creates new products), which is then used to propel further research (design-oriented research => that produces new knowledge) (Fallman 2007). The current thesis aims to suggest that design and research could be "two intertwined processes in support of each other", a statement that Fallman (2007) contradicts.

The thesis makes small contribution to a big space where the health and wellbeing of teenagers is the main concern. It is the hope that some of the ideas of this work might eventually, in some small way, bring more happiness to teenagers.

Appendices

Chapter 4

Researcher/Year	No./ gender/age/place	Methods	Tools	Research findings
Boyatzis et. al (1994)	60 children 30 M 30 F 5 to 6 ½ years old US	Question about fav colour and then shown 9 coloured patches and had to say how did the colour make them feel and why.	questions	"children revealed distinct emotional reactions to particular colours"
Wilson (1966)	20 Unable to find the full paper free version.	Each exposed for 60 sec to 5 red and 5 green slides in alternating order.	Electrical skin conductance (galvanic skin response)	red is more arousing than green
Nourse et. al (1971)	14 students 6 M 8 F Undergraduates (age not specified) US	A total of 6 min exposer to green and violet light with 60 sec. intervals between the two lights in alternating order in a windowless room.	Electrical skin conductance (galvanic skin response)	violet had greater response than green
Nakshian (1964)	48 students 24 M 24 F 18 to 30 years old US	Participants were sat in a dark room and were exposed to an illuminated box where they had to solve tasks while the box's walls would be changed to red, green, and grey, following a predefined order. Munsell colour system was used and the saturation values of green and red were noted	Nine different tasks were measured separately and classification analysis was done for all nine in order to determine "whether task sequence or colour sequence was a significant source of variation"	red had higher affects on participants than green

Gerard (1957, 1958)	Unable to find the full paper free version.	Red, blue, and white lights were projected on a diffusing screen.	Physiological measurements such as heart rate, palmar conductance, cortical activation, blood pressure, respiratory movements, and frequency of the eye blink	Red is arousing and blue relaxing
Schaie (1961)	44 25 M 19 F Not mentioned US	Participants had to associate ten printed colours with eleven mood-tones.		yellow and orange were associated with excitement and stimulation; blue was associated with secure, comfortable, tender, soothing; blue, white grey were associated with calm, peaceful, serene.
Wexner (1954)	94 students 46 M 48 F Not mentioned US	Displayed coloured paper patches were associated with moods written on papers. Not explained why those and not other adjectives were chosen.	Paper pieces displayed on light-grey cardboard and lists of group of moods.	Some colours are more often associated with certain moods.
Wright et. al (1962)	3660 participants / 955 M 2705 F 16 to 65 years old Germany	Interviewed on a door-to-door basis, during a year.	Interviews, colour printed patches and list of words.	Age and gender differences were minor regarding colour rating. A relationship between shades of blue and calmness and between shades of red and greatest warmth and less calmness has been noticed.
Snyder et. all (2015)	30 participants Evenly distributed (51.5% male, 48.5% female)	Participants were sat in a room and exposed to coloured ambient light so that their arousal levels	skin conductivity	participants would have preferred to use other colours than the given ones

	18 – 34 years old US	would be measured using skin conductivity.		
Hemphill (1996)	40 participants 20 M 20 F Undergraduate students Caucasian (study took place in Australia)	Participants answered a questionnaire with questions about their favourite colour, the major colour they were wearing, their emotional response to colour, and the reasons for their choices. They had to choose colours from 10 different coloured cardboard rectangles.	Questionnaire and coloured cardboard rectangles that represented 10 different colours (white, pink, red, yellow, blue, purple, green, brown, black, and grey).	Results showed that bright colours were mainly associated with positive moods, while dark colours were mainly associated with negative moods. Findings also showed that males tended to respond to dark colours more positively than females did. It was also noticed that colours were chosen because of different reasons.
Cimbalo et al (1978)	136 participants males and females Children and students US	One group of children had to judge 20 coloured slides as happy or sad using a nine-point scale. Only eight slides were selected and presented for 15 seconds to the second group. They had to colour a rectangle with a colour from a given palette (red, orange, yellow, green, blue, brown, and black). Same method applied to the students.	Coloured slides, groups divided in 'judges' and 'participants', colouring rectangles from a given palette of crayons. The colours used were red, orange, yellow, green, blue, brown, and black.	There was "a strong and reliable association between emotional tone and colour".
	40 participants Male and female Children and students US	Firstly, participants had free choice association of the colours above. Secondly, the college students were asked to arrange crayons from lightest to darkest.	Free associations of colours; ordering crayons based on their lightness.	Firstly, results showed that "for both groups, black was associated with night, darkness, and death, whereas yellow was associated with sun, brightness, and warmth." Second findings showed that yellow was the most preferred, followed

				by orange, red, green, brown, blue, and black.
Harleman et. al (2007)	72 participants Not specified Architects, interior designers and students reading these subjects Sweden	Two different methods were used in order to gather data regarding one's impression on the colour perception in two identical rooms, one north sided, and the another south sided. Methods used: verbal description and semantic scales, which in general is a list of opposite adjectives used like a Likert scale.	Thirteen colours were used: six pinkish, five greenish, one yellowish, and one bluish colour.	The results showed that participants had different opinions regarding the same colour.
Nakamura et. al (2008)	37 participants Not specified adults China	Participants had to choose the most preferred colour from a number of different colour pairs which were displayed either on silicon squares, or as coloured objects. The colours used were red, blue, yellow, and green.	Infrared spectroscopy measurements of the anterior prefrontal cortex activities and judgement time were used.	Blue colour was the most preferred one as well as the saturated or bright colours. The choice of a preferred colour depended on the kind of object that was presented
Je et. al (2011)	348 participants (150 Korean and 198 Canadian) Not specified University students Korea and Canada	Participants had to select a colour they liked and then one that they disliked within 5-6 seconds. All the colours, hues, and tones choices were then categorized and analysed.	The study conducted a survey using PCIS (Psychological Color Image Scale) color charts of hue and tone.	Both countries like red, blue, neutral colours and dislike yellow; both countries differed in disliking yellow-red class hue, and there were different preferences regarding red-blue hues, red hues, grey hues and white hues.
Gong, 2011	80 participants Not specified Average age 22.3 years old China	Participants had to arrange eleven coloured patches (red, orange, yellow, green, blue, brown, purple, pink, white, black, and grey) and nine coloured mugs (red, orange, yellow, green, blue, brown, pink, white,	Coloured patches and coloured mugs.	The preferred colours were white, black, red, and yellow. The most disliked colour was brown. When participants were allowed to take away one of the

