

UNIVERSIDADE FEDERAL DE SÃO CARLOS

CENTRO DE CIÊNCIAS EXATAS E DE TECNOLOGIA

PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIA DA COMPUTAÇÃO

**STUDIES ON EMOTIONAL ASPECTS IN THE DESIGN
OF USER INTERFACES**

RENATA GERMANO BIANCHI

ADVISOR: PROF^A. DR^A. VÂNIA PAULA DE ALMEIDA NERIS

São Carlos - SP
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RENATA GERMANO BIANCHI

Master dissertation submitted to the Department of Computer Science at Universidade Federal de São Carlos, in partial fulfillment of the requirements for the degree of the Master Program in Computer Science, concentration area: Human-Computer Interaction.

Advisor: Dra. Vânia Paula de Almeida Neris

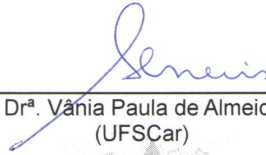
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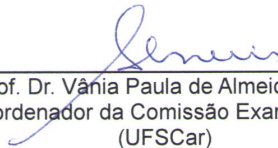


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“The riddles of God are more satisfying than the solutions of man.”

G. K. Chesterton

“Isn't it funny how day by day nothing changes, but when you look back everything is different?”

C.S. Lewis

ABSTRACT

Emotions play a crucial role in the way people interact with each other, objects and computing systems, and are a key factor in human-computer interaction. The choice of the appropriate elements for a user interface may result in a better experience of how it can be used. However, most studies investigate people's preferences and visual aesthetics, without taking into account people's emotion in the design. This dissertation carries out a series of detailed studies on the emotional effects of user interface elements, by examining colors, fonts and images. A critical analysis of the literature (through a systematic review) combined to the Semantic Space of Emotions, which covers a broad spectrum of emotions, resulted in the proposal of Bianchi's Color Wheel. An empirical study was conducted on the emotional effects of font types and sizes; this involved 60 users and was necessary because there are so few studies on fonts and emotions in the literature. With regard to font types, in statistical terms, it was found there were no significant differences, although *Arial* was more closely linked to positive emotions than *Times New Roman* in the discourse analysis. Small font sizes, 8pt, caused negative experiences and led to tiredness, while medium (12pt) and large (16pt) sizes were mainly related to pleasant and comforting experiences. The third study investigated tagged and felt emotions evoked by images which were collected through social tags that were clearly related to emotions. The aim of the study was to determine whether or not these images are reliable for the design and retrieval. Thus, an online survey was planned and carried out by a group of 410 volunteers who classified pictures from Flickr. The results suggested that there are some emotions tagged that were similar to observers emotions, while others are diffuse and need other criteria for their selection apart from social tags. Finally, it should be mentioned that further studies are needed to address the complete user interface with all these elements and findings combined.

Keywords: Design, Emotion, Human Factors, Human-Computer Interaction, HCI, Colors, Font sizes, Font types, Social tagging, Pictures.

RESUMO

As emoções desempenham um papel fundamental nas interações dos seres humanos com outras pessoas, objetos e sistemas computacionais, tornando-se um aspecto fundamental na interação humano-computador. A escolha dos elementos apropriados para a interface de usuário pode resultar em uma melhor experiência de uso. No entanto, a maioria dos estudos investigam as preferências e estética visual, não apoiando o design que considera emoções. Esta dissertação detalha uma série de estudos sobre o impacto emocional de elementos de interface de usuário, com foco em cores, fontes e imagens. A combinação de uma análise crítica da literatura (através de uma revisão sistemática da literatura) ao Espaço Emocional Semântico, que abrange um amplo espectro de emoções, resultou na proposta do Círculo de Cores de Bianchi. A fim de contribuir com os poucos trabalhos encontrados em fontes e emoções, um estudo empírico com 64 usuários foi realizado sobre o impacto emocional de tipo e tamanho de fontes. Quanto aos tipos de fontes, estatisticamente não foram encontradas diferenças significativas, embora *Arial* tenha sido mais associada a emoções positivas do que *Times New Roman* no discurso dos participantes. O tamanho pequeno, 8pt, causou experiências negativas e cansativas, enquanto os tamanhos médio (12pt) e grande (16pt) foram principalmente relacionados a experiências agradáveis e confortáveis. O terceiro estudo investigou as emoções esperadas e de fato sentidas evocadas por imagens que foram coletadas por meio de *tags* explicitamente relacionadas a emoções. Tentou-se responder se essas imagens são confiáveis para o design e para a área de recuperação de dados (imagens, no caso). Assim, uma pesquisa online foi lançada e concluída por um conjunto de 410 voluntários que classificaram imagens do Flickr. Os resultados sugerem que existem algumas emoções que tendem a ser a mesma entre indexadores e observadores, enquanto outras são difusas e precisam de outros critérios de seleção além das *tags* utilizadas por participantes de redes sociais ou de compartilhamento. Como consideração final, é importante mencionar que mais estudos são necessários para abordar a interface de usuário completa, com todos esses elementos e resultados combinados.

Palavras-chave: Design, Emoção, Fatores Humanos, Interação Humano-Computador, IHC, Cores, Tamanhos de fonte, Tipos de fonte, Indexação coletiva, Imagens.

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ABBREVIATIONS AND ACRONYMS

EEG - *Electroencephalogram*

EmIR - *Emotional Information Retrieval*

ERP - *Event-Related Potential*

FACS - *Facial Action Coding System*

GAPED - *Geneva Affective Picture Database*

HCI - *Human Computer-Interaction (IHC in Portuguese)*

IAPS - *International Affective Picture System*

LPP - *Late Positive Potential*

OASIS - *Open Affective Standardized Image Set*

PrEmo - *Product Emotion Measurement*

SAM - *Self-Assessment Manikin*

VisAWI - *Visual Aesthetic of Website Inventory*

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Chapter 1

INTRODUCTION

1.1 Background, Problem Statement and Research Motivation

Emotions are a core factor in people's interactions, and allow immediate information of the world to be obtained, such as an imminent danger and decisions to be made (NORMAN, 2004). A study of a sample of people who suffered from a neurological disease in the part of the brain responsible for decision making, showed that this affected their ability to experience emotions while their rational faculties (such as knowledge, attention and memory) remained intact (DAMASIO, 1995). Owing to a lack of emotions, the subjects were unable to decide between equally valid alternatives – e.g., where to live, which chair to sit on or products to buy (DAMASIO, 1995). Since emotions can provide a better experience of use, they are increasingly drawing the attention of researchers in Design and Human-Computer Interaction (HCI).

According to Norman and Ortony (2003), there are three kinds of emotional response to design: visceral (perception), behavioral (satisfaction) and reflective (affective memory). The first level is related to appearance, and involves automatic evaluations and rapid classifications (e.g., safe or dangerous, good or bad). The behavioral level is linked to the function and use of the design solution (e.g., a computing system), including the users' satisfaction and learning capacity. The last category, the reflective level, refers to self-examination, understanding and progress,

and is influenced by cultural and personal experiences (NORMAN; ORTONY, 2003). Norman (2004) highlights the importance of taking account of emotions in the design of environments. The author argues that when experiencing too much anxiety, people become so concentrated on a particular task that they may fail to find an obvious alternative course of action (i.e., their creativity becomes blocked at that particular moment). For example, people inside a building that is on fire will be frantic to escape. When they find the exit door, they will push it and if it doesn't open, they will push it harder, without thinking about pulling it instead. As a result of scenarios like this, fire safety measures were taken to ensure exit doors are designed to open outward regardless of pressure applied. In the same way, the designers of exit stairways have to guarantee that the path takes everyone to the ground floor, and block any other path, such as to the basement (NORMAN, 2004).

With regard to physical products, Desmet and Dijkuis (2003) suggest an approach to emotion-driven design. They conducted a case-study for designing a children's wheelchair, with the aim of achieving a positive emotional effect. The procedure followed four main stages: 1. research into the effects of existing models and what emotions were induced in the users; 2. understanding why these emotions were induced; 3. creating a new design, that takes into account these previous points; 4. evaluating the new design, by comparing the emotions of children who use the existing wheelchairs with those of the planned scheme. The authors state that understanding the emotions of the user proved to be important when creating the design and manufacturing the product, to ensure it was acceptable both for the children that would use it and for their parents (DESMET; DIJKUIS, 2003).

Kim and Moon (1998) were concerned with visual design factors, and claimed that the user's perception of a particular interface influences the emotions evoked by it. They showed 26 interfaces to a group of people and asked them to describe their emotions. According to the researchers, the subjects would be able to remember the most striking features (from attention, judgement and emotional intensity, for example), and thus asked them to draw the interfaces in a way they could remember. On the basis of these results, the designers ranked the items they believed to be important, and analyzed the participants' drawings to determine which visual elements were most clearly remembered. After that, they investigated the relationship between emotional and design factors and designed two interfaces to test the degree

of trustworthiness showed. At the end, they concluded that it is possible to evoke emotions targeted at people from user interfaces (KIM; MOON, 1998).

In general, the studies investigate people's preferences, visual aesthetics, and emotional responses and how they affect the use of the design. Despite a number of important contributions made by the authors mentioned in the next chapters, it was not possible to find a way that supports designers' decisions (among other stakeholders) when concerned with emotional effects in the design. How can the designer use interface elements to evoke a set of emotions?

1.2 Objectives and Methodology of the Research

Most guidelines for user interfaces refer to the following elements: colors; texts or typography; graphics or images; and multimedia (e.g., audio, video and animation) (JIANG *et al.*, 2008; LYNCH; HORTON, 2002; SMITH; MOSIER, 1986). Although they understand the importance and use of emotions, in general, designers still rely on empirical knowledge and intuition (SCOLARI, 2008). There is a range of studies on emotions evoked by environments and physical products, although in the field of user interfaces, further attempts are still needed to support design decisions. This project investigated the emotional effect of colors, typographical features and images, with the aim of supporting design decisions based on emotional intentions.

This work explores three areas (both theoretical and empirical). It was found that there were comprehensive studies in the literature on experiments involving the emotional effects of colors, but these still had some discrepancies. In view of this, we conducted a systematic literature review of colors in user interfaces and emotions to analyze the state-of-the-art consensus and disagreements. After that, a set of rules were established to adapt these findings to Scherer's Semantic Space for Emotions (SCHERER, 2005).

Finally, on the basis of this detailed analysis of the literature, we proposed Bianchi's Color Wheel, which includes variations in hue, saturation and brightness within a range of colors. This method differs from previous works insofar as it explores colors within a broad spectrum of emotions rather than in limited areas or partial emotions (e.g., PLUTCHIK, 2001, shown in Figure 1.1).

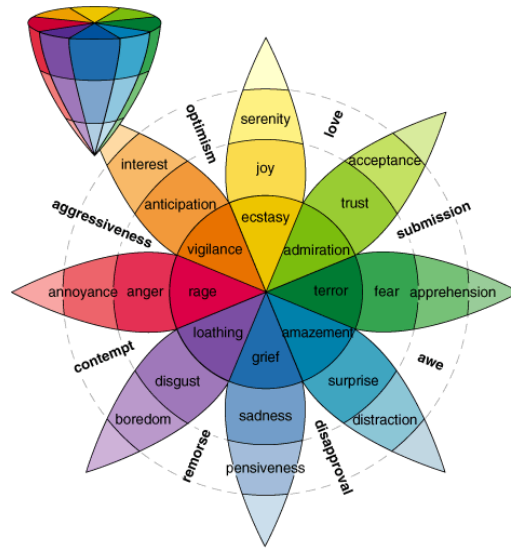


Figure 1.1 – Three dimensional circumplex model (PLUTCHIK, 2001).

Typography was another user interface element studied: most of the research studies people's preferences rather than the emotions evoked by this element and few works on emotional impact were found to support the designers' decisions. For this reason, an empirical study was carried out on the emotional effects of font types and font sizes. The most common font types studied are *Arial* and *Times New Roman*, which were also examined here. Moreover, by comparing newspaper websites and the literature studies, it was possible to adopt three sizes for the experiment: 8pt, 12pt and 16pt, which represent small, medium and large, respectively. Sixty volunteers took part in reading five texts each and responding to various instruments to report their emotional state. At the end of the experiment, we analyzed the data that had been gathered and discussed our findings, while at the same time, highlighting any divergences from the literature.

The third area was an empirical online study to address whether selecting pictures from user-generated tags is a reliable method for assisting the designers in their decision-making and whether they reflect the observers' emotions. Thirty pictures from Flickr¹ were selected by hand and these were based on the five basic emotions plus "neutral" from people's tags. An online survey was carried out to display these pictures in a random order, and thus ensure that the participants were able to rate each basic emotion according to their emotions when each image was looked at. A statistical analysis was conducted of the completed answers, obtained

¹ An online gallery of pictures available with social networking. Available on <https://www.flickr.com/>.

from a total number of 410 volunteers, and this was followed by a discussion of the findings for the design and media retrieval, by exploring the tagged emotions and felt emotions (observers) in pictures from social tags.

1.3 Outline of the Dissertation

This dissertation consists of five chapters. Chapter 2 presents a scientific paper that was approved in a national conference, but has not yet appeared. Chapters 3 and 4 introduce papers submitted to international conferences, that are still awaiting reviews. Finally, Chapter 5 concludes this work. In addition, Appendix A has been included as a means of disseminating the findings and reaching the international community. There is a summary in Appendix A of Chapter 2, which has been translated from Portuguese. Appendices B to D show all the data that was gathered and how it was drawn on for a detailed analysis in Chapter 3.

Summaries of the contribution to research that is made by these studies:

[Chapter 2] BIANCHI, R. G.; NERIS, V. P. A. Com que cor eu vou? Um estudo sobre cores e emoções na Interação Humano-Computador. In Proceedings of the 14th Brazilian Symposium on Human Factors in Computing Systems (IHC 2015). Brazilian Computer Society, 2015. p. 73-82. To appear.

There are many papers in the literature that link colors with abstract categories of emotions – for example, clean-dirty, weak-strong – as well as modern, classical and romantic. On the other hand, there are others that relate colors to emotions such as happiness, sadness or to positive/negative pleasure, arousal, and control. In this scenario, abstract categories may not effectively help to decide which colors to use to evoke emotions, since there are so many methods to evoke emotions from colors that it may be difficult to decide which one to employ. We conducted a systematic literature review and critical analysis of previous works to find out a consensus in the literature, and to give initial support to the designers' decisions. The main contribution of this paper is Bianchi's Color Wheel, the combination of the consensus noticed in the state-of-the-art, that shows saturation and brightness variations, and Scherer's

Semantic Space for Emotions (SCHERER, 2005), which defines an emotional spectrum.

[Chapter 3] BIANCHI, R. G.; NERIS, V. P. A. Emotional Responses to Font Types and Sizes in Web Pages. Submitted to a conference.

With regard to typographical features, most studies investigate people's preferences, visual aesthetics, legibility and readability rather than the emotion evoked. Many of these go deeper by exploring *Arial* and *Times New Roman* font types, and thus it was decided to investigate these from the perspective of their emotional impact. Since few papers were found on font sizes, we studied the sizes that are generally used by designers in user interfaces. A set of instruments (both qualitative and quantitative) was used to collect the emotions, further understand the results from the interaction and cover a broad spectrum of emotions. This paper sets out the experiments that were conducted and discusses the findings, while at the same time, suggesting that caution is needed in making a decision about which font size to use in the design. The results of font types suggest that there are some divergences from the literature, which are also listed in the chapter.

[Chapter 4] BIANCHI, R. G.; NERIS, V. P. A.; ARA, A. Tags vs. Observers - A study on emotions tagged and emotions felt with Flickr pictures. Submitted to a conference.

Assuming that designers and retrieval systems want to use pictures from user-generated tags, with the aim of evoking specific emotions in users, will these images evoke the same emotions in the observers as the ones tagged? Rather than investigating the feasibility of social tagging feasibility for the retrieval of emotional information, this study examines whether design decisions should rely on emotions that are clearly written as tags in images from collective indexing and retrieval systems. It discusses findings for happiness, anger, sadness, disgust, fear and "neutral", by giving a detailed analysis of which emotions that are tagged and felt tend to be similar, as well as which ones should be treated with caution for both design and retrieval.

1.3.1 Another way of reading this work

The format of the dissertation (as previously mentioned) follows the chronological sequence of the study. However, Table 1.1 provides a summarized skeletal structure to give a clear idea of the main areas of this scientific research.

Table 1.1 – Main areas of scientific research and the sub-divisions of this dissertation.

Main areas of scientific research	Issues addressed in the dissertation	Sections
Synthesis of the literature	A dimensional and categorical approaches to emotion Emotion as a key factor in Design A brief overview of the properties of colors, existing theories about colors and the relationship between colors and emotions Summary of works on font types and sizes (preferences, aesthetics, readability, and emotions) Previous studies on emotions in the area of collective indexing and retrieval of pictures	4.2.1 4.2.2 2.2.2 3.3 4.2.3
Outline of the theoretical framework	Semantic Space of Emotion A Hybrid Approach to the Assessment of Emotional Experience Basic Emotions	2.2.1 and 3.2 3.2 4.2.1
Detailed description of the studies	A systematic literature review of colors and emotions An empirical study with 60 volunteers on the emotional impact of font types and sizes An empirical online study with 410 volunteers on images collected from user-generated tags	2.3 3.4 4.3
Analysis and interpretation of the results	Proposal of Bianchi's Color Wheel Analysis and discussion of the results obtained from font types and sizes, with recommendations Analysis and discussion of tagged emotions and felt emotions from collective indexing, with recommendations	2.4 3.7 4.5
Conclusion	Summary of this dissertation contributions, critical analysis and future work	5

Chapter 2

COM QUE COR EU VOU? UM ESTUDO SOBRE CORES E EMOÇÕES NA INTERAÇÃO HUMANO-COMPUTADOR²³

Color is one of the most important dimensions of visual understanding and it has the power to evoke emotions. In this sense, choosing the appropriate color for user interface design may cause specific emotions, improving human-computer interaction. However, current studies do not support the designer in the choice of appropriate colors when it comes to a spectrum of emotions. Thus, this article proposes Bianchi's Color Wheel, which combines colors to Scherer's Semantic Space of Emotion. This association is the result of a systematic review conducted in seven databases. The proposed wheel allows designers to choose colors, including variations in saturation and brightness, taking into account the emotions mapped in Semantic Space.

2.1 Introdução

As emoções estão em todas as interações entre os seres humanos, caracterizando um fator importante na área de Interação Humano-Computador

² BIANCHI, R. G.; NERIS, V. P. A. Com que cor eu vou? Um estudo sobre cores e emoções na Interação Humano-Computador. In Proceedings of the 14th Brazilian Symposium on Human Factors in Computing Systems (IHC 2015). Brazilian Computer Society, 2015. p. 73-82. To appear.

³ A summary in English of the study is presented in Appendix A.

(IHC). Com o estudo das reações emocionais provocadas pelas interfaces de sistemas computacionais, pode-se desenvolver soluções de interface de usuário melhores (NORMAN, 2004; XAVIER; GARCIA; NERIS, 2012).

Uma página web, por exemplo, é fundamentalmente formada por cores, imagens e textos (JIANG *et al.*, 2008). As cores, foco deste estudo, atraem os olhos e desencadeiam emoções, criando uma reação antes mesmo de o usuário reconhecer o conteúdo ou a organização da página (HOLTZE, 2006). Visto que são carregadas de emoção, elas não simbolizam apenas pensamentos, mas também contribuem efetivamente para o julgamento estético (CSURKA *et al.*, 2010), assim como impactam no comportamento e processos cognitivos do usuário (BONNARDEL; PIOLAT; LE BIGOT, 2011).

Devido à sua influência, as decisões de design referentes às cores deveriam ser bem fundamentadas (SILVEIRA, 2011), porém muitos designers ainda as definem de forma subjetiva e intuitiva (BOULTON, 2009). Além disso, os estudos atuais não apoiam o designer na escolha das cores adequadas quando se trata de um espectro de emoções.

Este artigo visa auxiliar designers na escolha de cores para todo o conjunto de emoções mapeadas no Espaço Emocional Semântico de Scherer (SCHERER, 2005). Esta associação foi realizada em três etapas: 1. levantamento do estado da arte por meio de uma revisão sistemática; 2. criação de regras para adequar o estado da arte ao Espaço Emocional Semântico; 3. proposta do Círculo de Cores de Bianchi, resultado e contribuição deste trabalho. Dessa forma, o Círculo de Cores de Bianchi considera o espectro de emoções do Espaço Emocional Semântico, diferenciando-se de trabalhos anteriores que relacionam cores com quantidades limitadas e parciais de emoções (cf. PLUTCHIK, 2001).

O trabalho está organizado da seguinte forma. Na próxima seção, Referencial Teórico, os principais conceitos que foram adotados são sumarizados. A seção de Revisão Sistemática especifica as definições e objetivos da revisão. Em Resultados é apresentado o Círculo de Cores de Bianchi, proposto a partir de regras que analisam pontos consensuais e divergentes do estado da arte. Por fim, em Conclusões são discutidas as limitações desta pesquisa e os trabalhos futuros.

2.2 Referencial Teórico

2.2.1 O Espaço Emocional Semântico

De acordo com Scherer (SCHERER, 1984), uma das funções da emoção é a avaliação constante de estímulos externos e internos, segundo suas relevâncias para o organismo, e a preparação de reações comportamentais que podem ser necessárias. Dessa forma, o pesquisador aponta cinco componentes da emoção, alterados de forma inter-relacionada e possivelmente ao mesmo tempo nesse processo (SCHERER, 2005). São eles: avaliações cognitivas, reações fisiológicas, tendências comportamentais, expressões motoras e sentimentos subjetivos (SCHERER, 1984).

O Espaço Emocional Semântico de Scherer (SCHERER, 2005), ilustrado na Figura 2.1, aponta emoções que abrangem os componentes citados e que, portanto, preparam o organismo para uma ação. A adoção deste modelo tem como objetivo auxiliar o designer a compreender e avaliar o impacto emocional do usuário, identificando conjuntos de emoções que podem desencadear reações (XAVIER; GARCIA; NERIS, 2012).

O modelo possui uma classificação por meio de domínios, descritos a seguir (SCHERER, 2005):

- Valência: refere-se ao grau de satisfação ou de prazer. Aparece no círculo de Scherer como Positivo e Negativo;
- Excitação: está associada à agitação e motivação do usuário. No círculo, é apontada como Ativo/Excitado e Passivo/Calmo;
- Sentimento de Controle: está relacionado à sensação de poder do usuário na interação. É apontado como Alto Poder/Controle e Baixo Poder/Controle no Espaço Emocional Semântico;
- Facilidade de Conclusão do Objetivo: grau de facilidade (conducividade) ou de dificuldade (obstrutividade) na realização de uma tarefa. Este domínio não foi considerado na revisão devido à falta de dados na literatura.

