Manipulative Textile Design Patterns

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Abstract

Horizontal and vertical lines have consistently been found in designs throughout history. The stripes are bold, and the contrast of these lines creates a form of illusion that was used to deliver a goal in this thesis. This goal involves preventing others from observing the flaws of an individual body with the aid of illusion. The research used the Malaysian batik pattern and modernised it to fit customers' needs. Moreover, this research aimed to realise the goal of distinction in clothing. Within the scope of this research, distinction refers to finding a textile pattern for individuals that creates a flattering figure and hides flaws. This research investigated various design patterns that acted as optical illusions to affect viewers' perceptions of body size and shape. Some existing theories state that specific patterns can influence how broad or thin the wearer looks. Patterns can visually manipulate the sizes of shapes, while the different positioning and placement of patterns can trigger different visual outcomes on various forms. The present study suggests that the critical component to creating an optimal appearance is applying the right textile pattern on specific body shapes. Quantitative methods were utilised and involved psychological investigation. The data collection process involved psychometric scaling, paired comparison and magnitude scaling methods. Paired comparison is an easy method of approaching respondents from all age groups, while the use of magnitude scaling improves efficiency by allowing participants to simultaneously assess four designs.

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Chapter 1

Introduction

Individuals have specific preferences regarding the design and colour of clothing as well as what they consider beautiful. Aristotle was one of the first to mention the concept of beauty. This perception is an intangible matter that has no specific formula. Beauty is an intangible characteristic, which is very subjective (Clarke, 1887). The Merriam-Webster Dictionary defines beauty as the quality or aggregate of qualities in a person or thing that pleases the senses or pleasurably exalts the mind or spirit. Today, a slim and tall figure represents the ideal body type in many cultures. This can often result in body image disturbance and eating disorders since people consciously consider thin and tall figures as their ideal preference (Thompson & Stice, 2001). The desire for a "perfect" body figure is ubiquitous worldwide. The mass media plays a persuasive role in thin-ideal internalisation by showing their elusive ideal beauty, which creates a phenomenon of people wishing to look slimmer and taller (Boone et al., 2014). Body image relates to self-admiration and how bodies are viewed by others (Rudd & Cater, 2006). Hence, people attempt to model themselves after their idols by following their fashion sense and lifestyle habits. This behaviour results in people becoming increasingly concerned with their appearance and striving for the quickest solution to achieving their desired appearance.

Thinness is known as the ideal global look because Western cultures have established thinness as a body ideal. However, the thinness phenomenon of Western countries has not always been idolised in the past (Swami, 2015). Historically, the ideal female figure was plumper and rounder until the 19th century. The Western lifestyle has a major global impact, which has resulted in the preference for thinness spreading to invade the minds of people across countries and cultures. However, many cross-cultural differences in ideal body size, weight, height and obesity preferences remain (Brown & Konner, 1987; Ford & Beach, 1952; Sobal & Stunkard, 1989). This can be observed by Western cultures seeking thinness, whilst non-Westernised cultures prefer body figure to be relatively plump and this plumpness reflects greater selfworth, sexiness, femininity and fertility (Ghannam, 1997; Treloar et al., 1999). In some societies, body fat gain during motherhood is a symbol of maternity and nurturance (Powdermaker, 1960). These differences in culture result in varied perceptions of ideal beauty. Traditionally, the South Pacific Islanders work to make their body fatter because fatness is associated with wealth, authority and high status, while also being associated with sexuality and femininity among women (Pollock, 1995). Moreover, researchers have documented that the Pacific societies have different ideal body preferences that differ from those of comparable groups in New Zealand, Britain or Australia (Becker, 1995; Brewis & McGarvey, 2000; McGarvey, 1991; Wilkinson et al., 1994). Additionally, changes over time have resulted in different styles and standards for physical attractiveness (Sherrow, 2001).

Today, the living trend is moving fast, with the food industry, instant living and hectic lifestyles representing factors that make it difficult for people to achieve their desired body type. Each culture holds a different view of ideal body shape. Some cultures prefer a thinner body figure, whilst others prefer a plumper appearance. Regardless of the cultural preferences, the various ideologies behind ideal beauty (considering rounder or thinner figures as ideal beauty) lie in the eye of the beholder. Generally, people function better when they are confident, and one way of becoming confident is by dressing well. One supporting element that people use to select clothing is the pattern, which acts as a medium to visually beautify the wearer. Patterns can create a multitude of appearances on fabric, and by adding illusion, patterns can help enhance the appearance of those wearing them. One method of transferring patterns onto fabrics is known as batik making.

Batik's direction has been extensively discussed among artists, designers and the government of Malaysia. Notably, Malaysia has taken the approach of making government workers wear batik every Thursday. Since Malaysia is a Muslim country, the motifs used for batik must refrain from using animals and devilish motifs. The use of stripes is practical and acts as a universal language for all to experience. Furthermore, the use of the golden ratio is adopted in placing the stripes. The golden ratio is known to represent absolute beauty. Since patterns are works of art, the placement of lines inside partitions of the golden ratio achieves a measurable proportion of size in pattern placement.

Visual perception is a Gestalt phenomenon due to how various shapes and colours blend or stand out. Gestalt theory proposes that a whole is more important than an individual part. However, the present study will not touch on all causes of illusion. Instead, it will focus on illusions using horizontal and vertical stripes in black and white. Studies have found that the first thing an eye notices is colours. However, patterns on clothing will influence how colour appear as well as how the attire functions. Colours can also create illusions of body size, which explains why colour illusion is not included in the present study. Illusions involving colour represent an entirely separate topic. For example, colours with lighter shades will make clothing appear larger, whilst darker colours create a more defined and narrower illusion (Osei & Agyemang, 2008).

Black and white are used due to the high contrast of this combination, which allows for optimum illusion effect. Scientifically speaking, black and white are not colours because, in physics, colours have a wavelength and visible light. Black is the absence of light and white covers all the hues in the colour wavelength. The study did not involve colours because the use of colours represents another set of findings.

Thus, the present research investigates types of design patterns that can act as optical illusions to affect viewers' perceptions of body size. Several theories state that certain patterns can influence how wide or narrow the wearer appears. These theories include the Helmholtz illusion, camouflage, Ponzo illusion, Poggendorff illusion, Zöllner illusion, Hering Illusion, Wundt illusion, Müller-lyer illusion, and the Herman grid illusion, among others. This research proposes the development of different types of design to assist illusions that manipulate visual perceptions of clothing wearers' actual size through the mediation of textile embellishments. With the right pattern, clothing can beautify the body and automatically boost the wearer's confidence level.

1.1 Aims

The aims of this research are:

1. To study/examine the form and shape criteria that impact the quality of optical illusions.
2. To manipulate patterns of illusion using horizontal and vertical stimuli for different body shapes.
3. To produce manipulative visual perception design pattern guidelines to fit the needs of different preferences.

1.2 Objectives

The objectives of this research are:

1. To study past experiments using horizontal and vertical lines on two-dimensional (2D) and three-dimensional (3D) forms and to conduct a pilot study to test the possibility of conducting experiments using horizontal and vertical lines.

2. To create a pattern of illusion for 2D and 3D human models with various shapes and heights using patterns of horizontal lines, vertical lines, and combinations of both.

3. To summarise the data collected from experiments into a chart explaining the effects of patterns applied to different body shapes.

1.3 Significance of the Study

First and foremost, the present study aspires to contribute to the literature on optical illusion designs—especially visual perceptions. To the best of my knowledge, studies on the compilation of eye illusion theories—especially from the fashion and textile industry perspective—are debatable. Existing research on stripes and illusion in fashion was mostly conducted on 2D surfaces. However, available research using 3D surfaces segregated horizontal or vertical lines. The final stage of this study concentrates on applying a combination of horizontal and vertical stripe patterns on 3D figures and animated 3D models to determine the presence of optical illusions.

Part of being human involves having judgements and opinions. Each individual has different perceptions, and this experience represents a complex process that differentiates each human. Furthermore, perceptions are closely linked to human cultures since certain experiences only occur in some cultures. For example, beauty standards differ between countries, with some countries preferring thinner or wider bodies based on their culture and upbringing. The same theory applies to textile patterns since different cultures will have different standards of beauty. In some cases, religion prohibits the use of certain symbols or items on clothing. This research caters to the batik industry, and particularly towards the Malaysian batik industry. Thus, the use of horizontal and vertical lines is the required criteria for manipulation into patterns in this study. The present research aimed to propose a guideline to aid textile designers in creating patterns. Notably, calculation of the golden ratio is applied as a structure to combine the horizontal and vertical lines to form patterns. The significance of applying the golden ratio revolves around creating beautiful patterns. In visual perception, beauty aids optical illusions by camouflaging flaws and enhancing strengths. The research proposes a manipulative guideline to allow instant body consciousness relief while providing an instant confident boost to those wearing a designated pattern. The patterns proposed aim to assist the Malaysian batik industry. Malaysian batik patterns differ from region to region, and as a Malaysian Handicraft, batik falls under the artistic product category. Malaysian batik patterns are mostly patterns that do not involve animals and use more abstract and organic patterns. This abstract and organic approach is heavily influenced by the religious belief that using animals in clothing should be discouraged. Hence, the use of stripes works well as a medium to create illusions on textile surface patterns. This research gives a new set of directions for batik artists to explore, thereby allowing them to implement the illusion theory of constructed horizontal and vertical lines on their work to enhance body figures. Adding an illusion effect on textile patterns to enhance body appearance represents a new pattern creation approach for designers.

The notion of pattern guidelines for different preferences and needs was created as a proposal for Malaysian batik designers. Using such guidelines, a series of collections can be created. The collection can involve designs and collections that are made for specific body shapes. The beauty of making batik is that it is a handmade process. Moreover, in Malaysia, government workers must wear batik to work every Thursday. Therefore, commercialisation of the aforementioned pattern guideline would have a high market value. In Malaysian batik, there are both cheap and more exclusive designs. For exclusive batik, designs are made purposely for one shirt or dress, which makes these designs more expensive. The pattern guideline should be directed at exclusive batik designers due to the design process being time consuming and requiring highly-skilled individuals to create.

Thus, the present study is considered an attempt to further advance the pioneering work by Helmholtz on horizontal and vertical lines, while exploring the illusion theory in greater detail using textile surface patterns. Furthermore, the findings could also improve pattern construction in the textile and fashion industries. The intended outcome of this research is to propose a pattern guideline for different preferences and needs. This will consist of images and design pattern formulae that complement wearers' body shapes.

1.4 Thesis Overview

The ultimate aim of the experiments performed in this thesis is to shed light on how patterns consisting of horizontal and vertical lines affect perceived body width. Moreover, the study also proposes a new type of pattern consisting of horizontal and vertical lines that complement body shapes preferences.

1.4.1 Chapter 2

Chapter 2 provides a review of the relevant literature related to patterns and illusion. The chapter first discusses the lifestyles of modern humans and how they affect the fashion industry, which is followed by a discussion of how illusion can aid in these lifestyles. The second part discusses the patterns used in the batik industry. The third part elaborates on the history of lines and stripes, previous research regarding horizontal and vertical stripes and the importance of lines in illusion. The fourth part discusses camouflage, the types of illusions, previous research conducted on illusions and how these illusions affect perception.

1.4.2 Chapter 3

This chapter describes the methods used to conduct the psychophysics experiments described in Chapters 4 and 5 as well as technical details regarding the equipment used.

1.4.3 Chapter 4

The aim of Chapter 4 is to further advance the pioneering work of Helmholtz on horizontal and vertical stripes and to explore the illusion theory in greater detail by using horizontal and vertical lines on different 2D and 3D images. This chapter first discusses the pilot study and the reviews received on it during a conference presentation. In Chapter 4, four different sets of image width assessments were conducted using 2D and 3D models.

1.4.4 Chapter 5

Chapter 5 provides a summary and evaluation of the results presented in this thesis. It highlights the present study's contribution to scientific knowledge and discusses future research ideas arising from present findings.

Chapter 2

Literature Review

Introduction

Over the last 20 years, industry boundaries have evolved significantly—especially in the fashion sector (Djelic et al., 1999). Body and beauty preferences are visible, tangible and personal decisions. Aesthetically, good fashion is the ultimate desire of most women worldwide (Sherrow, 2001). Moreover, contributions from fashion magazines, fast foods and actors have created certain standards for bodily beauty. However, these standards are not constant, vary across cultures and change over time (Savacool, 2009). Moreover, the appreciation of beauty varies between countries due to different cultures, customs and fashion trends that reflect the cultures and beliefs (Yalom, 1997).

The changing dynamics of the fashion industry, such as the fading of mass production, have resulted in retailers having a greater desire for low cost and flexibility in design, quality, delivery and speed to market (Doyle et al*.,* 2006). Additionally, fashion seasons and modified structural characteristics in the supply chain have forced an increase in speed to market and design, while marketing and capital investment have also been identified as driving forces for competitiveness in the fashion industry (Sinha, 2001). Franks (2000) suggested that 'sense and respond' is a key strategy used to maintain a profitable position in the increasingly dynamic and demanding fashion market. In this context, a defining characteristic of rapid responsiveness and greater flexibility is the existence of closer relationships between suppliers and buyers (Wheelright & Clark, 1992).

Individuals are aware of their surroundings through sensation and perception. While sensation is viewed as the first stage of perception, perception is regarded as a complex process that occurs through the acceptance, interpretation, selection and regulation of sensory information. The concept of perception is a subject in fields such as psychology, physiology, and art. Notably, perception varies from person to person. Movement is essential to perception, and humans gather information from their environments in accordance with their preferences (Caglayan et al., 2014).

Human vision functions based on our sense of sight and creates a perception of vision. Sight allows people to evaluate their external environment, which creates a relationship with this environment (Inceoglu, 2010). Notably, a light source is one of the components required for a person to see. This light source can be strong or weak since humans can adapt to various light situations (Bayav, 2008).

In visual perception, distance from an object, illumination and perspective can trigger illusion, while colour, shape and brightness rarely alter illusion (Gombrich, 1960). The Gestalt theory focuses on how visual perception occurs, the factors affecting the process and how these affect the process internally (Agag & Sakarya, 2015). Gestalt also states that the complementary principles in organising perception include figure and ground relation, the proximity principle, similarity principle, closure principle, continuation principle, simplicity principle and *pragnanz*.

However, visual perception and the things humans see with their eyes are a different matter (Agag & Sakarya, 2015). This can be confirmed by a comparison of horizontal and vertical lines (Gombrich, 1979). The visual perception shows differently in the length of the lines where actual line lengths differ. The brain judges perceived vision by accounting for the expectations resulting from previous experience (Agag & Sakarya, 2015).

It is important to note that every human has a blind spot and that this blind spot can send false information to the brain, thereby resulting in false interpretations. Hence, what is seen and what is thought can provide different perceptions, which can create illusions. The illusion of perception indicates that the sequence of perceptions is imperfect. In psychology, these inaccurate perceptual interpretations are called “the perceptual illusion” or “the optical illusion” (Agag & Sakarya, 2015). The illusion of perception indicates that the sequence of perceptions makes mistakes and that the results of perception are not perfect. The illusion of perception is a situation in which the interaction between physical reality and psychological experience is optimal

(Eryayar, 2011). Even today, humans are developing products that cater to human needs that exist between physical reality and psychological experience. In this context, sectors that never run out of business include fashion and textiles. One objective of the fashion industry is the production of products by marketing brand strategies. In the field of textiles, the construction of patterns and designs represents the major area of focus.

2.1 Fashion and Textiles

Fashion and textiles are profoundly linked because fashion depends on textiles to complete a look. Fashion and textiles are two great industries that represent major forces in the contemporary world. Design has many meanings and invokes a variety of definitions from designers. Oakley (1990) defines design as a plan conceived in the mind, not only as a set of drawings or instructions but also as the outcome of manufacturing. Furthermore, design is also defined as the process of relating and visually arranging components or elements to create effects (Wilson, 2001) and can also be considered as an essence of the problem-solving process (Archer, 1965; Jones, 1970; Cross, 1975; Simon, 1996). In art and design, numerous design theories support the arts. The design theory is also known as the elements and the principles of design. It represents the fundamental building block that makes a good design, and all art contains most elements of design (Lovett, 1998). The key design elements include lines, shapes, spaces, forms, colours, textures and values (Wilson, 2001). Additionally, the principles include repetition, movement, balance, emphasis/contrast and unity (Wilson, 2001). In textile design, a motif is a decorative image or design, and repeated motifs produce a pattern. Furthermore, patterns can be ornamental designs or decorative elements in fabric. A pattern is an arrangement of forms or colours (or both) to be implemented as ornamentation in various textile materials (Tortora & Merkel, 2005). Repetitions are widely used in textile design and represent repeated design elements that can have a variety of repeated structure types. Variations in repetition create active and rewarding appearances, whilst repetition without variation can be seen as monotonous (Louvet, 1998; Justema, 1976). However, there is no empirical evidence of this and no indication of how much variation is required for an optimal effect. Designers are trained to work freely, which results in the production of a wide variety of designs, especially in the textile and fashion context. Recent work regarding the use of textile design repeats to create optical illusions lacks the solid structure required to serve as a guideline for designers. The linkage between fashion and optical illusion patterns can create a new direction of pattern development, and recent work on the use of illusion in fashion and textiles has begun to experiment with horizontal and vertical lines as a medium to transfer optical illusions to fashion.

The forecast for fashion and textiles suggests that designers will tackle body-centred, social, performance and work-related projects (Gale & Kaur, 2004). Additionally, Gale and Kaur (2004) also noted the new functions of fashion and textiles as a means of delivering communication. Notably, this communication can be used to address beauty via pattern construction. According to Postrel (2004), while functionality matters in a crowded marketplace, what projects most are the aesthetics and products that appeal to fundamental human emotion. Products can function as more than just clothing—they can also fulfil people's emotional needs (Norman et al., 2000). Feldon (2000) stated that through dressing well, low self-esteem, poor self-image and sagging confidence are alleviated. Moreover, clothing also aids psychological judgements. Feldon named this the camouflaging technique, where the attention is focused on the whole body instead of its parts. The camouflaging rules render any problem areas the wearer might have as less consequential. An effective design reflects the emotional relationship between consumers and products by exploring the affective properties that products communicate through their physical attributes. This helps designers produce products and services that users connect with on an emotional level to inspire maximum pleasure (Surhone et al., 2010). However, males and females have different tastes in beauty, and this difference must be segregated based on male and female preferences.

2.1.1 Gender Differences in Beauty Perception

The way a human perceives beauty is "in the eye of the beholder" and this difference can be categorised according to gender preferences. Notably, men are less cautious about weight issues compared to women. A study by Marloew et al. (2005) noted that when men look at a woman, the eyes tend to focus on the female's waist-to-hip ratio first, with wider hips signalling better fertility. Male eyes also focus on the breast area (Jasienska et al.,2004), followed by the facial area (William et al., 2001). The movement of men's eyes demonstrates that focus is first concentrated in the waist area, which is followed by moving upwards towards the face. Both men and women show an interest in the breast section when analysing a body. In women, the first direction the eye moves to on a man is the face. The eyes later move down to the shoulders, followed by the chest, waist and the leg area (Hewig et al., 2008). Ideal female beauty involves wider hips, a narrower waist and longer legs than men (Vithanage et al., 2017). However, beauty preferences for the human body also vary according to culture (Marlowe et al., 2005), and bodies change continuously before and after puberty (Furnham et al., 1996). Since the human body is constantly evolving, the textile and fashion industries will continue to produce clothing. Clothing must address gender preferences, while pattern construction should address issues related to how body images are portrayed. Many procedures are used to create a piece of clothing. One traditional procedure used for creating patterns is known as batik making.

2.2 Batik

Batik can be traced to Malaysia, Indonesia, West Africa, and India, with each country having its own unique motifs and patterns. These motifs and patterns are created based on the surroundings and society of each area. The Indonesian batik motif is made to reflect its identity and is commonly known as *batik kraton* (Anjana & Nagar, 2010). The motifs of Indonesian batik include *parang rusak*, *garuda* bird and the sacred lotus flower. West African batik can be traced back to the 17th century, and the motifs used to consist of local figures and reflect respect and pose symbolic meanings (Chaoudhary, 2015). The Indian batik motifs vary greatly, with the paisley motif being a prominent subject. The paisley motif derives from plants and remains widely used in the textile and fashion industries (Sylvanus, 2007). However, Malaysia does not have any strong justification for its batik motif (Syed et al., 2013). Malaysian batik mostly consists of flowers and leaves as well as geometric and abstract designs (Ismail, 1986) that were created for their aesthetic value and do not possess any intrinsic meaning. The trend in Malaysia is to create a batik motif that favours aesthetically pleasing designs rather than embedded meaning (Haron et al., 2014). Malaysia is struggling to produce a motif that signifies or reflects the Malaysian identity (Ahmad et al., 2014). In this context, modernisation and fast fashion pose a significant threat to the direction of Malaysian batik. Without evolving the batik industry in Malaysia, the possibility of sustaining it will slowly diminish (Mazlan & Omar, 2012). Batik in Malaysia continues to progress with minimal changes to pattern designs. Since batik designers are buried under repetition, advancement must be made through new designs. One element that will enhance batik designs is the use of stripes.

2.3 Stripes

Modern textile designers draw inspiration from a multitude of sources. An increase in exhibitions and published materials from global sources facilitates easy access to cultures and their artistic traditions. Stripes are one of the simplest and most widely used patterns. Regardless of the time, gender and age differences, stripes are a highly versatile communication tool. They are one of the simplest design motifs and have a high impact on the surfaces they cover. They can be used for elegant, playful or brash situations. Moreover, their high contrast can highlight a feature or distinguish specific areas through juxtaposing colours, textures or materials in simple lines that can be straight or curved. Notably, the use of stripes seems to be more dominant than the use of other patterns.

When making a statement, stripes are a dominant symbol to portray aggressive messages. The high visual contrast lures designers and artist to use stripes in their products. Additionally, the fundamental ability of stripes to highlight and distinguish objects from their surroundings has been used since the 5th century (Hampshire & Stephenson, 2006). Pastereau (2001) stated that, during the Middle Ages, stripes were widely used to clothe social outcasts such as prostitutes, prisoners, jugglers or devils. This was due to stripes interrupting any sense of visual harmony, which creates a visual sense of mistrust. Also, stripes were used as means of identification to signal membership of a team, establishment or country. It is also an important means of communicating hierarchy and rank. The well-known stripes of English and American prisoner uniforms served as a means to visually distinguish and discredit them. The hidden messages behind stripes could act to unite, identify, punish and reward.

Top artists who have passionately used stripes in their work include Bridget Riley, Daniel Buren and Mark Rothko.

Bridget Riley

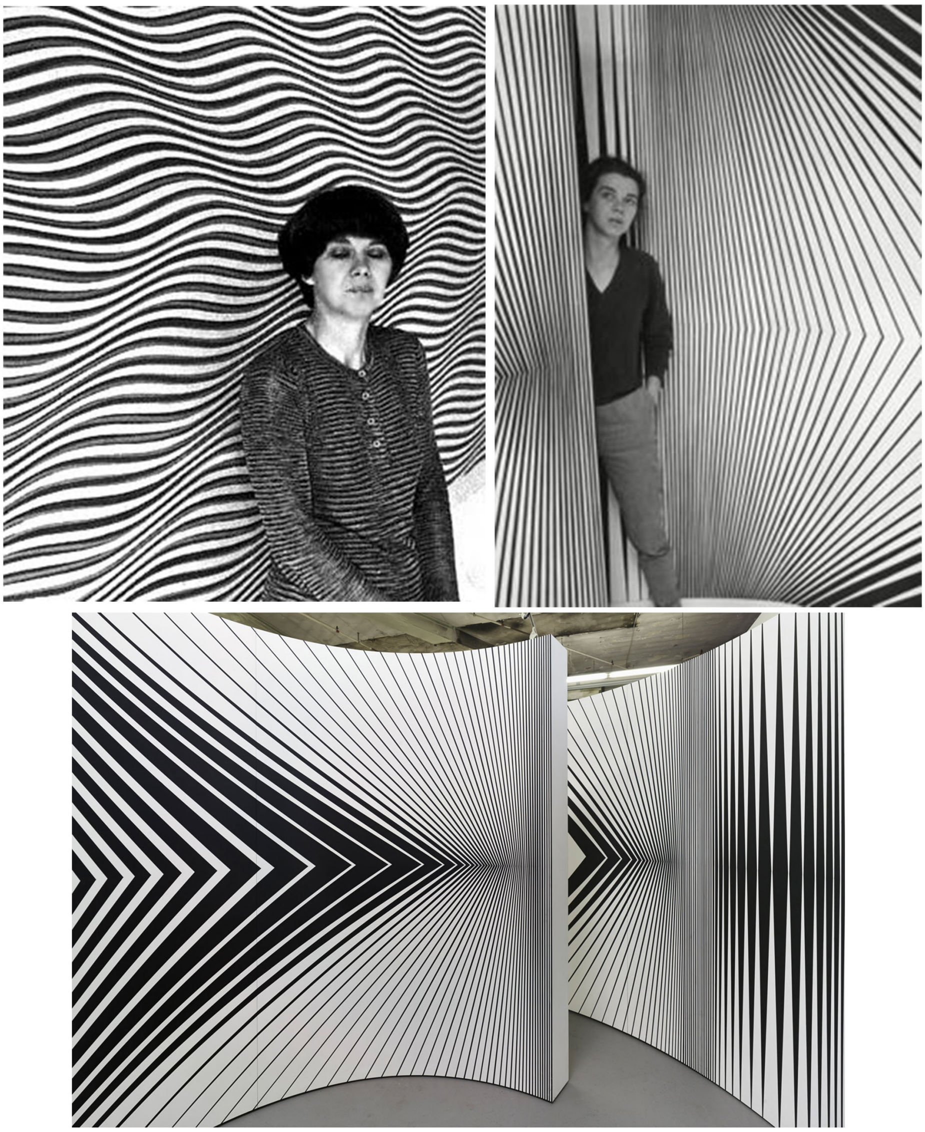


Figure 2.1 Bridget Riley, an Op Artist

Bridget Riley is a 20th-century op artist. Her work deals with simple black and white patterns that create optical illusions. The art created by Riley create vivid and dynamic illusions based on still objects (Zanker, 2004).

Daniel Buren

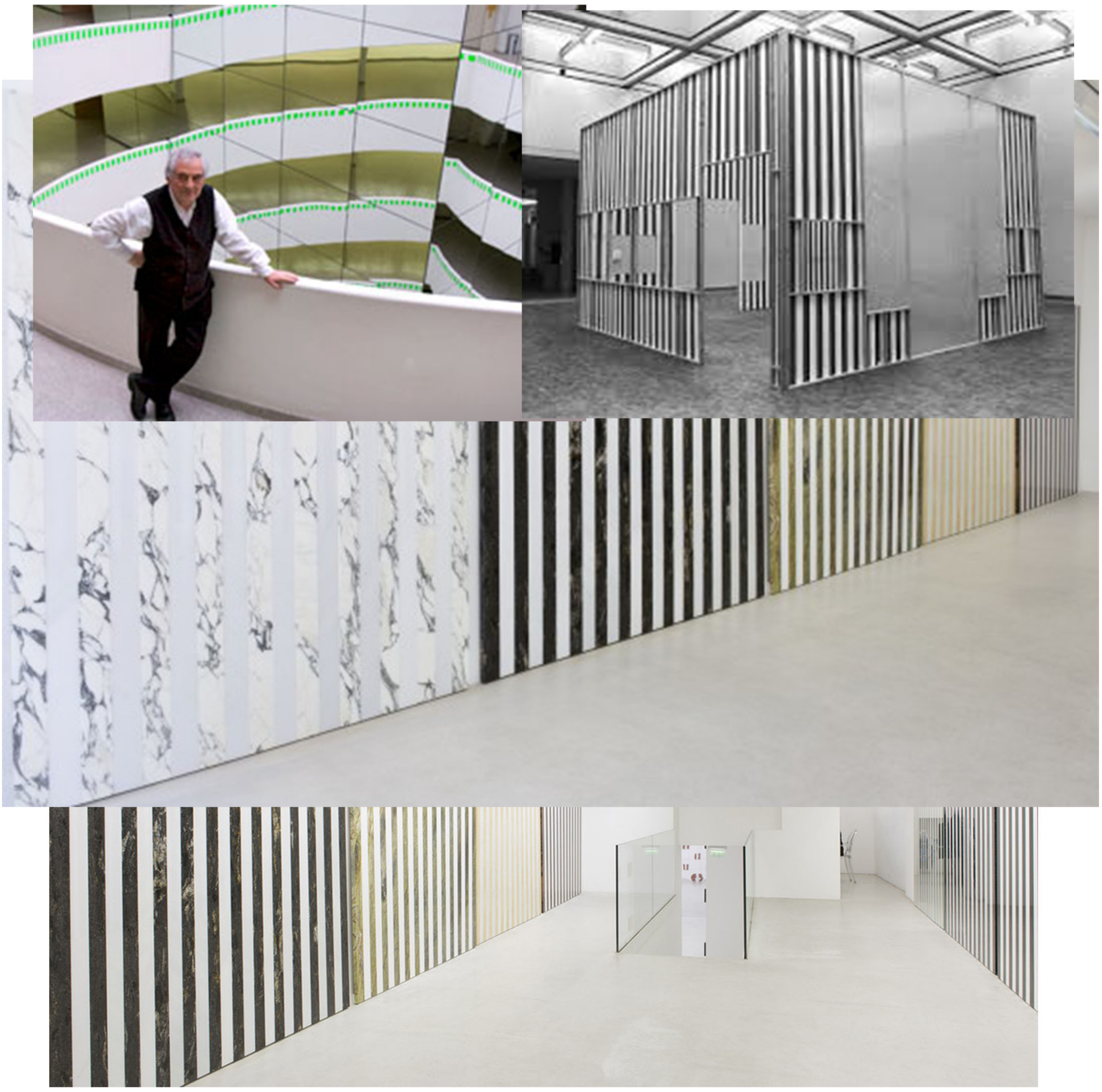


Figure 2.2 Daniel Buren, a French Painter

Daniel Buren is a French painter, sculptor and conceptual artist. For half a century, Buren has painted 8.7 cm-wide stripes in his artwork. His work carries contemporary vibes and serves as a political statement (Fraser, 2005). The stripes that Buren conducts has a repetitive element and abstract forms.

Mark Rothko

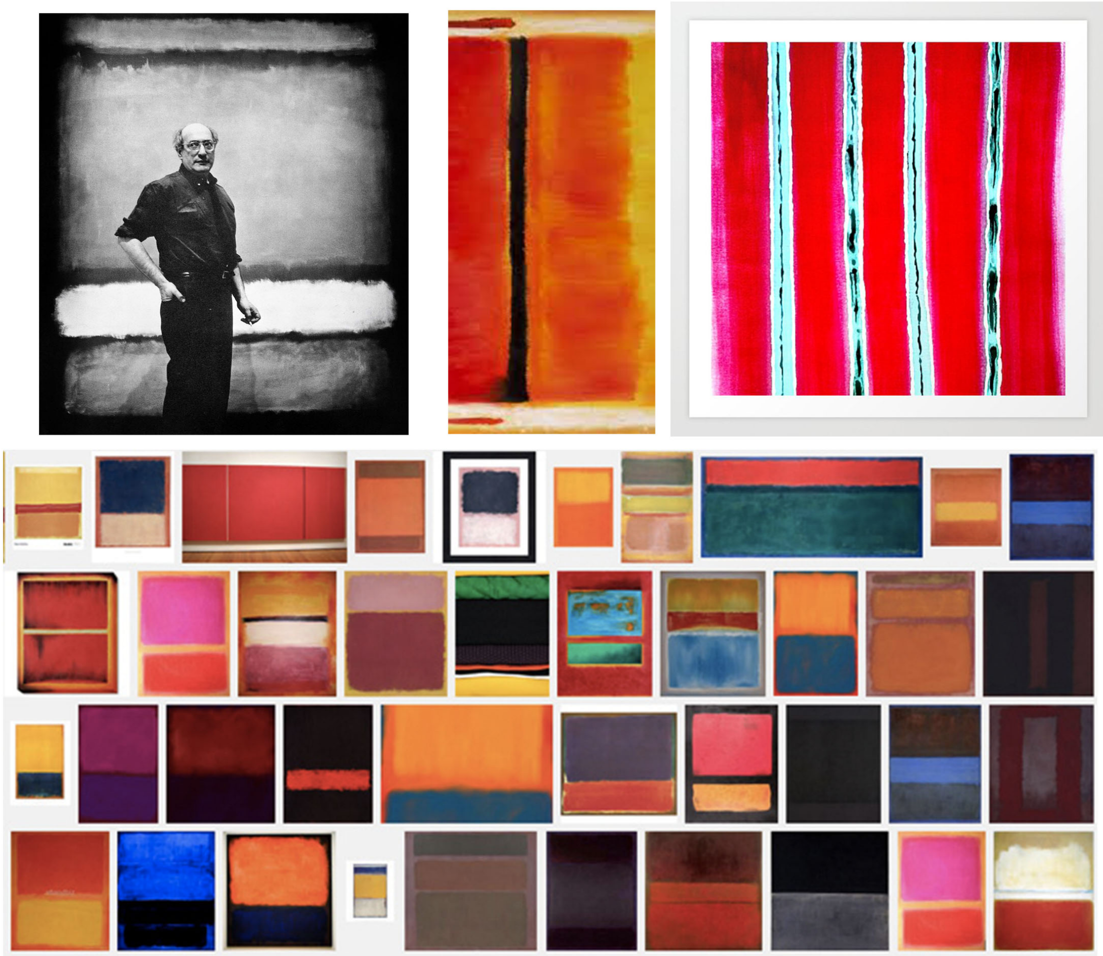


Figure 2.3 Mark Rothko, an American Painter

Mark Rothko was a Russian-born American painter of the mid-20th century. His genre of art was abstract expressionist. Rothko's signature was colours and rectangular blocks that were mostly horizontal on canvas. His paintings conveyed human emotion ranging from happiness to grief and depression.

Additionally, fashion brands such as Paul Smith, Agnes Missoni and Adidas all use stripes to achieve a very individual aesthetic. Today, stripes are widely used in clothing and surfaces as aesthetic patterns for all ages and genders. Figures 2.1, 2.2, 2.3, 2.4 and 2.5 are collective fashion trends involving stripes from well-known designers and brands from fashion magazines. The limitless possibilities of stripes represent a forever-green design. Moreover, the potential market for horizontal and vertical patterns in aiding illusion stimulus for clothing can be viewed as a trending focus cycle for both designers and consumers (Hampshire & Stephenson 2006).