		and black) in their colour preference order.		mugs, they took a different coloured mug than the one chosen as the most preferred colour during the experiment.
Mahovic (2011)	Not specified Not specified Children and designers Croatia	Participants were asked about their preference on three different graphics with blue, red, and yellow backgrounds. Children were exposed to this experiment three times a day (morning, noon, and afternoon) for several days in a row. Each of these graphics was held up for five seconds to provoke emotional reactions.	Colourful graphics presented for few seconds.	Children prefer colours depending on different light surroundings. Graphic designers' choice of colour for products was in correlation with children's preferences: red, yellow for girls and blue for boys.
Yildirim et. al (2012)	70 participants Females 18-60 years old Turkey	Participants had to evaluate three pictures of a salon with three different wall colours using ten bipolar adjectives.	Survey, evaluating pictures, something similar to Likert scale using bipolar adjectives.	Results showed that lilac walls were perceived more positively than cream or orange walls. Moreover, it was noticed that young customers perceived the spaces more positively than middle-aged ones.
Guilford et. al (1959)	40 participants 20 M 20 F students North America	Participants had to scale the level of pleasantness for 361 Munsell colours using a 0 to 10 scale, 0 being the most unpleasant and 10 the most pleasant.	Colours displayed on neutral grey patches; some scale system similar to Likert scale.	Results showed that green to blue colour were most preferred while yellow and yellow –green were the least, "when brightness and saturation are held constant". Moreover, brightness and saturation are positively related to affective value.

Eysenck (1941)	42 participants Gender equally spread University students, professional people, artists England	Two experiments were carried in order to find out what is peoples' general colour preference, if they preferred saturated or unsaturated colour and if there is any difference between genders. All participants, who were divided in two groups, had to rank ten colours in their order of preference: blue, red, green, violet, orange, yellow, and five shades: green, red, orange, and yellow.	Ten different coloured papers were used on a coloured preference ranking.	Results showed that there are people who prefer saturated colours and others who prefer unsaturated colours. Regarding gender preference, men slightly preferred orange while women had a preference for yellow but other than that their colour preferences do not differ.

Table 49. Key colour references.

Age groups	5-6 years old	18-34 years old	16-65 years old	Children and students	Children and professional	undergraduates	Students and professional	Unable to find full paper	Not specified
Studies no	1	2	2	1	1	2	3	2	5

Table 50. Age groups of participants found in the key studies about colour research.

Place	England	US	Germany	Australia	Sweden	China	Korea and Canada	Croatia	Turkey	Unable to find full paper
Studies no	1	8	1	1	1	2	1	1	1	2

Table 51. The places where the key studies were run.

Chapter 6

Colour my Mood Version 1 (CMV1)

1	6. What is your favourite colour?
2	
3	
4	
5	Black
6	Black
7	white
8	blue
9	Gold
10	Green
11	Blue
12	Blue
13	Blue
14	Green
15	RED
16	Purple
17	red
18	Blue
19	blue
20	Blue
21	Pink
22	teal
23	purple
24	Light blue
25	black
26	Maroon
27	purlple
28	black
29	Brown
30	green
31	red and black
32	Black
33	electric blue
34	White

1	6. What is your favourite colour?
35	Green
36	Blue
37	green
38	White and navy blue
39	blue
40	Yellow
41	black
42	Orange
43	Pink
44	Black
45	black
46	Gray
47	Pire
48	Gray
49	purple
50	green
51	white and black
52	black
53	Orange
54	turquoise
55	Black
56	Green
57	Yellow
58	yellow
59	Black
60	Blue
61	None
62	Blue
63	aqua
64	Purple
65	Pink
66	Black
67	Orange
68	BLUE
69	green
70	Blue
71	Blue
72	blue
73	green

1	6. What is your favourite colour?
74	Aquamarine
75	Blue
76	Grey
77	orange
78	Purple
79	Gold
80	Blue
81	White
82	blue
83	Blue
84	Purple and blue
85	Navy Blue
86	Blue
87	Purple
88	Blue
89	green
90	Black
91	mint green
92	Blue
93	white
94	green
95	Light blue
96	Dark blue
97	white
98	Dark blue and lilac purple
99	White
100	Orange
101	teal
102	Blue
103	Purple
104	purple
105	army green
106	Blue
107	dark blue
108	red
109	Purple
110	Blue
111	purple
112	Red
113	Teal
114	Dark red
115	Purple/Green
116	Blue
117	Purple
118	Red or Blue
119	Purple
120	Elktongue
121	Green
122	Blue
123	Blue and red. salmon
124	Orange
125	black
126	Red
127	Blue
128	Gold
129	Blue
130	Pink
131	Purple
132	Green
133	red and black

Figure 174. Raw data of all study participants for the question: "What is your favourite colour?"

	12. What colour light would you like in your bedroom?
1	
2	
3	
4	15A
5	8A
6	10B
7	13A
8	5A
9	13A
10	3C
11	13A
12	1B
13	13C
14	3C
15	16B
16	5B
17	1C
18	3B
19	13B
20	6C
21	13A
22	13A
23	13A
24	15A
25	3C
26	9A
27	13A
28	13A
29	2C
30	13C
31	13A
32	13A
33	5C
34	11C
35	9B
36	1C
37	13A
38	3A
39	1A
40	11B
41	13A
42	13A
43	7C
44	15A
45	10C
46	14A
47	7A
48	7C
49	1A
50	3C
51	4B
52	3A
53	2A
54	1C
55	10B
56	1C
57	10B
58	3A
59	13A
60	13C
61	2C
62	13A
63	13A
64	1C
65	13C
66	3A
67	10B
68	10C
69	13A
70	7C
71	13B
72	13A
73	10C
74	6C
75	14B
76	3C
77	13A
78	2B
79	13A
80	5C
81	1A
82	13A
83	13A
84	13A
85	8A
86	13A
87	9A
88	1C
89	7A
90	1C
91	1C
92	4B
93	13A
94	13B
95	13A
96	13A
97	1A
98	16C
99	13A
100	12B
101	11B
102	13A
103	13A
104	6B
105	10B
106	10B
107	13A
108	1C
109	13B
110	13A
111	13A
112	6C
113	13B
114	11B
115	9B
116	13B
117	1C
118	1C
119	15A
120	7B
121	9B
122	5B
123	13A
124	10B
125	10B
126	9C
127	2B
128	6C
129	1C
130	13A
131	2C
132	13C
133	

Figure 175. Raw data of all study participants that answered the question: "What colour light would you like in your bedroom?"