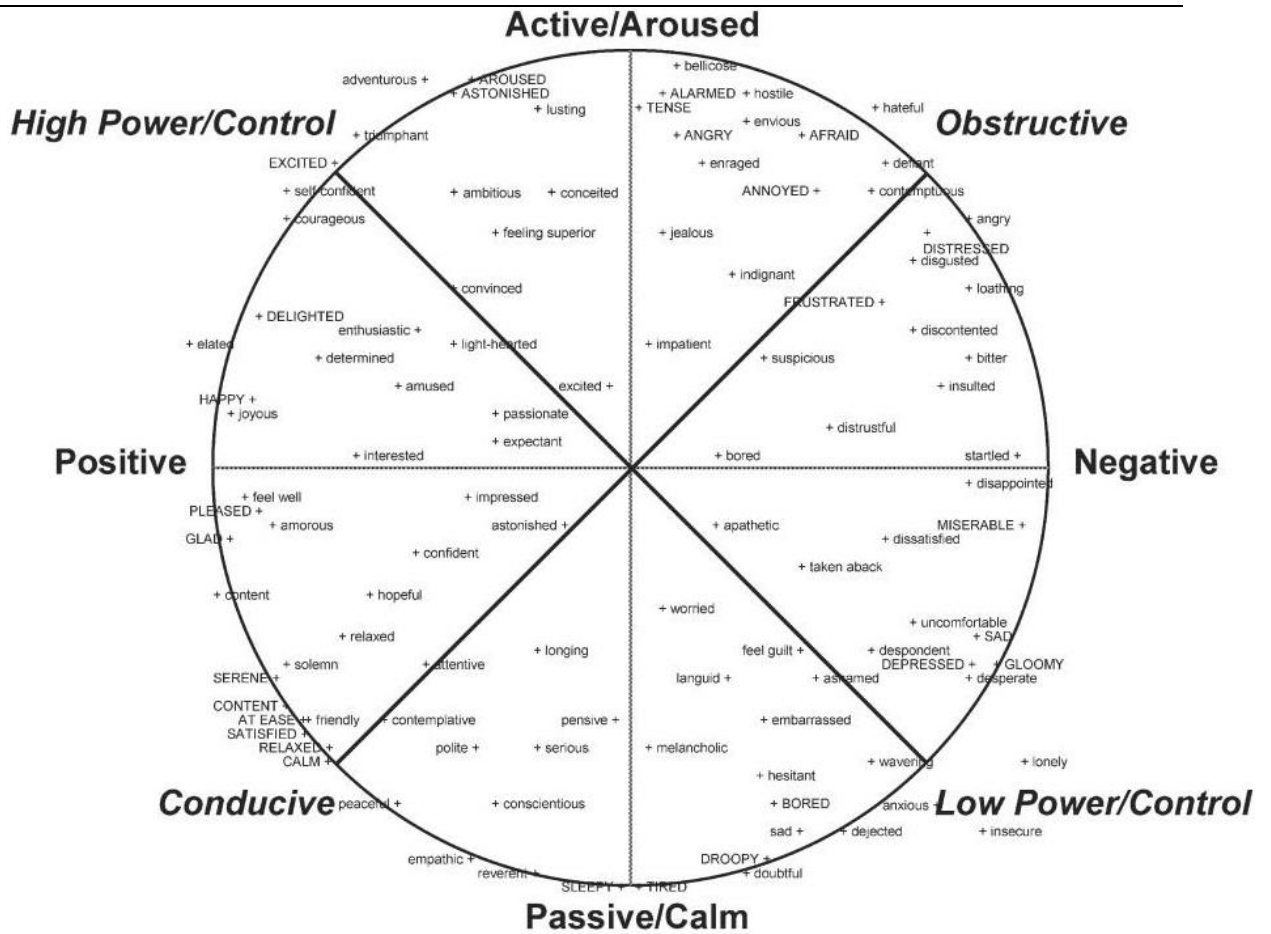


Figura 2.1 - Espaço Emocional Semântico. Retirado de (SCHERER, 2005).

O Círculo de Scherer (SCHERER, 2005) é dividido pelo próprio proponente em oitantes que podem ser numerados como mostrado na Figura 2.2. Neste trabalho, adota-se como Oitante 1 o mais superior à direita, seguindo o sentido horário para a identificação de cada um. O último, Oitante número 8, é o mais superior à esquerda.

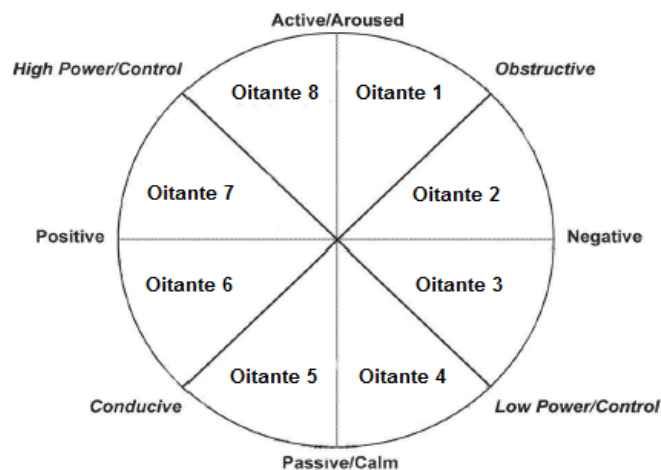


Figura 2.2 - Identificação dos oitantes no Espaço Emocional Semântico. Adaptado de (XAVIER, 2013).

2.2.2 Cores e a Emoção

A compreensão das cores é determinante para a percepção do mundo e pode ser influenciada pelo conhecimento e experiências do observador (CROZIER, 1996; SILVEIRA, 2011). Existem três propriedades básicas que as caracterizam: tonalidade, brilho e saturação. Tonalidade é o que normalmente se entende como cor (e.g. verde e amarelo) e se refere ao comprimento de onda da luz (BOULTON, 2009; CROZIER, 1996; ELLIOT; MAIER, 2014; HOLTZE, 2006; NAZ; EPPS, 2004). Já brilho corresponde à amplitude da fonte de luz ou altura da onda (CROZIER, 1996), ou seja, o quanto de branco (luminosidade), ou de preto, está contido na cor (BOULTON, 2009; ELLIOT; MAIER, 2014; HOLTZE, 2006; NAZ; EPPS, 2004). Por fim, saturação está associada à complexidade da onda de luz e ao seu grau de pureza (CROZIER, 1996; NAZ; EPPS, 2004), isto é, refere-se à intensidade da cor (BOULTON, 2009; ELLIOT; MAIER, 2014; HOLTZE, 2006) – quanto mais pura a cor, maior a sua saturação.

O Círculo Cromático, ilustrado na Figura 2.3, é composto por cores primárias, secundárias e terciárias. As cores primárias são divididas em dois grupos: aditivo, formado por vermelho, verde e azul, e subtrativo, representado por ciano, magenta e amarelo. Com a combinação do primeiro grupo, obtém-se a cor branca, e com a do segundo, tem-se o preto. As cores secundárias são resultantes da combinação das primárias, ao passo que as terciárias são formadas pela combinação de primárias e secundárias. (BOULTON, 2009)



Figura 2.3 - Círculo Cromático. Retirado de (BOULTON, 2009).

O conjunto de considerações sobre as relações existentes pelas posições das cores no Círculo Cromático é chamado de Teoria das Cores, uma base teórica que auxilia a tomada de decisão do designer. A partir dela, são propostas algumas formas de seleção de cores no Círculo: monocromática (apenas uma cor); complementar (cores que se opõem) e tríade (três cores equidistantes) (BOULTON, 2009). A utilização da complementariedade, por exemplo, é bastante comum e atual quando se deseja chamar atenção para os detalhes (SILVEIRA, 2011). Apesar de ser um auxílio na escolha de cores, o Círculo Cromático não assiste o designer que deseja ir além e considerar o impacto emocional.

As respostas emocionais são uma das explicações sugeridas para a preferência de cores, na tentativa de compreender por que se gosta de cores específicas ou então por que existem tais preferências. Acredita-se que as pessoas gostam das cores à medida que elas gostam das emoções evocadas por ou associadas a essas cores. (PALMER; SCHLOSS; SAMMARTINO, 2013)

No entanto, lidar com as emoções no design ainda não é trivial, sendo uma dificuldade recorrente devido a três causas principais: o conceito de emoção é apresentado como amplo, indefinido e subjetivo; mais de uma pode ser evocada simultaneamente; e pelas emoções serem pessoais (DESMET, 2003).

A expressão *colour emotion* (em tradução livre, “emoções de cor”) se refere às emoções evocadas tanto por cores quanto por combinações de cores (OU *et al.*, 2004). Ela também é definida como sendo a avaliação da resposta emocional de cores (GAO; XIN, 2006). As *colour emotions* podem ser exemplificadas pelas seguintes classificações: limpo-sujo, pesado-leve, masculino-feminino, moderno-clássico, transparente-turvo, fraco-forte, entre outras (GAO; XIN, 2006; OU *et al.*, 2004). De forma semelhante, pode-se associar combinações de cores a categorias como clássica, delicada, elegante, romântica, sensual, serena, espiritual, entre outras (CSURKA *et al.*, 2010). Apesar das contribuições destes trabalhos que abordam as emoções com categorias abstratas, eles não auxiliam efetivamente o designer que deseja evocar emoções a partir de cores. Caso o designer queira elicitare felicidade e não saiba quais cores utilizar, ter o conhecimento de que uma cor é, por exemplo, clássica ou moderna não o ajudará nesta tomada de decisão.

Silveira (2011) afirma que amarelo causa tensão e insegurança; azul traz segurança, conforto e paz; branco gera paz e tranquilidade; preto estimula tristeza e

poder; e vermelho evoca alegria, apreensão e atenção. Novamente, algumas destas classificações são em níveis bastante abstratos (e.g., segurança).

O foco deste trabalho foram classificações de emoções a partir de um ou mais domínios das emoções (i.e., Valência, Excitação e Sentimento de Controle). Por exemplo, vermelho, laranja e amarelo podem ter como resposta emocional alta excitação (FIORE, 2010). Foram também analisadas publicações que trazem emoções apontadas no Espaço Emocional Semântico (SCHERER, 2005) ou sinônimos delas (e.g., alegria ao invés de felicidade). Dessa forma, artigos com contribuições dentro do modelo de emoções adotado, mesmo que também tenham citado emoções abstratas, foram igualmente considerados (e.g., SILVEIRA, 2011, apontado previamente).

Para relacionar cores e o Espaço Emocional Semântico (SCHERER, 2005), foi-se à literatura buscar trabalhos que já estudaram respostas emocionais frente às cores. A partir do conhecimento adquirido, propõe-se um círculo de cores e emoções resultante do estado da arte, nomeado como Círculo de Cores de Bianchi. A próxima seção descreve detalhadamente como foi realizada a coleta de dados.

2.3 Revisão Sistemática

Uma revisão sistemática tem como objetivo realizar um levantamento do estado da arte, analisando os estudos realizados até o momento de forma aprofundada (PETERSEN *et al.*, 2008). Comumente são analisados resultados conflitantes e coincidentes encontrados na literatura (LINDE; WILLICH, 2003; SAMPAIO; MANCINI, 2007). Três passos são fundamentais em uma revisão sistemática: planejamento, execução e análise dos resultados. No planejamento são definidos os tópicos a serem investigados e o protocolo de revisão, em que se define em quais bases de dados os trabalhos serão buscados, os termos de pesquisa, critérios de inclusão e exclusão. A segunda fase envolve a identificação de estudos, assim como a seleção e avaliação deles de acordo com os critérios definidos anteriormente. Em seguida, na fase de análise dos resultados, são extraídos os dados relevantes, obtendo-se o estado da arte (BIOLCHINI *et al.*, 2005; SAMPAIO; MANCINI, 2007).

Com o objetivo de auxiliar designers que desejam considerar o impacto emocional das cores, adotou-se como fundamental a revisão sistemática para obter o estado da arte. Logo, neste artigo são explorados estudos que buscam responder as seguintes perguntas: “qual a influência das cores sobre as emoções?” e “qual cor evoca qual emoção ou domínio de emoção?”.

2.3.1 Coleta de dados

2.3.1.1 Bases de dados

Como os tópicos estudados englobam uma temática que envolve fatores humanos, a busca incluiu bases de dados eletrônicas identificadas como relevantes para as áreas de Computação, Design e Psicologia. Dessa forma, as seguintes bases foram escolhidas: ACM (*Association for Computing Machinery*), IEEE Xplore (*Institute of Electrical and Eletronics Engineers*), APA PsycNET (*American Psychological Association*), Science Direct, Scopus, Taylor & Francis Online e Wiley Online Library.

2.3.1.2 Termos de pesquisa

Os termos utilizados para a pesquisa de trabalhos foram: “*emotion color*”, “*emotion colour*” e “*emotion color design*”. Desta forma, procurou-se obter estudos que envolvessem tanto cores quanto emoções.

2.3.1.3 Critérios de inclusão

Foram incluídos todos os tipos de estudos (e.g. qualitativos, quantitativos, experimentais) que pesquisaram sobre a relação de cores e emoções, levando a emoções (seja a partir dos domínios citados anteriormente ou a partir de classes de emoções, como, por exemplo, felicidade). Além disso, o artigo completo deveria estar disponível.

2.3.1.4 Critérios de exclusão

Estudos que abordaram apenas cores ou apenas emoções foram removidos do conjunto de artigos selecionados. Igualmente, foram excluídos trabalhos que

discutiram sobre diferenças culturais e de sexo; assim como criatividade; cores em ambientes ou objetos físicos (i.e., mostrados fora de interfaces de usuário); percepção de tempo; cognição e memória; e apenas conceitos abstratos de emoções (citados em Referencial Teórico). Além disso, aqueles que analisaram desenhos feitos por participantes de experimentos também foram desconsiderados.

2.3.1.5 Condução da revisão

Após a definição das bases de dados, os termos a serem pesquisados e os critérios de inclusão e exclusão, esta revisão sistemática teve os seguintes passos:

1. Identificar estudos relevantes, buscando nas bases de dados eletrônicas definidas;
2. Exclusão de trabalhos com base no título, seguindo os critérios de exclusão;
3. Exclusão de trabalhos com base no resumo, de acordo com os critérios citados;
4. Exclusão com base nos resultados, também conforme os critérios;
5. Avaliação crítica dos estudos selecionados.

2.4 Resultados

A busca na base de dados ACM retornou aproximadamente 2 mil resultados, por isso os trabalhos foram ordenados por relevância e apenas os 200 primeiros foram avaliados. Ressalta-se, porém, que a partir do momento em que relevância foi selecionada, não existe uma regra clara utilizada pela base de dados para a classificação e apresentação dos estudos. O mesmo procedimento foi realizado para outras bases quando necessário – no caso de muitos estudos apresentados pela busca (mais de mil, por exemplo). Aproximadamente, os seguintes números de resultados foram obtidos para cada base: *IEEE Xplore* – 300; *PsycNET* – 100; *Science Direct* – 3 mil; *Scopus* – 1700; *Taylor & Francis* – 30 mil; e *Wiley Library* – 34 mil.

Devido à amplitude dos termos de busca, obteve-se grande número de resultados irrelevantes. Muitas publicações retornadas consideraram emoções em

outros campos de estudo (e.g., classificação musical de arte abstrata, regulação de emoções, entre outros). Dentre os artigos que relacionaram emoções com cores, grande parte se aprofundou em ambientes e objetos, sendo desconsiderados por se diferenciarem de interfaces de usuário no uso, volatilidade, estratégias de comunicação, natureza da tarefa e *affordances*. Diversos estudos culturais foram apresentados, fugindo do escopo deste artigo. Além disso, alguns trabalhos não foram disponibilizados pelas bases *Taylor & Francis*, *Scopus* e *Wiley*.

A Tabela 2.1 mostra o número de artigos de cada base de dados correspondentes aos critérios de inclusão. Ressalta-se que artigos relevantes iguais foram encontrados em diferentes bases, sendo contabilizados em apenas uma. Inicialmente, 50 artigos foram selecionados a partir do título. Em seguida, a partir do resumo e dos resultados, 18 foram selecionados para a avaliação crítica. A eles, foram adicionados dois livros e cinco publicações que se mostraram potencialmente relevantes – da *Springer* (COLLIER, 1996), *Pigment & Resin Technology* (CROZIER, 1999), *Journal of the International Colour Association* (DA POS; GREEN-ARMYTAGE, 2007), *Annual Reviews of Psychology* (ELLIOT; MAIER, 2014) e *American Scientist* (PETERSEN *et al.*, 2008), resultando na leitura de 23 artigos.

Tabela 2.1 - Número de publicações identificadas em cada base de dados e inclusas pelos critérios.

Base de dados	Número de publicações identificadas pelo título	Número de publicações analisadas criticamente
ACM	7	1
IEEE Xplore	7	4
PsyNET	5	2
Science Direct	10	1
Scopus	3	2
Taylor & Francis	8	4
Wiley Library	11	5
Total	50	18

Em geral, foram apresentados estudos empíricos – de 23 analisados, 15 realizaram experimentos com usuários. Enquanto isso, os outros artigos relataram revisão da literatura de cores considerando aspectos psicológicos e reações emocionais, bem como estudos analíticos.

As contribuições dos artigos, de modo geral, foram análises sobre a relação de cores e emoções, sendo o caso de 18 dos 23 avaliados. Dentre as outras colaborações estão regras, modelos, recomendações e um *framework*.

2.4.1 Constatações

Para Camgöz *et al.* (CAMGÖZ; YENER; GÜVENÇ, 2002), preferência é um sinônimo de valência. Como resultado de avaliações empíricas, os autores sugerem que as cores menos preferidas são o verde, amarelo, branco e preto. Azul foi a cor que obteve maiores pontuações. Argumenta-se também que a tonalidade possui um efeito sobre a preferência e que brilho e saturação também possuem um papel importante neste domínio.

Existe, em geral, alguma consistência em preferências de cores, como, por exemplo, o gosto pelo azul e a aversão pelo amarelo (CROZIER, 1996). Neste sentido, Terwogt e Hoeksma (1995) hipotetizaram que cor e emoção estavam ligadas uma a outra com base na ordem da preferência dada a cada uma delas. Para verificar esta suposição, foi pedido que participantes do estudo classificassem as emoções pelas suas preferências e depois fizessem o mesmo para as cores. Em seguida, eles deveriam ligar as cores às emoções. Ao final, refutou-se a hipótese: raramente azul é combinado com a emoção felicidade, apesar de ambos serem os mais preferidos. Em geral, felicidade foi combinada com amarelo, apesar desta cor ser uma das que possui menor preferência (TERWOGT; HOESMA, 1995).

Laranja, vermelho e amarelo frequentemente aparecem como cores alegres, sendo consideradas excitantes (CLARKE; COSTALL, 2008; ELLIOT; MAIER, 2014). Vermelho é considerado um sinal importante, de alerta, que implica em um comportamento (CROZIER, 1996). Verde e azul são tidos como calmos, ou seja, pouco excitantes (CLARKE; COSTALL, 2008; ELLIOT; MAIER, 2014). Já preto e branco foram julgados como neutros por Suk e Irtel (2010), diferentemente de outras publicações.

Um erro metodológico comum é alterar mais de uma das propriedades das cores ao mesmo tempo durante um experimento (ELLIOT; MAIER, 2014). Por exemplo, caso o estudo varie tanto tonalidade quanto saturação, torna-se difícil a análise dos resultados e a conclusão de qual propriedade está de fato interferindo na resposta emocional (ELLIOT; MAIER, 2014).

Com o intuito de tornar as publicações, citadas nesta subseção e as outras estudadas, um auxílio a designers, foi realizada uma análise detalhada para melhor compreendê-las. A partir disso, o Espaço Emocional Semântico (SCHERER, 2005) foi preenchido com o consenso encontrado na literatura sobre cores e emoções.

2.4.2 Análise das publicações

Para uma melhor compreensão dos dados encontrados, decidiu-se que todos eles deveriam ser convertidos em domínios de emoção (i.e., Valência, Excitação e Sentimento de Controle), abordados pelo Espaço Emocional Semântico de Scherer (SCHERER, 2005). Desse modo, as classificações de emoções (e.g. felicidade, medo e raiva) apresentadas nas publicações foram adaptadas seguindo o Espaço Semântico e as classificações apontadas nele. Para as publicações que não apontaram os mesmos termos de Scherer (SCHERER, 2005), adotou-se a seguinte conduta: o termo foi buscado nos dicionários online *Cambridge* (2015) e *Oxford* (2015); se a definição apresentou emoções apontadas por Scherer, então eles foram considerados sinônimos e a emoção de Scherer foi adotada. No caso de não serem sinônimos, então o termo da publicação em análise foi desconsiderado. Algumas pesquisas, porém, não precisaram ser adaptadas por possuírem resultados relevantes já nos domínios de emoções.

Em seguida, foram definidas regras a serem seguidas na análise do consenso ou da divergência dos artigos. São elas:

Regra 1. Se apenas uma publicação afirmasse um determinado domínio como positivo ou como negativo, este seria desconsiderado.

Regra 2. Se números idênticos ou próximos de artigos (i.e., diferença de um a três) afirmassem sinais opostos do domínio, então este seria desconsiderado. Caso não fossem números próximos, o sinal com mais artigos seria o considerado.

Regra 3. Caso todos os domínios de uma mesma cor fossem desconsiderados pela *Regra 2*, então um domínio predominante deveria ser definido, considerando aquele com a maior diferença no número de publicações. Por exemplo, no caso de 5 artigos afirmarem Valência positiva e 3 negativa, e 4 artigos que estabeleçam Excitação positiva e 3

negativa, seria considerada Valência positiva. No caso de empate entre os domínios, aquele com mais publicações citadas no total seria o considerado.

Com tais regras, objetivou-se abordar o maior número de conjuntos de emoções que podem ser elicitados por uma cor, levando em conta também casos menos frequentes nas publicações em análise.

Depois, as publicações, seus resultados e conclusões foram organizados e filtrados pelas regras mencionadas, conforme apresentado na Tabela 2.2. Nela são citadas quais publicações apontam quais domínios (positivos ou negativos) para cada cor, além das regras aplicadas. Os domínios Valência, Excitação e Sentimento de Controle foram abreviados respectivamente em V, E e C. Os sinais “+” e “-” indicam se o domínio é positivo ou negativo, respectivamente.

Tabela 2.2 - Análise das referências para cada cor e domínio.

