Analysing Formal Visual Elements of Corporate Logotypes using Computational Aesthetics

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Dedicated to Jennifer, Alexander and

of course, Raphael.

Contents

Abstract

The marketing mix contains a significant proportion of elements that derive their appeal and effectiveness from visuals. This thesis proposes the application of quantitative measures from the literature on computational aesthetics to evaluate and study the formal characteristics of corporate visuals in the form of logotypes (logos). It is argued that the proposed approach has a number of advantages in terms of efficiency, consistency and accuracy over existing approaches in marketing that rely on subjective assessments. The proposed approach is grounded on a critical review of a diverse literature that encompasses Marketing, Art History and Philosophy, and, Visual Science and Psychology. The computational aesthetic measures are framed within the construct of Henderson and Cote (1998) and van der Lans et al. (2009), in order to analyse brand logo design elements along with their effect on consumers. The thesis is underpinned by three empirical studies.

The first study uses an extensive set of 107 computational aesthetic measures to quantify the design elements in a sample of 215 professionally designed logotypes drawn from the World Intellectual Property Organization Global Brand Database. The study uses for the first time an array of different measures for evaluating design elements related to colour that include hue, saturation, and colourfulness. The metrics capture both global design features of logos along with features related to visual segments. The metrics are linked to logo elaborateness, naturalness and harmony, using the theoretical framework of Henderson and Cote (1998). The results show that measures have a very diverse behaviour across metrics and typically follow highly non-normal distributions. Factor analysis indicates that the categorisation of the measurements in three factors is a reasonable representation of the data with some correspondence to the dimensions of elaborateness, naturalness and harmony.

The second study demonstrates that the proposed computational aesthetic measures can be used to approximate the subjective evaluation of logo designs provided by experts.

Specifically, eight design elements for the sample of 215 logos, corresponding to harmony, elaborateness and naturalness, are evaluated by three experts. The results show for the first time that computational aesthetic measures related to colour along with other measures are useful in approximating subjective expert reviews. Unlike previous literature, this research combines both standard statistical methods for modelling and inference, along with more recent techniques from machine learning. Linear regression analysis suggests that the objective computational measures contain useful information for predicting proxy subjective expert reviews for logos. Model accuracy is substantially improved using neural network regression analysis based on Radial Basis Functions.

The last study examines the role of consumer personality traits as moderators of the effect of perceived logo dynamism on consumer attitude towards the logo. One hundred and twenty-two participants were asked to evaluate elements of logo design (visual appearance, complexity, informativeness, familiarity, novelty, dynamism and engagement), their attitude towards the brand and their personality traits (sensation seeking, risk taking propensity, nostalgia and need for cognition). The estimates extracted were shown to vary significantly in terms of central tendency and dispersion and mostly follow non-normal distributions. Following Cian et al. (2014) the moderated mediator model by Preacher and Hayes (2008) is applied to test the suitability of personality traits as moderators of the effect of logo dynamism on attitudes towards the logo. The personality traits used as moderators are Need for Cognition and Risk-Taking Propensity, whereas Engagement was used as a Mediator. This is the first study to employ personality traits as moderators in such a study using this methodology. The results offer limited support of the role of personality traits as moderators in this relationship. Therefore, the study strengthens the case for the development of objective measures of visual characteristics.

The working hypothesis in the thesis is that, with the help of computational aesthetic measures, marketing visuals such as corporate logos, can afford themselves to a consistent quantitative approach which can prove to be important for researchers and practitioners alike. By being able to group and measure the aesthetic differences, similarities and emerging patterns, access is gained to a new family of metrics, which can be applied to any type of logo across time, product, industry or culture.

Chapter 1. Introduction

1.1 Thesis Background

The complexity and interrelations of the pictorial elements within marketing communications call for an approach that stems from very diverse theoretical and methodological standpoints and is informed by various disciplines (MacInnis and Jaworski 1989). Within the past fifteen years, the processing of visual information from marketing visuals has been receiving increasing attention in literature with the emergence of new theories in neuroscience (Milosavljevic and Cerf, 2008) and cognitive psychology (Kress and Van Leeuwen, 2006; Maes and Schilperoord, 2008; Yus, 2009; Gkiouzepas and Hogg, 2011; Lagerwerf, van Hooijdonk and Korenberg, 2012). For the most part of the literature in marketing studies addressing the visual elements in marketing communications (e.g., corporate visuals, product advertisements, advertising banners etc), the focus is on the analysis of the stimuli after they have been conceptualised by the brain (e.g., concrete objects or products and their connotations and narratives). Nevertheless, the formal pictorial elements of the image, i.e. the size, colour, line, space, texture and shape, interact with the eye before the brain can register what the content or the intent of the image is. The formal pictorial elements constitute the first contact point between the brand or product and the consumer and are pre-attentively processed within less than one second of exposure to a visual scene (Quiroga et al., 2008).

In the existing literature, there has been a long debate over the mechanisms that shape the response of consumers to marketing imagery. Developments in both psychology and neuroscience, which investigate the ways by which visual information is processed, have largely influenced this debate. For decades one of the major issues between opposing theories is whether visual processing and attention capture is organized in a bottom-up or top-down manner. In other words, is the visual perception process driven by the information provided in the formal sensory data? Or, is it dependent on contextual information and prior expectations of the viewer? Recent studies have shown that it is most likely that both types of processing take place but on a different level. Theeuwes (2010) maintains that visual selection is entirely stimulus-driven during the first scan of the visual field, and only at a later stage does it become influenced by top-down processing. He also arrives to the conclusion that salient features of the objects establish an initial selection priority that cannot be altered by top-down knowledge. These findings are deemed very important for key elements in the success of marketing communications relating to attention capture and retrospective (RM) and prospective memory (PM) effects of engaging with images.

In the stream of the marketing literature studying advertisements, three key elements which impact attention have been identified: brand, pictorial and text. Following a study of 1,363 printed advertisement conducted on 3,600 consumers, Pieters and Wedel (2004) concluded that between these three elements, the pictorial has the highest impact on attention capture to the entire advertisement, regardless of its size. The *"superiority effect"* of image over text has been extensively analysed in the literature (e.g., see Paivio, 1969, 1990; Nelson, et al., 1976; Childers and Houston, 1984; Unnava and Burnkrant, 1991; Leong et al., 1996; Singh et al., 2000; Fink et al., 2012).

Singh et al. (2000), in particular, have drawn attention to the difference between the low sensory level processing of an uninterested reader, and the more semantic level of processing of a reader who is already interested in buying the advertised product. According to their research, the low sensory level processing 'is more conducive to learning pictorial than verbal material'. For Fink et al. (2012), the role of semantic processing is significantly diminished when considering the advantage of pictures over text, and, in line with Nelson's *Sensory Somatic Model*, pictures are considered to have '*greater visual sensory distinctiveness than words*'.

This thesis focuses on the specific type of processing which treats formal elements of images as primal visual stimuli. A chosen sample of corporate visuals is analysed through the application of computational aesthetic measures and their quantified formal characteristics are then compared to subjective assessments by humans. A retrospective examination of the basic formal principles that govern the designing aesthetic of visuals, in a wide spectrum of areas such as painting, graphic and industrial design, suggests the existence of many overlays between such principles. By developing a computational framework and validating its effectiveness on identifying marketing visuals using concordance measures, this thesis aims to contribute to the objective measurement, analysis and study of marketing visuals. The primary motivation for this research stems from the simple observation that the digitization of marketing communication has led to an abundance of visual communication, which makes the task of assessing its effectiveness overwhelming. The research objectives and implications, as well as its targeted audience, are discussed in the sections that follow.

1.2 Research Scope

The primary goal of this thesis is to enrich the methodological toolbox of consumer researchers for the analysis, documentation as well as the categorization of the different functions of formal visual elements within marketing communications imagery. This can be used to analyse the formal visual characteristics of marketing visuals. In addition, the proposed methodology aspires to simplify measurement problems of the purely formal aesthetic aspect of images, which cannot be easily evaluated in an objective and consistent manner within the marketing literature. The development of objective measures can shed some light, also, on the possible effects of the formal visual elements of corporate logo on brand affect. By facilitating the recognition and classification of elements which could enhance the effective reach of corporate branding and advertising, this research also attempts to address a significant problem of contemporary marketing research: cutting through '*competitive clutter*' (Davenport and Beck, 2001; Pieters, Wedel and Zhang, 2007).

The objective is to use a family of techniques in a new context in order to operationalize visual features of corporate logos. This will be assisting researchers in identifying, isolating and describing the systematic characteristics of marketing visuals and help in examining recurrent patterns that may govern their formal aesthetic. Computational aesthetic measures will be used as a tool to provide precise values of each of the formal features. The objectivity of algorithmically extracted visual features presents the additional advantage of enabling the possibility of consistently applying specific measurements to any type of corporate visual, regardless of medium or context. This approach will assist researchers to sort and classify large numbers of individual images. The use of computational aesthetic measures will allow researchers to explore and identify large or small scale systematic visual patterns across large sets of corporate logos and examine how they have evolved across time, industry and product.

This thesis addresses three key challenges: First, considering the issue of how visual aesthetic concepts and perceptions can be operationalized in objective measures. Second, assessing their validity in drawing attention to specific formal features of corporate logos. Third, investigating what is the link between quantified formal elements and visual information functions encapsulated on the corporate visual.

To address these issues, the following research questions are considered in the context of this thesis:

i. How can the field of computational aesthetics contribute to identify, classify and analyse the formal characteristics of corporate logos?

   a. How can formal elements of corporate visuals be identified using implicit measurements?

   b. What conclusions can be drawn about the validity of these measures and how do they relate to the way visual elements are evaluated by expert raters?

ii. What can art history and aesthetics tell us about the approaches used diachronically for addressing any type of imagery, what appeals most to the eye, which visual elements are believed to increase image appreciation and how they are organized within the corporate visual?

   a. Has this information been used in the past in a consistent and systematic manner in the creation of corporate logos?

   b. What is the input of disciplines like psychology and neuroscience concerning image preferences, visual processing and image analysis?

iii. Can a quantitative analysis of the formal characteristics of corporate visuals potentially contribute to the investigation of links between corporate imagery form, brand, corporate identity, environment and context?

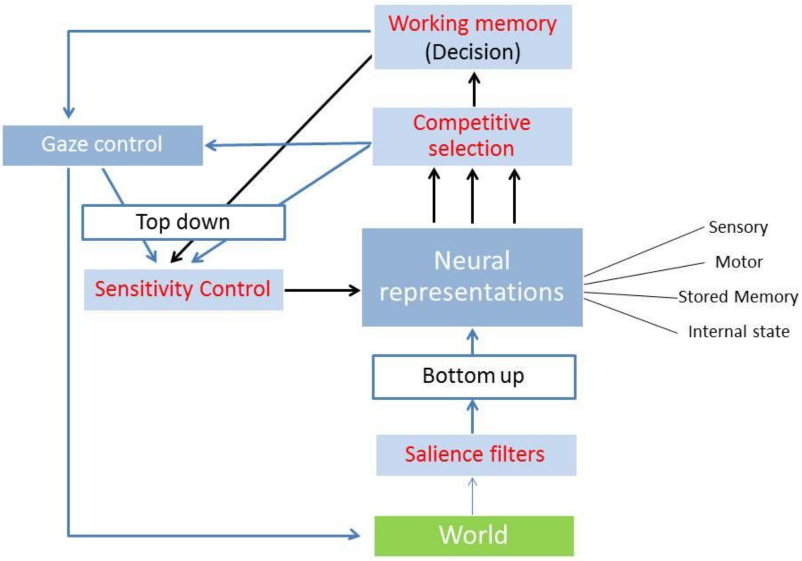
Computational aesthetic measures can be used to quantify the aesthetic elements of JPEG images of any type of corporate visual: logos, advertisements, product packaging etc. of all styles and time periods. The quantified characteristics of form are then related through statistical techniques to the responses of selected groups of participants to determine patterns of regularities and evaluate if the results are verified. A formal analysis is expected to locate any systematic variations or patterns that may exist.

As such, the results of this study are envisaged to yield substantial information on the ways in which consumers interact with the visual stimuli, and how these elements are or can be put into use to enhance the reception of any message. In addition, it offers a systematic record of practices and trends in the form and style of corporate visuals, which could assist in putting together a visual vocabulary in re-occurring situations.

1.3 Research Approach

As it was mentioned earlier, the primary goal of this thesis is to investigate the impact of the elementary formal visual characteristics of a corporate logotype on the processing functions which take place when a consumer first encounters it. One of the most important concepts, central to this research is the issue of stimulus-driven processing. This study considers the debate between top-down and bottom-up visual processing and focuses on identifying, classifying and evaluating the visual characteristics that can be detected during the early stages of bottom-up processing, and contribute to the engagement with an image. Knudsen (2007) identifies working memory, competitive selection, top-down sensitivity and bottom-up filtering for salience stimuli as the four component processes that are fundamental to attention, which according to marketing literature is one the most important components towards brand affect. As shown in Knudsen (2007) and depicted in Figure 1.1, the model for attention which is based on the work by Desimone & Duncan (1995) and Miller & Cohen (2001) shows the salient visual features which are identified in early bottom up processing and can gain access to working memory.

Figure 1.3.1. Model for visual attention (Knudsen 2007)



In Figure 1.3.1. those processes that contribute to attention are shown in red. Information about the world (green rectangle) is received by the nervous system and is processed by salience filters that respond to important stimuli (bottom-up). This thesis focuses on the study of the early stages of visual processing and works under the hypothesis that certain formal characteristics of corporate logos are important for capturing attention which in turn has an impact on affect, and therefore, on the way consumers visually engage with marketing visuals.

This thesis strives to provide a deep understanding to both researchers and practitioners of how objective measures can be developed for the evaluation of corporate visuals, and to some extent other forms of visual imagery that are prevalent in marketing communications. Thus, the approach selected for this study, includes the investigation of the related theory from the field of visual aesthetics to inform the development of objective measures as a basis of predicting cognitive responses from consumers and experts in corporate imagery. The development of the theoretical framework is the cornerstone of this thesis which can allow any predictions to be measured in terms of accuracy and external validity (Ghauri & Grønhaug, 2005). As such, the methodology that will be followed through this dissertation will encompass:

a. *Research Synthesis from relevant fields:* The thesis will be informed in providing a theoretical framework by research in the fields of visual aesthetics, art history and neuroscience to provide an outline of the requirements for developing objective measures of corporate visuals.
b. *Image processing and Binary Content Analysis:* The thesis will provide an interlinking between the various families of available algorithms and calibrate their design elements against the theoretical framework synthesized from the prior literature.
c. *Inter-rater agreement and concordance measures:* The thesis will make use of an expert panel recruited with the help of a market leader in the field of corporate marketing communications to inform and validate the objective measures developed in the previous steps.

As such, the methodology of this thesis is based on a quantitative approach for the analysis of corporate visuals through numerical data obtained by computational aesthetic measurements.

1.4 Targeted Audience and Structure of Thesis

The target audience is located at the intersections of marketing and data analytics and in particular those researchers and practitioners who are engaged with evidence-based or data-driven marketing decisions. Researchers in these fields have identified issues related with the development of objective measures to drive corporate marketing communications spending (Lehmann, 2004). On the other hand, designers of corporate visuals often lack feedback and evaluation mechanisms that can provide an accurate representation of the engagement of their productions. Been able to rely on objective measures rather than normative approaches of *test and succeed/fail*, can greatly enhance corporate workflows and customer satisfaction (Stern et al., 2001).

This thesis encompasses five chapters, which are outlined as follows:

- *Chapter 1. Introduction.* The current chapter, which provides the general background to the thesis along with the scope, approach and structure.
- *Chapter 2. Literature Review.* A critical examination of the research that guides the analysis of corporate visuals is provided. This review is informed by two main streams of analysis for visual elements: Art History and Philosophy (in particular the field of Visual Aesthetics) and Vision Science and Psychology (where aspects such as affect, attention capture, memory and recall are discussed).
- *Chapter 3. Methodology.* This chapter begins by laying the foundations for the development of formal measures for image analysis in marketing. A critical discussion of the use of the formal features as variables in assessing the impact of corporate visuals is provided along with an outline of objective measures. Finally, this chapter outlines the methodological techniques that will be used in the subsequent empirical analysis.

- *Chapter 4. Empirical Analysis*. This contains three empirical studies. First, the proposed set of computational aesthetic measures is estimated and studied for a sample of corporate logos. Second, these computational aesthetic measures are used to explain subjective ratings of design elements by experts for the sample of logos. The final study examines if the effect of logo design elements is universal across consumers with different personality characteristics.
- *Chapter 5. Conclusions.* This concludes the dissertation by outlining the contribution, the limitations of the research approach and external validity of the results. An outline for possible applications for future research is also provided.

Chapter 2. Literature Review

2.1 The Pre-eminence of the Visual

In his book *Image by design* published in 1991, C. Chajet draws attention to the fact that the design systems used to project corporate marketing and branding messages represent the *single most significant capital expenditure* associated with the implementation of these projects (Chajet, 1991). Financial reasons aside, there is considerable agreement that a variety of features of corporate visuals interact with the way corporate messages are transmitted and received.

A comprehensive analysis of these messages would necessarily involve, at some stage, examining the core elements by which they are synthesised. In order to examine fundamental models in marketing and branding message transmission, we need to be able to analyse the core components of brand-related stimuli that are part of a of an organization's design and identity: products, packaging, communications, and environments. Brand-related stimuli include colours, shapes, typefaces, designs, slogans, mascots, brand characters and general environments, corporate and commercial, where brand experiencing can occur. They work as corporate visual cues, projecting the organizations image to all stakeholders. They can be accessed directly, through physical contact with a product/service/environment, or indirectly when a product/service is presented virtually or in an advertisement (Brakus et al., 2009).

Identifying the reasons behind the selection of each visual stimulus, can provide a better understanding of the intentions and contents of each corporate communication effort. Yet, most importantly, it is necessary to understand their vital significance as a communicating tool.

There is a general consensus that most human meaning is shared visually (Patterson, 1991). Mehrabian (1971) indicated that only 7% of the meaning in any message is contained in verbal language, and approximately 93% is communicated non-verbally. Birdwhistell (1970) reported that words convey no more than, a surprising, 30% of the meaning in a social exchange, while Weisser (1988) reached a similar conclusion, stating that approximately 80% of human communication is nonverbal. Ultimately, according to Knapp (1980), when it comes to matters of persuasion, in the presence of doubt or inconsistency, visual cues are always more likely to be believed over verbal ones.

When comparing different sources of sensory stimuli, the dominance of visual sources has been consistently supported through various experimental manipulations. Colavita (1974), Colavita et al. (1976) and Colavita and Weisberg (1979) have drawn attention to the phenomenon of *visual dominance*, which has been supported since its conceptualization by a plethora of research. Hecht and Reiner (2009), in summarizing the research on sensory dominance of combinations of stimuli (visual, audio and haptic), concluded that the "*Colavita effect*" is a robust phenomenon which is persistent even after doubling the subjective intensity of other stimuli, whether auditory responses were slower than visual responses or vice versa (Koppen and Spence, 2007). This was evident in both simple and more complex detection tasks (Sinnett et al. 2007).

Recent research has confirmed that visual information often received preferential processing and eventually dominated awareness and behaviour when multisensory information arrived synchronously at our receptors. Even more importantly, Li et al. (2017) indicated that visual information was preferentially processed within the motor system and that visual dominance was sustained even irrespectively of the semantic congruence/incongruence between stimuli (Koppen et al., 2008).

This pre-eminence of the visual has not been ignored by marketing and branding professionals. Corporate visual imagery is continuously used in messages to change or strengthen an organization's general image and promote or differentiate its products. Brand related imagery is comprised of, both, pictorial and textual elements. Both elements perform specific functions in their use within different contexts of corporate visuals, such as brand identifiers, advertisements and webpages. However, throughout the study of visuals a clear "*superiority effect*" of image over text emerges.

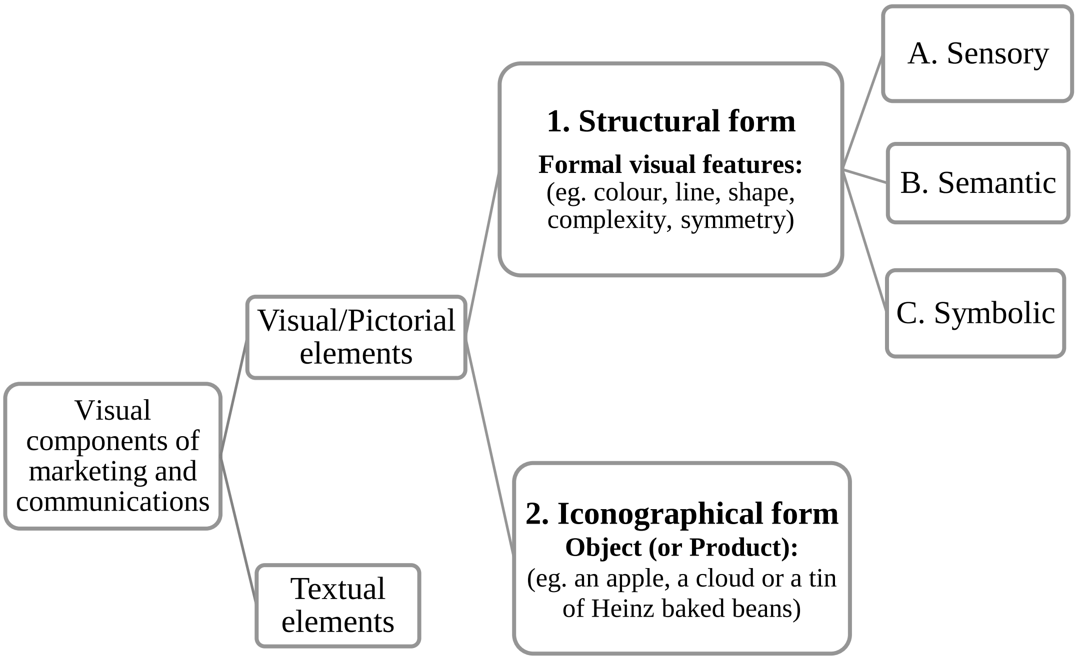
The picture superiority effect theory was founded on the research developed by Paivio (1971), Paivio & Csapo (1973), Colavita (1974), Nelson, Reed & Walling (1976), and Weldon & Roediger (1987), and revisited by McBride & Dosher (2002). Paivio's dual coding theory, in particular, has been extremely influential. Concurrently with the experiments performed by Colavita, a significant bias towards the visual sensory modality is supported. According to Paivio's theory, images present a clear advantage over words, because they enable semantic encoding to happen through two different pathways: *when people process an image, they do not only address the visual elements, but at the same time, automatically, the visual elements make them verbalize the information they are seeing*. The theory is based on the idea that this dual coding accelerates the access to the sematic store and increases the strength of encoding, thus significantly aiding recall. Paivio & Csapo (1973) have shown that recall is generally higher for items presented as pictures than for items presented as words. Also, the visual system can process information in a holistic way (Paivio, 1990) and impact affective-emotional reactions more directly (Paivio, 2007). Dual coding theory suggests that the presence of any relevant visual cues significantly increases the potential for learning and recall.

Further support to the conclusion that pictures show superior recognition results compared to their verbal labels comes from Nelson's Sensory-semantic model (1979). Nelson's model suggested that the pictorial superiority effect *"is related to the qualitative superiority of the sensory codes for pictures"*. Contrary to Paivio, Nelson's (1979), and later, Weldon's (1987) models distinguished between conceptual and perceptual processing of pictures and words (process disassociation) and suggested that pictures directly activate a meaning code, while words work indirectly, through phonetic representation. Nelson's model was more generic in its application, while Weldon's model supported evidence that process disassociation can be task specific. In another study, Weldon & Roediger (1987) reach the conclusion that, overall, pictures elicit more conceptual processing than words, and for this reason they result in better performance on tasks that require conceptual processing, such as recall and recognition. Similarly to Weldon & Roediger (1987), McBride & Dosher (2002) suggested that information received from pictures engages deeper levels of processing, thus, when pictorial and verbal information is compared in recall tasks, pictures present a significant advantage. In turn, Kiselious (1982), based on the information processing theory in consumer research by Bettman (1979), suggested analyzing media selection decisions in terms of the differential processing capabilities of the presentation formats of pictures and sentences.

Naturally, the complexity and interrelations of pictorial elements within any type of marketing visual can be discussed from very diverse theoretical and methodological standpoints (MacInnis & Jaworski 1989). At the same time, there is often a dichotomy of opinions for which specific elements an analysis should focus on. Especially in recent marketing literature, when addressing marketing visuals, the majority of researchers tend to analyse visual stimuli after they have been conceptualised by the brain. They address their iconographic form within a corporate visual as an actual object (e.g. an apple or a cloud) or a product (e.g. a tin of Heinz baked beans) and then their connotations and narratives are discussed. Justly, all aspects of corporate visuals are viewed as, or expected to be, informational statements about brands: *"communicative artefacts functioning in a manner analogous to a writing system*" (Scott and Vargas 2007). However, these informational statements contain several elements which can receive various levels of analysis.

Accordingly, when looking at the literature concerned with the formal analysis of corporate visuals, two major research streams can be identified: The first one deals with the structural form of pictorial elements (colour, shape, size etc.), and the second one with their iconographical form, as analogues to objects. As can be seen in an overview of the research path of this thesis (Figure 2.1.1.), the focus here is on the structural form of pictorial elements in corporate visuals (1). Their purely formal elements can be addressed, in turn, as sensory, semantic or symbolic cues; often standing alone or as cues contributing to the structure of more complex arguments, corporate logos, as the most characteristic formal pictorial elements of corporate visuals will be addressed.

Figure 2.1.1. Research path of the thesis for the analysis of visual components



Although informed mainly by the first line of thought, this thesis, does not refute or exclude the second. It aims at contributing to further understanding and quantifying a specific part of the process of engaging with marketing visuals: the interaction that takes place during the first encounter with the elementary blocks of any marketing and corporate visual. The formal visual elements which operate as corporate visual cues are seen as the initial contact point between company, product and consumer.

Whether relying on explanations that support dual coding theory or process dissociation models, the picture over text superiority effect has been consistently demonstrated throughout the literature. Marketing research, recognising the importance of the picture superiority effect, has sought to incorporate these findings in a number of studies with different starting points. One of the most significant elements of these studies is the importance that information processing holds for marketing, as it links directly to insights on consumer behaviour. Research on functions such as attention capture and subsequent effects of memory and recall have often appeared in marketing literature and their importance is highlighted by both academics and practitioners. Pieters and Wedel (2004, 2007) and Milosavljevic and Cerf (2008) have identified attention capture as one of the predominant functions for marketing literature when analysing marketing visuals. The ways by which visual characteristics affect attention, has also investigated several visual features, their significance for attention capture and the extent to which they can affect consumer behaviour (Gorn, Chattopadhyay, Yi and Dahl 1997; Janiszewski 1988, 1993). Rosbergen, Pieters and Wedel (1997) were among the first ones to demonstrate that attention can result to an increase of sales through brain mechanisms that influence memory. Nevertheless, as has been discussed above, the exact processes behind these functions have been the subject of much controversy between researchers. Henry Roediger (1990) used as a starting point Ebbinghaus's (1913/1964) influential experimental study on human learning and memory, in which he outlined the existence of distinct forms of memory. Roediger supported the view that in many of the skills that humans acquire, conscious memory is not likely to be necessary. Despite the initial assumption in the relevant literature that perceptual (data-driven) and meaningful (conceptually driven) modes of processing are directly associated respectively with the declarative/explicit and procedural/implicit memory systems, Roediger (1990) suggested that it is 'perfectly possible to develop explicit memory tests that rely on perceptual (data-driven) information'. In other words, data-driven information can have an impact on both implicit and explicit memory systems. Robert Zajonc's (1968) seminal research had looked into the relationship between explicit and implicit memory, suggesting that mere repeated exposure of visual stimulus, enhances attitude toward it, thus linking visual stimuli with 'attitudinal liking'. Both Roediger's and Zajonc's research was very influential for marketing research (especially advertising) and can justify an interest in achieving objective, quantifiable information about various types of visual stimuli, in order to be able to evaluate and analyse more effectively their effect on attention, retention and attitudes. Interestingly, the majority of these studies, also prioritizes the effect of visual over textual information. Collectively they outline a critical role for visuals in theoretical models of marketing literature.

At the outset, the following section aims to provide an overview of how visuals have been addressed within a marketing and branding context. A detailed account of the approaches for analysing marketing and branding visuals is presented. The development of concepts such as ‘corporate image’ and ‘corporate identity’, and their reliance on the visual aspect of communication, will be discussed. Furthermore, the disciplines which have provided the theoretical background for the analysis of corporate imagery, and their contribution to the creation of different narratives, will be outlined. Subsequently, in the following chapter, the most influential studies of visuals for marketing, branding and consumer research will be analysed and the efficiency and consistency of their measurements within this context will be discussed.

2.2 Corporate Visual Imagery, Marketing, Branding and Design

In 1989 W. Olins, the renowned corporate identity and brand consultant, published one of his most influential books entitled: *Corporate Identity: Making strategy visible through design*. Indicative of the importance he attributed to the visual aspect of corporate communications is the following quote:

> "*Most people think that corporate identity is about symbols, logotypes, colours, typography, even about buildings, products, furniture, about visual appearance, design. And it is*"
>
> (Olins 1989, p. 78).

Similarly to the concept of corporate identity introduced by Lippincott and Margulies (1957), Olins focused on the visual elements of corporate identity. His insights on the marketing and communications industry were part of a driving force which prompted an English corporate marketing revolution (Malewar 2001). His work influenced generations of corporate identity scholars and practitioners who fostered the emergence of an academic field of research on corporate marketing. Bernstein (1984) argued for the corporate-level to be emphasised within the strands of marketing; Schmidtt (1995) following the same concept, built extensions to corporate culture, behaviour and communications, and van Rekom (1997) advocated for 'centrality' in the operational conceptualization of corporate identity, to facilitate its use for corporate communication.

At the same time, Balmer (1995, 1998) begun describing a new identity type, which, ultimately led to the establishment of corporate marketing in the late 1990s: the corporate brand. Most importantly, this idea contributed to a new mind-set, focusing on the importance of looking holistically at the visual communication tactics of organisations. As Abratt (1989) persuasively stated, the visual system which a company uses to communicate its identity *"is the outer sign of its inward commitment*". This approach to the corporate identity of an organization made it clear that it can have both internal and external effects (Baker and Balmer, 1997), influencing employees, customers, and investors, while representing an asset which needs to be managed at the highest level (Anson 2000). Abratt's summing up of the various emerging definitions had previously pointed out the obvious relationship between the concepts of "corporate identity", "corporate image" and "corporate personality". He extensively referred to the abundance of definitions in the literature, and went on to propose how the terms could be used more accurately:

> "*Every company has a* <u>*personality*</u>*, which is defined as the sum total of the characteristics of the organisation. These characteristics — behavioural and intellectual —serve to distinguish one organisation from another. This personality is projected by means of conscious cues which constitute an* <u>*identity*</u>*. The overall impression formed by these cues in the minds of audiences constitutes an* <u>*image*</u>*."*
>
> (Abratt, 1989, p.67).

Yet, even though Abratt's discussion of the terms put the concepts in a certain perspective, it still did not provide an all-compassing definition. His insistence on the need to clarify the terminology continued to be supported in more recent literature. Cornelissen and Harris (2001) drew attention to the fact that various metaphorical, fashionable and loose uses of the terms within relevant literature and popular language have led to considerable confusion as to how corporate identity should be defined. More importantly, Stern et al. (2001) view this definitional vagueness as an obstacle in theory development, and the origin of poor measurement techniques. Balmer and Greyser (2006), and Melewar and Karaosmanoglou (2006), also asserted that, although this is an issue that occupies a large volume of the literature, a definitive construct of corporate identity and its measurements do not yet exist. In a recent study, Abratt and Mignone (2017), emphasized that, after nearly forty years of research, definitions continue to be elusive, because of the dynamic and fluid nature of these concepts and the fact that they are socially constructed.

This complicates matters on which specific elements are treated and analysed each time a researcher addresses relevant issues. It is, therefore, essential to elucidate what will be the point of intersection of this research with the existing literature and precisely how various terms will be used. For this reason, it would be necessary to clarify how some of the terminology has been used in research so far. Indeed, numerous researchers have pointed to the overlapping, even confusing and interchangeable meanings and usage of terms like “corporate image”, “corporate identity” and “corporate personality”. There seem to be no universally accepted definitions. To further illustrate this confusion, Tables 2.2.1., 2.2.2. and 2.2.3. quote several definitions and descriptions proposed in the literature for the above-mentioned concepts. As will be discussed to a greater extent below, these definitions subscribe to different paradigms for the analysis of the concepts and, thus, concentrate on different components as the focus of their analysis. Initially, the timeline for different paradigms seemed to progress linearly through time: emphasis from design paradigm gradually shifted to paradigms including a (visual and non-visual) single image of the organizational culture and then a mix of multiple corporate cultures within an organization. Yet, in more recent literature, the design paradigm keeps re-emerging, either as a core component of corporate expression or an indispensable tool for sensory marketing. There is a range of reasons why the visual aspect could never really be displaced from the conversation. However, before these reasons are discussed in detail, it is important to have a clear overview of how relevant terms have been addressed so far.