Figure 2.4 Fashion Trends of 2013

Figure 2.5 Fashion Trends of 2014

Figure 2.6 Fashion Trends of 2015

Figure 2.7 Fashion Trends of 2016

Figure 2.8 Fashion Trends of 2017

2.3.1 Stripes in Malaysia

A Malaysian batik is a heritage handicraft and has existed since 1921 (Wan Hashim, 1996). The batik is thriving given its current developments. However, the pattern varieties of batik design have not yet been much cultivated in Malaysia, as batik makers mostly rely upon traditional motifs. Dawa (2014) has stated that motif presentation is the priority for batik making, stressing that recreating an existing traditional motif as a stylised version of contemporary batik is needed for the art form. He expresses his frustration that the abstract patterning on Malaysian batik exists more for the sake of aesthetic beauty than any meaning behind the motif usage. Yet the intentions behind contemporary batik motifs, recreated from traditional ones, should only be reflected upon, and batik producers should explore the global trends in patterning to widen their market.

Malaysian batik makers value the traditional roots of the production process and the motifs, but the lack of enhancements of their artworks has resulted in poor incomes for them. This is problematic as the time spent on creating a batik piece, as well as the artistic skills, does not reflect the maker's effort. Furthermore, using traditional motifs limits the customer base as the younger generation is more aware of current trends (Nordin et al., 2012). The fashion of the younger generation is more oriented towards aesthetically pleasing looks, which do not necessarily carry any special meaning (Harun et al., 2014). Young people are less interested in the batik industry as they are more attracted to higher income jobs. Hence, young people scarcely venture into batik making, which has resulted in a lack of fashionable batik designs. Currently, customers for Malaysian batik products are limited to Malaysia itself. Therefore, to attract more customers, attention should be paid to the creativity of the patterns, and the makers' skills and knowledge of their products, which will help the products to penetrate the global market. Akhir et al. (2015) discuss the needs of the batik industry by focusing on research and development activities that can enhance Malaysian batik design in making it more attractive and marketable. Further, there is a need for drastic change, especially in the business strategies required for enhancing both domestic and global market shares.

Batik makers are open to creating artistic work. There are no specific guidelines for developing a decorative batik design, though there are certain restrictions to be respected. Batik creation must conform with Islamic principles because Islam is the Malaysian state religion. Motifs of living things such as peoples or animals are restricted but permissible if stylised in an abstract form. As such, flowers and leaves predominate as motifs; the usage of abstract and geometric designs is also prevalent (Akhir et al., 2016). Some batik makers are adapting to the current demands for more abstract and simpler designs. Such designs are seen in the yearly international batik competition: the Piala Seri Endon. Abstract patterns are more accepted and sought after among batik products. However, modern abstract patterns do not carry any embedded meaning as is typical of the Malaysian batik motif.

In terms of the development of patterns, horizontal and vertical stripes on batik can be traced as far back as the 19th century (Aziz, 2006). The stripes, though, were not specially hand drawn but stamped with blocks. These block techniques are classified as traditional. Bamboo was the material for the blocks (Aziz 2006), and its natural fibre imprinted the stripes on the fabric. The stripes vary in size according to the size of the blocks, which consist of sticks and twigs to stamp the wax and colours. (Aziz, 2006). Furthermore, in Malaysian textile design, weaving techniques are the closest documented pattern of stripes' effect on a textile product. The pattern is a reproduction of geometric and symmetrical designs consisting of stripes. The carefully woven pattern forms a geometric line from a repetitive weaving process (Sulaiman, 2019). There is no documented motif derived from stripes in the history of Malaysian batik, but stripes are used on contemporary batik products. It can be concluded that, in the Malaysian context, stripes do not bear any symbolic meaning, unlike in other countries. Yet abstract, stripe-based designs are available today among batik products. The abstract approach constitutes an interpretation on the part of the batik artist, whereby the aesthetic beauty of the stripes is valued.

In textile design, a designer should have in mind a design before actualising it. One design sample can be manipulated into many patterns with the usage of repeats. Some of the quintessential repeats in textile design are straight, border, half drop, mirror, and tile and brick repeats (Wilson, 2001). These repeat designs are also used in batik making. Batik styling consists of both organic and geometric motifs. The organic motifs are based on natural subjects, including plants, animals, and flowers. The abstract motifs are stylised ideas, which do not have any physical existence. The repeats that are used in this research are straight ones, which create a horizontal and vertical stripes pattern in an abstract style.

The Malaysian batik is categorised into traditional and contemporary forms. For traditional batik, stamping techniques are most commonly used as the patterns created are made to cover the entire fabric. Meanwhile, the contemporary batik is more flexible, and the patterns are usually placed sporadically over the fabric. Contemporary batik is the preferred form in Malaysia today. Modern and abstract batik motifs with simpler designs are preferred over their traditional counterparts by young people.

2.4 Camouflage

Camouflage is the act of disguise and is also known as protective concealment. In the animal domain, camouflage is required for adaptation and self-defence. In humans, camouflage patterns are mainly used by hunters and military personnel. The most prominent use of camouflage is the avoidance of detection and recognition. During World War I, artist Abbott Thayer (1902) created an art piece that aimed to make the detection of warships more difficult. Thayer proposed the patterns behind the dazzle camouflage used by warships during world war I. His original work was related to concealing colouration in the animal kingdom, while Hugh Cott (1938) focused on adaptive colouration in animals. These designers created a proper foundation for optical illusion and camouflage that represents the basis for further research in biology, technology and art (Behrens, 1988). The study of camouflage has evolved from focusing on the behaviour of an organism in its complex environment to creating designs that affect human perception.

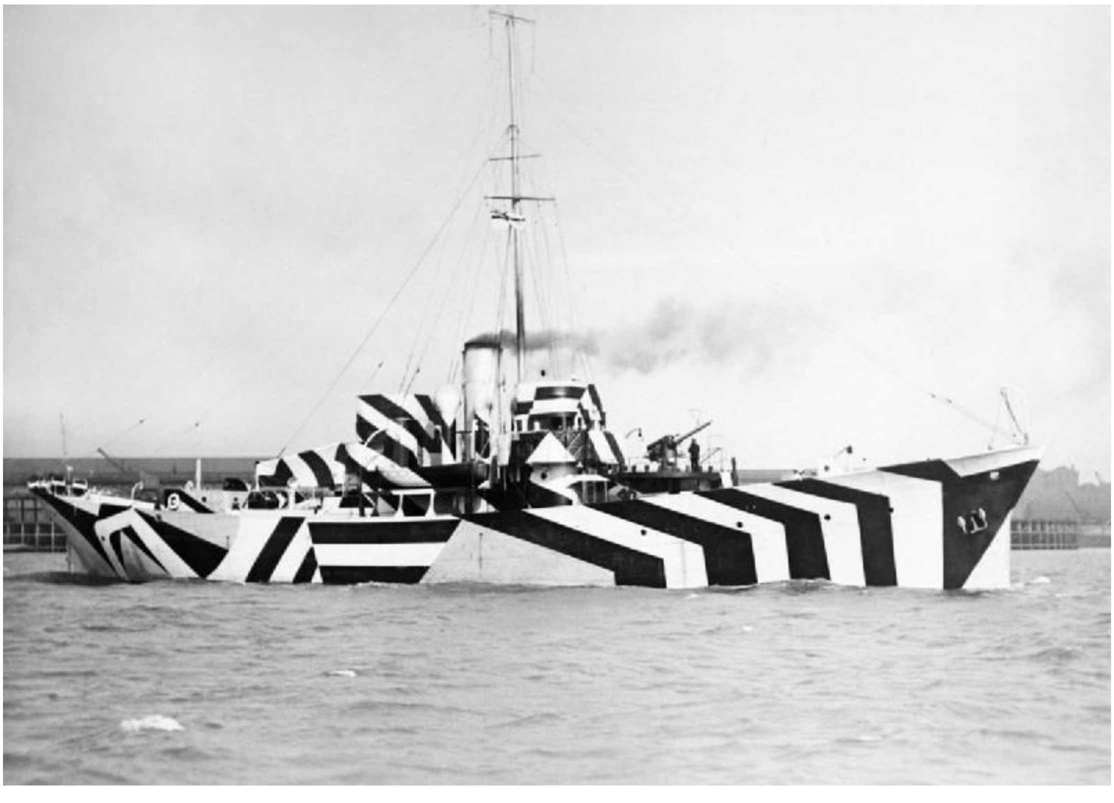


Figure 2.9 Dazzle camouflage warship

According to Stevens and Merilaita (2009), camouflaging is categorised into six principle mechanisms, which include background matching, self-shadow concealment, obliterative shading, disruptive colouration, flicker-fusion camouflage and distractive markings. Distractive markings involve the act of deflecting attention away from the actual image (White, 2018). Distractive markings aim to prevent the detection of the actual shape or outline of an object by creating a visual illusion. The illusion acts to conceal the distinctive outlines of the actual shapes. Additionally, Thayer proposed a theory called Thayer's "ruption", with the theory behind the name being based on disruption (i.e. the breakup of shapes or objects) (Santos et al., 2004). Thayer's ruption and distractive marking are two similar subjects that carry different names. According to Thayer (1896), the colouring on most organisms carries the same shades. The shade starts as dark on the outer margins and gradually turns to near-white towards the centre area. This gradient causes a perceptual illusion of the object, making it appear as more of a flat 2D surface than a 3D object. However, Thayer (1896) highlighted that the amount of gradient applied to designs will determine whether they succeed or fail. He called ruption the development of patches of light and dark covering that functions as the barrier to joining the outline of the subject (Santos et al., 2004). Notably, there is a difference between camouflage and the Thayer's motion dazzle pattern. Camouflage involves patterns that prevent a subject from being exposed, whilst motion dazzle (ruption) involves patterns consisting of stripes to disguise the speed, direction and shape of a moving object.

Additionally, Thayer (1909) mentioned that visual camouflage was a work of art that was difficult to digest by an average person and that camouflage art can only be interpreted by the artist. The process of analysing camouflage deals with optical illusions and the artist that created the pattern should be counted on to interpret what the illusion portrays (White, 2018). Furthermore, Thayer (1909) stated that he was gifted from birth with a sense of design and vision that was supernatural and that he observed animal patterns and delicately worked towards his form of pattern construction. Pattern construction was a progressive movement that improved the state of military camouflage during World War I, and the military camouflage pattern continues to be used on vehicles and installations (Newark et al., 1996). Notably, further studies on illusion in fashion should address the criteria affecting illusion in camouflage. The criteria affecting illusion on camouflaging include movements, shadows and surface textures.

One approach created from the study of pattern construction and illusion is the marine uniform. Santos et al. (2004) patented the US Marine Corps utility uniform, including its pattern, fabric, and design. This patented work has functions for fashion and hunting, with the ability to be applied on non-fabrics. The principle behind this pattern consists of natural camouflage, human perception and psychophysics. The patented camouflage has two purposes: to disrupt the features of the target and to blend the target with the characteristics of the background. The patented US Marine Corps pattern was a continuation of Thayer's theory. However, the stripes used for warships were not used in this pattern due to the different scenarios that the camouflage military pattern caters to. The stripes of a zebra are needed in grassland since the lines of multiple zebras create the illusion of greater size. In a soldier's context, the patterns should not stand out and instead focus on blending with multiple scenarios across a range of terrains and environmental conditions. Therefore, the striped pattern was not used, and greater focus was placed on colouration and macro-patterns (Santos et al., 2004). Military and natural camouflage reduce the visual distinguishability of an object from its background or surroundings.

2. 5 Illusion

Optical illusion are an interdisciplinary phenomenon affecting various disciplines in scientific studies. Such illusions are due to factors such as motion, brightness, contrast, geometry and perspective, cognitive status interpretation of 3D images, and colour (Saliha et al., 2015), which results in a wide range of optical illusions. These illusions are used in various disciplines, such as architecture, fashion, engineering, art, craft and design.

In recent years, optical illusions have frequently been used in the field of fashion design on clothing models, styles, silhouettes, and fabrics (Saliha et al., 2015). Studies on the attractiveness of illusion in the visual arts were investigated as a subject in various disciplines. Many designers have created clothes with visual optical motions by utilising the works of optical artists in the application of black and white patterns (Karaccali, 2008). Ozel (2007) found that relationships between the size and weight of an object affect the illusion. Furthermore, numerous studies have been performed on the impact of optical illusions in humans. The most important types of known optical illusions include the Oppel-Kundt illusion, Curvature-Hering illusion, Muller-Lyler illusion, Ebbinghaus illusion, Ponzo illusion, the Helmholtz square, and the Hermann grid, among others.

2.5.1 Types of Illusion

Illusions can affect the apparent size of an object. Notably, illusions of filled extent—such as the Oppel-Kundt and irradiation illusions—affect the perceived size of objects in everyday settings (Long & Murtagh, 1984).

2.5.1.1 Oppel-Kundt Illusion

One of the earliest known illusions is the Oppel-Kundt illusion. Oppel (1855) was the first researcher to report on dividing stripes affecting perceived size, while Kundt (1863) studied the length of the lines. This illusion relates to the width of the lines drawn. As shown in Figure 2.10, segment B was found by dividing two vertical lines ('A' and 'C') into two equal spaces. Then, the space between lines A and B was subdivided into vertical lines with equal spaces between them. Thus, the space between lines B and C (with equal length) was left empty. Here, the space between lines A and B is perceived as wider than the space between B and C (Figure 2.10).

Researchers later advanced this study and reported an effect called 'effect of partition', which occurs when the perceived size of a segment increases with the addition of several dividing lines (Hering, 1861; Delbouef, 1865; Ebbinghous, 1908; Gori et al., 2011). The Oppel-Kundt illusion has also been found in dynamic touch for the haptic filled-space illusion (Sanders & Kappers, 2009). In 1972, Robinson suggested that the number of dividing lines affects the illusion, with more dividing lines causing a stronger illusion. However, Coren and Gorgus (1978) stated that the optical illusion only exists to a certain limit, beyond which the perceived size gradually decreases. Additionally, Piaget and Osterrieth (1953) and Oyama (1960) argued that both a very small and very large number of dividing lines moderates the illusion effect, while seven to nine lines increase the illusory percept to its highest level. On the other hand, by manipulating the retinal size of the Oppel-Kundt stimulus whilst maintaining a constant number of lines, Coren and Girgus (1978) found that a combination of the distance between the line and its width (i.e. the task cycle)—and not the number of lines—is what determines the size of its effect. Furthermore, it has been reported that large and simple illusions are more prominent than small ones with great stimuli (Obonai, 1954; Long & Murtagh, 1984).

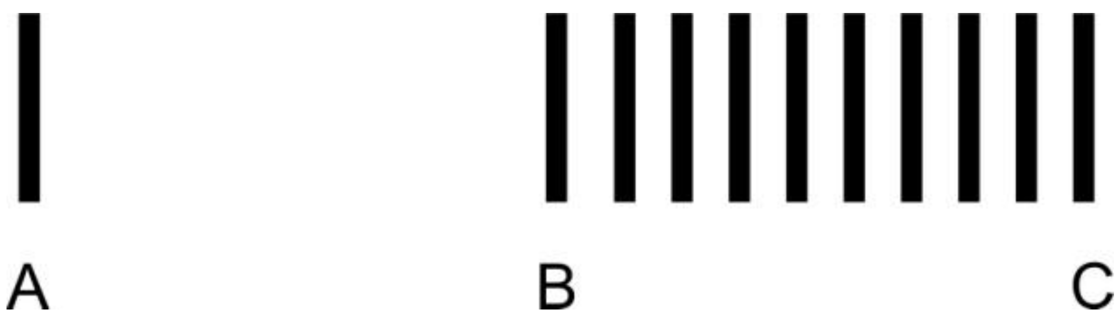


Figure 2.10 Oppel-Kundt Illusion

2.5.1.2 Irradiation Illusion

Helmholtz (1867) described the irradiation illusion as humans perceiving a bright object on a dark background larger than a dark object of the same physical size on a bright background (Figure 2.11). This illusion affects the perceived size of objects and has often been used in the areas of architecture and clothing (Thompson, 2011).

Figure 2.11 Irradiation Illusion

2.5.1.2 Direction Illusion (Zöllner Illusion)

German Astrophysicist Johann Karl Friedrich Zöllner discovered the direction illusion in 1860. In the illusion, the long lines shown in Figure 2.12 are perceived to intersect each other. This suggests a perceptual illusion related to the angles of lines intercepting the parallel line (Rothkopf et al,. 2004).

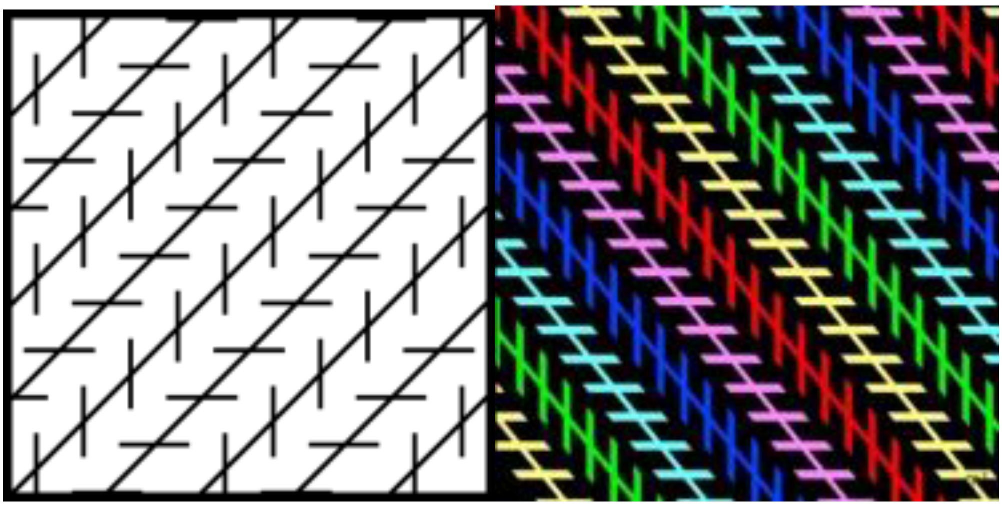


Figure 2.12 Direction Illusion (Zöllner Illusion)

2.5.1.3 Helmholtz Square Illusion

In the Helmholtz square illusion (Figure 2.13), the square consisting of horizontal lines is perceived as being larger than the square consisting of vertical lines (Swami, 2012). While Hermann Von Helmholtz discovered the illusion in 1867, his research provided no empirical evidence supporting his observation (Agac & Sakarya, 2015). Following Helmholtz's original theory, a study was conducted to measure the apparent size of a square patch filled with horizontal or vertical lines. The study findings suggest that the horizontal square was perceived as being taller than the vertical square, while the vertical square was perceived as being wider than the horizontal one (Yoshioka et al., 2004). The horizontally striped square was perceived as being 14% taller than its actual height, while the vertically striped square was perceived as being 4.06% wider than its actual width (Imai, 1982). Asymmetry of the effect is possible, which increases in the vertical dimension. The Helmholtz illusion was investigated by Thompson and Mikellidou (2013) regarding its impact on the duty cycle of the stimulus and the size of the Helmholtz square illusion. The results displayed two patterns with the same height. The horizontally striped pattern was perceived as 4.1–10.1% taller, depending on the duty cycle, while a square of the same width with a vertically striped pattern was perceived as 1.3–6.5% wider, depending on the duty cycle. This result validates the Helmholtz square illusion and highlights that the smaller the duty cycle, the greater the perception (i.e. narrow black lines on a white background). This discovery confirms Imai's (1982) finding of the illusion effect being more significant in the vertical dimension. The Helmholtz experiment was also conducted by Mikellidou and Thompson (2011) on 3D forms using oriented cylinders. Their study showed that while the perceived width of cylinders with horizontal stripes was close to veridical, observers systematically overestimated the diameter of vertically striped cylinders. This finding confirms the results of Long and Murtagh (1984) and Obonai (1954), which suggest that the Kundt illusion diminished with larger stimuli. This illusory percept gradually decreased as the size of the cylinders increased. The findings suggest that illusions remained on 3D forms with vertical stripes, which contradicts Taya and Miura's (2007) suggestion that the addition of 3D cues such as shading and vertical stripes makes cylinders appear narrower.

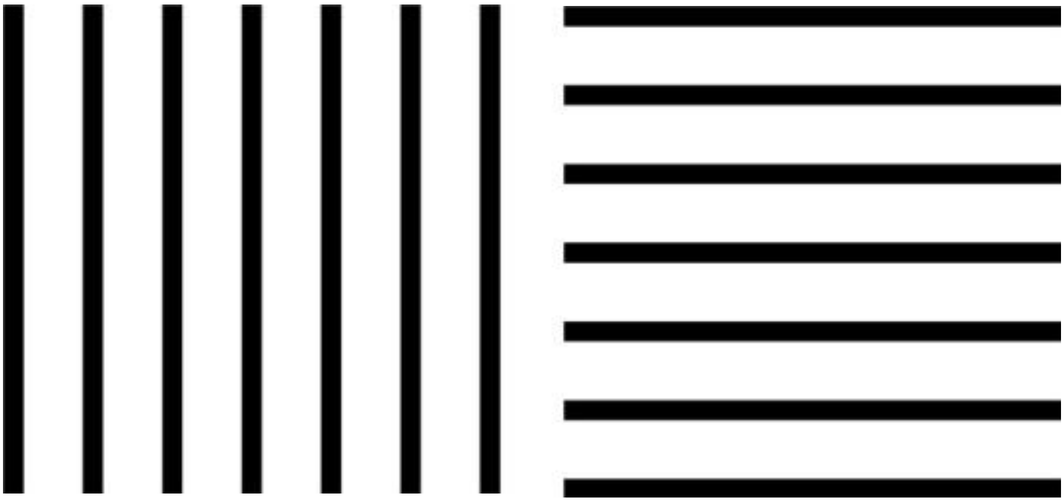


Figure 2.13 Helmholtz Square Illusion

2.5.1.4 Bending/Hering Illusion

The Hering illusion was founded by German physiologist Ewald Hering in 1861. The illusion includes a vertical red line that forms two parallel line segments (Figure 2.14). However, these lines appear to be bent due to the depth perception and inaccurate perspective caused by stripes with angles in the background. This illusion is also called the 'illusion of bending.' (Sarnıc, 2011)

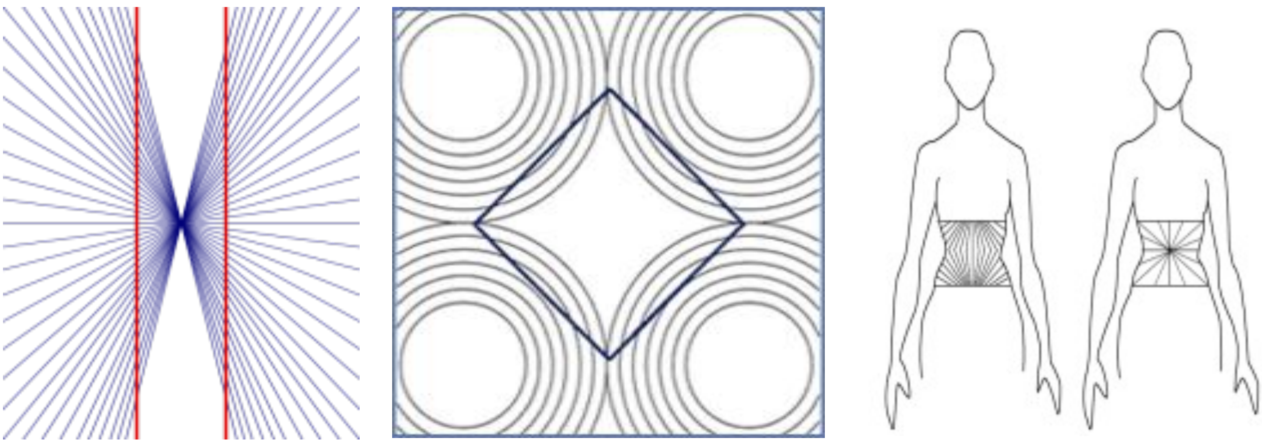


Figure 2.14 Bending / Hering Illusion

2.5.1.5 Müller-Lyer Illusion

German psychologist Franz Carl Müller-Lyer discovered the Müller-Lyer illusion in 1889. Two lines of the same length are seen as different lengths due to linear patterns with the fins of the arrows at the beginning and end of the lines (Figure 2.15) (Tuğal, 2018).

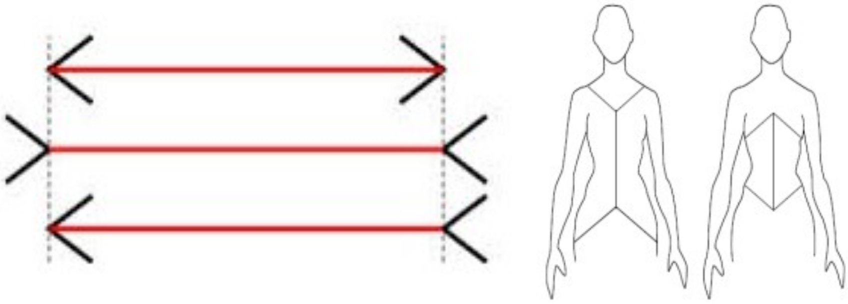


Figure 2.15 Müller-Lyer Illusion

2.5.1.6 Ponzo Illusion

Psychologist Mario Ponzo (1930) suggested that the human brain interprets the magnitude of objects according to their background. In the Ponzo illusion, depth gestures such as lines, perspectives, and others cause perceptions to develop in this manner. While the human girl object and the yellow line shown in Figure 2.16 actually has the same length, the perspective given in the background causes the brain to perceive them differently.

Figure 2.16 Ponzo Illusion

2.5.1.7 Café Wall Illusion

The café wall illusion was discovered by Dr Richard Gregory in 1979. The horizontal black and white straight parallel dividing lines (bricks) appear to be sloped (Figure 2.17).

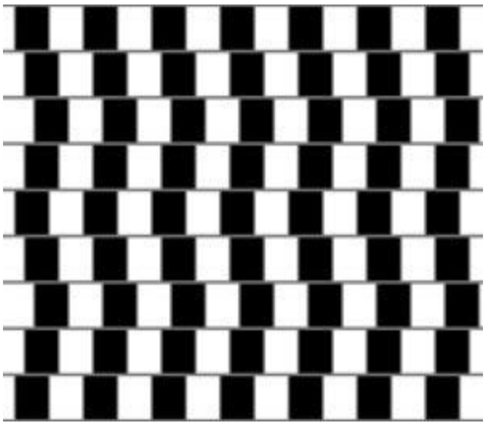


Figure 2.17 Café Wall Illusion

2.5.1.8 Ebbinghaus Illusion (also known as 'the Titchener circles')

German psychologist Hermann Ebbinghaus discovered the Ebbinghaus illusion in 1890. This illusion is related to the proportional perception of two circles of identical size. The orange circle on the right appears larger than the other orange circle, even though their size is the same. This is caused by the proportion of the size of the outer circles relative to the central circle (Figure 2.18).

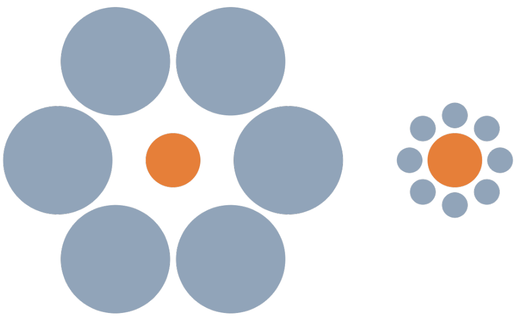


Figure 2.18 Ebbinghaus Illusion

2.5.2 Research on Illusions in Textile Surface Designs

The first optical illusions were formed long before the existence of humans. A mirage is one example of this, where weary desert creatures in a desperate search for water may have easily been fooled and led to their deaths. Illusions fool the eyes and are usually due to the incorrect analysis of visual inputs; however, they are sometimes the product of the eyes' optical mechanisms (Gregory, 1997). An optical illusion is defined as something visual that is deceiving and produces an incorrect depiction of reality. Although some optical illusions occur due to the limitations of the eye, most are usually the result of data being misinterpreted by the brain. Sometimes these mistakes are due to prior knowledge being inappropriate or misapplied. Hermann von Helmholtz, a German polymath, first proposed the theory that visual perceptions are unconscious inferences with little influence from data extracted from the eyes. In 1866, Helmholtz theorised that images perceived by the eye were naturally ambiguous and required the mind to fill in the gaps. However, this is a controversial subject due to the work of Gibson (1992), who argued that visual perception required little or no knowledge. Although this field is in constant debate, there appears to be a consensus that existing knowledge serves a role in visual perception (Gregory, 1997). In 2001, Eaglemen noted that visual illusions and neurobiology serve vital roles in manipulating perceptions, and stated that all visualised images are monitored and transferred to the brain for processing and manipulation. The visual system might also allow humans to formulate novel illusions (Eaglemen, 2001). One of Feldon's (2000) theories behind vertical and horizontal stripes is that the faster the eye scans a line, the longer and narrower the area it defines will seem. Thus, since the eye scans vertical lines rapidly, the image will appear longer, taller and narrower. As the eye rest on horizontal stripes, it follows the lines very slowly, which manipulates the illusion of wideness (Feldon, 2000). Sarnic (2011) stated that the use of stripes on clothing to create a perfect body impression is fundamental in creating the optical illusion.

Helmholtz (1867) reported that a square composed of horizontal lines appears to be too tall, while one composed of vertical lines appears too wide. To date, no convincing explanation for this illusion has emerged, and most suggestions related to differential eye movements and constancy mechanisms can be dismissed. Notably, Taya and Miura (2007) claimed that the 2D Helmholtz illusion does not hold for 3D forms, such as the human figure. Moreover, Thompson (2011) indicated that more research is required to identify the underlying mechanisms of such an effect. Thompson (2011) also stated that no evidence exists to support the widely held belief that horizontal stripes make the human form appear wider and that vertical stripes have a slimming effect—in fact, all existing evidence points in the opposite direction. In his study, Thompson (2011) conducted four experiments to investigate the generality of Helmholtz square illusion on 2D and 3D forms. Notably, the Thompson finding persists on real forms and contradicts Taya and Miura's (2007) claim that vertical stripes could increase three-dimensionality of figures by making a subject appear narrower. However, Thompson (2011) found that the illusion effect seems to disappear for larger cylinders, while a space covered with vertical stripes appears wider than a space covered with horizontal stripes. The stimuli used in his experiments are presented in Figure 2.19. However, Thompson & Mikellidou (2011) did not use real women as models due to multiple methodological problems, such as the inability to manipulate the stimuli.

Figure 2.19 Thompson's stimuli experiments Source: (Thompson & Mikellidou , 2011)

Subsequently, during a talent show aired on a BBC radio programme, Watham (2012) (Figure 2.21) was supervised by Thompson himself while demonstrating the common belief of horizontally striped garments appearing wider and vertically striped outfits appearing taller. Notably, her discovery contradicted Thompson's (2011) finding. The experiment involved 500 participants rating video models of people walking while wearing horizontally and vertically striped clothing. Participants rated how tall or wide the models appeared in each outfit.

Figure 2.20 The BBC's Amateur Scientist Award winner 2012, Val Watham.

Figure 2.21 Stimuli used in Thompson (2011) and Imai (1982) study (Source: Ashida et al., 2013)

Ashida, Kuraguchi and Miyoshi (2013) questioned the Thompson finding by stating that the female figures (Figure 2.17) that were used by Thompson and Mikellidou (2011) were relatively thin and tall which resulted in biased findings. This contrasts with the fat men of Imai (1982), as shown in Figure 2.17, which supported the common belief of vertical stripes as reflecting thinner looks than the one with horizontal stripes by 15.37% (137 participants). The large difference has led Ashida et al. (2013) to the possibility that the effect of stripes might depend on the shape of a person (Figure 2.21), which is also suggested by Experiment 3 in Thompson and Mikellidou (2011), where they found fading of the effect of stripes on simple cylinders as they became fatter.

Ashida et al. (2013) identified three factors that create inconsistencies in the illusion effect of striped clothing. His evidence showed that the appropriate use of stripes depends on body shape. Clothes with horizontal stripes can make a slender person seem fitter, but the effect could be reversed for others. They noted that multiple factors contribute to an effective striped outfit. For example, the long dress shown in Figure 2.21 could be more effective with Helmholtz's stripe theory but less effective for men. Second, the effect varies across people, which makes it even less practical. Lastly, the effectiveness of a striped outfit may depend on the clothing and/or fitness of the wearer.

Figure 2.22 Stimuli used in Asida et al. (2013) (Source: Ashida et al., 2013)

Notably, Cheng and Peng (2013) countered Mikellidou's and Thompson (2013) finding. The experiments conducted by Mikellidou and Thompson (2013) were on well-suited, straight-up dresses, whilst Cheng and Peng's (2013) study focused on looser and softer fabrics (see Figure 2.23). The results of Cheng and Peng (2013) noted that clothing with horizontal lines does not make the wearer appear thinner. Moreover, their findings indicate that horizontal lines seem to create a visual effect of parallel width. This implies that horizontal lines accentuate the wideness of heavy people and accentuate the slenderness of thin people. The findings also showed that wearing clothing with horizontal lines makes tall and thin people appear shorter. For short and heavy people, wearing clothing with vertical lines can prevent the effect of sideward expansion. Furthermore, the study indicated that short and thin people will appear taller with clothing featuring vertical lines (Cheng & Peng, 2013).