1	17a. Excited	17b. Scared	17c. Determined	17d. Irritable	17e. Enthusiastic	17f. Nervous	17g. Inspired	17h. Afraid	17i. Attentive	17j. Jittery
2										
3										
4										
5	15A	15A	15A	15A	15A	15A	15A	15A	15A	15A
6	1A	5A	15A	15A	5A	13C	5A	5A	14B	7A
7	5A	4A	14C	13B	10B	10A	13B	9A	3C	3B
8	5A	15A	5A	5A	4B	13A	1A	15A	13A	13A
9	11A	1B	3B	5B	8B	9B	10B	11B	14B	1B
10	6B	15A	9A	5A	5B	14A	1B	15C	10A	7C
11	1A	15C	4B	6B	11B	6A	9B	5A	16B	1B
12	1A	15A	8A	5A	11B	14A	1B	15B	3A	6B
13	1A	9B	5A	4A	8B	10C	13A	16C	11B	16A
14	11B	4A	8A	5A	5B	12A	10A	5A	7B	3C
15	12A	11A	10A	9A	8A	7A	3A	10A	4A	4A
16	1A	15A	13A	5A	11A	4A	13A	14A	10A	6A
17	1A	5A	10A	15A	3A	9B	7A	11B	15A	16A
18	5B	15B	16C	5A	10A	11C	10C	5A	9B	8A
19	5A	15A	10B	6C	5B	2B	1A	15A	6C	8A
20	1B	16B	9B	5B	10B	14A	13A	4C	11C	1A
21	6B	5C	9B	5A	3A	12C	1A	10A	4C	14C
22	1C	14B	5A	5A	2C	10C	7B	15A	13A	12B
23	1C	14B	5A	5A	1A	9A	7B	15A	13A	12B
24	6A	15A	9B	5A	11B	14C	7C	15C	8A	4A
25	15C	15C	15C	15C	15C	15C	15C	15C	15C	15C
26	6B	10A	5C	5A	1A	3A	10A	1C	5A	6B
27	13A	16C	8A	14A	6B	13C	5C	3A	7B	9B
28	1A	15A	9A	4A	1A	11B	7A	5A	11A	10A
29	1B	15A	5A	5A	1A	15A	11A	15A	1A	1A
30	1A	15A	8A	5A	10B	14A	7B	5A	3A	5B
31	10B	12B	6A	5A	12C	1C	11A	9C	13A	10C
32	5A	15A	15A	5A	8A	13A	10B	15A	5A	15A
33	4B	9C	11C	14B	6B	8A	12B	8C	5B	1B
34	4B	5A	9A	4A	11A	12A	5A	5A	11A	11A

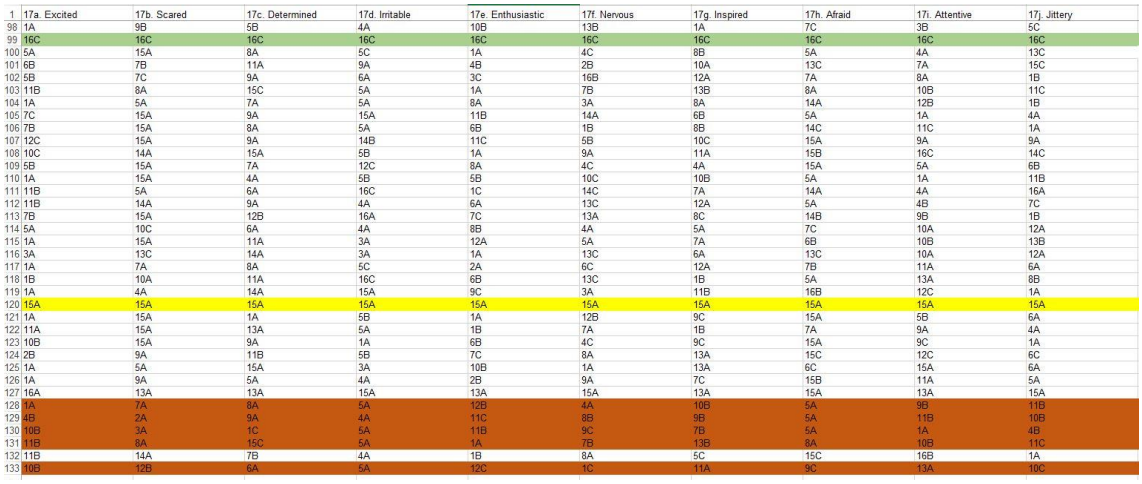
Figure 176. Raw data of question 2 (first part).

1	17a. Excited	17b. Scared	17c. Determined	17d. Irritable	17e. Enthusiastic	17f. Nervous	17g. Inspired	17h. Afraid	17i. Attentive	17j. Jittery
35	11A	5A	1A	12A	11A	9B	11A	5A	1A	11A
36	1A	15A	7A	5A	11B	14C	9A	15B	5B	2C
37	1A	15A	5A	5B	11B	16C	10B	15A	3B	13A
38	5A	14A	15A	3A	5C	4B	10B	15C	13B	11B
39	10B	15A	15A	5A	1A	12A	1A	15A	7B	7B
40	2A	3B	11C	12A	16B	3B	2C	6A	8B	13A
41	13B	13B	13B	13B	13B	13B	13B	13B	13B	13B
42	11A	7A	5A	4A	9A	16B	1A	15A	3A	11A
43	5A	15A	13A	15A	1A	14C	13A	16A	13A	16A
44	1A	15C	8A	15A	1A	13C	1A	5A	13A	15A
45	11A	5A	15A	15A	15A	15A	15A	5A	15A	5A
46	4A	5B	6B	6B	6B	6B	6B	6B	6B	6B
47	1A	15A	7A	5A	5A	5A	10B	5A	4A	12C
48	15C	1A	15A	4A	15C	15C	15C	15C	15C	15C
49	7C	7C	7C	7C	7C	7C	7C	7C	7C	7C
50	10B	15A	9A	5A	10B	7A	3A	15A	4A	5B
51	13B	15A	13C	15A	15B	16A	13C	15B	13C	12A
52	4A	14A	11A	3A	5A	1A	12A	5A	12A	16A
53	3A	3A	3A	3A	3A	3A	3A	3A	3A	3A
54	1B	15C	9A	5B	1A	16A	10B	7A	4C	11C
55	1A	15A	8A	5A	11C	14A	2A	4B	4C	10A
56	12B	15B	14B	16B	12C	13C	8B	16A	5A	12C
57	6C	16A	8A	5A	2B	6A	12C	15A	12B	5C
58	1A	15A	12A	16B	1A	13A	11A	15A	11A	13A
59	5A	13A	9C	2B	3A	11B	7A	13B	15A	16C
60	11B	15A	8B	6A	1B	6C	10C	4A	2C	1A
61	5A	15B	1A	6A	5A	7A	4A	11A	12A	11B
62	1A	7A	9B	4A	3B	10A	12C	16C	4C	1A
63	15B	15B	15B	15B	15B	15B	15B	15B	15B	15B
64	1B	5A	4A	8A	12C	10C	7C	5B	8C	4B
65	10B	3A	1C	5A	11B	9C	7B	5A	1A	4B
66	4A	15A	2A	10B	11A	14A	8A	15A	7A	5A
67	5A	14A	8A	3A	5B	10A	7B	14A	13A	1A
68	4A	4C	7A	5A	1A	5B	11A	14A	16A	12A
69	5A	9B	16B	15A	2B	12A	9C	4A	13A	5B
70	3A	8B	4A	5A	11A	8A	1A	15C	11B	10B
71	13A	1A	5A	5C	10C	3A	6A	2C	11C	11B
72	8B	15A	6A	5B	9A	14A	2A	15C	14C	12C
73	1B	15A	3A	1A	11B	16B	10B	9A	12B	8C

Figure 177. Raw data of question 2 (second part).