Cor	Dom.	Publicações em acordo
Amarelo	+V	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; HEMPHILL, 1996; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; NAZ; EPPS, 2004; PLUTCHIK, 2001; TERWOGT; HOEKSMASMA, 1995 (desconsiderados – Regra 2)
	-V	CAMGÖZ; YENER; GÜVENÇ, 2002; CROZIER, 1999; DA POS; GREEN-ARMYTAGE, 2012; MOHARRERI <i>et al.</i> , 2014; SILVEIRA, 2011; TERWOGT; HOEKSMASMA, 1995; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regra 2)
	+E	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; FIORE, 2010; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; NAZ; EPPS, 2004; PLUTCHIK, 2001; SILVEIRA, 2011; TERWOGT; HOEKSMASMA, 1995; VALDEZ; MEHRABIAN, 1994
	-E	MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; WANG <i>et al.</i> , 2008 (desconsiderados – Regra 2)
	+C	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; NAZ; EPPS, 2004; PLUTCHIK, 2001; TERWOGT; HOEKSMASMA, 1995; VALDEZ; MEHRABIAN, 1994
	-C	MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001 (desconsiderados – Regra 2)
Azul	+V	CAMGÖZ; YENER; GÜVENÇ, 2002; CLARKE; COSTALL, 2008; CROZIER, 1996; CROZIER, 1999; HEMPHILL, 1996; KAJIYAMA; SATOH, 2014; MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; SUK; IRTEL, 2010; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regra 2)
	-V	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; KAJIYAMA; SATOH, 2014; LEE <i>et al.</i> , 2014; MACDONALD, 1990; PLUTCHIK, 2001 (desconsiderados – Regra 2)
	+E	KAJIYAMA; SATOH, 2014 (desconsiderado – Regra 1)

Cor	Dom.	Publicações em acordo
	-E	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; CROZIER, 1999; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; KAJIYAMA; SATOH, 2014; LEE <i>et al.</i> , 2014; MACDONALD, 1990; MOHARRERI <i>et al.</i> , 2014; NAZ; EPPS, 2004; PLUTCHIK, 2001; SUK; IRTEL, 2010; VALDEZ; MEHRABIAN, 1994
	+C	KAJIYAMA; SATOH, 2014; PLUTCHIK, 2001; SUK; IRTEL, 2010 (desconsiderados – Regra 2)
	-C	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; KAJIYAMA; SATOH, 2014; MACDONALD, 1990; PLUTCHIK, 2001 (desconsiderados – Regra 2)
Branco	+V	COLLIER, 1996; ELLIOT; MAIER, 2014; PLUTCHIK, 2001; TERWOGT; HOEKSMAS, 1995; VALDEZ; MEHRABIAN, 1994 (Regras 2 e 3)
	-V	CAMGÖZ; YENER; GÜVENÇ, 2002; COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; PLUTCHIK, 2001 (desconsiderados – Regras 2 e 3)
	+E	COLLIER, 1996; PLUTCHIK, 2001; TERWOGT; HOEKSMAS, 1995 (desconsiderados – Regras 2 e 3)
	-E	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; PLUTCHIK, 2001; SILVEIRA, 2011; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regras 2 e 3)
	+C	COLLIER, 1996; PLUTCHIK, 2001; TERWOGT; HOEKSMAS, 1995 (desconsiderados – Regras 2 e 3)
	-C	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; PLUTCHIK, 2001; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regras 2 e 3)
Cinza	+V	-
	-V	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; HEMPHILL, 1996; MACDONALD, 1990; NAZ; EPPS, 2004; SUK; IRTEL, 2010
	+E	-
	-E	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; MACDONALD, 1990; NAZ; EPPS, 2004; SUK; IRTEL, 2010; WANG <i>et al.</i> , 2008
	+C	-
	-C	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; MACDONALD, 1990; NAZ; EPPS, 2004; SUK; IRTEL, 2010
Laranja	+V	CLARKE; COSTALL, 2008; COLLIER, 1996 (desconsiderados – Regra 2)
	-V	CROZIER, 1999; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regra 2)
	+E	CLARKE; COSTALL, 2008; COLLIER, 1996; ELLIOT; MAIER, 2014; FIORE, 2010; KAJIYAMA; SATOH, 2014; PLUTCHIK, 2001; VALDEZ; MEHRABIAN, 1994
	-E	-
	+C	CLARKE; COSTALL, 2008; COLLIER, 1996
	-C	-
Preto	+V	-
	-V	CAMGÖZ; YENER; GÜVENÇ, 2002; COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; HEMPHILL, 1996; SILVEIRA, 2011; TERWOGT; HOEKSMAS, 1995; VALDEZ; MEHRABIAN, 1994
	+E	COLLIER, 1996; TERWOGT; HOEKSMAS, 1995 (desconsiderados – Regra 2)

Cor	Dom.	Publicações em acordo
	-E	CLARKE; COSTALL, 2008; COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; TERWOGT; HOEKSMASMA, 1995 (desconsiderados – Regra 2)
	+C	CLARKE; COSTALL, 2008; COLLIER, 1996; SILVEIRA, 2011; TERWOGT; HOEKSMASMA, 1995; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regra 2)
	-C	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; TERWOGT; HOEKSMASMA, 1995 (desconsiderados – Regra 2)
Rosa	+V	DA POS; GREEN-ARMYTAGE, 2012 (desconsiderado – Regra 1)
	-V	-
	+E	DA POS; GREEN-ARMYTAGE, 2012 (desconsiderado – Regra 1)
	-E	-
	+C	DA POS; GREEN-ARMYTAGE, 2012 (desconsiderado – Regra 1)
	-C	-
Roxo	+V	COLLIER, 1996 (desconsiderado – Regra 1)
	-V	COLLIER, 1996; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; PLUTCHIK, 2001 (desconsiderados – Regras 2 e 3)
	+E	COLLIER, 1996; MANNING; AMARE, 2009 (desconsiderados – Regras 2 e 3)
	-E	CLARKE; COSTALL, 2008; COLLIER, 1996; NAZ; EPPS, 2004; PLUTCHIK, 2001; WANG <i>et al.</i> , 2008 (Regras 2 e 3)
	+C	COLLIER, 1996 (desconsiderado – Regras 1, 2 e 3)
	-C	MANNING; AMARE, 2009; PLUTCHIK, 2001 (desconsiderados – Regras 2 e 3)
Verde	+V	CLARKE; COSTALL, 2008; COLLIER, 1996; HEMPHILL, 1996; LEE <i>et al.</i> , 2014; MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; TERWOGT; HOEKSMASMA, 1995 (desconsiderados – Regra 2)
	-V	CAMGÖZ; YENER; GÜVENÇ, 2002; DA POS; GREEN-ARMYTAGE, 2012; KAJIYAMA; SATOH, 2014; MACDONALD, 1990; PLUTCHIK, 2001 (desconsiderados – Regra 2)
	+E	DA POS; GREEN-ARMYTAGE, 2012; MOHARRERI <i>et al.</i> , 2014; TERWOGT; HOEKSMASMA, 1995; VALDEZ; MEHRABIAN, 1994; WANG <i>et al.</i> , 2008 (desconsiderados – Regra 2)
	-E	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; ELLIOT; MAIER, 2014; LEE <i>et al.</i> , 2014; MACDONALD, 1990; MANNING; AMARE, 2009; NAZ; EPPS, 2004; PLUTCHIK, 2001; WANG <i>et al.</i> , 2008
	+C	DA POS; GREEN-ARMYTAGE, 2012; MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; TERWOGT; HOEKSMASMA, 1995 (desconsiderados – Regra 2)
	-C	KAJIYAMA; SATOH, 2014; MACDONALD, 1990; PLUTCHIK, 2001 (desconsiderados – Regra 2)
Vermelho	+V	COLLIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; HEMPHILL, 1996; KAJIYAMA; SATOH, 2014; LEE <i>et al.</i> , 2014; SILVEIRA, 2011 (desconsiderados – Regra 2)
	-V	DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; VALDEZ; MEHRABIAN, 1994 (desconsiderados – Regra 2)

Cor	Dom.	Publicações em acordo
	+E	CLARKE; COSTALL, 2008; COLLIER, 1996; CROZIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT; MAIER, 2014; FIORE, 2010; KAJIYAMA; SATOH, 2014; LEE <i>et al.</i> , 2014; MANNING; AMARE, 2009; MOHARRERI <i>et al.</i> , 2014; NAZ; EPPS, 2004; PLUTCHIK, 2001; SILVEIRA, 2011; VALDEZ; MEHRABIAN, 1994
	-E	-
	+C	COLLIER, 1996; CROZIER, 1996; DA POS; GREEN-ARMYTAGE, 2012; ELLIOT, MAIER, 2014; KAJIYAMA; SATOH, 2014; MANNING; AMARE, 2009; MOHARRERI <i>et al.</i> , 2014; PLUTCHIK, 2001; SILVEIRA, 2011
	-C	-

Resumindo os domínios resultantes para cada cor obtidos a partir da análise da tabela, tem-se:

- Amarelo: +E e +C;
- Azul: -E;
- Branco: +V;
- Cinza: -V, -C e -E;
- Laranja: +E e +C;
- Preto: -V;
- Rosa: não foi possível chegar a uma conclusão, apenas uma publicação mencionou a cor;
- Roxo: -E;
- Verde: -E;
- Vermelho: +E e +C.

Ademais, ressalta-se que diferentes nuances influenciam na emoção que será evocada (DA POS; GREEN-ARMYTAGE, 2007). Por exemplo, vermelho pode evocar tanto raiva quanto felicidade, porém são diferentes vermelhos. Um vermelho mais escuro seria aquele que evocaria raiva (DA POS; GREEN-ARMYTAGE, 2007). Os resultados obtidos pela análise das publicações concordam com estas considerações, isto é, mesmo as diferentes nuances do vermelho são +E e +C, diferenciando-se apenas na Valência, domínio desconsiderado para a proposta do círculo resultante. Ao evocar raiva, Valência seria negativa, enquanto que felicidade teria Valência positiva, estando ambas as emoções no conjunto Excitação positiva e Sentimento de Controle positivo.

2.4.3 O Círculo de Cores de Bianchi

O entendimento adotado dos domínios apresentados no Espaço Emocional Semântico de Scherer (SCHERER, 2005) é ilustrado pela Figura 2.4. A cor cinza indica quadrantes negativos, enquanto os positivos estão em branco.

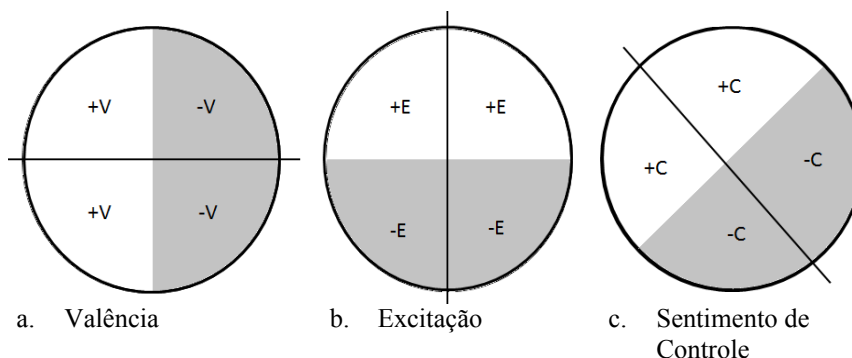


Figura 2.4 - Identificação dos oitantes no Espaço Emocional Semântico. Adaptado de (XAVIER, 2013).

Tem-se que cores mais brilhantes e mais saturadas são mais prazerosas (domínio Valência) e possuem correlação positiva com o domínio Excitação (VALDEZ; MEHRABIAN, 1994). Saturação foi a propriedade mais relacionada à excitação (VALDEZ; MEHRABIAN, 1994). Além disso, cores brilhantes são aquelas que se associam principalmente com emoções positivas, enquanto cores escuras são as que elicitam emoções negativas (HEMPHILL, 1996). A partir destes dados, são propostas configurações de saturação e brilho para os domínios Valência e Excitação, ilustradas na Tabela 2.3.

Tabela 2.3 - Configurações de saturação e brilho para Valência e Excitação.

Combinações de domínios	Saturação (%)	Brilho (%)
-V+E (Oitantes 1 e 2)	100	80 a 90
-V-E (Oitantes 3 e 4)	70	50
+V-E (Oitantes 5 e 6)	60 a 70	90 a 100
+V+E (Oitantes 7 e 9)	100	100

A partir da avaliação dos dados descritos anteriormente e das configurações apresentadas, obteve-se o artefato resultante, mostrado na Figura 2.5, proposto como Círculo de Cores de Bianchi. Nele, porém, foram inclusas exceções para branco, preto e cinza para as características de saturação e brilho. Branco e preto possuem 0% tanto de saturação quanto de brilho e cinza, para os Oitantes 3 e 4, tem 0% de saturação e, como indicado na Tabela 3 para -V e -E, 50% de brilho.

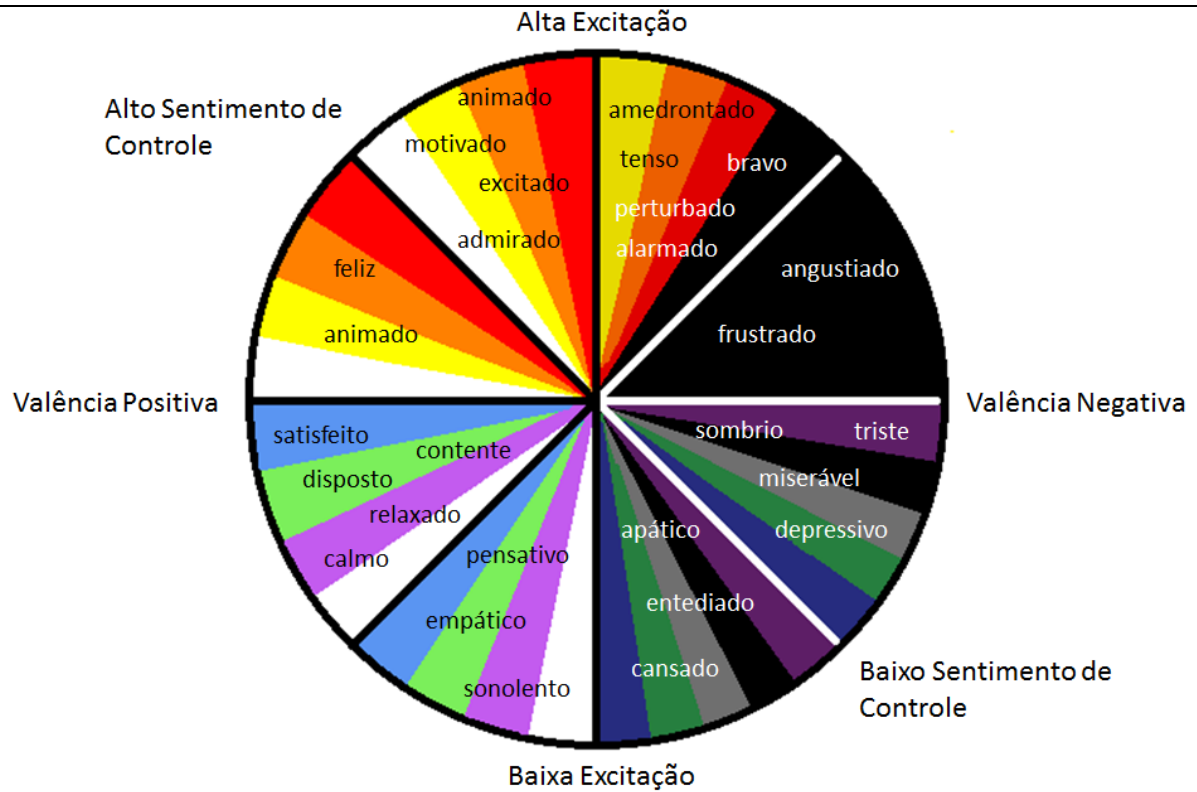


Figura 2.5 – Círculo de Cores de Bianchi.

Para facilitar a distinção, a Figura 2.6 ilustra o mesmo círculo no modelo de cores RGB, que teve seu nome originado da combinação das cores vermelho (*red*), verde (*green*) e azul (*blue*) para obtenção de outras cores. O valor para o vermelho, verde e azul varia entre zero e 255, sendo que quando todos estão no máximo, o resultado é o branco. Inversamente, quando estão no valor mínimo, tem-se o preto. O formato escolhido para a representação foi: `rgb(valor para vermelho, verde, azul)`.

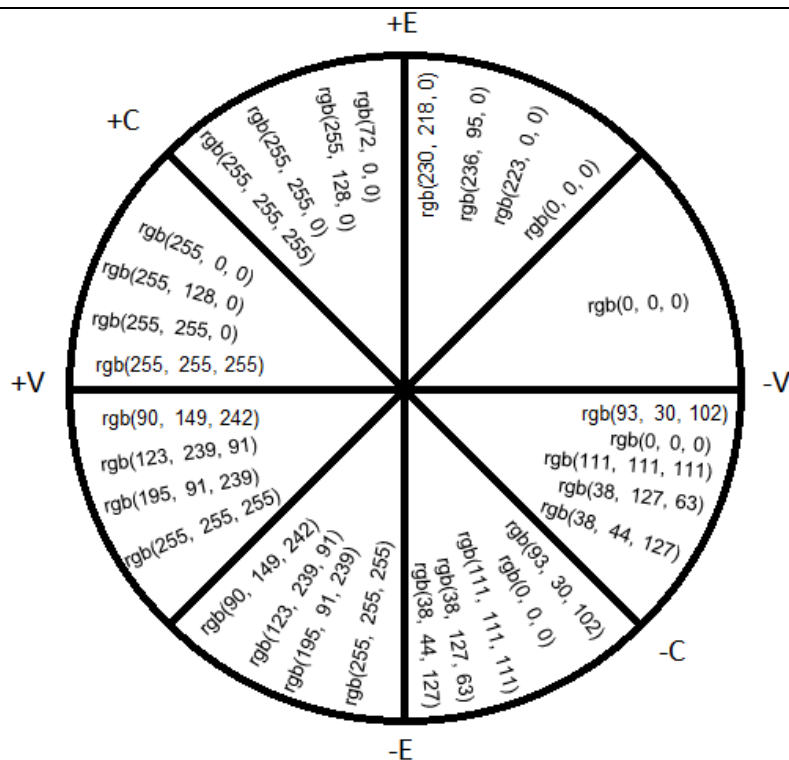


Figura 2.6 – Círculo de Cores de Bianchi em RGB.

Neste primeiro momento, apenas algumas emoções foram apontadas no Círculo de Cores de Bianchi, exibido na Figura 2.5, tendo em vista manter uma visualização e compreensão claras. Com o mesmo objetivo, apenas os domínios foram explicitados na Figura 6, em que é ilustrado o Círculo de Cores de Bianchi no modelo RGB.

2.5 Conclusões

Com os estudos, foi possível compreender que as cores são formadas não só pelo termo conhecido como cor, que se refere à tonalidade, mas também por saturação e brilho. Cada uma dessas propriedades atua diretamente nas emoções que são evocadas. Alguns pesquisadores declaram que as respostas emocionais variam mais pela influência do brilho e da saturação do que pela tonalidade em si (SUK; IRTEL, 2010). Deve-se, portanto, ter cautela com cada um desses atributos, já que, por exemplo, cores altamente saturadas podem causar fadiga aos olhos (HOLTZE, 2006).

A partir do Círculo de Cores de Bianchi, contribuição deste trabalho, observa-se que uma mesma cor pode evocar um ou mais conjuntos de emoções, apontados pela literatura. Dessa forma, estudos anteriores foram confirmados (cf. DESMET, 2003; SUK; IRTEL, 2010). Para o rosa, porém, não foi possível definir um domínio resultante, já que apenas um dos artigos analisados citou esta cor.

A decisão do designer de qual cor utilizar levando em consideração fatores emocionais relacionados às cores começa a se tornar respaldada pelo Círculo de Cores de Bianchi.

A seguir são discutidas as limitações deste trabalho, assim como são descritos trabalhos futuros.

2.5.1 Limitações do trabalho

Existem diversas dificuldades relacionadas à temática desta pesquisa, desde as divergências entre os artigos até questões limitantes. Algumas restrições que podem ser elencadas são:

- Emoções não encontradas no referencial teórico adotado – como explicado anteriormente, termos das leituras que não são apontados no Espaço Emocional Semântico de Scherer (SCHERER, 2005) foram substituídos por sinônimos, identificados em definições de dicionários online. Dessa forma, a limitação foi contornada e se possibilitou o aproveitamento das contribuições desses estudos.
- Questão cultural – apesar da base em artigos internacionais, que fizeram avaliações com usuários, as diferenças culturais encontradas no uso da cor para elicitare emoções não foram aprofundadas neste trabalho.
- Contexto – ainda que as cores e seus significados, os quais podem modificar as emoções evocadas, sejam dependentes de contexto (ELLIOT; MAIER, 2014), este aspecto também não foi aprofundado.
- Estudo parcial – este artigo estuda as cores isoladamente, apesar de elas aparecerem no design somadas a outros elementos de interface de usuário. Em um primeiro momento, cores, imagens e tipografia estão sendo estudados separadamente, mas futuramente uma mesma

interface será composta por todos eles. Desse modo, as respostas emocionais do conjunto serão avaliadas.

2.5.2 Trabalhos futuros

Em próximos trabalhos, serão estudadas as diferentes combinações de cores relacionadas ao Círculo de Cores de Bianchi, com o objetivo de contribuir com recomendações para a seleção de mais de uma cor, de acordo com as emoções que se pretende evocar com uma interface de usuário. Ademais, outros estudos serão realizados para confirmar ou alterar o Círculo de Cores de Bianchi.

Futuramente, outros círculos serão propostos para relacionar as emoções com os elementos de interface de usuário imagem e tipografia. Não existe, contudo, conhecimento aprofundado ou suficiente na literatura para tanto, por isso estudos empíricos estão em planejamento e em breve serão realizados.

Tendo-se as associações de emoções e elementos de interface de usuário (i.e., cor, imagem e tipografia), pretende-se analisar a viabilidade e validação das propostas. Serão realizados experimentos em que os círculos propostos serão a base de designers para o design de uma interface de usuário. Dessa forma, o fator limitante de ser um estudo parcial e individual de cada elemento será contornado.

Chapter 3

EMOTIONAL RESPONSES TO FONT TYPES AND SIZES IN WEB PAGES⁴

Emotions play a critical role in decision-making and behavior. Several elements in the design are combined to evoke specific emotions, although typography is usually related to preferences rather than the emotion evoked. For this reason, the aim of this paper is to investigate the emotional effects of font types and sizes to support design decisions that have an emotional intention. The main stages in the research study were as follows: i) preparing webpages; ii) varying the font types and sizes, one at a time; iii) carrying out experiments with 60 volunteers; iv) conducting a statistical data analysis with a wide range of evaluative instruments. The results from the comments made by the subjects suggest that *Arial* was more closely allied to positive emotions than *Times New Roman*. However, there were no significant differences in the reading time and number of errors. Font size 8pt caused unpleasant experiences and tiredness, and had the highest number of errors. The medium and large sizes, represented by 12pt and 16pt respectively, were mainly related to pleasant and comforting experiences. There were some differences in the findings on font types from the literature and further studies are necessary.

⁴ BIANCHI, R. G.; NERIS, V. P. A. Emotional Responses to Font Types and Sizes in Web Pages. Submitted to a conference.

3.1 Introduction

Emotions play a critical role in decision-making and behavior, which was formerly regarded as rational, such as deciding which chair to sit on or which sandwich to eat (DAMASIO, 1995; HUDLICKA, 2003; NORMAN, 2004). Thus, they should be examined in people's daily activities, such as in their interaction with the media (e.g., web pages, television etc), to provide a better experience of use (LIVINGSTONE, 2003; NORMAN, 2004).

Some authors state that it is possible to design user interfaces to evoke particular emotions in people (KIM; MOON, 1998). According to Jiang et al. (2008), a webpage is basically formed of colors, images and text. The aim of this paper is to explore the last element more deeply, by examining the relationship between certain typographical features and emotions.

Typographical features are based on fonts and typesetting. The first includes color, background color, sizes and types, while the latter consists of plain, bold, italics, bold-italics, among other features (TSONOS; IKOSPENTAKI; KOUROUPETROLOGOU, 2008). In seeking to achieve their goals, there are many ways for designers to display online texts, such as changing these combinations (LING; VAN SCHAİK, 2006). It should be noted that each variation can evoke different emotions (JIANG *et al.*, 2008).

Most studies investigate people's preference for a particular type rather than the emotion evoked (cf. ALTABOLI, 2013, 2014; BERNARD *et al.*, 2003; LING; VAN SCHAİK, 2006). Furthermore, few works were found that investigated the emotional effects of the font size (e.g., KOCH, 2011; TSONOS; IKOSPENTAKI; KOUROUPETROLOGOUM 2008; TSONOS; KOUROUPETROLOGOU, 2008). This study explores these font elements in greater depth with the aim of filling the gap between font types and emotions and looking more closely at the effects of font sizes.

The desire to overcome these drawbacks and to support design decisions where there is an emotional intention about which font type and size to use to evoke emotions, has led this paper to link font features with the emotions defined in Scherer's Semantic Emotional Space (SCHERER, 2005). This research study followed a sequence of stages: 1. preparing webpages and varying font elements; 2.

Carrying out experiments with 60 volunteers; 3. Conducting an analysis of the collected data, both individually and grouped according to the Hybrid Approach to the Assessment of Emotional Experience (XAVIER, 2013; XAVIER; NERIS, 2014); and 4. a critical data analysis.

The results with regard to the font type suggest that *Arial* was more positive than *Times New Roman* in the comments made by the subjects. There were no significant differences between these font types with regard to the reading time and number of errors. However, when all the instruments were merged to produce a final emotional experience, there were similar results among the font types. Concerning the font sizes, the volunteers reported 8pt as being hard to read, unpleasant and tiring, in both subjects' discourse and when all instruments were converged. Further measures suggested that it had the highest number of errors. In contrast, 12pt and 16pt were mainly related to pleasant and comforting experiences.

3.2 Theoretical Framework

Owing to the complexity of the subject, the literature has some difficulty in defining the term 'emotion', and this has led to a good deal of discussion among researchers (COLOMO-PALACIOS *et al.*, 2011; NORMAN, 2002; PLUTCHIK, 2001; SCHERER, 2005; XAVIER, 2013). This study has adopted Scherer's approach (SCHERER, 1984, 2001, 2005) as a means of covering a broad spectrum of emotions within a dynamic model, with the purpose of assisting designers to understand and evaluate the effects of their decisions. The author claims that emotion is "the interface between an organism and its environment mediating between constantly changing situations and events and the individual's behavioral responses" (SCHERER, 1984), and thus involves preparing reactions of the organism to situations and events seen as important (SCHERER, 2001). During these evaluations that are carried out by the emotion, five components undertake specialist functions: cognitive appraisals, physiological reactions, behavioral tendencies, motor expressions, and subjective feelings (SCHERER, 1984).