Table 2.2.1. Concept of Corporate Identity

Year	*Author*	*Definition/description of corporate identity*
1975	Selame and Selame	*'The corporate identity [...] is all planned and all visual […] (It) is the firm's visual statement to the world of who and what the company is—of how the company views itself'.*
1978	Olins	*'Corporate identity is about appearance. […] The tangible manifestation of a corporate personality is a corporate identity. It is the identity that projects and reflects the reality of the corporate personality'.*
1983	Anspach	*'Corporate identity is the total presentation of an organisation—the sum of all the elements that make (it) distinctive'.*
1983	Lee	*'The corporate identity is the 'personality' and 'soul' of the corporation'.*
1984	Topalian	*'An organisation's corporate identity articulates what the organisation is, what it stands for, and what it does'.*
1984	Bernstein	*'Corporate identity [...] is the sum of the visual cues by which the public recognises the company and differentiates it from other(s)'.*
1986	Downey	*'Corporate [...] identity in its most basic sense […] is the fundamental style, quality, character and personality of an organisation, those forces which define, motivate and embody it'.*
1986	Lux (Cornelissen and Harris 2001)	*'Corporate identity is the expression of the personality of a company, which can be experienced by everyone. It is manifested in the behaviour and communication of the company, and in its aesthetic, formal expression'.*
1991	Chajet and Shachtman,	*'[…] is what (a corporation) choses to use to shape (the) perceptions (of its various audiences)'*
1994	Dowling	*'[…] the symbols an organization uses to identify itself to people'.*
1995	Blauw	*'[…] the total of visual and non-visual means applied by a company to present itself to all its relevant target groups […]'*
1995	Balmer	*'[…] this is what the organization 'is', ego its innate character. Everything an organization says, does and makes impacts upon an organization's identity […]'*
2001	Cornelissen and Harris	*'Corporate identity is not only an image, i.e. visual design and communication, but is also fundamentally concerned with "what the organisation is", the strategies and culture specific to an organisation in particular'.*
2003	Bick et al.	*'(Corporate) identity is the embodiment of the organisation. It is the communication (via visual and behavioural media) of the core values, philosophy and strategy of the organisation through the delivery of its products and/or services'.*
2012	Abratt and Kleyn	*'The corporate identity of the organisation is concerned with what the organisation is and what it seeks to be, and comprises two parts. First, the strategic choices made by the organisation […] and, secondly the corporate expression, which is also part of the corporate brand'.*

Table 2.2.2. Concept of Corporate Image

Year	*Author*	*Definition/description of corporate image*
1967	Bevis	*'Corporate image is the net result of the interaction of all the experiences, beliefs, feelings, knowledge and impressions, that people have about a company'.*
1975	Selame and Selame	*'[…] is composed of all planned and unplanned verbal and visual elements that emanate from the corporate body and leave an impression on the observer'.*
1984	Topalian	*'[…] of an organisation is the profile—or sum of impressions and expectations of that organisation built up in the minds of individuals who comprise its publics'.*
1985	Gray and Smeltzer	*'(It is) the impression of the overall corporation held by (its) various publics. The image that each public has of the corporation determines, to a large degree, the success of the strategy vis-à-vis that group'.*
1986	Dowling	*'An image is the set of meanings by which (a company) is known and through which people describe, remember and relate to it. That is, it is the net result of the interaction of a person's beliefs, ideas, feelings and impressions about (it). […] Corporate images are selectively perceived mental pictures about the organization'.*
1991	Chajet and Shachtman	*'[…] is what is perceived by its various audiences –how it appears to outsiders such as the financial community or to potential consumers of its products or services'.*
1995	Balmer	*'[…] this refers to commonly held perceptions of an organization by a group or groups. A corporate image can be based on belief as well as on fact. A corporate image may be positive, negative, inaccurate, etc. It is quite common for different groups to hold different perceptions of an organization'.*
2003	Bick et al.	*'(Corporate) image is the immediate impression of an organisation, whilst reputation is a stakeholder's overall assessment of the organisation's ability to meet predefined criteria (set by the stakeholder) such as integrity'.*

Table 2.2.3. Concept of Corporate Personality

Year	*Author*	*Definition/description of corporate personality*
1978	Olins	*'Corporate personality embraces the subject at its most profound level. It is the soul, the persona, the spirit, the culture of the organisation manifested in some way. A corporate personality is not necessarily something tangible that you can see, feel or touch- although it may be'.*
1988	Howard (Bick et al. 2003)	*'[...] the factor that distinguished one organisation from another. He saw corporate personality as a distinct set of characteristics that acted as a channel to bind all employees together, despite the fact that they might have different values, personalities, backgrounds and beliefs'.*
1989	Abratt	*'[...] is defined by the sum total of the -behavioural and intellectual- characteristics of an organization (which) serve to distinguish one organisation from another'.*
1995	Balmer	*'[...] the cornerstone of corporate identity formation (corporate brand management). It refers to the distinct mix of ideologies which are present within a particular organization and as such reflects the various loyalties personnel have to different cultures, e.g. organizational, departmental, professional, etc'.*
1998	Balmer	*'[...] the concept of corporate personality refers to the mix of cultures present within an organization [...]'.*
2003	Bick et al.	*'Personality is an amalgamation of all the sub-cultures that are present within an organisation'.*

A detailed analysis of the concept of corporate identity and its relevant concepts by van Riel and Balmer (1997) identified three distinctive paradigms, emphasising different aspects of the construct.

i. The *graphic design paradigm*: where corporate identity uses visual elements not only as an appealing or fashionable statement but as a strategic tool which communicates organization.

ii. The *integrated communications paradigm*: emphasising the need for consistency in corporate communications, using all visual and non-visual means, in order to project a more accurate image of the organization's personality.

iii. The *inter-disciplinary paradigm*: arguing that the issue of corporate identity lies somewhere between the intersection of corporate communications, marketing and organizational behaviour. Particular emphasis is placed in the existence of a strong association between marketing and organizational behaviour, echoing the corporate culture, or – according to Balmer (1995) and Balmer and Wilson (1998) – '*a mix*' of multiple corporate cultures present within an organization.

The graphic design paradigm appeared consistently in earlier literature of corporate identity (Selame and Selame 1975, Olins 1978, Topalian 1984, Bernstein 1984, Lux 1986, Chajet and Shachtman, 1991, Dowling 1994). The visual elements representing an organization called for consistency and coordination, in order - not only to identify it externally, but also - to project what the company really is, and what it stands for. Schmitt et al. (1995) have further developed the concept of corporate identity management by introducing the *four Ps of aesthetics management*, namely *properties*, *products*, *presentations* and *publications,* as vital elements. Their framework has paved the way for viewing corporate visual elements holistically, across all manifestations of corporate identity. Melewar and Saunders (1998) place the focal points of the design paradigm within an integrated communications model and have proceeded in identifying a corporate visual identity system (CVIS) of an organization, consisting of a cluster of five elements: name, symbol and/or logotype, typography, colour and slogan. Even when paradigms later moved the point of focus to include non-visual and strategic elements drawing from corporate communications and organizational behaviour, there is a wide agreement that visual elements have always been a vital part of corporate identity, image and personality and are to an extent "*one of the most dominant factors*" (Bartholmé and Melewar 2011). In more recent literature, the design paradigm has often resurfaced in various forms. Apart from the undisputed centrality of corporate visuals for corporate identity, there is a multitude of reasons which make the design aspect a recurring theme.

The design paradigm principally addresses an aspect which can be considered comparatively evident. When Simões et al. (2005) re-examined the design paradigm and its significance for corporate image and identity, they drew attention to the fact that visual characteristics are seen as the most consistent and "*tangible facet of corporate identity*" (p. 158). This perceived consistency seems to afford itself as a stable point of reference. Yet, as it was discussed earlier in this section, the inherent complexity and elusiveness of the concepts of corporate identity and image, support the general observation of a relative tangibility of visuals. Though they appear to be more tangible than other aspects, visuals per se, and their specific areas of performance, are quite problematic to describe and measure. One major issue is the question of aesthetics, and the extent of objectivity or subjectivity with which they can be addressed. Still, an extensive number of researchers agree that corporate visuals function as important cues which drive consumer behaviour (Bloch, 1995; Henderson and Cote, 1998; Bloch et al., 2003; Muller et al., 2013). In particular, the factor of perceived attractiveness addresses the aesthetic and hedonic aspect of visuals (Van den Bergh and Vrana, 1998; Reber, et al. 2004; Dhar and Novemsky, 2008), and the factor of their perceived strength of design considers issues pertaining to their attention driving and utilitarian value (Janiszewski and Meyvis, 2001; Page and Herr, 2002; Bafna, 2008).

While looking at how aesthetics affect consumer behaviour, Chernev (2004), Horsky and Honea (2009), Batra et al. (2009) and Giese et al. (2014) have revisited the counter-intuitive theory of the aesthetic middle, which posits that visuals which are moderately attractive cause more positive reactions to consumers, than visuals of higher or lower aesthetic appeal. Their research has uncovered several trade-offs between design attractiveness and strength depending on consumers' predetermined hedonic or utilitarian goals. In contrast, research from Bloch et al. (2003), and Creusen and Schoormans (2005) supports the hypothesis that aesthetic attractiveness is positively associated with purchase intentions, especially in cases where designs appear to be of a similar utilitarian value (Kotler and Rath, 1984). A critical issue throughout the literature, appears to be how to determine, rank and classify concepts such as aesthetic appeal or attractiveness. In order to achieve an objective and quantifiable answer, which could serve as a tangible value, relatable to other markers of consumer behaviour, it is essential to understand the multitude of concepts that the word aesthetic itself encompasses.

Nevertheless, the conceptual density surrounding the field of aesthetics deducts nothing from their significance as corporate tools. On the contrary, it presents researchers with the opportunity of multiple levels of analysis and delivers versatile constructs with rich theoretical underpinnings. Though this issue will be further investigated in the following section, at this point it should be allowed that there is a standard agreement on the significance of aesthetic issues for the analysis of corporate visuals. As the most - seemingly - tangible facets of corporate identity, with definite signs of influence in consumer behaviour, the omnipresence of visuals may partly justify the unavoidable attraction of the design paradigm.

In addition, Gioia et al. (2000), argue that the increased importance of the image in the today's world, combined with the constantly shifting connections between identity and image, have altered the strategic concerns of management. Emphasis is not placed anymore in safeguarding a static corporate identity, but on the ability to navigate change. Every possible instrument must be into place in order to "*manage and balance, a flexible identity in light of shifting external images'* and to be able to evaluate as rapidly as possible the potential *'success of the projected representation*" (p.79).

The current research revisits the design paradigm of CVI, focusing on the concept of corporate visual identity (CVI), seen as part of an organizations deeper corporate identity. Emphasis is placed on the visual cues that an organization is using to project its image. Nevertheless, this research is not limited at looking at the cluster of five elements, namely: name, symbol and/or logotype, typography, colour and slogan, which form a corporate visual identity system (CVIS) according to Melewar and Saunders (1998). Drawing from the framework suggested by Schmitt et al. (1995), this thesis aspires to provide tools for researchers to address any type of visual cue that can be used to signal an organization's CVI.

A CVI which contributes to the creation of a distinct and positive corporate image is generally regarded as "*a visual common thread"* that runs through the way an organisation expresses itself (van den Bosch et al. 2006). The value of investigating in depth the concepts of CVI has received a great deal of attention from marketing academics and practitioners, as well as from researchers in organizational behaviour and strategy. Still, researchers have had a hard time reaching a consensus on exactly what elements make up the corporate identity mix (Balmer and Soenen, 1999) and where exactly CVI fits in within each construct. Even though the engagement with the various effects of marketing and communications visuals has been extensive within marketing literature, multiple analyses have identified and focused on different components (Baker and Balmer 1997). The impact and contribution of CVCs to various stages and at different levels of the corporate identity projection, strongly supports the suggestion made by Karaosmanoglou and Melewar (2006) that all these elements do not interact in an isolated environment. Moreover, their inherent composite nature indicates that a multidisciplinary approach is needed for their in-depth analysis (Van Riel and Balmer, 1997; Bick et al., 2003; Karaosmanoglou and Melewar, 2006).

Indicatively, Melewar and Jenkins (2002), attempted to provide an outline of the elements comprising the corporate identity mix. Similarly to Balmer and Soenen before them, they drew attention to the challenge of categorizing the elements of corporate identity due to the different approaches taken by researchers, the significant construct overlap, and the existence of related but distinct concepts. They saw CVI as a sub-construct of communication (and visual identity), together with corporate communication, uncontrollable communication, and architecture and location. Alternatively, He and Balmer (2007) organized the corporate identity construct by outlining four sub-perspectives: (a). visual identity, (b). corporate identity, (c) an organisation’s identity, and (d) the general organisational identity. The list of different categorizations and classifications is long and an all-embracing definition is out of the scope of this thesis.

To a certain extent, the aim of this thesis is not to untangle the semantic intricacies of terms and constructs related to corporate image and identity studies. This research chooses to focus on one single component: the purely visual elements that serve as cues of CVI wherever they may be present. Further emphasis is placed on logotypes, which will form the basis of the empirical examination. They are seen as the most important element of corporate visuals, as they represent a concentrated visual form of the essence of what an organization wants to convey to their audience. While supporting the theoretical diversity surrounding the field, this thesis calls attention to the fact that corporate visual cues (CVCs) are present in every visual that an organization uses to signal its identity, regardless of methodological approach. Throughout this research, the term visual identity refers to the synthesis of CVCs that a company marshals as part of any communication policy, epitomised by their logotype. Even though CVI includes the organisation's name, slogan, colours and everything else that is related to visual design, the logotype is almost invariably present in the marketing mix and relates to a variety of CVCs which need to be managed at all stages. In order to comprehend the role of CVCs within the marketing mix, it is important to discuss the significance of managing CVI.

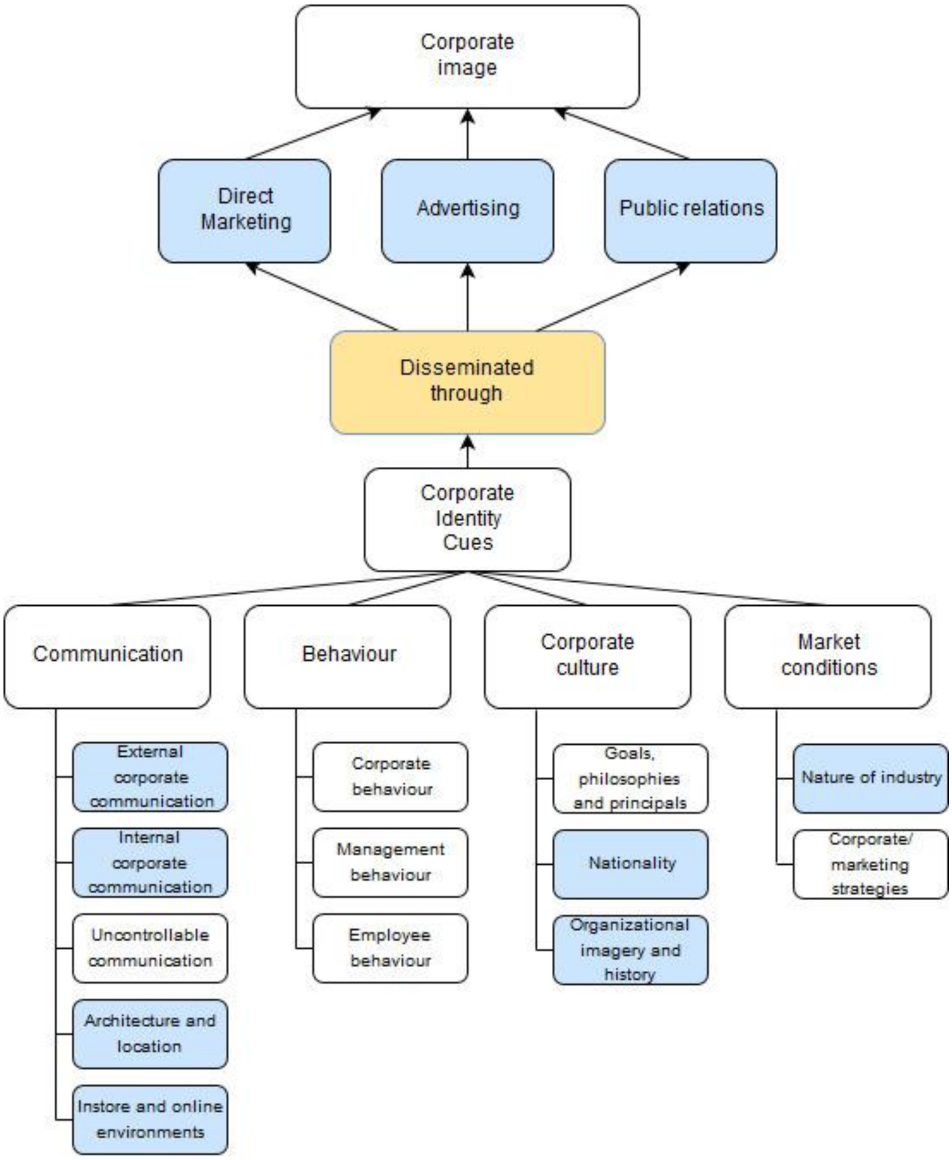
Therefore, the following question arises: *Why is it so important to be able to manage CVI?* For one, the importance of CVI's implications for corporate communications have been well documented in relevant literature. More specifically, CVI is seen as having four primary functions: a. to provide visibility and recognisability, b. to construct the symbolic form of an organization for all external and internal stakeholders, c. to express the structure of an organization and d. to strengthen employee identification with the organization. All four functions have profound implications for elements which fall at the heart of all communication efforts (marketing, advertising and branding alike): image and reputation, memory and attention, likability and affect.

Secondly, as it is briefly mentioned earlier, it is widely acknowledged that the concept should be central to the formulation of an organization's marketing strategy. This view is further supported by Abratt and Kleyn (2012), who argued that visual identity is also part of the corporate brand, as it forms part of what they termed *'corporate expression'*. They specifically addressed this issue by stating that a *'distinctive and well communicated visual identity is […] an important anchor that enables stakeholders to associate an experience with a specific brand, and over time, to build a perception of the organisation's reputation'*. Admittedly, an organization's CVI can become a powerful communicator, relevant to numerous sources of corporate identity messages. These sources embrace all company, formal and informal, internal and external forms of communication. This, also supports the conclusion that experiences across stakeholder groups, and not only customers, '*need to be designed, influenced, managed and monitored in order to build strong corporate brands and ultimately* *reputations'*. Thus, a carefully managed CVI system, applied with consistency and coordination, can reinforce messages and project a strong positive and beneficial corporate image (Gray and Smeltzer 1985)

Finally, more than projecting an image, CVI can help create a brand. As all company stakeholders are exposed to many brand-related cues, these experiences strengthen consumers' memories and depths of association with brands. Likewise, building on the concept proposed by Brakus et al. (2009), all CVCs in "*brand identifying colours, shapes, typefaces, background design elements, slogans, brand characters, packaging, marketing communications, and the environment in which the brand is sold*" are linked with all four dimensions of a brand experience: sensory, affective, behavioural, and intellectual (Abratt and Kleyn 2012). This research follows their argument that CVCs play a major part in forming an overall experience of a brand. Indeed, as early as in 1991, Chajet, had pointed out that, even though most people in the world of business realise that a brand image is a good thing to have, they have difficulty expressing what exactly it might do for their products. Sanford I. Weill, former chief executive and chairman of Citigroup, has managed to zero in on one of its critical functions in plain business terms: "*A good brand image can remove something from just being a commodity-type product with very narrow margins to the kind of product for which you can get premium prices*." (in Chajet, 1991, p. 67).

In the literature, most efforts to address CVI have loosely concentrated around two main constructs: (a) The relationship between strategy and CVI, or (b) The effects of CVI's visual elements. As was discussed earlier, this thesis will lay emphasis on the second construct, analysing aspects of CVI's visual form, by focusing on their most representative element: their logotypes. These visual elements are treated as cues of a brand experience which ultimately contribute to the development of a corporate image. By reducing visuals to their bare essentials, this thesis plans to access a pathway to uncover their structures and patterns, and assist classification, categorization and consistency. Having stated the complications that arise from addressing a field of multiple definitions and constructs, it is necessary to demonstrate where this research locates CVCs in the broader context.

Figure 2.2.1. Antecedents of Corporate Identity Cues



In Figure 2.2.1. we can see how various CVCs permeate the different functions which shape the corporate image of an organization. This depiction helps to clarify the many elements that need to be examined, and where they fit in the stages of formation of a corporate image. It is modelled on Melewar and Jenkins' (2002) construct, but has been extended to reflect the ways an organization communicates with various stakeholders, and how the CVCs used in this context serve as corporate identity cues to form the corporate image. It is evident that CVCs are present in many types of communication, external and internal, and across different aspects of corporate identity. The company logotypes, in particular, are omnipresent components of marketing communications, whether during direct marketing, advertising or public relations endeavours.

Figure 2.2.1. demonstrates clearly (highlighted in blue) the areas where visual elements of an organization's identity are more prominent. In addition, any marketing, public relations and advertising efforts contain elements of CVCs. With that in mind, in this research, particular weight is given on the visual cues that are used in the communications of an organization. As mentioned above, throughout this research, the term Corporate Visuals (CV) will be used in its broadest sense to refer to all visuals that contribute to the construction of an organization's Corporate Visual Image (CVI) and the term Corporate Visual Cues (CVCs) for all purely visual elements that are present in an organization's marketing and branding efforts alike.

Following the discussion earlier in the chapter, CVs are an important part of the corporate identity mix, a vital part of the company's system of communications, and can be employed across the spectre of all company visuals. As the most tangible elements of corporate identity, purely structural visual elements, are the ones that should be managed in detail (Melewar and Jenkins, 2002) so that they can afford themselves to more consistent measurements and classifications. Still, corporate imagery is a complex argument. An argument that is constructed effectively when multiple steps are understood and put into place. For that reason, it is seen as essential to be able to deconstruct corporate visual imagery with precision into its most elementary components, in order to analyse, identify, classify and relate their various features to the specific functions within the marketing and branding process.

In the previous section, the importance of engaging with the purely visual aspects of corporate imagery and the relevant literature up to date has been discussed. In the present section, the search for a coherent narrative for analysing corporate visuals has, hopefully, provided answers to some fundamental questions: First of all, why are visual elements so important that they keep re-emerging as a key reference point of corporate image and identity? Since their significance as a communicative tool has been established the following section will try to address the following questions: Which disciplines and theories have been employed for the analysis of corporate visuals and how effective have they been in covering diverse angles? Which techniques have been summoned from these disciplines for analysing the sensory, semantic or symbolic extensions of visuals? Which different starting points and theoretical approaches have researchers used for constructing narratives and examining visual element functions? How have formal features of visuals have been used in literature in assessing the varying aspects corporate visuals? And finally, the importance of efficiency and reliability in measuring elements of corporate visuals will be discussed, and the development of tools for more consistent measurements will be suggested and applied to a selection of corporate logotypes.

2.3 Art, Philosophy, Aesthetics and their application to corporate visuals

> *"Remember, that a picture, before it is a picture of a battle horse, a nude woman, or some story, is essentially a flat surface covered in colours arranged in a certain order."*
>
> (Denis M., in *Definition of Neo-Traditionism*)

This thesis focuses on the analysis of the formal design elements of corporate logotypes. A key identifying design element of an organization, the logotype stands out as the epitome of the visual representation of a brand and the most significant medium for communicating corporate identity (Schechter, 1993). The ubiquity of corporate logotypes within marketing visuals offers a valuable opportunity to study visual formal elements of the marketing mix in their most condensed form. Approaching marketing visuals from their formal point of view may not be as straightforward as it initially sounds. The study of any visual, necessarily, entails an engagement with multiple levels of understanding of what is included in 'a message' transmitted through our sense of sight. It is at the same time a blessing and a curse that our brain has the capacity to work with images in a very spontaneous way. Refraining from providing an instant interpretation of what we are seeing can prove to be a challenge. Sometimes, just being able to break down an image into its constituent parts, and name them, can be perplexing. Traditionally, in order to extract the structure, meaning and intentions of a visual image, researchers have relied in techniques originating from art work analysis. Art theory has provided a multitude of methods on how to analyse visuals and discuss the various qualities that shape them into an aesthetic experience. Venturing into the realm of the aesthetic presents on its own a different set of complications.

The very term 'aesthetic' is too broad and has proved very resilient to a consistent and universally accepted definition. At this point, it is important to outline how the word 'aesthetic' has been used within relevant debates and which specific aspects of the aesthetic experience will be addressed within this research. The debate on aesthetics as an independent discipline initially started as part of a more general discussion in the field of philosophy. Conventionally linked to the idea of beauty, aesthetics has, unsurprisingly, centred on issues arising from the study of the arts in an effort to answer the question of what beauty is. Beauty, as the primary aesthetic category, appears to be the starting point in most narratives. C. Sartwell (2017) identifies the nature of Beauty - along with the nature of art itself - as one of the two elemental points of debate in philosophical aesthetics. He discusses how the nature of Beauty has been addressed as an ultimate value since the earliest debates in western philosophy, playing a persistent role in the most-heated disagreements in western literature. A rapidly growing literature on the subject has highlighted additional aspects of the aesthetic experience, when trying to define the very subject of aesthetics and, similarly, different methods of analysis have been employed whenever concepts of an aesthetic nature become the focus of various disciplines. There is a series of recurring concepts, often approached from different perspectives, while trying to define notions that seem stubbornly determined to escape definition. In order to gain a better understanding on how various issues fit within the general conversation on aesthetics, as well as which forms they assume diachronically within aesthetic debates, the following section will outline the past history of approaching visuals from an art historical or philosophical point of view. A vast amount of theories stemming from art history and philosophy have provided insights for the analysis of concepts linked to the analysis of visuals. The following section will present the concepts that lie at the heart of this discussion and provide the historical backdrop of the ideas which influenced the most significant debates in the field of aesthetics.

2.3.1 Insights from the History and Philosophy of Art

Philosophers and art historians have been debating on the nature and elements of the aesthetic experience for centuries. All forms of artistic expression (including literature, poetry, music, architecture, sculpting and painting) provided rich subject matter for investigating a concept that appeared to be as elusive as it was fascinating. The consequent inability to describe the boundaries of the discipline, necessarily, led the discourse towards outlining the concepts that appeared to be the most relevant. Throughout the ages, the concept of aesthetic beauty, either as an attribute, judgement, attitude or experience has always been at the centre stage.

An analysis of the vast literature on the subject cannot be easily condensed in one section. Yet, with the purpose of presenting an overview of the central concepts, Table. 2.3.1. has been compiled. It presents a brief historical record of the most important points of focus in the study of the concept of aesthetics in art and philosophy literature. The list is certainly not exhaustive, but indicative of the diversity and dichotomy of opinions on the concepts through which aesthetic value in any visual can be approached. This is done with the realisation that these brief descriptions of concepts are taken out of a larger context. Yet, a diachronic presentation of the fundamental angles from which the central concepts have been approached, helps to illustrate how persistently the elements of visual form keep re-emerging as a nuclear concept of aesthetic value throughout the ages. Either on their own merit, as pure sensory stimuli, or as components of processes influencing psychological, cognitive or conative experiences, formal elements of visuals have been recurrent constants in the aesthetic debate. At this point, it is also important to emphasise that Table 2.3.1. presents directions of approach for different issues concerning the field of Aesthetics and not comprehensive descriptions.

Table 2.3.1. Historical perceptions of notions linked to aesthetic analysis

Notions linked to aesthetic analysis	*Author*	*Date*	*Original work/Reference*
Perfect unity of form and Idea	Plato	4thc BC	*Symposium*, Spiropoulos I. (trans), 2007
Order, Symmetry and Definiteness	Aristotle	4thc BC	*Poetics*, Barnes J. (trans), 1995
Order, Proportion and Symmetry	Vitruvius M.	1stc	*On architecture*, Granger F. (trans), 1970
Forms eternally present in Intellect	Plotinus	3rdc	*Ennead I.6: On beauty*, Smith A. (trans), 2016
Integrity, Due Proportion and Clarity	Aquinas T.	13thc	*Summa theologica*, Fathers of the Dominican Province (trans), 2000
Harmony/Geometry of forms	Alberti L.B.	1435	*De Pittura/On Painting*, Sinisgalli R. (trans), 2011
Beauty of mathematic proportions	Pacioli L./ da Vinci L.	1509	*De Divina Proportione*, in *Aesthetics from classical Greece to the present*, Christodoulides P. (ed & trans), 1989
Combination of colour and figure, causing delight	Locke J.	1689	*An essay concerning human understanding*, in *Aesthetics from classical Greece to the present*, Christodoulides P. (ed & trans), 1989
Beauty of the Divine mind, the notion of internal sense	3rd Earl of Shaftesbury	1711	*Characteristics of men, manners, opinions, times*, Klein L.E. (ed), 1999
Perfection in formal and substantive terms (suitability of form to purpose)	Wolff C.	1719	*Rational thoughts on God, the world, and the soul of man*, in *The Stanford encyclopaedia of philosophy*, 2016
Internal sense, uniformity amidst variety	Hutcheson F.	1725	*An inquiry into the original of our ideas of beauty and virtue*, Leidhold W. (ed), 2004
Perfection conceived through the senses	Baumgarden A.G.	1750	*Aesthetica/Ästhetik*, in *Selected writings on aesthetics*, Herder J.G. (ed & trans) Moore G., 2006
The line of beauty, beauty in form	Hogarth W.	1753	*The Analysis of Beauty*, in *To see with our own eyes: Hogarth between native empiricism and a theory of "beauty in form"*, Davis C. (ed), 2010
Noble simplicity and calm greatness	Winckelmann J.J.	1755	*Essays on the philosophy and history of art*, Lodge G.H. (trans), 1880, reprinted 2006
Psychological attraction, Mental taste, Beauty as impression, not idea	Hume D.	1757	*Of the standard of taste*, Green T.H. and Grose T.H. (eds), 1987
Beauty of forms in space and time	Lessing G.E.	1766	*Laocoon, or On the limits of painting and poetry*, Frothingham E. (trans), 2005
Disinterested pleasure, the Sublime	Kant I.	1790	*The critique of aesthetic judgment*, in *Theory of taste*, Allison H.E., 2001
Higher spiritual synthesis of formal and sensual impulses	Schiller F.	1795	*On the aesthetic education of man*, Tribe K. (trans), 2016
Connection between beauty and ourselves	Hegel G.W.F.	1820	*Vorlesung über Ästhetik*, in *Aesthetics*, Knox T.M. (trans), 1975

Notions linked to aesthetic analysis	*Author*	*Date*	*Original work/Reference*
Synthesis of forms	Herbart J.F.	1808	*Sämtliche werke*, in *Aesthetics from classical Greece to the present*, Christodoulides P. (ed & trans), 1989
Instinctive imagination, unity in variety	Coleridge S.T.	1817	*Biographia literaria*, in *Aesthetics from classical Greece to the present*, Christodoulides P. (ed & trans), 1989
Elevation through experiencing beauty	Schopenhauer A.	1818	*The world as will and representation*, Payne E.J.F. (trans), 1969
Intrinsic beauty, Objectified pleasure	Santayana G.	1896	*The sense of beauty*, Santayana G., 1896
Intuitive knowledge	Croce B.	1902	*The essence of the aesthetic*, Ainslie D. (trans), 1921
Easy beauty (accessible to all) vs difficult beauty (accessible to the trained eye)	Bosanquet B.	1915	*Three Lectures on Aesthetic*, in *A History of Aesthetic*, 2005
Decorative feeling of form	Wölfflin H	1915	*Principles of art history*, Hottinger M.D. (trans), 1932
Significant form	Bell C. Fry R.	1913 1920	*Art*, 1913, in *Philosophy of art*, *Vision and design*, Carroll N., 1999
Appreciation through experience and understanding the culture of the period	Wittgenstein L.	1921	*Tractatus logico-philosophicus*, Ogden C.K. (trans), 1999
Sense of unity in an experience through emotion and imagination	Dewey J.	1934	*Art as experience*, 1934
A consideration of humanity's state of feeling in relation to the beautiful	Heidegger M.	1935	*The origin of the work of art*, 1963
Psychology of perception, Schemata	Gombrich E.	1950	*The story of art*, 1950, *Art and illusion*, 1960
Perception	Sibley F.	1954	*In the philosophy of perception*, Warnock G. (ed), 1967
The autonomy of the artwork; unity, intensity and complexity	Beardsley M.C.	1958	*Aesthetics: Problems in the philosophy of criticism*, 1980
The obtuse meaning	Barthes R.	1964	*Rhétorique de l'image*, 1964; *L'obvie et l'obtus: Essais critiques III*, 1982
Cultural context	Danto A.	1964	*The Artworld*, 1964
Art as a symbol scheme correlated with a field of reference	Goodman N.	1968	*Languages of art*, 1968
The matrix of conventions, artwork's 'inner life' and art as 'experience of completion'	Dickie G.	1969 1977	*Defining Art*, 1969 and *Art and the Aesthetic*, in Walton K.L., *Categories of Art*, 1977
The internal truth content of art	Adorno T.W.	1970	*Aesthetic theory*, 1964
Dynamic of form	Arnheim R.	1974	*Art and visual perception*, 1954, and *Visual thinking*, 1969
Beauty and ugliness as central aesthetic concepts	Zangwill N.	1995	*The Beautiful, the Dainty and the Dumpy*, 1995, and 'Feasible aesthetic formalism', 1999, in *The metaphysics of beauty*, 2001

Whether the focus of every analysis is on physical, perceptual or conceptual features, and the subjectivity or objectivity of judgements, when it comes to analysing the aesthetics of a visual, in most cases, there is an initial level of engagement with their formal elements. Within early discourses engaging with aesthetic issues, up until the 18th century, most treatises located beauty in the object itself and its qualities. Starting with classical antiquity, when the first theoretical philosophical analyses on aesthetics (in the modern sense) were still developing, the orthodox theory associated beauty with aspects of form. Emphasis was placed in attributes such as order, symmetry, unity and proportion. Whether subscribing to the Platonic or the Aristotelian approach, at this point, beauty is ontologically seen as '*at least as objective as any other concept*' in the sense that it was not considered to be residing in the eyes of the beholder (Sartwell, 2017). Platonic ideas on unity of form and ideal persisted throughout medieval times, though reliant on a theological perspective, where the perfection of form is seen as a reflection of God's eternal truth and beauty.

The coming of the Renaissance embraced several Platonic, Aristotelian and neo-Platonic ideas of beauty safeguarded by Plotinus and Aquinas. Nevertheless, renaissance artists and art theorists moved one step further from any pre-Renaissance Platonist, to raise beauty to a way of life, almost a religion. Yet, at the same time, the superb artists of this era introduced an impressive combination of empirical research and systematic interest in theory formation for the production of beauty (Beardsley, 1989). Even the emphasis on the content of the art work, which has to depict a story (*istoria*) to be truly beautiful, is closely connected to the correctness of formal elements. According to Alberti, precision and the appropriate choice of formal elements produce a reliable visual story. Consistently with this view, Da Vinci (1509, cited in Beardsley, 1989, p.116) claimed that the study of physical forms, to the point of mathematical precision, was the artist's means to uncover nature's hidden secrets. Thus, systematising art as a science – the science of depicting beautiful natural objects - becomes one of the higher purposes for renaissance artists.

Renaissance ideas about the precision of forms persisted through the Age of Reason. In 1690, Locke considered the idea of beauty the product of the interplay between composition and colour causing delight in the beholder. The Cartesian concept of reason was considered to govern everything, even the arts. Descartes called for a method in arranging expression. He suggested that we can provide systematic definitions and reasonable examinations of emotions by analysing their physical expressions (Beardsley, 1989). Consequently, the arts have to be based on logical principles too. Sartwell, in his treatise on *Beauty* (2017), points to the most characteristic expression of this view, found in the writings of Hutcheson. Combining the spirit of the Enlightenment with Aristotelian philosophy Hutcheson was a proponent of the application of a *Mathematical Style* in the arts:

> "*What we call Beautiful in Objects, to speak in the Mathematical Style, seems to be in a compound Ratio of Uniformity and Variety; so that where the Uniformity of Body is equal, the Beauty is as the Variety; and where the Variety is equal, the Beauty is as the Uniformity.*"
>
> (Hutcheson, F., 1725, in Sartwell, C., 2017, p.29)

Yet, by the middle of the eighteenth-century Hume (1757) was wavering on an antinomy between the role of the intrinsic qualities of objects and the condition of the observer, in forming aesthetic judgements. As an advocate of subjectivity in the aesthetic experience, he suggested that beauty and deformity belong to the sentiment of the observer. Even so, he admitted that *'it must be allowed, that there are certain qualities in objects, which are fitted by* *nature to produce those particular feelings'*, and formal design appeared to be one of them (Hume, in Green and Grose, 1987); and while Immanuel Kant, in his *Theory of Taste* (1790), shared Hume's stance on the subjectivity of taste, he is more Aristotelian in his method of categorizing the types of beauty that can produce an aesthetic response. He saw types of beauty that are dependent, and some that are free or absolute. For Kant '*absolute or free beauty* [can be] *found in the form or design of the object'*.

During the 20th century, the notion of beauty as a quality itself was displaced from the centre of the aesthetic experience. The general consensus that any objective aspects of beauty that can be identified can only be 'determinable' and not 'determined'-in the Kantian sense-has made beauty surprisingly irrelevant in the study of visual arts. Aesthetic value was not a value in itself anymore, and the point of focus moved from the aesthetic object, to the aesthetic experience of the observer. Subjective judgement and context dominated the conversation. It was the arrival of Formalism that, for the first time, made a clear distinction between form and content. At the beginning of the 20th century Heinrich Wölfflin (1915) wrote an influential treatise suggesting the existence of stylistic patterns underlying the development of art through the ages. For Wölfflin, stylistic form was the most significant source of the aesthetic, and the progress of art in imitating nature was '*anchored in* [the] *decorative feeling*'. The study of forms was proposed as a system which defies national characters. It was, thus, seen as a unifying element in comprehending a general human tendency to use previous pictorial references as a factor in the evolution of style. This, Wölfflin suggested, has more effect on the development of a visual vocabulary than the drive for the imitation of nature itself. His preoccupation with uncovering '*universal forms of representation*' has opened novel ways of analysing art and beauty, by looking at the elements through which they are expressed.