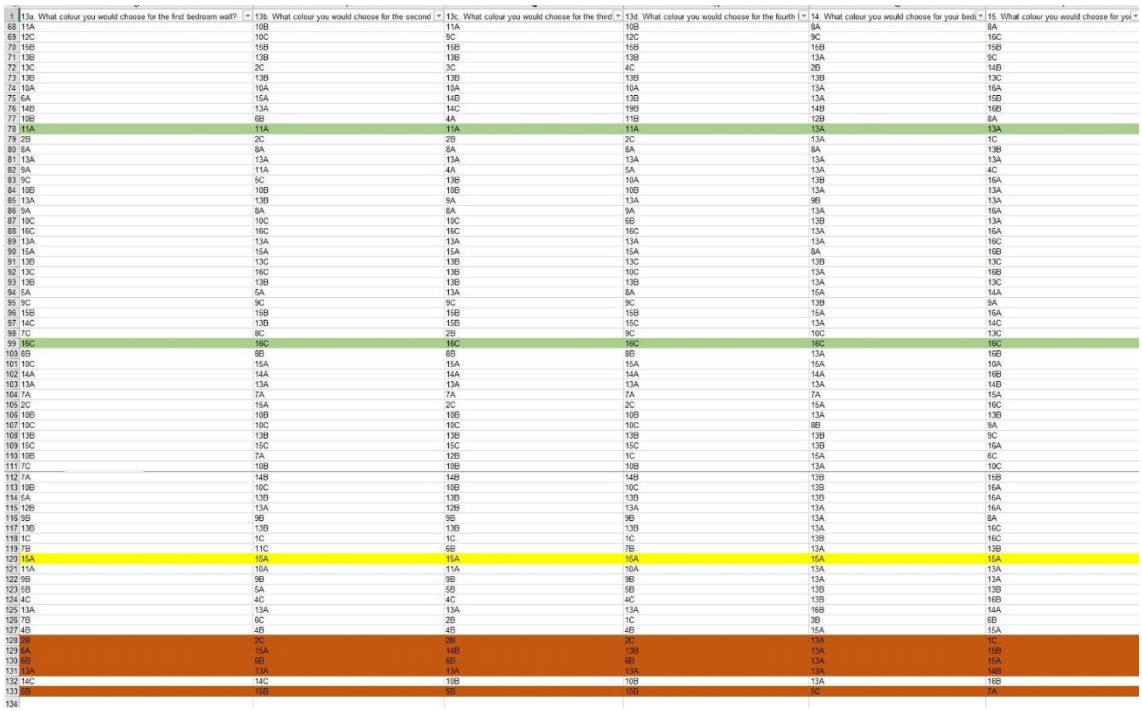
1	17a. Excited	17b. Scared	17c. Determined	17d. Irritable	17e. Enthusiastic	17f. Nervous	17g. Inspired	17h. Afraid	17i. Attentive	17j. Jittery
74	5A	15A	9A	14A	10B	4A	10C	15A	8A	11A
75	4B	2A	9A	4A	11C	8B	9B	5A	11B	10B
76	14A	12A	9B	16C	5A	4A	15A	13A	14C	10B
77	3B	15B	13B	5A	7C	13C	4B	9B	10A	1C
78	1A	12B	14B	5A	1A	2B	9B	1A	11A	1A
79	1A	7A	8A	5A	12B	4A	10B	5A	9B	11B
80	12B	15A	13C	13C	1A	10B	13A	12A	1A	2B
81	13A	13A	13A	1B	13A	5A	13A	13A	13A	13A
82	1A	16C	14A	16B	4A	1C	10B	4C	13A	1B
83	5A	15A	1A	4A	6B	1C	9B	15A	10B	2C
84	1B	5A	8B	5A	1A	12B	2B	5A	1A	7C
85	4A	15C	15A	5A	4A	8B	1C	7A	12C	3B
86	1B	14A	5A	13C	10B	5C	7C	15A	13B	4B
87	3A	9A	4A	5A	1A	6C	1A	9C	12B	10C
88	6B	4A	14A	14A	4A	13B	3A	5A	10B	1B
89	11B	9B	11A	5A	11A	4A	12C	13B	11C	12C
90	12A	6A	15A	1A	5A	1A	15A	6C	14A	1C
91	5B	13A	9A	5A	1A	9A	11C	5A	10B	5A
92	1A	13A	9A	5A	3A	7A	11A	15A	2A	16A
93	4A	5A	15A	15B	5B	11A	12B	9A	11C	14A
94	11A	9C	5A	1C	13A	16C	11A	6A	15A	3B
95	10C	15B	9B	5B	1A	9A	2C	5A	8C	12B
96	5A	9B	16C	4A	11A	13C	8A	15A	1A	6C
97	5B	5A	9A	16A	12B	3A	8A	2C	1A	10A

Figure 178. Raw data of question 2 (third part).



	17a. Excited	17b. Scared	17c. Determined	17d. Irritable	17e. Enthusiastic	17f. Nervous	17g. Inspired	17h. Afraid	17i. Attentive	17j. Jittery
98	1A	9B	5B	4A	10B	13B	1A	7C	3B	5C
99	16C	16C	16C	16C	16C	16C	16C	16C	16C	16C
100	5A	15A	8A	5C	1A	4C	8B	5A	4A	13C
101	6B	7B	11A	9A	4B	2B	10A	13C	7A	15C
102	5B	7C	9A	6A	3C	16B	12A	7A	8A	1B
103	11B	8A	15C	5A	1A	7B	13B	8A	10B	11C
104	1A	5A	7A	5A	8A	3A	8A	14A	12B	1B
105	7C	15A	9A	15A	11B	14A	6B	5A	1A	4A
106	7B	15A	8A	5A	6B	1B	8B	14C	11C	1A
107	12C	15A	9A	14B	11C	5B	10C	15A	9A	9A
108	10C	14A	15A	5B	1A	9A	11A	15B	16C	14C
109	5B	15A	7A	12C	8A	4C	4A	15A	5A	6B
110	1A	15A	4A	5B	5B	10C	10B	5A	1A	11B
111	11B	5A	6A	16C	1C	14C	7A	14A	4A	16A
112	11B	14A	9A	4A	6A	13C	12A	5A	4B	7C
113	7B	15A	12B	16A	7C	13A	8C	14B	9B	1B
114	5A	10C	6A	4A	8B	4A	5A	7C	10A	12A
115	1A	15A	11A	3A	12A	5A	7A	6B	10B	13B
116	3A	13C	14A	3A	1A	13C	6A	13C	10A	12A
117	1A	7A	8A	5C	2A	6C	12A	7B	11A	6A
118	1B	10A	11A	16C	6B	13C	1B	5A	13A	8B
119	1A	4A	14A	15A	9C	3A	11B	16B	12C	1A
120	15A	15A	15A	15A	15A	15A	15A	15A	15A	15A
121	1A	15A	1A	5B	1A	12B	9C	15A	5B	6A
122	11A	15A	13A	5A	1B	7A	1B	7A	9A	4A
123	10B	15A	9A	1A	6B	4C	9C	15A	9C	1A
124	2B	9A	11B	5B	7C	8A	13A	15C	12C	6C
125	1A	5A	15A	3A	10B	1A	13A	6C	15A	6A
126	1A	9A	5A	4A	2B	9A	7C	15B	11A	5A
127	16A	13A	13A	15A	13A	15A	13A	15A	13A	15A
128	1A	7A	8A	5A	12B	4A	10B	5A	9B	11B
129	4B	2A	9A	4A	11C	8B	9B	5A	11B	10B
130	10B	3A	1C	5A	11B	9C	7B	5A	1A	4B
131	11B	8A	15C	5A	1A	7B	13B	8A	10B	11C
132	11B	14A	7B	4A	1B	8A	5C	15C	16B	1A
133	10B	12B	6A	5A	12C	1C	11A	9C	13A	10C