For this reason, Semantic Emotional Space (SCHERER, 2005), shown in Figure 3.1, includes emotions that cover the components cited. Four dimensions are

Emotional Component	Measure	Dimension Evaluated
Cognitive appraisals	Thinking Aloud (SOMEREN; BARNARD; SANDBERG, 1994)	Control
Physiological reactions	Electrocardiogram	Arousal
Behavioral tendencies	Performance metrics and effectiveness	Conduciveness
Motor expressions	Facial Action Coding System (FACS) (COHN; AMBADAR; EKMAN, 2007)	Pleasure
Subjective feelings	Self-Assessment Manikin (SAM) (LANG; BRADLEY; CUTHBERT, 2008)	Pleasure, Arousal and Control
	Oral questionnaire	Conduciveness

The second stage is the generalization of the results for each measure in terms of positive, neutral or negative. The evaluator relates each positive or negative result to the respective hemisphere (four octants), which are assessed as positive or negative. However, although it can be assumed that the subjects did experience one or more emotions during the interaction, when it is not possible to complete a final experience for the measure, the result can be regarded as neutral and not related to any dimension (XAVIER, 2013).

Next, in the third stage, the octants' incidence process is carried out. For each measure evaluated, the result is the octant with the highest rate (XAVIER, 2013). In the end, a set of emotions is obtained that represents the participant's emotional experience, which has been elicited from the interaction with computing systems.

3.3 Related Work

As well as the other user interface elements, typography has an influence on observer evaluations and decision-making (MOSHAGEN; THIELSCH, 2013). They instantly affect emotions, satisfaction, preferences and the intention to use the media again (MOSHAGEN; THIELSCH, 2013). Hence, it is of value to both designers and

users to examine how typography (and the design itself) affects people's emotions, and thus to provide a better use experience.

According to Altaboli (2013), the most common font types are *Times New Roman* (Serif font style) and *Calibri* (Sans-Serif), owing to their everyday use and for being default in word processing and web development software. In an attempt to measure the user's perceptions of visual aesthetics, the author displayed four designs of the same webpage to a group of 30 people, and obtained 22 valid responses. The pages had an identical format (e.g., color and menu), but different font types in the title and body; there were only variations between *Times New Roman*, and *Calibri* and mixtures of types in *Times New Roman* and *Calibri*. After seeing a picture of each design, the participants were instructed to answer the instrument Visual Aesthetic of Website Inventory (VisAWI) (MOSHAGEN; THIELSCH, 2013). Overall, they regarded the designs with *Times New Roman* as having a better visual aesthetics.

Another study sought to determine what font type (*Times New Roman* or *Arial*) and size (10pt or 12pt) are the most readable and preferred for reading on computers (BERNARD *et al.*, 2003). In terms of accuracy, there were no significant differences for each font type and size. However, with regard to the reading time, *Arial* with a font size of 10pt lasted a longer time than *Arial* and *Times New Roman* with 12pt. Despite these results, most of the participants showed preference for *Arial*. This preference was also noted in (LING; VAN SCHAİK, 2006).

A group of researchers related font size to the following dimensions of emotions: Pleasure, Arousal and Control. They found that the emotional state Pleasure increased by up to 15pt, while Arousal and Control declined; and between 15pt and 18pt, Pleasure declined but Arousal and Control increased (TSONOS; IKOSPENTAKI; KOUROUPETROLGOU, 2008). In more specific terms, the results of a more detailed study revealed a reduction in Pleasure and increase of Arousal between 9pt and 13pt and from 27pt, whereas between 14pt and 27pt, Pleasure increased and Arousal decreased (TSONOS; KOUROUPETROLGOU, 2008).

The work of Koch (2011) investigated whether viewing typefaces evokes emotions and whether all the subjects feel the same emotions. The participants in the experiment were mainly designers (32 out of 42). They interacted with an online questionnaire in which the alphabet was shown in six different typefaces and, after each one, for twelve emotions they responded to the PrEmo™ instrument (DESMET;

HEKKERT, 2002), as illustrated in Figure 3.2, to show whether they felt each or not. The typefaces investigated were: Helvetica Bold, Helvetica Ultra Light, Helvetica Bold Extended, Helvetica Condensed Bold, Helvetica Rounded Bold, and Glypha Medium. In general, the results showed that the participants did feel emotions and ones that could be compared. However, emotions reported were different among the typefaces. For example, Glypha Medium and Helvetica Light were closely related to satisfaction, while Helvetica Extended Bold was more linked to boredom (KOCH, 2011).



Figure 3.2 – The PrEmo instrument (KOCH, 2011).

Most previous studies investigate people's preferences with regard to font type, visual aesthetics, legibility and readability rather than the emotion evoked (cf. ALTABOLI, 2013; ARDITI; CHO, 2005; BERNARD *et al.*, 2003; BEYMER; RUSSEL; ORTON, 2008; HALL; HANNA, 2004; LING; VAN SCHAİK, 2006; MOSHAGEN; THIELSCH, 2013). On the other hand, some research studies, such as those outlined above, are showing the first signs of support for designers who wish to examine the emotional impact of typography. Since few works were found about font size, this paper seeks to ascertain the findings of these studies and focus on the sizes that are generally used by designers in user interfaces. It can also be differentiated from previous studies on font types and sizes for gathering emotions employing more than one instrument established in the literature, and embodies four emotional components - cognitive appraisals, behavioral tendencies, motor expressions, and subjective feelings. This leads to a better view of the emotions resulting from the interaction in question, in addition to addressing a broad spectrum of emotions.

3.4 Experimental Procedure

3.4.1 Hypothesis

The overall null hypothesis states that different font types and sizes in user interface design evoke the same emotions and/or sets of emotions. The alternative hypothesis is that the various ways these elements are shown have different emotional effects, i.e., those of the fonts *Arial* and *Times New Roman* are all different, as well as the 8pt, 12pt and 16pt sizes.

3.4.2 Participants

A total of 60 volunteers participated in the experiment involving both font sizes and font types (i.e., all of them interacted with both stimuli). There were 43 men and 17 women, aged between 18 and 63, with an average age of 24.89. The educational level ranged from college students and graduates to PhD students.

3.4.3 Instantiation of the Hybrid Approach

The instruments selected to assess the volunteers' emotional state when faced with each emotional component are shown in Table 3.2.

Table 3.2 - Instruments selected to evaluate the emotional experience of the participants.

Emotional Component	Measure	Dimension Evaluated
Cognitive appraisals	Discourse of the Collective Subjects (GONDIM; FISCHER, 2009)	Control
Physiological reactions	-	-
Behavioral tendencies	Reading time and number of errors	Conduciveness
Motor expressions	Ten Emotion Heuristics (DE LERA; GARRETA-DOMINGO, 2007)	Pleasure
Subjective feelings	SAM (LANG; BRADLEY; CUTHBERT, 2008)	Pleasure, Arousal and Control

The Discourse of the Collective Subject (GONDIM; FISCHER, 2009) was the instrument selected to measure cognitive appraisals, and these were analyzed by one evaluator. A semi-structured interview was conducted after each stimulus. The participants were encouraged to comment on what the experience was like - whether it changed their emotional state or whether they had any general comments.

Physiological reactions were not included because of the high cost of the instruments, such as electroencephalogram (EEG), or monitors for skin temperature and heart rate.

The evaluation of behavioral tendencies was carried out on the basis of the measurement of the reading duration and number of errors. The subjects were asked to read the texts aloud, and this made it possible to take notes.

In this study, the motor expressions were evaluated with the aid of the Ten Emotion Heuristics (DE LERA; GARRETA-DOMINGO, 2007), a set of guidelines to assess participants' emotions by analyzing their facial expressions and reactions during the interaction (e.g., eyebrow-raising, smiles, compression of the lips etc). A negative emotional experience characterizes five or more of the different negative heuristics identified (DE LERA; GARRETA-DOMINGO, 2007). The application of the Ten Emotion Heuristics took place in two phases: the first was individually - each evaluator watched the videos with the interactions and noted each heuristic violated, while in the second stage the group of evaluators discussed their findings so that they could reach a consensus. The group was formed of an experienced evaluator (with more than 5 applications), a less experienced one (2-5) and another with no experience, in accordance with levels defined by Norman (2004).

The subjective feelings were measured with SAM (BRADLEY; LANG, 1994), a non-verbal pictorial instrument shown in Figure 3.3. It evaluates Pleasure, Arousal and Control with ratings based on their degree of intensity. Manikins vary for each dimension: Pleasure ranges from 'smiling' to 'frowning'; Arousal from 'excited' to 'sleepy'; and Control from a large to a small manikin. Classifications between 1 and 4 correspond to a negative state (e.g., low pleasure), 5 represents a neutral response, and values from 6 to 9 are positive (e.g., high pleasure) (LANG; BRADLEY; CUTHBERT, 2008).

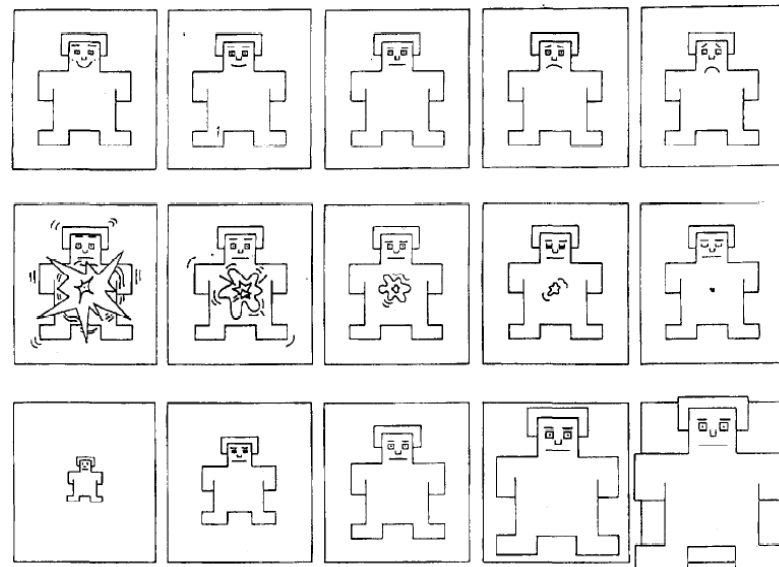


Figure 3.3 – The SAM instrument (BRADLEY; LANG, 1994).

3.4.4 Stimuli

With regard to font styles and types, the literature mainly focuses on investigating Serif and Sans-Serif styles; the former is generally represented by the font type *Times New Roman*, while the latter by *Arial* or *Calibri* (ALTABOLI, 2014; BERNARD *et al.*, 2003; MOSHAGEN; TIELSCH, 2013; TSONOS; KOUROUPETROLOGOU, 2008). This paper studies font types, and is based on the assumption that *Arial* and *Calibri* do not represent the style in its totality since each of them has particular features. *Times New Roman* and *Arial* are the types that are most often reported in the literature, but still have little relation to emotions, and for this reason were investigated (in the same font size – 12pt).

The selection of font sizes to analyze their emotional impact was based on a range of strong candidates for user interface design. In the newspaper webpages of G1⁵, Folha de S. Paulo⁶, Estadão⁷ and BBC Brazil⁸, the contents are displayed between 10 and 12pt. Similarly, in general, the scientific studies employ the 10pt, 12pt and 14pt sizes (cf. BERNARD *et al.*, 2003; BEYMER; RUSSEL; ORTON, 2008;

⁵ <http://g1.globo.com/>

⁶ <http://www1.folha.uol.com.br/>

⁷ <http://www.estadao.com.br/>

⁸ <http://www.bbc.com/portuguese>

LING; VAN SCHAİK, 2006; MACKIEWICZ; MOELLER, 2004), and hence the medium size investigated was based on 12pt. A value to characterize a small size should be lower than 10pt, as this is what is generally used. For the proximity, 9pt was disregarded and 8pt was adopted instead. Since this research is examining font sizes on webpages', sizes larger than 20pt were not included because they are generally used for titles (see online newspapers such as G1, Folha de S. Paulo, Estadão and BBC Brazil). For this reason, the value determined to represent content in a large size was 16pt.

When the same text is read several times, it results in an automatic reading without the participants paying any attention to the text and to its typographical forms. This influences the outcome of the experiment, in particular, in the results which are hardly attenuated. Different topics were selected from newspaper articles to keep the participants interested: these were from the areas of Science and Health, Economics, Sport, World Affairs, and Technology - two per topic, making a total of ten. Each passage had approximately 130 words, within a range of 15%.

This study takes into account that the participants' emotions may be linked to the content and not to the font type and size. However, different subjects can arouse different interests and emotions among the various participants, which reduces the significance of this factor.

The articles selected were divided into two periods: font type (Phase 1) and font size (Phase 2). In Phase 1, the texts alternated between Times New Roman and Arial. In Phase 2, the participants always interacted with the same font type (Times New Roman or Arial) and the texts were displayed at random using 8pt, 12pt and 16pt; in both phases the font color was black. The experimental design ensured that all the themes were shown the same number of times in each reading.

Briefly, different newspaper articles were selected to investigate the emotional effects of *Times New Roman* and *Arial*, as well as the influence of the 8pt, 12pt and 16pt sizes on the reader's emotions, in both font types. After that, we prepared the webpages. A sample of the stimulus is shown in Figure 3.4.

Being focused, concentrating and meditating help to keep the brain active and avoid a loss of memory

The head holds so much information that the memory can fail when someone least expects it. The program invited the psychiatrist and consultant Daniel Barros and the neuroscientist Rogerio Panizziatti to talk about these brain failures.

Being focused, concentrating and meditating are ways to keep the brain working and avoid loss of memory. The mind has to be exercised in the same way as our body. It is also important to keep your senses sharpened. Good vision and hearing, for example, help us to retain information.

And why does memory fail? According to the psychiatrist Daniel Barros, our brain works in an economical way. At the time of remembering, it resorts to an information network and reconstructs what has occurred. We are also influenced by factors such as attention span, stress and the significance of particular facts.

Figure 3.4 –Stimulus sample.

3.4.5 Procedure

The experimental procedure complied with the protocols approved by Ethics Committee and was as follows.

First of all, there was a brief description of the research objectives, as well as the tasks that would be carried out, risks involved and estimated time frame. At the same time, the volunteers were instructed to read and sign a participant consent form if they agreed, as well as to give their authorization to record the interaction.

Next, the participants provided information about their age, gender and educational level.

From this time on, the interaction was recorded so that the Ten Emotion Heuristics could be employed and notes taken of the reading time and number of errors. The subjects read five texts aloud, two in Phase 1 and three in Phase 2; these were delivered one at a time and in a random order at each stage, as described previously.

After each reading, they responded to the SAM test for gathering data on emotional states and were encouraged to comment on the font types and sizes.

3.5 Data Analysis and Results

Each collected measure was assessed individually and the findings were also summarized in accordance with the guidelines of Stages Two and Three of the Hybrid Approach (XAVIER, 2013; XAVIER; NERIS, 2014) (i.e., generalization of results and incidence with octants), to obtain the final sets of emotions evoked.

By employing this method, after the measures (i.e., instruments) had been selected and the data collection, the results of each measure had to be generalized in terms of positive, neutral and negative (XAVIER, 2013; XAVIER, NERIS, 2014).

The generalization of the SAM data for *Times New Roman* is illustrated in Table 3.3, which describes the data of some participants. It should be noted that owing to constraints on the length of this article, it has only been possible to show the results of 10 out of the 60 participants in the experiment (which were chosen at random). The signs “+”, “0” and “-” mean positive, neutral and negative, respectively.

Table 3.3 - Generalization of the SAM data of ten participants for *Times New Roman*.

Participant	Pleasure	Arousal	Control
1	+	+	+
2	+	+	+
3	+	+	-
4	+	-	0
5	+	+	-
6	+	+	+
7	+	0	+
8	+	+	+
9	+	0	+
10	0	-	+

The same procedure was carried out for other measures of each font type and size – Discourse of the Collective Subject, number of errors and Ten Emotion Heuristics. Since the reading times were very close together, it was not possible to create a parameter to determine whether they were positive or negative, and hence they were disregarded at this stage.

After this, the octants’ incidence process took place. The Semantic Emotional Space contains eight sets for each dimension of emotion: four positive octants and four negative. In this stage, results obtained for each domain are related to their respective octants, as shown in Table 3.4. Neutral results are not included.

Table 3.4 – The positive and negative octants of each dimension.

Dimension	Positive Octants	Negative Octants
Pleasure	5, 6, 7, 8	1, 2, 3, 4
Arousal	1, 2, 7, 8	3, 4, 5, 6

Dimension	Positive Octants	Negative Octants
Control	6, 7, 8, 1	2, 3, 4, 5
Conduciveness	4, 5, 6, 7	1, 2, 3, 8

Figure 3.5 illustrates the incidence stage for Participant 6, in Phase 1 of the experiment, which involves reading *Times New Roman*. It also shows the resulting emotional experience of this subject, i.e., the emotions contained in Octant 7 of the Semantic Emotional Space represent the set of emotions felt by this person. This underlines the fact that the participants may respond their emotions in one way in their speeches while, when filling forms (e.g., SAM), they report the exact opposite. This became apparent when several different instruments were used to assess their emotional experience, as proposed by the Hybrid Approach.

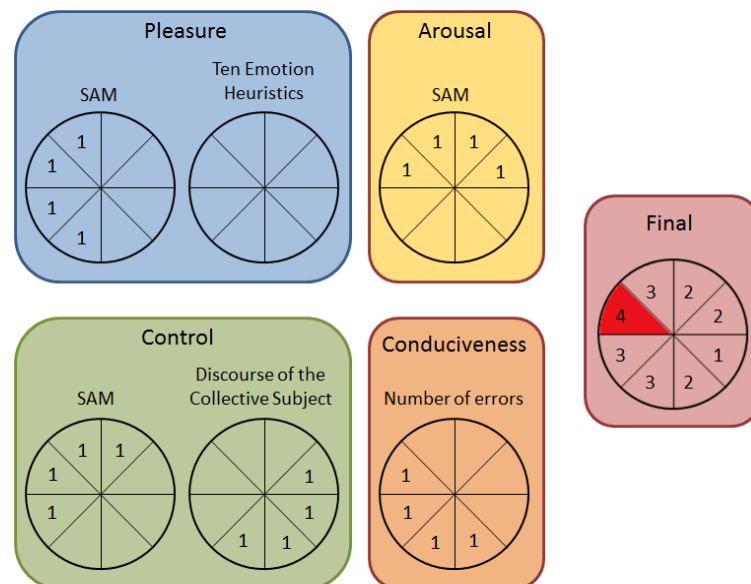


Figure 3.5 – Incidence of octants for Participant 6 in Phase 1.

The following subsections examine the data analysis and results obtained from both the statistical methods and the application of the Hybrid Approach in Phase 1 (font type) and Phase 2 (font size).

3.5.1 Font type

3.5.1.1 Discourse of the Collective Subject

Words such as “normal” and “small” were often used in the volunteers’ comments after they read the first text in *Times New Roman*. In contrast, *Arial*, the second font type, was described as “better”. Some examples of sentences expressed by the participants are as follows: “This font is pleasant, quite normal” (first reading); “I had some difficulty in viewing it, the letters were too small for me” (first reading); “This one is better to read than the first” (second reading); “I think the letters were bigger the second time, so it was more pleasant” (second reading).

In cases where *Arial* was the first font type, the participants also often described it as “normal”. However, after reading the second text in *Times New Roman*, they thought that this font type was worse than the one before. The following are some typical examples of the participant’s comments: “This is what I usually use, it was normal” (first reading); “It seems normal to me” (first reading); “I had some more difficulty” (second reading); “It looks like this font size is smaller” (second reading).

3.5.1.2 Reading time and number of errors

Arial and *Times New Roman* had similar reading times. Table 3.5 summarizes the average values for each font type.

Table 3.5 - Average reading time, in minutes, for each font type.

Newspaper article – theme	<i>Arial</i> (min)	<i>Times New Roman</i> (min)
Science and Health	01:03	01:02
Economics	01:12	01:16
Sport	00:51	00:58
World Affairs	00:59	00:59
Technology	00:48	00:49

The number of errors was calculated by the nonparametric paired Wilcoxon test (WILCOXON, 1945), adopting global confidence level of 95% ($\alpha = 0.05$). There was no significant difference between *Arial* and *Times New Roman*, the p-value ranged from 0.06 to 0.85 (p-value > 0.5).

3.5.1.3 Ten Emotion Heuristics

The measure adopted for motor expressions requires at least five different heuristics violated to classify a positive or negative emotional experience (DE LERA; GARRETA-DOMINGO, 2007). Only one participant had a final emotional experience after reading in *Arial* font type, by achieving a negative result.

The other subjects did not violate five heuristics, since it was not possible to classify their emotional experience.

3.5.1.4 SAM

The Wilcoxon paired test (WILCOXON, 1945) was also used to analyze the SAM results; this is an evaluative measure of subjective feelings. A global confidence level of 95% ($\alpha = 0.05$) was adopted. There was a significant difference between font types in Control: *Arial* had a higher rate than *Times New Roman*, that is, the participants stated that there was more control when the text was in *Arial*. On the other hand, the method did not indicate significant differences in the areas of Pleasure and Arousal.

3.5.1.5 The Hybrid Approach

Table 3.6 illustrates the results obtained in the incidence rate of octants for ten participants in Phase 1, when *Times New Roman* was the first font type read. The gray cells highlight the highest frequencies of the respective octant, i.e., the resulting set of emotions.

Table 3.6 - Individual incidence rate of ten participants when *Times New Roman* was the first reading.

Participant	Octants							
	1	2	3	4	5	6	7	8
1	2	1	0	1	2	3	4	3
2	2	1	0	0	1	2	3	3
3	2	3	2	1	2	1	2	3
4	0	0	1	2	3	3	2	1
5	1	2	1	2	3	2	3	2
6	2	2	1	2	3	3	4	3
7	1	0	0	0	1	2	2	2

Participant	Octants							
	1	2	3	4	5	6	7	8
8	3	2	1	0	1	2	3	4
9	1	0	0	1	2	3	3	2
10	2	0	1	1	1	3	2	2

Results from the participants that interacted with *Times New Roman* in the second reading, still in Phase 1, are shown in Table 3.7.

Table 3.7 - Individual incidence rate of ten participants when *Times New Roman* was the second reading.

Participant	Octants							
	1	2	3	4	5	6	7	8
1	1	1	1	2	3	3	3	2
2	2	1	0	1	2	3	4	3
3	0	1	1	1	2	1	1	1
4	2	1	0	1	2	3	4	3
5	1	1	1	2	2	2	2	1
6	1	1	0	1	2	2	3	2
7	2	1	0	0	1	2	3	3
8	1	1	1	2	2	2	2	1
9	2	1	0	1	2	3	4	3
10	3	2	1	2	1	2	3	2

Octant 7 had the highest incidence rate with regard to all the participants in Phase 1, when the *Times New Roman* was read either first or later. This means that most of the volunteers experienced positive Pleasure, Arousal, Control, and Conduciveness.

Table 3.8 shows how many times each octant was the resulting set of emotions for readings in *Times New Roman*.

Table 3.8 - Overall incidence rate for *Times New Roman*.

Incidence rate for <i>Times New Roman</i>	Octants							
	1	2	3	4	5	6	7	8
First reading	1	3	3	0	5	12	16	10
Second reading	3	0	1	5	6	10	17	2

The findings for *Arial* were similar to those of *Times New Roman*. When all the participants are taken into account, Octant 7 had the highest incidence rate. Table 3.9 shows the number of times each octant was the final emotional experience.

Table 3.9 - Overall incidence rate for *Arial*.