Moving one step further, Clive Bell (1914, cited in Carroll, 1999) suggested that '*lines and colours combined in a particular way, certain forms and relations of forms, stir our* *aesthetic emotions'*. He affirmed (1913), that in exploring the aesthetic aspect of art '*we need bring with us nothing from life, no knowledge of its ideas and affairs, no familiarity with its emotions [...] nothing but a sense of form and colour and a knowledge of three-dimensional space'*. People who cannot appreciate pure form were, according to Bell, like '*deaf men at a concert*' (Averill et al., 1998; Railton, 1998).

Several of the fundamental ideas of Formalism were echoed in Beardsley's seminal treatise *Aesthetics: Problems in the philosophy of criticism*, published in 1958. Subscribing simultaneously to a more general form of the analytic tradition, which emphasised empiricism, and New-Criticism, which emphasized the autonomy of the artwork from any political, social, or individual connections, Beardsley maintained that the object and purpose of Aesthetics is the meticulous critical examination of the fundamental concepts that lie beneath works of art, the aesthetic properties that '*make them work*' (Wreen, 2014). The fact that the art of his time was developing into an 'open concept' which included novel types of experiences, and not only aesthetic ones, was for Beardsley above all a challenge. One of the most fundamental challenges of philosophy: '*how to cope conceptually with change*'. The answer he provided was to not reject the free expansion of the concept of art, instead allow it to be applied to other objects that might merit attention, though at the same time ensure that the actual concept of the aesthetic experience remained restricted (Beardsley 1969, p. 11). The focus on 'artistic goodness' should not be displaced. In a constant dialogue with (and often against) Dickie's notion of art as experience of completion, Beardsley linked the aesthetic experience with the '*various features of* [the] *phenomenally objective field*' that is attended by the viewer. This '*field*' is constructed by '*objective qualities and forms*' which need to be examined closely and independently from any preconceptions, in order to be described.

> “*We can describe the phenomenally objective qualities and forms: these are the properties of the work of art that appear in the experience. We can describe the phenomenally subjective feelings and emotions: they may be said to be “evoked by” or to be “responses to” the work of art, and in this special sense these affects can be said to be caused by the objective features*”.
>
> (Beardsley, M.C, 1969, pp. 5-6).

Beardsley, proceeded to suggest that, not only aesthetic values can be described, but, emotional reactions to the aesthetic experience should also be measured by some dimension, however simple or complex. This dimension should be ‘aesthetic pleasure’.

> “*The view I propose, then, is that X is artistically better than Y if X is capable of providing a more pleasurable aesthetic experience than any that Y is capable of providing.*”
>
> (Beardsley, M.C., 1969, p. 9).

Since 1876, in an attempt to produce a quantifiable, and therefore, more objective account of some formal visual aesthetic qualities, Fechner had suggested specific metrics for evaluating formal aspects of beauty in a psychophysical way. Even though some of the results of his research have not been uncontested, Fechner succeeded in introducing an innovative methodology which informed the work of many researchers. Birkhoff (1933), on a similar note, attempted to define an aesthetic measure in which beauty is a function of effect and means, namely the optimal ratio of order and complexity of a visual stimulus. Birkhoff contributed significantly to the development of experimental aesthetics, and although parts of his theory have not been fully substantiated by later research (Smets, 1973; Dörner and Vehrs, 1975; Berlyne, 1972) his idea of a relation between effect and means has been considered as a useful criterion to assess and quantify significant aspects of aesthetic value (Boselie and Leeuwenberg 1985). Arnheim (1998), in an interview for the *Neue Bildende Kunst*, discussed how he saw Art, just like perception, as dependent on the structure of forms and colour. He went on to suggest that it is vision that orders reality, and it does so in its primary, projecting structural features. Arnheim specified that what is essential for perception, as well as for art, is that *what* is seen, possesses dynamic character. So, in order to understand perception and artistic expression one has to view them as a dynamic relationship.

> '*Everything that appears in a work is effective due to forces that are manifested in form and colour. The dynamic between the forces, between the elements, conveys the expression'*
>
> (Arnheim, T., 1998).

Formalism in the analysis of visual art has been adopted with many variations and levels of intensity. For some formalist theorists, extreme formalism claiming that all beauty is formal beauty, and extreme anti-formalism claiming that all beauty is non-formal beauty, have come to converge with time. A more defendable version of moderate formalism suggested that 'there is much beauty of both sorts' (Zangwill, 2001). Accordingly, the approaches focusing on the formal aspects of visual stimuli are not necessarily incompatible with parallel judgements of subjectivity in aesthetic value. Even though non-formalist theorists certainly don't view them as exhaustive, they recognise that they can offer important insights in the arduous task of outlining some of Aesthetics' constituent parts.

The dichotomy between the two major theoretical paths for analysing visuals (form vs content) is seen as a productive one in this thesis. The two approaches are viewed as, essentially, complimenting each other. Each one of them, though, calls for the use of different methodologies to achieve its potential. While examining the points of focus of the formalist approach, which has been theoretically founded in the objective analysis of pure formal elements, one realises the potential for developing measures in order to be able to identify, categorize and interpret the various visual parts that form an image. Formalism has provided the theoretical underpinning for addressing independently the various visual elements which compose an image and deriving value from this analysis.

At the same time, Formalism accomplished an important double task: freeing aesthetics, both, from the Platonic burden of linking moral goodness to beauty, and from the Hegelian legacy of idealising art. The possibility of a disassociation of morality and ideals from formal evaluation proposed that we *can*, actually, judge '*not the message, but its expression'* (Levinson, 2001). As a result, Formalism effectively paved the way for appreciating and researching visual form outside of art. It was within this framework that, Holbrook and Zirlin (1985), suggested the existence of a '*continuum'* between simple and profound hedonic pleasure of aesthetic appreciation. By allowing that the aesthetic experience is not limited to the appreciation of objects which can be categorized as artworks, an extensive armoury stemming from art history, psychology and philosophy of art can be utilised to analyse a variety of visuals.

Even with the contribution of the above-mentioned efforts, the task of objectively evaluating, or even classifying the aesthetic aspect of images has been inherently problematic for researchers within any literature. Yet, the rich tradition of philosophical and historical aesthetics has informed directly or indirectly the disciplines which study aspects of the interaction between a viewer and a visual (Fillis 2009). The systematic approach of Formalism and the scientific advances in experimental aesthetics, enriched the toolbox of researchers engaging with the study of visuals. Combined with contributions from different theoretical perspectives, the history and philosophy of the arts has provided essential frameworks for the analysis of the form, rhetoric and cultural context of visual messages, and significantly influenced the methods by which everyday imagery and content is interpreted. Albeit working under different agendas, researchers both in Art and Marketing have engaged with several facets of visual aesthetics when trying to explain the determinate factors for encoding or decoding visual messages, their effects and applications.

2.3.2 Applications to Marketing and Branding Visuals

In the previous section, the philosophical and theoretical approaches which dominated the discussion in art and aesthetics have been considered. Particular attention has been drawn to the theories concerned with the study of the formal aesthetic qualities of visuals in art. The overview of the central concepts of art and aesthetics was aimed at highlighting the vast contribution of art theory in the analysis and understanding of visuals, and the degree of inter-disciplinarity, which is required for approaching aesthetic value in any visual. More than that, the universal models elaborated for the analysis of art works have often been used to address issues which extend further than aesthetic considerations.

Halliday (1999) discussed how the adaptation of approaches in the study of the arts could contribute to the understanding of Marketing. For Halliday the art historical approach enables a contribution to the knowledge of personality, aesthetics and judgement. Similarly, Schroeder and Borgerson (2002) used critical visual analysis of the use of advertising imagery in the same way that an art historian would. Looking at the art of the Renaissance as an era of technological innovation in the forms and mediums and subjects of painting, the authors established a link between the evolution of art and culture, and the new value of luxury consumption. In this case they used an art historical approach as a means for better understanding the "*consumption spectacle*" (2002, p.166). They observed how innovations such as: life-like portraiture, enabled by technical and stylistic advances, inclusion of secular subjects in paintings and the increasing demand for secular art allowed patrons to establish personal connections to the messages transmitted through artworks. The authors advocated that a visual/art historical approach can inform the conversation on fundamental issues in marketing including message transmission, persuasion, brand image, and innovation management. Most importantly, they point to the similarities that this method of analysis reveals with the reliance of contemporary marketing on consumers' personal connections to brands. The subject of the appeal to the personality of the consumer is becoming increasingly relevant with the rise of modern technologies, yet, it is not a novel observation. In his 1985 ground breaking book *Art & Mass Media*, Robert Pelfrey argues that the appeal to the consumers' personality is what makes advertising so efficient. He, also, was one of the first to introduce the concept that the visual language derived by art historical theory and practice is closely connected to the evolution of contemporary mass media society.

From a similar perspective, Schroeder (2005 p. 1293), saw *'branding as a powerful representational system that produces knowledge through discursive practice'.* His emphasis on the representational aspect of branding underlined the need of including interdisciplinary research in order to examine the cultural dimension of brands and gain a deeper insight into various components of consumer culture. Employing examples from the work of famous artists, such as Kruger, Warhol and Sherman he professed that art criticism is closely linked to marketing, and especially branding, as 'brands are inherently visual' (2005, p. 1292). The author observed that *'the visual arts are an impressive cultural referent system that brand managers, art directors, and advertising agencies draw upon for their strategic representational power'* (2005, p. 1301). Finally, he concluded that, art historical analysis and the artists' skills at image creation, juxtaposition, and attention building could serve as valuable guides for the corporate world on how to invoke issues of identity, recognition and values.

It is noteworthy, that the relationship between art and marketing has been reciprocal. Robert Nelson, in his influential book entitled *Critical terms of art history* (2010), declares that "*Global advertising agencies are the true semiotic magicians of our world*'. (Nelson, 2010, p.164). The aim of understanding the principles behind constructing visuals that effectively project the message their creator wishes to project, has never been too far away from the scope of art. In turn artists have used all the available resources for understanding human vision and using it for their advantage. As it will be discussed in the following chapter, the corporate world should also benefit from this approach.

2.4 Vision Science and Psychology

Even though it has exceeded the limits of design, an organisation's core CVI, still focuses on five basic components: its name, logotype and/or symbol, typography, colour and slogan (Dowling, 1994; Olins, 1989; Melewar and Saunders, 2000). Most, or all of these elements are constantly present in a company's marketing and communication efforts, both internal and external. Whether researchers and practitioners are looking at these components from the point of view of branding or advertising, there is an initial engagement with their core visual elements. In accordance with earlier (Treisman and Gelade, 1980), and more recent research (Theeuwes, 2010), one of the premises of this thesis is that structural visual cues (i.e. colour, tone, line, shape, direction etc.) interact with the eye before the brain can register what the content or the intent of the image is, and can trigger affect sometimes even prior to cognitive processing (Lutz and Lutz, 1977; Theeuwes, 2010). Among the fundamental tasks core visual elements perform, is capturing consumer's attention (Adler, 1997; Janiszewski, 1988; Davenport and Beck, 2001; Pieters and Wedel, 2004; Pieters, Wedel and Zhang, 2007; Milosavljevic and Cerf, 2008). Subsequently, the literature on the analysis of marketing visuals, either in their primary, or in their conceptualized form, is directly linked to the longstanding debate over how visual processing actually works. Therefore, each strand of literature examines what mechanisms shape consumers' engagement and response to marketing visuals.

For decades among the major issues between opposing theories is whether visual processing is organized in a bottom-up or top-down manner. In other words, is visual perception process driven by the information provided in the formal, sensory data or is it dependent on contextual information and prior expectations of the viewer? Recent studies have shown that both types of processing take place, but on a different level (Van der Stigchel et al., 2009; Theeuwes, 2010; Awh et al., 2012; Borji and Itti, 2013). For instance, according to Van der Stigchel et al. (2009) and Theeuwes (2010), visual selection is entirely stimulus-driven during the first scan of the visual field and only at a later stage does it become influenced by top-down processing. The exact timing of visual processing is still a matter of debate but some specific elements that drive attention capture have been identified.

In a review of the existing literature, Wolfe and Horowitz (2004) estimate that there are between ten and fifteen first order attributes and an additional three second order attributes which occupy a prominent role in the deployment of attention in visual scenes. They affirm that some properties of visual stimuli can be used to control the deployment of attention, and specify that they are not just present during the early stages of visual processing, but they function as a specific abstraction from the visual input. They report a large number of studies supporting the hypothesis that the following attributes have an impact on attention capture. Table 2.4.1. is adapted by Wolfe and Horowitz (2004) and has been updated to include more recent findings. First order attributes such as colour, motion, orientation, and size emerge as undoubted. Flicker (luminance onset), contrast (luminance polarity), pictorial depth, shape, symmetry, and curvature have also been found to impact attention. Also, a group of second order attributes, such as pictorial depth (e.g. linear perspective, apparent size, and occlusion), shadow and shading are identified as being analysed in early visual stages and found to impact attention not in isolation but through their interactions with other attributes. Moreover, some of the above-mentioned attributes have been shown to be processed at a different speed than others, for instance Quinlan and Humphreys (1987) have shown that colour is processed at a faster speed than shape.

Table 2.4.1. Classification of design attributes for attention guidance adapted by Wolfe and Horowitz (2004)

Attribute	*Classification for attention guidance*	*Author (date)*	*Research focus*
Colour	Undoubted	Treisman & Souther (1985) Treisman & Gormican (1988) Nagy & Sanchez (1990) D'Zmura (1991) Bauer et al. (1996)	Search asymmetry: a diagnostic for preattentive processing of separable features. Feature analysis in early vision: evidence from search asymmetries. Critical colour differences determined with a visual search task. Colour in visual search (review). Visual search for colour targets that are or are not linearly-separable from distractors.
Motion	Undoubted	Rosenholtz (2001) Dick et al. (1987) McLeod et al. (1988)	Search asymmetries. Parallel and serial processes in motion detection. Parallelism in visual search for conjunctions of movement and form.
Orientation	Undoubted	Foster & Ward (1991) Wolfe et al. (1992) Bergen & Julesz (1983) Moraglia (1989) Cavanagh et al. (1990) Wolfe et al. (1999)	Early vision asymmetries in oriented-line detection indicate 2 orthogonal filters. The role of categorization in visual search for orientation. Rapid discrimination of visual patterns. Display organization and the detection of horizontal lines segments. Effect of surface medium on visual search for orientation and size features. Two representations of orientation in visual search.
Size (incl. length & spatial freq.)	Undoubted 1storder attributes	Treisman & Gormican (1988) Sagi (1988) Moraglia (1989)	Feature analysis in early vision: evidence from search asymmetries. Effortless perception of the combination of spatial frequency and orientation. Visual search: spatial frequency and orientation.
Flicker (Luminance onset)	Probable 1storder attributes	Theeuwes (1995) Yantis & Jonides (1990)	Abrupt luminance change pops out; abrupt color change does not. Abrupt visual onsets and selective attention: voluntary versus automatic allocation.
Contrast (Luminance polarity)	Probable 1storder attributes	Theeuwes & Kooi (1994) Gilchrist et al. (1996) Pashler et al. (2004)	Parallel search for a conjunction of shape and contrast polarity. Grouping and extinction: evidence for low-level modulation of visual selection., Contrast as a feature for visual selective attention.
Stereoscopic depth & tilt	Probable 1storder attributes	Nakayama & Silverman (1986) Epstein & Babler (1990) O'Toole & Walker (1997) He & Nakayama (1992)	Serial and parallel processing of visual feature conjunctions. In search of depth. Preattentive accessibility of stereoscopic disparity: evidence from visual search. Surfaces versus features in visual search.

Attribute	*Classification for attention guidance*	*Author (date)*	*Research focus*
Shape (incl. aspects of shape: Line termination Closure Topological status Curvature Aspect ratio)	Probable 1st order attributes	Treisman & Gormican (1988) Bergen & Julesz (1983) Tsal et al. (1995) Wolfe & Bennett (1997) Kristjansson & Tse (2001) Chen (1982) Chen (1990) Zhuo et al. (2010) Cheal & Lyon (1992) Pomerantz & Pristach (1989)	Feature analysis in early vision: evidence from search asymmetries. Rapid discrimination of visual patterns. Towards a resolution theory of visual attention. Preattentive object files: shapeless bundles of basic features. Curvature discontinuities are cues for rapid shape analysis. Topological structure in visual perception. Holes and wholes: a reply to Rubin and Kanwisher. Topological change disturbs object continuity in attentive tracking. Attention in visual search: multiple search classes. Emergent features, attention, and perceptual glue in visual form perception.
Inter-item symmetry	Probable 1st order attributes	Roggeveen et al. (2004) van Zoest et al. (2006)	Influence of inter-item symmetry in visual search. Inter-item Symmetry on Visual Search.
Vernier Offset	Probable 1st order attributes	Findlay (1973) Fahle (1991)	Feature detectors and Vernier acuity. Parallel perception of Vernier offsets, curvature, and chevrons in humans.
Pictorial depth (linear perspective, apparent size & occlusion)	Probable 2nd order attributes	Enns et al. (1990) Enns & Rensink (1993)	The influence of line relations on visual search. Preattentive recovery of three-dimensional orientation from line drawings.
Shadow	Probable 2nd order attributes	Elder et al. (2004) Rensink and Cavanagh (2004)	Rapid processing of cast and attached shadows. The influence of cast shadows on visual search.
Lighting direction (shading)	Probable 2nd order attributes	Ostrovsky et al. (2005)	Perceiving illumination inconsistencies in scenes.

Furthermore, Theeuwes (2010) arrives to the conclusion that salient features of a visual object establish an initial selection priority that cannot be altered by top-down knowledge. In addition, Milosavljevic et al. (2012) show that, at rapid decision speeds, visual saliency influences choices even more than preferences do, and that it is particularly strong when individuals do not have strong preferences among the available options. Thus, visual salience can be an important factor in marketing for capturing attention reflexively and immediately (Pieters, Wedel and Batra 2010) and depends, at least partially, on the relationship of salient features with their surrounding elements.

Similarly, Anderson et al. (2016) have demonstrated that, contextual information (top down processing) provides some guidance of eye movements and can decrease the latency and increase the amplitude of the first saccade into a natural scene, yet, it is still not strong enough to completely override the influence of salience. In this particular case, higher contrasted sides of the images were significantly more likely to be attended. Further supporting this evidence, Anderson and Donk (2017) suggested that the prioritization of object changes can be influenced by the underlying salience of the changed object and results in more central object targeting. Hence, salient signals which work as cues for capturing attention in a natural scene are an important component in both object prioritization and targeting.

Prior research on how visual characteristics affect attention, has also addressed several visual features, their significance for attention capture and the extent to which they can affect consumer behaviour (Gorn, Chattopadhyay, Yi and Dahl 1997; Ellis and Miller 1981; Janiszewski 1988, 1993; Itti 2005; Pieters, Wedel and Batra 2010). Therefore, attention capture is one of the predominant functions marketing literature is concentrating on when analysing marketing visual elements (Pieters and Wedel 2004, 2007; Milosavljevic and Cerf 2008). In addition, it has been demonstrated that attention capture has various extensions to other areas of human interactions with the visual world, which have proven valuable for marketing purposes. For example, it has been demonstrated that attention can result to an increase of sales through brain mechanisms that influence memory (Rosbergen, Pieters and Wedel, 1997; Janiszewski, 1998; Wedel and Pieters, 2000), and can have positive effects on consumer attitudes and preferences (Lohse, 1997; Pieters and Warlop, 1999). The following sections will discuss the extensions of the reception of the corporate visual massages for various constructs such as memory, affect, likability and familiarity.

Childers and Houston (1984) have indicated that picture superiority occurs in both immediate and delayed recall tasks and even though verbal-only stimuli are also present in immediate recall, they become inferior once again in delayed recall, when processing is directed at the semantic content of the ads. Similarly, Edell and Staelin (1983) drew upon theories of information storing and recall (likelihood and speed of recall) to propose a model for explaining differences in consumer responses to verbal and pictorial stimuli, incorporating measures of the consumer's cognitive activities. Although they specify that the mere presence of a picture is not a sufficient condition for differences in cognitive processing of the message, they find that the structure and content of the visual is directly linked to the method according to which it is processed. The less positive brand attitudes resulted from negative evaluations of the pictures themselves. Since pictures are seen to be more attention-getting, pleasant, and easier to process than verbal text, viewers attend more to the pictorial cues and tend to expend less processing resources on the more effortful verbal text.

In addition, according to research by Henderson and Cote (1998), Henderson et al. (2003) and van der Lans et al. (2009), shared meaning and subjective familiarity of stimuli, enhance perception and interpretation of logos, thus, creating a stronger effect in consumer memory and recall than stimuli that are abstract (Shinar et al., 2003), or have a varied meaning (Rodewald and Bosma, 1972).

Westcott Alessandri (2001) mentions how the psychological impact of corporate visuals has been formally documented as early as 1942 by the US Supreme Court, in Justice Felix Frankfurter's trademark decision stating that '*the protection of trade-marks is the law's recognition of the psychological function of symbols. […] A trade-mark is a merchandising short-cut which induces the purchaser to select what he wants, or what he has been led to believe he wants.*'

In a recent review paper looking into aspects of colour from a psychological approach, Elliot and Maier (2014) focus on the influence of perceiving colour on psychological functioning in humans and especially on the effects of colour perception on affective, cognitive and behavioural responses. At the same time, the choice of visual features in all marketing imagery (colour, layout, contrast, symmetry etc.) affects the overall aesthetic of visual marketing cues, and has great impact on how it can influence both affect and perceptions of quality (Page & Herr 2002).

Another function is examining how they interact as parts of an aesthetic experience influencing affect, likability and familiarity (Bloch 1995; Gorn et al. 1997; Veryzer and Hutchinson 1998; Hynes 2009; Labrecque and Milne 2012). More recently, an examination of the picture superiority effect in the mass media domain, found that the mere presence of more pictures surely attract more readers (Ma 2016). Rossiter and Percy (1978), in their study on visual and verbal components of advertisements, postulated that visuals have a direct impact on consumers' brand attitude and found this attitude effect to be the most significant for consumers' brand beliefs.

In their seminal research on the visual elements of logos, van der Lans et al. (2009) arrive to the conclusion that the differences in the appearance of logos are important even in the presence of well-known brand names. They present evidence to support that, logos that are more elaborate, more natural, and more harmonious produce more positive attitudes toward the brand. More specifically, according to van der Lans et al. (2009), carefully managing the visual elements is fundamental for logo design. The authors suggest that they have direct impact on consumer responses to logos. Additionally, the above-mentioned logo design characteristics have been observed to impact on the general affect towards the brand. Their claim that logo design features increase positive affect towards the brand is supported by research suggesting that prototypicality makes logos more pleasing (Seifert, 1992), by facilitating perception (Anand and Sternthal, 1991; Martindale et al., 1988) and stimulating arousal (Raymond et al., 2003). Thus, by leveraging the design characteristics of their logos companies can strengthen their brands through increasing positive affect (Zajonc 1968; Hendreson et al., 2003) and enhancing brand choice (Henderson and Cote 1998). Similarly, design elements that such as true and false recognition, can be used accordingly, depending on the purpose of each specific logo. The element of true recognition can contribute to a more rapid communication of brand information through the feeling that consumers instantly recognize logos that they have seen before (Edell and Staelin, 1983). Also, the element of false recognition can be equally useful for companies who want to create new logos which seem familiar to their target groups, even though they encounter them for the first time.

2.5 Computational Aesthetic Measures for Quantitative Image Analysis

The theoretical tradition of Gustav Theodor Fechner, George David Birkhoff and Daniel Ellis Berlyne has opened up a new world of metrics for disciplines engaged in the analysis of visual stimuli. More recent developments in the computational aesthetics literature (Whitfield and de Destefani 2011) provide new tools and methodologies for the formal analysis of visuals. Questions on how aesthetic concepts can be operationalized on objective measures are addressed by Chamorro-Premuzic, Burke, Hsu and Swami (2010), Cropley and Cropley (2008), Tinio, Leder and Strasser (2011), and Jansson-Boyd (2011). Mathematical, cognitive and psychological theories of the mind are now brought together in order to experimentally examine the effect of objective aesthetic measures on emotions and aesthetic appraisal (Kuchinke, Trapp, Jacobs and Leder 2009; Perlovsky 2010). Several algorithms aim at measuring and analysing the aesthetic of images with applications in computer vision and graphics (Machado and Cardoso 1998; Datta, Li and Wang 2008; Rigau, Feixas and Sbert 2008; Wallraven, Fleming, Cunningham, Rigau, Feixas and Sbert 2009; Zhang 2012).

Itti, Koch and Niebur (1998) have proposed an algorithm which evaluates three key factors for saliency in visual stimuli: colour, intensity and orientation. These characteristics are summed into a saliency map. Milosavljevic and Cerf (2008) proposed to study attention to advertisements with a research paradigm which combines marketing and computational neuroscience. Using the saliency algorithm of Itti et al. (1998) they simulated what an individual could preattentively process within the first half second of exposure to an advertisement, the order in which attention shifts and the time required for each shift of attention.

Moving one step further San Pedro and Siersdorfer (2009) examine the level of 'attractiveness' of photos by automatically ranking and classifying photos according to their perceived attractiveness. The authors implement a multi-modal approach where they combine image features which have been proposed to have significant effects on the visual quality perceived by humans, such as higher colourfulness, increased contrast and sharpness, with textual metadata. Hochman and Manovich (2013) have integrated methods from social computing, digital humanities, and software studies to analyse visual social media. They use data visualization techniques to sort large numbers of individual images by their algorithmically extracted visual features aiming to show how globally shared media and metadata can be used to study both large scale patterns and the particular unique trajectories, without sacrificing one for another. Here, a quantifiable approach of visual features is suggested, where advances in computational aesthetics are employed in order to quantify and evaluate formal visual characteristics of company logos. By combining the tools provided by the field of computational aesthetics in achieving objective measurements of specific visual characteristics of logos this research aspires to contribute in identifying, isolating and describing in a consistent manner some of the basic principles that govern the formal aesthetic choices and their possible effects on brand image across time, products, industries or cultures.

Even more so in the case of electronic advertising where perceived visual aesthetics of web design can be consistently associated to subjective evaluations of usability (Tractinsky, Katz and Ikar, 2000). For internet users, aesthetics is also strongly related to reliability, security and privacy. As Wolfinbarger and Gilly (2003) suggest, judgments concerning the quality of an online site are most strongly related to website design factors and fulfillment/reliability, and also, inferences of security/privacy are initially obtained from quality factors, particularly website design, when shoppers are new to a website.

When analysing the two dimensions of web aesthetics, aesthetic formality and aesthetic appeal, it is important to investigate whether they can influence online consumers' psychological reactions and conative tendencies. The results from Wang et al. (2011) indicate that consumers' cognitive, affective, and conative outcomes can be significantly evoked by aesthetic stimuli (p. 46) and agree with Page & Herr (2002) that the aesthetics of a corporate image can indeed influence affect and perceptions of quality.

Sutcliffe and Namoune (2008) suggest that aesthetics is the most important determinant for overall attractiveness of a web site to the point that judgment on aesthetics may even override users' usability experience. In more recent research (Wang, Minor and Wei, 2011), identify two dimensions of web aesthetics which influence online consumers' psychological reactions and conative tendencies: aesthetic formality and aesthetic appeal. Even though these dimensions appear to operate at a different level depending on consumers' motivational orientations, aesthetic stimuli are believed to evoke consumers' cognitive, affective, and conative outcomes. Moshagen and Thielsch (2013) have developed a measure for assessing the perceived visual aesthetics of websites. The Visual Aesthetics of Website Inventory (VisAWI) was based on a broad definition of visual aesthetics where four facets of perceived visual aesthetics of websites were used: Simplicity, Diversity, Colourfulness, and Craftsmanship. Their research was based on the evaluation of the above features from 1673 participants.

Table 2.5.1. Design features as variables in assessing formal aesthetics

Aspects of visual aesthetics	*Authors (Year)*	*Design variables*
Balance, equilibrium, symmetry, order	Bauerly & Liu (2006)	Balance of compositional elements on interface and design aesthetics.
	Bauerly & Liu (2008)	Symmetry and number of compositional elements
	Bi et al. (2011)	Symmetry and number of compositional elements.
	Brady & Phillips (2003)	
	Lai et al. (2010)	Balance and symmetry.
	Lavie & Tractinsky (2004)	Order and clarity.
	Ngo et al. (2003)	Balance, symmetry, sequence, unity, rhythm, order of layout.
	Zheng et al. (2009)	Organizational symmetry, balance and equilibrium.
Colour	Brady & Phillips (2003)	Colour and balance.
	Coursaris et al. (2008)	Colour temperature.
	Cyr et al. (2010)	Colour appeal across cultures.
	De Angeli et al. (2006)	Colour as part of expressive aesthetics & style.
		Text-background colour combinations.
	Hall & Hanna (2004)	Text and background colour on visual search.
	Ling & van Schaik (2002)	Perceived value of colour.
		Colour as hedonic quality.
	Papachristos et al. (2006)	Screen type, ambient illumination, and colour combination.
	Schrepp et al. (2006)	
	Shieh & Lin (2000)	Colour preferences for culture and gender.
	Simon (2001)	
Complexity, diversity, variety	de Angeli et al. (2006)	Diversity and perception of information quality.
	Ngo et al. (2003)	Simplicity, density, economy, rhythm, order and complexity of layout.
	Pandir and Knight (2006)	Berlyne's theory of complexity.
	Tuch et al. (2009)	Visual complexity.
Proportion, cohesion, size	Bauerly and Liu (2006)	Size and proportion of compositional elements on interface and design aesthetics.
	Bauerly and Liu (2008)	Cohesion of compositional elements.
	Ngo et al. (2000 & 2003)	Sequence, cohesion, unity, proportion.
	Schmidt et al. (2009)	Image size and font size.
Simplicity, clarity, parsimony, density	Bi et al. (2011)	Number of visual elements, abstract, geometric or realistic images.
	Karvonen (2000)	Simplicity
	Ngo et al. (2003)	Unity, simplicity, density and economy of layout.
	Rau et al. (2007)	Richness of design and animations on visual search.

Adapted from the work by Moshagen and Thielsch (2010) on facets of visual aesthetics, Table 2.5.1., summarises the different features that have been used as variables in assessing the formal visual aesthetic of websites. From the list proposed by Moshagen and Thielsch, Table 2.5.1. isolates the characteristics that the authors classify as structural and quantifiable and can also be applied across the spectrum of the marketing mix visuals (e.g. animations, visual effects, motion, links etc. are omitted). The features that have been identified within the literature to contribute to the evaluation of visual characteristics of logos are highlighted.

Table 2.5.2. Descriptive measures (Descriptions from Datta et al., 2006, 2008)

Descriptive Measures	*Description*
Light exposure	A measure of the total amount of light falling on a given surface. Over-exposed (very bright) or under-exposed (very dark) images are often associated with lower quality, less appealing images.
Saturation	Saturation indicates chromatic purity. Pure colours in a photo tend to be more appealing than dull or impure ones. The average saturation is computed.
Hue	Hue is generally synonymous with shade (a particular tint or quality of colour). It is the attribute of a colour by virtue of which it is discernible as red, green, etc., and which is dependent on its dominant wavelength and independent of intensity or lightness. The average hue is computed.
Colourfulness	The attribute of a visual sensation according to which an area appears to exhibit chromatic content.
Depth of field	The depth of field is the distance between the nearest and the farthest object that are in focus in an image.

Yet, whether formal visual elements are viewed as stimuli for capturing attention or as distinctive parts that construct an aesthetic experience, a common issue faced by researchers in both directions is how to consistently measure them. The need and difficulty of effectively measuring specific formal features of marketing visuals has often come up in the literature.

The measures can be separated into two major categories: The first comprises of measures of a purely descriptive character and the second of evaluative measures which claim to possess explanatory value. Table 2.5.2. contains a brief presentation of the Descriptive measures. Table 2.5.3. gives a brief presentation of the available Evaluative measures, which will be further analysed in the end of this section.

Table 2.5.3. Evaluative measures (Descriptions from Datta et al., 2006, 2008)

Evaluative Measures	*Description*
Machado and Cardoso Aesthetic Measure	The aesthetic measure proposed by P. Machado and A. Cardoso (1998) quantifies the aesthetic content of an image in terms of its visual complexity and suggests that images that are at the same time visually complex and easily processed are associated with higher aesthetic values.
Ralph's Model of Aesthetics	Ralph's model of aesthetics (2006) is constructed through empirical analysis of artworks, in which a work is supposed to be more appealing when it exhibits bell curve distributions of colour gradients. This bell-curve gradient measurement is usually present in images that have harmonious and balanced visual characteristics.
Global Contrast Factor	The global contrast factor computes the contrast of an image (i.e. the difference in luminance or brightness at various resolutions). It is suggested that images with little or few differences have low contrast and are considered to have a lower aesthetic value (Datta et al. 2006).
Benford Law	Benford Law (2005) posits that the first digit of real signals follows a logarithmic distribution, and this distribution, is a natural prior for several types of real life images. Specifically, Benford law is utilized over the distribution of brightness of the pixels of an image.
Fractal Dimension	The fractal dimension of an image was found to be correlated with the aesthetic preference of people categorizing different types of fractals as natural or artificial. It is suggested that there is a peak in preference for fractal images with a fractal dimension around 1.35. Images with higher fractal dimension were considered too complex while images with lower fractal dimension were considered uninteresting (Spehar, Clifford, Newell and Taylor 2003; Graham and Redies 2010).

Evaluative Measures	*Description*
Rule of thirds	A widespread rule in photography the Rule of thirds is seen as a rough calculation of the principle of the 'golden ratio'. It stipulates that human eye naturally gravitates to intersection points that occur when an image is split into thirds. Images are spit into thirds by two vertical lines and two horizontal lines making three columns, three rows, and nine sections.
Wavelet-based texture analysis	This measure performs an analysis of the intrinsic properties of surfaces (e.g. smoothness, roughness, granulation and regularity). If a picture appears to be completely smooth overall this could mean that it is out of focus, and as a result would not as pleasing to the eye. Based on psycho-visual studies which suggest that the eye processes images in a multiscale way, it has been found that the responses of the visual cortex correspond to Gabor-like functions.
Familiarity measures	They are centred on the integrated region matching (IRM) image distance which computes image similarity by using colour, texture and shape information from automatically segmented regions. While it was initially used for image retrieval applications, they can be used to quantify familiarity and are expected to produce higher values for uncommon images.
Size and aspect ratio:	The size of an image has a good chance of affecting the photo ratings. Although scaling is possible in digital and print media, the size presented initially must be agreeable to the content of the photograph. A more crucial parameter is the aspect ratio. It is well-known that 4:3 and 16:9 aspect ratios, are chosen as standards for television screens or 70 mm movies, for reasons related to viewing pleasure. The 35mm film used by most photographers has a ratio of 3:2 while larger formats include ratios like 7:6 and 5:4.

2.5.1 Computational Aesthetic Models for Marketing and Branding Visuals

The visual elements that have been identified by prior literature as significant for the success of marketing visuals have been studied so far through both qualitative and quantitative methods. Nevertheless, even in the case of methodologies who adopt a quantitative approach the valuation and categorisation of the visual features themselves relies mainly on qualitative assessments of their characteristics. For instance, in some cases of research looking at the effects of colour, experts produce the colour matches according to the Munsell system (Gorn et al., 1997) or in other cases participants are asked to associate a given set of colours to specific characteristics (Grimes and Doole 1998, Hynes 2009). The study of Pieters et al. (2010) is an exception, since feature complexity is calculated by the file size of the JPEG-compressed visual image of the advertisement, but the rest of the measures were rated by a separate panel of trained judges.

The proposed study aspires to use the theoretical insights from the fields of art history, aesthetics, vision science and psychology combined with the methodological tools from computational aesthetics in order to provide a novel approach to the analysis of marketing visuals. In this research, the analysis will be concentrating in corporate logotypes. The ambition of this research is to propose an application of the theory that can be expanded through further research in analysing any form of marketing visuals. It aspires to provide marketing researchers with a tool for classifying, analysing and interpreting marketing visuals. By enabling the possibility of algorithmic analysis of large sets of images, the proposed research is also aiming at providing a tool which will help identify general patterns and regularities on multiple scales.