Figure 179. Raw data of question 2 (last part).



	13a. What colour you would choose for the first bedroom wall?	13b. What colour you would choose for the second	13c. What colour you would choose for the third	13d. What colour you would choose for the fourth	14. What colour you would choose for your bed	15. What colour you would choose for yo
68	11A	10B	11A	10B	8A	8A
69	12C	10C	9C	12C	9C	16C
70	15B	15B	15B	15B	15B	15B
71	13B	13B	13B	13B	13A	9C
72	13C	2C	3C	4C	2B	14B
73	13B	13B	13B	13B	13B	13C
74	10A	10A	10A	10A	13A	15A
75	6A	15A	14B	13B	13A	15B
76	14B	13A	14C	19B	14B	16B
77	19B	6B	4A	15B	12B	8A
78	11A	11A	11A	11A	13A	13A
79	2B	2C	2B	2C	13A	1C
80	8A	8A	8A	8A	8A	13B
81	13A	13A	13A	13A	13A	13A
82	9A	11A	4A	5A	13A	4C
83	9C	5C	13B	10A	13B	16A
84	10B	10B	19B	10B	13A	13A
85	13A	13B	9A	13A	9B	13A
86	9A	8A	8A	9A	13A	16A
87	19C	19C	19C	6B	13B	13A
88	16C	16C	16C	16C	13A	16A
89	13A	13A	13A	13A	13A	16C
90	15A	15A	15A	15A	8A	16B
91	13B	13C	13B	13C	13B	13C
92	13C	16C	13B	19C	13A	19B
93	13B	13B	13B	13B	13A	13C
94	5A	5A	13A	8A	15A	14A
95	9C	9C	9C	9C	13B	9A
96	15B	15B	15B	15B	15A	16A
97	14C	13B	15B	15C	13A	14C
98	7C	8C	2B	9C	10C	13C
99	16C	16C	16C	16C	16C	16C
100	8B	8B	8B	8B	13A	16B
101	19C	15A	15A	15A	15A	10A
102	14A	14A	14A	14A	14A	16B
103	13A	13A	13A	13A	13A	14B
104	7A	7A	7A	7A	7A	15A
105	2C	15A	2C	2C	15A	19C
106	10B	10B	10B	10B	13A	13B
107	19C	19C	19C	10C	8B	9A
108	13B	13B	13B	13B	13B	9C
109	15C	15C	15C	15C	13B	16A
110	10B	7A	12B	1C	15A	6C
111	7C	10B	19B	10B	13A	19C
112	7A	14B	14B	14B	13B	15B
113	10B	10C	19B	10C	13B	16A
114	5A	13B	13B	13B	13B	16A
115	12B	13A	12B	13A	13A	16A
116	9B	9B	9B	9B	13A	8A
117	13B	13B	13B	13B	13A	16C
118	1C	1C	1C	1C	13B	16C
119	7B	11C	6B	7B	13A	13B
120	15A	15A	15A	15A	15A	15A
121	11A	10A	11A	10A	13A	13A
122	9B	9B	9B	9B	13A	13A
123	5B	5A	5B	5B	13B	13B
124	4C	4C	4C	4C	13B	16B
125	13A	13A	13A	13A	16B	14A
126	7B	9C	2B	1C	3B	6B
127	4B	4B	4B	4B	15A	15A
128	2B	2C	2B	2C	13A	1C
129	6A	15A	14B	13B	13A	19B
130	6B	6B	6B	6B	13A	15A
131	13A	13A	13A	13A	13A	14B
132	14C	14C	19B	10B	13A	16B
133	6B	15B	6B	19B	6C	7A
134						

Figure 180. Raw data of question 4.

Room types

- traditional rooms (TR): where all walls are one of these (traditional) colours: blue, yellow, pink, green, red, brown, white; the ceiling is white or similar to the walls; floor is different from ceiling and walls and is brown, beige, or grey;
- modern rooms (MR): three walls are white and one coloured; the ceiling is white or coloured (black, dark grey, yellow, blue, red); floor is white, brown, or grey;
- futuristic rooms (FR): four walls same colour or shades of it; ceiling same as walls, or floor, or white if the floor is the same as the walls; floor same as walls or ceiling; or white if the ceiling is the same as the walls; or five surfaces same colour plus one surface different colour and not traditional; maximum two colours (or shades of two colours) in the room;

- surreal rooms (SR): three or more different colours and not traditional;
- other rooms (OR): what does not fit in the other four types.

Colour my Mood Version 2 (CMV2)