Incidence rate for <i>Arial</i>	Octants							
	1	2	3	4	5	6	7	8
First reading	3	0	1	3	4	9	21	9
Second reading	4	1	2	8	6	11	18	3

3.5.2 Font size

3.5.2.1 Discourse of the Collective Subject

Most of the participants stated that size 8pt was unpleasant, “bad”, tiring and hard to read. Some of the sentences used by the participants were as follows: “Is it possible to make this font size bigger? It’s hard to read”; “I thought this size bad and tiring, it was harder to read”; “This font is really small, because of the reading it was tiring”.

Words such as “good”, “comforting” and “pleasant” were those that were most associated with 12pt. The volunteers described this size in phrases such as “This font size was more comforting”; “This is a good size to use”; “This font size made me more satisfied with my reading”.

Most of the participants described 16pt as good, pleasant and comforting. However, it was interesting to note that a few people (approximately ten) also considered the last to be disquieting and tiring because it was so large. A few other comments were: “The bigger the better”; “This was a good size”; “It wasn’t more difficult, but it was less comforting”.

3.5.2.2 Reading time and number of errors

There were a few differences in the reading times between the font sizes. Table 3.10 shows average values for each.

Table 3.10 - Average reading time, in minutes, for each font size.

Newspaper article – theme	8pt (min)	12pt (min)	16pt (min)
Science and Health	00:58	01:02	00:59
Economics	00:59	00:58	00:55
Sport	00:47	00:48	00:49
World Affairs	01:00	00:58	00:59
Technology	01:02	01:02	01:01

The non-parametric statistical Friedman test (FRIEDMAN, 1937) was used to investigate the number of errors among the font sizes, since there are three categories (8pt, 12pt and 16pt). A global confidence level of 95% ($\alpha = 0.05$) was adopted. On the basis of the analysis, significant differences were found, with the p-value = 0.048 (p-value < 0.05). The results showed that 8pt led to a total number of 17 errors, while 12pt had 14 errors and 16pt, 6 errors.

3.5.2.3 Ten Emotion Heuristics

Three participants had a negative emotional experience in the 8pt size. Other subjects did not violate five heuristics, and so it was not possible to classify their emotional experience.

3.5.2.4 SAM

The results of the SAM questionnaire were also evaluated by running Friedman test (FRIEDMAN, 1937), with a global confidence level of 95% ($\alpha = 0.05$). The ratings may range from one to nine, as cited in the Instantiation of the Hybrid Approach.

When all the texts were in *Arial*, the average ratings of the significant differences (p-value < 0.05) were at the levels shown in Table 3.11.

Table 3.11 - Significant differences between the sizes of *Arial*.

Font size	Economics - Pleasure	Sport - Control
8pt	6.17	5.67
12pt	7.83	7.67
16pt	5.17	7.33

The significant findings (p -value < 0.05) in *Times New Roman* are shown in Table 3.12.

Table 3.12 - Significant differences between sizes of Times New Roman.

Font size	Economics		Sport	World Affairs	
	Pleasure	Control	Pleasure	Arousal	Control
8pt	5	4	5	3.83	4.33
12pt	6.33	7.17	6.17	4	5.83
16pt	6.67	7.33	7.67	5.5	7.3

Previous tables of significant differences between the font sizes indicate that 8pt had lower rates than all the other sizes. The readings in *Arial* had a higher rate when 12pt was used. On the other hand, when the texts were in *Times New Roman*, the highest rates were related to 16pt.

3.5.2.5 The Hybrid Approach

Table 3.13 summarizes the individual incidence rate of some of the participants in Phase 2 while reading texts using 8pt in *Times New Roman*.

Table 3.13 - Individual incidence rate of ten participants for 8pt in Times New Roman.

Participant	Octants							
	1	2	3	4	5	6	7	8
1	3	3	2	2	1	1	2	2
2	2	4	3	4	3	1	2	1
3	0	2	3	4	4	2	1	0
4	2	4	4	3	2	0	0	1
5	1	2	2	2	1	0	0	0
6	3	1	0	1	2	4	5	4
7	0	1	2	3	3	2	1	0
8	2	2	3	2	3	3	2	3
9	1	1	1	2	2	2	2	1
10	0	2	2	3	4	2	2	1

An overview of the incidence rate is shown in Table 3.14 for 8pt, 12pt and 16pt sizes in *Times New Roman*.

Table 3.14 - Overall incidence rate of 8pt, 12pt and 16pt in *Times New Roman*.

Incidence rate	Octants							
	1	2	3	4	5	6	7	8
8pt	1	6	5	13	12	5	8	1
12pt	3	1	1	2	6	11	14	9
16pt	3	3	2	1	4	4	18	9

In short, reading *Times New Roman* using 8pt evoked conducive emotions, but negative Pleasure, Arousal and Control (Octant 4). In opposition to this, sizes 12pt and 16pt achieved Octant 7, which addresses positive values of Pleasure, Arousal and Control, and also includes conducive emotions.

The overall ratings in *Arial* for each size are listed in Table 3.15.

Table 3.15 - Overall incidence rate of 8pt, 12pt and 16pt in *Arial*.

Incidence rate	Octants							
	1	2	3	4	5	6	7	8
8pt	3	3	3	4	3	3	17	9
12pt	1	2	1	2	4	11	19	20
16pt	1	1	1	2	5	9	20	6

In contrast with the results for *Times New Roman*, texts using 8pt in *Arial* led to an experience including emotions with positive Pleasure, Arousal, Control, and Conduciveness (Octant 7). Sizes 12pt and 16pt had the same final set of emotions, as well as Octant 7.

3.6 Discussion

Previous studies of font types have mainly addressed issues related to visual aesthetics, readability and preference, although Kock (2011) demonstrated that typefaces evoke different emotions in subjects. It was found that there was a gap in the literature with regard to the emotional effects of font types. This paper has carried out an extensive study on specific types - *Arial* and *Times New Roman*, while avoiding font styles such as *Serif* or *Sans Serif*, since each font type has its own different and particular features, even in the same style.

The findings from measures related to font types suggested that *Arial* was more closely linked to positive emotions in the subject's discourse, whereas motor expressions caused a negative emotional experience. The Ten Emotion Heuristics did not achieve a final experience for most of the participants, which may be due to the short period of interaction. The reading time and number of errors were quite similar between *Times New Roman* and *Arial*, with no significant differences. On the basis of the SAM data, it was noted that the participants reported greater control from the reading of texts in *Arial*.

The Hybrid Approach (XAVIER, 2013; XAVIER; NERIS, 2014), that is adopted in this paper covering four out of five components of emotions, obtained the same results for both *Times New Roman* and *Arial*. The final emotional experience contained positive Pleasure, Arousal, Control, and Conduciveness.

With regard to the measures employed for the analysis of font sizes, the participants' comments suggest that the smallest, 8pt, was unpleasant, tiring and hard to read. The medium and large sizes were mainly associated with pleasant and comforting experiences. As was the case with the font types, the reading times were close among the font sizes. The largest number of errors was encountered in the readings of texts in 8pt, followed by 12pt, the lowest rate being 16pt. The 8pt size caused a negative emotional experience in the evaluation of motor expressions for three people, while the other sizes did not achieve a final emotional experience for this component. When the texts were in *Arial*, the size with highest Pleasure was 12pt, followed by 8pt and 16pt, respectively. *Times New Roman* had different findings in this area: the highest rate of Pleasure was in 16pt, and afterwards in 12pt and 8pt. The highest rate for Control in *Arial* was in 12pt and 16pt for *Times New Roman*, while the lowest for both was in 8pt. Arousal had significant values in *Times New Roman*, and had the highest rate for 16pt and lowest for 8pt.

One reason for the different results obtained for the font sizes among the *Times New Roman* and *Arial* may have been their x-height. This is a characteristic of typefaces which represents the letter "x" height in lower case (BOULTON, 2009). Most of the participants believed that *Arial* in 12pt was bigger than *Times New Roman* in the same size; this may have been because the first has a larger x-height.

When Xavier's approach was adopted for font sizes, the resulting emotional experiences were as follows. The smallest size, 8pt, shown in *Times New Roman* achieved Octant 4 – negative Pleasure, Arousal and Control, but still conducive. The

final emotions for the other sizes in *Times New Roman*, as well as all the sizes in *Arial*, were related to Octant 7 (positive Pleasure, Arousal, Control, and Conduciveness).

The literature on font sizes has linked ranges of sizes to dimensions of emotions, from 9pt up to 35pt. As mentioned previously, this paper is based on the assumption that sizes larger than 20pt are mainly used in titles, and are thus beyond the scope of this study. Apart from this, there is a divergence in the findings of previous works, in which 12pt had a lower Pleasure rate than 16pt, as well as the fact that the smallest size reported in (TSONOS; IKOSPENTAKI; KOUROUPETROLGOU, 2008) 9pt reached higher levels of Arousal and Dominance than 12pt and 16pt. However, this paper employed Friedman test (FRIEDMAN, 1973) to analyze statistical and significant differences, while the works referred to in the literature were based on mean values for each dimension.

In general, the null hypothesis was accepted for font types but rejected for font sizes. As described previously, *Times New Roman* and *Arial* had the same final emotional experience, while there were few differences among the 8pt, 12pt and 16pt font sizes.

3.7 Conclusion and Future Work

The literature states that various combinations of font types and sizes evoke different emotions in users interacting with computing systems. This means that they influence a subject's decision-making, preferences and attitudes (MOSHAGEN; THIELSCH, 2013).

The main purpose of this paper was to explore the emotional effects of font types and sizes in greater depth. A number of different evaluative instruments and measures, for assessing emotional components, were combined to reduce the risk of obtaining inaccurate or distorted results. The data were analyzed individually, together with the statistical methods, and in groups, with the aid of the Hybrid Approach (XAVIER, 2013; XAVIER; NERIS, 2014) to assess emotional experiences.

This paper carried out a study with 60 participants with no previous formal knowledge of typography and their links to emotions (they were not design students,

for example). In addition, four components of emotions were measured for each subject – cognitive appraisals, behavioral tendencies, motor expressions, and subjective feelings. In summary, among the font types, *Arial* tends to have positive emotions and as a result, is recommended for general use. Our findings showed significant differences between the font sizes, and this suggests that designers should treat the question of choosing their texts and font sizes with caution. Table 3.16 shows recommended use.

Table 3.16 – Recommendation for font sizes.

Font size	Recommendation
8pt	No – generally related to negative emotions
12pt	Yes – usually associated with positive emotions
16pt	Caution necessary – related to both positive and negative emotions

Further studies are needed on font types and on the effects of texts, topics and typographical features. Future work should address the question of whether typography (when compared with different topics) has as much impact as the content.

Chapter 4

TAGS VS. OBSERVERS – A STUDY ON EMOTIONS TAGGED AND EMOTIONS FELT WITH FLICKR PICTURES⁹

Designers and retrieval systems can select media from user-generated tags in social networks to improve the design with the aim of evoking certain emotions. However, can they be relied on for that? Will users feel the same emotions as those that were linked to the media? This paper aims to support the decision-making of the designers and media retrieval systems, by exploring the observers' emotions in pictures from social tags. An empirical online study was carried out with 410 volunteers who classified pictures from Flickr that were related to the five basic emotions plus "neutral" tag. The results suggest that there are differences between the tag and the emotion felt by this group of people for particular emotions. For instance, the findings suggest that the selection of pictures for disgust and anger needs additional criteria as well as collective indexing.

4.1 Introduction

Emotions have been increasingly drawing the attention of researchers over the years. They can be found in every human interaction: instant information about

⁹ BIANCHI, R. G.; NERIS, V. P. A.; ARA, A. Tags vs. Observers - A study on emotions tagged and emotions felt with Flickr pictures. Submitted to a conference.

situations, decision-making and responses to stimuli are modelled by them (HARPER *et al.*, 2008; NORMAN, 2004). When examining emotions in Design and Human Computer Interaction (HCI), a better use experience can be provided (NORMAN, 2004).

Most guides for user interfaces refer to the following factors: texts or typography; graphics or images; multimedia (e.g., audio, video, animation); and colors (JIANG *et al.*, 2008; LYNCH; HORTON, 2002; SMITH; MOSIER, 1986). Regardless of their content, when these elements provoke emotions in observers, they are considered to be emotional-laden (SCHMIDT; STOCK, 2009).

Social media is an issue that occurs in various research studies, such as public health, politics, and the evolving pattern of world and social networks (e.g., BOOTEN, 2016; GARIMELLA; ALFAYAD; WEBER, 2016; KENNEDY *et al.*, 2007; KIM *et al.*, 2013). There is still ongoing research into design that have an emotional intention involving collective indexing, particularly in the decision-making of user interface elements. In the case of pictures, the designer and search engines may be able to get support from user-generated tags containing terms related to emotions.

In this scenario, designers for emotional intention can use pictures from media-sharing or hosting websites based on social tags and then have the worry whether a group of observers will feel the same emotion described by the tag. In view of this, the main purpose of this paper is to analyze whether or not these designers should choose pictures from user-generated tags, and then make some recommendations. A secondary goal is to examine the retrieval area, with regard to the use of tags to express emotions.

Neal (2007) claims that the decision about which tags to use is directly related to the emotions felt by that person while viewing the document being indexed. However, this paper does not assume that the emotion tagged by an indexer represents the emotion this person felt, since there are not enough data about the indexer's intention to confirm the truth of this statement. The aim of this research is to investigate the observers' emotions when faced with a picture that was linked to an emotion included as a tag. In other words, regardless of whether or not the indexers felt the emotion being tagged, they have associated the picture with that emotion, which means it can be used by designers and search engines for the purpose of evoking emotions in subjects. In this case, should they rely on the emotions that are

tagged? Will the users feel the same emotions as those that were associated with the media?

The study outlined here is the result of the following stages: 1. a manual selection of 30 pictures from Flickr, based on the emotions of happiness, anger, sadness, disgust, fear plus “neutral“, clearly written as tags; 2. the planning and deployment of an online survey based on the pictures that have been answered by a set of 410 volunteers (called observers), who rated how much they felt the basic emotions for each picture; 3. finally, an analysis of the results obtained was carried out. The purpose of this was to determine whether the emotions reported by the participants had significant results when statistical methods were employed, as well as if there were differences between them and whether the emotions felt by the participants matched the emotions tagged in the pictures.

The results suggest that some of the emotions need to be treated with a degree of caution if the designer wishes to choose images from social tags, while others can be more clearly distinguished by the observers. Retrieval also requires some caution since many kinds of emotions were reported in pictures with different emotions tagged.

4.2 Theoretical Considerations

4.2.1 Emotion

Defining emotion is a challenging task and there is no consensus among authors about this because of its great complexity (NORMAN, 2002; PLUTCHIK, 2001; SCHERER, 2005). Some approaches to emotion are as follows: dimensional, componential and categorical (or discrete) (POWER; DALGLEISH, 2008; SCHERER, 1984).

Some authors adopt the dimensional approach, which characterizes emotions in terms of specific dimensions (POWER; DALGLEISH, 2008). For example, a pictorial method was proposed by (BRADLEY; LANG, 1994), called Self-Assessment Manikin (SAM), to measure emotion directly by assessing the dimensions of pleasure, arousal and dominance. Similarly, Affect Grid is another instrument that

assesses the affective domain through the dimensions of pleasure and arousal (RUSSEL; WEISS; MENDELSON, 1989).

For instance, Scherer's approach (1984, 2001, 2005) is componential. The author states that emotion comprises five organismic systems, also called components: cognitive appraisals, physiological reactions, behavioral tendencies, motor expressions, and subjective feelings. The organism is continually evaluating every stimulus and responding to the most important ones, what is called emotion (SCHERER, 1984, 2001). Scherer proposes an extended Semantic Emotional Space, based on Russell's circumplex model (1980), which relates emotions to the following dimensions: pleasure, arousal, control and conduciveness (SCHERER, 2005).

Categorical approaches classify emotions in restricted numbers of basic emotions (POWER; DALGLEISH, 2008). Ekman (1992) clarifies the use of the term "basic" for defining these emotions: 1) they have particular characteristics, and differ from each other in expression, appraisal and physiology, for example; 2) but, they also have similarities, such as their rapid onset, short duration, unbidden response, and so forth; 3) the author also seeks to ensure that emotions resulting from the combination of basic emotions are distinguished, called non-basic.

There is no agreement on what these basic emotions are. For example, Ekman and Keltner (1970) assign six basic emotions: happiness, sadness, anger, fear, surprise and disgust. Similarly, Forgas (2012) mentions the following ones: anger, fear, disgust, happiness, surprise and sadness.

This paper has adopted Power and Dalgleish's (2008) categorical classification for providing insight into a core list of basic emotions when comparing different approaches. In addition, the proposal includes scenarios for the appraisal that are integrated with the general development of the self. These also formed basis of previous studies on images and emotional responses (see MURPHY *et al.*, 2010; SCHMIDT; STOCK, 2009). The work assumes that there are five basic emotions linked to a combination of goals and plans. Happiness is the emotional response of goals and plans that are successfully achieved. Sadness implies failure or loss, while anger is related to frustration or blocking situations. Fear is the result to some kind of threat to self-preservation. And, finally, when something or someone is repulsive, the resulting basic emotion is disgust (POWER; DALGLEISH, 2008).

4.2.2 Emotion in Design

Human factors were incorporated and emotions became a key factor in the use experience, by determining the quality of the user's interaction (DE LERA; GARRETA-DOMINGO, 2007; JORDAN, 1998; SPILLERS, 2004). Emotions were shown to play an important role in rational behavior and decision-making, even those that had formerly been considered to be rational (DAMASIO, 1995; DESMET; DIJKHUIS, 2003; NORMAN, 2004).

When designing products leading to emotions, researchers adopted an approach, that was demonstrated in the design of a wheelchair for children, which was intended to have a positive emotional impact on them (DESMET; DIJKHUIS, 2003). Four stages were followed: 1. examining the impact of conventional models and what results they had; 2. understanding why those emotions were evoked; 3. creating the design of a new model, that took account of the points noticed previously; 4. evaluating the new model, and comparing the resulting emotions.

In the case of emotions in the design of webpages, one study examined how the perceived aesthetic qualities of web stores affect the emotions and attitudes of the customers in the store (PORAT; TRACTINSKY, 2012). Hence, it was possible to describe the influence of aesthetics and usability on their emotional state and behavioral consequences. The main findings were that aesthetics and usability do contribute to the customers' pleasure, as well as initially strongly influencing their arousal. Behavioral tendencies, such as approach or avoidance, were mainly associated with pleasure (PORAT; TRACTINSKY, 2012).

A set of criteria for users' emotions was established for the design of web applications by Mori, Paternò and Furci (2015). This involved different users in a survey where emotions were linked to design attributes, such as colors, visual features, structural content, navigation components, multimedia and interactive elements. For instance, the emotion "fun" was connected with animations and videos, color medium-clear images, short and clear text, and dynamic features (MORI; PATERNÒ; FURCI, 2015).

A design that seeks to evoke emotions should be well-founded rather than subjective or intuitive (SILVEIRA, 2011; BOULTON, 2009). When attempting to evoke specific emotions in users, designers and retrieval systems can select media from user-generated tags in social networks to form the design. However, are the

emotions that are tagged in collective indexing systems reliable enough for the decision-making of the design and for search engines?

4.2.3 Emotion in Collective Indexing and Retrieval

Social tagging is an alternative way of indexing images to make them accessible, and are also called cooperative or collective indexing (JÖRGENSEN, 2007). The method of generating metadata by tagging pieces of digital information with uncontrolled terms is called folksonomy (DYE, 2006; SCHMIDT. STOCK, 2009). For this reason, Hastings et al. (2007) state that “individuals are not just users but creators and indexers of multimedia information”.

The purpose of the basic level theory is to understand human categorization and to gather the different levels of abstraction of labels (RORISSA; IYER, 2008). This theory defines three levels of abstraction in which the following category labels are found in a hierarchical structure: subordinate, basic and superordinate (ROSCH *et al.*, 1976). The basic level covers objects in a general way, and employs single terms, like bag, costume, girls, party and happiness. The subordinate level is below the first and describes the objects in more specific terms – for example, aggressive dog, smiling face, Halloween costume. Lastly, superordinate terms are more generic than basic ones and may have different meanings for each person – e.g., animal, clothes, emotion, outdoor activities (RORISSA; IYER, 2008; ROSCH *et al.*, 1976).

Schmidt and Stock (2009) studied the area of Emotional Information Retrieval (EmIR), and demonstrated that in more than half of the images gathered from collective emotion indexing, there were specific emotions that represented them. The authors believe that collective indexing is a suitable method for carrying out a search in image information systems using basic emotions. Their research aimed to find out if it was possible to describe emotions homogeneously using pictures from collective indexing (regardless of the tag included by the indexers), while this paper seeks to ensure designers can rely on the tag for the design with emotional intention, whether or not the emotion tagged matches the emotion felt by the observers.

Previous studies have examined the feasibility of social tagging for the retrieval of emotional information, with regard to the content of the image, indexing and searches (see DYE, 2006; HANJALIC; XU, 2005; JÖRGENSEN, 2007; ORNAGER, 1995; SCHMIDT; STOCK, 2009). In contrast, this work seeks to

investigate the design of web applications with emotional intention and the use of images obtained from collective indexing and retrieval based on emotions tagged. It conducts an analysis of the relationship between emotion tagged and emotion felt through the stimulus of collective indexing.

4.3 Methods

The following experimental procedure was adopted for the investigation described above.

4.3.1 Hypotheses

The overall null hypothesis is that tagged emotion and felt emotion (observer emotion) are the same. The alternative hypothesis is that there may be differences between the emotion tagged in a picture and the emotion felt by observers.

4.3.2 Participants

An online survey¹⁰ was conducted, in which 410 subjects completed and submitted the questionnaire form. The sample of the study only included those who completed the survey. The final sample comprised 215 female and 195 male respondents, with an average age of 28.2, ranging from 14 to 83 years old.

4.3.3 Stimuli

Apart from the adoption of the five basic emotions (i.e., happiness, sadness, anger, fear and disgust), we also included the neutral state, which for the purposes of this study, is the absence of any of the basic emotions. The neutral state was not assumed to be the absence of emotions, but represented the fact that the basic emotions were not felt by the observers.

¹⁰ Visualization of the survey in English: <https://www.surveylegend.com/l/3e8>

Among the existing photo-sharing and hosting websites, Flickr is widely known for its use of tags and for the high number of users in the community and in its groups to share media. Thus, each emotion cited, together with the tag neutral, were searched as tags that were clearly added by users in Flickr.

A manual selection was carried out with the aim of reducing the risk of tags being included as a joke and ensuring that a wide range of contexts would be presented to the participants (e.g., nature, people, animals and objects) for the same emotion. Five pictures were selected for each of the basic emotions and neutral state (tag included by the indexers), comprising a total of 30 images. There were few results for anger, and thus the synonyms “fury” and “rage” were included in the search.

After the selection of the stimuli, the online survey was created with each picture followed by five scroll bars - one for each emotion, ranging from 1 to 10, as illustrated in Figure 4.1 (tagged emotion: sadness). The pictures were arranged in a random order in the questionnaire and all the participants interacted in the same order – one of the limitations listed in next subsections.

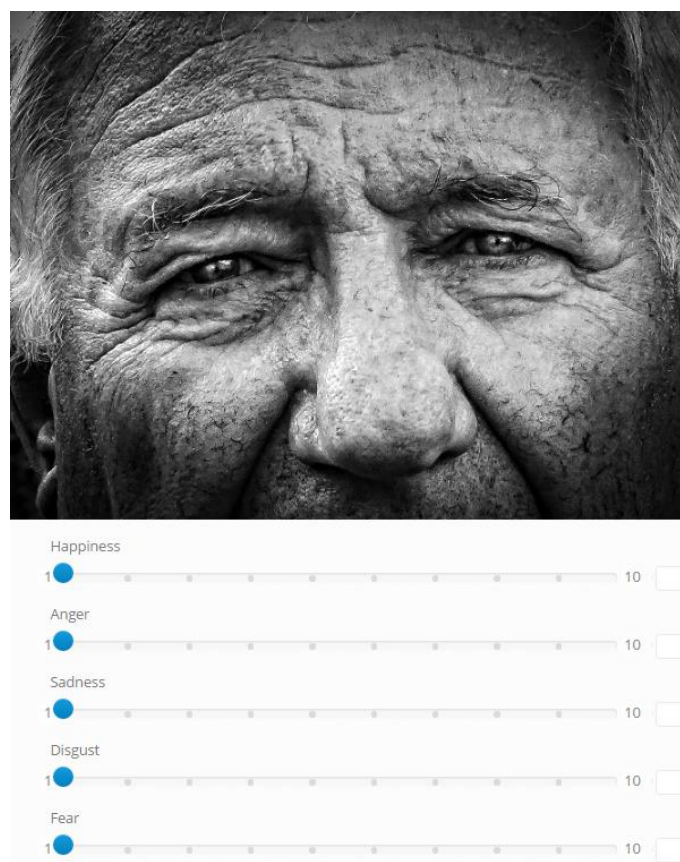


Figure 4.1 – Picture selected from Flickr and scroll bars for emotions.