In the subsequent chapter, the methodological approach of this thesis will be presented and the following issues will be discussed in detail: How have individual formal features been used for assessing the varying aspects of corporate visuals, and what will the methodological approach of this research can contribute? Can visual elements of logotypes be consistently and reliably measured? What are the methodological differences between measurements by individuals and computational aesthetics? Which tools can be developed to aid researchers and practitioners to detect, classify and relate them more accurately to significant variables for marketing research, such as attention, memory and affect?

Chapter 3. Methodology

'No endeavour to describe visual language can assume the name of 'visual semiotics', if it does not provide a preliminary level of description, analogous to phonology in verbal linguistics, that can explain how primary elements are joined together to form larger units. Only then, can the study of their syntactic rules of association be undertaken, both fields being necessary parts of a 'grammar' of visual language'.

(Saint-Martin, F., 1990, p.5)

The previous chapter discussed the research that has shaped the endeavour of analysing corporate marketing visuals and identified the most important debates. Having argued how significant, for marketing research, the comprehension of every step of the construction of a visual message is, the difficulties for objectively evaluating and defining their constituent parts have been highlighted. The current research, by addressing the confusion arising from the diversity and complexity of approaches for analysing marketing visuals, has identified a formalistic approach as the most befitting and applicable for achieving a level of consistency and objectivity in measuring design characteristics. The current research is concentrating on measuring the characteristics of corporate logotypes. The approach proposed in this research does not claim to have unique access to the understanding of marketing visuals. Nevertheless, this level of engagement with the primary elements of logos can provide important insights on the rules of formation of a visual language and on the systematic variations of the forms that make these corporate visuals effective.

Several authors (Gorn et al., 1997; Henderson and Cote, 1998; van der Lans et al., 2009) have proposed that an obvious route for accessing the syntactic organization of marketing visuals is through the analysis of their formal visual characteristics. Yet, at the same time, a number of researchers (Orth and Malkewitz, 2008; Giese et al., 2014) have pointed to the existing gaps in the literature relating to the ways formal design features can be used in marketing to achieve consistent results. In this section, the suggested methodological choices for addressing these gaps will be discussed, and the research philosophy and process of the thesis will be presented. The research design, data collection methods and sampling aspect of the thesis will be described. The methodologies and efficiency of treating design dimensions as variables for marketing research will be investigated, and suggestions on how to improve on the existing practices will be made. Finally, the endeavours, so far, to discover consistent links between the specific design dimensions of marketing visuals and the consumers' reactions to them will be discussed. An outline of the formal elements of corporate visual messages will be presented and how each characteristic has been treated as a variable in marketing literature will be analysed.

3.1. Research philosophy and approach

As was mentioned previously, in the introductory chapter (1.3) the aim of this thesis is to provide a deeper understanding of how objective measures can be developed for the analysis classification and evaluation of corporate logotypes. A more general aspiration is to provide a methodological basis that could, in the future be also applicable to other forms of visual imagery used in marketing communications. Following from the findings of chapter 2, and especially the insights for the analysis of visuals provided by the formalist art historical/aesthetics approach (2.3.1) the research philosophy selected for this thesis is grounded on positivist theoretical underpinnings. The formalist approach, examined in the previous chapter, justifies the quest for developing objective measures for the analysis of corporate logotypes. Especially, the aspects of formalist analysis which acknowledge mathematical relations between the constituent parts of visuals align effortlessly with the positivist research philosophy and quantitative method chosen to address the research objective of this thesis. In addition, the theoretical tradition of Gustav Theodor Fechner, George David Birkhoff and Daniel Ellis Berlyne has offered invaluable tools for disciplines engaged in the analysis of visual stimuli. Their research, which introduced the concept of operationalizing aesthetic concepts through the use of objective and consistent metrics, further validates the necessity for a methodological framework which addresses the objective qualities of visuals.

3.1.1 Research Strategy and Data Collection

The development of the methodological framework of this thesis is designed in a way to allow any predictions to be measured in terms of accuracy and external validity (Ghauri & Grønhaug, 2005). Thus, the methodology of this thesis is based on a quantitative approach for the analysis of the visual design elements of corporate logotypes, through numerical data obtained by computational aesthetic measurements, expert panel ratings and a series of surveys as part of an experiment conducted using Mechanical Turk (MTurk). The research objective to investigate the possibility of the development of consistent and reliable measures, explores the assumption of predicting cognitive responses from consumers and experts to corporate imagery, and specifically corporate logotypes.

More precisely, this research will endeavour to produce an interlinking between the various families of available algorithms for computational aesthetic analysis and calibrate the design elements based on the theoretical framework synthesized from prior literature. A panel of experts recruited to provide ratings for the various formal design elements of corporate logotypes will be used to assess and validate the developed objective measures.

Three separate studies comprise the section of the empirical analysis (Chapter 4). The first study employs an extensive set of computational aesthetic measures to quantity the design elements in a sample of logotypes. In a related seminal study, Henderson and Cote (1998), factorised subjective assessments of logo design elements in line with a theoretical framework of eight elements corresponding to harmony, elaborateness and naturalness (later extended by Lans et al., 2009). The present study follows the same theoretical framework, but, differs in at least two significant ways. First, rather than using subjective measures, a large set of objective measures is employed from the computational and experimental aesthetics literature. And, second, a serious limitation of the seminal studies in the field of analysing design elements of corporate logotypes (Henderson and Cote, 1998; Lans et al., 2009 and Zhang et al., 2017) is addressed, by accounting for design elements related to colour. This is the first study in marketing that uses computational aesthetic measures for information related to colour to such an extent.

The second study investigates whether the subjective evaluation of logo design by experts can be approximated using objective measures based on computational aesthetics. An extensive array of 107 computational measures are estimated for 215 professionally designed logos. The design elements of these logos are evaluated by three experts. The study then investigates if the computational aesthetics measures can explain the variation in average expert assessments between logos. Based on the same theoretical framework of the seminal previous literature this study significantly extends knowledge in a number of directions. Again, this study investigates the importance of metrics related to colour, replaces subjective ratings with objective measurements obtained through computational aesthetics and finally, in addition to the machine learning techniques (also used by Zhang et al., 2017), a number of standard statistical methods is applied in an attempt to draw inferences from the analysis.

The final study investigates whether the effect of a perceived logo design element to the attitude of consumers towards the logo is moderated through the personality traits of each consumer. As subjectivity in the analysis of the elements of marketing visuals has been identified as one of the most important factors impeding the development of objective measures of visual characteristics, this emerges as a significant and relevant question. Using the element of Dynamism/activeness as a starting point, this study follows the methodological approach developed by Cian et al. (2014) and Preacher and Hayes (2008). A set of two fictional logos were developed for the study, which are otherwise identical and differ solely on the activeness dimension. Two groups of consumers evaluated the visual characteristics of each logo, corresponding to visual appearance, complexity, informativeness, familiarity, novelty, dynamism, engagement, as well as their attitude towards the brand. The consumers also provided information with respect to their personality traits, corresponding to sensation seeking, risk taking propensity, nostalgia and need for cognition. A series of models were then estimated to assess whether the influence of the visual characteristics of logos, as perceived by the consumers, on their attitude towards the brand is moderated by their personality traits. This study is the first to assess the role of personality traits, rather than consumer engagement, as moderators in the effect of subjective logo visual characteristics to consumer attitudes towards the brand.

The following sections will discuss the available methodological approaches for the measurement of formal features as they have been applied in a variety of marketing visuals, the efficiency and consistency of those measurements, and the methodological approach proposed by the field of computational aesthetics.

3.2 Measuring the Formal Features of Visuals

The following section will begin with addressing the element of colour, the most widely researched element of marketing visuals, and will proceed to look at several individual elements that have attracted the attention of researchers within marketing literature. Using the element of colour as a starting point for this account seems to be the obvious choice, since, as it has been argued earlier in the sections addressing aesthetics, vision science and psychology, colour appears to be the most uncontested design attribute, impacting the affective, cognitive and attentional state of consumers.

3.2.1 Colour

Regular associations have been found between colour or line drawings and emotions (Osgood 1960). D' Andrade and Egan (1974) have demonstrated that specific characteristics of certain visual stimuli produce 'distinct, innate, unconditioned responses' enabling an association between colours and emotions. Schindler (1986) has suggested adherence to known principles of colour combinations and contrast to increase the potential for effective magazine advertising.

Valdez and Mehrabian have studied the emotional reactions to colour hue, saturation, and brightness using the Pleasure-Arousal-Dominance emotion model. Their study has been extensively used in marketing literature, providing the basis for looking into various aspects of how colour choices can be operationalized and optimized. More specifically, Gorn, Chattopadhyay, Yi and Dahl (1997), have analysed the effects of colour as an executional cue in advertising. They proposed a conceptual framework linking the value and croma of colours in an advertisement to consumer's feelings and attitudes and discussed their importance for increasing the range of available options in the selection process of colours advertisements. Kaltcheva and Weitz (2006) have studied colour manipulation (along with background music and store layout) as a means of influencing customers' experience while engaging in retail and consumption environments.

Hynes (2009) argues that there is a triadic relationship between colour, design and the evoked meanings of logos, and explains how this relationship contributes to building a consistent corporate image. Hynes suggests that consumers have strong opinions about which colours are appropriate for different corporate images and Gaillard and Romaniuk (2006) assert that most brands result in a strong association with specific colours. Labrecque and Milne (2013) demonstrate how marketers can strategically use colour to alter brand personality and purchase intent, and how colour influences the likability and familiarity of a brand.

Table 3.2.1. A review of colour as a variable in marketing research (adapted from Labrecque and Milne, 2013)

Authors (Year), Journal	*Area*	*Independent Variables*	*Dependent Variables*	*Methodology*
Gorn et al. (1997)	Advertising	Hue (red vs. blue), chroma (saturation) and value	Attitude toward ad, attitude toward brand, excitement and relaxation	Experiment; print ads using Munsell colour system
Lohse and Rosen (2001)	Advertising	Colour (full colour vs. black), graphics (photograph or line art), ad size, and order	Quality, credibility, attitude toward ad, and attitude toward advertiser	Experiment; print ads
Mehta and Zhu (2009)	Advertising	Hue (red vs. blue)	Reaction time, preference, recall, creativity score, motivation (accuracy vs. speed)	Experiment; computer displays with HSL colour space
Meyers-Levy and Peracchio (1995),	Advertising	Ad colour (full, highlighted, black & white), resource demands (high vs. low), and type of claim (functional vs. image)	Attitude toward product, positive/negative thoughts, and recall	Experiment; print ads
Bottomley and Doyle (2006)	Branding—logo design	Hue and product type (functional vs. sensory-social)	Colour appropriateness and functional vs.sensory benefits	Experiment; printed stimuli
Hynes (2009)	Branding—logo design	Logo colour (Hue. Eight different colours)	Colour appropriateness for type of company	Experiment; online and random street intercept
Labrecque and Milne (2012), (2013)	Branding—logo design	Hue, saturation, and value Logo colour (main and accent colours)	Brand personality, purchase intent, likability, familiarity, Brand equity, product category colour norms	Experiment; web-based stimuli with HSB colour space, and calibrated monitors. Calculated homogeneity scores with 281 real brand logos
Gorn, et al. (2004)	Internet	Hue (red, yellow, blue), chroma (saturation), value, and number of exposures (1 vs. 2)	Relaxation, perceived download speed, attitude toward Web site, and likelihood to recommend.	Experiment; web-based stimuli with HSB colour space
Kaltcheva and Weitz (2006)	Internet	Arousal (warm vs. cool, saturation, and complexity), and motivation (goal-oriented or recreational)	Pleasantness and purchase intention	Experiment; computer displays
Hagtvedt (2014)	Product design	Colour value (degree of darkness or lightness)	Perceived weight (density), convenience and durability of the product.	Experiment; computer displays

Table 3.2.1. is adapted from Labrecque and Milne (2013) and extended to include more recent research. It presents a comprehensive list of major recent colour research (1997-2017), within the marketing literature, in which colour is considered the focal variable. Emphasis is placed on Advertising and Branding.

3.2.2 Contrast

Schindler (1986) has suggested adherence to known principles of colour combinations and contrast to increase the potential for effective magazine advertising. He argues that hue and brightness are the major determinants of contrast and impact and that at the time of this study only 14.5% of advertisements fully employed contrast principles. Many advertisers simply failed to optimize the legibility and readability of their message by the contrast between the selected colours. Parkhust and Niebur (2004) researched the effects of texture contrast and argued that it strongly influences attentional guidance for natural scenes. They suggest that while both luminance contrast and texture contrast contribute to the calculation of visual salience, their results indicate that texture contrast contributes 10 times more than luminance.

Labrecque and Milne (2013) suggest that contrast between colours is used by rival brands to make the brand more distinctive or eye-catching than its competitors (e.g., Pepsi's use of blue in contrast to Coca-Cola's red). The same colour (red) is used by both to identify the product category and blue is added to contrast with competitors.

3.2.3 Layout

Another factor that appears to be positively influencing the comprehension and appreciation of printed advertising is the effective layout of the various visual elements within the advertisement. Sutcliffe and Namoune (2008) suggest that one of the main components that govern attention is the high-level structural layout of the viewed area. Prior research has also drawn attention to the importance of the visual layout of information. The advantages of an organization of the verbal information on the right side and the pictorial information on the left side (Ellis and Miller 1981), or a presentation format that encourages processing at a preconscious level, like the placement of non-attended pictorial print advertisements to the left of attended material (Janiszewski 1988) have been proposed.

Luca Cian (in Batra et al., 2015) has considered the dimension of verticality in design product, looking at the connections between verticality and power, valence and morality. The author concluded that a layout with a vertical visual positioning can have significant impact on consumers' recognition, interpretation and preferences on information and stimuli.

3.2.4 Proportion, Symmetry, Harmony and Balance

Raghubir and Greenleaf, (2006), have discussed the importance of proportion as a distinctive design element. In their research, they suggest that proportions of a rectangular product or package can have an impact on consumers' preferences and purchase intentions. Apart from research conducted on the design of product packaging, which appears to be an obvious starting point, several researchers have looked at the proportions, symmetry and harmony of the design characteristics of corporate visuals. Mardsen and Thomas (2013) address symmetry in corporate visuals either as an ordering principle reflecting aesthetic balance, or as a metaphor evoking stability and harmony. In their research, they suggest that perceived symmetries can be used to allude to particular organizational values, such as integrity, innovation and perceived teamwork.

3.2.5 Naturalness, Representativeness, Organicity and Roundness

Roundness (or curvature) has been studied as one of the features that are processed preattentively (Treisman, 1986; Foster, 1983). The curvature cue has been proven to be a sufficiently salient feature when is it not concealed by other components, for example when curves from a mouth form a happy or a sad face (Wolfe, 2000; Nothdurft, 1993). The main debate on the issue of curvature is whether human vision can code it as a roundness of shape on its own account, or is it detected as merely a change in orientation. Wolfe et al. (1992) propose that curvature has its own merit as a preattentive feature and is considered one of the visual elements that reflect more naturalness in a design.

Henderson and Cote (1998), Henderson et al. (2003), and van der Lans et al. (2009) have created a framework for looking at features, which have an effect on the perception of naturalness of design. They concentrate on the analysis of company logos and reach the conclusion that the degree of naturalness that a logo exhibits improves the affect towards the logo. Even though, they advise against a logo being too naturalistic (resembling a photograph), their research suggests that natural looking logos are more appealing because they convey more meaning (Henderson and Cote, 1998). Similarly, van der Lans et al. (2009) propose that naturalness has also a positive influence on true recognition, increasing positive affect, shared meaning and subjective familiarity. The conceptual framework from van der Lans et al. (2009) is especially relevant for this study as it addresses the most significant design characteristics for logos and will be analysed further in the following chapters.

3.2.6 Complexity

The notion of visual complexity is closely linked to the basic concept of Gestalt psychology of *good form* and structuralist approaches on understanding human behaviour. The concept revolved around the idea that a person’s behaviour is guided by the information that they pick out of the visual world. Even though, this visual input is seen as nothing more than ‘a spatial distribution of variously coloured individual points’ the information conveys regularities which human perception groups together as unitary forms. Donderi (2006), in his review of the phenomenon describes.

MacInnis, Moorman and Jaworski (1991, pp.36-37) offer a review of how visual complexity can influence communication effectiveness in printed advertisements. They use Berlyne’s (1960) definition of complexity as: ‘*a function of the number of distinguishable elements in the stimulus, the dissimilarity between elements, and the degree to which combinations of stimulus elements are responded to as separate*’. They report how Morrison and Dainoff (1972) have found significantly longer looking times for visually complex than for simple ads; Fleming and Shekhian (1972) propose that complex pictures influence picture memory and Schleuder (1990) found that complexity in ads enhanced attention to the ads and memory. In addition, Cox and Cox (1988) propose that complex ads wear out more slowly than simple ads.

The importance of quantifying and measuring features, such as, visual complexity in advertising, has been more recently discussed by Pieters, Wedel and Batra (2010). In their research they make a distinction between feature complexity and design complexity. They suggest that feature complexity and design complexity have divergent effects on advertising performance. Feature complexity hurts brand attention and attitude toward the advertisement, whereas design complexity helps comprehensibility, attention to the pictorial and to the advertisement as a whole. They propose a methodology tested through eye-tracking where feature complexity is calculated by the file size of the JPEG-compressed visual image of the advertisement and the size reflects the amount of visual clutter in the image. Design complexity is calculated through manually coded measures. When Pieters et al. (2010) discuss the central role of visual complexity in print advertisements, they point out that ‘objective measures are rare'. In their discussion on the two distinct types of complexity the authors use a quantitative approach to try to measure and assess each. As it was stated earlier, the measurement of feature complexity is done computationally by the JPEG algorithm, which is a standard for image compression (Wallace 1991).

As was mentioned previously, Henderson and Cote (1998), Henderson et al. (2003), and van der Lans et al. (2009) address the influence of individual low-level design dimensions on the affect, recognition, recall and meaning of logos for consumers. In their framework, van der Lans et al. (2009), view complexity as a part of the elaborateness of design, and group together complexity, activeness and depth to achieve an overall rating for the elaborateness of design. Complexity is viewed as a combination of characteristics (irregular arrangement of features, variety and number of elements and richness of design). Similarly, the activeness of design is seen as a perception of movement and a creation of an impression of flow and dynamism within the design and it is suggested that it makes a design more interesting. The third design dimension grouped together with complexity and activeness to create the higher-level design dimension of elaborateness, is depth. Within this framework, depth is considered to be the appearance of perspective of a design, namely how much of a 3D effect it seems to have on the viewer. In line with the largest number of studies on design characteristics of corporate visuals the aforementioned researchers have also used, either, experts or groups of consumers to evaluate the design dimensions of their logo database and have concentrated on monochrome logos.

3.3 Efficiency and Consistency in Measuring various Types of Corporate Visuals

According to van den Bosch et al. (2006) one of the main difficulties that arise from the literature examining all aspects of marketing visuals of an organization is how to manage its visual identity and make it more consistent. Melewar and Karaosmanoglu (2006) highlighted that academic researchers are increasingly realizing the significance of developing better measures to analyse its various components in order to be able to examine the way the corporate world expresses itself. In accordance with Cornelissen and Elving (2003), they recognise the *'need for an in-depth analysis to decipher the essence of the corporate identity construct and its derivatives'.* As was discussed earlier, the various components of an organization's visual identity are studied on different levels within marketing literature. Nevertheless, they are present in all corporate efforts to project an organization's identity visually. Whether it is though branding, advertising, product design or product packaging, visual elements have a significant role as cues, which influence any form of internal or external communication.

For this reason, this research proposes an analysis focused on the purely visual structural elements of the corporate visual identity. In marketing literature, visual structural elements functioning as corporate cues have been the object of study from very diverse standing points. The previous section has presented an account of the different visual features that have been studied so far in relation to marketing concepts. A common issue often faced by researchers in similar approaches is how to consistently measure different elements which impact on an organization's visual identity. The need and difficulty of effectively measuring specific formal features of marketing visuals has often come up in the literature.

Very early in the literature of marketing visuals Twedt (1952) remarked on the importance of accurately categorizing data by such pertinent variables as size and colour, especially where large numbers of observations are available. Whittlesea et al. (1990)

concluded that even judgements on seemingly objective features, such as visual clarity, can be influenced by repeated exposure to a stimulus, effectively suggesting that measuring the feature itself in order to relate it with other variables can become complicated. Noël (2000) pointed out that this is especially true when we are trying to determine, and name sensory design elements that are, by default, hard to define '*such as scale, form, mass, texture, colour, […] feel and overall […] cohesiveness*'. In his research, the author proposed that measuring the details of the design, can enhance the precision of the marketing effort, since separate elements can be more efficiently compared with a similarly detailed set of consumer reactions, and relying solely on semiotics to retrieve consumers' connotations attributed to products or experiences may not be enough to construct better measures. A purely semiotic approach, valuable though it may be, it cannot exclude incorrectly worded or chosen attributes, nor can it identify any attributes omitted by the consumers when they are asked to describe the different design dimensions. Orth and Malkewitz (2012) also point out to the fact that these oversights can lead to important informational gaps in the construction of the measures and pose limitations which would ultimately be caused by the lack of an appropriate measuring tool of design elements. What is more, they recognize that even though there are a number of studies which agree that design features are thoroughly related to consumer evaluative judgments, there are only a handful of articles which address *'the accuracy issue from a design or visual stimulus perspective'* (p.422).

The notion of inter-personal consensual accuracy in judgements, also referred to as 'stimulus codability', has been an important issue in research as it can directly impact on the perceived outcome on consumer choice and preferences. Consensus variance cannot be clearly accounted for, and has been known to be affected by elements such as age (Butterfield and Butterfield, 1977), individual abilities (Bloch et al., 2003), motivation (Wyer et al., 2008), personal relevance (Reimann et al., 2010), and culture (Henderson and Cote, 1998). Moreover, the consistency of judgments on design features may be influenced by the nature of the design itself. Previous research is conclusive about how elements like spatial accuracy or the typicality of the design can have a notable impact on judgements. Study no 3 in the research by Orth and Malkewitz (2012) indicates that it is essential to account for any *‘changes in observer distance when examining links between design and brand evaluation’* (p. 432). Similarly, the typicality of design should be taken into consideration, since typical designs are expected to show higher consensual accuracy than less typical designs. Similarly, recognising the challenge of introducing an amount of accuracy in the study of visual complexity as a formal element for capturing consumers’ attention in print advertisements, Pieters et al. (2010) also point out that *‘objective measures are rare’* and attempt to measure their dependent variable (visual complexity) computationally.

Likewise, Myers-Levy and Peracchio (2005) mention yet another issue that may arise when manually coding different technical visual characteristics: the possibility that explicit probing of dependent variables could prevent coders from distinguishing which descriptive concepts are inferred by stylistic properties, as opposed to judgment. Even though suggestions are made on how to avoid this pitfall, there is still reason to question whether the concept will be able to escape circularity during coding, especially in cases where nonexpert coders are used.

Undeniably, a range of experiential information, such as perceptual fluency (Novemsky et al., 2007; Reber et al., 2004) and prior associations (Madsen et al., 2013) can increase the difficulty of measuring a specific visual variable. Madsen et al. (2013), in particular, point out, that it is especially hard to de certain that a variable (e.g. symmetry) is measured on its own merit. As one measure to address this issue, they suggest the use of fabricated, rather than existing symbols, in order to decrease prior associations with the brand marks. However, as it was acknowledged by Veryzer and Hutchinson since 1998, this could pose the risk of basing a judgment on images that have not been previously tested as adequate for entering the real world market. They had remarked on how visual aesthetics and consumers' responses to all aspects of visual properties are challenging areas to study partly due to the difficulty of creating viable stimuli for the relevant constructs.

Following this line of thought, the current research tries to add to the existing literature of methodologies of measuring visual properties by focusing on the specific type of processing which treats formal elements of marketing visuals as primal stimuli, whether for their attention-capturing properties or as part of an affective aesthetic experience. Working alongside with expert coders, the existence of objective and reliable measurement tools which can be applied to every type of corporate-related visual is believed to significantly increase the efficiency and accuracy of measurements of any visual elements. At this point, it should be stated that a distinction between form and content of the visuals, albeit not true in actual examples, can prove extremely useful rhetorically and analytically, for it allows an objective insight on how marketing imagery can be consistently synthesised, categorized and measured.

3.4 A Computational Aesthetics Methodology for Corporate Logotypes

This section discusses more specifically the main elements of the methodology used in the thesis with respect to the computational aesthetics measures of corporate visuals. The choice of measures follows Haas et al. (2015) and is based on three recent comprehensive studies of computational aesthetics for picture and painting evaluation (Datta et al., 2006; Ke et al. 2006; Li and Chen, 2009). In total, 107 measures are considered which aim to quantify the intensity and the contrast of colour, position and size of distinct objects and the texture in an image. Measures can be grouped in two major categories with respect to if they capture global or local features. The first are derived by analysing all the pixels in the picture while the second concentrate on specific segments or objects. The measures of global and local features will be discussed in subsequent sections and are outlined in Table 3.4.1. and Table 3.4.2., respectively. The presentation of the methodology below follows that of Haas et al. (2015) with the discussion being simplified as to reach a wider audience. Each aesthetic measure is represented with FTR_i for $i = 1,2,\ldots,107$.

3.4.1 Colour

The different aspects of colour have a significant impact of how an image is perceived by the human brain. In this context, the first set of measures represents the colour tones, saturation, value and lightness of an image. To compute these measures, the image files should first be converted to the so-called HSV and HSL spaces, respectively, where HSV (L) stands for Hue, Saturation and Value (Lightness). The outcome of this procedure is a set of M x N matrices for each image representing the values of these properties for each pixel, where M x N is the total number of pixels in the image. These matrices are denoted as $I_H(m, n)$, $I_S(m, n)$ and $I_V(m, n)$ in the HSV space and $I_{H\_}(m, n)$, $I_{S\_}(m, n)$ and $I_{L\_}(m, n)$ in the HSL space, respectively, where *(m,n)* is the corresponding pixel. The average values of hue, saturation, value and lightness are then computed in each of the two spaces with:

$$\text{FTR}_1 = \frac{1}{MN} \sum_n \sum_m I_H(m, n) \tag{3.1}$$

$$\text{FTR}_2 = \frac{1}{MN} \sum_n \sum_m I_S(m, n) \tag{3.2}$$

$$\text{FTR}_3 = \frac{1}{MN} \sum_n \sum_m I_V(m, n) \tag{3.3}$$

$$\text{FTR}_4 = \frac{1}{MN} \sum_n \sum_m I_{S\_}(m, n) \tag{3.4}$$

$$\text{FTR}_5 = \frac{1}{MN} \sum_n \sum_m I_{L\_}(m, n) \tag{3.5}$$

where the average is taken across all pixels in the image. The colourfulness of an image is measured using the relative colour distribution. This measures the distance of the colour distribution of the image of interest from the ideal colour distribution. The smaller this distance, the more colourful the image is. The distance can be measured in two ways. The first (FTR_6) relies on the quadratic-form distance (Ke et al., 2006) and the second (FTR_7) uses the Earth Mover's Distance (Rubner et al., 2000).

As an alternative way to evaluate colourfulness, a series of hue-focused measures that have been proposed by Li and Chen (2009), Ke et al. (2006) and Haas et al. (2015) can be adopted. These are the most observed hue in the image (FTR_8), the standard deviation of the colourfulness (FTR_9), the present (FTR_{10}) and missing (FTR_{11}) number of hues, the contrast of hue in the image (FTR_{12}), the contrast between hues missing (FTR_{13}), the number of pixels of most frequent hue (FTR_{14}), and, the number of significant hues (FTR_{15}).

Table 3.4.1. Global Measures of Computational Aesthetics

Feature	Aspect of image	Brief description
FTR_1	Colour	Mean hue in HSV colour space
FTR_2	Colour	Mean saturation in HSV colour space
FTR_3	Colour	Mean value in HSV colour space
FTR_4	Colour	Mean saturation in HSL colour space
FTR_5	Colour	Mean brightness in HSL colour space
FTR_6	Colour	Colourfulness (quadratic-form distance)
FTR_7	Colour	Colourfulness (earth mover's distance)
FTR_8	Colour	Value of most frequent hue in image
FTR_9	Colour	Dispersion (Standard deviation) of colourfulness
FTR_{10}	Colour	Number of hues contained in image
FTR_{11}	Colour	Number of hues not present in image
FTR_{12}	Colour	Hue contrast
FTR_{13}	Colour	Contrast between hues not present
FTR_{14}	Colour	Number of pixels belonging to most frequent hue in image
FTR_{15}	Colour	Number of significant hues
FTR_{16}	Colour	Distance to 1st hue model
FTR_{17}	Colour	Distance to 2nd hue model
FTR_{18}	Colour	Distance to 3rd hue model
FTR_{19}	Colour	Distance to 4th hue model
FTR_{20}	Colour	Distance to 5th hue model
FTR_{21}	Colour	Distance to 6th hue model
FTR_{22}	Colour	Distance to 7th hue model
FTR_{23}	Colour	Distance to 8th hue model
FTR_{24}	Colour	Distance to 9th hue model
FTR_{25}	Colour	Best fitting hue model out of 1 to 9
FTR_{26}	Colour	Arithmetic Mean of brightness
FTR_{27}	Colour	Logarithmic Mean of brightness
FTR_{28}	Colour	Brightness contrast of image using 100 bin histogram
FTR_{29}	Colour	Brightness contrast of image using 255 bin histogram
FTR_{30}	Texture	Area of bounding box containing 81% of edge energy
FTR_{31}	Texture	Sum of edges
FTR_{32}	Texture	Range of texture
FTR_{33}	Texture	Dispersion (Mean standard deviation) of texture
FTR_{34}	Texture	Entropy of red matrix I_r
FTR_{35}	Texture	Entropy of green matrix I_g
FTR_{36}	Texture	Entropy of blue matrix I_b
FTR_{37}	Texture	Wavelet feature level 1 for H
FTR_{38}	Texture	Wavelet feature level 2 for H
FTR_{39}	Texture	Wavelet feature level 3 for H
FTR_{40}	Texture	Wavelet feature level 1 for S
FTR_{41}	Texture	Wavelet feature level 2 for S
FTR_{42}	Texture	Wavelet feature level 3 for S
FTR_{43}	Texture	Wavelet feature level 1 for V
FTR_{44}	Texture	Wavelet feature level 2 for V
FTR_{45}	Texture	Wavelet feature level 3 for V
FTR_{46}	Texture	Wavelet feature level 1 (avg)
FTR_{47}	Texture	Wavelet feature level 2 (avg)
FTR_{48}	Texture	Wavelet feature level 3 (avg)

Li and Chen (2009) and Haas et al. (2015) further propose to measure the aesthetic value of an image related to the colours by fitting the image in a series of 9 colour models. In this way, one can identify whether the distribution of the colour follows a specific pattern. If $F_{i,\alpha}$ stands for the distance between the image of interest and the i model rotated with an angle a, then Haas et al. (2015) end up with following features:

$$\mathrm{FTR}_{15+i} = \min_{\alpha} F_{i,\alpha}, \tag{3.6}$$

for $i = \{1,2,\ldots,9\}$. The best fitting model (FTR_{25}) is also computed. The levels of brightness of an image is one of the key influences in the human perception of an image. Two main measures of brightness are the arithmetic average (FTR_{26}) and the logarithmic average (FTR_{27}) of brightness:

$$\mathrm{FTR}_{26} = \frac{1}{MN} \sum_m \sum_n L(m, n) \tag{3.7}$$

$$\mathrm{FTR}_{27} = exp(\frac{255}{MN} \sum_m \sum_n log(\epsilon + \frac{L(m,n)}{255})) \tag{3.8}$$

for $L(m; n) = (I_r(m; n) + I_g(m; n) + I_b(m; n))/3$ being the average of the R, G, and B channels of the image, respectively (Li and Chen, 2009). One advantage of the logarithmic average is that it can capture the dynamic range of the brightness. Finally, the contrast of brightness across the image can be calculated in two manners as proposed by Li and Chen (2009) (FTR_{28}) and

Ke et al. (2006) (FTR_{29}), respectively. The contrast of brightness allows to examine whether the uniformity of an image has any aesthetic effect.

3.4.2 Texture

Texture analysis allow us to quantify the smoothness of an image. The first simple measures in this category reflect the distribution of the edges. The intuition is that when a painter wishes to highlight an object, this usually has a higher number of edges. One can assess the distribution of the edges by considering a bounding box that encapsulates a prefixed portion of the edge energy of the image. Li and Chen (2009) determine that the smallest bounding box accounts for 81% of the energy of the edge and so propose the following feature:

$$FTR_{30} = H_{90}W_{90}/HW \tag{3.8}$$

where H_{90} (W_{90}) stands for the height(width) of the bounding box and H (W) denotes the width of the image. Alternatively, the "sum of edges" measure developed by Haas et al. (2015) (FTR_{31}) can be used where a Sobel matrix is constructed for each of the three colour channels. Then, the "sum of edges" measure can be calculated as the sum of the L1 norms of the three Sobel matrices.

Haas et al. (2015) further consider five novel aesthetic texture-focused measures. The first two respectively represent the range (FTR_{32}) and the standard deviation of the texture (FTR_{33}). The rest evaluate the randomness of a picture through the entropy measure which is calculated for each of the three colour channels:

$$FTR_{34} = entropy(I_R) \quad (3.9)$$

$$FTR_{35} = entropy(I_G) \quad (3.10)$$

$$FTR_{36} = entropy(I_B) \quad (3.11)$$

The wavelet transformation of Datta et al. (2006) is an alternative approach to analyse the smoothness of an image. The authors use a three-level wavelet transformation in each of the colour band matrices $I_H(m, n)$, $I_S(m, n)$ and $I_V(m, n)$ and end up with three features for each level of the transformation and for each band. Let FTR_{37}, FTR_{38} and FTR_{39} be respectively the first-, second- and third-level transformation for I_H, FTR_{40}, FTR_{41} and FTR_{42} be respectively the first-, second- and third-level transformation for I_S *and* FTR_{43}, FTR_{44} and FTR_{45} be respectively the first-, second- and third-level transformation for I_V. The average across level for each colour band matrix can also be calculated. This is denoted as FTR_{46}, FTR_{47} and FTR_{48} for $I_H(m, n)$, $I_S(m, n)$ and $I_V(m, n)$, respectively.

A blurrier image is generally considered inferior to a sharper one, all else being equal. In this context, the final global measure in this category (denoted as FTR_{49}) quantifies the blurriness of an image as proposed by Ke et al. (2006) and Li and Chen (2009), applied with the modification developed by Haas et al. (2015).

3.4.3 Rule of Thirds and Focused Region

The rule of thirds, a popular concept in professional photography, separates a composition in 9 equal rectangles. Then, the "rule of thirds" feature aims to measure the average hue in the central rectangle and is defined as

$$FTR_{50} = \frac{1}{\left(\left\lceil\frac{2M}{3}\right\rceil - \left\lceil\frac{M}{3}\right\rceil + 1\right)\left(\left\lceil\frac{2N}{3}\right\rceil - \left\lceil\frac{N}{3}\right\rceil + 1\right)} \sum_{m=\left\lceil\frac{M}{3}\right\rceil}^{\left\lceil\frac{2M}{3}\right\rceil} \sum_{n=\left\lceil\frac{N}{3}\right\rceil}^{\left\lceil\frac{2N}{3}\right\rceil} I_H(m, n) \quad (3.12)$$

If I_H is replaced with I_S and I_V, the average saturation and value for the central portion of the image is derived (which is denoted with FTR_{51} and FTR_{52}). A similar set of features is proposed by Li and Chen (2009) who use the HSL space, and instead, suggest to expand the central region by a small percentage. They call the expanded region, focused region (FR). They then compute in a similar way the average hue, saturation and lightness in *FR*. The respective features is denoted by FTR_{53}, FTR_{54} and FTR_{55}.