Figure 2.23 Stimuli used in Cheng and Peng's (2013) study (Source: Cheng and Peng, 2013)

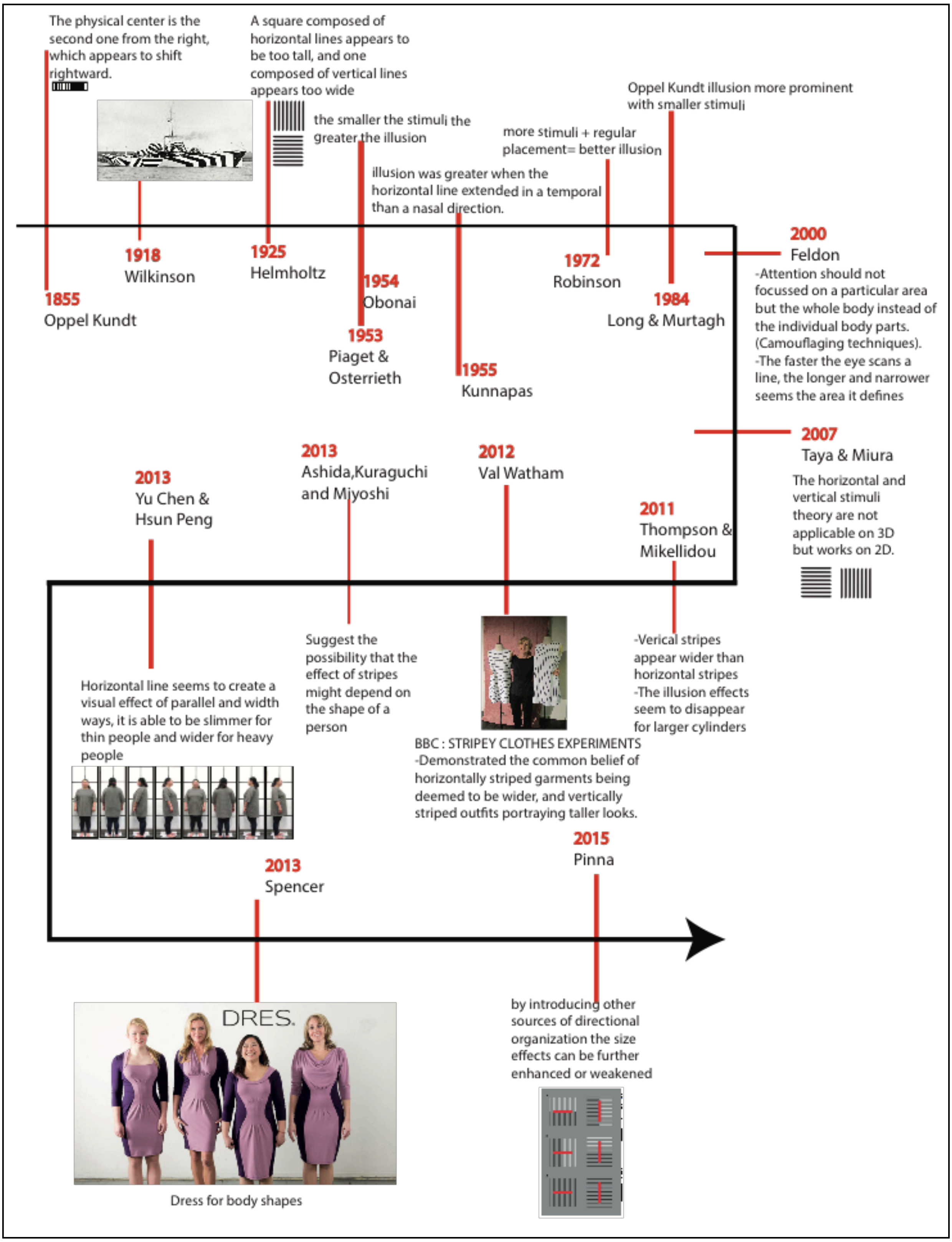


Figure 2.24 Timeline for the collection of horizontal and vertical lines for fashion use.

Conclusion

The purpose of this review was to outline trends in the use of illusion and camouflage in the textile and fashion industries. Existing research has investigated illusions involving lines to determine how the textile and fashion industries have evolved through the use of optical illusions. This review aims to help readers understand different aspects of optical illusions, particularly in the context of horizontal and vertical lines. Based on the reviewed research, it is evident that lines—regardless of their orientation and thickness—will interact with human visual perception. Additionally, the shape of an item will affect how lines are perceived. Notably, the shapes of stimuli are the most dominant aspect of pattern adjustments. While much research and discussion have surrounded the alteration of shape and size perception, the most appropriate studied were conducted by Ashida et al. (2013), Chen et al. (2013) and Spencer (2014). Thus, the present review suggests the need to experiment on different shapes and set a certain shape structure for the proposed manipulative textile pattern guidelines. Research conducted by Taya and Miura (2007) suggested that the optical illusion of horizontal and vertical stripes only applies to 2D objects and will not work on 3D objects. However, since the object mentioned by Taya and Miura (2007) only applies to non-living objects, it does not apply to fashion. Thus, one direction of this research involves an investigation into 3D moving objects to further explore the pattern illusion theory. Another relevant knowledge gap is that the direction of horizontal and vertical stripes currently involves either a horizontal or vertical placement. To date, no scientific research has been conducted on a combination of horizontal and vertical lines in the textile fashion fields. Therefore, more research and testing should be performed to gain a better understanding of mixed patterns consisting of horizontal and vertical lines on different body shapes. Furthermore, the differences between male and female body structures should be considered since gender differences vary and pattern insertion should include the proper prescription of pattern arrangements. This field of inquiry is vital because it focuses on the perception of illusion and textile pattern management for the textile and fashion industries. Within this broader context, the present research is specifically designed to cater to the batik industry.

Chapter 3

Psychophysical Method and Figure Width Methodologies used for Conducting 2D and 3D experiments

This thesis aims to investigate the human visual perception of patterns by using stripes on 2D and 3D objects. The methodology described in this thesis represents a psychophysical approach used to review the threshold of human visual perception and to assess illusory prospects by using patterns on 2D and 3D figures. The present study developed a variety of designs to help manipulate the visual perception of actual body size using textile design patterns. Due to the relatively short span provided by a PhD project, this research is not intended to be a technical statement of the textile design pattern for body figures. On the contrary, it aims to provide an in-depth exploration of the characteristics of patterns consisting of horizontal and vertical lines for different body shapes. Therefore, the final results of the patterns were produced in 3D models with the insertion of horizontal and vertical lines on the models' clothing. This chapter presents the datasets used in this work. Images from this dataset are used to make pairwise comparisons and magnitude estimations.

3.1. Research Design

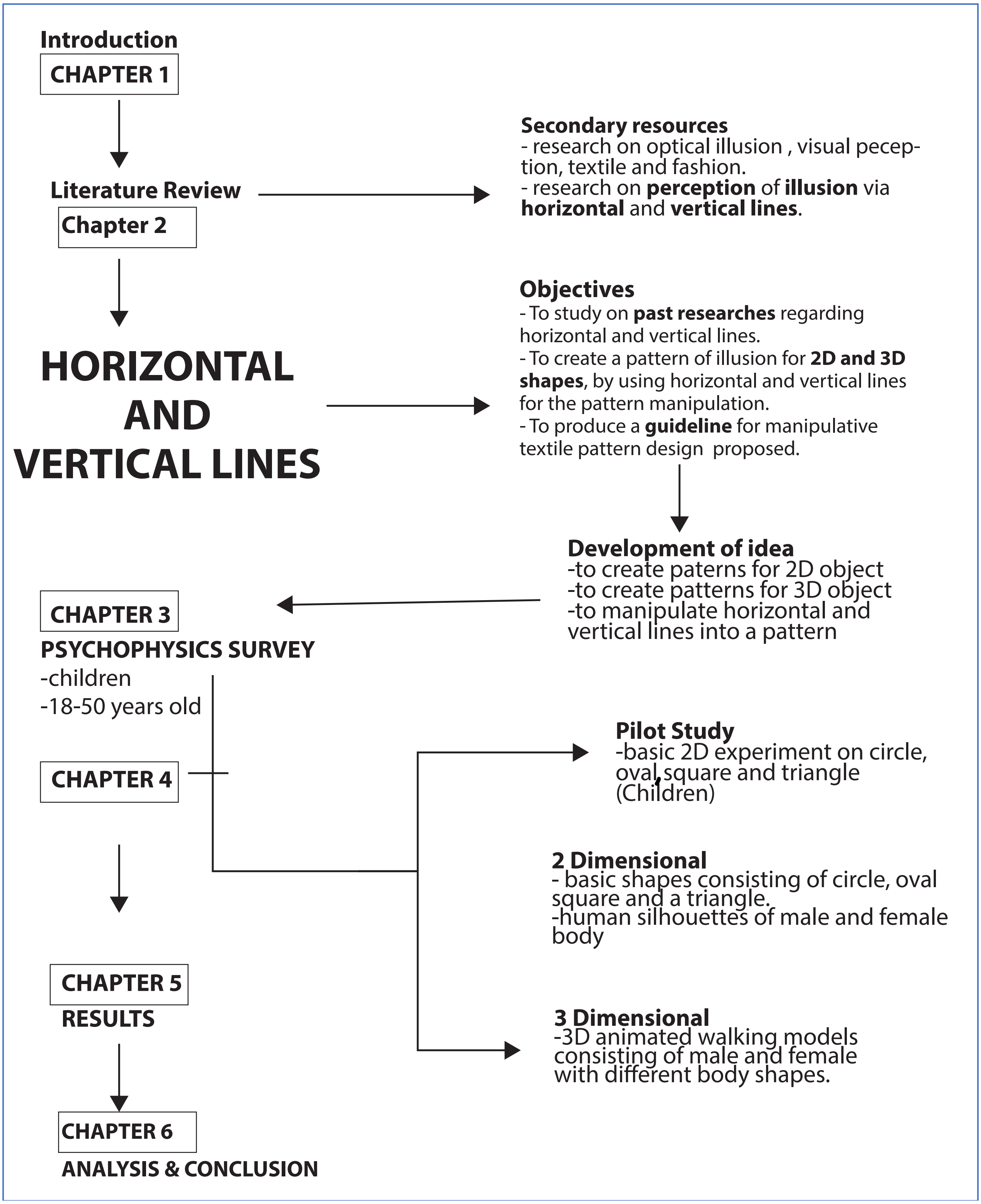


Figure 3.1 Research Design

Figure 3.1 presents the research design of this thesis. Chapter 1 introduces perception, pattern and fashion. The literature gathered in Chapter 2 provides a discussion of the perception of illusion via horizontal and vertical lines. The literature mentioned in Chapter 2 directed the research to develop a pattern of textiles for various body shapes. Different shapes change the way that horizontal and vertical lines are seen, which represents the topic of this study. The basis for this research is illusions in the perception of vertical and horizontal lines. This study focuses on the manipulation of patterns by applying horizontal and vertical lines to create manipulative visual pattern guidelines for different body needs. The development of ideas is divided into two categories, which include 2D and 3D surfaces. Chapter 3 discusses the methodology used for this research and the stimuli used. Chapter 4 describes the 2D trials and the 3D experiment in detail. Chapter 5 discusses the results for all of the experiments, while Chapter 6 provides the conclusions of the research.

3.2 Introduction

At the beginning of the research process, the research focused on 2D models. This phase aimed to determine the most appropriate data collection techniques. Since this research involves a combination of art, statistics and psychological assessments, the 2D research phase was crucial for testing and assessing the techniques before proceeding with the time-consuming process of rendering and animating 3D models. Hence, the pilot study and experiment 1 were conducted using the paired comparison technique, whilst Experiment 2 was conducted using the magnitude estimation technique. Additionally, the experiments conducted for the 2D experiments were designed to enhance the findings on horizontal and vertical lines. Based on previous research, the application of patterns on 2D surfaces has been very limited. Therefore, testing was performed using basic shapes (i.e. square, oval, circle and rectangle). The first phase of this research involved testing the possibility of shapes creating different illusions when applying patterns. The shapes used in the first phase of research consisted of 2D human outlines with either horizontal or vertical lines applied to them.

The research began with a pilot study that involved using either horizontal or vertical lines within various shapes. The second phase of the research involved manipulating horizontal and vertical lines within different shapes. Notably, the golden ratio was used to guide the manipulation of lines. The golden ratio was used as a medium to merge the horizontal and vertical lines into forming a pattern. Based on the findings of Chen and Peng (2013), the designs applied to 3D models have solely focused on either horizontal or vertical lines. Therefore, applying the golden ratio as a medium to construct patterns suggests the possibility of using another medium to tackle the pattern for body size manipulation. Based on the literature and pilot study, a possible illusion effect may result from the application of horizontal and vertical lines. Thus, the present research aims to determine whether the combination of horizontal and vertical lines will create another set of findings. To achieve patterns that combine both horizontal and vertical lines, a medium is required to serve as a structure to hold the lines together. Since this research involves the manipulation of textile patterns on the human body, the proposed patterns focus on manipulating the horizontal and vertical lines as a new textile pattern and its application on different body shapes.

The basis of combining horizontal and vertical lines is due to the need to explore a new route of pattern manipulation using horizontal and vertical lines. Since research using 3D models has been performed using only horizontal or only vertical lines, the researcher identified the need to enhance the stripes and create a new formula for pattern development. Moreover, as the literature suggests, the way a line is drawn can add an illusion effect. For example, the Oppel-Kundt illusion and Zöllner illusion create the illusion of wideness by adjusting the width of the same length of lines (see Section 2.5.1). The present research investigates the practicality of using the golden number of proportions (the golden triangle) to determine the possibility of utilising visual illusion to camouflage the human body's actual size through pattern adjustments.

The research began with 2D figures and then progressed to 3D animated models. The 3D model is the closest available human-like model for testing manipulated patterns. Notably, the research encountered a barrier due to human models of different sizes not being comparable for testing. Hence, the closest representative for human models was 3D animated models. The use of 3D models works perfectly with the need for different body shapes and heights for testing. The first phase of the pilot study involved executing paired comparison techniques. The experiments were crucial in this research because they demonstrated the appropriateness of using paired comparison testing. After testing the paired comparison technique for the pilot study, the research shifted to using the magnitude estimation technique, which was utilised for Experiment 2. This experiment involved a combination of horizontal and vertical stripes within the golden ratio partitions. Another shift was then made to determine the most practical questionnaire to use for collecting data on the 3D animated models.

3.2 Psychophysics

German physicist Theodor Fechner published a book outlining various psychophysical methods, such as the method of limits, adjustment and constant stimuli to quantify perceptual judgements (Sekuler & Blaike, 2000). Psychophysics is a psychological division related to the relationship between physical stimulation and the sensations produced in various human mental states. Psychophysical trials are conducted to examine the relationship between the physical characteristics of a stimulus and subjective human perceptions towards it. It requires the subject to respond to the presented stimuli by providing subjective responses or considerations related to the stimuli. Notably, this technique requires human judgement to evaluate product development. This process involves the physical measurement of the image based on perception considerations. The psychophysical basis is to obtain the correct percentage of answers from subjects (Wichmann & Hill, 2011). Moreover, constructing psychophysical functions requires different strengths or levels of stimulation being presented to the subject. Furthermore, the image function transmits information visually through text, graphs, graphics or images.

Measurement has evolved to benefit different fields including politics, medicine, business and arts. Measurement is the act of assigning numerals to different degrees of the qualities of a person, object or event (Duncan, 1984). An example of this could involve assigning a numerical value to calculate human emotion on an attitudinal continuum with fixed values. Notably, numerical measurement is partly conceptual and partly empirical (Bagozzi, 1997).

In psychology and social sciences, the most dominant method of data collection involves the use of questionnaires (Rohrmann, 2003). Also, the fixed interval rating scale is the most commonly used response mode in surveys. (Bagozzi, 1981; Rohrmann, 2003). Surveys were initially paper-based and were posted out to designated addresses. However, with the emergence of the internet, the advancement of software development has opened up limitless online research activities. Online surveys are a strong platform that supports the practice of social scientists by providing a solid structural support system that facilitates the cognitive approach to survey research.

3.2.1 Psychometric functions

Psychometric functions are used to explore the threshold area in the detection of the stimulus when the detection of the stimulus becomes probabilistic. These functions should model the probability of detection as a value ranging between 0 (certain failure) and 1 (certain success) in a way that approaches the real human detection rate. One important role of psychometric functions is setting thresholds (i.e. points such as intensities) where the detection of stimuli is as important as the failure to detect stimuli.

Psychometric functions depend on the estimates of the observer regarding the intensity of the stimulus. Generally, psychometric functions increase monotonically with stimulation intensity. Psychometric functions relate observers' performance to independent variables, usually by some physical quantities of stimuli in psychophysical tasks.

3.2.2 Psychometric scaling

Psychometric scaling is a method that acts as a tool to assess the human perceptions of illusions. It is also known as a tool for mind-measuring when evaluating a product (Engeldrum, 2000). Perception judgement is an estimation of the “ness” that the stimuli attribute to each image. In this study, the “nesses” sought were for wideness and thinness in human perception through the use of horizontal and vertical lines as the stimuli.

Notably, it is critical to select the correct survey data for research since this will affect the way that respondents interpret and respond to the instruments. The purpose of data collection is to assign numerals to peoples' judgements (Campbell, 1928). Surveys are a dominant data collection method in psychology and the social sciences in general (Rohrmann, 2003).

The first step in determining the appropriate type of quantitative survey involves identifying the variable of interest. In this study, the variables of interest included horizontal and vertical stripes in the form of patterns. The scaling method includes two different categories: open-ended and close-ended questions. In scaling, the objective is to generate a continuum for collecting sequences of values and to analyse the data according to the objectives.

An open-ended question asks participants to state their opinions and can provide a broad range of answers. This technique tends to create variable responses because it allows respondents to communicate their thoughts without any limitations. Open-ended questions are advantageous due to having a wide range of answers and not being restricted to a selective view. Additionally, such qualitative findings may create new insights or aid in developing research ideas (Kingsley et al., 2010). However, the disadvantages of using open-ended questions include time-consuming data analysis and interpretation as well as difficulties related to comparing qualitative answers.

Closed-ended questions are more practical for this research since respondents would not need to be critical. Moreover, closed-ended questionnaires produce quick responses that make respondents feel satisfied with making good progress towards completion. Also, closed-ended questions are easier to answer than open-ended questions. The simple choice of selecting an answer is also more suitable for the different age groups involved. Furthermore, the data are easier to analyse and can be decoded using Excel spreadsheet software (Version 16.37 of Microsoft 365 Subscription). However, one major disadvantage of conducting a closed-ended questionnaire is the inability to obtain in-depth responses, which reduces the potential for new insights.

Therefore, this research used closed-ended questions because it aimed to determine the possibility for optical illusions using patterns manipulation and does not require further insights from participants.

3.2.2.1 Types of psychometric scaling

The considered types of psychometric scaling involved comparative scaling, which includes ranking, magnitude estimation and paired comparison techniques. In comparative scaling, respondents are asked to perform direct comparisons of stimulus objects. Comparative scaling was chosen because it can detect even the smallest differences between stimulus objects. Moreover, the same known reference point can be used for all respondents. Notably, comparative scaling reduces halo or carryover effects from one judgement to another.

Magnitude estimation is a psychophysical scaling technique used to measure sensation where observers assign numbers to stimuli in response to their perceived intensity. The technique is straightforward and presents a proper interval scale result. Magnitude estimation also allows for multiple items to be presented simultaneously for scaling, which reduces the number of questions on the questionnaire. The drawbacks of magnitude estimation are that the technique is not easy to master and requires participants to perform test runs before proceeding with the questions. Moreover, the task involves critical thinking and will be time consuming for participants.

Paired comparison is a method that has been used to document human judgements since the 19th century. The technique is typically performed by presenting all possible pairs of items to each respondent and allowing the respondents to choose the item that best fits their specific choice criterion. With paired comparison, there is no absolute measure of width that corresponds to a given stimulus; however, with the two stimuli presented simultaneously, the participant must choose an answer. Paired comparison acts as a method of eliciting human judgement through its simplicity and use of comparative judgements. Also, the paired comparison analysis model can even make judgements with missing data due to the scaling being independent of the other stimuli. This implies that incomplete data will not affect the results. Ultimately, the approach is straightforward and flexible, and can thus easily cater to all age groups and provide a proper interval scale value. However, the downside to using paired comparisons is that they can be difficult to perform if the number of items is large as the necessary comparison grows exponentially and makes the tests too long with the growing questions. Moreover, the difference between each item should not be too large and the answer should not be the same decision since this will not provide an interval scale value.

Simple Ratings are more difficult to provide than pairwise comparisons. For example, the question "On a scale of 10 being the biggest, how big is the pattern on the models?" is more difficult to answer than "Which image seems bigger?". Simple rating is a straightforward technique that provides a proper interval scale result. The downside of using ratings is that they can be difficult to perform if the number of items is large. Furthermore, if the difference between each item is too large or the answers are the same, simple ratings will not provide an interval scale value. However, ratings can be more informative than pairwise comparisons since they can show how preferable an item is.

Of the three proposed comparative scale techniques, only two methods were used in the present study: magnitude estimation and paired comparison.

3.2.3 "Nesses" and attributes

In this research, "ness" and attributes were used to characterise visual perceptions of patterns. These are measurements of what can be observed in the assessment of the images. Identifying the "nesses" involves finding the perceptual attributes of an image, which are the characteristics that humans sense or observe.

In this study, the “nesses” to assess include the width of illusions in human perception.

3.3 Stimuli used for this research

Gescheider (1997) indicated that the constant stimuli method involves repeatedly using the same stimulus set—typically five to nine different values—throughout the experiments.

The objective of this study is to scale the human judgements of illusion made from the effect of horizontal and vertical lines. The image samples used in this study included horizontal and vertical lines. These image samples are also called “stimuli” and “stimulus objects”. The name “stimuli” is used due to their ability to stimulate the human sensory system.

Four different experiments were performed for the present study. The first, second and third experiments were run using 2D shapes, whilst the third experiment was run using 3D figures. For the pilot study and Experiments 1 and 2, the stimuli consisted of stripes built from horizontal and vertical stripes to form a pattern. The construction of horizontal and vertical lines used the golden ratio as a medium to guide stripe placement. The golden ratio was chosen as a guide for experiments due to its ability to reflect ideal beauty (Livio, 2003).

3.3.1 Pilot study and Experiment 1

In the pilot study and Experiment 1, the stimuli included plain horizontal and vertical lines applied on 2D shapes. The 2D shapes used for the experiments included a circle, triangle, square, oval and different sizes of human silhouettes (Figure 3.2).

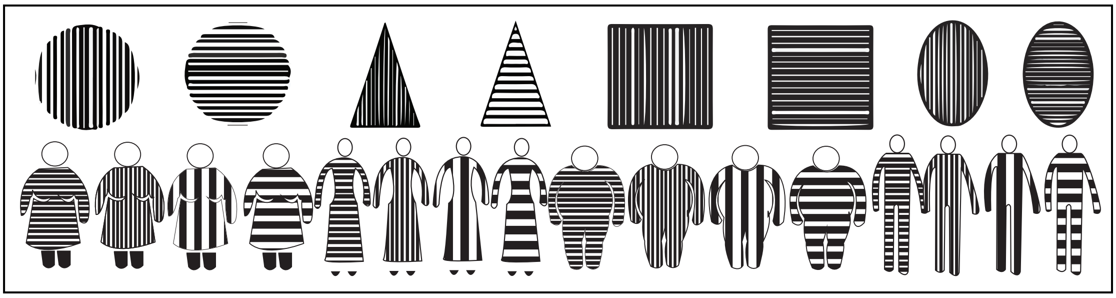


Figure 3.2 Horizontal and vertical lines within 2D shapes

3.3.2 Golden ratio for Experiment 2 and Experiment 3

The stimuli for Experiments 2 and 3 used the golden ratio as a medium to display the horizontal and vertical lines on different body shapes. It was chosen because of its popularity in working with proportions (Livio, 2002).

3.3.2.1 Experiment 2

For Experiment 2, horizontal and vertical lines were developed and combined into patterns. The vertical and horizontal lines were of the same thickness and diameter. These lines were added into the golden ratio segments (see Figure 3.3).

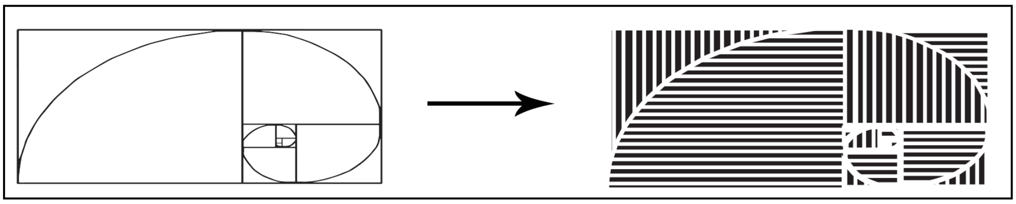


Figure 3.3 Horizontal and vertical lines inside the golden ratio segments

The golden ratio acts as a medium for lines to join and become a pattern before being applied to 2D human figures (see Figure 3.5). The patterns are divided into four patterns with two sets of similar size patterns (A-B and C-D) (see Figure 3.6). Figure 3.4 presents figures with a combination of horizontal and vertical lines of the same thickness and diameter. The patterns were oriented 180 degrees and enlarged by 0.25cm.

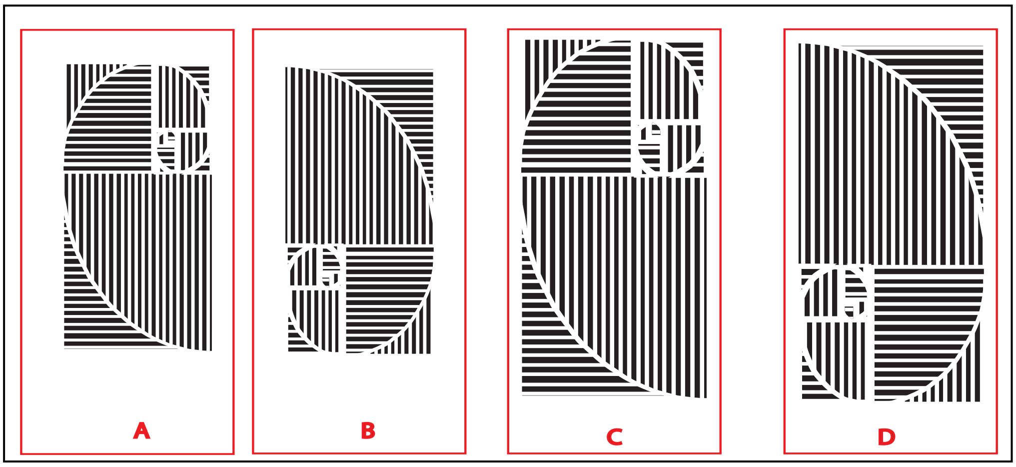


Figure 3.4 Orientation of patterns inside the golden ratio segments

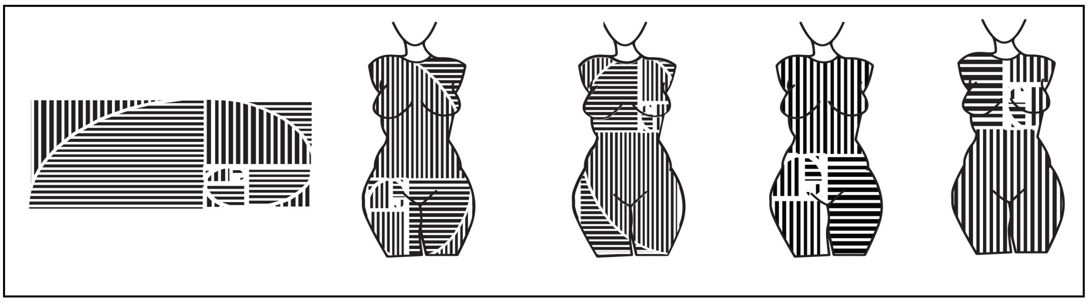


Figure 3.5 The golden ratio on 2D surfaces

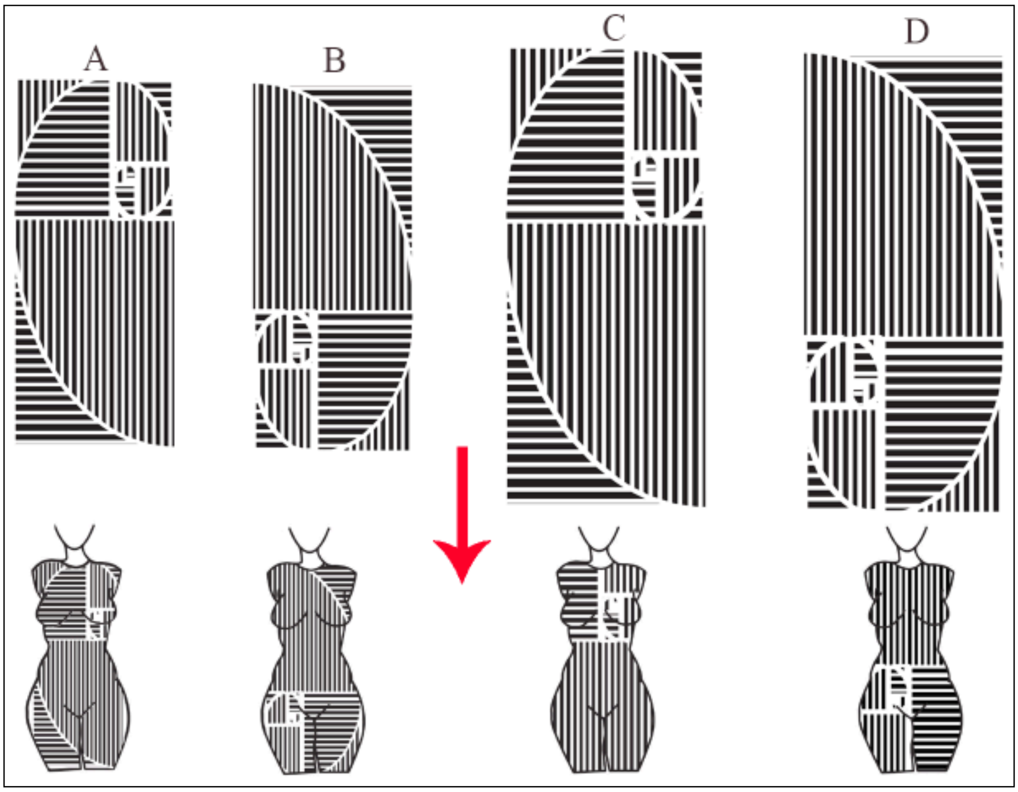


Figure 3.6 Figures with the implementation of a combination of horizontal and vertical stripes

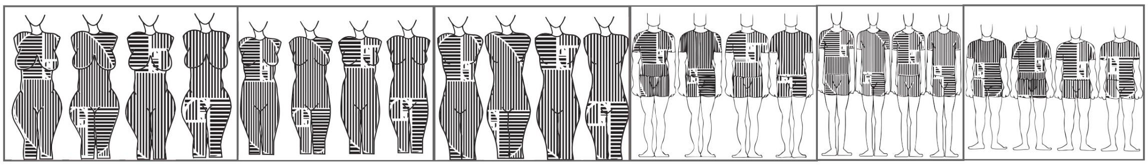


Figure 3.7 Compilation of 2D stimuli used for Experiment 2

In total, six 2D figures were selected (three female figures and three male figures) (see Figure 3.7). For Experiment 2, six questions involving the magnitude estimation bar were included.

3.3.2.2 Experiment 3

For Experiment 3, the stimuli consisted of a combination of horizontal and vertical lines. The lines varied in thickness and were applied on human-like 3D walking models. The orientation of the lines maintained their horizontal and vertical positions. Alterations were made to the thickness of the lines used. The golden ratio used for Experiment 3 triangular in shape. Female and male models were given a different triangle orientation due to male and female bodies being different, which is explained in Chapter 2 (see Section 2.1.1). Psychologically speaking, women with wider hips considered more aesthetically pleasing, while men with broader shoulders are considered more masculine. Hence, the female models were given the triangular golden ratio side for the stimulus, whilst male models were given an inverted triangle golden ratio for stimulus (see Figure 3.8).

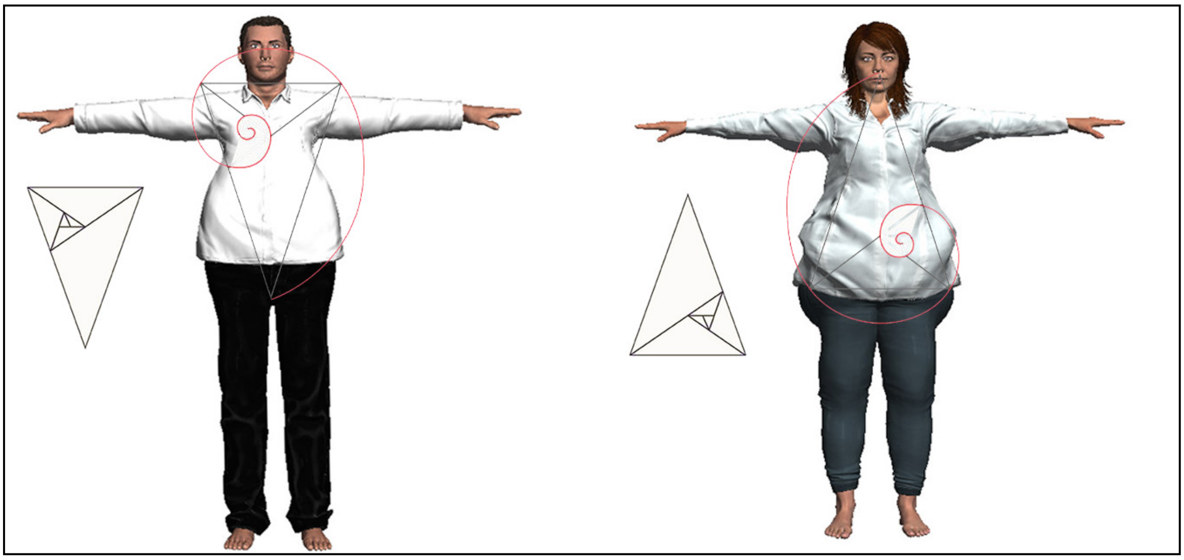


Figure 3.8 Triangular golden ratio on 3D models

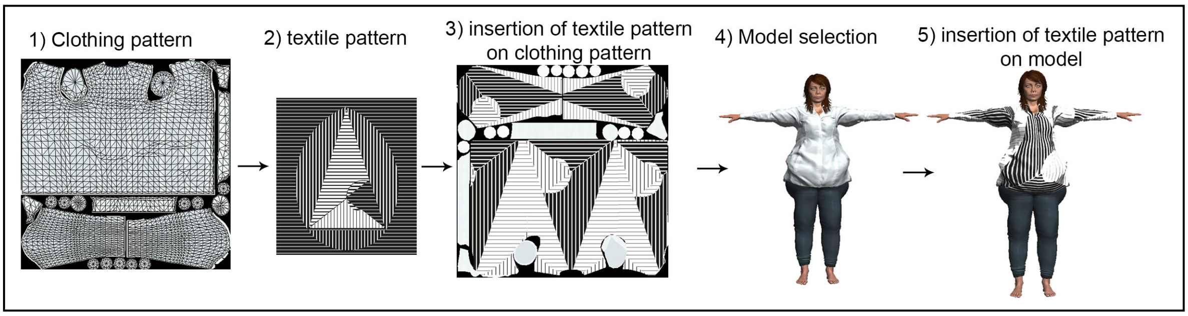


Figure 3.9 The process of creating stimuli for Experiment 3

Figure 3.9 describes the process of creating stimuli for Experiment 3. First, the clothing patterns were created and the textile patterns were inserted (see Figure 3.9). Male and female clothing patterns differed due to their respective body contours. Patterns consisting of horizontal and vertical lines of varying thickness were placed into triangle-shaped golden ratio segments (see Figure 3.10).