4.3.4 Procedure

Online invitations were sent to universities email groups and social networks, as well as being disseminated to the whole community. They included a brief summary of the research: goals, task to be performed, estimated time, clarification of the nature of the participation, survey link and researcher contacts.

First of all, the participants gave their age and gender. After this, they were instructed to select the intensity of their emotions - happiness, anger, sadness, disgust and fear - for each picture, according to the emotions they felt when observing it.

Following this, they had to move the corresponding scroll bars, which were zeroed by default. The instructions made clear that if no emotion was felt at all, it was not necessary to move the scroll bar, and that the value 10 represented an emotion with great intensity. The instructions for the task were as follows:

“Look at each picture below, and select the intensity of your emotions - happiness, anger, sadness, disgust and fear. Depending on what emotion you feel, move the scroll bar to one or more emotions. By default, all the values are zeroed. The values range from zero to 10, the lowest number means that the emotion was not evoked at all by that image (in this case, you do not need to scroll it), while 10 represents a high intensity of that emotion. As soon as you select a value, it will be shown on the right-hand side of the bar.”

After responding to the emotions felt for all the 30 pictures, the participants had to submit the form, so that it could be statistically analyzed.

4.4 Analysis and Results

While noting that some data may be visually similar, the following methods were adopted in the analysis: descriptive statistics (mean and standard deviation), the Friedman test, and Bonferroni confidence interval. The Friedman test (FRIEDMAN, 1937), a non-parametric test, was applied to determine whether the emotions have significant results. The differences found by the test were investigated

by means of the Bonferroni method, which examines multiple confidence intervals simultaneously (HOLM, 1979).

The findings are summarized in Table 4.1, and based on the fact that this study adopted a global confidence level of 95% ($\alpha = 0.05$), with a confidence coefficient $(1-\alpha/g)$, where g is the number of emotions. The Bonferroni indices of inequality ensure that the overall confidence coefficient is at least $1-\alpha$. The Table 4.1 shows the picture number, tagged and felt emotions resulting from Friedman test, mean and standard deviation (SD), and Bonferroni confidence interval (CI). The tagged emotion is the emotion that was clearly written as a tag by the indexers in Flickr, and taken as an emotion that was associated with the picture, regardless of the indexers' subjective emotional experience or intentions. Felt emotion is the emotion reported by our participants while observing and rating the pictures.

Table 4.1 – Summary of findings.

Picture	Tagged Emotion	Felt Emotion	Mean (SD)	Bonferroni CI
1	Neutral	Happiness	3.08 (3.16)	[2.69; 3.49]
		Fear	2.74 (2.98)	[2.36; 3.12]
2	Fear	Fear	4.0 (3.39)	[3.56; 4.43]
3	Happiness	Happiness	6.85 (2.97)	[6.47; 7.22]
4	Disgust	Disgust	6.08 (3.37)	[5.65; 6.50]
5	Disgust	Disgust	6.44 (3.30)	[6.02; 6.86]
6	Sadness	Sadness	5.23 (3.05)	[4.84; 5.62]
7	Sadness	Sadness	5.23 (3.23)	[4.81; 5.64]
8	Fear	Fear	5.96 (3.36)	[5.53; 6.39]
9	Fear	Fear	3.82 (3.37)	[3.39; 4.25]
10	Happiness	Happiness	5.01 (3.52)	[4.56; 5.46]
11	Anger	Happiness	4.09 (3.70)	[3.62; 4.56]
12	Happiness	Happiness	7.90 (2.75)	[7.54; 8.25]
13	Fear	Fear	2.88 (3.18)	[2.47; 3.28]
14	Disgust	Happiness	0.98 (2.2)	[0.70; 1.26]
		Sadness	1.5 (2.6)	[1.17; 1.83]
15	Neutral	Sadness	2.6 (2.83)	[2.25; 2.97]
16	Neutral	Happiness	2.08 (2.89)	[1.71; 2.45]
17	Neutral	Happiness	5.15 (3.08)	[4.76; 5.54]
18	Fear	Sadness	2.92 (3.14)	[2.52; 3.32]
		Fear	2.59 (2.91)	[2.22; 2.96]
19	Disgust	Happiness	3.26 (3.47)	[2.82; 3.70]

Picture	Tagged Emotion	Felt Emotion	Mean (SD)	Bonferroni CI
20	Sadness	Happiness	2.18 (3.02)	[1.80; 2.56]
		Sadness	2.73 (3.20)	[2.32; 3.14]
21	Anger	Anger	3.07 (3.50)	[2.63; 3.52]
22	Neutral	Happiness	1.31 (2.42)	[1.00; 1.62]
		Sadness	1.44 (2.42)	[1.14; 1.75]
		Fear	1.46 (2.39)	[1.16; 1.77]
23	Anger	Sadness	2.87 (2.96)	[2.49; 3.25]
24	Happiness	Happiness	7.44 (2.79)	[7.08; 7.79]
25	Anger	Sadness	3.32 (3.18)	[2.91; 3.72]
26	Anger	Happiness	3.79 (3.48)	[3.35; 4.23]
27	Happiness	Happiness	7.14 (2.81)	[6.78; 7.50]
28	Sadness	Happiness	5.21 (3.82)	[4.73; 5.70]
29	Sadness	Sadness	6.71 (2.80)	[6.36; 7.07]
30	Disgust	Sadness	2.27 (2.89)	[1.90; 2.64]

Picture Number 12, shown in Figure 4.2, is a representative for the emotion of happiness. It obtained the highest mean value (7.90), with a standard deviation of 2.75. The other emotions obtained a median equal to zero and the following mean values: anger = 0.22; sadness = 0.37; disgust = 0.09; fear = 0.66. Figure 4.3 displays the boxplot corresponding to Figure 4.2, and describes that the information as follows: the maximum value given to happiness while observing this picture was 10; the median was 9; the lowest extreme was 7; and the minimum value zero.



Figure 4.2 – Representative picture for happiness.

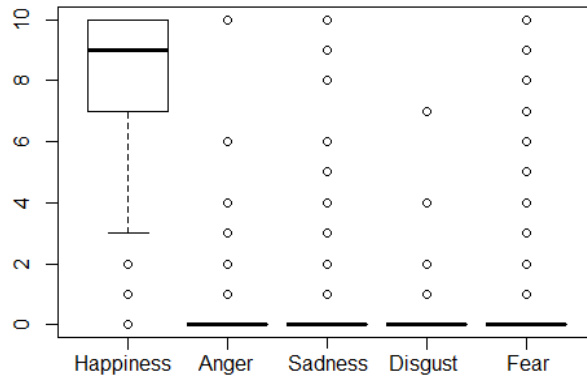


Figure 4.3 – Emotions and their degree of intensity for Figure 4.2.

The only picture that resulted in anger was Number 21, shown in Figure 4.4. The mean value for this emotion was 3.07, with a standard deviation of 3.5 and median equal to 2.0. The median value for the other emotions was zero and the mean values were: happiness = 1.73; sadness = 0.35; disgust = 0.85; fear = 0.83. Figure 4.5 displays these results in visual terms.

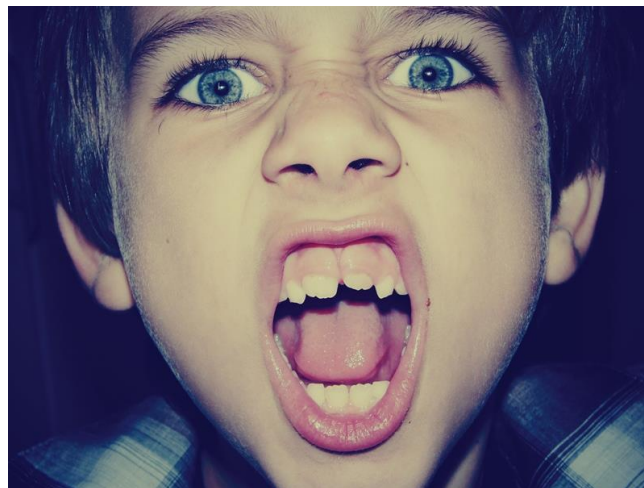


Figure 4.4 – Picture resulting in anger.

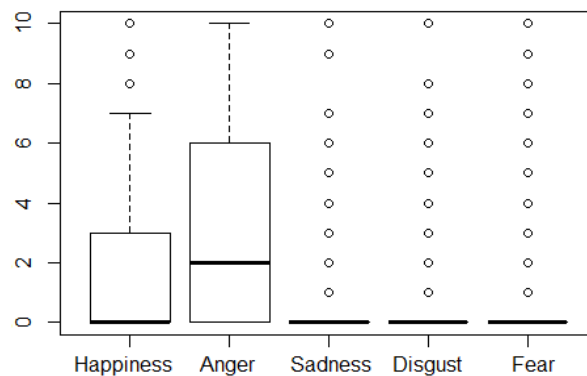


Figure 4.5 – Emotions and their degrees of intensity for Figure 4.4.

With regard to sadness, Figure 4.6 shows picture Number 29, which had the highest mean value for this emotion, equal to 6.71 (with a standard deviation of 2.80).

The median value for sadness was 7.0, while it was zero for the other emotions, as shown in Figure 4.7. The mean values for the other emotions were: happiness = 0.19; anger = 0.97; disgust = 0.20; fear = 0.97.



Figure 4.6 – Representative picture for sadness.

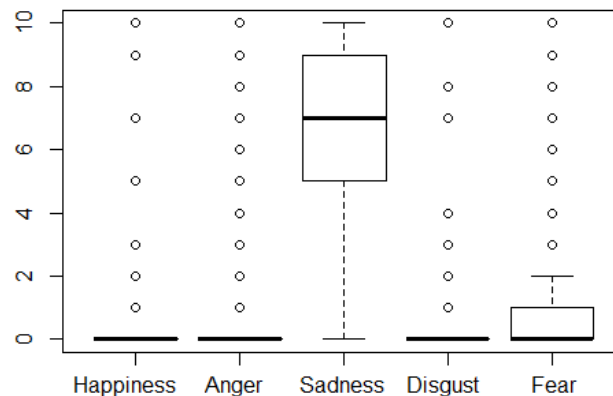


Figure 4.7 – Emotions and their degrees of intensity for Figure 4.6.

Among the disgust pictures, the highest mean value was 6.44, with a standard deviation equal to 3.30, obtained by number 5, illustrated in Figure 4.8. For disgust, the median was equal to 7, for fear it was 2 and zero for the other emotions, as shown in Figure 4.9.



Figure 4.8 – Representative picture for disgust.

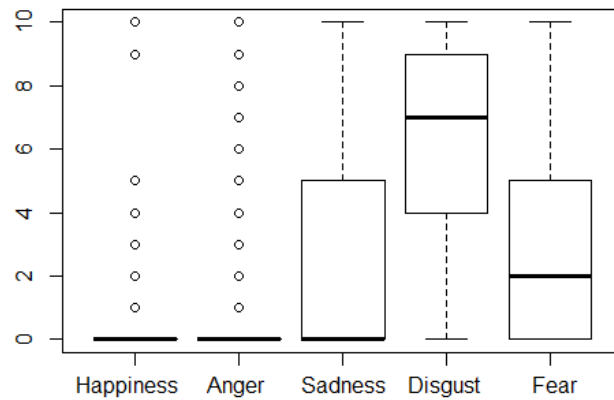


Figure 4.9 – Emotions and their degrees of intensity for Figure 4.8.

Fear, the fifth basic emotion, is represented by picture Number 8, shown in Figure 4.10. The mean values were as follows: happiness = 0.17; anger = 0.27; sadness = 1.75; disgust = 0.08; and fear = 5.96. Also, the median value was 6.5 for fear and zero for the other emotions, as illustrated by Figure 4.11.

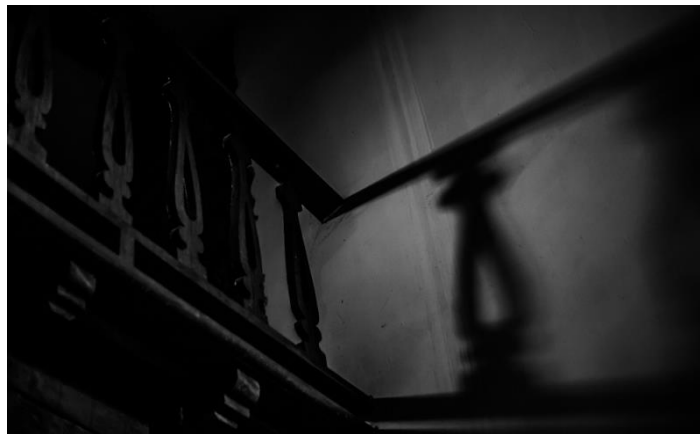


Figure 4.10 – Representative picture for fear.

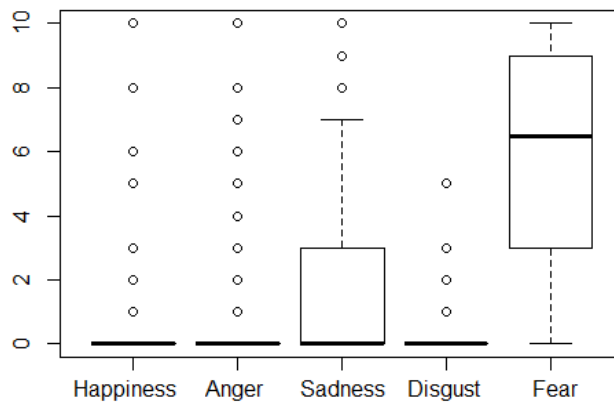


Figure 4.11 – Emotions and their degree of intensity for Figure 4.10.

There would be a neutral result if it satisfied the following conditions: 1. the Bonferroni confidence intervals of two or more emotions intersected with each other in the same picture; 2. zero was included in these intervals. This means that no picture achieved a neutral result, i.e., all the pictures were associated with at least one of the basic emotions.

4.5 Discussion

The results are shown in detail in Table 4.2 and contrast user-generated tags (tagged emotion) with the resulting emotion (felt emotion). It should also be noted that some pictures resulted in more than one emotion felt – and therefore, the sum of each row does not result in exactly five. Every happiness picture achieved this emotion as felt. One out of five pictures for anger was linked to it. Among the pictures for sadness, three were related to sadness, one resulted in both happiness and sadness and another in happiness. The pictures with the tagged emotion disgust had the following results: two achieved disgust as a felt emotion, one was connected to happiness and disgust, one to happiness, and one to sadness. It was found that all the pictures tagged with fear matched this emotion, and one of them was also combined with sadness.

It is worth noting that the results obtained that half of the pictures (i.e., 15) were classified as evoking happiness and 11 sadness. Apart from this, only one of them was associated with anger. The following subsections discuss these and other findings.

Table 4.2 – Summary of Tagged Emotion versus Felt Emotion.

Tagged Emotion	Felt Emotion					
	Happiness	Anger	Sadness	Disgust	Fear	Neutral
Happiness	5					
Anger	2	1	2			
Sadness	2		4			
Disgust	2		2	2		
Fear			1		5	
Neutral	4		2		2	

4.5.1 Neutral

Previous studies have found that valence ratings were similar to both arousal and neutral pictures, but arousal was higher in the former (BLAKE; VARNHAGEN; PARENT, 2001). On the other hand, when physiological factors were measured for pleasant, neutral and unpleasant pictures, pleasant and unpleasant evoked larger late positive potential (LPP) than neutral, and all the types had different results for event-related-potential (ERP) (SCHUPP *et al.*, 2000).

In this work, there was no picture that resulted in neutral as a felt emotion. The survey made clear to the participants that when they did not feel any of the basic emotions at all, it was not necessary to move the corresponding scroll bars. In view of this instruction, if a significant number of participants experienced the absence of the five basic emotions for the same picture(s), this would be observed by the statistical methods adopted – Friedman test and Bonferroni confidence interval.

The results for neutral have three possible interpretations: 1. those pictures indeed evoked some of the basic emotions in the participants and because of this, every image was associated with at least one emotion; 2. The participants were asked to classify their emotions and may have felt uncomfortable about being unable to associate an emotion with the picture in question; 3. in response to stimuli, people were interested in expressing a value for the basic emotions.

Although no picture resulted in neutral, as mentioned earlier, the survey instrument and instructions allowed this to happen. Our findings diverge from the literature, since previous research studies have obtained neutral results, both when people classified their emotions and when the physiological data were collected. Further studies are necessary to understand the concept of neutrality, and whether and how it can be evoked in people when they look at pictures.

4.5.2 Happiness

The findings on happiness corroborate with those in the literature. The participants reported this emotion as felt for all the happiness pictures and also for those with different tagged emotion, such as neutral, anger, sadness and disgust.

In the design with emotional intention, results indicate that the designers who employ user-generated tags for happiness may achieve their intention. In

confirmation of previous studies (DELLAGIACOMA *et al.*, 2011; MACHAJDIK; HANBURY, 2010), happiness was found to be easily differentiated from other emotions, since it can be observed and felt homogeneously.

However, for retrieval purposes, it may be necessary to treat this matter with caution: people felt happiness in pictures with other tagged emotions. This result underlines the fact that happiness is the only positive emotion among the basic emotions and yet it was seen by the participants in the pictures tagged with anger, sadness and disgust. For instance, Figure 4.12 displays picture number 20, in which the tagged emotion was sadness and its felt emotion was both happiness and sadness.

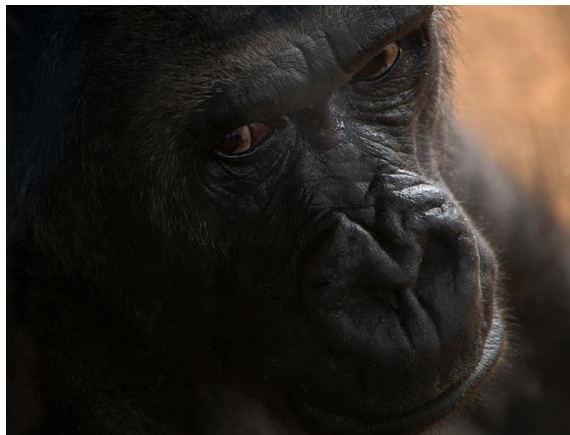


Figure 4.12 – Picture with a tagged emotion of sadness, resulting in happiness and sadness as felt emotions.

4.5.3 Fear and Sadness

Similar to happiness, fear was felt by the participants in all the five pictures selected with this social tag. Among the pictures it was the tagged emotion, fear was the felt emotion together with sadness for one of them. With regard to the pictures tagged with other emotions, fear was part of the result for two neutral pictures together with sadness and happiness.

Sadness appeared in four out of the five pictures selected with this tagged emotion. Happiness was the felt emotion accompanied by sadness in one of them and was the result of another picture. In addition, it is worth noting that sadness was also felt in the neutral, disgust, fear and anger pictures.

Overall, fear tags indicate a standard behavior and may be used for the design, but sadness pictures may be treated with some caution. Although the participants did feel fear and sadness when they observed their respective pictures, in the case of retrieval, some attention is needed to the way these tags are used – both were reported in pictures designed to evoke other emotions.

4.5.4 Anger and Disgust: Caution

Santaella (2002) claims that there are various ways of expressing anger, like emotional momentum, aggressive behavior and mental abuse, for example. The researcher also points out that anger is an explosion triggered by a specific cause: something or someone induces a stimulus that is the direct cause of anger as a reaction. They may be insults, injuries, offensive remarks or teasing.

An alternative view is given by Lakoff (1987) who sets out a prototypical scenario for anger that follows five stages. According to the author, this emotion has minimum variances among different cognitive models. The person who gets angry goes through the following experiences: 1. an offensive event; 2. anger; 3. attempt at control; 4. loss of control; 5. an act of retribution.

Further social psychology research studies suggest that anger is usually caused by high-impact manipulations and deception (HARMON-JONES; AMODIO; ZINNER, 2007). Harmon-Jones, Amodio and Zinner (2007) observed that “whereas other emotions can be induced using film clips or photo-graphs, anger is difficult to induce using such stimuli”.

Our analysis revealed only one picture resulting in anger as felt emotion, which may be due to the nature of this emotion, as supported by the finding in the literature. It should be noted that there were several contexts in the pictures, as well as some that were repeated, for example there was more than one picture with people, although only one brought about anger, as mentioned earlier.

With regard to disgust, the participants felt this emotion in only two pictures out of five. The emotions reported in the other images were: happiness and sadness in one of them (Figure 4.13), happiness in another and sadness in the other.

Although there was some confusion with happiness and sadness while it was the tagged emotion, disgust was not reported resulting from pictures with other

tagged emotions. In other words, for example, it was not the felt emotion of any picture with happiness as a tagged emotion.



Figure 4.13 – Picture of the tagged emotion sadness, resulting in happiness and sadness as a felt emotion.

Previous research studies on disgust have selected stimuli from IAPS (LANG; BRADLEY; CUTHBERT, 2008), a widely known and well-established database, in which emotions are assessed through a dimensional approach. The findings are that disgust pictures hold the observers' attention more than fear and happiness, even when they have similar valence and arousal (VAN HOOFF *et al.*, 2014). Some authors have designed an instrument to assess someone's tendency to feel disgust, called the Disgust Scale (HAIDT; MCCAULEY; ROZIN, 1994). It was revised and its subscales were updated to: Core Disgust, Animal Reminder Disgust, and Contamination-Based Disgust (OLATUNJI *et al.*, 2007).

Although there are works in the literature that demonstrate disgust as a homogeneous emotion, our findings on emotional social tags resulted in different emotions for disgust pictures. The results suggest that anger and disgust require caution in the use of user-generated tags both for the design with emotional intention and for the retrieval.

In summary, Table 4.3 sets out the recommended use of tags associated with emotions for both Design and Retrieval areas on the basis of the results obtained. The results of happiness, sadness and fear suggest that designers can use tags associated with these emotions, although it is recommended to treat these emotions with caution by the search engines. In the case of both designers and retrieval systems, it is not advisable to use tagged emotions when examining anger and disgust.

Table 4.3 – Recommended use of tagged emotions for the Design and Retrieval areas.

Emotion	Design	Retrieval
Happiness	Yes	Caution
Sadness	Yes	Caution
Fear	Yes	Caution
Anger	No	No
Disgust	No	No
Neutral	No	No

4.6 Conclusion and Future Work

For several decades, human factors have been increasingly included in user-centered designs (JORDAN, 1998). For this reason, designers have concentrated on emotional-laden content, such as images, colors and typography. This paper has addressed the following issues: i) the use of social tagging (tagged emotion) in Flickr, which is a sharing website; ii) whether a user-generated tag reflects the emotions of a group of people (felt emotion); iii) whether designers with emotional intention should use social tagging to choose images to include in their design; and also, iv) a discussion on the retrieval of pictures indexed with emotions by user-generated tags.

The basis of this study was Power and Dalglish's categorical approach to emotion (POWER; DALGLEISH, 2008). Five pictures were thus selected for each basic emotion (happiness, anger, sadness, fear and disgust) plus the neutral state and there were shown to 791 people, 410 of whom had completed the online survey.