3.4.4 Segmentation

Datta et al. (2006) apply a segmentation method to examine the important objects of an image. Using this method, Haas et al. (2012) identify the list of connected segments *L* in each picture and denote the five largest with $s_1, \ldots, s_5$, respectively. Then, they compute a set of features for the 3 or 5 largest segments. The first feature corresponds to the number of segments in *L* (FTR_{56}) and indicates the complexity of the picture. The next feature measures the number of segments above a given threshold (FTR_{57}). Features FTR_{58} to FTR_{62} in this work represent the size of the largest segments while the position of the five largest segments is determined using the rule of thirds and respectively represented by the features (FTR_{63} to FTR_{67}).

The colour properties of the five largest segments can be reflected in their average hue, saturation, value and brightness, which the related features respectively denoted with FTR_{68}-FTR_{72}, FTR_{73}- FTR_{77}, FTR_{78}-FTR_{82} and FTR_{83}-FTR_{85}. Using these measures, one can compute the average colour spread (FTR_{86}) and the average complementarity of colours (FTR_{87}) for the top 5 patch hues.

Table 3.4.2. Local Measures of Computational Aesthetics

Feature	Aspect of Image	Description
FTR_{49}	Texture	Measure of blur
FTR_{50}	Colour	Mean hue (using rule of thirds with HSV)
FTR_{51}	Colour	Mean saturation (using rule of thirds with HSV)
FTR_{52}	Colour	Mean value (using rule of thirds with HSV)
FTR_{53}	Colour	Mean hue for focus region (with HSL)
FTR_{54}	Colour	Mean saturation for focus region (with HSL)
FTR_{55}	Colour	Mean brightness for focus region (with HSL)
FTR_{56}	Objects	Number of colour-based clusters formed by K-Means (LUV)
FTR_{57}	Objects	Number of segments s_i that are larger than 1% of the image (i in [1,5])
FTR_{58}	Objects	Size of largest segment divided by size of entire image
FTR_{59}	Objects	Size of 2nd largest segment divided by size of entire image
FTR_{60}	Objects	Size of size of 3rd largest segment divided by size of entire image
FTR_{61}	Objects	Size of 4th largest segment divided by size of entire image
FTR_{62}	Objects	Size of 5th largest segment divided by size of entire image
FTR_{63}	Objects	Block which contains centroid of 1st cluster
FTR_{64}	Objects	Block which contains centroid of 2nd cluster
FTR_{65}	Objects	Block which contains centroid of 3rd cluster
FTR_{66}	Objects	Block which contains centroid of 4th cluster
FTR_{67}	Objects	Block which contains centroid of 5th cluster
FTR_{68}	Objects	Mean hue for largest segment (HSV)
FTR_{69}	Objects	Mean hue for 2nd largest segment (HSV)
FTR_{70}	Objects	Mean hue for 3rd largest segment (HSV)
FTR_{71}	Objects	Mean hue for 4th largest segment (HSV)
FTR_{72}	Objects	Mean hue for 5th largest segment (HSV)
FTR_{73}	Objects	Mean saturation for the largest segment (HSV)
FTR_{74}	Objects	Mean saturation for the 2nd largest segment (HSV)
FTR_{75}	Objects	Mean saturation for the 3rd largest segment (HSV)
FTR_{76}	Objects	Mean saturation for the 4th largest segment (HSV)
FTR_{77}	Objects	Mean saturation for the 5th largest segment (HSV)
FTR_{78}	Objects	Mean value for the largest segment (HSV)
FTR_{79}	Objects	Mean value for the 2nd largest segment (HSV)
FTR_{80}	Objects	Mean value for the 3rd largest segment (HSV)
FTR_{81}	Objects	Mean value for the 4th largest segment (HSV)
FTR_{82}	Objects	Mean value for the 5th largest segment (HSV)
FTR_{83}	Objects	Mean brightness for the largest segment (HSV)
FTR_{84}	Objects	Mean brightness for the 2nd largest segment (HSV)
FTR_{85}	Objects	Mean brightness for the 3rd largest segment (HSV)
FTR_{86}	Colour	Mean colour spread across top the 5 patch hues
FTR_{87}	Colour	Mean complimentary colours across the top 5 patch hues
FTR_{88}	Objects	Horizontal coordinate for mass centre of the largest segment
FTR_{89}	Objects	Horizontal coordinate for mass centre of the 2nd largest segment
FTR_{90}	Objects	Horizontal coordinate for mass centre of the 3rd largest segment
FTR_{91}	Objects	Vertical coordinate for mass centre of the largest segment
FTR_{92}	Objects	Vertical coordinate for mass centre of the 2nd largest segment
FTR_{93}	Objects	Vertical coordinate for mass centre of the 3rd largest segment
FTR_{94}	Objects	Mass dispersion (variance) for the largest segment
FTR_{95}	Objects	Mass variance for the 2nd largest segment
FTR_{96}	Objects	Mass variance for the 3rd largest segment
FTR_{97}	Objects	Mass skewness for the largest segment
FTR_{98}	Objects	Mass skewness for the 2nd largest segment
FTR_{99}	Objects	Mass skewness for the 3rd largest segment
FTR_{100}	Objects	Shape convexity
FTR_{101}	Objects	Hue contrast between image segments
FTR_{102}	Objects	Saturation contrast between image segments
FTR_{103}	Objects	Brightness contrast between image segments
FTR_{104}	Objects	Blur contrast between image segments
FTR_{105}	Texture	Low depth for field indicator for hue in HSV
FTR_{106}	Texture	Low depth for field indicator for saturation in HSV
FTR_{107}	Texture	Low depth for field indicator for value in HSV

Datta et al. (2006) further propose a set of aesthetic measures that are based on the idea that the shape of an object affects its aesthetic value. Their hypothesis is that convex and symmetric shapes are more pleasing to the eye than concave or irregular shapes. To evaluate the shape of the segments, following Dass et al., Haas et al. (2015) calculate the horizontal coordinate of the mass centre (FTR_{88}-FTR_{90}), the vertical coordinate of the mass centre (FTR_{91}- FTR_{93}), the variance of the mass (FTR_{94}-FTR_{96}) and the skewness of the mass (FTR_{97}-FTR_{99}) for each one of the three largest segments. They also compute the percentage area of the image that is filled with convex shapes (FTR_{100}) to identify how important such shapes to the image of interest.

The final segmentation-based measures considered include features FTR_{101}–FTR_{104} that respectively measure the contrast of the hue, of the saturation, of the brightness contrast and of the blurriness across the 5 largest segments.

3.4.5 Low Depth of Field Indicators

The four final measures are drawn from Datta et al. (2006) and are based on the hypothesis that simple pictures with a focused centre can be more attractive to the human eye. These features aim to identify if there is low depth of field for the hue (FTR_{105}), the saturation (FTR_{106}) and the value (FTR_{107}).

Chapter 4. Empirical Analysis

4.1 Measuring Elements of Logo Design using Computational Aesthetics

This study uses an extensive set of computational aesthetic measures to measure the design elements in a sample of logos. In a related study, Henderson and Cote (1998), factorised subjective assessments of logo design elements in line with a theoretical framework of eight elements corresponding to harmony, elaborateness and naturalness (this was later extended by Lans et al., 2009). The present study adopts the same theoretical framework but differs in at least two significant ways.

First, rather than using subjective measures, a large set of objective measures is employed from the computational and experimental aesthetics literature. As discussed earlier, such measures have a number of advantages in terms of efficiency, consistency and accuracy. Second, the present study addresses a serious limitation of Henderson and Cote (1998) by accounting for design elements related to colour. This is the first study in marketing that uses computational aesthetics measures for information related to colour. Computational aesthetic measures for logo design assessment have also been used in a recent study by Zhang et al. (2017). This study shares the same limitation as Henderson and Cote (1998) in that colour is ignored in the analysis of logos. Moreover, only three computational aesthetic measures are calculated without theoretical framing and with very limited inferential statistical analysis.

4.1.1 Introduction

Drawing on the tradition of Berlyne (1971) and Dondis (1973), of examining individual components of the visual process in their most simplified form, Henderson and Cote (1998) have suggested a conceptual framework for analyzing characteristics that are critical for logo design. The authors point to the fact that a selection of logos with low recognisability, negative evaluations and lack of associations with the brand, have been proven to be damaging for the overall evaluations of the company. Their study was the first in the literature to suggest a comprehensive set of selection or modification guidelines for logos based on specific design characteristics that were hypothesised to influence affective responses. The authors also recognize the conflict that arises from the study of visual elements from different theoretical standpoints that make equal claims of value for comprehending visuals. Yet, even though they highlight that most suggestions in the graphic design paradigm are based on practice and experience from the industry and not on theoretical underpinnings, they accept the premise that *‘Designs thought to possess "good form" typically are liked more than other designs’* (Henderson and Cote, 1998, p.18). In their study, they chose a standard methodological approach for empirically studying design elements, adopted from experimental aesthetics. Using suggestions from two professional graphic designers, they identified thirteen design elements from a long list proposed by Dondis (1973).

This list was derived in turn from suggestions by the design experts as critical for logo design. Three judges were used to select logos that would include an extensive range of design characteristics. Graphic designers were also used to rate the following specific elements: activeness, complexity, cohesiveness, depth, organicity, representativeness, roundness and symmetry. Finally, the authors suggested to reduce the various stimuli ratings to their *‘underlying dimensions’* and arrived at the conclusion that the most significant design characteristics for logo design are the following: Naturalness (containing Representativeness and Organicity), Harmony (containing Balance and Symmetry) and Elaborateness (containing Complexity, Activeness and Depth). Parallelism, Proportion, Repetition and Roundness were also measured. The research from Henderson and Cote (1998) was an important first step for measuring and analyzing formal visual characteristics of logos, and it is seen as a key for brands for harnessing the power of visual reflex for enhancing brand recognition, affect and familiarity.

As was discussed earlier, using the conceptual framework of logo design evaluation proposed by Henderson and Cote (1998) the present study investigates the design characteristics for every logo. Three design dimensions are considered: elaborateness, naturalness and harmony, each of which is subdivided to a number of subjective elements. Elaborateness consists of Complexity, Activeness and Depth; Naturalness consists of Representativeness, Organicity and Roundness; and, Harmony consists of Symmetry and Balance. As the aim of this study is to provide a tool to increase the consistency of measurements of perceived visual characteristics, all variables are treated as equal in our measurements. All characteristics are measured computationally on their own merit.

4.1.2 Sample description

The list of logos has been sourced from the public access website of the Global Brand Database supported by the World Intellectual Property Organization (WIPO). In agreement with the WIPO Terms and Conditions, the information used in this research was not obtained through bulk acquisition or downloading, and the list of logos was compiled through the performance of separate queries. According to section 29A of the Copyright, Designs and Patents Act 1988 (CDPA), their intended use is solely for non-commercial, academic research purposes and they are included in this research with the following disclaimer, according to the organization's guidelines: "*The World Intellectual Property Organization (WIPO) bears no responsibility for the integrity or accuracy of the data contained herein, in particular due, but not limited, to any deletion, manipulation, or reformatting of data that may have occurred beyond its control.*"

The sample was selected from a total of 36,790,000 records from some 40 national and international collections. Filtering options include: source country, image, status, origin, application year, expiration year, trademark class under the Nice Classification, registration year, image class under the U.S. or Vienna Classifications, rights-holder, and countries chosen for protection. The database can be used to spot branding trends over time, or across certain business sectors, countries or regions. The sample selection was undertaken as following.

First, the records with complete images were selected which resulted in over 48,000 entries. There were additional difficulties for arriving at a final sample of suitable images. The images contained in the Global Brand Database consist not only of the official corporate logotypes, but of various types of corporate images categorized under the general heading of 'trademarks'. Thus, the queries returned a large amount of images that would not fit the criteria of inclusion in this study. The 48,000 entries had to be checked individually to eliminate trademarks such as shapes and pictures of packaging of goods, colour shades used as distinguishing features, armorial bearings, flags and other emblems, which are included in the database.

Second, logos for larger companies (as defined by turnover) were excluded from the sample. This was done in order to reduce the possibility that the team of design experts would be very familiar with a lot of them. Not all possibly familiar logos were excluded, as one of the important aspects of this study is that the sample needs to be representative of the logos encountered in a market environment. This was also the reason behind the choice of including logos that companies are actively using. Third, logos containing words, company names, acronyms and other textual elements as part of the logo design were excluded. Fourth, a random sample was selected out of the remaining logos in a manner that ensured that a wide range of design characteristics and graphic styles was included. Finally, a thorough check was conducted for each individual logo to verify that it was the official version, currently used on the company website. This signifies that all logos have been through a thorough vetting process and selection and deemed appropriate to enter the market. Once the logos were identified, the properties of each image had to be checked again individually in order to assure that the resolution of the image files was:

a. adequately high i.e. providing enough detail and clarity (a generally accepted standard minimum is between 200x200 pixels), and

b. similar across images, making the files comparable between them and ensuring that the results of the computational analysis would be not compromised by large variances in resolution, as according to Yu & Winkler (2013) large differences in spatial information can impact the results of computationally calculated measures such as complexity.

At this point it must be specified that the term resolution commonly refers to the level of detail that each image has stored. High resolution images, for example, include much more detail than low resolution images, i.e. the quality of the image is denser. This does not refer to the output/display resolution (dpi) of an image, which depends on the screen it is displayed on, or the printing process. It has to do with the amount of units of information per dimensional unit. This restriction eliminated a large number of images, as a large proportion of the logos submitted for inclusion in the database were of low resolution. The final sample of 215 logos is presented in the Appendix.

It is important to note that for the logos in the sample only nine out of the 215 are pure black and white and a further two are in grayscale. The previous research on logos by Henderson and Cote (1998) and Zhang et al. (2017) converted logos to black and white prior to the analysis. Given that colour is a common feature of logos, ignoring this characteristic may bias their analysis. The research approach in this thesis has a significant advantage in this respect as it explicitly accounts for colour through several computational aesthetics measures.

4.1.3 Descriptive Statistics

In order to estimate the computational aesthetic measures for our logos, the Matlab code provided by Haas et al. (2015) was adapted for the purpose of this study. These measures are originally drawn from three of the most comprehensive studies of computational aesthetics for picture and painting evaluation (Datta et al., 2006; Ke et al. 2006; Li and Chen, 2009). The 107 estimated measures (FTR1 to FTR107), which are discussed in the methodology section, are summarised in Table 4.1.1. The table also provides information on overall feature groupings with respect to colour, texture and objects.

Table 4.1.1. Computational Aesthetic Measures

Feature	Aspect	Description	Feature	Aspect	Description
FTR$_{1}$	Colour	Mean hue in HSV colour space	FTR$_{55}$	Colour	Mean brightness for focus region (with HSL)
FTR$_{2}$	Colour	Mean saturation in HSV colour space	FTR$_{56}$	Colour	Number of colour-based clusters formed by K-Means (LUV)
FTR$_{3}$	Colour	Mean value in HSV colour space	FTR$_{57}$	Objects	Number of segments s_i that are larger than 1% of the image (i in [1,5])
FTR$_{4}$	Colour	Mean saturation in HSL colour space	FTR$_{58}$	Objects	Size of largest segment divided by size of entire image
FTR$_{5}$	Colour	Mean brightness in HSL colour space	FTR$_{59}$	Objects	Size of 2nd largest segment divided by size of entire image
FTR$_{6}$	Colour	Colourfulness (quadratic-form distance)	FTR$_{60}$	Objects	Size of size of 3rd largest segment divided by size of entire image
FTR$_{7}$	Colour	Colourfulness (earth mover's distance)	FTR$_{61}$	Objects	Size of 4th largest segment divided by size of entire image
FTR$_{8}$	Colour	Value of most frequent hue in image	FTR$_{62}$	Objects	Size of 5th largest segment divided by size of entire image
FTR$_{9}$	Colour	Dispersion (Standard deviation) of colourfulness	FTR$_{63}$	Objects	Block which contains centroid of 1st cluster
FTR$_{10}$	Colour	Number of hues contained in image	FTR$_{64}$	Objects	Block which contains centroid of 2nd cluster
FTR$_{11}$	Colour	Number of hues not present in image	FTR$_{65}$	Objects	Block which contains centroid of 3rd cluster
FTR$_{12}$	Colour	Hue contrast	FTR$_{66}$	Objects	Block which contains centroid of 4th cluster
FTR$_{13}$	Colour	Contrast between hues not present	FTR$_{67}$	Objects	Block which contains centroid of 5th cluster
FTR$_{14}$	Colour	Number of pixels belonging to most frequent hue in image	FTR$_{68}$	Objects (Colour)	Mean hue for largest segment (HSV)
FTR$_{15}$	Colour	Number of significant hues	FTR$_{69}$	Objects (Colour)	Mean hue for 2nd largest segment (HSV)
FTR$_{16}$	Colour	Distance to 1st hue model	FTR$_{70}$	Objects (Colour)	Mean hue for 3rd largest segment (HSV)
FTR$_{17}$	Colour	Distance to 2nd hue model	FTR$_{71}$	Objects (Colour)	Mean hue for 4th largest segment (HSV)
FTR$_{18}$	Colour	Distance to 3rd hue model	FTR$_{72}$	Objects (Colour)	Mean hue for 5th largest segment (HSV)
FTR$_{19}$	Colour	Distance to 4th hue model	FTR$_{73}$	Objects (Colour)	Mean saturation for the largest segment (HSV)
FTR$_{20}$	Colour	Distance to 5th hue model	FTR$_{74}$	Objects (Colour)	Mean saturation for the 2nd largest segment (HSV)
FTR$_{21}$	Colour	Distance to 6th hue model	FTR$_{75}$	Objects (Colour)	Mean saturation for the 3rd largest segment (HSV)
FTR$_{22}$	Colour	Distance to 7th hue model	FTR$_{76}$	Objects (Colour)	Mean saturation for the 4th largest segment (HSV)
FTR$_{23}$	Colour	Distance to 8th hue model	FTR$_{77}$	Objects (Colour)	Mean saturation for the 5th largest segment (HSV)
FTR$_{24}$	Colour	Distance to 9th hue model	FTR$_{78}$	Objects (Colour)	Mean value for the largest segment (HSV)
FTR$_{25}$	Colour	Best fitting hue model out of 1 to 9	FTR$_{79}$	Objects (Colour)	Mean value for the 2nd largest segment (HSV)
FTR$_{26}$	Colour	Arithmetic Mean of brightness	FTR$_{80}$	Objects (Colour)	Mean value for the 3rd largest segment (HSV)
FTR$_{27}$	Colour	Logarithmic Mean of brightness	FTR$_{81}$	Objects (Colour)	Mean value for the 4th largest segment (HSV)
FTR$_{28}$	Colour	Brightness contrast of image using 100 bin histogram	FTR$_{82}$	Objects (Colour)	Mean value for the 5th largest segment (HSV)
FTR$_{29}$	Colour	Brightness contrast of image using 255 bin histogram	FTR$_{83}$	Objects (Colour)	Mean brightness for the largest segment (HSV)
FTR$_{30}$	Colour	Area of bounding box containing 81% of edge energy	FTR$_{84}$	Objects (Colour)	Mean brightness for the 2nd largest segment (HSV)
FTR$_{31}$	Colour	Sum of edges	FTR$_{85}$	Objects (Colour)	Mean brightness for the 3rd largest segment (HSV)
FTR$_{32}$	Colour	Range of texture	FTR$_{86}$	Colour	Mean colour spread across top the 5 patch hues
FTR$_{33}$	Texture	Dispersion (Mean standard deviation) of texture	FTR$_{87}$	Colour	Mean complimentary colours across the top 5 patch hues
FTR$_{34}$	Texture	Entropy of red matrix I_r	FTR$_{88}$	Objects	Horizontal coordinate for mass centre of the largest segment
FTR$_{35}$	Texture	Entropy of green matrix I_g	FTR$_{89}$	Objects	Horizontal coordinate for mass centre of the 2nd largest segment
FTR$_{36}$	Texture	Entropy of blue matrix I_b	FTR$_{90}$	Objects	Horizontal coordinate for mass centre of the 3rd largest segment
FTR$_{37}$	Texture	Wavelet feature level 1 for H	FTR$_{91}$	Objects	Vertical coordinate for mass centre of the largest segment
FTR$_{38}$	Texture	Wavelet feature level 2 for H	FTR$_{92}$	Objects	Vertical coordinate for mass centre of the 2nd largest segment
FTR$_{39}$	Texture	Wavelet feature level 3 for H	FTR$_{93}$	Objects	Vertical coordinate for mass centre of the 3rd largest segment
FTR$_{40}$	Texture	Wavelet feature level 1 for S	FTR$_{94}$	Objects	Mass dispersion (variance) for the largest segment
FTR$_{41}$	Texture	Wavelet feature level 2 for S	FTR$_{95}$	Objects	Mass variance for the 2nd largest segment
FTR$_{42}$	Texture	Wavelet feature level 3 for S	FTR$_{96}$	Objects	Mass variance for the 3rd largest segment
FTR$_{43}$	Texture	Wavelet feature level 1 for V	FTR$_{97}$	Objects	Mass skewness for the largest segment
FTR$_{44}$	Texture	Wavelet feature level 2 for V	FTR$_{98}$	Objects	Mass skewness for the 2nd largest segment
FTR$_{45}$	Texture	Wavelet feature level 3 for V	FTR$_{99}$	Objects	Mass skewness for the 3rd largest segment
FTR$_{46}$	Texture	Wavelet feature level 1 (avg)	FTR$_{100}$	Objects	Shape convexity
FTR$_{47}$	Texture	Wavelet feature level 2 (avg)	FTR$_{101}$	Objects (Colour)	Hue contrast between image segments
FTR$_{48}$	Texture	Wavelet feature level 3 (avg)	FTR$_{102}$	Objects (Colour)	Saturation contrast between image segments
FTR$_{49}$	Texture	Measure of blur	FTR$_{103}$	Objects (Colour)	Brightness contrast between image segments
FTR$_{50}$	Colour	Mean hue (using rule of thirds with HSV)	FTR$_{104}$	Objects	Blur contrast between image segments
FTR$_{51}$	Colour	Mean saturation (using rule of thirds with HSV)	FTR$_{105}$	Texture	Low depth for field indicator for hue in HSV
FTR$_{52}$	Colour	Mean value (using rule of thirds with HSV)	FTR$_{106}$	Texture	Low depth for field indicator for saturation in HSV
FTR$_{53}$	Colour	Mean hue for focus region (with HSL)	FTR$_{107}$	Texture	Low depth for field indicator for value in HSV
FTR$_{54}$	Colour	Mean saturation for focus region (with HSL)			

Table 4.1.2. associates each one of the computational metrics considered with the three essential design characteristics that Henderson and Cote (1998) identified: Elaborateness, Naturalness and Harmony. As in Henderson and Cote (1998), no theory was used to guide this grouping but association was led following discussions with expert designers. It was also informed by the literature review and how design elements have been discussed by others.

Table 4.1.2. Computational aesthetic measure design elements

Natural	The relation to objects that are commonly experienced. Natural logos are non-abstract and representative. They are organic and consist of natural shapes including irregular curves, non-geometric, non-angular designs.	Roundness (100) Hue models (16-25) Measures of blur (49) Average complementary colours (87) Coordinate of mass centre for segments (88-99) Measures of Objects (56-67)
Harmony	Related to the arrangement of parts in a symmetrical and balanced manner.	Rule of thirds measures (50-52, 59-67) Ratios between elements (57-62) Hue models (16-25) Average complementary colours (87) Coordinate of mass centre for segments (88-99)
Elaborate	Reflects design richness in terms of complexity, activeness and depth. It corresponds also to irregularity, a large number of elements, heterogeneity and ornateness.	Measures of texture (30-49) Measures of variance (9, 32, 33, 94, 104) Number of elements (10, 15, 56, 57) Depth (105-107) Measures of blur (49)

The next step is a descriptive analysis of the data, which is summarised in Tables 4.1.3a. and 4.1.3b., respectively. Out of all the variables, 11 take discrete values while the remaining are measured on a continuous scale. Variables are very different in terms of central tendency and dispersion with a wide range in the coefficient of variation (CV). A significant conclusion from the descriptive analysis is that the third and fourth moment suggest that most distributions deviate significantly from normality. Specifically, 48 variables are negatively skewed, and 61 have excess kurtosis compared to a normal distribution. A Jarque-Bera (1980) test rejects normality for 90 of the variables in our sample at a 5% significance level. The descriptive statistics motivate the inspection of the distributions in order to get a better understanding of the behaviour in the data.

Table 4.1.3a. Descriptive Statistics of Computational Measures in sample of logos

	Mean	Median	Max	Min	StDev	CV	Skew	Kurt	JB	Prob
FTR1	0.3046	0.2998	0.8456	0.0061	0.1577	0.5177	0.4657	3.1304	7.33	0.0255
FTR2	0.4040	0.3911	0.9410	0.0040	0.1727	0.4275	0.2381	3.1044	1.97	0.3732
FTR3	0.7816	0.8021	0.9943	0.3539	0.1381	0.1767	-0.7081	2.9282	16.67	0.0002
FTR4	0.5237	0.5376	0.9568	0.0028	0.1865	0.3561	-0.2002	3.0630	1.36	0.5060
FTR5	0.6609	0.6689	0.9461	0.2643	0.1314	0.1988	-0.5497	3.0901	10.09	0.0064
FTR6	0.4594	0.4456	0.7292	0.2400	0.0907	0.1974	0.4118	2.9169	5.68	0.0584
FTR7	53.9120	53.4629	96.1089	30.5383	9.0715	0.1683	1.0541	6.1394	118.57	0.0000
FTR8	0.5077	0.5676	0.9993	0.0000	0.3411	0.6719	0.0069	1.7923	12.09	0.0024
FTR9	0.0288	0.0212	0.0964	0.0000	0.0241	0.8368	0.8604	2.8612	24.71	0.0000
FTR10	2.5176	2.0000	16.0000	0.0000	2.0764	0.8248	2.5913	12.8300	1023.93	0.0000
FTR11	15.4422	17.0000	19.0000	0.0000	3.9422	0.2553	-2.0453	7.2832	290.86	0.0000
FTR12	0.1676	0.0500	0.5000	0.0000	0.1936	1.1551	0.7463	1.8479	29.48	0.0000
FTR13	0.4839	0.5000	0.5000	0.0000	0.0789	0.1631	-5.3148	31.0193	7446.47	0.0000
FTR14	0.7003	0.7445	1.0000	0.0000	0.2519	0.3597	-0.5554	2.3951	13.26	0.0013
FTR15	17.3668	18.0000	20.0000	5.0000	2.0254	0.1166	-2.3308	11.1767	734.55	0.0000
FTR16	4.3556	2.9151	25.0899	0.0097	4.7344	1.0870	1.9629	7.0049	260.78	0.0000
FTR17	1.7660	1.2392	8.4314	0.0068	1.6753	0.9486	1.6092	5.8156	151.62	0.0000
FTR18	7.9910	5.9022	40.3909	0.2842	7.4635	0.9340	1.5938	5.5194	136.88	0.0000
FTR19	8.0974	6.2894	33.3646	0.3442	6.8310	0.8436	1.4529	4.8139	97.29	0.0000
FTR20	4.6666	3.1932	18.6670	0.1795	4.1923	0.8984	1.3705	4.4531	79.80	0.0000
FTR21	14.4709	11.0284	49.8488	0.5740	12.0614	0.8335	0.9170	2.8826	28.00	0.0000
FTR22	5.3238	4.3565	14.5417	0.0549	3.8078	0.7152	0.6805	2.4659	17.72	0.0001
FTR23	8.2469	6.6754	29.2906	0.4839	6.4919	0.7872	1.0812	3.6168	41.93	0.0000
FTR24	26.2940	21.3179	74.0415	0.9831	19.6704	0.7481	0.6439	2.2509	18.40	0.0001
FTR25	7.5829	8.0000	9.0000	2.0000	1.5511	0.2046	-2.0846	7.7555	331.64	0.0000
FTR26	0.6495	0.6662	0.9428	0.2452	0.1350	0.2079	-0.4658	2.9918	7.20	0.0274
FTR27	0.5137	0.5334	0.9275	0.0480	0.1884	0.3668	-0.3403	2.5995	5.17	0.0754
FTR28	87.1709	92.0000	100.0000	40.0000	14.3288	0.1644	-1.1006	3.5388	42.59	0.0000
FTR29	245.1558	254.0000	255.0000	166.0000	18.4826	0.0754	-2.2221	7.4934	331.18	0.0000
FTR30	0.7071	0.6988	0.9761	0.4385	0.1072	0.1516	0.1438	3.0317	0.69	0.7068
FTR31	0.0357	0.0325	0.1083	0.0138	0.0149	0.4174	1.6211	7.2752	238.71	0.0000
FTR32	0.0345	0.0310	0.0841	0.0091	0.0146	0.4232	0.9285	3.5443	31.05	0.0000
FTR33	0.0136	0.0123	0.0363	0.0037	0.0059	0.4338	1.0056	3.8986	40.23	0.0000
FTR34	3.8028	3.7521	6.2506	1.6705	1.0905	0.2868	0.0593	2.2572	4.69	0.0958
FTR35	3.8472	3.8477	6.6495	1.6450	1.0978	0.2854	0.1973	2.4083	4.19	0.1229
FTR36	4.0132	4.0299	6.8040	1.7901	1.0997	0.2740	0.0625	2.2962	4.24	0.1202
FTR37	0.0193	0.0119	0.2950	-0.1851	0.0589	3.0518	0.6386	6.6824	125.96	0.0000
FTR38	-0.0186	-0.0113	0.3444	-0.3173	0.0641	-3.446	-0.2883	10.9278	523.89	0.0000
FTR39	-0.0150	-0.0100	0.1756	-0.3306	0.0709	-4.726	-0.7425	5.4265	67.11	0.0000
FTR40	-0.0083	-0.0045	0.1457	-0.1923	0.0419	-5.048	-0.7553	6.6010	126.44	0.0000
FTR41	0.0081	0.0124	0.2730	-0.2387	0.0640	7.9012	-0.3477	6.1795	87.83	0.0000
FTR42	-0.0021	-0.0012	0.2718	-0.2746	0.0674	-32.09	-0.4526	7.4957	174.38	0.0000
FTR43	-0.0004	0.0015	0.0874	-0.2340	0.0368	-92.00	-2.3773	16.4342	1683.91	0.0000
FTR44	0.0126	0.0010	0.4446	-0.1760	0.0772	6.1270	1.9972	11.3413	709.20	0.0000
FTR45	0.0321	0.0190	0.3480	-0.1772	0.0678	2.1121	1.5535	7.8207	272.74	0.0000
FTR46	-0.0143	-0.0040	0.3602	-0.5868	0.1216	-8.503	-0.6300	6.1287	94.33	0.0000
FTR47	-0.0023	0.0070	0.3485	-0.4737	0.1101	-47.86	-0.6780	6.9293	143.26	0.0000
FTR48	0.0443	0.0172	0.8638	-0.3208	0.1240	2.7991	2.9795	17.1189	1947.32	0.0000
FTR49	-0.4873	-0.5680	0.0000	-0.8560	0.2465	-0.505	0.5402	1.9981	18.00	0.0001
FTR50	0.3354	0.3107	0.9591	0.0000	0.1982	0.5909	0.4701	2.8320	7.56	0.0228
FTR51	0.4655	0.4522	1.0031	0.0000	0.2556	0.5491	0.1251	2.1717	6.21	0.0449
FTR52	0.7832	0.8113	1.0319	0.0622	0.1808	0.2308	-0.8946	3.9237	33.62	0.0000
FTR53	0.3424	0.3466	0.8561	0.0000	0.1879	0.5488	0.3286	2.6729	4.47	0.1070
FTR54	0.6059	0.6435	1.0021	0.0000	0.2285	0.3771	-0.6224	2.8048	13.16	0.0014

Table 4.1.3b. Descriptive Statistics of Computational Measures in sample of logos

	Mean	Median	Max	Min	StDev	CV	Skew	Kurt	JB	Prob
FTR55	0.6138	0.6044	1.0186	0.0666	0.1773	0.2889	-0.1959	2.9322	1.31	0.5192
FTR56	10.2563	5.0000	150.0000	2.0000	19.0632	1.8587	5.3370	35.0649	9469.86	0.0000
FTR57	3.6834	4.0000	5.0000	1.0000	1.1614	0.3153	-0.2749	1.6873	16.79	0.0002
FTR58	0.6254	0.6272	0.9807	0.2487	0.1753	0.2803	-0.0143	2.1868	5.49	0.0643
FTR59	0.2264	0.2386	0.4929	0.0058	0.1226	0.5415	0.1571	2.1468	6.85	0.0325
FTR60	0.0807	0.0687	0.2876	0.0000	0.0723	0.8959	0.7398	2.7342	18.74	0.0001
FTR61	0.0341	0.0177	0.2318	0.0000	0.0432	1.2669	1.5721	5.4637	132.30	0.0000
FTR62	0.0151	0.0000	0.1206	0.0000	0.0267	1.7682	2.1976	7.4167	321.93	0.0000
FTR63	21.9498	22.0000	23.0000	12.0000	0.7160	0.0326	-13.5843	189.3568	294080.50	0.0000
FTR64	22.5829	22.0000	33.0000	11.0000	4.7207	0.2090	0.1781	4.4859	19.36	0.0001
FTR65	22.3719	22.0000	33.0000	11.0000	5.5535	0.2482	-0.0026	3.2878	0.69	0.7093
FTR66	21.7286	22.0000	33.0000	11.0000	5.7231	0.2634	0.0165	3.1697	0.25	0.8835
FTR67	22.2864	22.0000	33.0000	11.0000	5.3384	0.2395	0.1020	3.5961	3.29	0.1929
FTR68	0.2720	0.2089	0.9926	0.0055	0.2231	0.8202	1.3217	4.2149	70.18	0.0000
FTR69	0.3795	0.3014	0.9951	0.0000	0.2943	0.7755	0.5694	2.1100	17.32	0.0002
FTR70	0.3895	0.3505	0.9814	0.0000	0.2692	0.6911	0.3242	2.0586	10.83	0.0044
FTR71	0.3900	0.3465	0.9813	0.0000	0.2678	0.6867	0.3742	2.1592	10.51	0.0052
FTR72	0.3794	0.3213	0.9960	0.0000	0.2738	0.7217	0.4408	2.1452	12.50	0.0019
FTR73	0.3487	0.1975	0.9989	0.0003	0.3691	1.0585	0.7859	1.9885	28.97	0.0000
FTR74	0.5730	0.7945	0.9968	0.0000	0.4112	0.7176	-0.3865	1.3410	27.78	0.0000
FTR75	0.5880	0.7722	1.0000	0.0000	0.3928	0.6680	-0.4339	1.4535	26.07	0.0000
FTR76	0.5932	0.7669	1.0000	0.0004	0.3850	0.6490	-0.4583	1.5064	25.46	0.0000
FTR77	0.5725	0.7116	1.0000	0.0003	0.3842	0.6711	-0.3168	1.4165	24.12	0.0000
FTR78	0.8111	0.9266	0.9986	0.0166	0.2362	0.2912	-1.4328	3.9273	75.21	0.0000
FTR79	0.7098	0.7805	0.9993	0.0117	0.2980	0.4198	-0.8369	2.4837	25.44	0.0000
FTR80	0.6768	0.7451	1.0000	0.0138	0.2973	0.4393	-0.6117	2.1161	18.89	0.0001
FTR81	0.6692	0.7385	1.0000	0.0138	0.3009	0.4496	-0.5813	2.0553	18.61	0.0001
FTR82	0.6667	0.7385	0.9986	0.0117	0.3052	0.4578	-0.6414	2.1500	19.64	0.0001
FTR83	2.0946	2.4553	2.9852	0.0352	0.8982	0.4288	-0.8456	2.2954	27.83	0.0000
FTR84	1.5365	1.1787	2.9847	0.0184	1.0205	0.6642	0.3076	1.5519	20.53	0.0000
FTR85	1.4729	1.1609	2.9908	0.0184	0.9825	0.6671	0.3184	1.6509	18.45	0.0001
FTR86	3.8575	3.6937	10.0756	0.0372	2.3303	0.6041	0.5014	2.6681	9.25	0.0098
FTR87	3.0231	3.0420	6.0000	0.0372	1.5530	0.5137	-0.0046	2.0398	7.65	0.0219
FTR88	0.4971	0.5019	0.6499	0.2843	0.0423	0.0851	-0.6759	8.2159	240.73	0.0000
FTR89	0.5199	0.5029	0.8547	0.1398	0.1300	0.2500	0.0009	3.8179	5.55	0.0625
FTR90	0.5072	0.5017	0.9197	0.1484	0.1629	0.3212	0.2745	2.8735	2.63	0.2681
FTR91	0.5010	0.5024	0.7426	0.2255	0.0401	0.0800	-0.3704	20.5054	2545.45	0.0000
FTR92	0.4976	0.5019	0.8942	0.1219	0.1242	0.2496	0.0070	4.3494	15.10	0.0005
FTR93	0.5031	0.5020	0.9008	0.0766	0.1590	0.3160	-0.0617	3.6476	3.60	0.1650
FTR94	0.1733	0.1759	0.3011	0.0448	0.0414	0.2389	0.0050	4.0044	8.37	0.0153
FTR95	0.1229	0.0932	0.3432	0.0011	0.0972	0.7909	0.8368	2.4223	25.99	0.0000
FTR96	0.0499	0.0229	0.3670	0.0000	0.0773	1.5491	2.4648	8.5022	452.52	0.0000
FTR97	0.0005	0.0001	0.0223	-0.0393	0.0073	14.6000	-0.5366	7.8438	204.09	0.0000
FTR98	-0.0011	0.0000	0.0175	-0.0337	0.0065	-5.9091	-2.1574	10.8188	661.26	0.0000
FTR99	-0.0001	0.0000	0.0432	-0.0770	0.0071	-71.000	-4.8181	81.4806	51839.97	0.0000
FTR100	0.3212	0.1518	1.0000	0.0000	0.3606	1.1227	0.8050	2.0926	28.32	0.0000
FTR101	0.3163	0.3502	0.4996	0.0040	0.1477	0.4670	-0.4513	1.8601	17.53	0.0002
FTR102	0.7693	0.8484	0.9897	0.0123	0.2208	0.2870	-1.3543	4.2932	74.70	0.0000
FTR103	1.9457	1.9773	2.9096	0.0834	0.6013	0.3090	-0.7668	3.3019	20.26	0.0000
FTR104	0.1678	0.1040	0.9040	0.0000	0.1994	1.1883	1.7514	5.5739	156.66	0.0000
FTR105	0.2391	0.1489	20.4713	-12.2193	2.6643	11.1430	2.0951	26.1320	4582.36	0.0000
FTR106	0.1899	0.1024	65.6657	-25.3404	6.3892	33.6451	5.3335	61.8826	29691.98	0.0000
FTR107	0.4408	0.0818	39.8119	-47.7617	6.1196	13.8829	-0.7743	31.9651	6976.39	0.0000