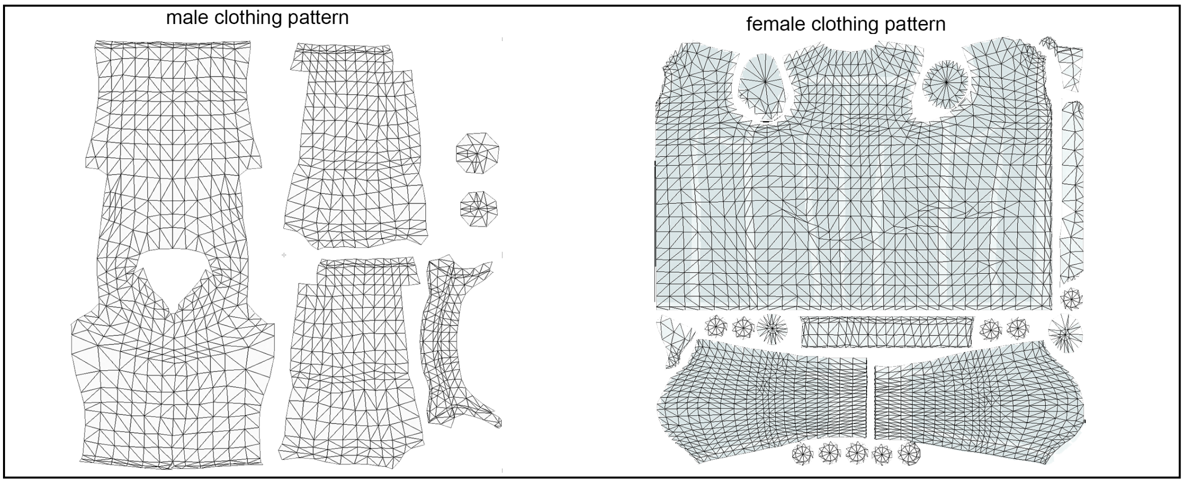


Figure 3.10 Clothing pattern for the 3D experiment

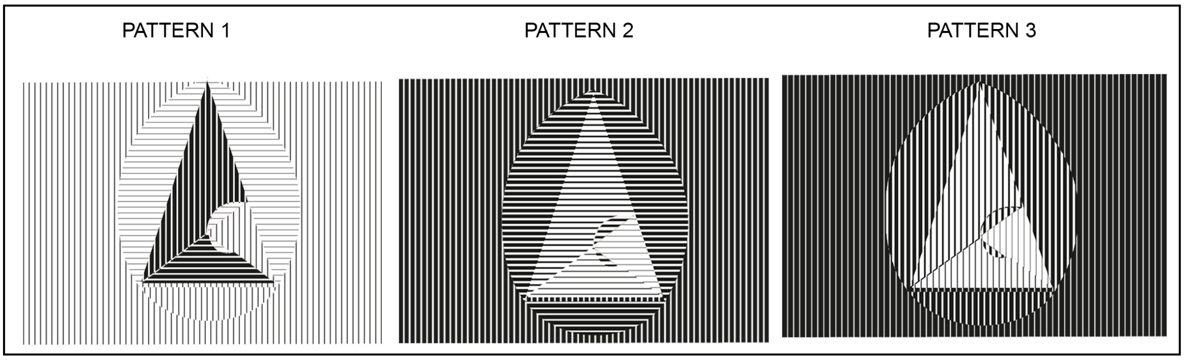


Figure 3.11 Combination of horizontal and vertical lines on a triangular golden ratio

The triangular golden ratio acted as a medium for the lines to merge as patterns before applying them on the clothing patterns (see Figure 3.12).

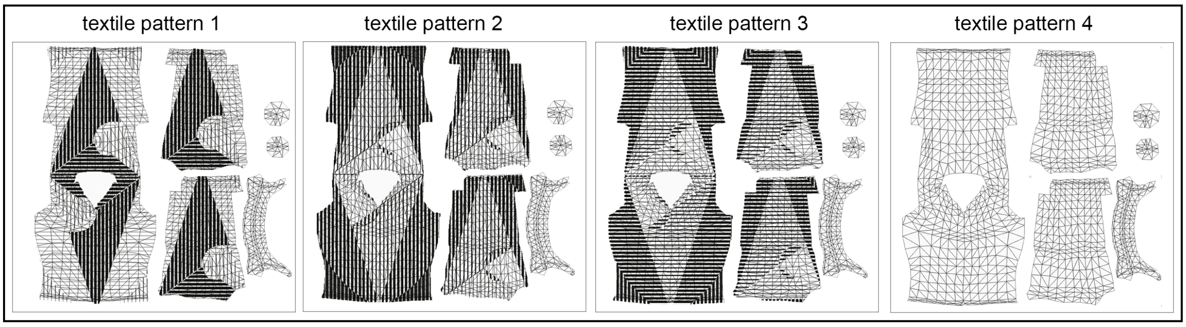


Figure 3.12 Insertion of stimuli on the clothing patterns

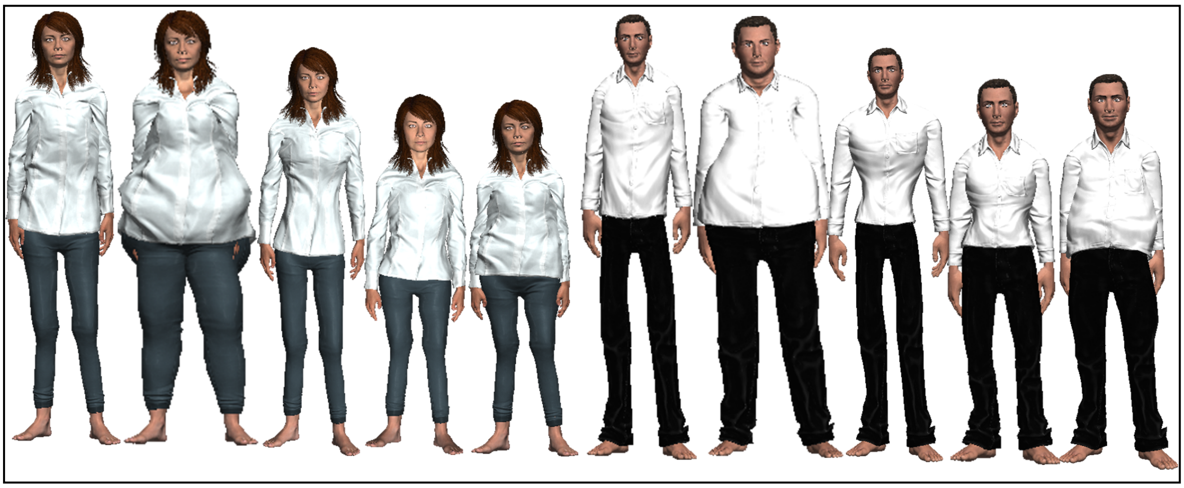


Figure 3.13 Model types used for Experiment 3

Figure 3.14 Completed 3D models with patterns for Experiment 3

A total of three textile patterns (see Figure 3.11) were created for ten 3D models comprising five female and five male models (see Figure 3.13).

Figure 3.14 presents the complete appearance of models with patterns of horizontal and vertical stimuli. For each model, four stimuli were used for the experiments. Since 10 models were created, 60 questions were required (the calculation is explained in 3.4.1.1).

3.3.3.1 3D models

For this research, models were fictional 3D characters created using Adobe softwares (Adobe Photoshop and Adobe Fuse). Animations were used due to the limited time available for finding the precise human body shapes for this experiment. However, using fictional 3D characters increases the possibility of matching different body shapes. The male and the female characters were identically created in terms of facial appearance and skin tone, while differences in body shape were based on gender. Overall, five male and five female models were included in Experiment 3. The male models were in the form of a triangle, oval, rectangle, inverted triangle and trapezoid. The female models were in the form of a triangle, oval, rectangle, inverted triangle and hourglass.

3.3.3.2 Software

All designs and models were created using Adobe software. Adobe Fuse (Version 2017.1.0 of Adobe Cloud Team) was used to create the 3D models, which were then exported to Adobe Photoshop (Version 20.0.9 of Adobe Cloud Team) for pattern layouts and animation.

3.3.3.2.1 Adobe Fuse

Adobe Fuse is an application used to create custom 3D characters for Photoshop projects. This app allows the rapid creation of characters using high-quality 3D library content (e.g. faces, bodies, clothing and textures). This app allows users to customise the colours, textures, and shapes of more than 280 attributes including hair, eyeglasses, and apparel, thus making it the best application for research on pattern manipulation on shapes. Moreover, it allows users to easily change the size and proportion of characters, with clothing and other attributes adjusting automatically. After the customisation process is complete, characters are transferred to Adobe Photoshop for animation and the insertion of shirt patterns.

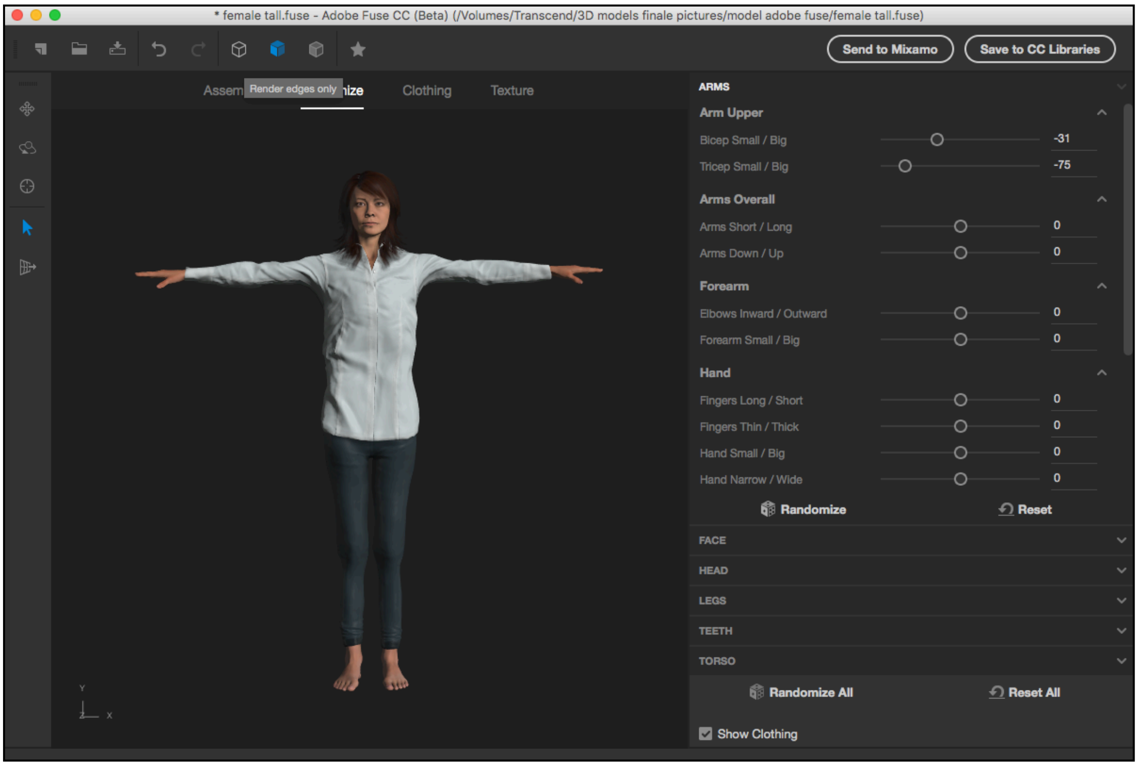


Figure 3.15 A character preview in Adobe Fuse

3.3.3.2.2 Adobe Photoshop

Adobe Photoshop is an editing application used by designers and photographers to edit images. Adobe Photoshop can be used to animate the 3D models created using Adobe Fuse. This bridge between the two applications was used to create 10 models for the experiment. The animation was created in Photoshop using the animation timeline in the 3D layer. The 3D layers allow for 3D motion and rendering effects to occur. The animation is automatically adjusted when a selection is chosen in the animation panel (see Figure 3.16).

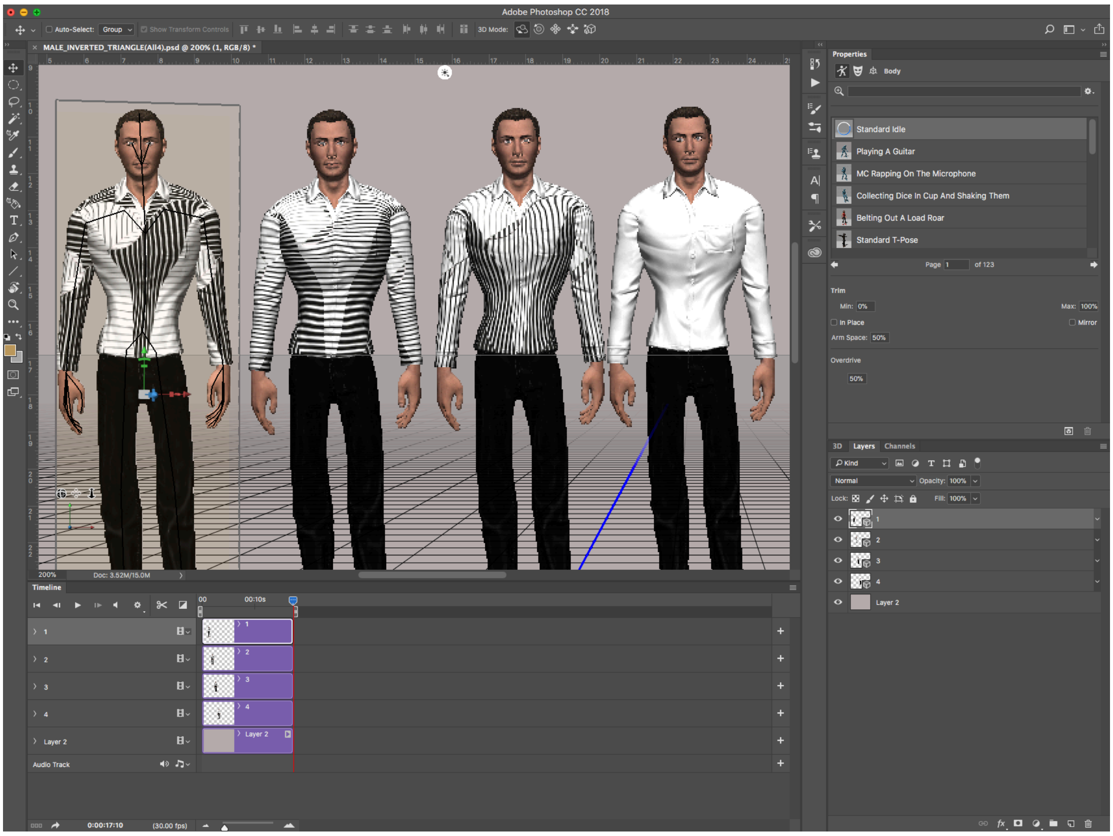


Figure 3.16 A preview of the animation timeline in Adobe Photoshop

3.4 Methods

This thesis uses a constant stimuli method with a forced-choice procedure. The constant stimuli method is used throughout this thesis due to its accuracy and because it is a standardised method that is less influenced by individual biases than other methods. Experiments 1 and 3 used the paired comparison method, whilst Experiment 2 used the magnitude estimation method. The reason for this selection relates to the amount of stimulus used for the experiment. The paired comparison method is straightforward and involves selecting one of two presented images, whilst the magnitude estimation method requires critical scale assessment between four presented images.

3.4.1 Forced-choice procedure

Fechner (1966) developed the forced-choice procedure. This procedure requires observers to decide on correct responses within a controlled set of choices. The comparative stimulus is repeated in the survey to ensure that observers are reminded of the stimulus variables to be classified, which reduces the possibility of shifting the standard. In the forced-choice experiment, observers are forced to select a stimulus even if they are uncertain of the correct response.

While several different psychophysical methods can attain estimates of threshold values, the psychophysical methods chosen for this research were paired comparison and magnitude estimation. The following sections discuss their relative advantages and disadvantages.

3.4.1.1 Paired comparison method

Pairwise comparison requires all pairs to present comparisons of two samples to the observer. The goal of pairwise comparison is to produce scale values and estimate psychometric functions. The psychometric function predicts the point at which wideness can be traced based on its parameters. This method asks participants to choose a sample in order to determine the hardly perceptible differences among stimuli. Both stimuli are simultaneously present in pairs. This method was used due to it being a simple way to approach respondents of all ages. However, one disadvantage of this approach is that number of questions increases when a larger scale needs to be checked. This can be time consuming because, with 20 samples, total consideration rapidly increases to 190 questions. The delivery of each pair of figures is repeated for all possible n(n-1)/2 pairs, which is the number of all possible combinations of *n* objects taken two at a time (where *n* is the number of comparable values). The participants must select the sample with the highest visible "ness".

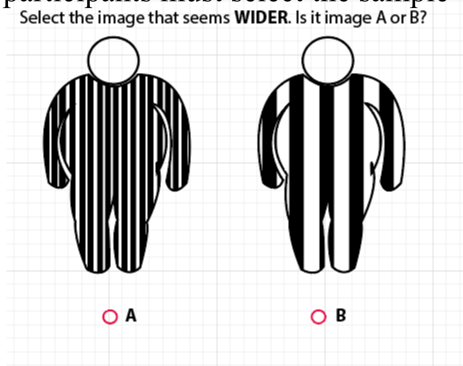


Figure 3.17 A sample of the paired comparison method

3.4.1.2 Magnitude estimation method

In magnitude estimation, participants must set a numerical answer in proportion to the strength of the "ness". Here, "ness" characterises participants' perceptions of image width. Magnitude estimation will reduce the number of questions when compared to the paired comparison. However, this method requires participants to consider critical scaling values, which can be time consuming and difficult.

Figure 3.18 presents a sample question for magnitude estimation. The question asks the participant to slide the scale bar at the bottom of the stimulus. Participants were asked to slide the bar according to their perception of the presented images.

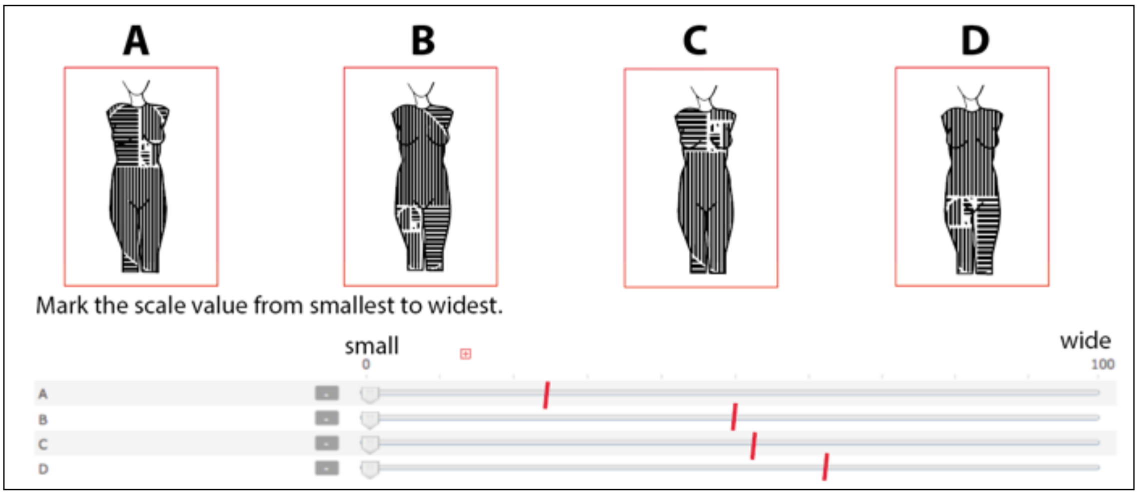


Figure 3.18 A sample of the magnitude estimation method

3.5 Conclusion

This chapter reviewed the experimental methods utilised in this thesis and the construction of patterns applied in the experiments.

Two different techniques (magnitude estimation and paired comparison) were used to analyse the findings of the experiment. Experiments 1 and 2 were conducted using a 2D surface, whilst Experiment 3 was conducted on a 3D surface. The pilot study and Experiment 1 only used horizontal or vertical lines, whilst Experiments 2 and 3 involved a combination of horizontal and vertical lines to form patterns. In Experiment 2, which used magnitude estimation techniques, 30% of observers estimated that the presented images were the same. These findings are not reliable for this study when compared to the forced choice used in the paired comparison technique, in which all participants were forced to choose the widest image. Thus, for Experiment 3, the paired comparison technique was selected to collect data on the 3D models. Experiment 3 was time consuming due to the amount of stimulus to be assessed via the paired comparison techniques and the limited room spacing to conduct the questionnaire. Therefore, Experiment 3 was reduced to 23 participants and took 1 hour to complete.

3.6 Discussion

Based on the data collected, it can be confirmed that interval data were gathered. The data collection process was considered a success because the data suggests a difference between the manipulated patterns and the patterns portray different visual results for each design. The data successfully demonstrated the possibility for optical illusions among the proposed patterns. However, the results were based on 2D and 3D models instead of real human bodies. Therefore, differences may exist between virtual models and reality.

Regarding data collection, participants understood the given task and participated throughout the experiments. The pilot study and Experiment 2 highlighted several concerns that were fully addressed in Experiment 3. Problems arising from the magnitude estimation technique included the practice being too time consuming for participants, which resulted in participants losing focus towards the end of the questionnaire. Furthermore, the magnitude estimation techniques were said to be difficult to answer and confusing. Therefore, Experiment 3 was conducted using the paired comparison method with an easy configuration for participants.

One limitation of this research was real human models not being used to test the proposed textile patterns. However, it was not possible to find individuals with the size preferences required (e.g. a tall female with an hourglass shape or a short male with an oval shape) with the limited time, funding and contacts available. Hence, 3D animated models were created to cater to the needs of this research.

The research acquired ethical approval from the University of Leeds and the Malaysian Research Institute. This arrangement was due to the research being conducted in Malaysia, with permission to conduct research being required from the University of Leeds. The University in Malaysia (Universiti Malaysia Kelantan) that participated in the questionnaire received consent from the Dean of the Faculty (Fakulti Teknologi Kreatif dan Warisan in Universiti Malaysia Kelantan) and received a support letter from the Education Research Application System (Malaysia).

The research was conducted in Malaysia because the Malaysian government sponsored this study and advised that the research should be directed towards Malaysian development. Hence, the data should cater to the textile and fashion trends of Malaysia.

While there was an initial complication related to ethical considerations, it has been dealt with by the University ethical team and resulted in approval. The ethical approval letter can be found in the Appendix.

Chapter 4

Psychometric Scaling and Image Width Assessment of Two-dimensional and Three-dimensional Objects

Introduction

This chapter explores width in two-dimensional (2D) and three-dimensional (3D) shapes from a psychophysical perspective. Specifically, it considers how patterns consisting of horizontal and vertical lines are applied on 2D objects and 3D walking models and identifies thresholds of perception in the application of pattern adjustment.

Experiment was first performed as part of a pilot study. This pilot study was conducted on children and the focus was placed on groups unaffected by bias in assessing lines on shapes. Initially, the direction of this research was to differentiate between the perspectives of adults and children regarding optical illusions using horizontal and vertical lines. However, this initial research direction did not carry through to children and the experimental focus was shifted from children to adults. The research shifted following a discussion session for a paper presented at a conference, (Proceedings of NordDesign 2016, Volume 1, Trondheim, Norway) which discussed the findings collected from Experiment 1. The conference was held by the Design Society, and participants were from the fields of design, arts and engineering. During the question and answer session, the questions that drove the direction of this research centred on how the research began and where it would lead. Notably, the research presented was focused on adult participants between the ages of

18 and 40 (and not on the pilot study data). During the question and answer session, there was a point at which the researcher mentioned a prior study conducted on children aged between 3 and 6 years and compared the opinions of adults and children regarding optical illusions. A majority of the conference participants disagreed with the idea and suggested focusing on conducting experiments with adults. Feedback from the presentation suggests that this research should be continued on adults since they are the audience that will be most heavily affected by perceptual judgements. Moreover, adults are the correct demographic to conduct this research on because they would more likely be interested in the research and wear the patterns. Additionally, the conference participants stated that the research should be conducted on adults since they will be wearing the patterns, while children are not conscious of their body image. Hence, the experimental focus was shifted to adults for Experiments 2 and 3.

Experiment 1, which was presented in the conference, aimed to explore width in 2D perception from a psychophysical perspective. Experiment 2 examined how the proposed pattern influenced observers' psychometric functions of the interval scale of perceptual width of 2D figures, while Experiment 3 used the same patterns to explore observers' psychometric functions of the interval scale of perceptual width on 3D animated human models. Experiment 3 represents the conclusion of this research since these results outlined manipulative pattern guidelines for different body needs.

4.1 Aims and objectives

This study aims to advance the pioneering work of Helmholtz (1867) on horizontal and vertical stripes and conduct a detailed exploration of the illusion theory within the context of different 2D and 3D images with horizontal and vertical lines as well as combinations of the two. Helmholtz (1867) suggests that vertical lines appear wider than horizontal lines, which contradicts the common assumption that horizontal lines make humans seem fat (a thorough explanation is discussed in Chapter 2. While Thompson (2011) agreed with Helmholtz, a student under Thompson's supervision named Watham (2012) conducted an experiment using horizontal and vertical lines. Watham (2012) noted that horizontal lines appear wider than vertical lines, which contradicted the works of Thompson and Helmholtz (2009). Ashida (2013) questioned the possibility that the effect of stripes might depend on the shape of a person, and his theory was supported by Thompson and Mikellidou (2009). Later, Cheng and Peng (2013) conducted a similar experiment using human stimuli wearing loose and soft fabrics. Their findings contradicted Helmholtz and Thompson since they observed that clothing with horizontal lines seemed to accentuate the wideness of overweight people and the slimness of slim people. Hence, the present study was conducted to further explore the findings of Thompson and Mikellidou (2011), Ashida et al. (2013), and Cheng and Peng (2013) regarding horizontal and vertical stripes presenting illusions that are dependent on body shape. Furthermore, by providing false illusions of body size, the present study adopted Spencer's (2014) pioneering work on body shapes to explore the stimuli consisting of horizontal and vertical lines performed on 2D and 3D figures.

The first phase of the research—the pilot study and Experiment 1—focuses on answering the criteria required to create an impact on the quality of illusions. The second phase of the study intends to discover the possibility for illusion by manipulating lines consisting of horizontal and vertical stripes to form patterns on different body shapes. The pilot study, Experiment 1 and Experiment 2 were conducted using 2D figures, while Experiment 3 tested stimuli on 3D animated human models. The intended outcome of this research is to produce manipulative visual perception design pattern guidelines for various needs (design to cater illusion for different body shapes).

4.2 Hypotheses

The experiments were designed to answer the following hypotheses:

0. Divergence from Thompson's and Helmholtz's notion of horizontal lines causing a widening effect is the result of cultural bias (pilot study).

1. Horizontal and vertical lines will appear differently on the various 2D human figures. The illusion will create different apparent widths on the shapes (Experiment 1).

2. The golden ratio can serve as a medium to aid optical illusions using horizontal and vertical lines (Experiment 2).

3. A relationship exists between 3D body shape and textile pattern embellishment, which modifies the apparent width of body shapes. This relationship can affect the overall appearance of the wearer (Experiment 3).

4.3 Method

The pilot study was performed using children belonging to the researcher's close friends and relatives at a very early stage of the research process. Since the researcher was unaware of standard research procedures, no ethical considerations were made for the pilot study. However, the parents of participating children gave their consent and were required to guide their children to provide answers on a computer. Hence, the procedure used in the pilot study was naïve and the researcher has since learned the correct procedure for subsequent research phases. Nevertheless, the results of the pilot study indicate that no significant difference exists between the perceptions of adults and children on cultural biasness theory, as proposed in the hypothesis of this pilot study.

Separate experiments using 2D shapes were conducted for the pilot study, Experiment 1 and Experiment 2. These experiments explored the effect of horizontal and vertical lines on width perception. The pilot study and Experiment 1 focused on horizontal or vertical lines on simple shapes, while Experiment 2 explored patterns constructed from a combination of horizontal and vertical lines on different human figures. Both experiments used the method of constant stimuli to evaluate the perceived width of the images by varying the stimulus. Notably, two different data collection approaches were taken. The pilot study, Experiments 1 and 3 used a paired comparison, forced-choice procedure in which observers viewed standard and comparison stimulus images presented side by side on a computer screen. The observers were then required to select the image they perceived to be wider. Experiment 2 used the magnitude estimation technique, in which observers were required to evaluate a value on the scale. For each question, four images were presented for scaling and participants were asked to slide a scale bar on the computer screen. The sliding of the scale bar is to collect the perceptions of image width of the stimuli.

4.3.1 Methodology used for the pilot study

The pilot study hypothesised that the human perception of lines is based on cultural biases. The theory is that adults are more experienced and aware of information such as lines making items appear wider or thinner. Thus, children were targeted for being natural, truthful and less likely to be exposed to the idea of horizontal stripes making objects seem wider. Psychological research indicates that people have a cognitive bias that leads them to misinterpret new information as supporting previously held hypotheses. As stated by Helmholtz's (1867) illusion theory, horizontal lines will make objects appear wider, while vertical lines make them appear slimmer. In contrast, Thompson (2011) stated the opposite. Could the illusion theory possibly spark bias among adults' judgements in determining the appearance of horizontal and vertical lines upon figures? To test the cultural biases hypothesis, children was chosen to complete questionnaires.

Eight different shapes were used as stimuli in the pilot study (see Fig. 4.2) and the pairwise comparison technique was used to conduct the research (see Section 3.4.1.1). A total of 20 questions were created (the same questions were used on different age groups in Experiment 1). To ensure the viability of the conducted research, the first and second questions of the interview focused on the participant's age since the study aimed to examine children's perceptions of horizontal and vertical lines. Another precaution taken in this study was the addition of two preliminary questions to identify whether the participants could differentiate between large and small (see Fig. 4.1). Participants that failed to differentiate between large and small were automatically excluded from the analysis.

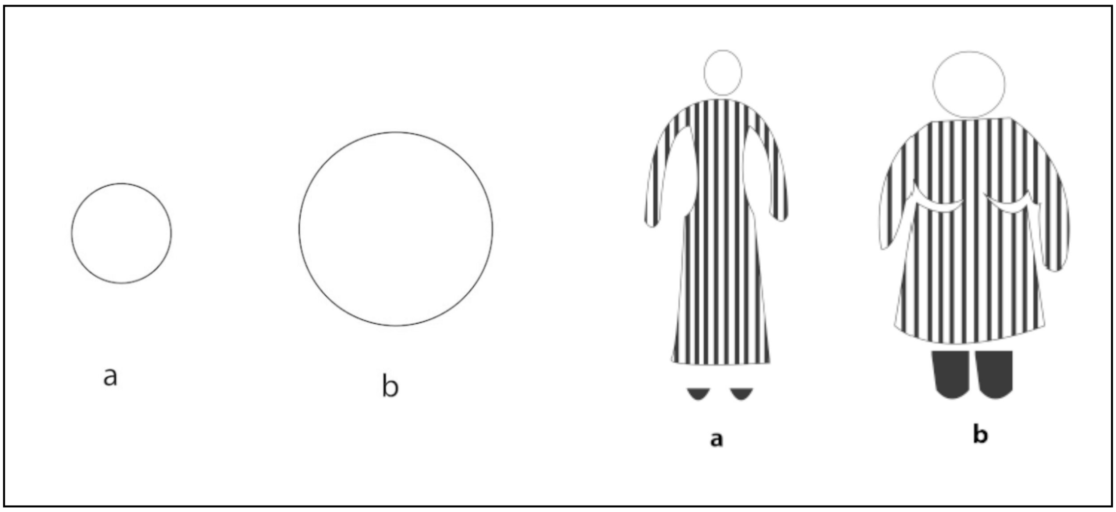


Figure 4.1 Paired comparison sample.

4.3.2 Methodology used for Experiment 1

Experiment 1 was performed to examine whether the placement of horizontal or vertical lines within shapes influences observers' perceptions. To achieve this, eight different shapes were used for the experiment (see Fig. 4.2). The pairwise comparison technique was used for data collection (see Section 3.4.1.1). All of the stimuli were transferred onto the QuestionPro website, which was used as the experimental platform. In total, 20 questions were created for Experiment 1 (see Appendix). The work conducted in this experiment was implemented as an online survey. The survey participants (N = 200) were students and staff from a university in Malaysia (Universiti Malaysia Kelantan). Participants were recruited via posters that were placed throughout the University campus two months before the experiment. The survey took one day to conduct.

4.3.3 Methodology used for Experiment 2

Experiment 2 was performed to determine whether pattern changes on a 2D object influence observers' perceptions. Experiment 2 explored the use of patterns consisting of horizontal and vertical lines within a golden ratio partition (see Section 3.3.3 for further information). The results from Experiment 2 were used to determine whether horizontal and vertical lines (and golden ratio partitions) are viable for further testing on 3D objects.

A total of six body shapes (see Fig. 3.7) were fitted with templates and transferred onto the QuestionPro website. The same body figure images with fitted patterns were then placed next to each other for size estimation by participants. The magnitude estimation method was used for this purpose, which involved participants being asked to estimate the width of an image by sliding scale bars provided under each image. Participants were asked four questions for each of the 33 questions. The method used in Experiment 2 is thoroughly explained in Section 3.4.1.2, and the questions are attached in the Appendix. The work conducted in this experiment was implemented as an online survey. The survey participants (N = 200) were students and staff from a university in Malaysia (Universiti Malaysia Kelantan). Participants were recruited via posters that were placed throughout the University campus two months before the experiment. The survey took one day to conduct.

4.3.4 Methodology used for Experiment 3

Experiment 3 used 3D animations encompassing a variety of body shapes and sizes wearing the proposed patterns. The methodology adopted a combination of online and offline techniques. The 3D models were run on a large screen for assessment (online), and participants had to manually (on a piece of paper) indicate the images that appeared widest to them. A combination of the online and offline techniques was used to standardise the overall condition of answers. While the video was being projected, all participants had to answer the questions simultaneously. The environment had a set standard for lighting and the ambience was identical for all participants. If questions were to be provided individually on computers, standardising responses would be more difficult due to differences in ambience from the varying gradients and screen resolutions of each computer.