The statistical analysis revealed that people tend to clearly distinguish happiness and fear. In other words, the participants felt them when they observed pictures indexed with corresponding tags. Thus, the felt emotion matched the tagged emotion in these cases. Most of the sadness pictures (four out of five) resulted in sadness. On the other hand, it may be necessary to rely on other criteria for the selection of pictures of disgust and anger. The first emotion was achieved as a felt emotion in two pictures with the corresponding tag. Yet, only one picture achieved anger as a felt emotion, which confirms the finding in the literature on the difficulty of evoking this emotion from pictures rather than social events (HARMON-JONES; AMODIO; ZINNER, 2007; LAKOFF, 1987; SANTAELLA, 2002). Another interesting

result is that half of the pictures (15 out of 30) were classified as evoking happiness and 11 were associated with sadness. This means that in the case of retrieval, tags and emotions are still diffuse, and hence require some caution.

The following criteria should be adhered to have a neutral result: Bonferroni confidence intervals of two or more emotions intersected with each other in the same picture; and zero should be included in these intervals. Although the instrument and instructions given to the participants made this result possible, there were not pictures with a neutral state as felt emotion, as discussed in the previous section.

4.6.1 Limitations

There are several difficulties arising from the area of this research, from cultural factors and gender to the stimuli selected. Some of the constraints that can be highlighted are listed as follows:

- Few pictures as stimuli and these were not presented at random for participants – only 30 pictures were selected and these were presented to the participants in the same order, which is a limitation in the experimental design phase. However, there were 410 volunteers, which may have been enough to avoid any possible bias;
- Cultural and gender differences – although these form the basis of a number of research studies throughout the world, these items were not explored in depth in this paper, although all the participants had the same nationality (omitted for peer review);
- Observers' personalities and moods – gender and age were the only data gathered about the participants, but their personalities and moods were included in the questionnaire;
- Neutralization of the participants' emotional state – further studies are needed to make it possible to neutralize the participants' emotional state before associating their emotions with pictures or other features.

4.6.2 Future Work

Further studies will focus on the elicitation of emotions on the basis of images already classified by a group of people in previous studies. The pictures will be

selected from literature databases such as the IAPS (LANG; BRADLEY; CUTHBERT, 2008), Geneva Affective Picture Database (GAPED) (DAN-GLAUSER; SCHERER, 2011) and the Open Affective Standardized Image Set (OASIS) (KURDI; LOZANO; BANAJI, 2016). The main purpose of this will be to determine which attributes the pictures evoking the same emotion have in common. This means that both designers and retrieval researchers will have further support in their decision-making.

With regard to the fact that the finding of the neutral pictures conflict with those in the literature, further studies are needed to explore neutral concepts, and establish whether indeed there are neutral pictures and how designers and retrieval can distinguish them from emotionally evocative images.

Finally, it is still necessary to develop a set of criteria to complement the user-generated tags in the selection of the pictures, particularly for cases such as anger and disgust, which only showed a few and sporadic results.

Chapter 5

CONCLUSION

The various combinations of user interface elements may have different results for users – their decision-making, behavior, and emotions. Most research studies investigate preferences, aesthetics and how emotional reactions affect the use of the design. This dissertation has carried out a detailed examination of theoretical and empirical studies on the emotional impact of the colors, font types and sizes, and images to assist decision-making on design with emotional intentions.

This chapter is structured as follows. Section 5.1 highlights the main contributions of this dissertation, and gives examples of how the results can be used. There is a critical analysis of the work and reflections on the paths to mastery in Section 5.2. Finally, Section 5.3 discusses some of the limitations of the research and makes recommendations for future work, followed by some final remarks in Section 5.4.

5.1 Summary of Contributions

The main contribution made by this dissertation is that it provides a set of results from the studies on colors, typographical features and images, which can assist decisions about design with emotional intentions. The key features of this study can be listed as follows:

- The establishment of critical rules to achieve a consensus in the literature, which is exemplified in the investigation of emotions evoked by colors;

- The Bianchi's Color Wheel, an artifact that combines and illustrates the consensus in the literature about which emotions can be evoked from which colors;
- An analysis of the emotional effects of the *Arial* and *Times New Roman* font types, and a list of the procedures followed for using the instruments cited, although it was found out that some of them are not recommended for short interactions;
- An analysis of the emotional effects of the 8pt, 12pt and 16pt font sizes, to determine whether they achieve a negative or positive emotional experience, by supporting the designers' decision-making;
- An analysis of whether pictures tagged with emotions by users in photo-sharing and hosting websites evoke the same emotion for the observers (i.e., to find out whether the tagged and felt emotions match);
- A discussion about the use of social tags for the design and media retrieval with emotional intention, which draws attention to the emotions that tend to be more reliable and signals which ones need to be treated with caution.

5.1.1 The use of Bianchi's Color Wheel in a therapeutic game

A research group from UFSCar, in collaboration with the Spiritual Hospital of Marília (Hospital Espírita de Marília – HEM, in Portuguese), designed a therapeutic game to assist healthcare professionals in the treatment of depression. Their goal was to free the patients from their state of apathy, by encouraging them to take care of themselves and others (both people and objects), as well as stimulate them to have fun and learn new activities. According to the authors, Bianchi's Color Wheel helped them to make design decisions on colors (NISHIKAWA et al., 2016).

The authors created some screens for the game to illustrate their use, as shown in Figures 5.1 and 5.2.



Figure 5.1 – One scenario of the game is to do gardening.



Figure 5.2 – After playing the game, the patients rank how they are feeling.

By observing the figures above, it can be seen that the authors decided to select colors on the left hemisphere of Bianchi's Color Wheel. This side is associated with positive emotions, seeing that there is a desire to avoid negative emotions in depressed people. The colors used in the design are associated with positive Pleasure, variances in Arousal and Control, and involve emotions ranging from excited and happy (yellow and orange, for example) to pleased and empathic (e.g., blue and green).

5.2 Final Thoughts and Lessons Learned

From the outset, this project was committed to studying design decisions and assessing their impact on users' emotional responses. Initially, it was decided to offer separate guidelines for the design with emotional intention. The prototypes would be designed to test the proposed guidelines (for colors, typographical features and images) together in the same interface. However, during the study, it was noticed that the field still needs further research with regard to some user interface elements. Nevertheless, the studies conducted in this dissertation contribute to the state-of-the-art, by describing each procedure, methodology, assumptions, and results that can be used during the designers' decision-making.

Since the aim was to achieve a consensus in the literature on colors and emotions, relevant works were not included on Bianchi's Color Wheel. However, this was part of a decision that was necessary to reach an agreement between the authors. The wheel provides a critical view of the literature, and the study also refers to these research areas. Those who may be interested in a more detailed approach are able to have a brief view and then explore it in great depth.

Conducting empirical studies is a complex activity since it entails planning, execution, analysis and reporting. During the planning stage, there may be some unforeseen factors when it is undertaken. In the analysis of the collected data, it may be possible to have a new view of the planning (e.g., other instruments could have been adopted), as well as to see faults while it was carried out or other ways in which it could be conducted. Reporting on the study and the results requires organization (a good structure) and should make it possible for others to understand and critically analyze the findings.

Another factor that affects the experiments is the difficulty of recruiting people and then dealing with them. In the case of face-to-face studies (e.g., typographical features), the planning of the schedules were shared with groups of people so that they could choose the most suitable time to participate; however there was little support. Most volunteers were recruited as a result of personal invitations and a date was scheduled as soon as they showed interest in participating. In the case of images, many people opened up and started on the online survey but did not complete it, which raises a number of questions: they were curious to see the survey,

so why did they give up before they had finished? Was there something that made them give up, such as the duration time or the images?

With regard to online studies, finding the appropriate tool – one that enables questions and responses that meet the needs of the study – requires a search carried out by various survey providers, as well as sometimes communicating with them to have a functionality that still does not exist. This was our case: it was necessary to include a picture as a question, but no provider had this functionality together with the necessary single option buttons (radiobuttons) as answers. When this was mentioned to the Survey Legend team, they decided to accelerate this development since it was already in their schedule.

The study on fonts resulted in approximately 300 videos of about one minute each. The time needed for the data analysis was underestimated and took longer than expected. The following notes were taken for each video: reading time, number of errors, motor expressions and volunteers' comments. It had not been planned to use statistical methods for these data, but during the analytical phase it proved to be important, and was thus adopted. Moreover, the instrument to evaluate motor expressions (Ten Emotion Heuristics – DE LERA; GARRETA-DOMINGO, 2007) required more than one evaluator. There were some difficulties during this last stage of the research: these lasted from the time when the individual evaluations were completed (each evaluator finished on different dates that were far apart) until the scheduling of an appointment when all the evaluators could join together to discuss the findings.

5.3 Limitations and Future Works

The results of this dissertation are still incomplete: each user interface element was studied separately, although they appear together in the design. Further investigations should address the prototypes by combining all the elements based on the detailed findings and on the results of the future works listed below; they should also evaluate whether the expected and targeted emotions were evoked.

With regard to colors, factors such as culture and context were not included in the study. Colors have various meanings in different cultures and contexts, and this

influences the emotions they evoke. There are authors that have referred to some specific aspects of Western culture and cultures in general (e.g., NAZ; EPPS, 2004; SILVEIRA, 2011; TEWORTG; HOEKSM, 1995). Elliot and Maier (2014) stressed that colors and their meanings depend on the context, but did not go deeper into this topic.

This dissertation investigated font types and sizes, while typography includes many more features, both in the areas of fonts and typesetting. There are also some other topics that can be explored in the future:

- further exploration of font types with different stimuli (other texts or just letters) and different instruments from the ones adopted;
- a comparison of typography with different themes of the texts to determine whether it has as much impact as the content;
- the question of whether themes and typography have any correlation (positive or negative).

Future studies on images should focus on the elicitation of emotions based on pictures that have already been classified by groups of people in previous studies. The selection should be made from the literature databases such as the IAPS (LANG; BRADLEY; CUTHBERT, 2008), GAPED (DAN-GLAUSER; SCHERER, 2011) and OASIS (KURDI; LOZANO; BANAJI, 2016). The main purpose will be to find out which attributes of the pictures that evoke the same emotion have aspects in common.

Neutral is a concept that requires attention, especially with regard to emotions and images. Further research should seek to determine whether indeed there are neutral pictures and how they can be differentiated from emotionally evocative images.

The selection of pictures from collective indexing with the aim of evoking emotions needs more criteria to supplement user-generated tags. Cases such as anger and disgust had few and sporadic results, and need more support.

5.4 Final Remarks

Emotions influence the way a user explores and uses an interface (SPILLERS, 2004), and thus it is important to support the designers' decisions with emotional intention. This dissertation has explored the emotional impact of colors, font types and sizes, and images, that have been described in theoretical and empirical studies.

Further research is necessary to examine the whole user interface and make a contribution to the literature, which has few works on typography and decision-making in images related to emotions. It is hoped that the findings described here can help designers to choose their colors, fonts and images when having emotional intention.

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Appendix A

SUMMARY: WHICH COLOR SHOULD I PICK? A STUDY ON COLORS AND EMOTIONS IN HUMAN-COMPUTER INTERACTION

Since colors have a great influence, design decisions on colors and emotions should be well-founded (SILVEIRA, 2011), even though many designers still define them in a subjective and intuitive way (BOULTON, 2009).

The study carried out in this paper (Chapter 2) seeks to help designers to choose colors for a series of emotions mapped in Scherer's Semantic Space of Emotion (SCHERER, 2005). The association of colors and emotions was conducted in three stages: 1. the collection of the state-of-the-art by means of a systematic literature review; 2. the setting up of rules to adapt the literature to the Semantic Space of Emotion (SCHERER, 2005); 3. the proposal of Bianchi's Color Wheel, which is the main contribution of the paper. This is because Bianchi's Color Wheel covers the spectrum of emotions found in the Semantic Space, and differs from previous works which related colors to partial and limited degrees of emotions (e.g., PLUTCHIK, 2001).

Colors have three basic properties: hue, brightness and saturation. Hue is the tone of the color, for example green and yellow, and can be referred to the wavelength of the light (BOULTON, 2009; CROZIER, 1996, ELLIOT; MAIER, 2014; HOLTZE, 2006; NAZ; EPPS, 2004). Brightness corresponds to the amplitude or height of the wave (CROZIER, 1996), in other words: how much white (lightness), or black, that color contains (BOULTON, 2009; ELLIOT; MAIER, 2014; HOLTZE, 2006; NAZ; EPPS, 2004). Finally, saturation, concerns the complexity of the light wave and

to its degree of purity (CROZIER, 1996; NAZ; EPPS, 2004) - the purer the color, the higher the saturation.

Some authors believe that emotional responses explain people's preference for specific colors, so they seek to understand why people tend to like a particular colors or even why these preferences exist. They believe that people like the colors as they like the emotions evoked by or associated with them (PALMER; SCHLOSS; SAMMARTINO, 2013).

This research study focuses on colors related to classifications of emotions from one or more emotional dimension (i.e., Pleasure, Arousal and Control). For example, red, orange and yellow may have a high (i.e., positive) arousal response, according to Fiore (2010). It also includes papers which describe emotions based on the Semantic Space of Emotion (SCHERER, 2005) or their synonyms (e.g., cheerful instead of happy). In the extraction of relevant papers, contributions with abstract categories of emotions (such as modern and dirty) but with relevant data for the Semantic Space of Emotions, were equally included in the study.

The systematic literature review covered the following:

- Research questions: What is the influence of colors on emotions? Which color evokes which emotion(s) or dimension(s) of emotion?;
- Databases searched: ACM (Association for Computing Machinery), IEEE Xplore (Institute of Electrical and Electronics Engineers), APA PsycNET, Science Direct, Scopus, Taylor & Francis Online, and Wiley Online Library;
- Search terms: "emotion color", "emotion colour" and "emotion color design", that were designed to produce studies that included both colors and emotions;
- Inclusion criteria: all kinds of publications (e.g., qualitative, quantitative, experimental) which examined the relationship between colors and emotions, and resulted in emotions (dimensions or classes of emotions, such as happiness). The complete text should also be made available;
- Exclusion criteria: studies focusing on only colors or only emotions; cultural and gender differences; creativity; colors in drawings, environments and physical objects (i.e., outside user interfaces); time perception, cognition and memory; only abstract concepts of emotion

(e.g., dirty-clean, classical, romantic). Some of these factors were disregarded because they differ from user interfaces in use, volatility, communication strategies, nature of the task and affordances.

A detailed and critical analysis of each selected publication was conducted after the relevant studies had been located and papers excluded on the basis of their title, abstract or results. For a better understanding of the findings, all of them were converted into dimensions of emotion (i.e., Pleasure, Arousal and Control), and covered by the Semantic Space of Emotion (SCHERER, 2005).

Next, a set of rules was established to analyze and document the degree of consensus or divergence between the studies. These rules made it possible to examine the largest number of sets of emotions that can be elicited by a color, while also taking into account the less frequent cases in the publications under analysis. These are as follows:

Rule 1. If only one publication described a particular dimension as positive or negative, it would be disregarded.

Rule 2. If identical or a similar number (from one to three) of publications gave opposite signals to the same dimension, then this would be disregarded. In the case of distant numbers (more than three), the signal with the highest number of publications would be the one included.

Rule 3. If all the dimensions were disregarded because of *Rule 2*, a predominant dimension should be defined, that takes into account the one with the biggest difference in the number of publications. For example, 5 papers state that Pleasure is positive and 3 negative, while another 4 papers state that Arousal is positive and 3 negative. In this case, the final result would be positive Pleasure. If there is a tie between the dimensions, the one with more publications cited in total would be the one included.

Following this, the publications, their findings and conclusions were arranged and filtered by these rules in a table (Table 2.2). It was explained which publications state the particular dimension for each color and which rules were applied. The dimensions Pleasure, Arousal and Control in Portuguese are Valência, Excitação and Sentimento de Controle, abbreviated in V, E and C, respectively. Signals “+” and “-” indicate whether the dimension is positive or negative, respectively.

A summary of the findings from Chapter 2 related to the resulting dimensions gives the following:

- Yellow: +A and +C;
- Blue: -A;
- White: +V;
- Gray: -V, -A and -C;
- Orange: +A and +C;
- Black: -V;
- Pink: it was not possible to reach a conclusion, only one publication mentioned this color;
- Purple: -A;
- Green: -A;
- Red: +A and +C.

Da Pos and Green-Armytage (2007) argue that different nuances of colors can influence the emotion that will be evoked. For instance, red can evoke both anger and happiness, but they are different reds. A darker red is the one that would evoke anger (DA POS; GREEN-ARMYTAGE, 2007). The findings obtained from the analysis of the literature corroborate this statement, since both shades of red are positive Arousal and positive Control, and differ only in Pleasure, which is the dimension disregarded.

Brighter and more saturated colors are more pleasurable (Pleasure) and have a positive correlation with Arousal, as well as this, saturation is usually related to Arousal (VALDEZ. MEHRABIAN, 1994). In addition, brighter colors are often associated with positive emotions, while darker ones evoke negative emotions (HEMPHILL, 1996). On this basis, we also designed settings of saturation and brightness for the dimensions Pleasure and Arousal, shown in Chapter 2 (Table 2.3) and in Table 5.1.

Table 5.1 - Settings of saturation and brightness for Pleasure and Arousal (in English).

Combinations of the dimensions	Saturation (%)	Brightness (%)
-P+A (Octants 1 e 2)	100	80 to 90
-P-A (Octants 3 e 4)	70	50
+P-A (Octants 5 e 6)	60 to 70	90 to 100

Combinations of the dimensions	Saturation (%)	Brightness (%)
+P+A (Octants 7 e 9)	100	100

From the summary of the findings and settings mentioned previously, the resulting artifact was obtained, which is Bianchi's Color Wheel, shown in English in Figure 5.3.

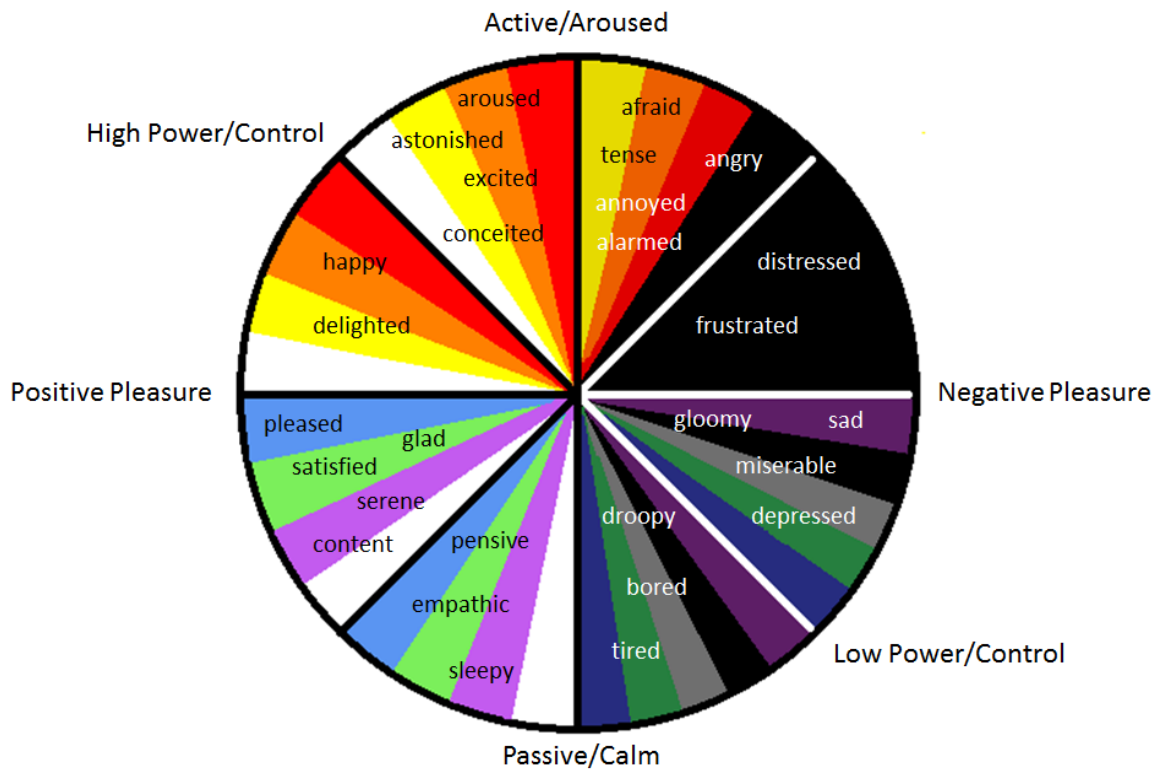


Figure 5.3 – Bianchi's Color Wheel, in English.

At first, only a few emotions were displayed in the wheel, although all the emotions cited by Scherer (2005) are covered in each octant, to maintain a clear visualization and understanding. In Chapter 2, Bianchi's Color Wheel is also displayed in the RGB model (Figure 2.6), in which Pleasure is V, Arousal is E and Control is C (abbreviations from their corresponding words in Portuguese).

From Bianchi's Color Wheel, it can be seen that the same color may evoke one or more sets of emotions (as mentioned in the literature), confirms the finding of previous studies (cf. DESMET, 2003; SUK; IRTEL, 2010). The resulting artifact examines colors and emotions, by introducing saturation and brightness related to hue and emotions. This gives an initial support to design decisions with emotional intention based on colors.

Appendix B

FONTS: RESULTS FROM SAM QUESTIONNAIRE

Phase 1 (Font type) – Reading 1 in *Times New Roman* and Reading 2 in *Arial*.

Participant	Pleasure		Arousal		Control	
	R1	R2	R1	R2	R1	R2
1	8	5	6	6	9	6
2	9	7	7	7	9	5
3	8	8	8	7	2	4
4	7	9	3	5	5	5
5	7	4	6	4	3	8
6	7	7	7	7	8	8
7	6	6	5	7	9	6
8	7	9	8	7	7	8
9	7	9	5	8	7	9
10	5	6	4	3	7	8
11	8	8	7	7	6	7
12	4	5	2	5	4	5
13	7	9	6	8	6	4
14	7	8	6	8	3	8
15	7	8	4	5	7	8
16	6	5	6	5	5	5
17	5	7	4	7	6	7
18	8	6	6	5	8	7
19	6	9	5	7	7	8
20	7	5	6	5	8	6
21	7	7	5	6	8	8
22	6	7	6	7	3	5

Participant	Pleasure		Arousal		Control	
	R1	R2	R1	R2	R1	R2
23	5	5	1	3	5	7
24	5	9	4	8	7	9
25	5	7	1	1	9	9
26	5	4	3	4	3	4
27	5	8	6	8	3	6
28	9	7	5	4	6	6
29	3	3	5	5	3	5
30	7	7	6	7	7	7
R1 = Reading 1; R2 = Reading 2.						

Phase 1 (Font type) – Reading 1 in *Arial* and Reading 2 in *Times New Roman*.

Participant	Pleasure		Arousal		Control	
	R1	R2	R1	R2	R1	R2
1	7	6	6	5	8	7
2	9	9	9	9	8	9
3	7	7	5	5	7	5
4	8	9	8	9	9	9
5	8	5	7	5	9	8
6	9	9	5	7	7	5
7	4	9	6	9	8	9
8	5	5	5	5	9	7
9	4	9	2	9	9	9
10	5	4	7	6	8	7
11	7	3	5	5	6	6
12	7	8	5	8	6	8
13	9	9	5	3	3	3
14	6	7	5	5	8	8
15	6	4	5	7	7	6
16	7	3	6	5	8	6
17	5	6	1	4	9	7
18	5	4	5	5	7	3
19	5	5	5	5	7	8
20	7	7	7	5	9	9
21	7	7	5	7	8	8
22	9	9	8	8	8	8
23	7	1	3	1	5	3

Participant	Pleasure		Arousal		Control	
	R1	R2	R1	R2	R1	R2
24	7	5	5	2	8	9
25	6	6	6	5	7	7
26	9	7	7	5	9	5
27	2	6	6	2	5	6
28	7	4	8	5	8	5
29	9	6	7	6	6	4
30	5	5	5	5	7	7
R1 = Reading 1; R2 = Reading 2.						

Phase 2 (Font size) – All texts in *Arial*, varying sizes (8pt, 12pt and 16pt) randomly.