Figure 4.1.1. Histograms of Computational Aesthetics Measures

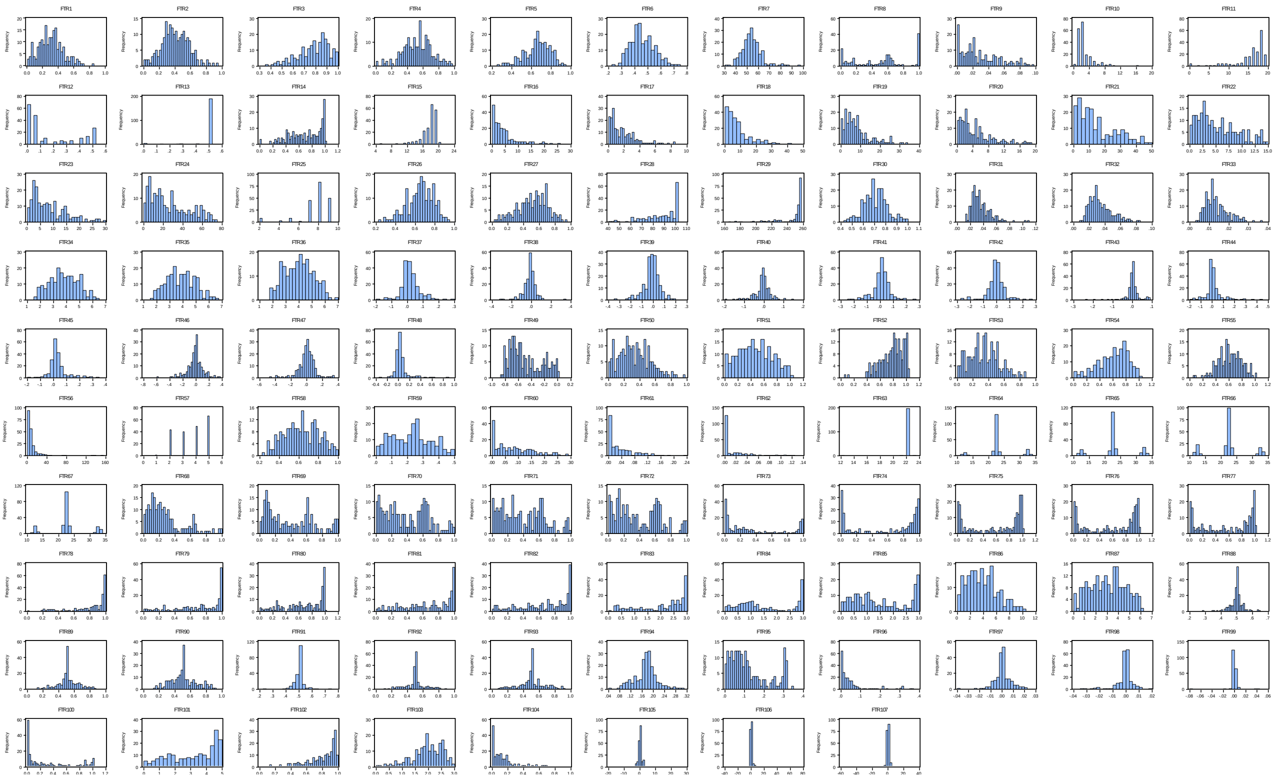
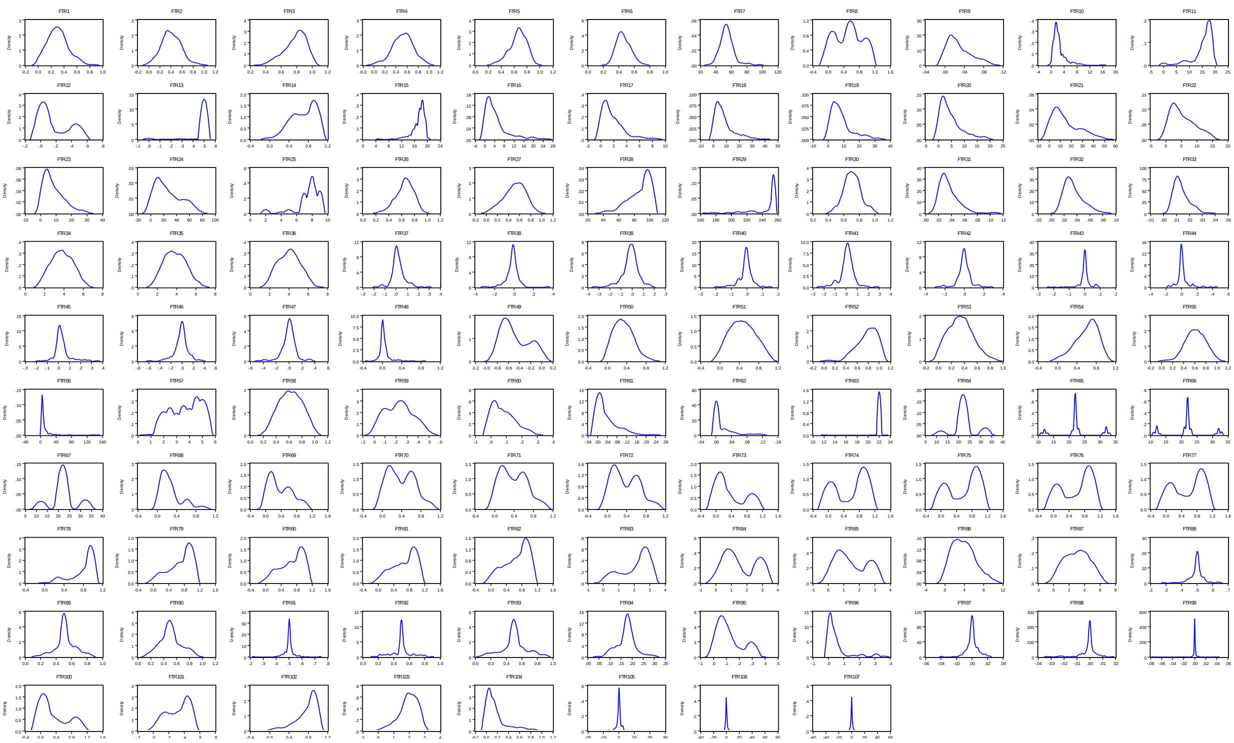
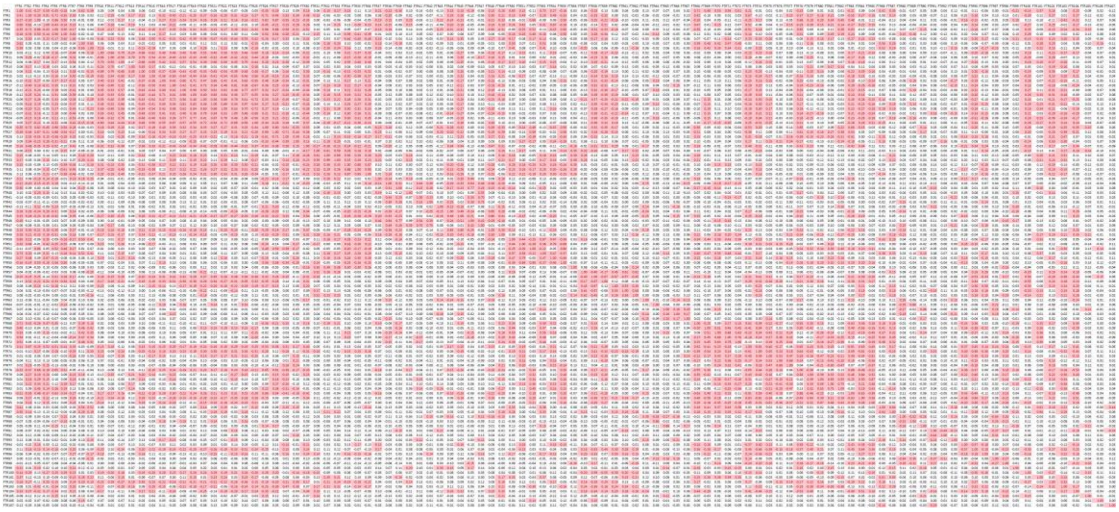


Figure 4.1.2. Kernel Densities of Computational Aesthetics Measures



Figures 4.1.1. and 4.1.2. depict the histograms and kernel densities respectively, for the variables under study. The later was estimated using an Epanechnikov kernel with 100 grid points through linear binning. It is evident from both histograms and kernels that most variables follow non-standard distributions with characteristics that include multimodality, plateaus, edge peaks and combs. Some variables are infested with outliers having as high as 10 values that are more than 3 standard deviations away from the mean.

Figure 4.1.3. Correlation matrix graph of computational aesthetic measures



Shaded areas represented correlation coefficients which exceed the 5% critical value.

In order to draw information about the bivariate relationships in the data, correlation coefficients were estimated. Given the dimension of the dataset, these are depicted as an infographic in Figure 4.1.3., with shaded areas representing statistically significant coefficients above the 5% critical value of 0.139. The figure suggests that the variables in the sample are interlinked and that clusters of correlation may exist. Summary statistics indicate an average correlation of 1.9% between our variables ranging from 0.99 to -0.91. Out of the 5671 pairs of correlation coefficients, 982 (17.3%) were statistically significant at the 5% level.

4.1.4 Exploratory Factor Analysis

Following Henderson and Cote (1998) and, more generally, the literature on experimental aesthetics, exploratory factor analysis is used in order to identify the underlying design dimensions. An important limitation of the analysis is the finding of nonnormally distributed variables which may lead to biased factor loadings and erroneous test statistics and standard errors. Given our large number of variables and adequate sample size, we start by using the maximum likelihood method of estimation. Squared multiple correlations were used for the initial communalities.

Computational measures FTR19, FTR24, FTR26, FTR33, FTR36, FTR53, FTR83 and FTR87 were removed from the analysis as they had correlations of above 90% with other variables. In choosing the number of factors, the main methods produced conflicting results. The Kaiser/Guttman method of the eigenvalue larger than one suggested 26 while the error scree approach indicated 60 factors, respectively. Bartlett adjusted version of a goodness of fit test suggests that at least 33 factors are needed to explain the data adequately. Removing measures with low communality scores did not change the results significantly. The previous studies on logos and Henderson and Cote (1998) and Van der Lans et al. (2009), suggested the existence of 8 elements within 3 factors using subjective measures in line with their theoretical construct. Rather than taking an atheoretic result, the analysis was undertaken by setting 3 factors. Table 4.1.4. summarises the estimation results by presenting the factor loadings with an absolute value higher than 0.5. Cross-loadings occur only in two cases (FTR2 and FTR78) with opposite signs for the first and last factor. The use of an alternative estimation approach or factor rotation did not significantly change the conclusions.

Table 4.1.4. Unrotated Factor Loadings for Computational Measures

Measure	F1: Elaborateness	F2: Naturalness	Factor 3: Harmony
FTR5	0.9284		
FTR27	0.9175		
FTR3	0.8974		
FTR52	0.6550		
FTR55	0.6495		
FTR6	0.6134		
FTR78	0.6125		
FTR2	-0.5435		
FTR28	-0.6225		
FTR10		0.8085	
FTR12		0.7738	
FTR22		0.7484	
FTR20		0.6895	
FTR18		0.6800	
FTR23		0.6794	
FTR21		0.6787	
FTR17		0.5882	
FTR16		0.5702	
FTR35		0.5007	
FTR11		-0.5838	
FTR7		-0.6013	
FTR14		-0.7139	
FTR25		-0.7382	
FTR15		-0.7644	
FTR84			0.8351
FTR73			0.7640
FTR79			0.7426
FTR68			0.5881
FTR85			0.5859
FTR95			0.5769
FTR80			0.5178
FTR74			-0.6445

Factor	Variance	Cumulative	Difference	Proportion	Cumulative
F1	10.0624	10.0624	1.9633	0.4365	0.4365
F2	8.0991	18.1615	3.2083	0.3513	0.7878
F3	4.8908	23.0523		0.2122	1.0000
Total	23.0523	23.0523		1.0000	

The three factors could be interpreted as Elaborateness, Naturalness and Harmony. Specifically, on the first factor, we have variables related to colour with respect to saturation, brightness and colourfulness on both global image features and objects. On the second factor, we have hue and entropy along with the colour models. Finally, in the last factor, we have variables related to objects.

4.1.5 Conclusions

This study applies an extensive set of 107 computational aesthetics measures to quantify elements of design using a sample of 215 logos. To objective is to provide new ways to consistently, efficiently and accurately measure objective elements of logo design. The study uses for the first time an array of different measures for evaluating design elements related to colour, including, hue, saturation, colourfulness. The sample estimates of measures have a very diverse behaviour across metrics and typically follow univariate distributions that are highly non-normal. The metrics were linked to logo elaborateness, naturalness and harmony using the theoretical framework of Henderson and Cote (1998) and Lans et al. (2009). Despite the nonnormality in the data, factor analysis indicated that our categorisation of the measurements in three factors is a reasonable representation of the data.

4.2 Can Computational Aesthetic Measures Capture Expert Evaluations of Logotype Design?

4.2.1 Introduction

This study investigates if the subjective evaluation of logo design by experts can be approximated using objective measures based on computational aesthetics. Specifically, 107 computational measures are estimated for 215 professionally designed logos. Eight design elements of these logos, corresponding to harmony, elaborateness and naturalness, are evaluated by three experts. The study then investigates if the computational aesthetics measures can explain the variation in average expert assessments between logos. Although the same theoretical framework is adopted in as previous literature (Henderson and Cote, 1998; van der Lans et al., 2009), it is extended significantly in a number of directions. First, unlike all previous papers examining the aesthetics of logos (Henderson and Cote, 1998; Van der Lans et al., 2009; Zhang et al., 2017), this study investigates the importance of metrics related to colour. Second, rather than using only subjective measures of logo design, as in Henderson and Cote (1998) and van der Lans et al., (2009), an extensive set of objective measures based on computational aesthetics is employed. Finally, in addition to the machine learning techniques used by Zhang et al. (2017), a number of standard statistical methods is applied in an attempt to draw inferences from the analysis.

4.2.2 Sample Description

Three expert judges were employed to participate in a survey. All three participants were expert graphic designers, with formal training and more than three years of work experience with corporate clients. The survey was designed and conducted through the *Qualtrics* survey system with unique access for the participants. Experts were informed that the survey is conducted for academic purposes and that their professional opinion was needed. Participants had no time limitation for viewing each logo, and they were allowed to complete the survey at their own pace by pausing, saving, and continuing with the survey during a time frame of two weeks. They were, also, informed that they could return to previous answers and amend them if they feel it is necessary. Two hundred and fifteen logos were evaluated by the team of expert judges. The logos appeared in random order for each judge, to avoid learning session effects.

Table 4.2.1. Questionnaire for experts for assessing aesthetic elements of logos

Variable label	*Variable*	*Scale*	*Question*
FML	Familiarity	Y/N/Not sure	Have you seen this logo before?
COMP	Complexity	(1) Very – (7) Not at all	How complex do you think this logo is?
ACT	Activeness	(1) Very – (7) Not at all	How active do you think this logo appears?
DEPT	Depth	(1) A lot – (7) Not at all	How much depth do you see in the design of the logo?
REPR	Representation	(1) Very – (7) Not at all	How realistic are the elements of this logo?
ORGN	Organicity	(1) Very – (7) Not at all	How organic are the shapes that compose this logo?
ROUN	Roundness	(1) Very – (7) Not at all	How rounded are the elements that compose this logo?
BALN	Balance	(1) Very – (7) Not at all	How balanced is the design of the logo?
SYMM	Symmetry	(1) Very – (7) Not at all	How symmetrical is the design of logo?

The team of experts had to examine the formal visual characteristics of the logos and rate a list of design dimensions through single factor questions, following previous literature by

(Henderson and Cote, 1998; van der Lans et al., 2009). They were provided with a description of the specific elements they needed to assess for each dimension. As has been indicated earlier, previous research from van der Lans et al. (2009) provided the conceptual framework selecting the design dimensions of logos which, most decisively, impact on consumers. Table 4.2.1 offers a list of all the variables, scales and wording of the questions presented to the team of experts. As in previous literature for rating design characteristics of logos (Henderson and Cote, 1998; van der Lans et al., 2009), the following guidance description was additionally provided for every design dimension to assist the participants in addressing the specific aspect of the visual that is of interest in this study.

Elaborateness

- *Complexity*: Please focus on the number of different elements incorporated in the logo, their arrangement, and their irregularities in order to rate the overall complexity of the design.
- *Activeness:* Please rate how much, if any, sense of motion is conveyed by this logo.
- *Depth:* Please rate how much, if at all, the elements of the logo appear to be sticking out of the background and creating a 3D effect.

Naturalness

- *Representation:* Consider how realistic (as opposed to abstract) the elements of this logo are. Do they tend to represent recognizable and identifiable objects or instead do they tend to depict abstractions?
- *Organicity:* By the term 'organic', what is meant here is natural, as opposed to man-made or geometrical.
- Harmony elements of the logo appear to be.

- *Balance:* Consider how evenly distributed is the weight of the various elements within the logo. E.g. does one part of the logo contain more elements than the other parts?
- *Symmetry:* Consider how much every unit on the one side of a centre line of the design is identically replicated on the other side. Symmetry can be seen as axial balance.

Table 4.2.2. Examples of logos at extremes of design features

	Most	Least
Active		
Balanced		
Complex		
Deep		ROMTEHNICA
Round		
Symmetrical		

4.2.3 Descriptive Statistics

In order to get a better feeling of the data, Table 4.2.2. provides some examples of logos which have some of the highest and lowest values in terms of average expert assessment scores for activeness, balance, complexity, depth, roundness and symmetry, respectively. As expected, the distinction between logos at the extremes for each dimension is clear and intuitive. For cases with average scores, distinctions can be expected to be more ambiguous.

An inspection of histograms for the responses from Expert 1 (R1), Expert 2 (R2), and Expert 3 (R3), is presented in Figure 4.2.1. Three main conclusions can be drawn. First, the shape of the distribution differs between the eight dimensions analysed with four appearing to be mostly skewed to the left (ACT, COMP, DEPT, REPR). This asymmetry is in line with the literature which suggests that that logo designs should be active, complex, representational and have depth (see Henderson and Cote, 1998). The second conclusion is that the shape of the distributions between experts is largely similar. Finally, for some dimensions, there is a high concentration of answers for one score (e.g. ACT and DEPT).

The descriptive statistics are summarised in Table 4.2.3. These suggest variation between the experts and dimensions in terms of the central tendency and dispersion. The dimensions with the highest (lowest) average value across reviewers are BALN, SYMM and ROUN (ACT, DEPT and COMP). This result is in line with the literature on the desirable characteristics of logos. Note that low values of ACT, DEPT and COMP, indicate high levels of activeness, depth and complexity, respectively. In terms of dispersion, as measured by the coefficient of variation (CV), the dimensions with highest (lowest) values are DEPT, ACT and REPR (BALN, ROUN and SYMM). These results suggest that there is less variability across logos for these characteristics. Cronbach's alpha scores for each of the eight dimensions had values well above 0.7 (0.9221, 0.9144, 0.9032, 0.9191, 0.936, 0.8962, 0.9226, 0.8956, 0.8879) indicating no problems related to reliability.

Figure 4.2.1. Histograms of Expert Responses

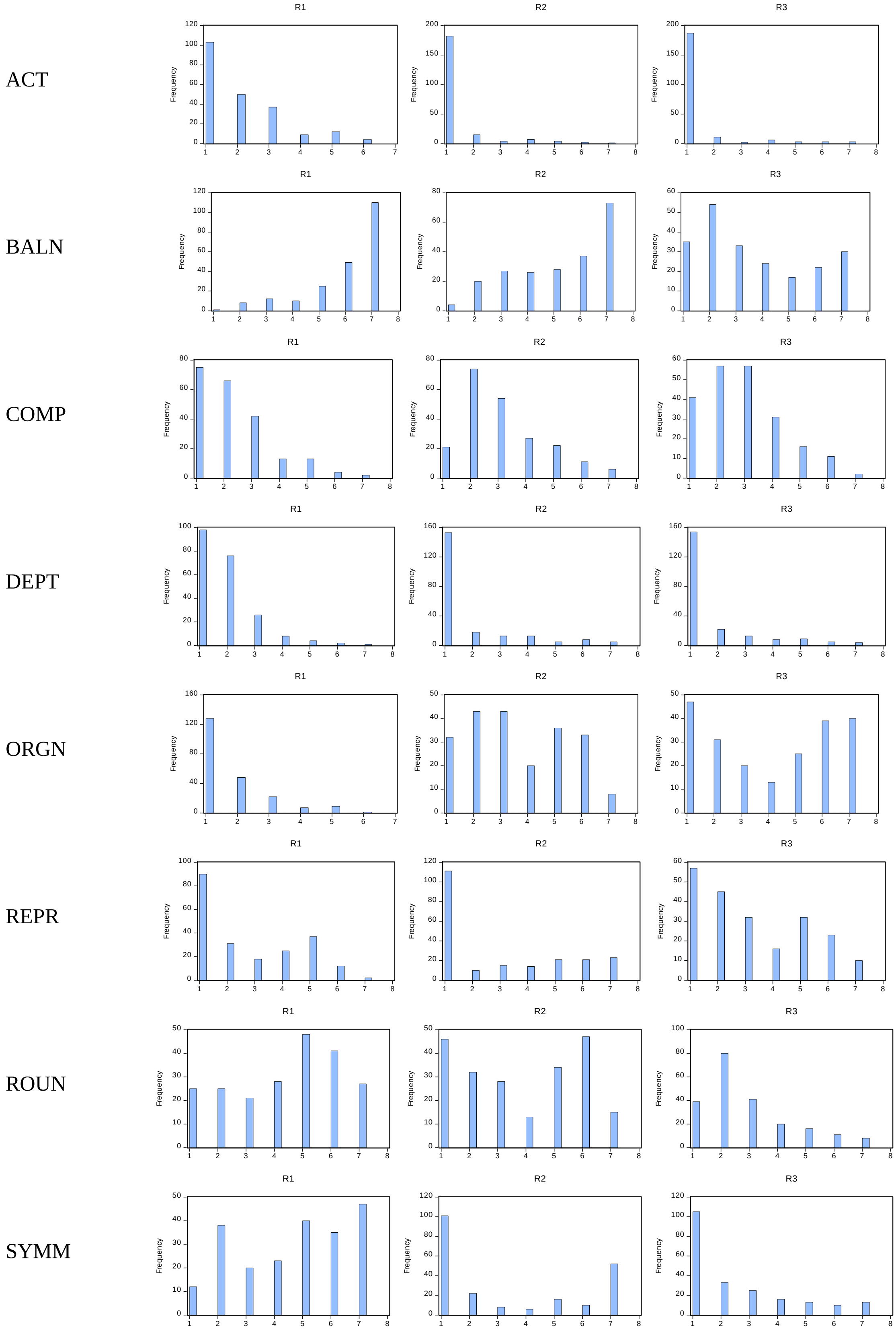


Table 4.2.3. Descriptive Statistics of Expert Responses

		ACT	BALN	COMP	DEPT	ORGN	REPR	ROUN	SYMM
Average	R1	2.0186	5.9349	2.2977	1.8512	1.7163	2.6744	4.2837	4.5442
	R2	1.3535	5.1023	3.0698	1.8093	3.5442	2.8884	4.2837	4.5442
	R3	1.3628	3.5442	2.8465	1.7349	3.9814	3.1163	4.2837	4.5442
Median	R1	2.0000	7.0000	2.0000	2.0000	1.0000	2.0000	5.0000	5.0000
	R2	1.0000	6.0000	3.0000	1.0000	3.0000	1.0000	4.0000	2.0000
	R3	1.0000	3.0000	3.0000	1.0000	4.0000	3.0000	2.0000	2.0000
Mode	R1	1.0000	7.0000	1.0000	1.0000	1.0000	1.0000	5.0000	7.0000
	R2	1.0000	7.0000	2.0000	1.0000	2.0000	1.0000	1.0000	1.0000
	R3	1.0000	2.0000	3.0000	1.0000	1.0000	1.0000	2.0000	1.0000
StDev	R1	1.2751	1.4647	1.3756	1.0705	1.0973	1.7842	1.9234	1.9471
	R2	1.0073	1.8339	1.4913	1.5425	1.8000	2.2768	2.0726	2.5586
	R3	1.1350	2.0545	1.4371	1.4402	2.2836	1.9044	1.5911	1.8760
CV	R1	0.6317	0.2468	0.5987	0.5783	0.6394	0.6671	0.4490	0.4285
	R2	0.7442	0.3594	0.4858	0.8525	0.5079	0.7883	0.4838	0.5630
	R3	0.8329	0.5797	0.5048	0.8302	0.5736	0.6111	0.3714	0.4128

A comparison between experts in terms of their average scores does not suggest at first glance that they have a clear systematic bias. For example, R1 gives the highest average score for 5 dimensions, R2 for 3 dimensions and R3 for 4 dimensions, respectively. If we consider the whole ranking (in positions 1, 2 and 3), no differences exist between experts. In terms of dispersion, R2 has the highest average CV (59.8%) across dimensions, followed by R3 (58.9%) and R1 (52.9%).

In order to shed more light on the differences between experts, a one factor ANOVA is undertaken. The results, summarised in Table 4.2.4 suggest that the average score is statistically different between reviewers at the 5% level all dimensions except DEPT and REPR.

Table 4.2.4. One-Factor ANOVA of differences between expert responses

	Average R1	Average R2	Average R3	F statistic	p-value
ACT	2.0186	1.3535	1.3628	23.8750	0.0000
BALN	5.9349	5.1023	3.5442	100.9991	0.0000
COMP	2.2977	3.0698	2.8465	17.5724	0.0000
DEPT	1.8512	1.8093	1.7349	0.4600	0.6315
ORGN	1.7163	3.5442	3.9814	97.5869	0.0000
REPR	2.6744	2.8884	3.1163	2.7920	0.0620
ROUN	4.2837	4.2837	4.2837	35.1174	0.0000
SYMM	4.5442	4.5442	4.5442	52.5111	0.0000

Critical value at the 5% (1%) level is 3.009755 (4.6383).

Further information on the similarities between experts can be drawn from a correlation analysis of scores. The results in Table 4.2.5 suggest high levels of correlation with an average of 43.9% and a range between 70.8% and -14.9%. Most correlations are significant with the critical value at the 5% level being 13.4%. The highest agreement was between R1 and R2 (correlation 49.6%) and R1 and R3 (46.5%). Across experts, the highest agreement in terms of average correlation was for ROUN, REPR and SYMM. For ORGN, correlations are statistically insignificant between R1 and R2 and have the lowest values for the other two pairs.

Table 4.2.5. Pearson Correlation Analysis between Expert Responses

	R1/R2	R2/R3	R1/R3	Average
ACT	0.4424	0.2878	0.3666	0.3656
BALN	0.4262	0.2705	0.3782	0.3583
COMP	0.5185	0.4623	0.6591	0.5466
DEPT	0.4539	0.3930	0.5146	0.4538
ORGN	0.0493	-0.1490	0.2358	0.0454
REPR	0.7080	0.3067	0.4859	0.5002
ROUN	0.6791	0.6106	0.5907	0.6268
SYMM	0.5788	0.5081	0.3708	0.4859
ALL	0.5853	0.4304	0.3886	0.4681
Average	0.4960	0.3559	0.4653	0.4391

Critical value at the 5% (1%) level is 0.134 (0.175) for the individual questions (N=215)

4.2.4 Regression Analysis

The next step in the analysis is to evaluate how the computational measures we have estimated in the previous study are associated to the expert scores for each one of the eight dimensions of logo design. An average score was selected as a 'representative' assessment for each logo that reflects all three experts. Despite the differences between experts, the average may better reflect the systematic element in the assessment beyond individual idiosyncrasies. The use of other averaging methods, such as the median and mode of scores, produced similar results. The average review as a dependent variable has the additional advantage that it is continuous and can be analysed directly within a simple regression framework.

As a large number of 107 independent variables exists, a forward stepwise regression estimation approach was selected in order to choose the most significant predictors. The lowest p-value was chosen as the criterion for adding variables. This method starts with no added regressors and then selects the variable that would have the lowest coefficient p-value if it was added to the model. If the p-value is lower than the specific stopping criterion of 0.5, the variable is added. This procedure continues by selecting the variable that has the lowest p-value in the model that includes the first variable. After that, both of the variables added are assessed against the p-value criterion, and any variable with a higher value is removed. Then the process is repeated and at each step all previously added variables are evaluated against the p-value criterion. The estimation ends when then lowest p-value for the variables not included is higher than the stopping criterion of 0.5.

Summary regression results for each one of the eight design elements considered are presented in Tables 4.2.6. to 4.2.13, respectively. The tables include the coefficients that are significant at the 5% level in the first column with the remaining coefficients not being reported in order to ease readability. The last three columns of each table give the standard error of the estimate, the t-statistic and the associated p-value. Variables are ordered in the table in terms of their statistical significance with those having the smallest p-values reported first. The title of each table includes the adjusted coefficient of determination (R^2). The results from the eight regressions are then summarised in Tables 4.2.14a. and 4.2.14b. which include statistically significant coefficients and R^2's for all models estimated. In these tables, variables are ordered with their number rather than their significance as to facilitate comparisons across the eight dimensions.

A number of conclusions can be drawn from the regression analysis. There is a significant amount of predictability in the data with adjusted R-squared values ranging between 25.6% (for DEPT) and 46.6% (for ACT). A large number of coefficients is statistically significant for each regression estimated with a median of 23 and a range between 11 (or DEPT) and 36 (for COMP). This means that the computational measures can provide a good proxy for the expert reviews of logo design. The average R-squared across regressions that represent the three factors suggest that the easiest to predict on the basis of our data is elaborateness (COMP, ACT, DEPT with average adj. R^2 = 35.06%), followed by naturalness (REPR, ORGN with average adj. R^2 = 30.42%) and Harmony (SYMM and BALN with average adj. R^2 = 28.09%).

Out of the 192 significant coefficients, 105 were positive, and 87 were negative. Out of the 107 computational measures, 16 were not significant in any regression: FTR4, FTR8, FTR17, FTR28, FTR40, FTR44, FTR45, FTR46, FTR47, FTR48, FTR56, FTR65, FTR77, FTR91, FTR94, FTR104 and FTR107. The majority of variables were significant in either one or two regressions, 33 and 30 cases, respectively. One variable (FTR72) was significant in 6 regressions, while two variables (FTR3 and FTR73) were significant in 5 regressions. For 24 out of the 57 variables that appear in more than 1 regression, they enter with a different sign in at least two models (i.e. they have the opposite effect between regressions).

In terms of a more qualitatively analysis of the significant coefficients with respect to the meaning of the variables and the context of the factors, a number of conclusions can be drawn. For the elaborateness factor, no clear picture emerges with only the measures of texture (30 to 49), the number of elements (10, 15, 56, 57) and depth (105-107) having some significance. The measures of variance and blur do not seem to explain this group of design aspects. For naturalness, variables related to roundness (100), hue models (16-25), colour complementarity (87) and the coordinate of mass centre for segments (88-99) tend to be predictors of relevant elements (ORGN, ROUN, REPR). Finally, for harmony, variables related to the rule of thirds measures (59-67), ratios between elements (57-62) and colour complementarity (87) appear to be more relevant.