This work is intended to extend the findings of the first and second experiments, which indicate that lines affect perceptions when applied to figures. It aims to explore the application of optical illusions in textile design to embellish and modify different body shapes. Additions on 3D models were made using 10 different 3D body shapes (five male and five female). A previous study highlighted that the shape of the body changes the way that clothes are viewed when different body shapes wear them (Spencer, 2014). Spencer (2014) stated that certain clothing will accentuate the shape of the body, which the user should consider. Thus, Experiment 3 uses a combination of lines within the golden ratio partitions to create patterns and uses 10 different body shapes to investigate the interval scale of perceptual width of the patterns created. This is used to study the possibility of using a pattern consisting of horizontal and vertical lines in the golden ratio partition as a formula to aid in creating optical illusions. In this work, using Spencer's (2014) formula of different body shapes requires the use of different types of clothing, with an emphasis on Experiment 3 (using patterns on a 3D model). The work conducted in this study adopted an online survey platform (QuestionPro). The survey participants (N = 23) were students from a university in Malaysia (Universiti Malaysia Kelantan). Participants were recruited via posters that were placed throughout the University campus 2 months before the survey.

This experiment focuses on 3D animated models to study how a pattern is perceived when movement is added to trials. Since humans are constantly moving in daily life, the trials were conducted using a moving 3D animated model. The animated models were created to resemble real humans walking and wearing clothing that bears the proposed trial patterns. For Experiment 3, the stimulus was only placed on the top portion of the model's clothing (shirt). All models were given standard white shirts. Adjustments were made by placing black patterns on the white shirts. To eliminate unnecessary interruptions in the test, the trousers were set in black with no additional accessories. The stimuli were only placed on the top portion of the body to downsize the data sampling and create a focal point for assessment.

4.4 Participants

4.4.1 Participants for the pilot study

The age group involved in the pilot study was children aged 3 to 6 years old (N = 20). The data was collected among friends and relatives. Their guardians were personally approached by the researcher through email and messaging. A link to the questions was released online and shared directly with the participants' guardians via email.

4.4.2 Participants for Experiments 1 and 2

A total of 200 male and female participants (aged 18–40 years) participated in the experiments. While participants were aware of the nature of the experiments, they were non-experts. The participants' normal work was not related to the textile or fashion industries, and they varied in nationality and cultural background. Participants were handed an instruction manual before the trials. The judgement request instructions for each questionnaire stated: "Mark the scale value from smallest to widest". The instructions contained example images to illustrate the nature of the questions and facilitate understanding.

4.4.3 Participants for Experiment 3

A total of 23 male and female participants (aged 18–40 (mean: 24) years) participated in the experiment. While participants were aware of the experiments, they were non-experts. The participants' normal work was not related to the textile or fashion industries, and they varied in nationality and cultural background. Participants were handed an instruction manual before the trials. The judgement request instructions for each observational video stated: "Select the image that seems widest". The instructions contained example images to illustrate the nature of the questions and facilitate understanding. Each participant was given the choice to acquire the findings of this research for future use. If requested, the information was provided via email after the session was completed.

4.5 Stimuli

Stimuli were grouped into the categories of shape, body shape and gender (male and female).

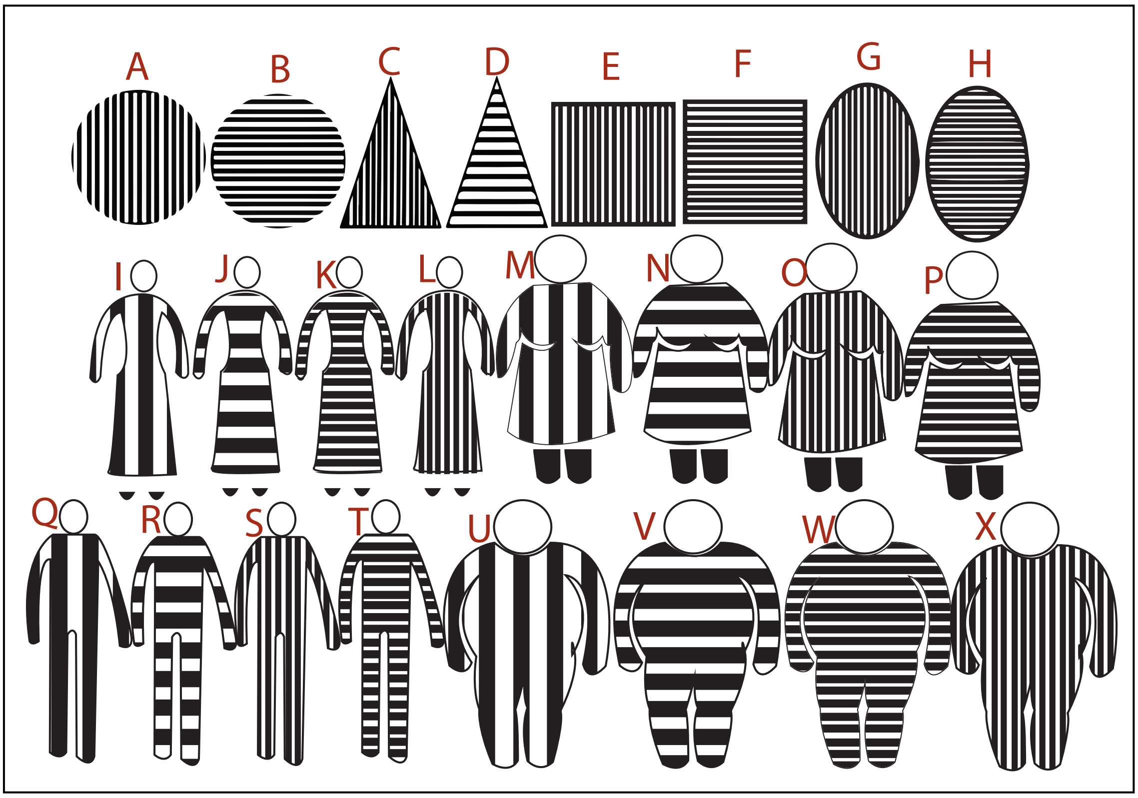


Figure 4.2 Stimuli for the pilot study and Experiment 1.

4.5.1 Stimuli used for the pilot study and Experiment 1

A total of eight shapes were used to conduct the pilot study and Experiment 1 (see Fig. 4.3). The shapes consisted of both simple and common shapes, including a circle, triangle, oval, square, slim female figure, wide female figure, slim male figure and wide male figure. For the basic shapes (i.e. circle, triangle, square and oval), only one line thickness was used for the assessment. The main focus of this research was to assess the effects of horizontal and vertical lines on the human body shape. Hence, the horizontal and vertical line experiment focused more on body shapes. The square, circle, triangle and oval were merely set as the starting point of the questionnaire to allow participants to understand the nature of the questionnaire.

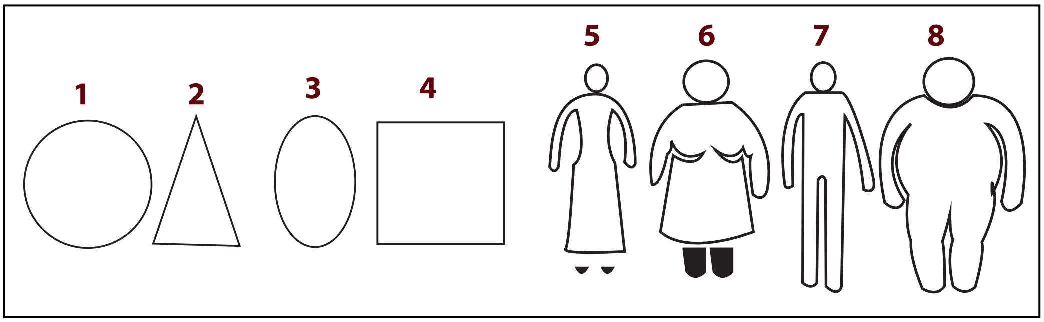


Figure 4.3 Shapes used for the pilot study and Experiment 1.

4.5.2 Stimuli used for Experiment 2

In Experiment 2, horizontal and vertical lines were developed and combined to create patterns. The lines were added in segments of the golden ratio (see Fig. 4.6). The golden ratio served as a medium for lines to merge before being applied on 2D human figures. The patterns were divided into four different pattern types with two sets of the same size patterns A-B and C-D. Patterns were rotated 180 degrees and enlarged by 0.25cm (see Fig. 4.5). A total of six 2D figures were chosen, with three female figures and three male figures. The total collection of figures (complete with final appearances) is presented in Fig. 4.4.

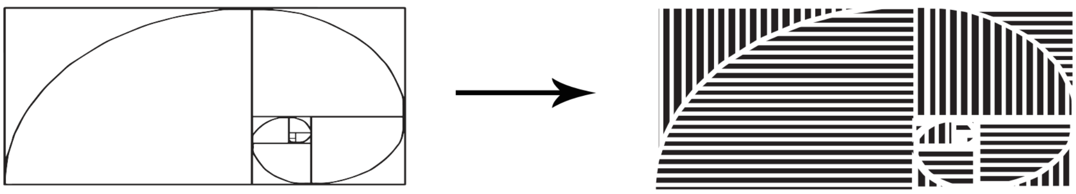


Figure 4.4 The process of implementing horizontal and vertical lines inside of the golden ratio partition.

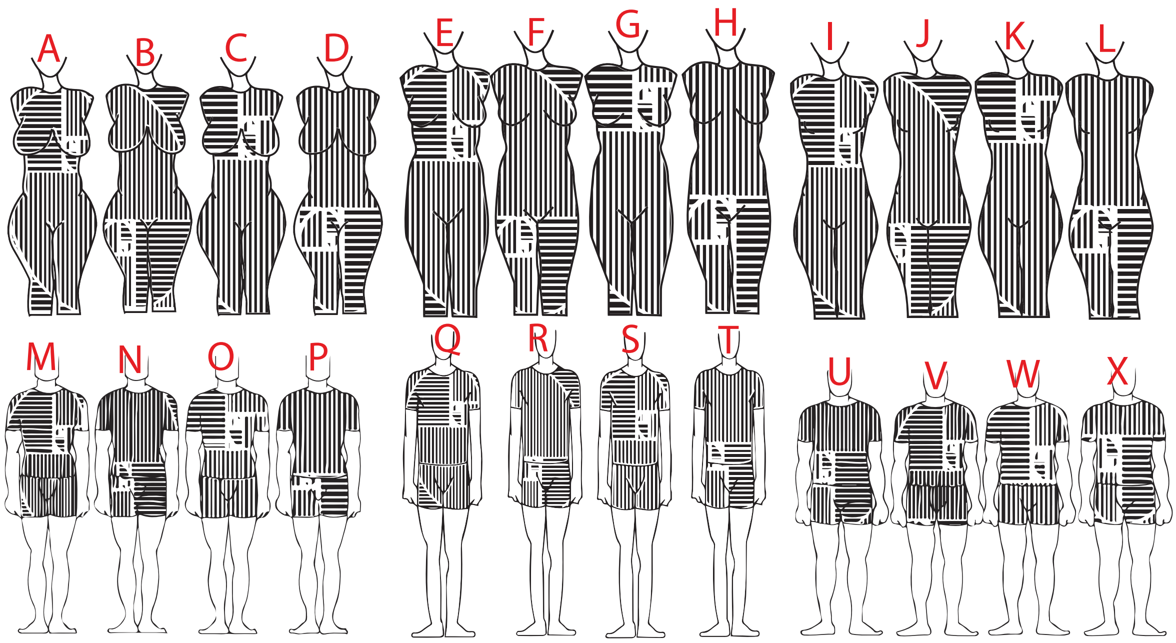


Figure 4.5 Collection of stimuli used in Experiment 2 (magnitude estimation).

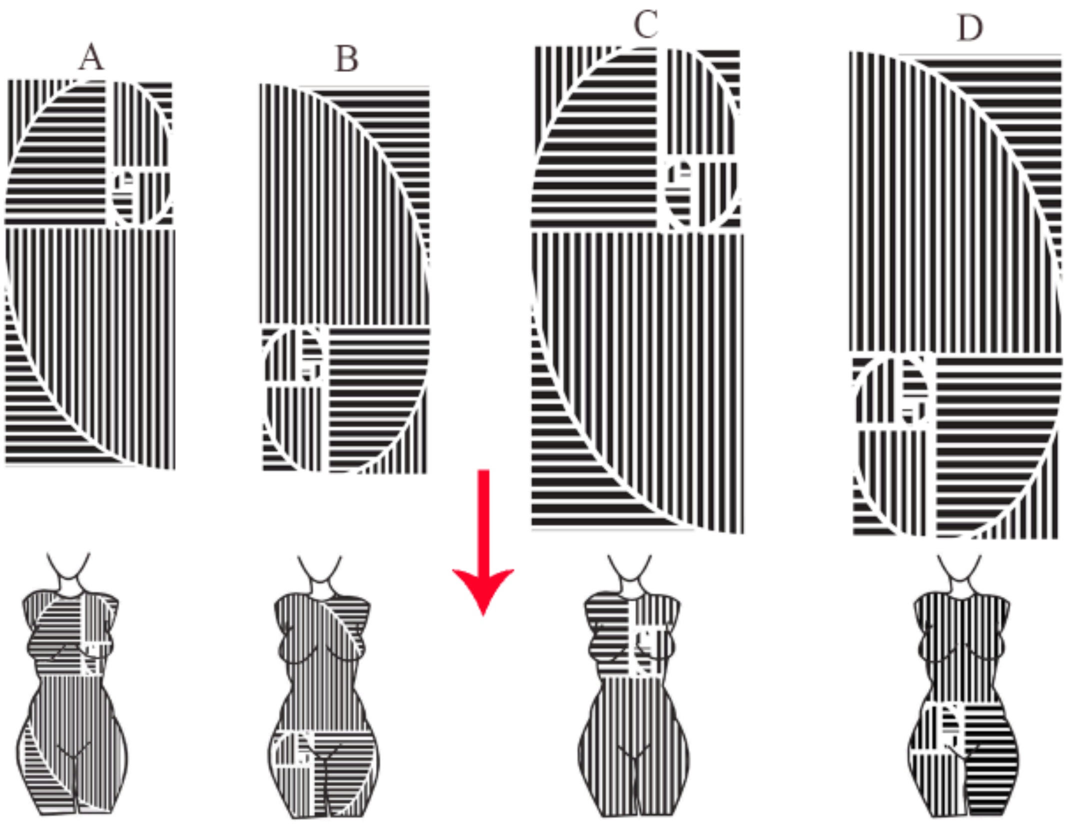


Figure 4.6 The insertion of patterns into shapes.

Fig. 4.5 outlines the implementation combining horizontal and vertical lines of the same thickness. The patterns were oriented 180 degrees and enlarged by 0.25 cm (see

Fig. 4.6). This process was designed to determine whether different body shapes would be visually affected by the addition of a pattern.

4.5.3 Stimuli used for Experiment 3

All stimuli were designed and rendered in Adobe Photoshop and Adobe Fuse from the Creative Cloud software. The general stimulus method is described in Section 3.3.4. Three stimulus patterns, paired with 15 body shapes, were selected for Experiment 3. The models were in 3D format and segregated into two groups. The first group (see Fig. 4.8) was selected to represent the female body shapes. These 3D female figures consisted of triangles, ovals, rectangles, inverted triangles and an hourglass form. The 3D models for the second group (see Fig. 4.9) were selected to represent the male body shapes. The 3D male figures consisted of triangles, ovals, rectangles, inverted triangles and a trapezoid form.

For Experiment 3, the stimulus was only present on the top portion of the model's clothing. All models were given standardised white shirts. Adjustments were made by placing patterns on white shirts. To eliminate unnecessary interruptions in the test, the trousers were set in black with no additional accessories. The stimuli were only placed on the top portion of the body to downsize the data sampling and create a focal point for assessment.

The 3D model was isolated into five different body forms. The body shapes consisted of triangles, ovals, rectangles, inverted triangles as well as an hourglass for women and a trapezoid for men. Both sexes were assigned to the same types of body shapes, except for trapezoid (male) and hourglass (female). Notably, the hourglass and trapezoid are recognised as ideal body shapes for women and men, respectively. The models were also assigned different heights and widths. A comprehensive explanation is provided in Figs. 4.7 and 4.8. Moreover, Figs. 4.8 and 4.9 describe the characteristics of the female and male models, respectively.

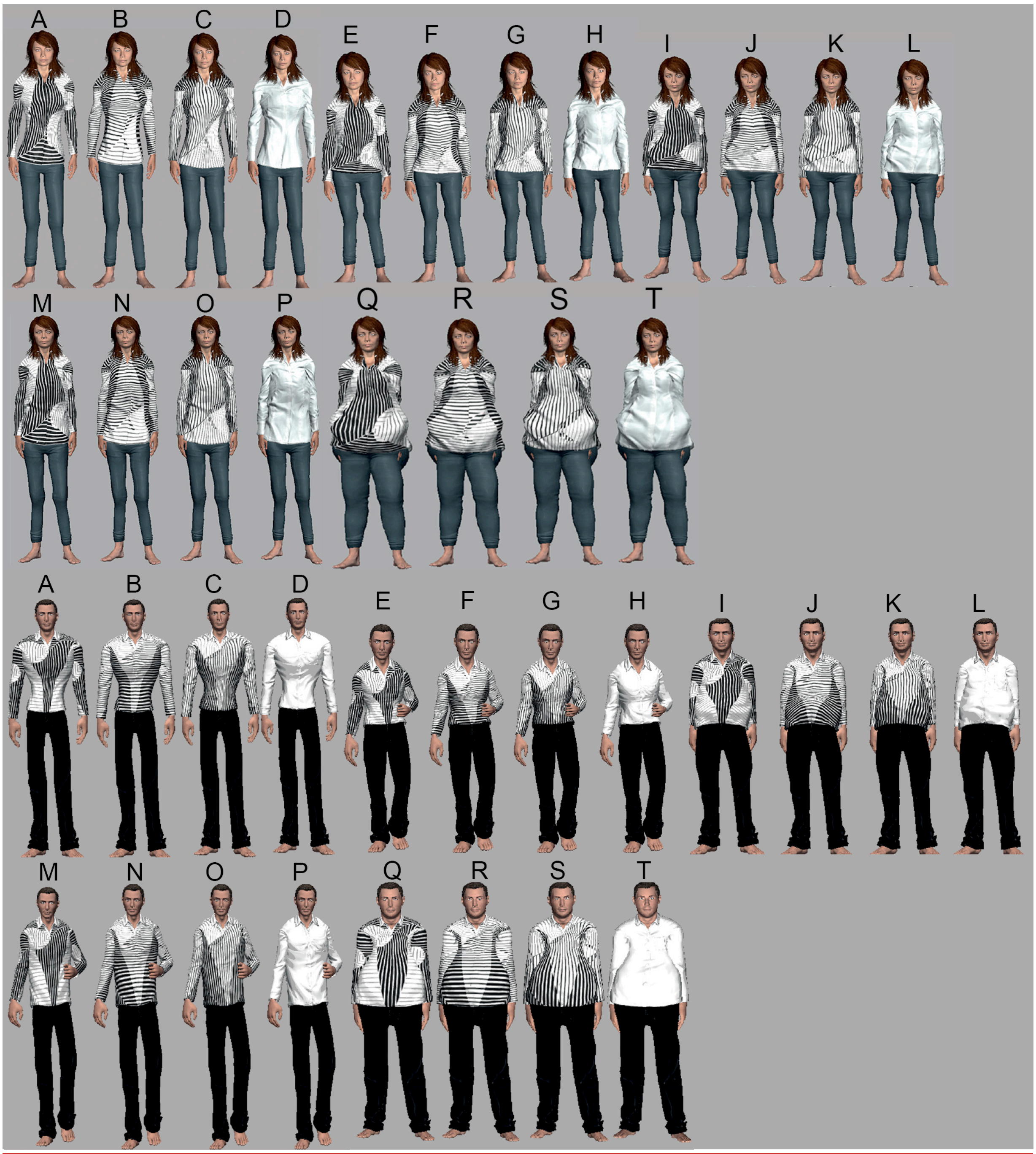


Figure 4.7 Stimuli for Experiment 3.

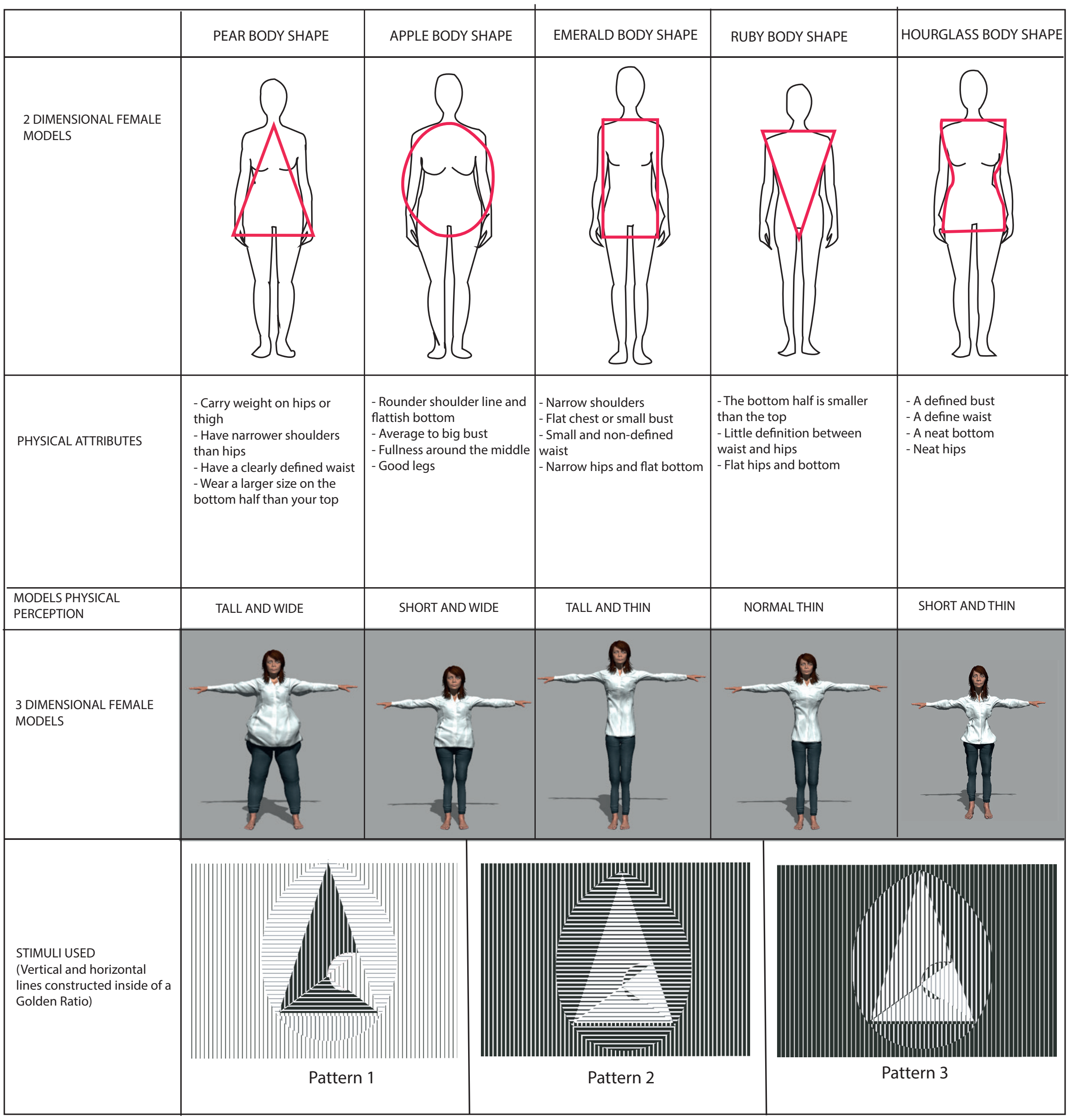


Figure 4.8 Three-dimensional female model template.

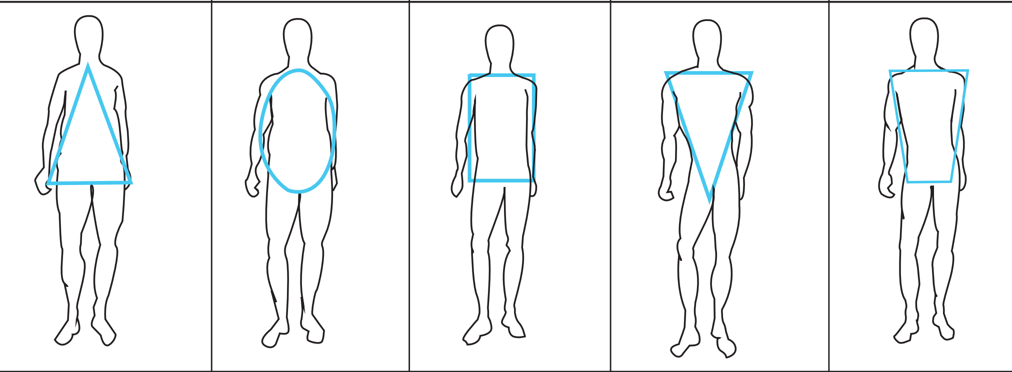
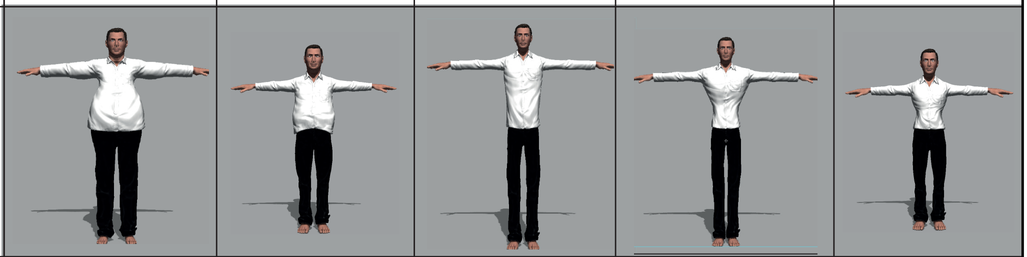
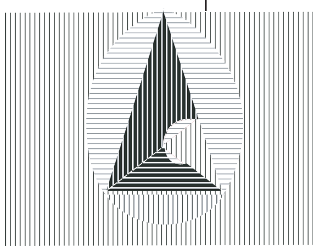
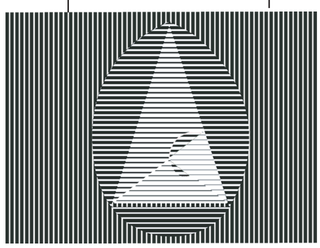
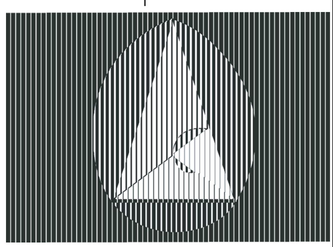
	THE TRIANGLE	THE OVAL	THE RECTANGLE	THE INVERTED TRIANGLE	THE TRAPEZIOD
2 DIMENSIONAL FEMALE MODELS					
PHYSICAL ATTRIBUTES	- Carry weight on hips or thigh - Have narrower shoulders than hips - Have a clearly defined waist - Wear a larger size on the bottom half than your top. -larger around the waist and hips and relatively narrow up top.	- Rounder shoulder line and flattish bottom - Fullness around the middle - Good legs. - Oval shapes appear round, particularly at the centre of the body, with shoulders and lower legs looking slimmer by comparison - Average to big bust - Fullness around the middle.- Good legs.	- Usually tall and thin, rectangular body shapes have shoulders roughly the same width as their waist and hips.	-chest and shoulders significantly broader than their waist and hips - The bottom half is smaller than the top - Little definition between waist and hips - Flat hips and bottom	- broad set of shoulders and chest and a gentle taper from the top down through the waist, hips and legs. - The ideal body shape and can wear most fashion.
MODELS PHYSICAL PERCEPTION	TALL AND WIDE	SHORT AND WIDE	TALL AND THIN	NORMAL THIN	SHORT AND THIN
3 DIMENSIONAL FEMALE MODELS					
STIMULI USED (Vertical and horizontal lines constructed inside of a Golden Ratio)	 Pattern 1		 Pattern 2		 Pattern 3

Figure 4.9 Three-dimensional male model template.

4.5.2.1 The golden ratio

Derived from the Fibonacci sequence, the golden ratio has been described as the most beautiful ratio in art and architecture. If one were to cut a square with the golden ratio, a golden rectangle would remain. The golden ratio is most often represented as the golden rectangle, which is a rectangle with a long side ratio of 1.618. This number has a pleasing harmonious quality and can be found in natural phenomena and a variety of man-made objects and works of art. The golden ratio can be designed in different ways and the golden rectangle is the simplest of its form. There is also a golden circle and golden triangle that uses the Fibonacci sequence for aesthetic purposes (see Fig. 4.10).

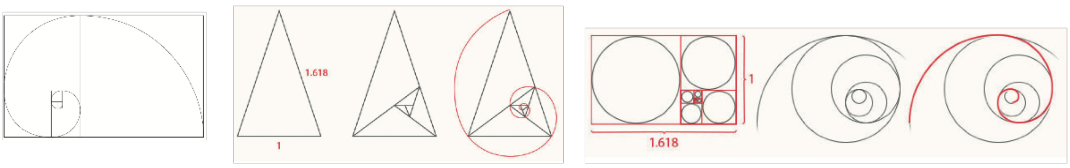


Figure 4.10 Different shapes using the golden ratio.

4.6 Apparatus

4.6.1 Apparatus for the pilot study

Children under the age of six were guided by guardians during interview sessions using their personal devices. A link to the questionnaire was provided to guardians via email correspondence. Guardians then helped participants complete the questionnaire (children pointed to answers).

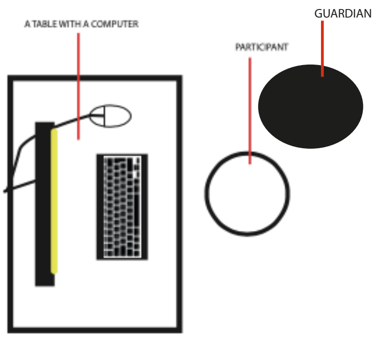


Figure 4.11 Apparatus for the pilot study.

4.6.2 Apparatus for Experiments 1 and 2

Participants were seated in a computer lab and provided with a computer. The questionnaires were opened on the computer screen and participants answered the questions on the computer provided. The questions were linked to the QuestionPro website.

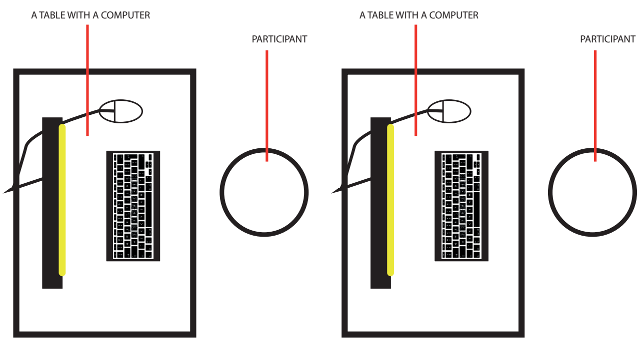


Figure 4.12 Apparatus for Experiment 1 and Experiment 2.

4.6.3 Apparatus for Experiment 3

A projector linked to a computer was used to display sets of 3D rendered animated models. The stimulus videos were projected in a dimmed space and observers were required to provide their answers simultaneously on a printed form provided to them.

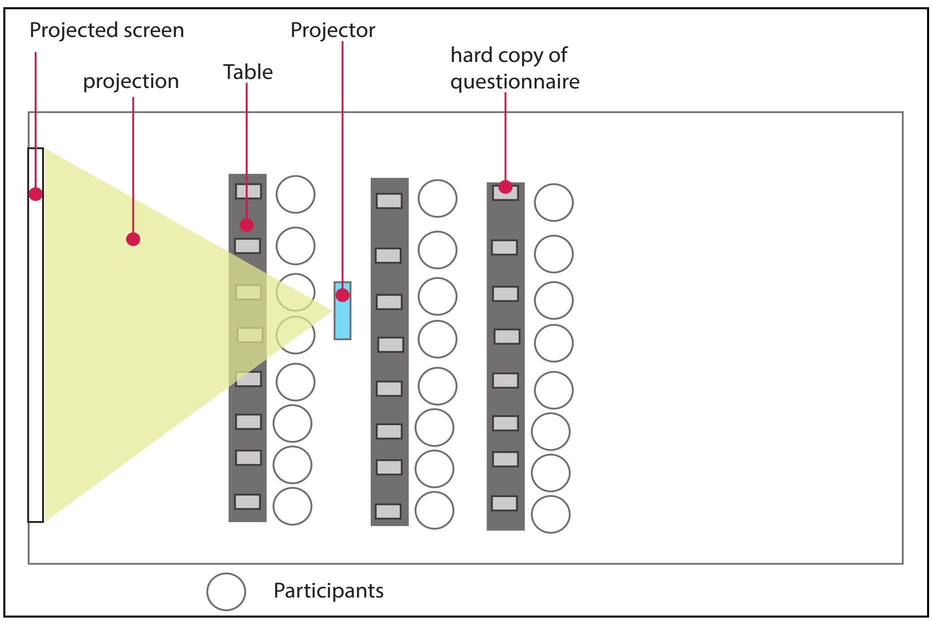


Figure 4.13 Apparatus for Experiment 3.

4.7 Procedure

In this study, the constant stimuli method was used to estimate thresholds for discriminating width perception based on pattern changes. The applied procedure used a forced-choice method in which participants were presented with comparison stimulus models shown side by side on a computer screen. They were then required to choose the widest images. The stimulus models were shown for each question and randomly switched from left to right. The instruction sheet can be found in the Appendix.

4.7.1 Procedure for paired comparison (pilot study)

For the pilot study, potential respondents were close friends and relatives with children. The researcher had personally contacted these individuals and asked if they had time to answer a questionnaire regarding illusions. Correspondence was performed via messaging and emails, and a link to the questionnaire was provided. Guardians were informed that the research was focused on children aged 3 to 6 years old and that a guardian was required to assist children with the answer selection process.