Analysis 1

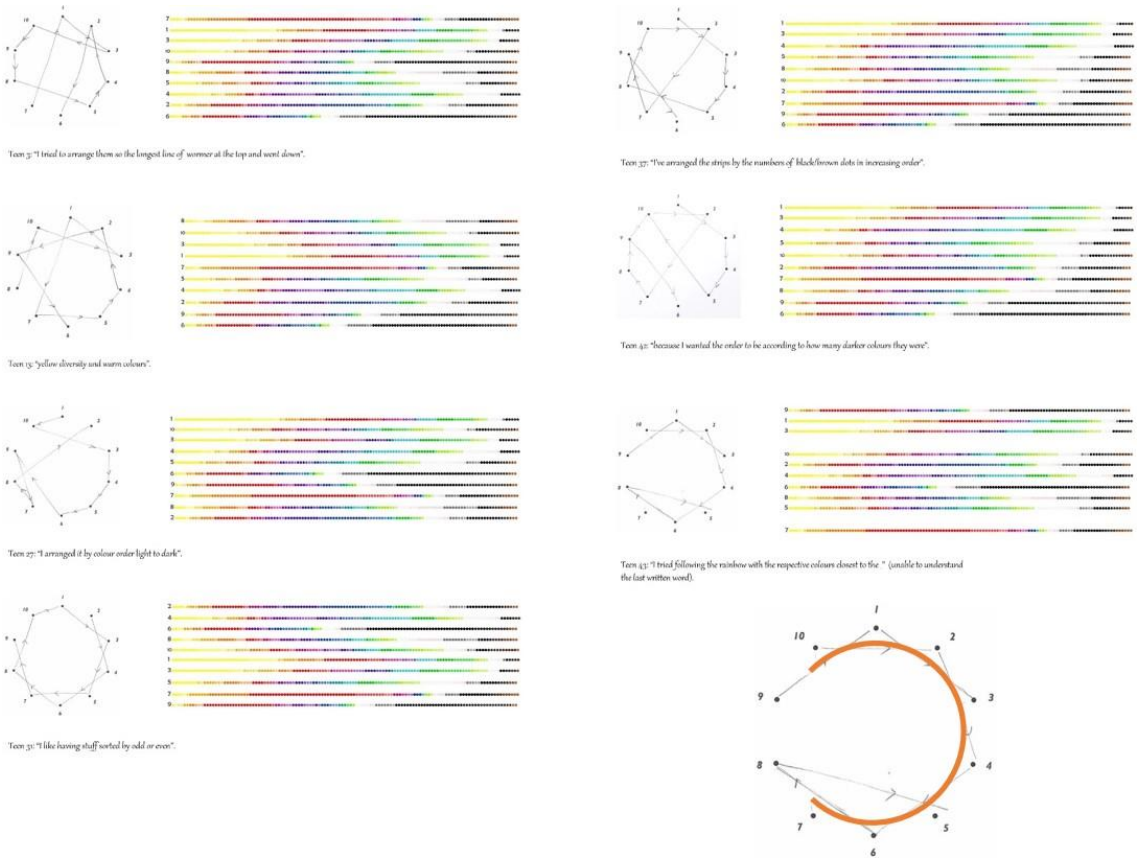


Figure 181. Group B

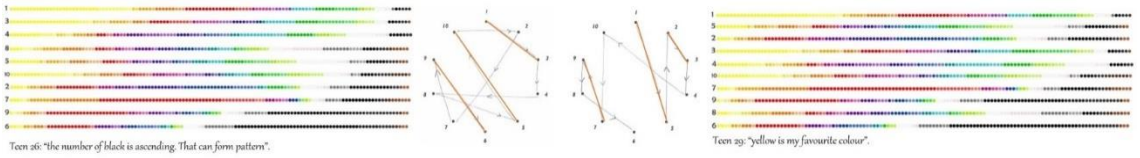


Figure 182. Group C.

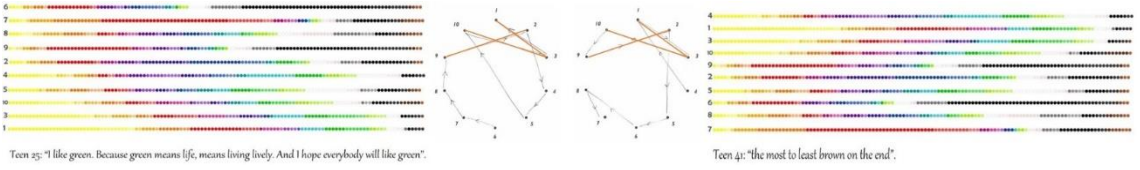


Figure 183. Group D.

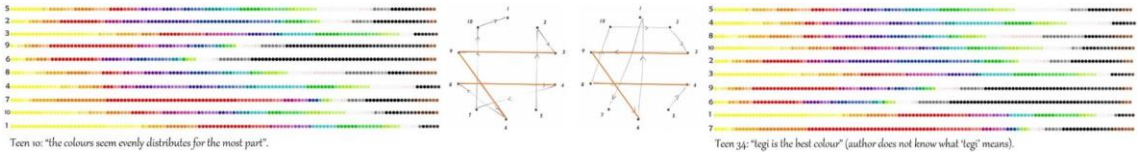


Figure 184. Group E.

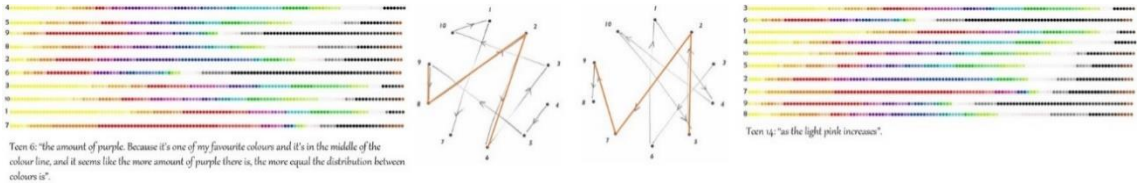


Figure 185. Group F.

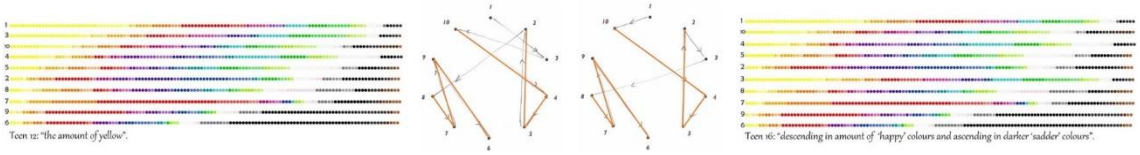


Figure 186. Group G.

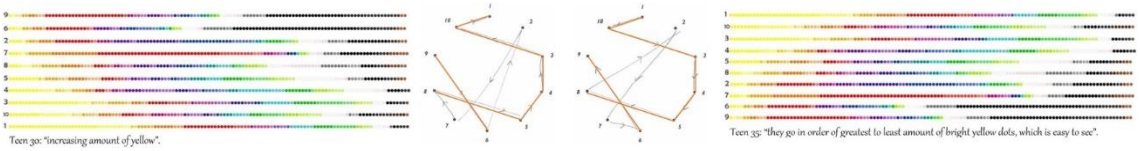


Figure 187. Group H.

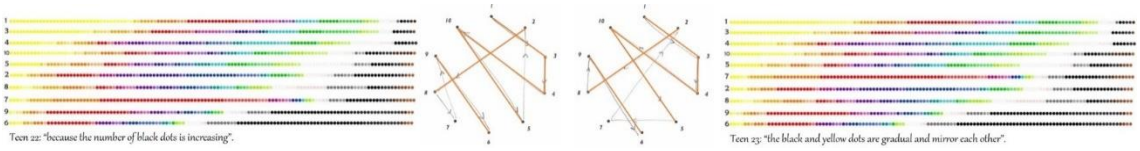


Figure 188. Group I.