Table 4.2.6. Regression for computational measures against COMP, adj. R^2 = 0.3312

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR63	-0.2463	0.0539	-4.5714	0.0000
FTR51	-2.7470	0.5624	-4.8846	0.0000
FTR3	-11.2903	2.5089	-4.5001	0.0000
FTR82	2.1229	0.3114	6.8180	0.0000
FTR81	-1.2540	0.2909	-4.3111	0.0000
FTR7	0.0549	0.0127	4.3207	0.0000
FTR50	5.9611	1.3428	4.4394	0.0000
FTR72	1.3796	0.3351	4.1174	0.0001
FTR86	0.1464	0.0367	3.9828	0.0001
FTR53	-5.5826	1.4435	-3.8674	0.0002
FTR55	-3.9149	1.1610	-3.3720	0.0010
FTR29	0.0119	0.0036	3.3150	0.0012
FTR31	16.9521	5.2185	3.2484	0.0015
FTR78	4.0368	1.3073	3.0879	0.0024
FTR59	2.5599	0.8416	3.0417	0.0028
FTR71	-1.0465	0.3533	-2.9621	0.0036
FTR26	12.2505	4.2134	2.9075	0.0042
FTR83	-1.7462	0.6163	-2.8333	0.0053
FTR52	2.0639	0.7354	2.8063	0.0057
FTR37	-2.6794	0.9817	-2.7295	0.0072
FTR42	2.0704	0.7651	2.7059	0.0077
FTR2	4.2437	1.6602	2.5562	0.0117
FTR101	-1.2681	0.5053	-2.5093	0.0133
FTR66	0.0215	0.0089	2.4102	0.0173
FTR24	0.0103	0.0045	2.2638	0.0251
FTR20	0.0444	0.0198	2.2416	0.0266
FTR95	-1.7992	0.8140	-2.2103	0.0287
FTR36	0.2320	0.1050	2.2097	0.0288
FTR70	-0.6805	0.3113	-2.1858	0.0305
FTR64	-0.0458	0.0210	-2.1838	0.0307
FTR73	-2.0291	0.9758	-2.0794	0.0394
FTR58	1.6655	0.8013	2.0784	0.0395
FTR41	-1.6802	0.8263	-2.0334	0.0439

Table 4.2.7. Regression for computational measures against ACT, adj. R^2 = 0.4646

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR63	-0.2463	0.0539	-4.5714	0.0000
FTR51	-2.7470	0.5624	-4.8846	0.0000
FTR3	-11.2903	2.5089	-4.5001	0.0000
FTR82	2.1229	0.3114	6.8180	0.0000
FTR81	-1.2540	0.2909	-4.3111	0.0000
FTR7	0.0549	0.0127	4.3207	0.0000
FTR50	5.9611	1.3428	4.4394	0.0000
FTR72	1.3796	0.3351	4.1174	0.0001
FTR86	0.1464	0.0367	3.9828	0.0001
FTR53	-5.5826	1.4435	-3.8674	0.0002
FTR55	-3.9149	1.1610	-3.3720	0.0010
FTR29	0.0119	0.0036	3.3150	0.0012
FTR31	16.9521	5.2185	3.2484	0.0015
FTR78	4.0368	1.3073	3.0879	0.0024
FTR59	2.5599	0.8416	3.0417	0.0028
FTR71	-1.0465	0.3533	-2.9621	0.0036
FTR26	12.2505	4.2134	2.9075	0.0042
FTR83	-1.7462	0.6163	-2.8333	0.0053
FTR52	2.0639	0.7354	2.8063	0.0057
FTR37	-2.6794	0.9817	-2.7295	0.0072
FTR42	2.0704	0.7651	2.7059	0.0077
FTR2	4.2437	1.6602	2.5562	0.0117
FTR101	-1.2681	0.5053	-2.5093	0.0133
FTR66	0.0215	0.0089	2.4102	0.0173
FTR24	0.0103	0.0045	2.2638	0.0251
FTR20	0.0444	0.0198	2.2416	0.0266
FTR95	-1.7992	0.8140	-2.2103	0.0287
FTR36	0.2320	0.1050	2.2097	0.0288
FTR70	-0.6805	0.3113	-2.1858	0.0305
FTR64	-0.0458	0.0210	-2.1838	0.0307
FTR73	-2.0291	0.9758	-2.0794	0.0394
FTR58	1.6655	0.8013	2.0784	0.0395
FTR41	-1.6802	0.8263	-2.0334	0.0439

Table 4.2.8. Regression for computational measures against DEPT, adj. $R^2 = 0.2561$

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR83	-0.4703	0.1405	-3.3464	0.0010
FTR15	0.1544	0.0506	3.0529	0.0027
FTR34	0.2490	0.0954	2.6090	0.0100
FTR70	-1.1057	0.4396	-2.5150	0.0129
FTR74	0.8349	0.3358	2.4860	0.0140
FTR18	0.0640	0.0275	2.3298	0.0211
FTR29	-0.0106	0.0047	-2.2486	0.0259
FTR81	-0.6688	0.3031	-2.2062	0.0288
FTR12	1.3057	0.6124	2.1322	0.0345
FTR11	-0.0500	0.0243	-2.0565	0.0414
FTR72	0.8785	0.4444	1.9767	0.0498

Table 4.2.9. Regression for computational measures against REPR, adj. $R^2 = 0.3049$

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR102	-2.9361	0.8091	-3.6288	0.0004
FTR54	-3.6688	1.0275	-3.5707	0.0005
FTR13	6.4126	1.7935	3.5755	0.0005
FTR73	-2.0482	0.6173	-3.3178	0.0012
FTR79	1.9498	0.6003	3.2481	0.0015
FTR100	-1.1622	0.3903	-2.9777	0.0034
FTR23	-0.1057	0.0369	-2.8615	0.0049
FTR85	2.0309	0.7300	2.7821	0.0061
FTR80	-4.2525	1.6187	-2.6271	0.0096
FTR69	1.7929	0.6910	2.5948	0.0105
FTR51	2.2421	0.9265	2.4199	0.0168
FTR68	2.3383	0.9659	2.4209	0.0168
FTR92	-2.4869	1.0571	-2.3525	0.0200
FTR53	-7.0365	3.0346	-2.3187	0.0218
FTR75	2.2884	1.0366	2.2076	0.0289
FTR95	4.1535	1.8970	2.1896	0.0302
C	8.7792	4.0815	2.1510	0.0332
FTR96	-4.0415	1.8992	-2.1280	0.0351
FTR26	-11.9252	5.6135	-2.1244	0.0354

Table 4.2.10. Regression for computational measures against ORGN, adj. R^2 = 0.2572

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR102	-1.9132	0.5616	-3.4064	0.0009
FTR99	40.2258	11.9472	3.3670	0.0010
FTR3	-15.6468	4.6985	-3.3301	0.0011
FTR78	9.9120	2.9670	3.3408	0.0011
FTR71	-1.8481	0.5596	-3.3026	0.0012
FTR26	26.9182	8.2628	3.2578	0.0014
FTR105	-0.0937	0.0289	-3.2403	0.0015
FTR83	-4.7229	1.5149	-3.1177	0.0022
FTR96	-3.8596	1.2666	-3.0473	0.0028
FTR12	2.4868	0.8204	3.0313	0.0029
FTR18	-0.0898	0.0301	-2.9800	0.0034
FTR53	-2.4075	0.8404	-2.8646	0.0049
FTR10	-0.1856	0.0669	-2.7730	0.0064
FTR80	1.1545	0.4295	2.6882	0.0081
FTR98	36.1880	13.4847	2.6836	0.0082
FTR73	-6.1423	2.3116	-2.6571	0.0088
FTR79	4.0525	1.5371	2.6364	0.0094
FTR81	-1.1853	0.4573	-2.5920	0.0106
FTR82	1.2618	0.5117	2.4660	0.0149
FTR25	-0.1923	0.0809	-2.3773	0.0189
FTR2	8.7274	3.6855	2.3680	0.0193
FTR93	1.2315	0.5317	2.3164	0.0221
FTR29	0.0127	0.0057	2.2265	0.0277
FTR35	0.3439	0.1585	2.1696	0.0318
FTR19	0.0647	0.0302	2.1403	0.0342
FTR42	2.5728	1.2147	2.1181	0.0360
FTR84	-1.5407	0.7332	-2.1015	0.0375
FTR39	2.5273	1.2226	2.0672	0.0407
FTR72	1.0669	0.5342	1.9972	0.0478
FTR49	0.8667	0.4382	1.9778	0.0500

Table 4.2.11. Regression for computational measures against ROUN, adj. R^2 = 0.3506

Variable	Coefficient	Std. Error	t-Statistic	Prob
FTR16	0.1954	0.0421	4.6363	0.0000
FTR3	-17.9738	4.0136	-4.4782	0.0000
FTR50	-4.3268	0.9170	-4.7182	0.0000
FTR18	-0.1588	0.0405	-3.9231	0.0001
FTR29	0.0282	0.0074	3.7875	0.0002
FTR69	2.5349	0.6511	3.8933	0.0002
FTR98	63.2331	17.6794	3.5767	0.0005
FTR27	6.6764	1.9569	3.4116	0.0008
FTR36	-1.0739	0.3179	-3.3785	0.0009
FTR6	-6.3035	1.8766	-3.3590	0.0010
FTR41	-7.3135	2.2752	-3.2145	0.0016
FTR87	0.3239	0.1006	3.2201	0.0016
FTR15	0.2388	0.0742	3.2169	0.0016
FTR67	-0.0591	0.0194	-3.0478	0.0027
FTR82	1.9650	0.6427	3.0575	0.0027
FTR55	-4.2350	1.4075	-3.0089	0.0031
FTR71	-2.1226	0.7141	-2.9723	0.0035
FTR35	0.9324	0.3189	2.9237	0.0040
FTR103	-0.9008	0.3136	-2.8730	0.0047
FTR14	2.4708	0.8617	2.8672	0.0048
FTR22	0.1562	0.0552	2.8322	0.0053
FTR79	3.7585	1.3714	2.7407	0.0069
FTR11	-0.1337	0.0499	-2.6776	0.0083
FTR19	0.1080	0.0412	2.6228	0.0097
FTR72	1.7570	0.6785	2.5897	0.0106
FTR106	-0.0399	0.0161	-2.4787	0.0143
FTR21	-0.0491	0.0200	-2.4606	0.0151
FTR60	-6.5510	2.6882	-2.4370	0.0160
FTR80	1.2517	0.5463	2.2912	0.0234
FTR43	-6.5793	2.9928	-2.1984	0.0295
FTR47	2.8052	1.2913	2.1724	0.0315
FTR81	-1.5557	0.7224	-2.1533	0.0330
FTR57	0.2765	0.1290	2.1432	0.0338
FTR86	-0.1749	0.0818	-2.1377	0.0342
FTR73	1.7959	0.8452	2.1248	0.0353
FTR5	7.5292	3.6501	2.0627	0.0409

Table 4.2.12. Regression for computational measures against SYMM, adj. R^2 = 0.2892

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	28.4334	5.4877	5.1813	0.0000
FTR57	-0.6330	0.1408	-4.4953	0.0000
FTR61	11.7559	3.4946	3.3640	0.0010
FTR49	2.2351	0.6633	3.3697	0.0010
FTR5	-19.2558	6.0245	-3.1963	0.0017
FTR76	1.4147	0.4522	3.1281	0.0021
FTR30	-5.2521	1.7581	-2.9874	0.0033
FTR6	7.1362	2.7326	2.6115	0.0100
FTR80	4.2571	1.7497	2.4330	0.0162
FTR2	-6.1540	2.5448	-2.4182	0.0169
FTR90	-3.8644	1.6559	-2.3337	0.0210
FTR70	1.7059	0.7412	2.3014	0.0228
FTR86	-0.2019	0.0879	-2.2968	0.0231
FTR88	-12.0968	5.3909	-2.2439	0.0264
FTR103	0.7622	0.3446	2.2122	0.0285
FTR67	-0.0484	0.0223	-2.1706	0.0316
FTR3	10.3248	4.8261	2.1394	0.0341
FTR107	-0.0415	0.0195	-2.1259	0.0352
FTR31	-23.7643	11.5098	-2.0647	0.0408
FTR38	-5.5270	2.7187	-2.0329	0.0439
FTR87	0.2352	0.1173	2.0060	0.0468

Table 4.2.13. Regression for computational measures against BALN, adj. R^2 = 0.2725

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FTR58	12.7075	2.4495	5.1879	0.0000
FTR60	13.1263	2.8086	4.6735	0.0000
FTR61	19.2732	3.6139	5.3331	0.0000
FTR6	7.8541	1.6753	4.6882	0.0000
FTR59	12.5171	2.3939	5.2288	0.0000
FTR86	-0.2291	0.0659	-3.4791	0.0007
FTR16	0.1064	0.0315	3.3781	0.0009
FTR30	-4.2522	1.2754	-3.3339	0.0011
FTR49	1.3985	0.4552	3.0722	0.0025
FTR22	0.1257	0.0417	3.0110	0.0031
FTR62	19.4664	6.5369	2.9779	0.0034
FTR88	-9.4213	3.2054	-2.9392	0.0038
FTR67	-0.0431	0.0175	-2.4584	0.0151
FTR64	-0.0963	0.0401	-2.4004	0.0176
FTR73	-0.9188	0.3847	-2.3881	0.0182
FTR12	2.1818	0.9165	2.3806	0.0186
FTR42	3.2950	1.4366	2.2936	0.0232
FTR72	1.0277	0.4518	2.2748	0.0244
FTR33	-439.3536	196.8008	-2.2325	0.0271
FTR27	-3.5203	1.5794	-2.2289	0.0274
FTR9	12.7281	5.8176	2.1879	0.0303
FTR101	1.8192	0.8884	2.0476	0.0424
FTR82	0.8340	0.4113	2.0277	0.0444
FTR32	159.9004	78.8615	2.0276	0.0444
FTR97	-37.6889	18.9776	-1.9860	0.0489
FTR89	3.1632	1.5936	1.9849	0.0490

Table 4.2.14a. Significant Stepwise Regression Coefficients

Variable	COMP	ACT	DEPT	REPR	ORGN	ROUN	SYMM	BALN
FTR1	3.4515							
FTR2	5.8197	4.2437			8.7274		-6.1540	
FTR3	-13.2686	-11.2903			-15.6468	-17.5155	10.3248	
FTR4								
FTR5	14.1923					7.5508	-19.2558	
FTR6						-6.4546	7.1362	7.8541
FTR7		0.0549						
FTR8								
FTR9								12.7281
FTR10	-0.1422				-0.1856			
FTR11			-0.0500			-0.1309		
FTR12	2.7358		1.3057		2.4868			2.1818
FTR13				6.4126				
FTR14						2.4337		
FTR15			0.1544			0.2326		
FTR16						0.2001		0.1064
FTR17								
FTR18			0.0640		-0.0898	-0.1571		
FTR19	0.0727				0.0647	0.1060		
FTR20		0.0444						
FTR21	-0.0449					-0.0505		
FTR22						0.1608		0.1257
FTR23				-0.1057				
FTR24		0.0103						
FTR25					-0.1923	0.2352		
FTR26		12.2505		-11.9252	26.9182			
FTR27						6.5167		-3.5203
FTR28								
FTR29		0.0119	-0.0106		0.0127	0.0292		
FTR30							-5.2521	-4.2522
FTR31	26.3326	16.9521					-23.7643	
FTR32								159.9004
FTR33								-439.3540
FTR34			0.2490					
FTR35					0.3439	0.9203		
FTR36		0.2320				-1.0592		
FTR37		-2.6794						
FTR38							-5.5270	
FTR39					2.5273			
FTR40								
FTR41		-1.6802				-4.4722		
FTR42		2.0704			2.5728			3.2950
FTR43						-6.6020		
FTR44								
FTR45								
FTR46								
FTR47								
FTR48								
FTR49							2.2351	1.3985
FTR50	4.1704	5.9611				-4.3619		
FTR51		-2.7470		2.2421				
FTR52		2.0639						
FTR53	-8.7532	-5.5826		-7.0365	-2.4075			
FTR54				-3.6688				
Adj. R2	0.3312	0.4646	0.2561	0.3049	0.2572	0.3506	0.2892	0.2725

Table 4.2.14b. Significant Stepwise Regression Coefficients

	COMP	ACT	DEPT	REPR	ORGN	ROUN	SYMM	BALN
FTR55	-1.4897	-3.9149				-4.0888		
FTR56								
FTR57						0.2788	-0.6330	
FTR58		1.6655						12.7075
FTR59		2.5599						12.5171
FTR60	4.0464					-6.3742		13.1263
FTR61							11.7559	19.2732
FTR62								19.4664
FTR63		-0.2463						
FTR64		-0.0458						-0.0963
FTR65								
FTR66		0.0215						
FTR67						-0.0611	-0.0484	-0.0431
FTR68				2.3383				
FTR69	1.5866			1.7929		2.6065		
FTR70	-0.9689	-0.6805	-1.1057				1.7059	
FTR71		-1.0465			-1.8481	-2.1015		
FTR72	0.9917	1.3796	0.8785		1.0669	1.7563		1.0277
FTR73		-2.0291		-2.0482	-6.1423	1.7890		-0.9188
FTR74			0.8349					
FTR75				2.2884				
FTR76							1.4147	
FTR77								
FTR78		4.0368			9.9120			
FTR79	1.3100			1.9498	4.0525	3.7686		
FTR80				-4.2525	1.1545	1.1995	4.2571	
FTR81		-1.2540	-0.6688		-1.1853	-1.5177		
FTR82		2.1229			1.2618	1.9281		0.8340
FTR83		-1.7462	-0.4703		-4.7229			
FTR84					-1.5408			
FTR85				2.0309				
FTR86		0.1464				-0.1756	-0.2019	-0.2291
FTR87						0.3307	0.2352	
FTR88							-12.0968	-9.4213
FTR89								3.1632
FTR90	1.0922						-3.8644	
FTR91								
FTR92				-2.4869				
FTR93					1.2315			
FTR94								
FTR95		-1.7992		4.1535				
FTR96				-4.0415	-3.8596			
FTR97								-37.6889
FTR98					36.1880	62.5183		
FTR99					40.2258			
FTR100				-1.1622				
FTR101		-1.2681						1.8192
FTR102				-2.9361	-1.9132			
FTR103						-0.9250	0.7622	
FTR104								
FTR105	-0.0757				-0.0937			
FTR106						-0.0383		
FTR107							-0.0415	
Adj. R^2	0.3312	0.4646	0.2561	0.3049	0.2572	0.3506	0.2892	0.2725

Table 4.2.15. Regression diagnostics

	COMP	ACT	DEPT	REPR	ORGN	ROUN	SYMM	BALN
JB	12.3115	67.8183	21.9547	7.4195	13.2576	0.6492	1.1714	2.3651
p-value	0.0021	0.0000	0.0000	0.0244	0.0013	0.7228	0.5567	0.3064
RESET	7.1779	98.2128	33.6401	6.4309	1.8348	4.8231	29.4003	9.9883
p-value	0.6730	0.0000	0.0000	0.0925	0.6074	1.6389	0.0000	0.1122

JB is the Jarque Bera (1980) test of normality for the residuals of the regression. RESET is the Ramsey (1969) test of order 3 for model specification.

As discussed in the previous section, the computational measures used follow a variety of non-normal distributions, and this may create problems in the regression analysis. Moreover, as argued by Henderson and Cote (1998), several of the variables considered may be subject to nonlinear relationships which are not captured within a linear regression model. In Table 4.2.15, we summarise two relevant residual regression diagnostics for each one of the models estimated. The results suggest that residuals tend to be moderately nonnormally distributed with the null hypothesis of normality rejected at the 5% level for 5 out of 8 regressions. According to the RAMSEY test, model misspecification is a problem in three regressions. In these cases, non-linear combinations of the fitted values help explain the dependent suggesting that a linear model may not be appropriate. An analysis of multicollinearity on the basis of variance inflation factors did not suggest serious problems with very few values above 10. Even if the relevant variables are removed, the overall conclusions of this section are not different. The use of factorised variables in regressions did not produce useful results which does not come as a surprise given the problems in the previous study. Specifically, 26 factors, based on the Kaiser criterion, could explain only a small portion of the data for each regression. Alternative estimation specifications, factor selection criteria or rotation schemes did not change the results significantly.

Table 4.2.16. Lasso estimation of the regression model

	ACT	BALN	COMP	DEPT	ORGN	REPR	ROUN	SYMM
Selected Features	FTR37	FTR12	FTR12	FTR14	FTR13	FTR3	FTR9	FTR30
	FTR42	FTR30	FTR31	FTR34	FTR36	FTR54	FTR39	FTR57
	FTR51	FTR49	FTR69	FTR81	FTR69	FTR73	FTR49	FTR61
	FTR63	FTR54	FTR73	FTR88	FTR98	FTR100	FTR63	FTR67
	FTR66	FTR67	FTR105	FTR93	FTR105	FTR102	FTR103	FTR76
M.S.E.	0.661	1.687	1.319	1.110	1.054	2.351	2.456	2.792
λ	0.107	0.142	0.151	0.134	0.120	0.205	0.177	0.177

As an alternative approach to stepwise regression, a lasso version of the original regression as proposed by Tibshirani (1996) is also estimated. The lasso methodology extends the standard regression model by adding the following constraint on the regression coefficients β:

$$\|\beta\|_1 \leq \lambda,$$

where λ represents a budget in the sense that the sum of the absolute values of the estimated coefficients cannot exceed λ. In this manner, lasso prevents overfitting the available data, and as a result, the lasso-based model usually performs better out-of-sample than the simple regression model. Moreover, the above constraint allows only a limited number of non-zero regression coefficients to be produced and this makes lasso a powerful feature selection tool.

The lasso is used to identify the aesthetic features that offer the highest ability to predict the expert responses. Table 4.2.16. presents the 5 features that best explain the average score of the experts for each aesthetic dimension along with the Mean Squared Error (M.S.E.) of the model and bound λ used. The findings are generally consistent with the results for the stepwise regression models. In particular, the features selected using the lasso tend to have a low p-value in the stepwise regression estimations. A notable result here is that FTR12, which corresponds to the contrast of the hue, is selected for 2 out of 10 dimensions.

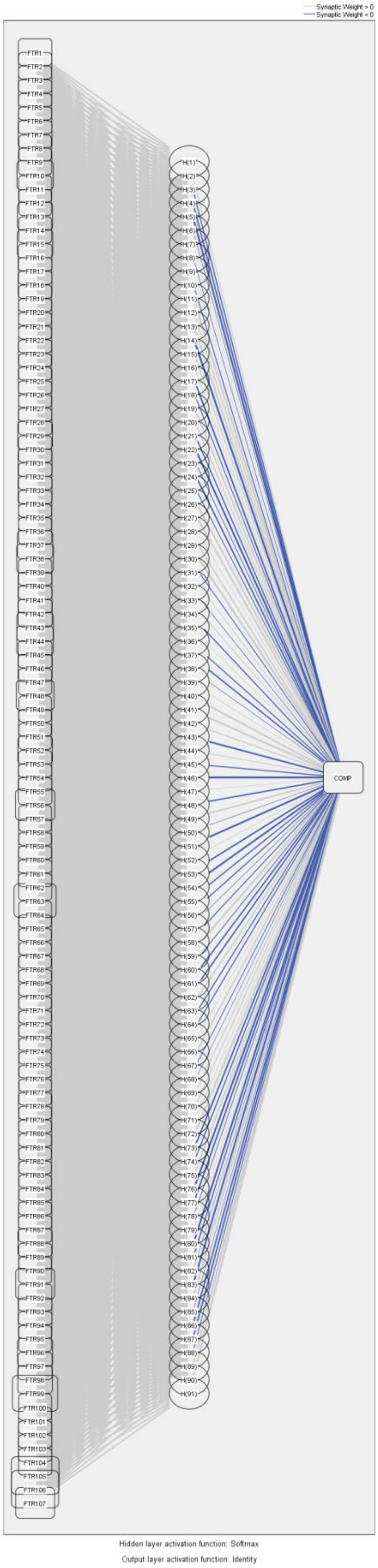
As a final robustness check, we repeated the regression analysis by excluding logos that were deemed familiar by the experts. This is important as in various instances in research it has been shown that familiarity with a stimulus can have an impact on the rating of its perceived characteristics (Goldstein 1961, Berlyne 1968, 1971). Specifically, as regards to complexity, Berlyne (1971) states that familiarization reduces the perceived amount of complexity of a pattern. In addition, according to Bornstein and D'Agostino (1992, 1994), prior exposure to stimuli can increase ease of perception and processing, thus biasing the rating process by misattributing this processing fluency to liking or acceptability (Janiszewski and Meyvis, 2001). Despite the previous research finding, the analysis of the sample that excluded the familiar logos produced comparable results. This is likely to be due to the fact that the number of such logos was small given the pre-selection.

4.2.5 Machine Learning

Most of the empirical studies in the area of computational aesthetics employ machine learning techniques, such as neural networks, decision trees and random forests in the analysis of the data. In particular, the one study that has studied logos (Zhang et al., 2017), notes that a "machine learning regression" is used to model computational aesthetic measures against human ratings of logo design elements. Although the reported results are very positive with R-squared values between 85% to 95%, no information is given on the estimation technique and specification. The widely cited study of Datta et al. (2006), used a Support Vector Machine (SVM) neural network along with recursive partitioning RPART tree approach and achieved classification accuracy rates in the order of 70% for photographs between classes of high and low aesthetic perception. Haas et al. (2015) used the same computational measures as in the present study in a neural network model to model coral reef image features against biochemical data and human ratings with R-squared values of over 90% and 80% in the estimation and test sample, respectively.

Motivated by the literature but also the alarming evidence from our regression residual diagnostics, a neural network modelling approach was taken. Specifically, Radial Basis Function (RBF) models were estimated in SPSS using 70% of the data for estimation (also known as training and the remaining 30% of the data for testing (also known as cross-validation). A softmax activation function was selected and a sum of squares error function. The number of units in the hidden layer was automatically selected from the range of 50 to 200.

Figure 4.2.2. Schematic representation of RBF neural network estimated for COMP



The specification of the neural network (also known as architecture) is depicted in Figure 4.2.2. As it is evident, part of the power and problem of these models lies in the very large number of parameters estimated. Although they are flexible enough to "learn" any kind of structure in the data and generalise, they can pose substantial computational problems and are prone to overfitting the data. Computational problems in recent years have been addressed with the advances in computer power and through more efficient estimation algorithms. The danger of overfitting is overcome by using testing data, not used in estimation, to continuously evaluate the out-of-sample performance of the model.

We first applied the RBF regression to model each one of the eight logo design elements using the computational aesthetic measures. In this spirit, the models are nonlinear generalisations of the linear regressions estimated previously. The results, summarised in Table 4.2.17. suggest that the neural networks have extremely good performance in terms of fit with R-squared values in the estimation sample above 99%. Note that simple rather than adjusted R-squared values are used here as the adjustment for the degrees of freedom is not applicable. The out of sample performance of the models is more than two or even three times better than that reported for the linear regressions (which is adjusted). The model performance is in line with that reported in the literature for logos and other images.

The analysis software allows to perform a sensitivity analysis to gauge the importance of each one of the variables used. In this process, each variable is perturbed, and the change in the dependent variable is measured. This is a very crude way of capturing the first order effect and importance but may give useful results. In our case, the twenty most significant variables are noted for each RBF model estimated. It is interesting to note that a number of variables are found significant in all models estimated (e.g. 63, 99, 106, 107). This suggests that certain image features are always important as predictors or moderators of perceived logo design aesthetics. From the remaining significant variables that vary between regressions, no clear conclusion could be drawn.

Table 4.2.17. RBF Neural network Model of Average Expert Score

	COMP	ACT	DEPT	REPR	ORGN	ROUN	SYMM	BALN
Training R^2	0.9913	0.9918	0.9904	0.9791	0.9947	0.9913	0.9968	0.9982
Test R^2	0.8020	0.9372	0.9329	0.8534	0.8890	0.9592	0.9535	0.9522

	Most important variables from sensitivity analysis							
	FTR63	FTR63	FTR99	FTR63	FTR63	FTR99	FTR63	FTR63
	FTR99	FTR99	FTR63	FTR99	FTR99	FTR56	FTR99	FTR99
	FTR106	FTR106	FTR105	FTR106	FTR56	FTR63	FTR13	FTR106
	FTR107	FTR56	FTR36	FTR107	FTR106	FTR105	FTR56	FTR105
	FTR105	FTR31	FTR91	FTR88	FTR91	FTR107	FTR107	FTR56
	FTR56	FTR91	FTR98	FTR105	FTR107	FTR48	FTR105	FTR91
	FTR97	FTR107	FTR106	FTR97	FTR105	FTR91	FTR91	FTR107
	FTR40	FTR10	FTR35	FTR91	FTR98	FTR106	FTR106	FTR43
	FTR48	FTR98	FTR37	FTR81	FTR61	FTR43	FTR97	FTR59
	FTR33	FTR105	FTR61	FTR3	FTR94	FTR44	FTR38	FTR98
	FTR98	FTR48	FTR34	FTR52	FTR97	FTR15	FTR88	FTR88
	FTR46	FTR13	FTR62	FTR98	FTR15	FTR10	FTR90	FTR97
	FTR43	FTR7	FTR7	FTR48	FTR43	FTR98	FTR31	FTR27
	FTR91	FTR15	FTR42	FTR103	FTR88	FTR38	FTR62	FTR10
	FTR32	FTR89	FTR54	FTR39	FTR10	FTR31	FTR40	FTR58
	FTR68	FTR64	FTR46	FTR59	FTR78	FTR45	FTR48	FTR3
	FTR3	FTR33	FTR60	FTR16	FTR50	FTR42	FTR43	FTR42
	FTR7	FTR47	FTR4	FTR27	FTR42	FTR78	FTR29	FTR37
	FTR88	FTR32	FTR97	FTR38	FTR37	FTR94	FTR65	FTR26
	FTR10	FTR18	FTR40	FTR89	FTR31	FTR52	FTR4	FTR15

4.2.6 Conclusions

This study demonstrated that expert evaluations for logo design elements could be closely approximated using computational aesthetics measures. In particular, it is shown for the first time that computational aesthetic measures related to colour, both as a global logo property and as a logo segment property, are useful in approximating subjective expert reviews. Three experts assessed 215 professionally designed logos across eight design elements. For this sample of logos, 107 computational aesthetics measures were estimated. Linear regression analysis suggested that the objective computational measures contain useful information for predicting proxy subjective expert reviews for logos. Model accuracy was substantially improved using neural network regression analysis based on Radial Basis Functions.

4.3 Consumer personality traits as moderators of the effect of subjective elements of logotype design on attitudes towards the brand

This study investigates whether the effect of perceived logo dynamism to the attitude of consumers towards the logo is moderated through the personality traits of each consumer. Extant literature has underscored the importance of the subjectivity inherent in the analysis of marketing visuals as one of the most important factors impeding the development of objective measures of visual characteristics, hence this is an important and relevant research question. A set of two fictional logos were developed for the study. The two logos are otherwise identical and differ solely on the activeness dimension. Two groups of consumers evaluated the visual characteristics of each logo, corresponding to visual appearance, complexity, informativeness, familiarity, novelty, dynamism, engagement, as well as their attitude towards the brand. The consumers also provided information with respect to their personality traits, corresponding to sensation seeking, risk taking propensity, nostalgia and need for cognition. A series of models were then estimated following Cian et al. (2014) and in particular the methodology developed by Preacher and Hayes (2008), designed to assess whether the influence of the visual characteristics of logos, as perceived by the consumers, on their attitude towards the brand is moderated by their personality traits.

This study differs from Cian et al. (2014) in that it is the first to assess the role of personality traits, rather than consumer engagement, as moderators in the effect of subjective logo visual characteristics to consumer attitudes towards the firm.

4.3.1 Introduction

The importance of developing consistent and reliable measures for analysing formal elements of corporate visuals has been extensively discussed in previous chapters. As it has been demonstrated[1], theories behind the analysis of decoding marketing visuals, often attribute the difficulties in developing objective measures of visual characteristics on the subjectivity of personal judgements, either by experts or consumers. The different theoretical starting points describing the dichotomy between the objectivity or subjectivity of personal judgements, for any type of visual stimulus have, also, been extensively debated in previous sections[2]. Several theories which considered the nature and validity of aesthetic judgements, and how personal and social influences can impact on the objectivity of judgements. This dichotomy, appears to be a significant factor, also mirrored in the approaches[3] for understanding the physiological/cognitive processes of encoding visual messages: bottom-up visual processing is mainly reliant on the external input of the object's attributes, whereas, top-down visual processing is mostly conditioned by internal factors, pertaining to the subject's personality preferences and preconceptions. This opposition appears inescapable when trying to assess the performance of objective visual metrics.

Hence, in this chapter, an additional element will be examined, in order to determine whether the personality traits of consumers produce a moderating effect on their subjective judgements, while rating visual characteristics. Four biosocial dimensions of personality have been included in this research: Sensation seeking, Risk taking propensity, tendency for Nostalgia and Need for cognition. At the same time, the above-mentioned personality traits as moderators of engagement and attitude toward the brand will be investigated.

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[1] Relevant issues are discussed in section 3.3 Efficiency and consistency in measuring corporate visuals.
[2] Relevant issues are discussed in section 2.3 Art, Philosophy, Aesthetics and their application to corporate visuals.
[3] Relevant issues are discussed in section 2.4 Theories from vision science and psychology.

As it has been discussed earlier in the section analysing brand attitude and beliefs[4], Rossiter and Percy (1978), have demonstrated how the impact of the marketing mix visual elements on brand attitude, is affecting consumers' brand beliefs. Similarly, both Goldman (2005) and Park et al. (2013), argued that the aesthetic appeal and attractiveness of logos contributes significantly in building stronger relationships between consumers and brands, and enhances firm performance.

Also, recent research from Cian et al. (2014) has demonstrated how the effect of a specific visual element (perceived movement) of a company logo can affect engagement with the logo even in the lack of brand information (p.187). Though in their research, the authors, examined dynamism's congruency, both with brand characteristics and consumer engagement, they argued, that static visual elements in a logo which expresses dynamism through perceived movement, can directly increase consumers' engagement. Their hypothesis was informed by a concept of aesthetic analysis, derived by the theory of Barthes (1971). In his seminal work on interpreting post-modernist art via the concept of representations, Barthes introduced the idea of the spectators' mental 'playful' interaction with images. Following this concept, the authors formulated the hypothesis that, the more the characteristics of a logo stimulate an aesthetic hedonic interaction between a consumer and an image, the more engaging their personal active experience would be. This involvement with the stimulus, via capturing the viewer's imagination would help create personal relevance for the stimulus (Lutz and Lutz, 1978). In turn, an increased feeling of engagement with the logo was suggested to positively affect consumer attitudes toward the brand.

[4] Relevant issues are discussed in section 2.4 Vision Science and Psychology.

4.3.2 Sample Description

An experiment was conducted using Mechanical Turk (MTurk). According to research by Paolacci et al. (2010) and Horton et al. (2011), the choice of this specific platform presented several practical and methodological advantages, such as, more representative demographic data of the general population and reported increased attentiveness to instructions (Hauser and Schwarz, 2016), than general internet or college undergraduate samples, fewer concerns of subject crosstalk and experimenter bias, and fast recruitment.

Based on the guidelines provided by Cian et al. (2014a) on the elements that suggest dynamism in static imagery, a set of 2 logos for the imaginary brand “Olile” was created for this study. The first image consisted of a simplified illustration of a skier in a standing, vertical position, over the name of the brand, exhibiting low dynamism. The second image consisted of the identical illustration of the skier, but this time at a diagonal angle, exhibiting high dynamism (Figure 4.3.1).

There is conclusive evidence from the literature that angular angles imply greater movement than vertical angles. The logos (Figure 4.3.1) were designed to convey the same attributes as the logos used by Cian et al. (2014a) and followed the same specifications. The logos were in grayscale and did not represent a specific type of company. Every aspect of the produced logo was identical, except for the diagonal direction of the pictured element. This is meant to determine how much movement and dynamism someone perceives in the logo and create the impression of the movement that is about to happen.

Figure 4.3.1. Treatment table

Dynamism Category	*Lower*	*Higher*
		

One hundred and twenty-two participants (forty-nine male and seventy-three female) were randomly assigned to rate one of the two logos. Participants were informed that they would be evaluating logos and were introduced to one of the randomly assigned logos from the set. They were asked to rate their overall attitude toward the brand (OVA1, OVA2, OVA3, OVA4) from 1-9 (1 = bad/dislike/unpleasant/unfavourable, and 9 = good/like/pleasant/favourable). They were also asked to rate their engagement with the logo. For this measurement, a four-item scale[5] was used, modified from Lefebvre et al. (2010) and O'Brien and Toms (2009) by Cian et al. (2014a). The rating of the scale was from 1-9 (1 = not at all - 9 = extremely, with the item EGM1_11 reversed). Participants replied to the following questions in order to rate engagement: EGM1_2 'How involving is the logo?', EGM1_10 'How engaging is the logo?', EGM1_11 'How boring is the logo?', and EGM1_12 'How stimulating is the logo?'). Subsequently, participants were asked to rate the perceived movement of the logo on a two-item scale (MV1, MV2).