The pilot study had three answer choices: Answer A, Answer B, or “The images are the same”. At this phase of the study, the questionnaire was in the development stage and the researcher noticed that this answer choice format should not be included for subsequent phases of the research. This is due to the selection “the images are the same” adding unwanted value to the data. Instead, the questionnaire should involve forced choices that result in participants selecting the images that seem thinnest to them.

4.7.2 Procedure for paired comparison (Experiment 1)

Participants were handed an instruction manual one month before the trials as well as on the day of the trials. This was done because most participants wanted a detailed outline of how the task will be conducted before participating. On the survey date, the instruction manual was provided at the beginning of the online questionnaire. Participants were notified that answering the questionnaire would be considered consent for data collection. The instruction manual is provided in the Appendix. The judgement request instructions for each questionnaire stated: “Select the image that seems slimmest”. The instructions contained example images to illustrate the nature of the questions and facilitate understanding (see Fig. 3.17).

4.7.3 Procedure for magnitude estimation (Experiment 2)

The participants were approached in computer classrooms at their university in Malaysia (Universiti Malaysia Kelantan). Before the experiment, the lecturer was informed about the questionnaire process. Participants were given prior notice regarding the process and were given the choice of whether to participate or not. Since the study was conducted after the class had ended, participants were allowed to exit the classroom and not participate in the questionnaires. Before starting the questionnaires, a brief explanation of how to answer the questions was provided. All participants were provided with a link to the questionnaire on their computer, which was connected to the QuestionPro website. Participants were encouraged to ask questions during and after the questionnaire. They were also allowed to leave the room at any time.

4.7.4 Procedure for paired comparison (Experiment 3)

A total of 23 male and female participants (aged 18–40 (mean: 24) years) participated in the experiment. While subjects were aware of the experiments, they were non-experts. The participants’ normal work was not related to the textile or fashion industries, and they varied in nationality and cultural background. Participants were handed an instruction manual before the trials. The judgement request instructions for each observational video stated: “Select the image that seems widest”. The instructions contained example images to illustrate the nature of the questions and facilitate understanding. Each participant was given the choice to acquire the findings of this research for future use. If requested, the information was provided via email after the session was completed.

In the present study, the constant stimuli method was used to estimate thresholds for discriminating width perception based on pattern changes in 3D images. The experiment used a forced-choice procedure in which observers were presented with comparison stimulus video models presented side by side on a projector screen. They were then required to choose the widest images. The stimulus video models were shown for each question and randomly switched from left to right. The instruction sheet can be found in the Appendix. Participants were instructed to provide answers on a printed form by selecting the widest images. The answer sheet can be found in the Appendix. The video images were played manually. Once the participant finished a question, the next video (question) was played. No time limit was given for participants answering the questions. Subsequent trials were displayed after the screen changed to a neutral grey colour throughout the experiment (see Fig. 4.14).

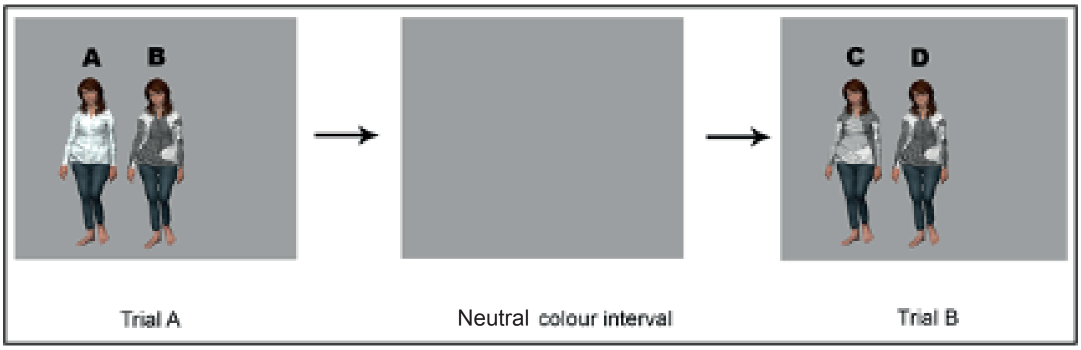


Figure 4.14 Transition between trials for Experiment 3.

The experiment began with a female model and participants were given a 15-minute break before proceeding with the male model test. Fig. 4.15 illustrates the time frame of the actual questionnaire. The animated models were arranged to walk around in a circle, thereby providing the front, side and back view of the manipulated design for assessment.

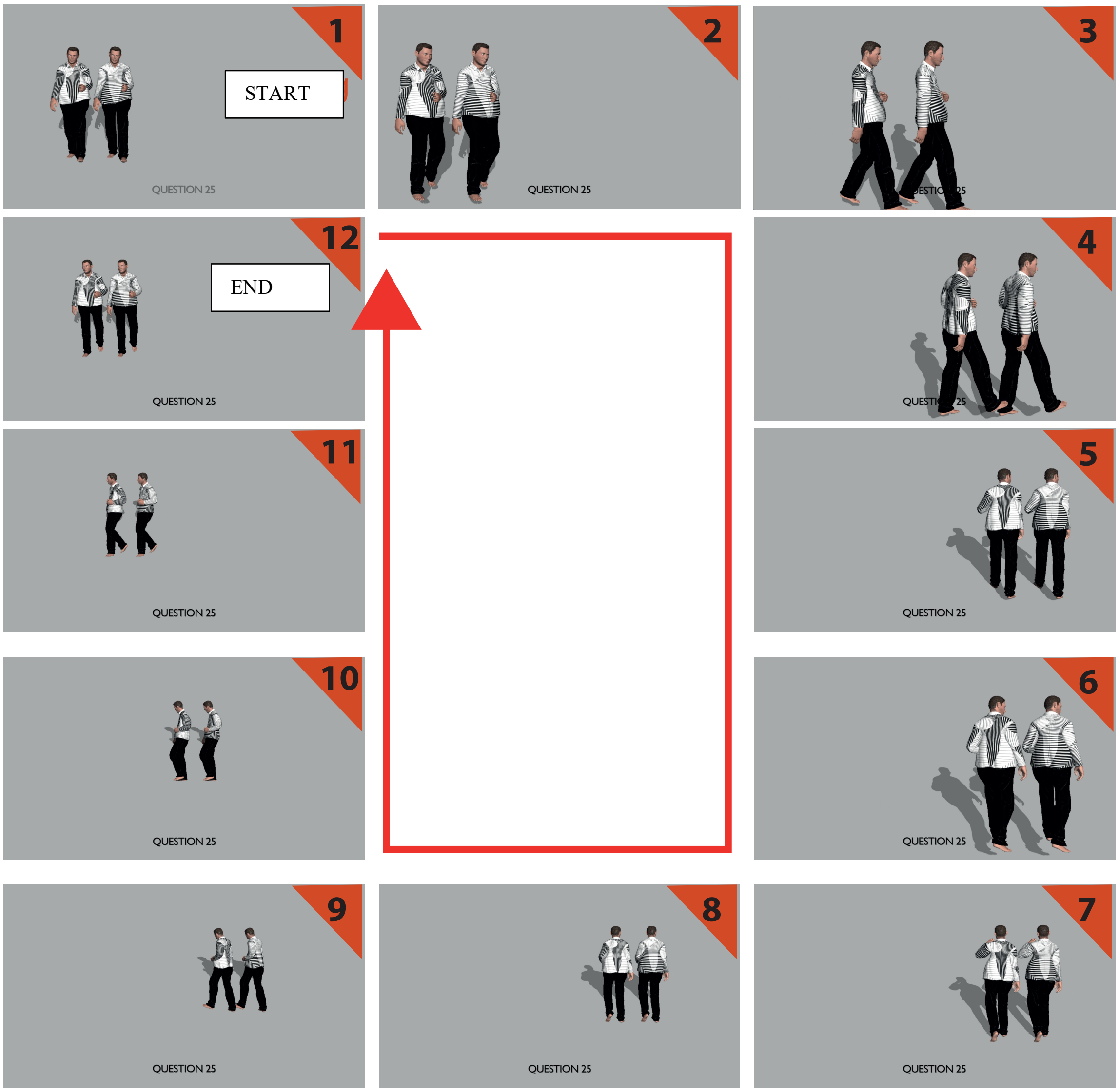


Figure 4.15 Sample of a time frame for Experiment 3.

Chapter 5

Results

The results of this thesis were collected from a web-based survey and divided into four parts: the pilot study, Experiment 1, Experiment 2 and Experiment 3. The data from the pilot study and Experiment 1 indicate the possibility of optical visual involvement in width adjustments. The pilot study and Experiment 1 were conducted to determine whether the use of different 2D shapes with horizontal and/or vertical stripes (of varying thickness) would impact illusion quality. After the results indicated an illusion effect of different shapes with horizontal and vertical lines, the research progressed to the manipulation of horizontal and vertical lines into a pattern.

5.1 Results of the pilot study

The square and the oval shapes with horizontal stripes indicate a possible size illusion, with the highest percentage being the widest among other shapes by 55%. However, for circles and triangles, the results indicate that neither horizontal- nor vertical-striped patterns create strong illusion effects. However, a contrast between females and males existed for 2D human figures. The results for male figures indicate that patterns with horizontal lines on both wide and thin shapes appeared bigger than those with the vertical-striped pattern. For female figures, the results indicate that neither vertical lines nor horizontal stripes portrayed strong illusion effects. However, vertical stripes had a slight size illusion effect for thin female figures.

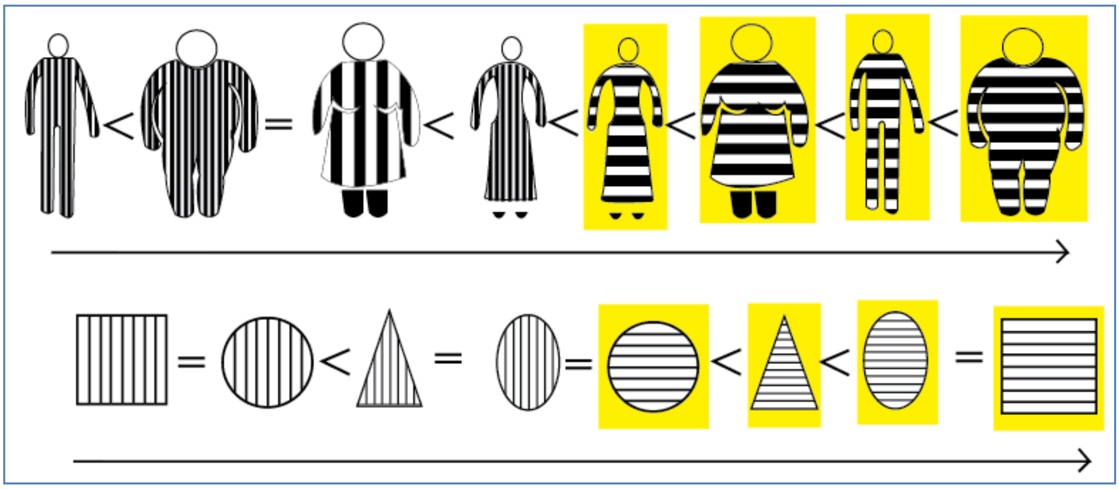


Figure 5.1 Pilot study results for horizontal and vertical line scaling and with yellow marks highlighting the widest illusion,

In Figure 5.1, horizontal lines are shown to possibly trigger a larger manipulation in size. Notably, different shapes with horizontal and vertical stripes allow for optical visual involvement. The figures with yellow backgrounds indicate the use of horizontal lines as the dominant hierarchy for creating the illusion of greater size. The various forms appeared to display different potentials of manipulation when horizontal and vertical lines were applied. The pilot study supports Helmholtz's illusion theory, which states that horizontal stripes are the dominant pattern of "bigness". However, future studies will not involve children in the data collection process. This is due to the inability to make decisions in expressing opinions of width differences based on smaller groups of children as well as children being less cautious about looks compared to adults. Furthermore, data collection for further experiments will not include "the same" as an answer since it does not provide interval data.

5.2 Results for Experiment 1

Based on the results of Experiment 1, it can be concluded that varying line thickness can trigger different visual outcomes. Figures with thicker lines as well as those with horizontal patterns exhibited the optical illusion of being wider and bigger. Also, vertical stimuli exhibited the optical illusion of being the slimmest of all four human shapes. This demonstrates that shapes applying the same pattern will appear to be different from one another.

Figures 5.2, 5.3, 5.4 and 5.5 present the image width chart for basic shapes, while Figures 5.6, 5.7, 5.8 and 5.9 present the image width for 2D human figures.

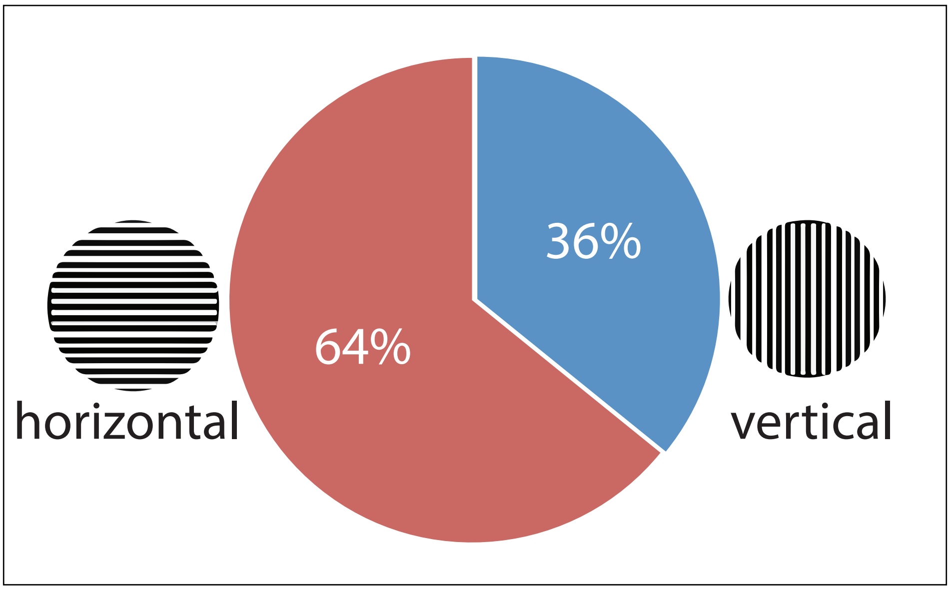


Figure 5.2 Perceived stimulus width in a circle (64% of participants responded that the shape with horizontal lines was widest)

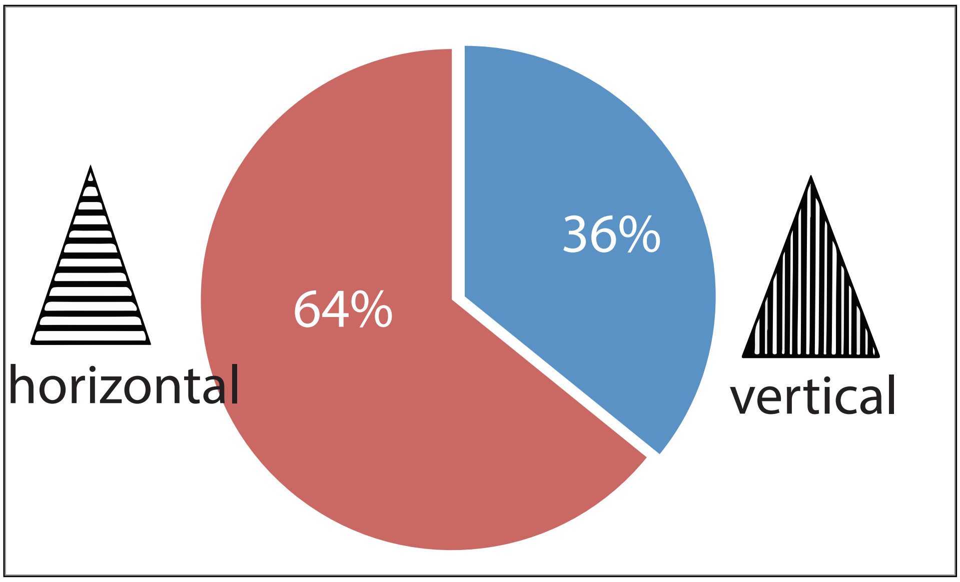


Figure 5.3 Perceived stimulus width in a triangle (64% of participants responded that the shape with horizontal lines was widest)

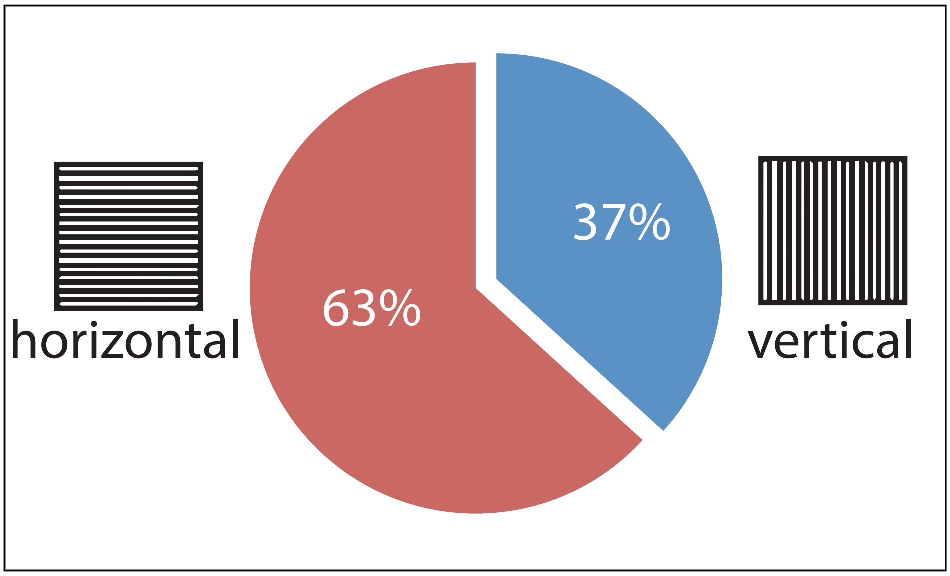


Figure 5.4 Perceived stimulus width in a square (63% of participants responded that the shape with horizontal lines was widest)

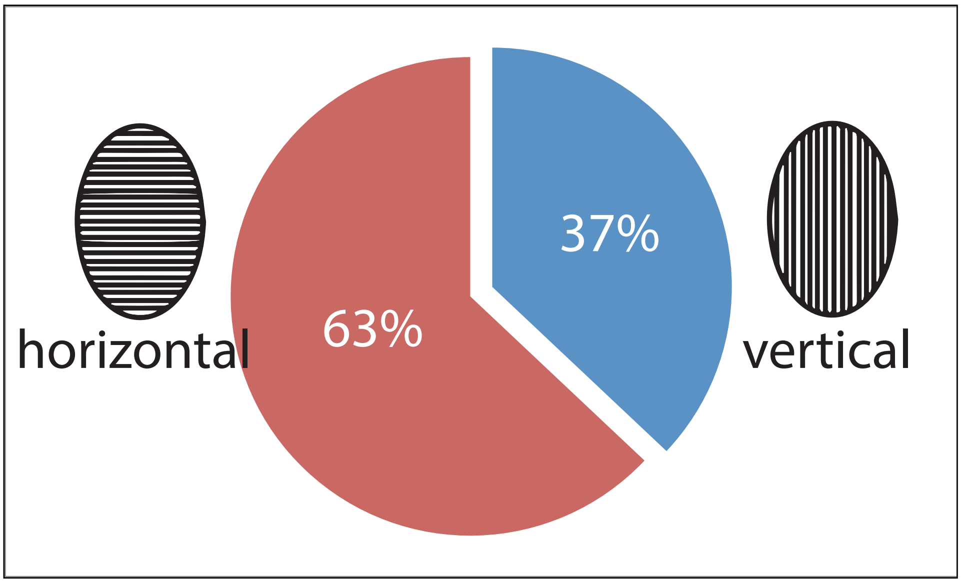


Figure 5.5 Perceived stimulus width in a circle (63% of participants responded that the shape with horizontal lines was widest)

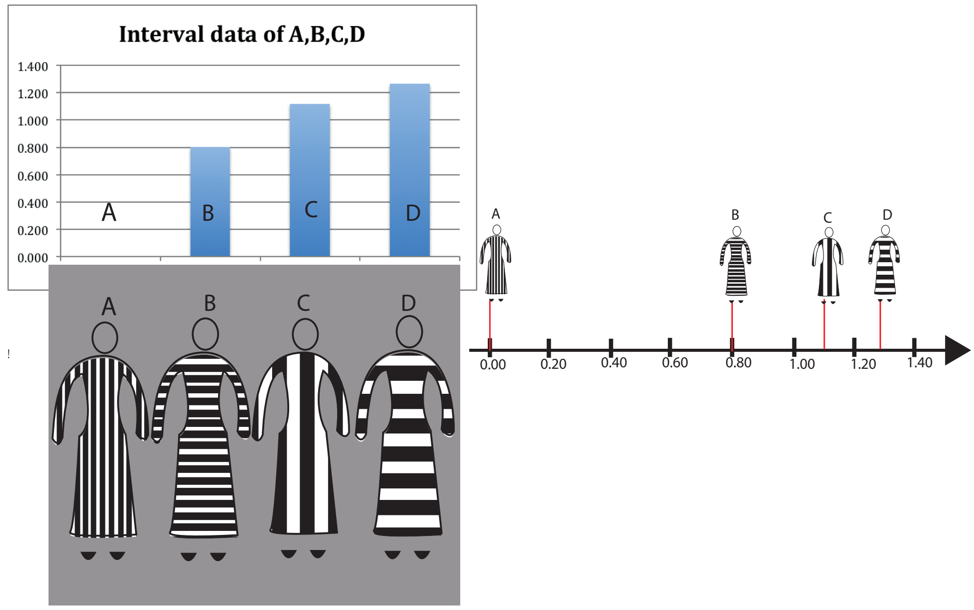


Figure 5.6 Scale bar for thin female figures. A large horizontal pattern was perceived as the widest, followed by large vertical patterns, horizontal small patterns and small vertical patterns

Figure 5.6 shows that stimulus D was considered the widest among all stimuli, followed by stimuli C, B and A. Larger stimuli with horizontal and vertical lines were considered wider than those with smaller horizontal and vertical lines.

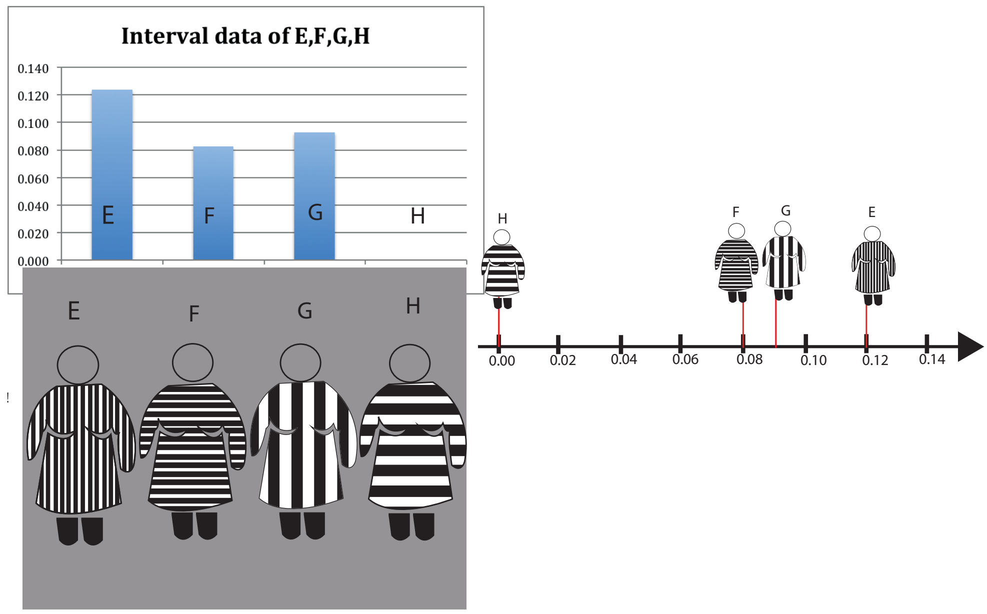


Figure 5.7 Scale bar for wide female figures. A large horizontal pattern was perceived as the widest, followed by large vertical patterns, small horizontal patterns and small vertical patterns

Figure 5.7 shows that stimulus E was considered to be the widest among all stimuli, followed by stimuli G, F and H. Larger stimuli with horizontal and vertical lines were considered wider than those with smaller horizontal and vertical lines.

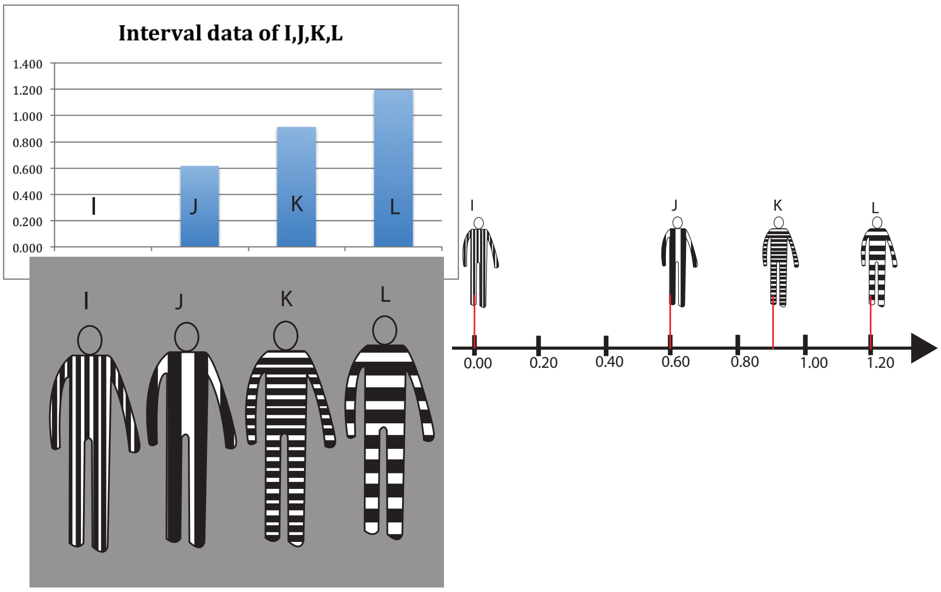


Figure 5.8 Scale bar for thin male figures. A large horizontal pattern was perceived as the widest, followed by small horizontal patterns, large vertical patterns and small vertical patterns

Figure 5.8 shows that stimulus L was considered the widest among all stimuli, followed by stimuli K, J and I. Stimuli with horizontal lines were perceived as the wider than those with vertical lines.

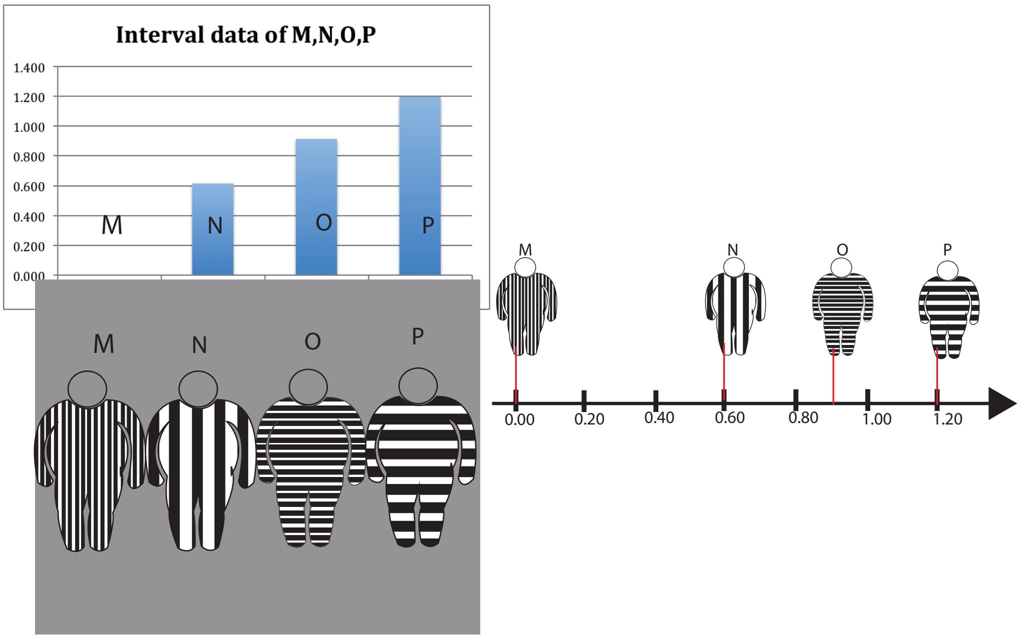


Figure 5.9 Scale bar for wide male figures. A large horizontal pattern was perceived as the widest, followed by small horizontal patterns, vertical big patterns and small vertical patterns

Figure 5.9 shows that stimulus P was considered the widest among all stimuli, followed by stimuli O, N and M. Stimuli with horizontal lines were perceived as the wider than those with vertical lines.

5.3 Results for Experiment 2

Based on the results of Experiment 2, it can be concluded that a mixed orientation of patterns can trigger an optical illusion. Also, female figures with heavy patterns on lower body parts (from hip to legs) appear wider. The results indicate that the scale difference between images varies, with the whitest (clearest) partitions resulting in the widest appearance.

Figures 5.10, 5.11, 5.12, 5.13, 5.14 and 5.15 present the image width scale (from 0 to 60 in votes) using the magnitude estimation method. The scale represents values collected from participants' assessments.

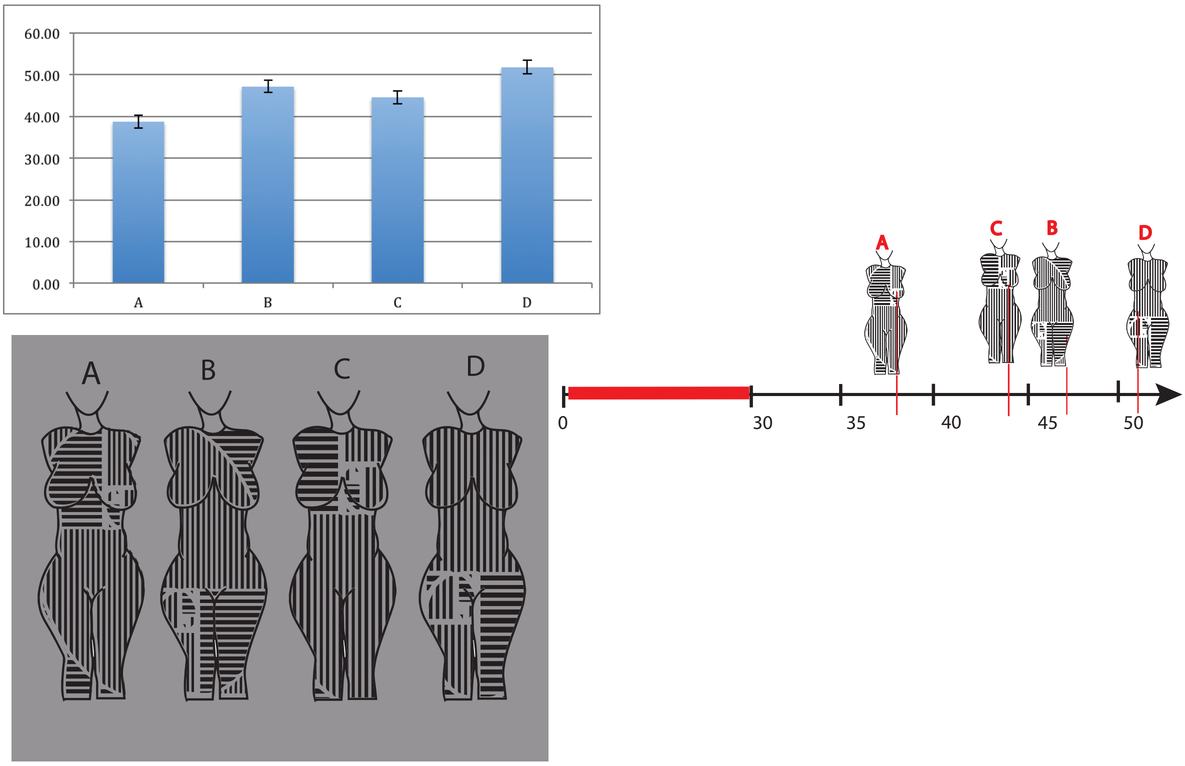


Figure 5.10 Scale bar for curvy female figures. Female figures with enlarged patterns were perceived as the widest, while heavy patterns on the lower body also contributed to a wider appearance. Small patterns with heavy pattern placement on the upper body were perceived as the slimmest

Figure 5.10 shows that stimulus D was perceived as the widest of all stimuli, followed by stimuli B, C and A. Stimuli B and C were equal since the difference was too close to distinguish.

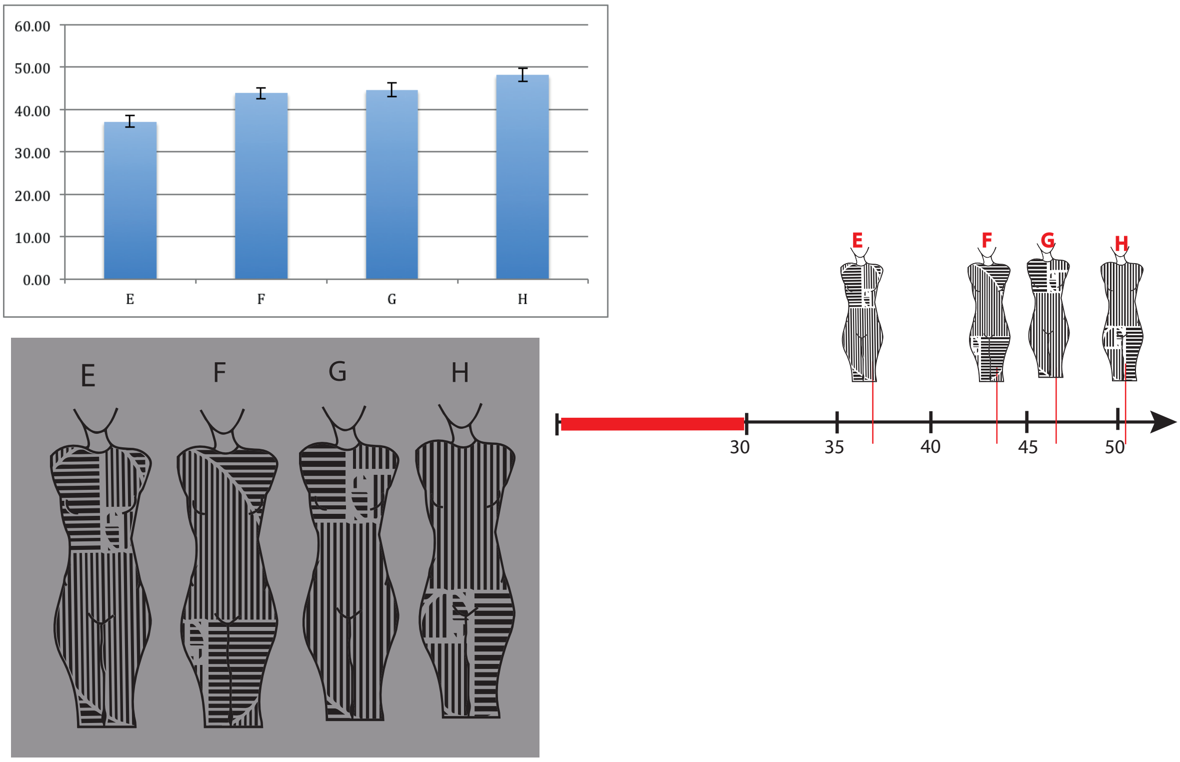


Figure 5.11 Scale bar for apple-shaped female figures. Female figures with enlarged heavy patterns on the lower body were perceived as the widest. Small patterns with heavy pattern placement at the upper body were perceived as the slimmest

Figure 5.11 shows that stimulus H was perceived as the widest of all stimuli, followed by stimuli G, F and E. Stimuli G and F were equal since the difference was too close to distinguish.