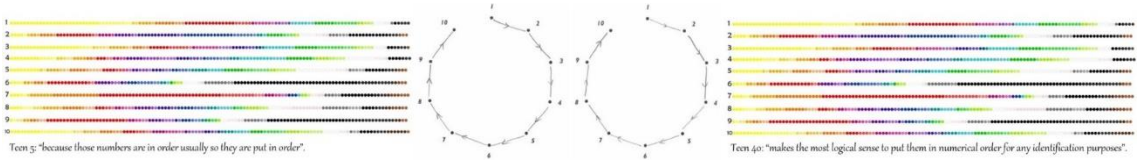


Figure 189. Group J.

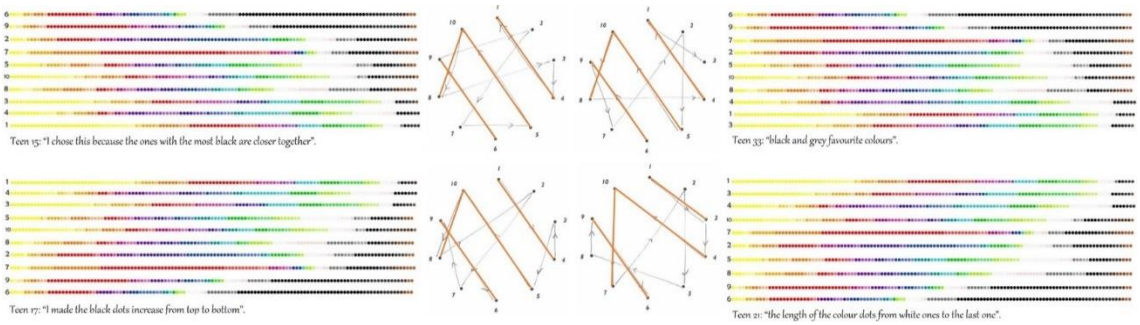


Figure 190. Group K.

Analysis 2

Female	Similar 1-3	Similar 6-9	Male	Similar 1-3	Similar 6-9
T3	"same amount of cool colours."	"they both have more cool colours."	T1	"similar amount of yellow."	-
T8	-	"they both have a lot of black."	T2	-	"small amount of yellow. Large black."
T9	-	"they both have a lot of black."	T13	"a lot of yellow."	"same kind of feeling, a lot of black."
T10	-	"they both have a lot of black."	T15	"they have the most yellow."	"they have the most black."
T11	-	"they both have a lot of black towards the end."	T16	"similar amount of yellow/orange."	-
T12	"all same amount of same colours."	"same amount of same colours."	T17	"large amount of yellow dots."	"large amount of black dots."
T14	-	"# of black dots."	T20	"yellow, orange in beginning."	"black at end."
T19	-	"they both have most black dots."	T23	"same # of white dots."	"same # of colours."
T21	"similar colour arrangement (order, #)."	-	T30	"same"	-
T24	-	"same amount of colours."	T31	-	"the black and yellows and blues match each other."
T27	"same pattern."	-	T32	"look to be almost identical."	-
T38	"colour amounts are similar."	"they have the most black."	T33	"a long duration of yellow spreading."	"because they both have the same amount of black and grey."
T41	-	"black prominent."	T34	-	"dark colours are prominent."
T42	"similar # of lights and darks."	-	T35	"large amount of yellow, small amount of black."	"large amount of black, small amount of yellow."

T43	"because the colours follow the 'same' colour sequence."	-	T36	"the blue are similar lengths."	"the black colour is similar."
T44	-	"they both have grey/pink and a lot of black."	T37	-	"similar amounts of yellow, black, and purple."
			T40	"both have one brown on the right side."	-
Gender not specified (Ns)			**No answer for 1-3 and 6-9 strips**		
T5/Ns	"colours are close to each other."	-	T4/Ns	-	-
T29/Ns	"colour pattern."	-	T6/F	-	-
T45/Ns	"similar amounts of same colour."	"similar amounts of same colour."	T7/ F	-	-
T18/ F+M (both genders were circled)	-	"because both have large amounts of black and small amounts of yellow."	T22/M	-	-
			T25/M	-	-
			T26/F	-	-
			T28/M	-	-
			T39/F	-	-

Table 52. Teens' reasons for why they have chosen similar sets. Their responses were grouped by genders such as male/female, unspecified gender, and no answers.

Female	**Opposite 1-6**	**Opposite 1-9**	**Male**	**Opposite 1-6**	**Opposite 1-9**
T3	"one has a lot of yellow, six has a lot of black."	-	T1	"most black to least."	"fewest number yellow the most."
T8	"lots of dark/lots of light."	-	T2	"large yellow vs. small yellow; large black vs. small black."	-

Female	Opposite 1-6	Opposite 1-9	Male	Opposite 1-6	Opposite 1-9
T9	-	"one has a lot of black and little yellow and one is the opposite."	T15	"black vs. yellow."	"minimal yellow vs. lots of yellow."
T10	"because 6 has a lot of black and 1 does not."	-	T16	"black + yellow are in opposite amounts."	-
T11	-	"the bulk of one colour is either at the beginning or end."	T17	"1 has least amount of black dots, 6 has largest."	-
T12	"one is majority black, the other mixed."	-	T28	"darker"	-
T19	"the different numbers of black dots."	"the different numbers of yellow dots."	T30	-	"black vs. yellow abundance (diversity)."
T24	-	"they have the most yellow + most black."	T31	-	"1 is happier and 9 is darker."
T26	"6 has the most black and 1 has the least black."	-	T32	-	"they look to be the opposite colours."
T38	"6 has most black, 1 has least."	"9 has least amount of yellow, 1 has most."	T34	"dark is low in 1 and high in 6".	-
T39	"1 has almost no black and a lot of yellow; 6 has almost no yellow and a lot of black."	-	T40	-	"1: longest yellow; 9: shortest yellow."
T42	"because 1 has many more light."	-			
T44	"yellow/black swap."	-			

Table 53. Teens' reasons for why they have chosen opposite sets. Their responses were grouped by genders such as male/female, unspecified gender, and no answers.