Participant	Pleasure			Arousal			Control		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
R1 = 8pt; R2 = 12pt; R3 = 16pt									
1	5	8	8	6	8	8	7	8	8
2	6	9	8	7	8	8	7	9	9
3	9	9	9	9	9	9	5	5	4
4	7	7	7	7	5	5	5	7	7
5	5	9	6	7	8	6	8	9	8
6	8	7	6	6	5	4	8	7	7
7	6	9	9	5	8	8	6	7	9
8	6	8	5	7	6	6	5	7	6
9	5	6	6	6	6	5	4	8	6
10	7	4	5	6	3	5	8	8	9
R1 = 12pt; R2 = 16pt; R3 = 8pt									
11	9	7	5	7	7	7	9	7	5
12	8	9	5	6	7	6	9	9	5
13	5	5	5	5	5	5	9	8	6
14	4	1	9	1	1	9	9	4	9
15	5	6	4	6	6	4	7	7	5
16	5	3	3	3	7	5	3	1	5
17	8	7	7	7	7	7	7	6	7
18	2	1	1	1	1	1	9	9	9
19	8	8	8	7	8	8	8	8	8
20	9	9	9	8	9	9	9	9	9
R1 = 16pt; R2 = 8pt; R3 = 12pt									

Participant	Pleasure			Arousal			Control		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
21	8	7	6	5	6	5	7	5	5
22	7	7	7	7	7	6	8	8	6
23	7	7	6	4	6	6	7	8	7
24	5	4	7	7	8	4	8	2	8
25	6	8	7	5	8	6	6	8	7
26	9	5	6	7	7	7	6	4	7
27	3	3	3	5	5	5	6	6	4
28	8	1	6	7	4	5	7	4	7
29	6	9	9	6	9	9	3	7	7
30	8	6	9	8	6	8	8	7	9
R1 = Reading 1; R2 = Reading 2; R3 = Reading 3.									

Phase 2 (Font size) – All texts in *Times New Roman*, varying sizes (8pt, 12pt and 16pt) randomly.

Participant	Pleasure			Arousal			Control		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
R1 = 8pt; R2 = 12pt; R3 = 16pt									
1	3	7	8	7	7	7	7	8	8
2	3	7	7	7	5	6	4	8	8
3	5	6	9	3	5	8	3	4	8
4	1	1	9	5	7	9	3	8	9
5	1	7	9	5	3	4	5	8	9
6	9	5	7	7	5	7	9	7	7
7	5	7	7	4	5	6	5	9	9
8	6	5	7	3	2	5	7	9	9
9	5	8	9	5	8	9	6	9	9
10	6	6	7	5	6	7	4	4	6
R1 = 12pt; R2 = 16pt; R3 = 8pt									
11	9	9	5	9	7	5	9	9	5
12	8	8	6	7	7	5	7	7	7
13	5	6	7	5	5	6	4	5	3
14	5	5	7	3	3	6	3	2	4
15	7	8	4	6	8	3	6	8	2
16	8	5	3	7	6	5	5	7	3
17	6	7	4	4	4	3	7	4	3
18	6	5	6	5	5	6	7	7	7

Participant	Pleasure			Arousal			Control		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
19	5	7	5	3	7	4	4	5	7
20	6	8	7	7	8	5	4	6	7
R1 = 16pt; R2 = 8pt; R3 = 12pt									
21	9	7	7	3	5	5	1	3	1
22	4	3	5	5	5	5	6	7	8
23	7	8	8	4	2	7	3	3	7
24	5	5	7	6	5	6	6	5	5
25	6	4	5	8	4	4	6	3	5
26	5	4	5	6	3	2	4	3	5
27	6	8	6	5	9	6	7	9	7
28	9	4	6	8	3	5	7	4	6
29	5	3	5	5	3	4	9	7	9
30	6	6	7	6	6	7	8	8	9
R1 = Reading 1; R2 = Reading 2; R3 = Reading 3.									

Appendix C

FONTs: PARTICIPANTS' NUMBER OF ERRORS AND READING TIMES

Phase 1 (Font type) – Reading 1 in *Times New Roman* and Reading 2 in *Arial*.

Participant	R1 – <i>Times New Roman</i>		R2 – <i>Arial</i>	
	No. Errors	Reading Time	No. Errors	Reading Time
1	1	01:10	3	01:32
2	0	01:30	1	01:02
3	4	01:05	1	01:10
4	1	00:54	0	00:41
5	1	01:02	2	01:22
6	1	01:00	2	01:10
7	0	01:05	1	00:45
8	4	00:59	0	01:05
9	2	01:02	2	00:50
10	0	00:44	1	00:50
11	0	01:14	3	01:28
12	7	01:45	6	01:05
13	3	01:32	2	01:21
14	1	01:14	0	00:57
15	5	01:04	0	01:19
16	0	01:04	2	01:13
17	0	01:01	1	00:48
18	0	00:45	1	00:54
19	0	00:50	3	00:47
20	3	00:55	1	01:06

Participant	R1 – <i>Times New Roman</i>		R2 – <i>Arial</i>	
	No. Errors	Reading Time	No. Errors	Reading Time
21	1	00:52	0	01:06
22	2	01:14	2	00:51
23	4	00:48	4	00:55
24	0	00:46	0	00:39
25	1	00:51	0	00:56
26	5	00:55	6	01:07
27	5	01:15	5	00:55
28	3	01:10	3	00:56
29	4	01:14	2	01:00
30	1	00:54	1	00:56
R1 = Reading 1; R2 = Reading 2; No. Error = Number of Errors; Reading Time in minutes and seconds.				

Phase 1 (Font type) – Reading 1 in *Arial* and Reading 2 in *Times New Roman*.

Participant	R1 – <i>Arial</i>		R2 – <i>Times New Roman</i>	
	No. Errors	Reading Time	No. Errors	Reading Time
1	1	01:11	1	01:23
2	0	01:00	2	00:45
3	2	00:53	0	00:59
4	0	01:03	2	00:50
5	2	00:57	1	01:04
6	1	01:06	1	01:17
7	1	01:27	0	00:59
8	1	01:05	1	01:12
9	5	01:02	2	00:45
10	2	00:43	3	01:04
11	1	01:04	2	01:20
12	1	01:15	1	00:53
13	0	00:41	1	00:50
14	0	00:50	1	00:40
15	2	00:49	2	01:00
16	0	00:57	2	01:03
17	2	00:54	2	00:37

Participant	R1 – <i>Arial</i>		R2 – <i>Times New Roman</i>	
	No. Errors	Reading Time	No. Errors	Reading Time
18	0	00:49	2	00:59
19	2	00:57	1	00:42
20	0	00:48	1	00:56
21	0	01:07	3	01:15
22	1	01:07	4	00:49
23	2	00:43	4	00:53
24	1	00:53	0	00:43
25	3	00:49	3	01:06
26	0	00:58	3	01:16
27	1	01:15	0	00:47
28	1	00:45	5	00:55
29	1	00:52	2	00:45
30	0	00:47	3	01:05
R1 = Reading 1; R2 = Reading 2; No. Error = Number of Errors; Reading Time in minutes and seconds.				

Phase 2 (Font size) – All texts in *Arial*, varying sizes (8pt, 12pt and 16pt) randomly.

Participant	R1		R2		R3	
	No. Errors	Reading Time	No. Errors	Reading Time	No. Errors	Reading Time
R1 = 8pt; R2 = 12pt; R3 = 16pt						
1	4	01:09	4	01:16	1	00:54
2	1	01:06	1	00:57	1	01:14
3	2	00:41	0	00:55	2	00:56
4	1	00:54	3	01:05	1	01:05
5	3	01:09	2	01:02	0	01:00
6	0	00:52	3	00:54	1	00:42
7	3	00:50	1	00:39	1	00:55
8	1	00:51	0	00:55	1	01:03
9	3	00:50	1	00:51	1	00:57
10	3	00:45	1	00:43	2	00:39
R1 = 12pt; R2 = 16pt; R3 = 8pt						
11	2	01:11	3	01:00	0	00:53

Participant	R1		R2		R3	
	No. Errors	Reading Time	No. Errors	Reading Time	No. Errors	Reading Time
12	0	01:00	1	00:50	2	01:08
13	2	00:56	1	01:02	3	01:11
14	2	00:58	4	01:05	4	01:01
15	2	01:10	6	01:02	5	01:08
16	3	00:57	6	01:01	5	00:46
17	4	00:59	1	00:51	2	01:02
18	1	00:47	1	00:52	2	00:56
19	1	01:00	4	01:02	5	01:05
20	0	00:53	2	00:57	2	01:00
R1 = 16pt; R2 = 8pt; R3 = 12pt						
21	2	00:52	2	00:48	0	00:41
22	1	01:05	0	00:46	2	01:00
23	5	01:12	7	01:18	5	01:19
24	1	01:01	2	01:04	3	01:03
25	1	01:00	0	00:57	3	00:58
26	4	01:07	7	01:04	4	00:54
27	2	01:06	2	00:56	0	01:15
28	1	00:46	4	00:53	2	00:58
29	2	01:14	1	01:08	3	01:09
30	4	01:10	4	01:01	4	00:57
R1 = Reading 1; R2 = Reading 2; R3 = Reading 3; No. Error = Number of Errors; Reading Time in minutes and seconds.						

Phase 2 (Font size) – All texts in *Times New Roman*, varying sizes (8pt, 12pt and 16pt) randomly.

Participant	R1		R2		R3	
	No. Errors	Reading Time	No. Errors	Reading Time	No. Errors	Reading Time
R1 = 8pt; R2 = 12pt; R3 = 16pt						
1	0	00:57	0	00:53	0	00:45
2	1	00:47	0	00:42	0	00:45
3	1	00:59	3	01:07	0	01:10
4	5	01:03	6	01:06	2	00:59
5	0	00:52	1	00:52	1	00:47
6	2	00:57	4	00:56	1	00:46

Participant	R1		R2		R3	
	No. Errors	Reading Time	No. Errors	Reading Time	No. Errors	Reading Time
7	2	00:55	3	00:46	3	00:50
8	4	00:50	3	00:58	4	00:59
9	1	00:53	5	00:52	1	00:52
10	1	01:01	2	01:05	1	01:01
R1 = 12pt; R2 = 16pt; R3 = 8pt						
11	1	01:24	3	01:05	3	00:55
12	0	01:10	0	01:05	3	01:34
13	4	01:05	5	01:01	5	01:17
14	2	01:00	2	01:11	2	00:56
15	3	01:18	3	01:18	6	01:25
16	4	00:49	4	00:44	5	00:37
17	2	00:49	0	00:39	1	00:46
18	3	00:48	5	01:01	3	00:59
19	1	00:51	3	00:56	1	00:54
20	2	00:59	5	01:00	5	00:59
R1 = 16pt; R2 = 8pt; R3 = 12pt						
21	2	00:49	2	00:50	1	00:41
22	4	00:54	1	00:40	3	00:48
23	3	00:47	1	00:54	3	01:00
24	1	00:54	1	01:02	0	01:02
25	2	00:55	1	00:59	3	00:51
26	0	00:58	0	01:00	3	00:50
27	3	00:49	3	00:39	5	00:54
28	2	00:44	2	00:50	3	00:58
29	1	01:09	03	01:10	2	01:16
30	2	00:58	1	00:55	2	00:57
<p>R1 = Reading 1; R2 = Reading 2; R3 = Reading 3; No. Error = Number of Errors; Reading Time in minutes and seconds.</p>						

Appendix D

FONTS: SUMMARY OF MEASURES' RESULTS

Phase 1 (Font type) – Reading 1 in *Times New Roman*.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	1	0
2	1	1	1	0	0	0
3	1	1	-1	0	-1	0
4	1	-1	0	0	1	0
5	1	1	-1	0	1	0
6	1	1	1	0	1	-1
7	1	0	1	0	0	0
8	1	1	1	0	-1	0
9	1	0	1	0	1	0
10	0	-1	1	0	0	1
11	1	1	1	0	0	0
12	-1	-1	-1	0	-1	-1
13	1	1	1	0	1	-1
14	1	1	-1	0	1	0
15	1	-1	1	0	-1	0
16	1	1	0	0	0	0
17	0	-1	1	0	0	0
18	1	1	1	0	0	1
19	1	0	1	0	0	-1
20	1	1	1	0	1	0
21	1	0	1	0	1	1
22	1	1	-1	0	1	-1
23	0	-1	0	0	-1	1
24	0	-1	1	0	0	0

Participant	M1	M2	M3	M4	M5	M6
25	0	-1	1	0	1	1
26	0	-1	-1	0	-1	1
27	0	1	-1	0	-1	-1
28	1	0	1	0	1	0
29	-1	0	-1	0	-1	0
30	1	1	1	0	1	-1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 1 (Font type) – Reading 2 in *Times New Roman*.

Participant	M1	M2	M3	M4	M5	M6
1	1	0	1	0	1	-1
2	1	1	1	0	1	0
3	1	0	0	0	0	-1
4	1	1	1	0	1	0
5	0	0	1	0	1	-1
6	1	1	0	0	1	0
7	1	1	1	0	0	0
8	0	0	1	0	1	-1
9	1	1	1	0	1	0
10	-1	1	1	0	1	0
11	-1	0	1	0	1	0
12	1	1	1	0	1	0
13	1	-1	-1	0	1	0
14	1	0	1	0	1	1
15	-1	1	1	0	1	0
16	-1	0	1	0	1	-1
17	1	-1	1	0	1	0
18	-1	0	-1	0	1	-1
19	0	0	1	0	1	0
20	1	0	1	0	1	0
21	1	1	1	0	1	0
22	1	1	1	0	-1	0

Participant	M1	M2	M3	M4	M5	M6
23	-1	-1	-1	0	-1	1
24	0	-1	1	0	0	0
25	1	0	1	0	1	-1
26	1	0	0	0	1	-1
27	1	-1	1	0	0	0
28	-1	0	0	0	-1	0
29	1	1	-1	0	1	-1
30	0	0	1	0	1	0

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 1 (Font type) – Reading 1 in *Arial*.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	1	0
2	1	1	1	0	0	0
3	1	0	1	0	1	1
4	1	1	1	0	0	0
5	1	1	1	0	1	0
6	1	0	1	0	1	0
7	-1	1	1	0	1	0
8	0	0	1	0	1	0
9	-1	-1	1	0	-1	0
10	0	1	1	0	1	0
11	1	0	1	0	1	0
12	1	0	1	0	1	0
13	1	0	-1	0	0	0
14	1	0	1	0	0	0
15	1	0	1	0	1	1
16	1	1	1	0	0	1
17	0	-1	1	0	1	0
18	0	0	1	0	0	1
19	0	0	1	0	1	0
20	1	1	1	0	0	0

Participant	M1	M2	M3	M4	M5	M6
21	1	0	1	0	0	0
22	1	1	1	0	1	0
23	1	-1	0	0	1	0
24	1	0	1	0	1	1
25	1	1	1	0	1	1
26	1	1	1	0	0	1
27	-1	1	0	0	1	0
28	1	1	1	0	1	0
29	1	1	1	0	1	1
30	0	0	1	0	0	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 1 (Font type) – Reading 2 in *Arial*.

Participant	M1	M2	M3	M4	M5	M6
1	0	1	1	-1	1	0
2	1	1	0	0	1	0
3	1	1	-1	0	1	0
4	1	0	0	0	0	0
5	-1	-1	1	0	1	-1
6	1	1	1	0	1	1
7	1	1	1	0	1	0
8	1	1	1	0	0	1
9	1	1	1	0	1	1
10	1	-1	1	0	1	1
11	1	1	1	0	1	0
12	0	0	0	0	-1	1
13	1	1	-1	0	1	0
14	1	1	1	0	0	1
15	1	0	1	0	0	1
16	0	0	0	0	1	0
17	1	1	1	0	1	1
18	1	0	1	0	1	0

Participant	M1	M2	M3	M4	M5	M6
19	1	1	1	0	1	0
20	0	0	1	0	1	0
21	1	1	1	0	0	0
22	1	1	0	0	1	0
23	0	-1	1	0	-1	1
24	1	1	1	0	0	0
25	1	-1	1	0	0	1
26	-1	-1	-1	0	-1	1
27	1	1	1	0	-1	1
28	1	-1	1	0	1	0
29	-1	0	0	0	1	0
30	1	1	1	0	1	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Times New Roman* using 8pt.

Participant	M1	M2	M3	M4	M5	M6
1	-1	1	1	0	0	-1
2	-1	1	-1	0	1	-1
3	0	-1	-1	0	1	-1
4	-1	0	-1	-1	-1	-1
5	-1	0	0	0	0	-1
6	1	1	1	0	1	1
7	0	-1	0	0	1	-1
8	1	-1	1	0	-1	-1
9	0	0	1	0	1	-1
10	1	0	-1	0	1	-1
11	0	0	0	0	1	-1
12	1	0	1	0	1	-1
13	1	1	-1	0	-1	-1
14	1	1	-1	0	1	1
15	-1	-1	-1	-1	-1	-1
16	-1	0	-1	0	-1	-1

Participant	M1	M2	M3	M4	M5	M6
17	-1	-1	-1	0	1	-1
18	1	1	1	0	1	-1
19	0	-1	1	0	1	-1
20	1	0	1	0	-1	1
21	1	0	-1	0	1	1
22	-1	0	1	0	1	-1
23	1	-1	-1	0	1	-1
24	0	0	0	0	1	-1
25	-1	-1	-1	0	1	-1
26	-1	-1	-1	0	0	-1
27	1	1	1	0	1	0
28	1	-1	-1	0	1	-1
29	-1	-1	1	0	1	-1
30	1	1	1	-1	1	-1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Arial* using 8pt.

Participant	M1	M2	M3	M4	M5	M6
1	0	1	1	0	-1	-1
2	1	1	1	0	1	-1
3	1	1	0	0	1	-1
4	1	1	0	0	1	0
5	0	1	1	0	1	-1
6	1	1	1	0	0	-1
7	1	0	1	0	1	-1
8	1	1	0	0	1	-1
9	0	1	-1	0	1	-1
10	1	1	1	0	1	0
11	0	0	0	0	0	-1
12	0	0	0	0	1	-1
13	0	0	1	0	1	-1
14	1	1	1	0	-1	-1

Participant	M1	M2	M3	M4	M5	M6
15	-1	-1	0	0	-1	-1
16	-1	-1	0	-1	-1	-1
17	1	1	1	0	1	-1
18	-1	-1	1	0	1	-1
19	1	1	1	0	-1	-1
20	1	1	1	0	1	-1
21	1	1	0	0	1	1
22	1	1	1	0	0	1
23	1	1	1	0	-1	1
24	-1	1	-1	0	1	-1
25	1	1	1	0	0	0
26	0	1	-1	0	-1	-1
27	-1	0	1	0	1	-1
28	-1	-1	-1	0	-1	-1
29	1	1	1	0	1	-1
30	1	1	1	0	-1	-1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Times New Roman* using 12pt.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	0	1
2	1	0	1	0	0	1
3	1	0	-1	0	1	-1
4	-1	1	1	-1	-1	0
5	1	-1	1	0	1	1
6	0	0	1	0	-1	1
7	1	0	1	0	1	1
8	0	-1	1	0	1	1
9	1	1	1	0	-1	1
10	1	1	-1	0	1	1
11	1	1	1	0	1	0
12	1	1	1	0	0	0

Participant	M1	M2	M3	M4	M5	M6
13	0	0	0	0	-1	0
14	0	-1	-1	0	1	0
15	1	1	1	-1	1	1
16	1	1	1	0	-1	0
17	1	-1	-1	0	1	1
18	1	0	0	0	1	0
19	0	-1	-1	0	1	0
20	1	1	1	0	1	-1
21	1	0	-1	0	1	-1
22	0	0	1	0	1	1
23	1	1	1	0	1	1
24	1	1	0	0	0	1
25	0	-1	0	0	1	1
26	0	-1	0	0	1	1
27	1	1	1	0	-1	0
28	1	0	1	0	1	0
29	0	-1	1	0	1	1
30	1	1	1	0	1	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Arial* using 12pt.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	-1	0
2	1	1	1	0	1	1
3	1	1	0	0	0	-1
4	1	0	1	0	1	0
5	1	1	1	0	1	1
6	1	0	1	0	1	1
7	1	1	1	0	1	1
8	1	1	1	0	0	1
9	1	1	1	0	1	1
10	-1	-1	1	0	1	1

Participant	M1	M2	M3	M4	M5	M6
11	1	1	1	0	1	0
12	1	1	1	0	0	0
13	0	0	1	0	1	1
14	-1	-1	1	0	1	0
15	0	1	1	0	1	0
16	0	-1	-1	0	1	1
17	1	1	1	0	-1	1
18	-1	-1	1	0	1	0
19	1	1	1	0	-1	1
20	1	1	1	0	0	1
21	1	0	0	0	0	0
22	1	1	1	0	1	1
23	1	1	1	0	-1	0
24	1	-1	1	0	0	1
25	1	1	1	0	0	1
26	1	1	1	0	-1	0
27	-1	0	-1	0	0	1
28	1	0	1	0	1	1
29	1	1	1	0	1	1
30	1	1	1	0	-1	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Times New Roman* using 16pt.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	0	1
2	1	1	1	0	0	1
3	1	1	1	0	0	1
4	1	1	1	0	1	1
5	1	-1	1	0	1	1
6	1	1	1	0	1	1
7	1	1	1	0	1	1
8	1	0	1	0	-1	1

Participant	M1	M2	M3	M4	M5	M6
9	1	1	1	0	1	1
10	1	1	1	0	1	1
11	1	1	1	0	1	1
12	1	1	1	0	0	0
13	1	0	0	0	-1	1
14	0	-1	-1	0	1	1
15	1	1	1	0	1	0
16	0	1	1	0	-1	0
17	1	-1	-1	0	0	0
18	0	0	1	0	-1	-1
19	1	1	0	0	1	1
20	1	1	1	0	-1	1
21	1	-1	-1	0	1	-1
22	-1	0	1	0	-1	-1
23	1	-1	-1	0	1	0
24	0	1	1	0	1	1
25	1	1	1	0	1	-1
26	0	1	-1	0	0	-1
27	1	0	1	0	1	1
28	1	1	1	0	1	1
29	0	0	1	0	1	1
30	1	1	1	0	1	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,
M1 = SAM – Pleasure
M2 = SAM – Arousal
M3 = SAM – Control
M4 = Ten Emotion Heuristics
M5 = Number of errors
M6 = Discourse of the Collective Subject

Phase 2 (Font size) – Reading in *Arial* using 16pt.

Participant	M1	M2	M3	M4	M5	M6
1	1	1	1	0	1	1
2	1	1	1	0	1	1
3	1	1	0	0	1	-1
4	1	0	1	0	1	1
5	1	1	1	0	0	0

Participant	M1	M2	M3	M4	M5	M6
6	1	-1	1	0	1	-1
7	1	1	1	0	1	1
8	0	1	1	0	1	-1
9	1	0	1	0	1	-1
10	0	0	1	0	1	1
11	1	1	1	0	1	1
12	1	1	1	0	1	1
13	0	0	1	0	1	-1
14	-1	-1	-1	0	-1	-1
15	1	1	1	0	-1	0
16	-1	1	-1	-1	-1	-1
17	1	1	1	0	1	-1
18	-1	-1	1	0	1	-1
19	1	1	1	0	-1	-1
20	1	1	1	0	1	0
21	1	0	1	0	1	0
22	1	1	1	0	1	1
23	1	-1	1	0	-1	0
24	0	1	1	0	1	1
25	1	0	1	0	1	-1
26	1	1	1	0	-1	1
27	-1	0	1	0	1	1
28	1	1	1	0	1	1
29	1	1	-1	0	1	1
30	1	1	1	0	-1	1

Given that 1 = to increment corresponding positive octants; 0 = no increment; -1 = negative octants,

M1 = SAM – Pleasure

M2 = SAM – Arousal

M3 = SAM – Control

M4 = Ten Emotion Heuristics

M5 = Number of errors

M6 = Discourse of the Collective Subject