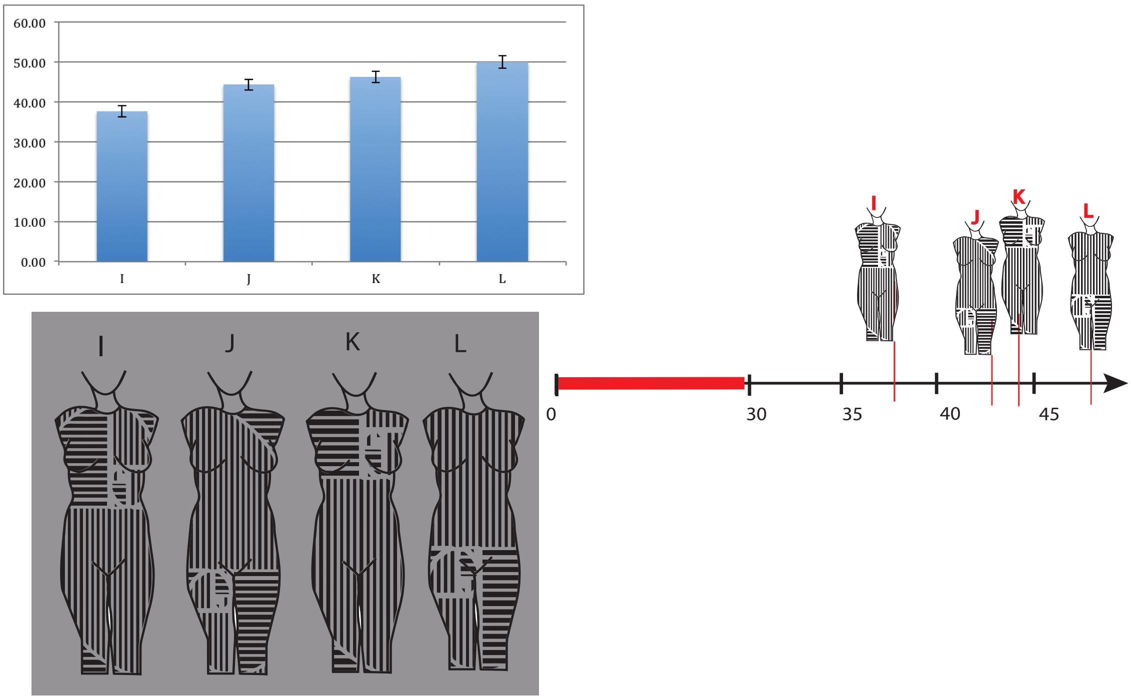


Figure 5.12 Scale bar for athletic female figures. Female figures with enlarged heavy patterns on the lower body were perceived as the widest. Small patterns with heavy pattern placement at the upper were perceived as the slimmest

Figure 5.12 shows that stimulus L was perceived as the widest of all stimuli, followed by stimuli K, L and I. Stimuli J and K were equal since the difference was too close to distinguish.

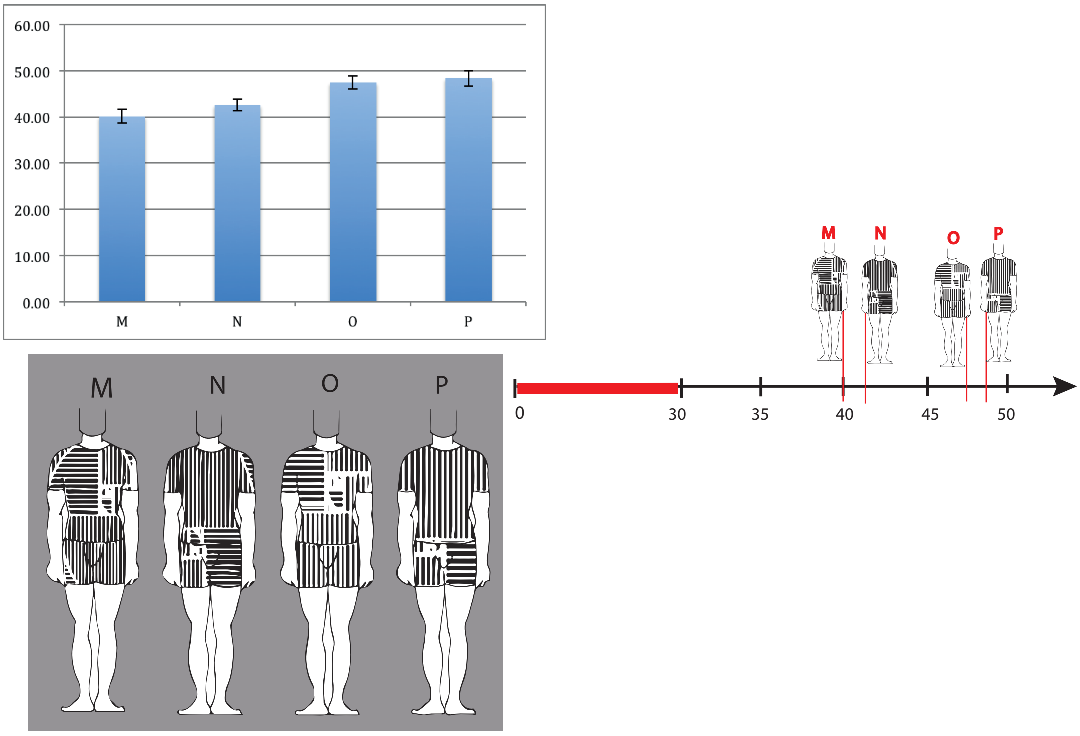


Figure 5.13 Scale bar for regular-shaped male figures. Male figures with enlarged heavy patterns on the lower body were perceived as the widest. Small patterns with heavy pattern placement at the upper body were perceived as the slimmest

Figure 5.13 shows that stimuli O and P were equally perceived as the widest of all stimuli, while stimuli N and M were equally perceived as the slimmest.

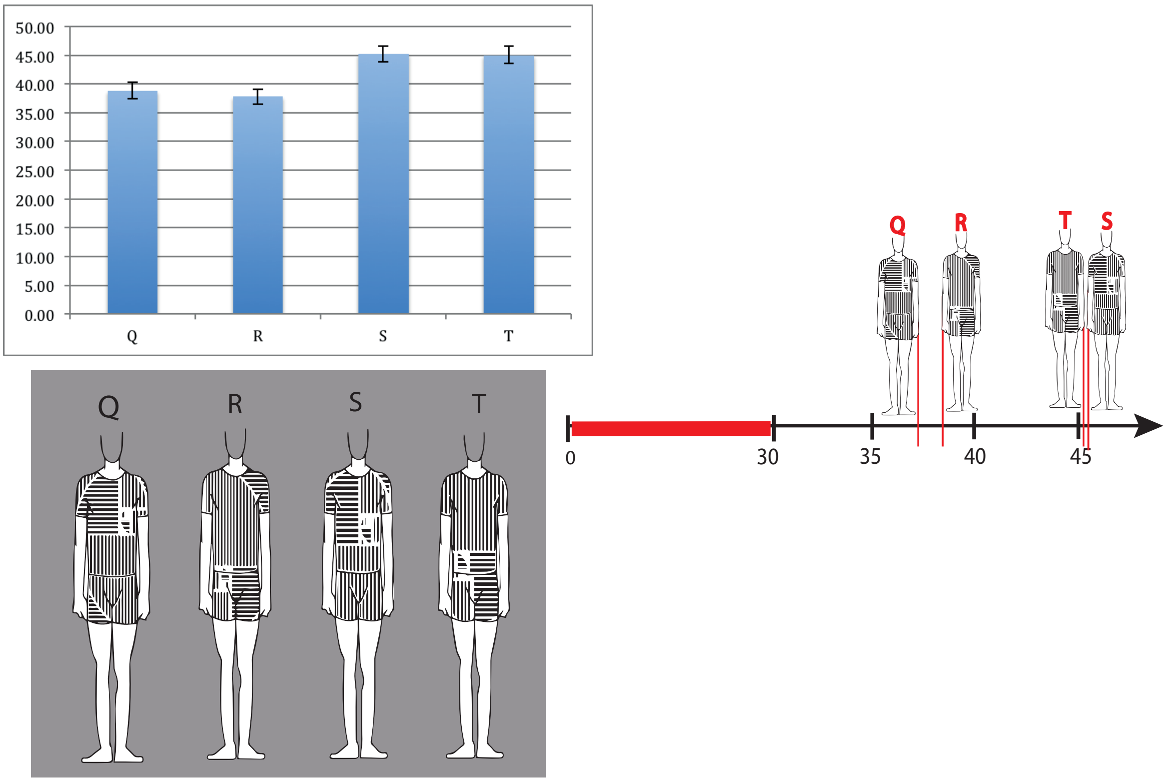


Figure 5.14 Scale bar for regular, tall and thin male figures. Male figures with enlarged heavy patterns on the upper body were perceived as the widest. Small patterns with heavy pattern placement at the upper body were perceived as the slimmest

Figure 5.14 shows that stimuli S and T were equally perceived as the widest among all stimuli, while stimuli Q and R were equally perceived as the slimmest

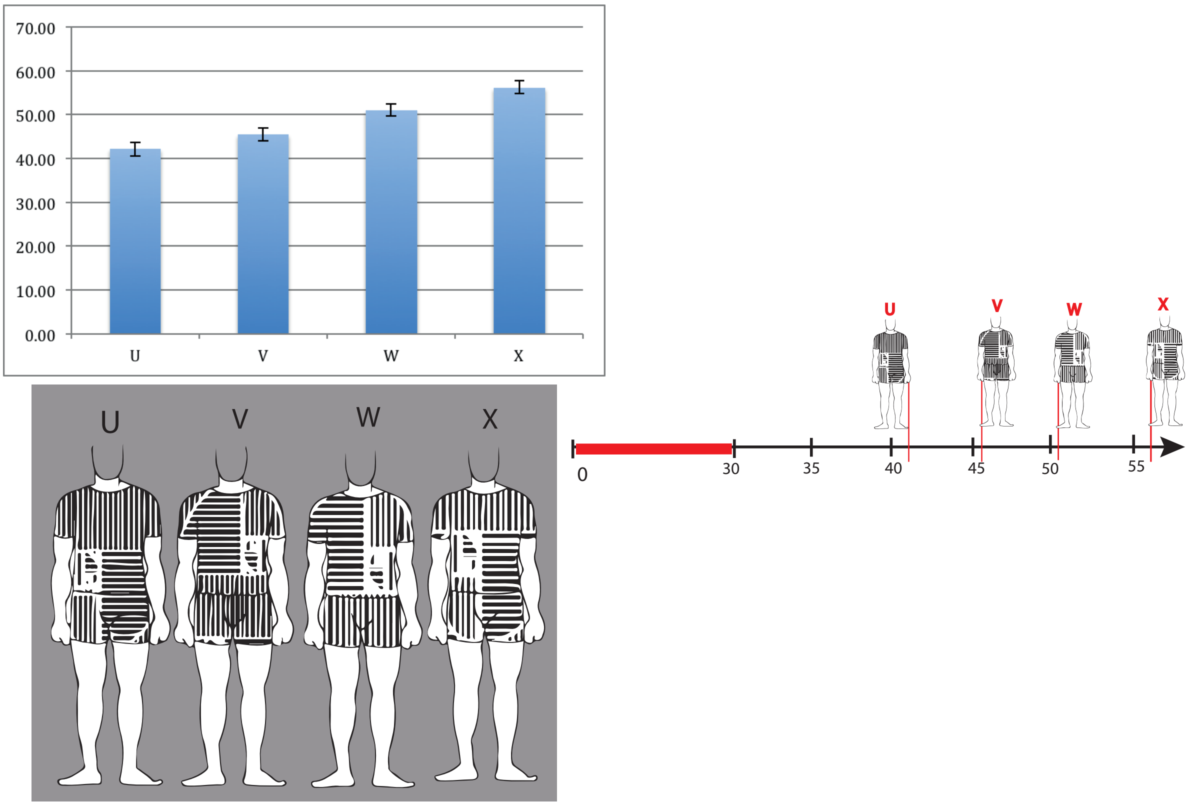


Figure 5.15 Scale bar for athletic male figures. Male figures with enlarged heavy patterns were perceived as the widest. Small patterns were perceived as the slimmest

Figure 5.15 shows that stimulus X was perceived as the widest of all stimuli, followed by stimuli W, V and U.

5.4 Results for Experiment 3

Experiment 3 involved analysing the application of patterns made from horizontal and vertical lines within the golden ratio partitions on 3D models. This experiment aimed to determine the interval scale of perceptual width for 10 3D models. The results indicate that the higher the interval scale value, the wider the stimuli were perceived. This implies that the higher the number for scale values, the wider a model with the same body shape was perceived among the stimuli.

From Experiment 3 of the paired comparison method, here are the results. Figures 5.7, 5.8, 5.9, 5.10 and 5.11 present the image width charts for 3D female stimuli, while Figures 5.12, 5.13, 5.14, 5.15 and 5.16 present the image width charts for 3D male stimuli.

5.4.1 Three-dimensional female models

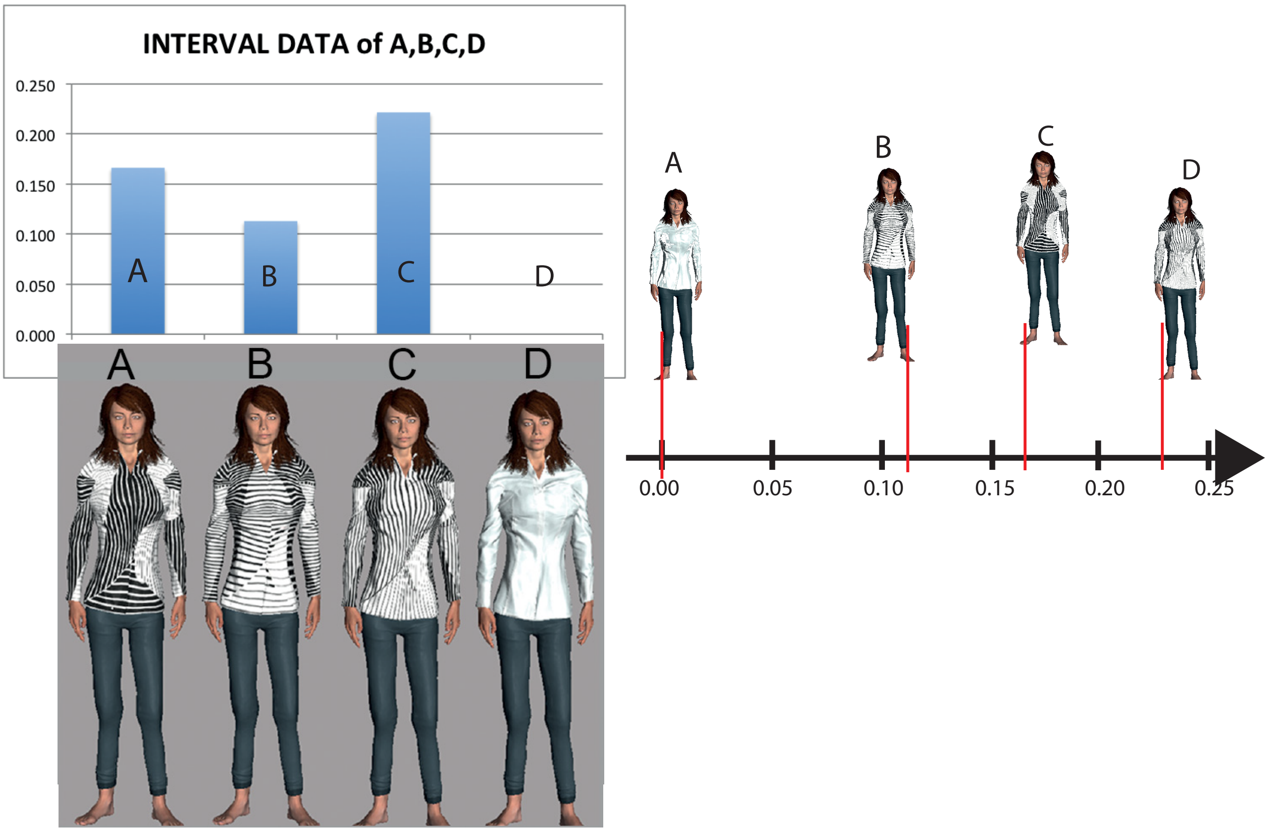


Figure 5.16 The scale bars, bar charts and stimuli used for tall, thin and inverted triangle body-shaped female models

The simulation of a female with a high, thin and inverted triangle body shows that stimulus C was perceived as the widest of all stimuli, followed by stimuli A, B and D.

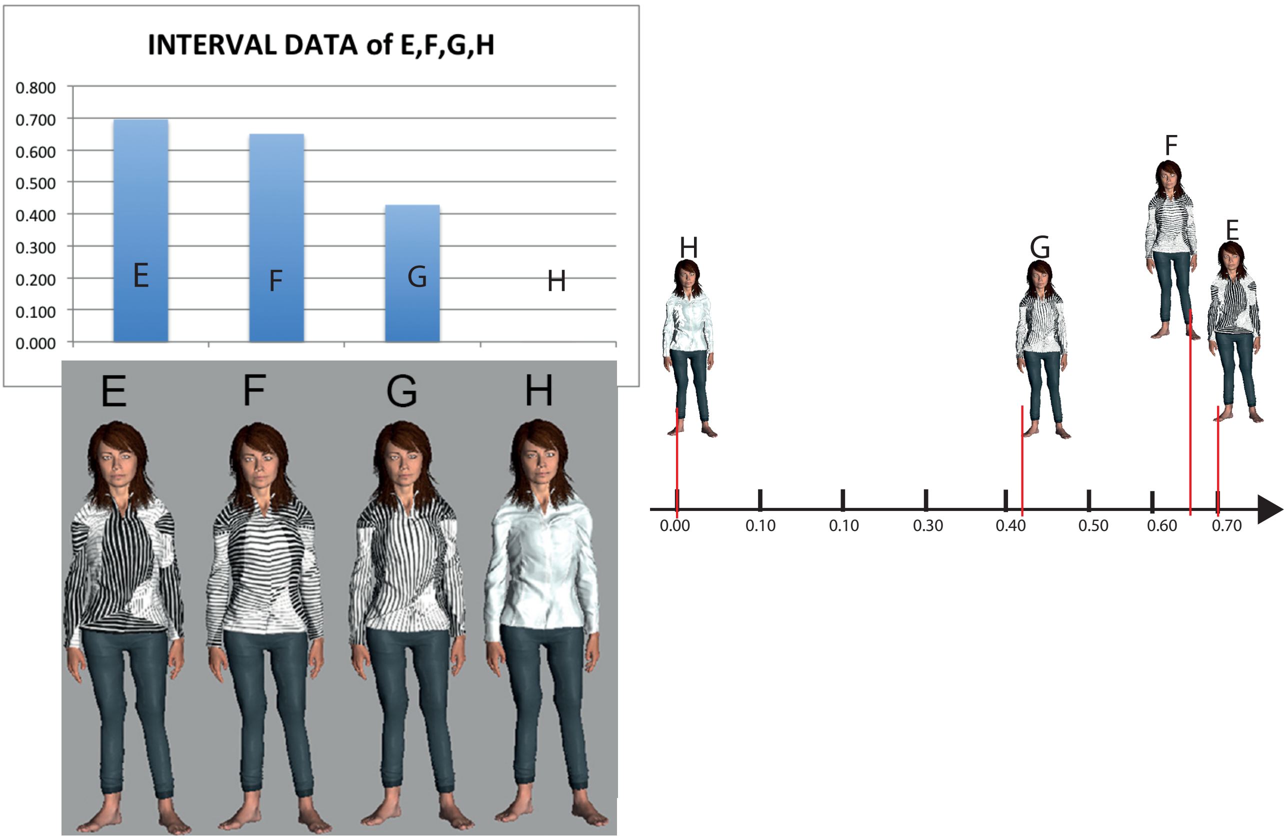


Figure 5.17 The scale bars, bar charts and stimuli used for short, thin and hourglass-shaped female models

The simulation of a female with a short, thin and hourglass-shaped body shows that stimulus E was perceived to be the widest among all stimuli, followed by stimuli F, G and H. The results for stimuli E and F were nearly identical. Notably, no participants chose stimulus H in the assessment.

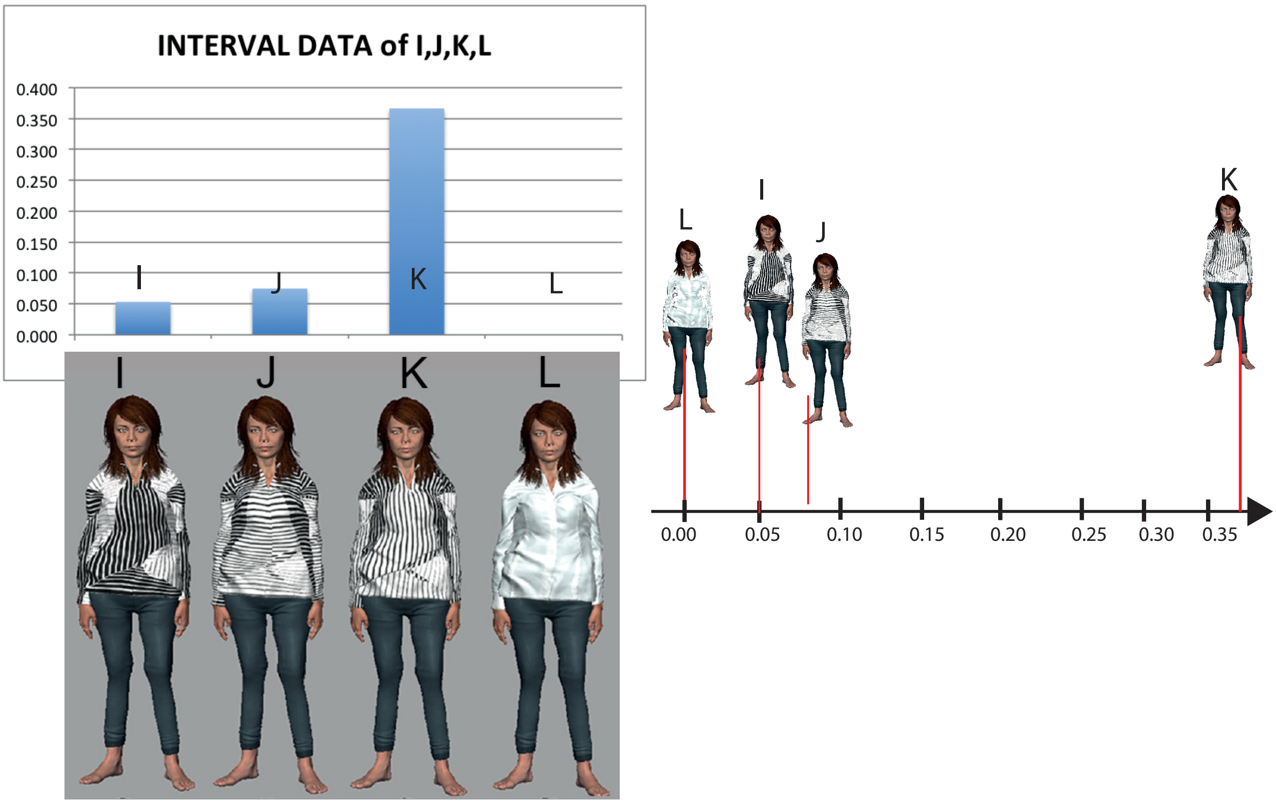


Figure 5.18 The scale bars, bar charts and stimuli used for short, wide and oval-shaped female models

The simulation of a female with a short, wide and oval-shaped body shows that stimulus K was perceived to be the widest among all stimuli, followed by stimuli J, I and L. Stimuli K shows the widest with the highest in value of the interval scale from the other stimuli for these trials.

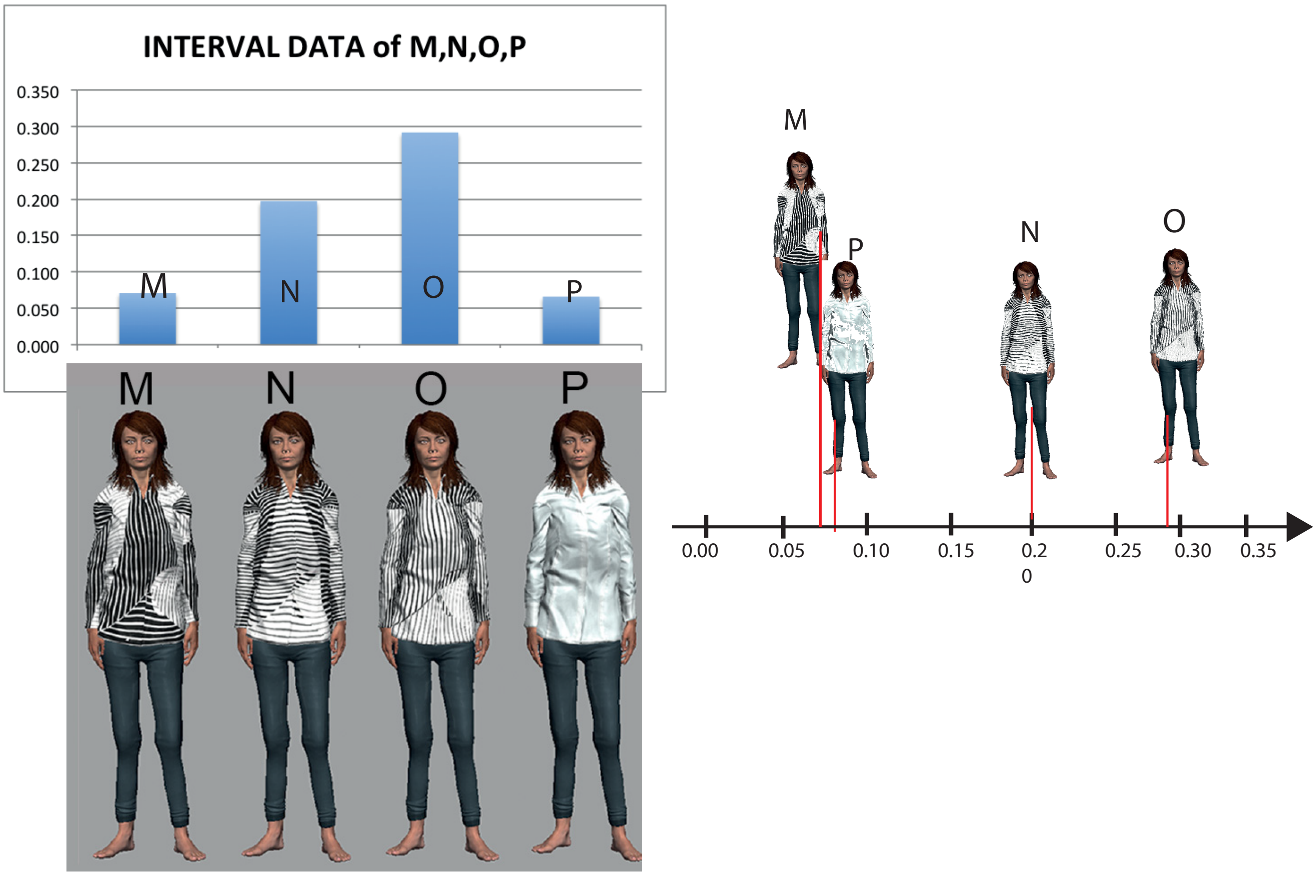


Figure 5.19 The scale bars, bar charts and stimuli used for tall, thin and rectangular-shaped female models

The simulation of a female with a tall, thin and a rectangular body shows that stimulus O was perceived to be the widest among all stimuli, followed by stimuli N, P and M.

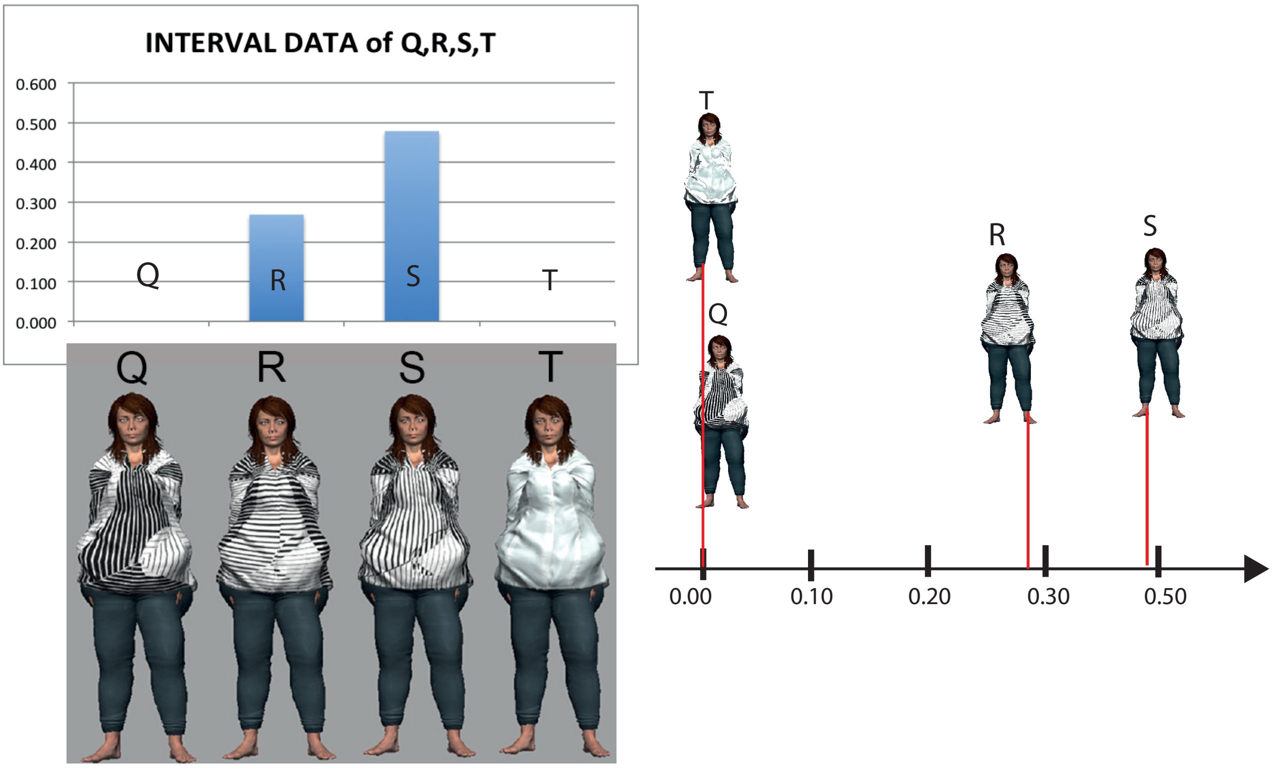


Figure 5.20 The scale bars, bar charts and stimuli used for tall, wide and triangular-shaped female models

The simulation of a female with a tall, wide and triangular body shows that stimulus S was perceived to be the widest among all stimuli, followed by stimuli R, Q and T.

5.4.2 Three-dimensional male models

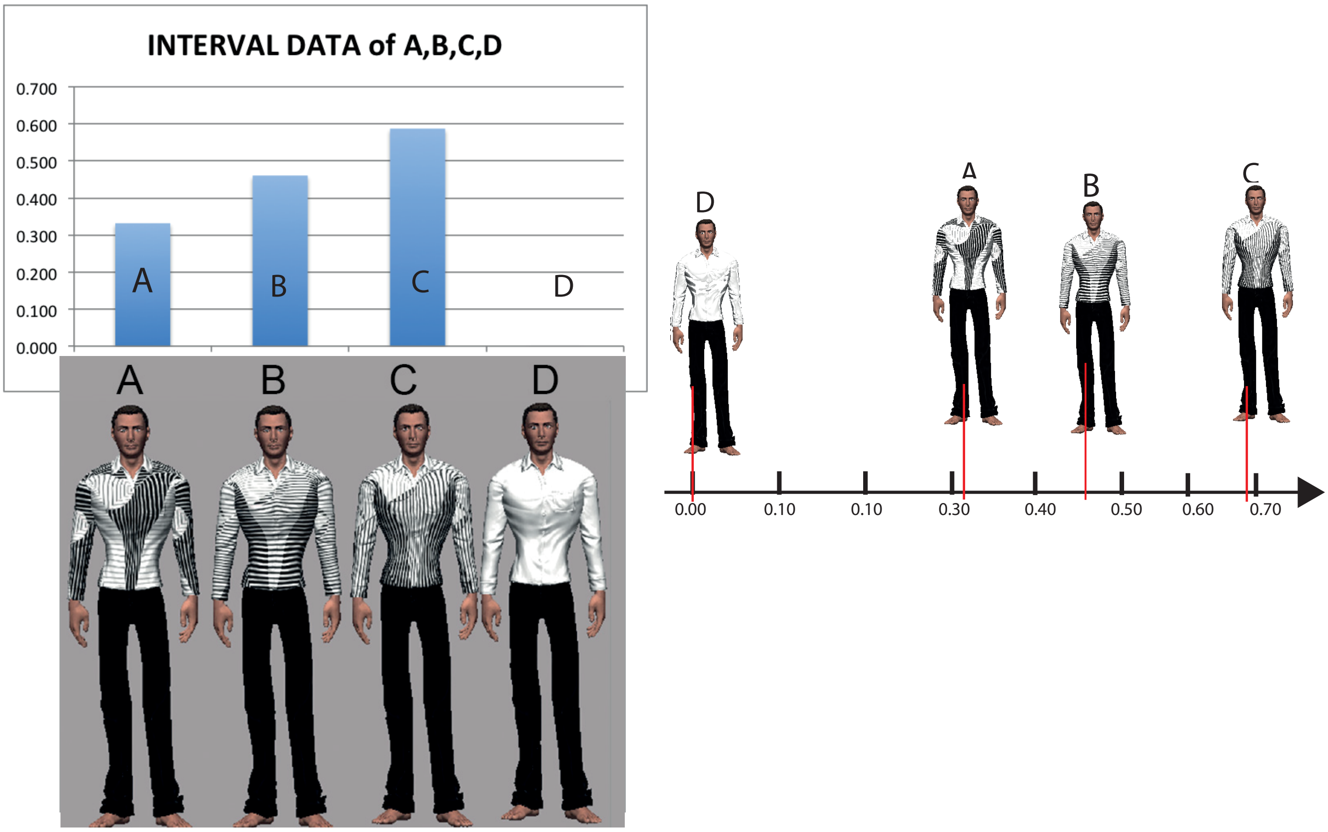


Figure 5.21 The scale bars, bar charts and stimuli used for tall, thin and an inverted triangle-shaped male models

The simulation of a male with a tall, thin and an inverted triangle-shaped body shows that stimulus C was perceived as the widest of all stimuli, followed by stimuli B, A and D.