DB Colour	DB Mood	Diary Colour	Diary Mood
	none	grey	cold, bleak weather
none	none	blue	expressed how she felt and she liked them
none	none	grey	expressed how she felt and she liked them
none	none	pink	expressed how she felt and she liked them
none	none	light blue	expressed how she felt and she liked them
none	none	pink	exams finished so happy and grateful
none	none	blue	exams finished so happy and grateful
none	none	orange	exams finished so happy and grateful
none	none	green	exams finished so happy and grateful
none	none	yellow	exams finished so happy and grateful
none	none	blue	happy
none	none	blue	none
none	none	black	none
none	none	yellow	none
none	none	pink	none
none	none	blue	represents the sky which looked good
none	none	pink	none
none	none	orange	none
none	none	purple	liked it
none	none	maroon	liked it
none	none	pink	positive
none	none	grey	moody
none	none	pink	none
none	none	blue	none
none	none	red	none
none	none	blue	none
none	none	grey	none

Table 54. Foxy

DB Colour	DB Mood	Diary Colour	Diary Mood
	Confused	luminous green	confused
none	none	bright pink	liked it
none	none	blue	liked it
	Tired	purple	bored
	Stressed	vibrant orange	stressed, angry
	Bored	blue	tired
	Bored	pink	liked it
none	none	green	liked it
	Excited	orange	excited
	Feels like Christmas	red	feels like Christmas
	Relaxed	light blue	relaxed
	none	hot pink	excited
	none	blue	chilled, relaxed

DB Colour	DB Mood	Diary Colour	Diary Mood
	none	turquoise	cold
	Freezing	bright blue	freezing
	I'm freezing	blue	none
	none	yellow	happy, laughing
	Haha	none	none
	Stressed	orange	stressed
none	none	red	stressed
	Carm	blue	carm
	Nervous	red	nervous, anxious
	none	grey	pain

Table 55. Kitty

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	yellow	happy, excited
none	none	musky green	jealous, upset, sad
none	none	red	neutral
	none	blue	hungry, sad
	none	none	none
	none	none	none
	none	bright pink	happy, neutral
	none	more colours	none
	none	none	none
	none	none	none
	none	yellow	excited
	none	light green	unhappy
	none	none	none
	none	none	none
	none	yellow	excited
	none	purple	relieved, relaxed
	none	pink	none
	none	none	none
	none	none	none
none	none	yellow	excited
none	none	orange	hungry, sad, happy
none	none	green	hungry?
none	none	orange	tired
none	none	green	sad
	none	yellow	excited
	none	light blue	sad, hungry
	none	pink	none
	none	purple	none
none	none	orange	none

Table 56. Mermaid

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	purple	hungry
none	none	black	stressed

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	light blue	cheeky
none	none	dark blue	sadness
none	none	red	none
none	none	purple	none
none	none	blue	none
none	none	black	none
none	none	green	none
none	none	white	tired
none	none	grey	cold
none	none	light blue	relived
none	none	yellow	excited
none	none	lilac	relaxed
none	none	green	none
none	none	red	none
none	none	blue	none
	none	black	bored
	none	pink	excited
	none	red	anxious
	none	grey	sad
	none	blue	tired
none	none	navy	none
none	none	black	none
none	none	orange	none
none	none	yellow	none
none	none	green	none
none	none	red	none
none	none	pink	none
	none	navy	her dress colour
	none	red	lovely jewelry
none	none	white	excited
none	none	black	disco
none	none	silver	special occasion
none	none	green	none
none	none	yellow	none
none	none	green	ill
none	none	red	festive
none	none	orange	bored
none	none	yellow	hungry
none	none	blue	sad
none	none	white	sleepy
none	none	red	festive
none	none	blue	cold
none	none	yellow	stressed
none	none	green	none
none	none	black	none

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	white	none
none	none	blue	none
none	none	yellow	none
none	none	pink	none
	none	light blue	relaxed
	none	pink	stressed
	none	black	depressed
none	none	green	ill
none	none	green	none
none	none	yellow	none
none	none	orange	none

Table 57. Monkey

DB Colour	DB Mood	Diary Colour	Diary Mood
	none	orange	mutucn???
	none	blue	cold
none	none	pink	none
none	none	green	none
none	none	blue	cold
none	none	green	liked it
none	none	red	annoyed, angry
none	none	pink	liked it
none	none	pink	none
none	none	blue	none
none	none	green	none
none	none	red	none
none	none	purple	none
none	none	orange	none
none	none	yellow	none
none	none	black	none
none	none	brown	none
none	none	white	none
none	none	pink	none
none	none	yellow	none
none	none	red	none
none	none	blue	none
none	none	purple	none
	none	green	festive
	none	red	festive
none	none	yellow	festive
none	none	green	none
none	none	pink	none
none	none	yellow	none
none	none	orange	none
none	none	blue	none
none	none	purple	none

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	pink	none
none	none	orange	none
none	none	yellow	none
none	none	brown	none

Table 58. Turtle

DB Colour	DB Mood	Diary Colour	Diary Mood
none	none	orange	none
none	none	yellow	none
none	none	light green	happy
none	none	red	upset, angry
none	none	dark blue	cold, tired
none	none	light-green minty	happy
none	none	black	stressed
none	none	red	angry
none	none	black	angry
none	none	yellow	cheerful
none	none	orange	Christmas and happy times
none	none	black	tired
none	none	dark blue	cold
none	none	dark red	excited
none	none	grotty green	ill
none	none	burgundy	Christmas excitement
none	none	cold blue	cold
none	none	grey	grim, ill
none	none	dark green	cold, illness, disgusting, tired, exhausted
none	none	black	stressed, unhappy
none	none	dark blue	cold
none	none	burgundy	Christmas
none	none	green	ill
none	none	red	angry
none	none	dark green	ill
none	none	light pink	happy
none	none	yellow	anxious
none	none	burgundy	Christmas
none	none	mint green	happy
none	none	light pink	very happy
none	none	light green	excited
none	none	yellow	ecstatic
none	none	red	angry
none	none	burgundy	Christmas

Table 59. Rabbit

Person	Day	DB Colour no mood	DB Colour with mood	Diary Colour no mood	Diary Colour with mood	Engagement (pg no/ diary)
Foxy	1	1	0	4	1	3
	2	0	0	0	6	2
	3	0	0	4	0	1
	4	0	0	2	1	2
	5	0	0	0	3	3
	6	0	0	3	1	1
	7	0	0	2	0	1
Kitty	1	0	1	2	1	2
	2	0	4	2	3	3
	3	1	3	0	4	5
	4	2	1	0	3	4
	5	1	2	2	1	6
	6	0	1	0	2	3
	7	1	2	0	3	5
Mermaid	1	0	0	0	3	10
	2	7	0	1	2	9
	3	4	0	0	2	7
	4	5	0	1	2	5
	5	0	0	0	4	10
	6	0	0	0	1	5
	7	4	0	2	2	10
Monkey	1	0	0	5	4	4
	2	0	0	3	5	3
	3	5	0	7	5	3
	4	2	0	2	5	3
	5	0	0	0	6	5
	6	0	0	6	3	4
	7	3	0	3	4	6
Turtle	1	2	0	2	2	2
	2	0	0	2	2	4
	3	0	0	10	0	2
	4	0	0	5	0	2
	5	2	0	0	3	2
	6	0	0	4	0	2
	7	0	0	6	0	2

Person	Day	DB Colour no mood	DB Colour with mood	Diary Colour no mood	Diary Colour with mood	Engagement (pg no/ diary)
Rabbit	1	0	0	2	2	3
	2	0	0	0	6	4
	3	0	0	0	5	3
	4	0	0	0	4	4
	5	0	0	0	5	5
	6	0	0	0	5	3
	7	0	0	0	5	3

Table 60. Sender to receiver

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