Also, following suggestions from relevant literature (Oppenheimer et al, 2009; Hauser and Schwarz, 2016), that there is a 'non-negligible' proportion of participants, even in paid

[5] Reported a= .86, Cian et al. (2014a) This logo moves me: Dynamic imagery from static images. Journal of Marketing Research, 51(2), 184-197.

survey studies, who apparently answer at random, an instructional manipulation check (IMC) was incorporated in the questionnaire (VA_3, 'Regardless of your views on the logo, please select option six'), to ensure participant attentiveness. Replies by participants, who have failed to answer correctly, were eliminated from the study, regardless of the level of completion, as have studies who were incomplete.

The visual appearance of the logo is evaluated along the dimensions of attractiveness/appeal of visual appearance (VA_1, VA_2, VA_4), visual complexity (VC1, VC2), informativeness (IF1), familiarity (FM1) and novelty (Q110_4, Q110_3, Q110_5). Following the suggestion by Cian et al. (2014a), the participants were asked to rate their perception of movement in the logo on a two-item scale: 'How much movement do you see in the Logo?' (MV1, No movement at all = 1 - A lot of movement = 9) and 'How dynamic is the logo?' (MV2, Not dynamic at all = 1 - Extremely dynamic = 9). (OVA1, OVA2, OVA3, OVA4) from 1-9 (1 = bad/dislike/unpleasant/unfavourable, and 9 = good/like/pleasant/favourable). Subsequently, participants were asked to rate the perceived movement of the logo on a two item, 1-9 scale (MV1, MV2).

In order to determine whether the manipulated logos triggered any favourable attitudes toward the brand for the participants, a standard four-item scale was used to evaluate the participant's attribute towards the fictional brand (Olile). Table 4.3.1Table 4.3.1 provides the outline of the measurement scale used (in a 1 to 9 discrete point using standard Likert representation). The four-item scale was based on the scales used by Cian et al. (2014a) and Mitchell and Olson (1981)[6] and consists of four anchor points that capture different affective states of the participants towards the logo. The first item captures the general suitability of the logo towards the brand (Bad and Good). The second item looks at the consumer's attitude and

[6] Reported a = .96, Cian et al. (2014a), p. 188 and a= .88, Mitchell and Olson (1981), p. 323 respectively.

brand likability (Like and Dislike). The third and fourth items of the construct look at sentiment regarding the appearance of the logos by evaluating favourability using two different anchor scales (Unpleasant - Pleasant and Unfavourable-Favourable).

Table 4.3.1 Questionnaire for Attitude toward the brand

Item Order	*SCALE* *All items measured on a Likert scale from 1 to 9*	*Measurement labels for each item*
1	How would you characterize the logo for this brand?	(1) Bad - (9) Good
2	What is your attitude toward the brand?	(1) Dislike - (9) Like
3	How pleasant do you find the logo for this brand?	(1) Unpleasant - (9) Pleasant
4	How favourable do you find the logo for this brand?	(1) Unfavourable - (9) Favourable

Participants were also asked to rate their engagement with the logo. For this measurement, a four-item scale[7] was used, modified from Lefebvre et al. (2010) and O'Brien and Toms (2009) by Cian et al. (2014a). The rating of the scale was from 1-9, with the item EGM1_11 reversed. Participants replied to the following questions in order to rate engagement: EGM1_2 'How involving is the logo?', EGM1_10 'How engaging is the logo?', EGM1_11 'How boring is the logo?', and EGM1_12 'How stimulating is the logo?').

[7] Reported a= .86, Cian et al. (2014a) This logo moves me: Dynamic imagery from static images. Journal of Marketing Research, 51(2), 184-197.

Table 1.3.2 Questionnaire for Engagement

Item Order	*SCALE* *All items measured on a Likert scale from 1 to 9*	*Measurement labels for each item*
1	How involving is the logo?	(1) Not at all – (9) Extremely
2	How engaging is the logo?	(1) Not at all – (9) Extremely
3	How boring is the logo?	(1) Not at all – (9) Extremely
4	How stimulating is the logo?	(1) Not at all – (9) Extremely

Sensation seeking represents a biosocial dimension of personality which is characterized by "the need for varied, novel, and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman, 1979, p. 10). In this experiment, a Brief Sensation-Seeking Scale with four items (BSSS-4) by Stephenson et al. (2003), was used. It is further abbreviated version of the eight-item Brief Sensation-Seeking Scale (BSSS) by Hoyle (2002), which was adapted by the 20-item Arnett Inventory of Sensation Seeking (AISS, Arnett, 1994). Items were represented by content domain and their current (BSSS) versus previous (AISS) position in the standard inventory is shown in parentheses on Table 4.3.3, e.g. (2) / (5).

Table 4.3.3 Measurement items of the BSSS adopted by Hoyle (2002).

Item Order /Previous order	*SCALE* *All items measured on a Likert scale* *from 1 (Strongly disagree) to 5 (Strongly agree)*
Experience seeking	
(1)/(1)	I would like to explore strange places.
(2)/(5)	I would like to take off on a trip with no planned routes or timetables.
Boredom susceptibility	
(3)/(2)	When I go to a restaurant, I feel it is safer to order dishes I am familiar with.
(4)/(6)	I prefer friends who are excitingly unpredictable.
Thrill and adventure seeking	
(5) /(3)	I like to do frightening things.
(6) /(7)	I would like to try bungee jumping.
Disinhibition	
(7) /(4)	I like wild parties.
(8) /(8)	I would love to have new and exciting experiences, even if they are illegal.

The items selected from the original inventory were classified in four categories: (a) Experience Seeking which assesses general affinity of the participant with seeking new experiences, (b) Boredom susceptibility which assesses how easily the participant gets bored, (c) Thrill and adventure seeking, which assesses the participant’s proclivity for thrill and adventure, and (d) Disinhibition, which assesses how likely are participants to partake in experiences that promise excitement, even if they potentially involve risky outcomes.

The Brief Sensation-Seeking Scale (BSSS) shown below has been further abbreviated in the 4-item model BSSS-4 (Stephenson et al., 2003). The BSSS-4 model is used in this research to measure Sensation Seeking.

Table 4.3.4 Questionnaire for BSSS-4 by Stephenson et al.

Item Order	*SCALE* *All items measured on a Likert scale from 1 (Strongly disagree) to 9 (Strongly agree)*
1	I would like to explore strange places.
2	I like to do frightening things.
3	I like new and exciting experiences, even if I have to break the rules.
4	I prefer friends who are excitingly unpredictable.

The following questionnaire for Risk taking propensity was used. Eleven items, suggested by the literature, are used for assessing how risk inclined or risk averse participants are. In the eleven items an instructional manipulation check (IMC) was incorporated in the questionnaire ('If you are paying attention when filling in a questionnaire please click on answer number four.'), to ensure participant attentiveness. Finally, Tables 4.3.6 and 4.3.7 present the questionnaires used to measure Nostalgia and Need for Cognition, respectively.

Table 4.3.5 Questionnaire for Risk-taking propensity

Item Order	*SCALE* *All items measured on a Likert scale from 1 (Strongly disagree) to 9 (Strongly agree)*
1	When I eat out, I like to try the most unusual items the restaurant serves, even if I am not sure I would like them.
2	A new store or restaurant is not something I would be eager to find out about.
3	When I go to a restaurant, I feel it is safer to order dishes I am familiar with.
4	1 am very cautious in trying new different products.
5	I like introducing new brands and products to my friends.
6	I would rather stick with a brand I usually buy than try something I am not very sure of.
7	I would rather wait for others to try a new store or restaurant.
8	If you are paying attention when filling in a questionnaire, please click on answer number four.
9	I never buy something I don't know about at the risk of making mistakes.
10	I enjoy taking chances in buying unfamiliar brands just to get some variety in my purchases.
11	If I did a lot of flying, I would probably like to try all the different airlines, instead of flying just one most of the time.
12	I enjoy exploring several different alternatives or brands while shopping.

Table 4.3.6 Questionnaire for Nostalgia

Item Order	*SCALE* *All items measured on a Likert scale* *from 1 (Strongly disagree) to 9 (Strongly agree)*
1	They don’t make things as they used to.
2	Things used to be better in the good old days.
3	Products are getting shoddier and shoddier.
4	Technological change will ensure a better future.
5	History involves a steady improvement in human welfare.
6	We experience a decline in the quality of life.
7	Steady growth in the gross national product (GDP) has brought increased human happiness.
8	Modern business constantly builds a better tomorrow.

Table 4.3.7 Questionnaire for Need for cognition

Item Order	*SCALE* *All items measured on a Likert scale from 1 (Strongly disagree) to 9 (Strongly agree)*
1	I would prefer complex to simple problems.
2	I like to have the responsibility of handling a situation that requires a lot of thinking.
3	Thinking is not my idea of fun.
4	I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.
5	I try to anticipate and avoid situations where there is a likely chance I will have to think in-depth about something.
6	I find satisfaction in deliberating hard and for long hours.
7	I only think as hard as I have to.
8	I prefer to think about small, daily projects to long-term ones.
9	I like tasks that require little thought once I've learned them.
10	The idea of relying on thought to make my way to the top appeals to me.
11	I really enjoy a task that involves coming up with new solutions to problems.
12	Learning new ways to think doesn't excite me very much.
13	I prefer my life to be filled with puzzles that I must solve.
14	The notion of thinking abstractly is appealing to me.
15	I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
16	I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
17	It's enough for me that something gets the job done; I don't care how or why it works.
18	I usually end up deliberating about issues even when they do not affect me personally.

4.3.3 Results and Discussion

Table 4.3.8 presents the descriptive statistics of the sample. Variables appear to vary significantly with respect to central tendency and dispersion, as depicted in the coefficient of variation (CV). Furthermore, as the coefficients of skewness and kurtosis suggest, most distributions vary significantly from normality. This is further supported by the Jarque-Bera (1980) test, which rejects normality for most of the variables at the 5% level of significance.

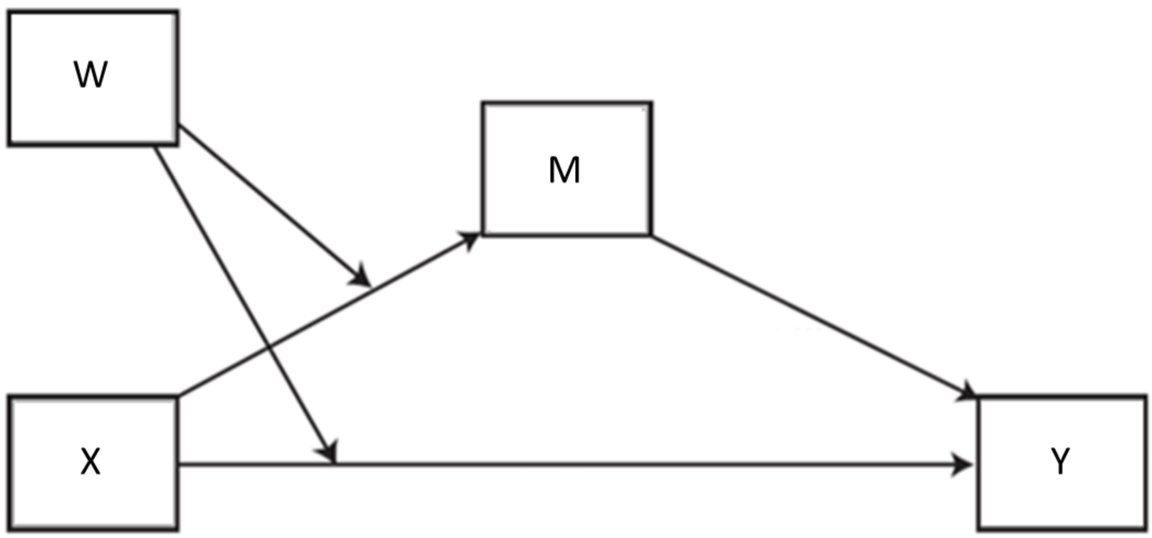
Table 4.3.8 Descriptive statistics

	Mean	Median	Max	Min	Std. Dev.	CV	Skew.	Kurt.	J-B	p-value
Engagement	4.955	5.000	9.000	2.000	1.315	0.265	0.268	2.900	1.516	0.469
Familiarity	3.025	2.000	9.000	1.000	2.247	0.743	1.062	3.239	23.226	0.000
Informativeness	4.574	4.500	9.000	1.000	2.476	0.541	0.164	1.856	7.203	0.027
Dynamism	4.906	5.000	9.000	1.000	2.198	0.448	-0.018	2.196	3.293	0.193
Need for Cognition	5.056	5.056	9.000	3.000	0.815	0.161	1.332	8.162	170.131	0.000
Nostalgia	5.696	5.500	9.000	3.500	1.115	0.196	0.827	3.888	17.931	0.000
Attitude towards Brand	5.395	5.625	9.000	1.000	2.323	0.431	-0.222	2.061	5.484	0.064
Sensation Seeking	5.111	4.875	9.000	1.000	1.994	0.390	0.132	2.271	3.058	0.217
Novelty	5.178	5.333	9.000	1.000	1.972	0.381	-0.269	2.392	3.352	0.187
Risk Taking Propensity	4.994	4.955	9.000	2.727	0.870	0.174	0.543	5.863	47.660	0.000
Visual Appearance	5.358	5.667	9.000	1.000	2.325	0.434	-0.325	2.077	6.475	0.039
Complexity	3.430	3.000	9.000	1.000	1.984	0.578	0.521	2.452	7.056	0.029

In order to examine the effectiveness of the dynamism manipulation we test whether the average perceived dynamism between the two images is different. To this end we run a t-test for equality of dynamism means. The average perceived dynamism for the “static” image is 4.18 whereas for the “dynamic” it is 4.94. The computed t-statistic of 2.647 is significant at the 1% level (p-value 0.0087), therefore the null hypothesis of equal means is rejected, which suggests that the difference in average perceived dynamism across the two images is statistically significant. This indicates that the dynamism manipulation is effective.

To examine the main hypothesis, we adopt a simple mediator model with a moderator. This model stipulates that the effect of a variable X on a variable Y is mediated through a variable M, and both direct and indirect effects are moderated through a variable W. As presented in Figure 4.3.1, in the model, apart from the direct effect of variable X on Y, X also exerts an influence on Y indirectly, through variable M (the mediator). Both of these effects are moderated by variable W, which is added in the regression both by itself and through its interaction with X. Finally, control variables (covariates) can be added in the model.

Figure 4.3.1 Model Conceptual Diagram – moderated mediation



In the study, Y is attitude toward the logo. This is captured as the average between items 1, 3 and 4 of Table 4.3.9. Item 2 is omitted as it is not pertinent to the logo. X captures dynamism and is encoded as a dummy variable (1-high dynamism, 2-low dynamism), whereas engagement is used as a mediator. Finally, need for cognition and risk-taking propensity are alternated as moderators. Familiarity is used as a control variable.

For the estimation of the models we used the PROCESS macro for SPSS based on model 8, proposed by Preacher and Hayes (2008) with 5,000 bootstrap repetitions. Estimation results are presented in Table 4.3.9.

Table 4.3.9 Estimation results of Moderation (models 1 and 3) and Moderated Mediation (models 2 and 4) models. Moderators used are Need for Cognition (models 1 and 2) and Risk-Taking Propensity (models 3 and 4). Engagement is used as a mediator and Familiarity as a covariate.

Variable	Model 1	Model 2	Model 3	Model 4
Constant	1.3414	1.9633	2.3242***	3.1635*
Dynamism	2.6330**	0.7796	1.7685**	-1.6757
Engagement		0.9130***		0.9168***
Need for Cognition	0.5559***	-0.2963		
Dynamism x Need for Cognition	-0.3804*	0.0230		
Risk Taking Propensity			0.3661**	-0.5474**
Dynamism x Risk Taking Propensity			-0.2059	0.5187*
Familiarity	0.1417***	0.0737	0.1340***	0.0737
R-squared	0.2478	0.3920	0.2331	0.3984

Overall the results indicate that the personality characteristics used in the models moderate to a limited degree the effect of perceived logo dynamism on attitudes towards the logo. Firstly, with respect to the antecedent variable (Dynamism) in the simple moderation models, it is statistically significant and has a coefficient that is also relatively high: ceteris paribus a 1 unit increase in perceived dynamism improves the attitude towards the logo (in the 1-9 scale) by 2.63 units for model 1 and 1.76 units for model 3.

The main effect of the moderators is also positive and statistically significant, albeit of a lower magnitude. A one unit increase in Need for Cognition results in 0.55 units increase in attitude towards the logo. Similarly, a one unit increase in Risk Taking Propensity results in 0.36 units increase in attitude towards the logo. This suggests that personality traits are associated with attitude towards the logo, which can be expected.

With respect to the interaction between the antecedent (Dynamism) and the moderators (Need for Cognition and Risk-Taking Propensity, respectively), the results vary. Although the marginal effect of the interaction term with Dynamism is statistically significant for Need for Cognition, it is not so for Risk Taking Propensity. This suggests that Risk Taking propensity does not moderate the effect of perceived Dynamism on attitudes towards the firm. The estimated coefficient for the interaction term between Need for Cognition and Dynamism also reveals a limited effect. The coefficient is statistically significant (albeit at the 10% level) and negative, but of moderate magnitude (-0.38). This suggests that Need for Cognition negatively affects the effect of Dynamism on attitude towards the firm. Although this seems contrary to what one would expect, the limited effect and statistical significance of the coefficient suggest that the effect is not very strong.

Finally, the covariate used (Familiarity) has, as expected, a positive and statistically significant effect on attitude towards the firm. The more familiar the logo appears to respondents, the better the attitude of respondents towards the logo. The R-squared coefficient of the models suggest that the models have adequate explanatory power.

With respect to the moderated mediation models, if one examines the estimation results for Models 2 and 4 of Table 4.3.9, it appears that they do not lend much support to the moderation effect of personality traits. In both models, Engagement behaves as expected of a mediator, being highly significant and rendering the antecedent variable statistically insignificant. Nevertheless, the inclusion of the mediator in model 2 renders both the moderator (Need for Cognition) and its interaction with the antecedent statistically insignificant. Interestingly, the addition of the mediator in model 4 makes the interaction of the moderator and the antecedent statistically significant (at the 10% level), but the fact that there is no evidence of moderator effects in model 3 makes this result of limited importance.

4.3.4 Conclusions

This study examines the role of consumer personality traits as moderators of the effect of perceived logo dynamism on consumer attitude towards the logo. One hundred and twenty two participants were asked to evaluate elements of logo design (visual appearance, complexity, informativeness, familiarity, novelty, dynamism and engagement), their attitude towards the brand and their personality traits (sensation seeking, risk taking propensity, nostalgia and need for cognition).

The estimates extracted were shown to vary significantly in terms of central tendency and dispersion and mostly follow non-normal distributions. Following Cian et al. (2014) the moderated mediator model by Preacher and Hayes (2008) is applied to test the suitability of personality traits as moderators of the effect of logo dynamism on attitudes towards the logo. The personality traits used as moderators are Need for Cognition and Risk-Taking Propensity, whereas Engagement was used as a Mediator. This is the first study to employ personality traits as moderators in such a study using this methodology. The results offer limited support of the role of personality traits as moderators in this relationship. Therefore, the study strengthens the case for the development of objective measures of visual characteristics.

Chapter 5. Conclusions

5.1 Summary

This thesis introduced computational aesthetics to the study of corporate visuals. This is motivated and framed on a critical review of a diverse literature that spans across Marketing, Art History and Philosophy, and, Visual Science and Psychology. The thesis argued why this new approach is justified in terms of the advantages it offers over existing methods. It also shows what new measures can be estimated and how this can be done empirically. The arguments in the thesis are backed up by evidence from three empirical studies.

The first study employs a set of 107 computational aesthetic measures to quantify the image characteristics in a sample of 215 professionally designed logos. This is the first application of its kind in the marketing literature. A particularly innovative aspect of the approach is the use of an array of different measures for evaluating design elements related to colour, including, hue, saturation, colourfulness. Within the theoretical framework of Henderson and Cote (1998), it is discussed how the computational aesthetic measures may correspond to logo design elements. The results show that the new measures have a very diverse statistical behaviour typically follow univariate distributions that are highly non-normal. Despite the nonnormality in the data, factor analysis indicated that our categorisation of the measurements in three factors is a reasonable representation of the data.

The second study investigates if it is possible to capture expert assessment of logo design characteristics using the proposed computational aesthetics. Eight design elements of the 215 logos in the sample, corresponding to harmony, elaborateness and naturalness, are evaluated by three experts. The results show that the behaviour of experts can be captured using the proposed computational aesthetics measures. Moreover, the performance of simple regression analysis can be substantially enhanced using machine learning techniques. This is justified on the basis of the nonormalities and possible nonlinearities in the data.

The final study investigates the role of consumer personality traits as moderators of the effect of perceived logo dynamism on consumer attitude towards the logo. This is the first study to employ personality traits as moderators in such a study using this methodology. The results offer limited support of the role of personality traits as moderators in this relationship. Therefore, the study strengthens the case for the development of objective measures of visual characteristics.

For the purposes of this study one hundred and twenty-two participants were asked to evaluate elements of logo design (visual appearance, complexity, informativeness, familiarity, novelty, dynamism and engagement) and their attitude towards the brand. At the same time participants were asked to answer questionnaires regarding traits of their own personality (sensation seeking, risk taking propensity, nostalgia and need for cognition).

The estimates extracted were shown to vary significantly in terms of central tendency and dispersion and mostly follow non-normal distributions. Following Cian et al. (2014) the moderated mediator model by Preacher and Hayes (2008) is applied to test the suitability of personality traits as moderators of the effect of logo dynamism on attitudes towards the logo. The personality traits used as moderators are Need for Cognition and Risk-Taking Propensity, whereas Engagement was used as a Mediator.

5.2 Limitations and Path for Future Research

The thesis recognises a number of key limitations in the analysis that could be addressed by future research. A brief discussion of each one follows in the remainder of this section.

- *Theoretical construct*: One of the major innovations of the proposed approach is the measurement of colour in corporate visuals and logos in particular. Although the thesis frames the discussion within the theory proposed by Henderson and Cote (1998), it recognises that this does not explicitly account for colour. It was argued that it is broad enough to encompass colour and it was shown how this is relevant. However, future research may develop a new or revised theoretical construct that explicitly accounts of the importance of colour. Also, further theoritising is needed to better establish the association between the computational aesthetics measures and the key design elements proposed by Henderson and Cote (1998).
- *Normality and nonlinearity*: The results showed that the computational aesthetics measures proposed follow highly non-normal distributions in our sample of logos. This may affect some of the methods and results used such as the exploratory factor analysis and regression analysis. An effort was made to address this using machine learning techniques that are nonparametric and have minimal assumptions. The results suggest that such nonparametric methods offer a substantially better fit to the data which indicates that parametric models may indeed be affected by a violation of assumptions. The drawback of machine learning is that it allows little inference in terms of hypothesis testing and interpretation of results. Further research is needed on exploring the use of other robust methods in the testing of hypotheses using the computational aesthetics measures. More robust versions of factor analysis may reveal a structure that is more useful for exploratory analysis.

- *Independence of observations:* The expert evaluations of logo design are nested within each respondent as each respondent evaluates all logos. This may affect the validity of some of the parametric methods employed. Although an effort was made to address this through the use of machine learning methods, more robust parametric methods could be used by future research.
- *Expert and Consumer Responses*: The empirical studies undertaken did not try to directly link the computational aesthetic measures of logos to expert or consumer responses in terms of, for example, affect towards the brand. Although this was beyond the scope of the thesis, future research could explore this relationship.
- *Other computational aesthetics measures and corporate visuals*: Although the thesis explored an extensive set of measures, this is by no means exhaustive. Future research could examine how other measures in this emerging field may also be useful. The present analysis was restricted to a sample of logos but it would be interesting to extend the application to other corporate visuals such as printed advertisements.

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Appendix – Sample of Logos Used

Holder	WIPO number	Logo
3pillar Global, Inc.	013613112	
Aachen-Laurensberger Rennverein E.V.	003575347	
ACCONCIATURE SABRINA Di TADDEI SABRINA	011067238	
Adata Technology Co., Ltd.	008710121	

Holder	WIPO number	Logo
Aeon Matrix Inc.	013167441	
Agro-Vital B.V.	009007618	
Akzo Nobel Coatings International B.V.	000132944	
Amazonen-Werke H. Dreyer Gmbh & Co. Kg	013523626	
Amf Capital Aktiengesellschaft	012165809	

Holder	WIPO number	Logo
Annika Keller	014685119	
Anova Holding B.V.	013960133	
Aspect Imaging, Ltd.	013876586	
Baby Einstein, Llc	002698967	

Holder	WIPO number	Logo
Banif - Banco Internacional Do Funchal, Sa	008289514	
Bank Of China Limited	004817888	
Basisbank A/S	013964275	
Berstscheiben Schlesinger Gmbh	008640501	

Holder	WIPO number	Logo
Better Fresh Limited-Unoco	011917382	
BIOGARAN, Société Par Actions Simplifiée	012701249	
Biosfera Consultoría Medioambiental Sl	010538049	
Blycolin Group International B.V.	012641411	

Holder	WIPO number	Logo
Bodet & Horst Gmbh & Co. KG	006783484	
Boehringer Ingelheim International Gmbh	015005812	
Bolletje B.V.	006748611	
Brauerei Beck Gmbh & Co. KG	004719951	

Holder	WIPO number	Logo
Broadcast Architech	012317988	
Buro Scandinavia B.V.	014748925	
Calevo Gmbh	011743721	
Carmignac Gestion	013924031	
Celltex Therapeutics Corporation	012532255	

Holder	WIPO number	Logo
CENTER EMUNI, Public Institution	007504921	
Chata Polska S.A	008691545	
Citycon Oyj	014629141	
Compania Nationala Romtehnica Sa	011197779	

Holder	WIPO number	Logo
Conservas Olasagasti Dentici, S.L.	013332812	
Consolidated Contractors Company Sal	010885531	
Consorzio Della Denominazione San Gimignano	014744577	
Copyer Co Ltd	000272393	

Holder	WIPO number	Logo
Cornelia Wolfrum Nail Art	012619433	
Crunchfish AB	011522422	
Cst Enterprises, Llc - Collibri	011290129	
Cultizm.Com DM International Trading E.K. Dejan Milenkovic	012113411	

Holder	WIPO number	Logo
Dansand A/S	008698714	
Deep-Secure Limited	014751929	
Delpharm	008832222	
Deutsche Post Ag	000797209	
Deutsches Elektronen-Synchrotron DESY, Eine Stiftung Privaten Rechts	011770039	

Holder	WIPO number	Logo
DIE ERSTE Österreichische Spar-Casse Privatstiftung	010296697	
Digital Sports Arena Limited	014989404	
Dkr Drinkatering S.R.L.	009603937	
DOREA Holding Gmbh	014632699	

Holder	WIPO number	Logo
Dörner + Helmer Gmbh	014763551	
Dragon Steel Corporation	010995058	
Drukarnia Piotr Suchecki	013775879	
Eblocker Gmbh	014032064	

Holder	WIPO number	Logo
EFCNI- European Foundation For The Care Of Newborn Infants	014957948	
Elasticsearch BV	013805486	
Emergo (Cyprus) Limited	003256252	
Emirates Nbd Bank P.J.S.C.	012684015	

Holder	WIPO number	Logo
Emnicon AG	011583598	
ENERGETICUM Gmbh & Co. KG	011423671	
Engelbert Strauss Gmbh & Co. KG	004376976	
Enoi S.P.A.	014779177	
Evropsko-Ruská Banka, A.S.	008224503	

Holder	WIPO number	Logo
Expedia, Inc.	009156043	
Extracadabra	014942411	
Farmer Automatic Gmbh & Co. KG	010828903	
Federacion Española De Baloncesto	004204723	

Holder	WIPO number	Logo
Finca International, Inc.	012118361	
First Link Oy	010240869	
Floraprima Gmbh	012451266	
FONDATION BETTENCOURT SCHUELLER (Fondation Reconnue D'utilité Publique)	009384637	

Holder	WIPO number	Logo
Fondazione "Banco Farmaceutico Onlus"	012041431	
Forward Technology Industries Plc	000265447	
Franz Rhiem Und Stefan Rhiem Gbr	002642007	
FROSYS Gmbh	009053075	

Holder	WIPO number	Logo
Fundación Diagrama Intervención Psicosocial	012580346	
Gärtner Von Eden Eg	009210841	
GENDERKA Spółka Z O.O.	008654006	
Genera Networks Ab	013393111	

Holder	WIPO number	Logo
Genesis Cryo Tech Gmbh	014788194	
Gernius Limited	1061939	
Globalfoundries Inc.	008555922	
Gmina Miasto Szczecin	006936793	

Holder	WIPO number	Logo
Grupa LOTOS S.A.	003577582	
HACKNER Security Intelligence Gmbh	012455903	
Hampshire Trust Bank Plc	014259171	
Hans Stockmar Gmbh & Co. KG	004040655	

Holder	WIPO number	Logo
Healthcare DENMARK	012569547	
Hendrikus Jacobus Marinus De Vries – The Bulldog	008758311	
Hilite Germany Gmbh	010455053	
Hirschmann Automotive Gmbh	013920376	

Holder	WIPO number	Logo
Houzz, Inc.	014549562	
Huawei Technologies Co., Ltd.	009214041	
Ikb Deutsche Industriebank Aktiengesellschaft	000398461	
Ilmor Engineering Limited	013616991	
Imprimerie Nationale	012325585	

Holder	WIPO number	Logo
Insol International	014805857	
INSS-POL Sp. Z O.O.	008690257	
INSTYTUT NARZĄDÓW ZMYSŁÓW Sp. Z O.O.	008473001	
INTAMS Ivzw	008140279	

Holder	WIPO number	Logo
Interlock Medizintechnik Gmbh	013801048	
Intersnack Group Gmbh & Co. KG	009629312	
Intrum Justitia Licensing Ag	000306662	
Irbis Bulgaria Ad	011613262	

Holder	WIPO number	Logo
ISTITUTO LUCE - CINECITTA' S.R.L.	014806707	
Iturus Limited	014592431	
Johanniter Orde In Nederland	001784206	
Jumbo Maritime B.V.	012787503	
Kahala Franchising L.L.C._Goldstone Creamery	011062882	

Holder	WIPO number	Logo
Khodabakhsh Bahmani- German Adler	012173563	
KIM Krick Interactive Media Gmbh	011118461	
Konstantīns Ņikitins	013753281	
Kraftringen Energi AB (Publ)	011788247	
Kruitbosch Zwolle B.V.	013908462	

Holder	WIPO number	Logo
KUNSTSTOFFWERK KREMSMÜNSTER Gesmbh & Co KG	001023332	
LACRUM Velké Meziříčí, S.R.O.	010563344	
Läpple Ag	012105541	
Leanix Gmbh	014034541	
Levantex Bocairent, S.L.	014680383	

Holder	WIPO number	Logo
LOBA Gmbh & Co. KG	003207495	
Lucobit Ag	008937203	
Mai Vision Onlus	014907166	
Mainfreight Limited	010550812	

Holder	WIPO number	Logo
Marcel Durchholz Appinaut	012548723	
Mark Murad Tarpinian Joy News Network	012630299	
Martin Braun Backmittel Und Essenzen KG	003179199	
Mcmullan Bros. Ltd -Maxol	011565025	

Holder	WIPO number	Logo
Melett Ltd	010251437	
Minusines S.A.	014664205	
Montes8615 Gmbh	014889893	
Myfox	012143781	
Nallian N.V.	014737531	

Holder	WIPO number	Logo
Naturvention Oy	013463047	
NAUTICA EDITRICE S.R.L.	008512568	
Nexen N.V.	014767495	
Nfon AG	013014204	
Obelink Vrijetijdmarkt B.V.	014686811	

Holder	WIPO number	Logo
Oceanteam Holding B.V.	012669602	
Odenwald-Chemie Gmbh	008434342	
Olivier Claire	014572011	
Ou Software, S.L.	008470346	

Holder	WIPO number	Logo
Phusion Holding B.V.	011707999	
Pioneer Europe Limited-Qualatex	011747425	
Pkf Cooper Parry Group Limited	012609442	
Polski Bank Komórek Macierzystych S.A	014813349	

Holder	WIPO number	Logo
Predator Nutrition Limited	011045473	
Project Zero A/S	012537981	
Publicis Groupe S.A. - Digitaslbi France	012401147	
Qeos	013682711	

Holder	WIPO number	Logo
Quality Is Our Recipe, Llc-Wendy's	011667359	
Queisser Pharma Gmbh & Co. KG	000787770	
Quimoalar, S.L.	014822803	
Rackspace US, Inc. DBA Rackspace Or Rackspace Hosting	010281194	
Regie Autonome Des Transports Parisiens (Ratp) - Epic	009766321	

Holder	WIPO number	Logo
Rental Alliance Gmbh	012479887	
Rls Global Ab	014860911	
S.M.A.T. NORD S.R.L.	013640438	
SALINI IMPREGILO S.P.A.	012449708	

Holder	WIPO number	Logo
Saunalahti Group Oyj	008432379	
Schott Diamantwerkzeuge Gmbh	012674057	
Seleni House Foundation, Inc.	010852119	
Selmers Industrial B.V.	013901301	

Holder	WIPO number	Logo
Sgl Carbon Se	000761601	
Shenzhen Beniao Online Technology Co., Ltd.	015008642	
Shinhan Financial Group Co., Ltd.	012204517	
Simcheng	013222401	
Sinter Ibérica Packaging, S.A.	014134068	

Holder	WIPO number	Logo
Skånemejerier AB	006476303	
Skistar AB	010630821	
Solrac Coatings S.L.	013687553	
Soundtrap AB	014637235	

Holder	WIPO number	Logo
Spectralink Corporation	012103727	
Speed4Trade Gmbh	011807575	
Ssp Co., Ltd.	000797183	
St. Peter's Brewery Co. Limited	014759849	

Holder	WIPO number	Logo
Starbucks Corporation	011597846	
Stiftung Bürgerspital Zum Hl. Geist	010147015	
Storci Perforazioni S.R.L.	011826591	
Stormtech Performance Apparel Ltd.	008875734	

Holder	WIPO number	Logo
Stratified Medical Limited	013543269	
SV Stuttgarter Kickers E. V.	010406701	
Sven Ifland- Ifland Dach	012168019	
Svensk Adressändring Aktiebolag	013324173	

Holder	WIPO number	Logo
Synergy (High Wycombe) Limited	012684701	
Synthetic Genomics, Inc.	006540901	
System Assistance Medical Sas	012271565	
T. Rowe Price Group, Inc	012695128	

Holder	WIPO number	Logo
Telepart Discount Distribution Gmbh	011631141	
The Bank Of Tokyo-Mitsubishi UFJ,Ltd	000289997	
TISKA Technische Instandsetzungs-Service Gmbh Für Kraftwerke	001386648	
Tokio Marine & Nichido Fire Insurance Co., Ltd.	014797385	

Holder	WIPO number	Logo
Top Farms Agro	014532287	
Trapeza Peiraios Ae (Piraeus Bank Sa)	012084745	
TSB24 Gmbh	014604797	
Twint Ag	013497541	

Holder	WIPO number	Logo
Uniggardin Aps	013824057	
United Intellectual Property B.V.	000817304	
VAG-Armaturen Gmbh	006463244	
Vedanta Resources Plc	013981006	
Verisec AB	014782247	

Holder	WIPO number	Logo
Vesuvius Crucible Company	000222356	
Visual Foods Limited	012253449	
Visualfood S.R.L.	014652028	
Voltaide S.R.L.	012096781	

Holder	WIPO number	Logo
Wat International Corp.	000890152	
WBV Weisenburger Bau + Verwaltung Gmbh	008677718	
Webswappers Ltd	008783219	
Węglokoks Kraj Sp. Z O.O.	014096267	

Holder	WIPO number	Logo
Węglokoks S.A.	011936382	
Xmldation Oy	009646613	
XYLEM IP MANAGEMENT S.À.R.L.	000866772	
YIPIN Pigments Gmbh	011796761	
Ziemann HOLVRIEKA Gmbh	012285987	

Holder	WIPO number	Logo
Zomato Media Private Limited	014529432	