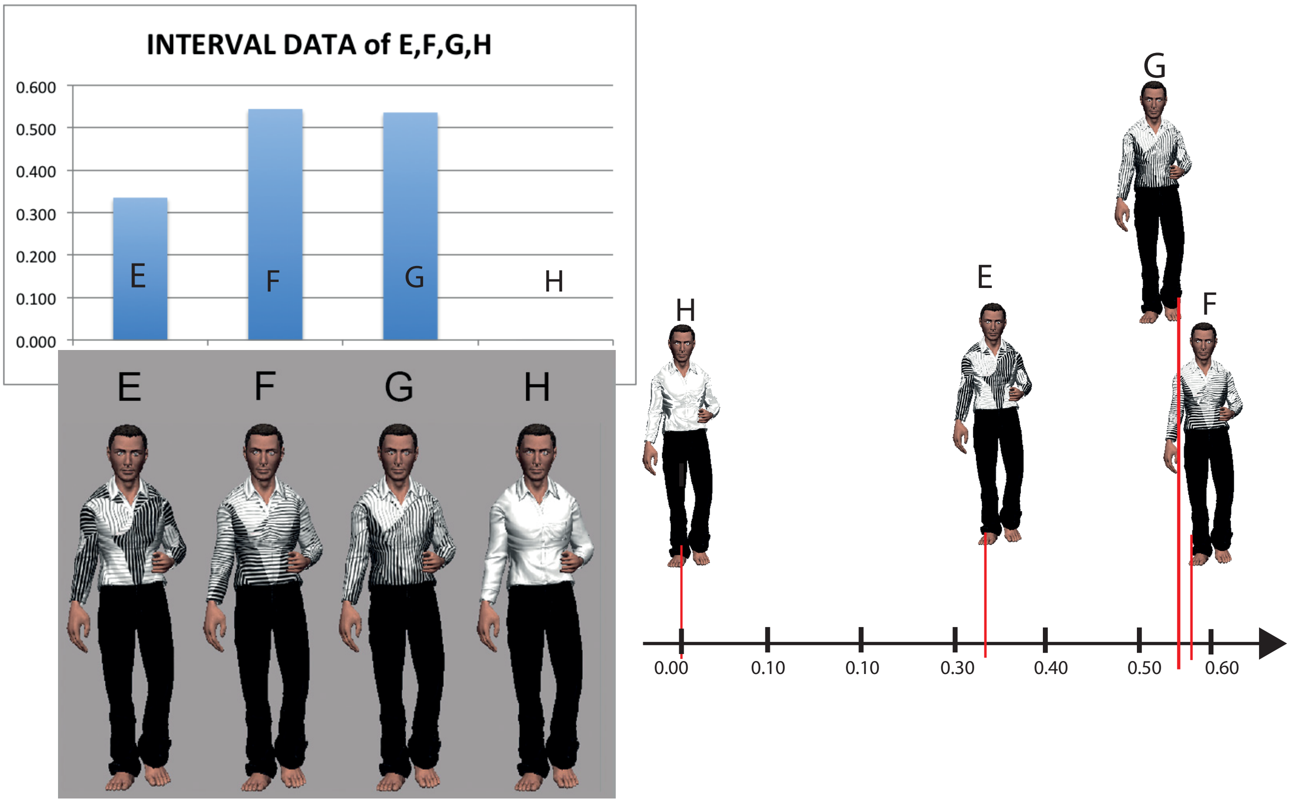


Figure 5.22 The scale bars, bar charts and stimuli used for short, thin and trapezoid-shaped male models

The simulation of a male with a short, thin and trapezoid-shaped body shows that stimulus F was perceived to be the widest among all stimuli, followed by stimuli G, E and H.

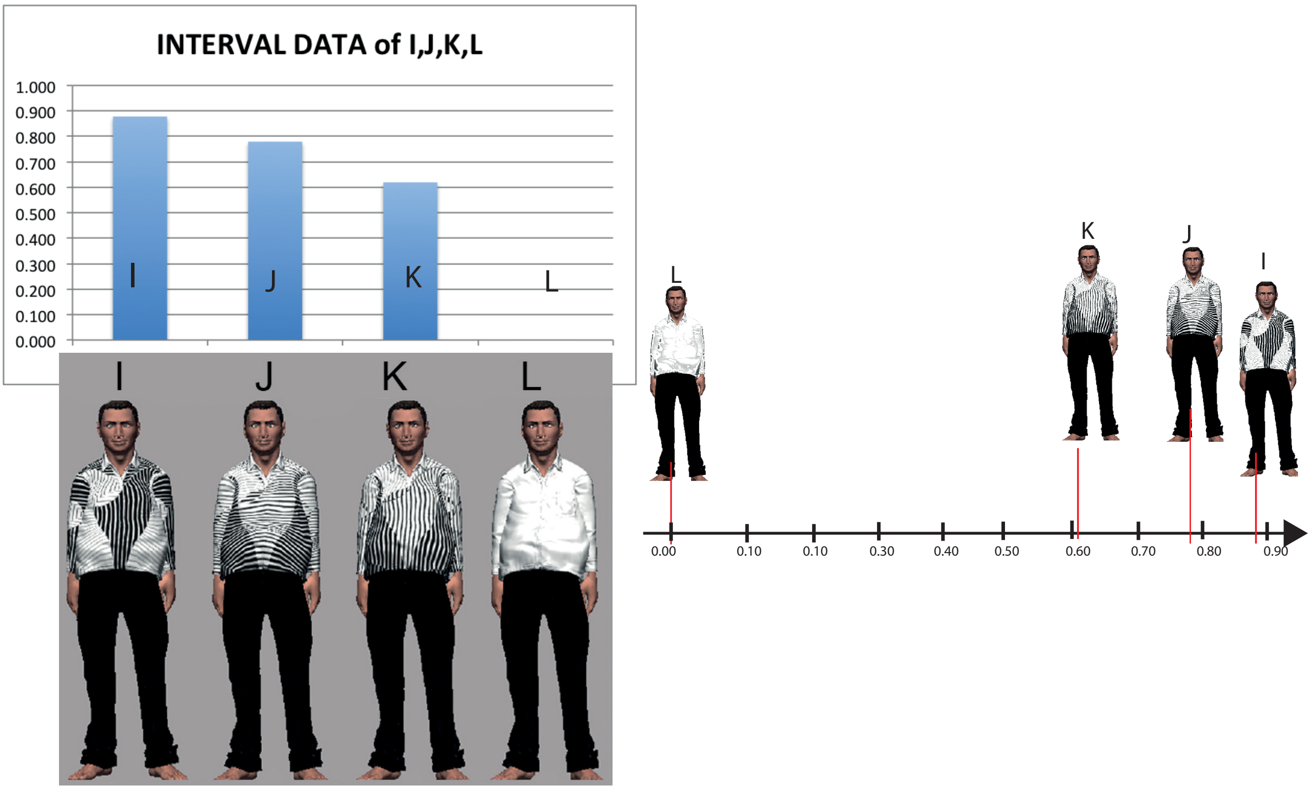


Figure 5.23 The scale bars, bar charts and stimuli used for short, wide and oval-shaped male models

The simulation of a male with a short, wide and oval-shaped body shows that stimulus I was perceived to be the widest among all stimuli, followed by stimuli J, K and L.

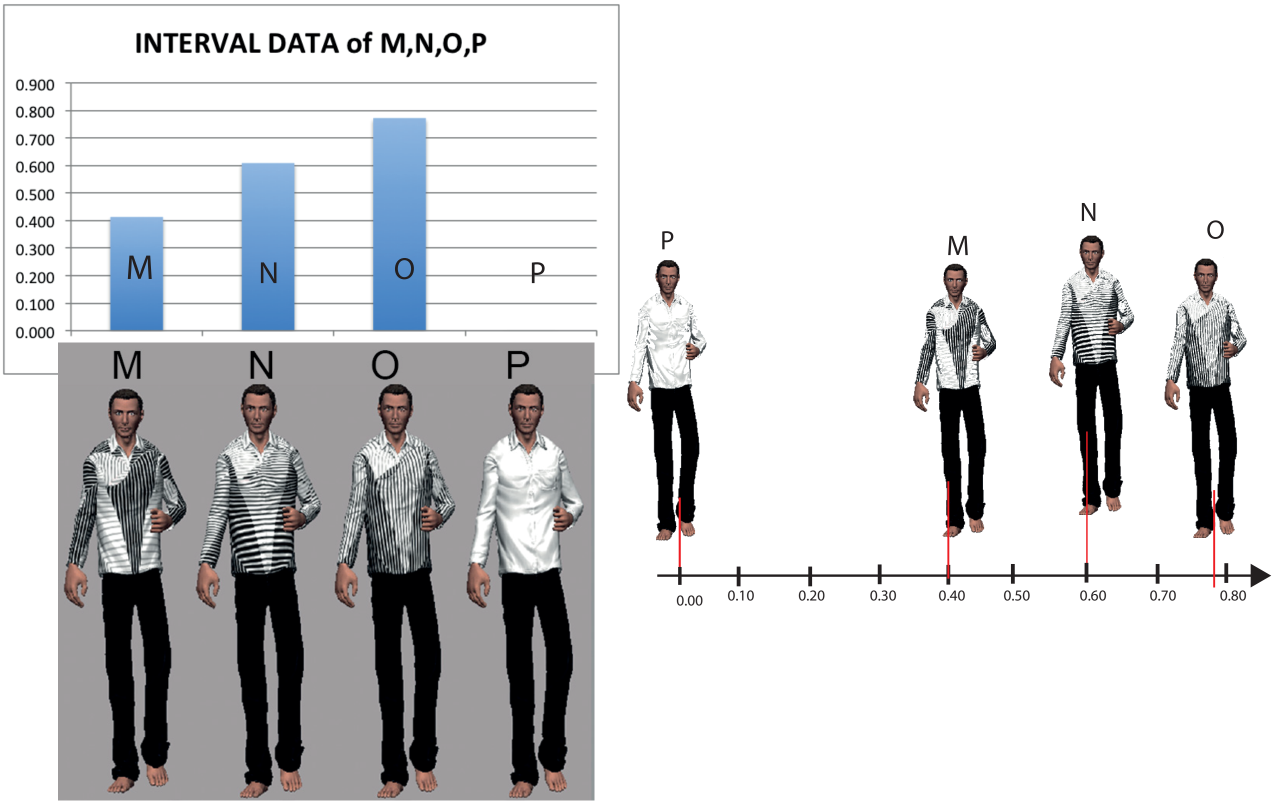


Figure 5.24 The scale bars, bar charts and stimuli used for tall, slim and rectangular-shaped male models

The simulation of a male with a tall, thin and rectangular-shaped body shows that stimulus O was perceived to be the widest among all stimuli, followed by stimuli N, M and P.

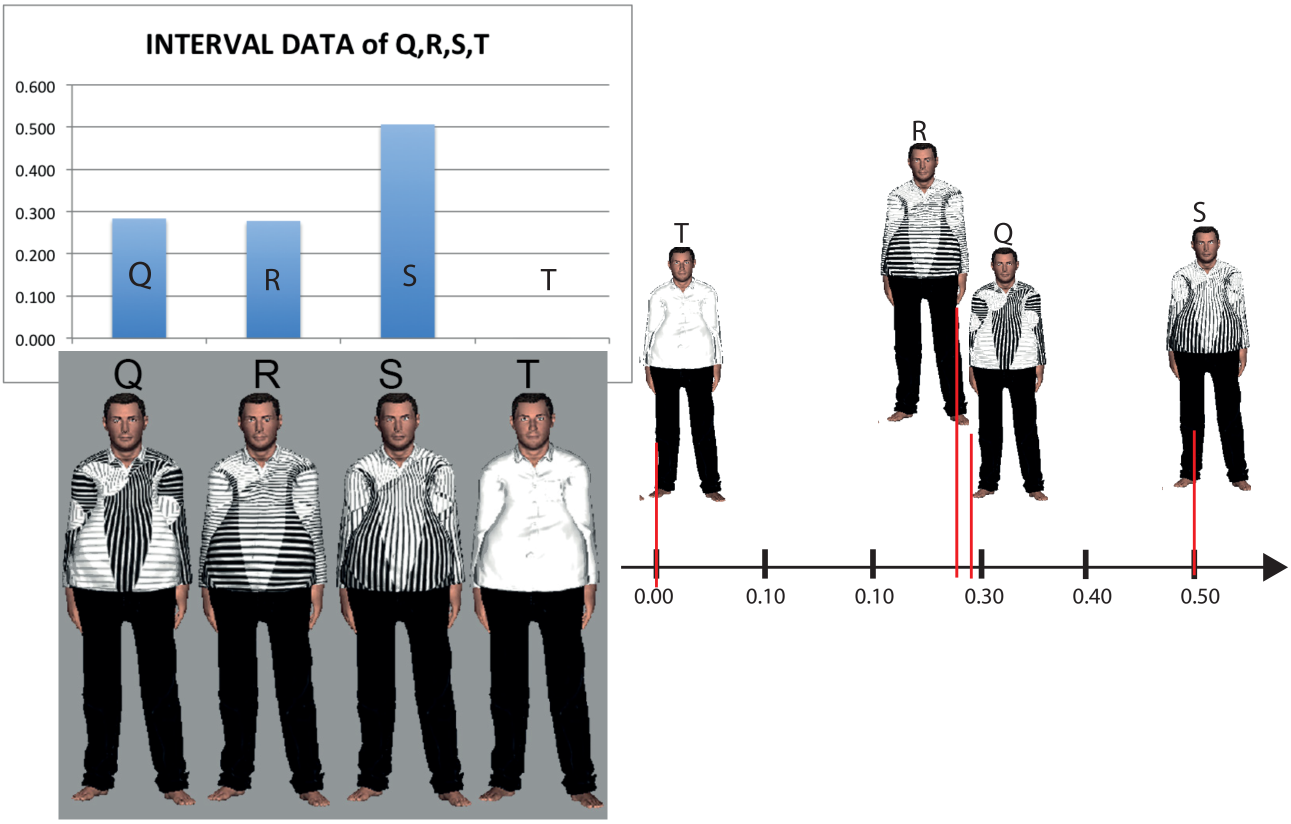


Figure 5.25 The scale bars, bar charts and stimuli used for tall, wide and triangular-shaped male models

The simulation of a male with a tall, wide and triangular body shows that stimulus S was perceived to be the widest among all stimuli, followed by stimuli R, T and S.

5.9 Overall results and the outcome of the manipulative textile design pattern

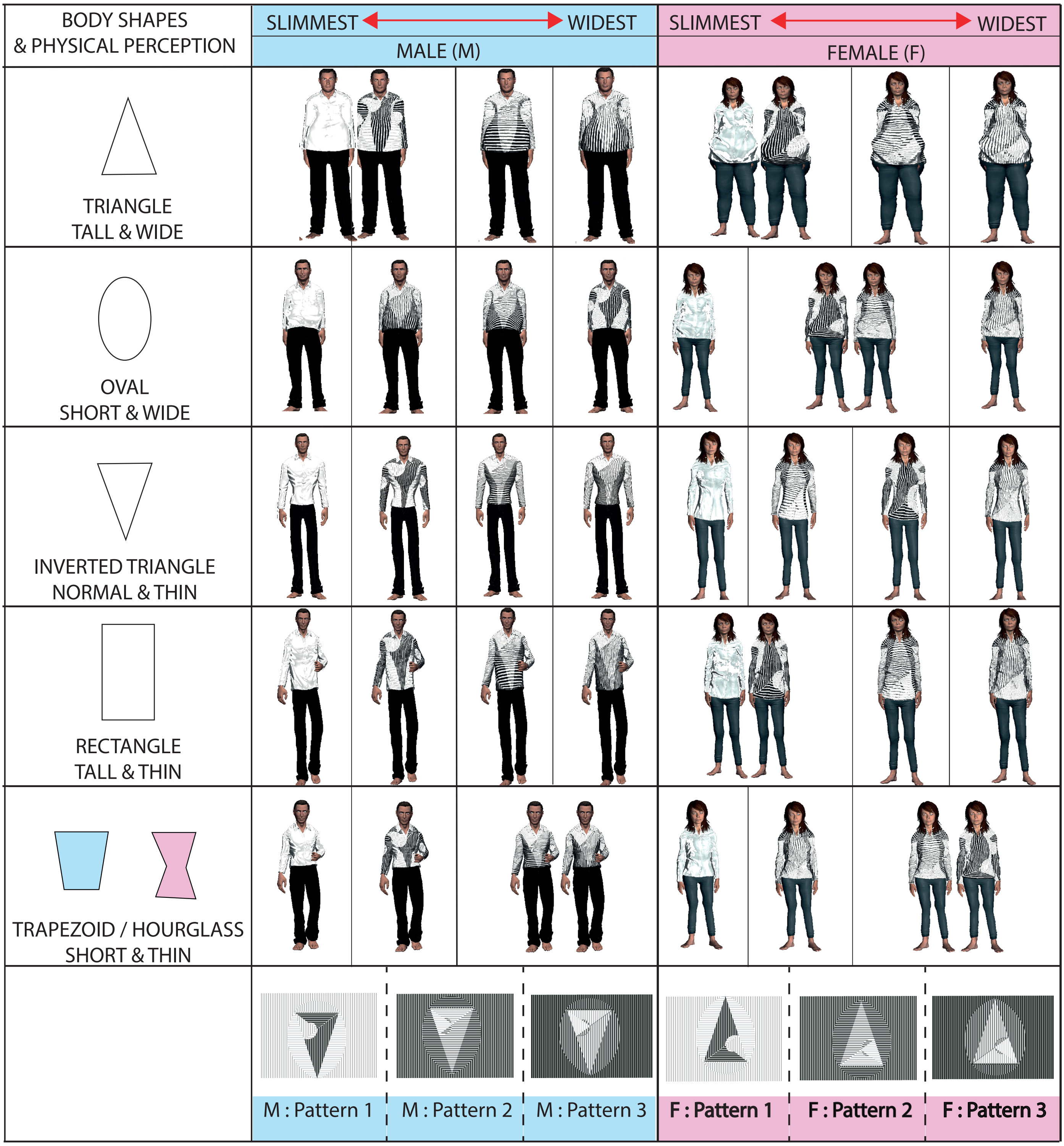


Figure 5.26 Overall results for Experiment 3

Figure 5.26 presents the results for Experiment 3. The experiments on 3D animated models conclude that patterns, regardless of their placement or line orientation, will make 3D models appear wider. This experiment shows that all of the stimuli with patternless shirts were perceived as the thinner than those with patterned shirts. Additionally, all of the models except for hourglass-shaped female and oval-shaped male models showed that Pattern 3 contributed most to making body shapes appear wider (see Figure 5.27).

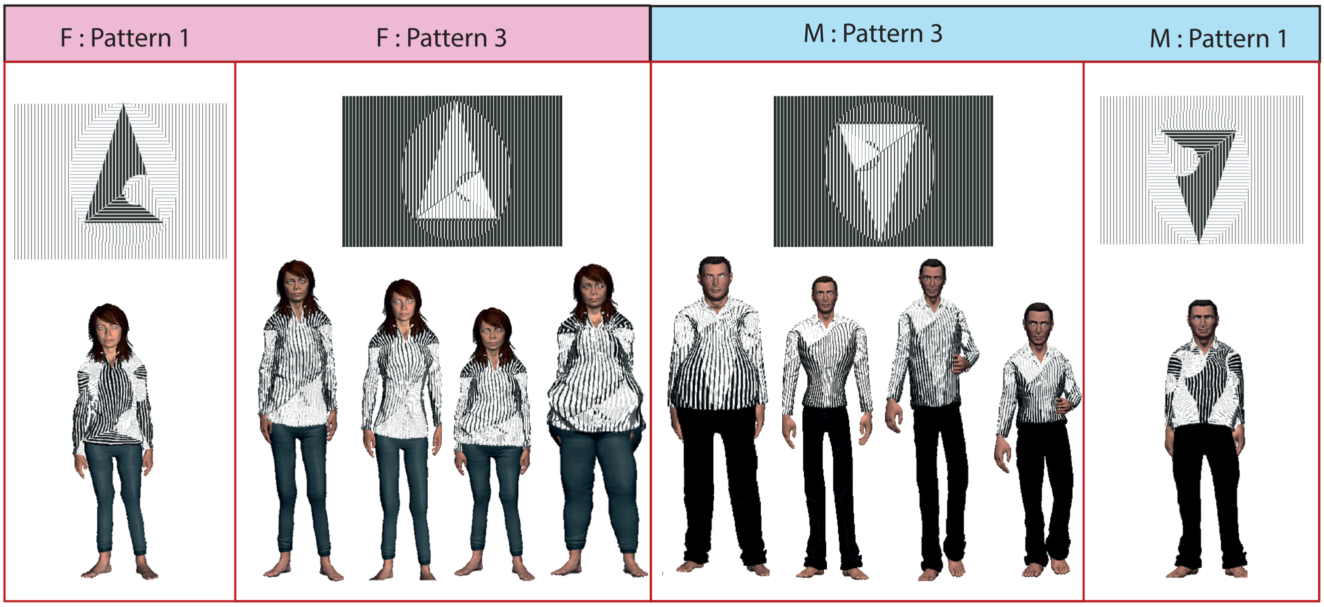


Figure 5.27 The pattern that contributed most to making the body shapes of 3D models appear wider (Experiment 3)

Chapter 6

Conclusion

Research summary

This research aims to investigate the validity of horizontal and vertical lines creating visual illusions in shapes and forms. Moreover, the present study aims to suggest (at least as a concept) useful textile surface pattern guidelines for body shape. This thesis contributes to the illusion theory of horizontal and vertical stripes and especially towards visual perceptions (from a psychological viewpoint) in the context of textiles and fashion. This work has primarily focused on the 2D and 3D applications of horizontal and vertical lines.

This thesis introduces the human visual perception of illusion by using horizontal and vertical lines and demonstrates how it can be scientifically assessed using psychophysical assessment. The study of illusions was reviewed to provide a wider perspective of visual perception and illusion development. This work is based on the conclusions of previous works indicating that horizontal or vertical lines influence optical illusions and width perception (e.g. Helmholtz, 1925; Thompson et al., 2011). Experimental evidence of horizontal or vertical lines causing changes in width perception further verified that patterns consisting of horizontal or vertical lines can also affect 3D width perception (Chen et al., 2013). However, no research on the effects of horizontal and vertical line combinations exists to shape the pattern. However, Spencer's (2014) findings on the construction of clothing patterns that assist in different body size appearances were later discovered, which resulted in the progression to 3D experiments.

The results related to horizontal and vertical lines provide an interesting perspective on the dominance of shapes in determining overall appearance when stimuli consisting of horizontal and vertical lines are applied. The four experiments in this study demonstrated that lines—especially horizontal and vertical lines—serve a significant role in aiding illusion. Horizontal and vertical lines can manipulate human perceptions regarding the width of a subject. The psychophysical experiments utilised to examine the threshold of the visual illusion of changes in horizontal or vertical lines indicated that horizontal or vertical lines affect illusion; however, the study also indicates that external shapes or forms of stimulus are the dominant factors driving the observed illusion type. The results suggest that the shape of an object determines how horizontal or vertical lines are perceived. This means that shapes or forms will illustrate different appearances when the same pattern is applied to them. Importantly, these findings apply to both 2D and 3D shapes and forms.

Furthermore, this research has implemented Spencer's (2014) theory of pattern manipulation processes. This theory states that body shape is an influential component that determines the suitability of fashion. Her theories segregate body shape into patterns to suit the shape of the body. Notably, her work applies only to the female body shape in the context of fashion and pattern adjustments. However, her theories were based on pattern construction and not on textile surface pattern adjustment. This research has used the basic concept of patterns manipulating how shapes are perceived and manipulated horizontal and vertical lines to form patterns. The manipulation of patterns was guided by the golden ratio, which was used to segregate the placement of lines to form patterns.

Based on findings related to the shape of the human body, further research was conducted using 3D male and female characters. While the initial plan was to experiment on real humans, ethical considerations and the challenge of finding the right body shapes for experimentation made it difficult to achieve this goal in the limited time available for PhD research. As a result, this research was limited to 3D models of humans. Furthermore, investigating the possibility of illusion by using patterns consisting of horizontal and vertical lines as a textile surface pattern continues to apply to this research. Experiment 3 used Spencer's theory (2014) by segregating body shapes and testing three textile surface patterns using combinations of horizontal and vertical lines.

The experimental results validated the insufficiency of merely considering pattern attributes when planning patterns for body shapes. Instead, one must consider the interaction between patterns and the shapes they are applied on. Notably, this study confirmed that the shape of objects is the dominant factor in determining width perception. Therefore, it should be the primary consideration in suggesting patterns for body shape enhancement. Pattern placement plays a critical role in facilitating visual illusions using horizontal or vertical lines. Forms without a pattern were perceived to be the slimmest on all of the models. This means that those with wide shapes should wear plain, patternless clothing to make the body appear slimmer. It can also be concluded that textile surface patterns promote a wider appearance. Thus, thin people are advised to wear shirts with textile surface patterns to help create a wider appearance. This finding was proven by experiments conducted using patterns with a combination of horizontal and vertical lines (Experiments 2 and 3). Thus, patterns—irrespective of their placement—help shapes appear wider.

Throughout this work, I aimed to perform high-quality research and provide useful suggestions for textile surface patterns—especially in batik—to achieve thinner or wider appearances. Research on fashion and visual illusion has made remarkable progress over the past decade. Within this context, the present research may serve as a foundation and inspiration for future work in textile design, perception research and its applications.

6.2 Research contributions

This research contributes to the fields of textile and fashion design practice, especially for the batik industry. Using this research, designers or practitioners can propose specific designs for specific body shapes. This is because the dominant factor in how a pattern is perceived is based on body shape characteristics.

6.2.1 Manipulative textile pattern guidelines

This research has produced guidelines to facilitate visual illusion via pattern adjustments. These guidelines are proposed to help textile and fashion designers, especially those in the batik industry. Using the manipulative textile pattern guidelines (MTPGs), designers can create patterns that will allow wearers to be seen at their best.

The process of using the MTPGs is visualised in Figure 6.5. The bottom of the MTPGs contains a symbolic colour and explanation of the steps to follow. The first step involves determining the person's body shape. For this demonstration, the researcher will use a wide female model (Figure 6.1). The body shape of this female model is consistent with the triangular category (see Figure 6.2).

Figure 6.1 A sample model for demonstrating the MTPGs

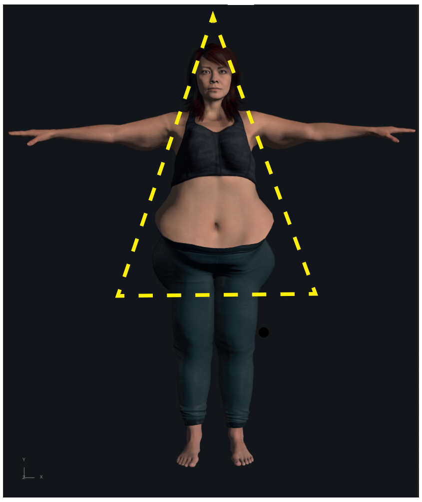
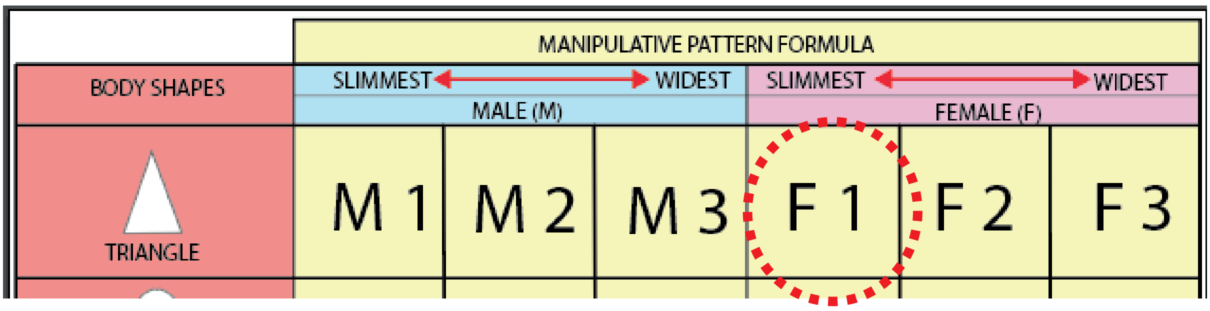


Figure 6.2 A sample model with a body shape judgement

The second step in using the MTPGs involves referring to the manipulative pattern formula. Since the sample model is wide, a suitable manipulative pattern formula would involve patterns that create the slimmest appearance. The MTPGs should first consider the gender of the target. For this example, since the gender is female, the right side of the MTPGs (coloured in pink) should be used, followed by the manipulative pattern formula. In this example, the manipulative pattern formula is under F1 (see Figure 6.3). F1 is a short form of Female 1, where F stands for female and 1 is the identification number for the proposed manipulative pattern (formula) arrangement.



	MANIPULATIVE PATTERN FORMULA					
BODY SHAPES	SLIMMEST ↔ WIDEST			SLIMMEST ↔ WIDEST		
	MALE (M)			FEMALE (F)		
TRIANGLE	M 1	M 2	M 3	F 1	F 2	F 3

Figure 6.3 An example of a model with a specific body shape judgement

The third step in using the MTPGs involves looking at the green section to determine which manipulative arrangement to use. Step two indicates that F1 is the slimmest look for the model. According to the manipulative pattern arrangement section, the formula for F1 is shown in Figure 6.4.

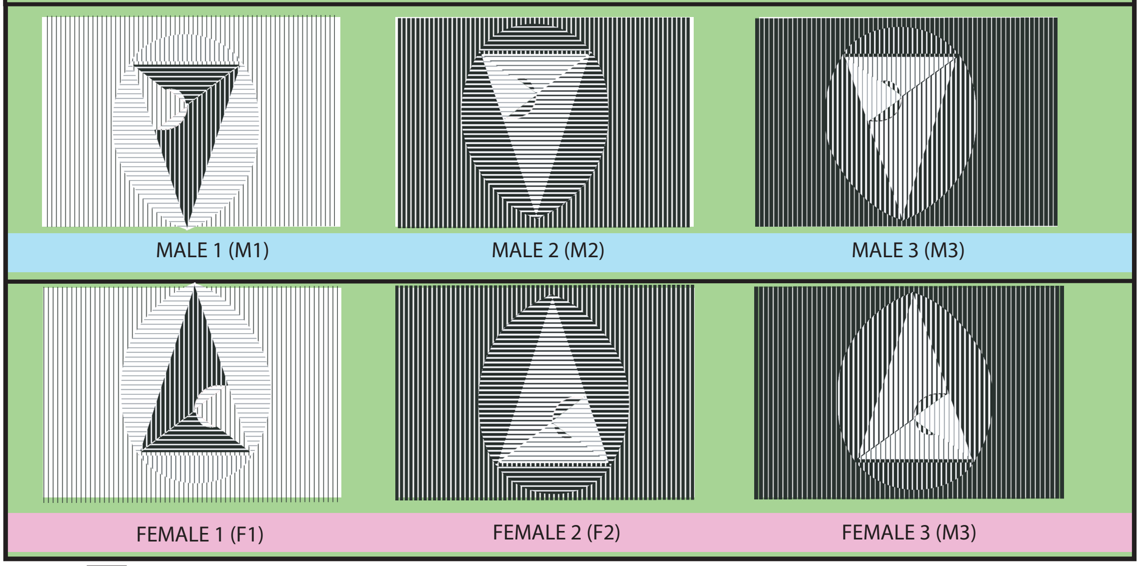
Figure 6.4 An example of a manipulative pattern arrangement for F1

After the three steps are completed, the manipulative textile pattern arrangement can then be applied to the model's shirt (see Figure 6.5).

Figure 6.5 An example of applying the MTPGs on a model

BODY SHAPES	MANIPULATIVE PATTERN FORMULA					
	SLIMMEST ↔ WIDEST			SLIMMEST ↔ WIDEST		
	MALE (M)			FEMALE (F)		
TRIANGLE	M 1	M 2	M 3	F 1	F 2	F 3
AN OVAL	M 3	M 2	M 1	F 1	F 2	F 3
AN INVERTED TRIANGLE	M 1	M 2	M 3	F 2	F 1	F 3
A RECTANGLE	M 1	M 2	M 3	F 1	F 2	F 3
A TRAPEZOID / AN HOUR GLASS	M 1	M 2	M 3	F 3	F 2	F 1

MANIPULATIVE PATTERN ARRANGEMENT



1ST STEP : BODY SHAPES

2ND STEP : MANIPULATIVE PATTERN FORMULA

3RD STEP : MANIPULATIVE PATTERN ARRANGEMENT

Figure 6.6 Manipulative Textile Pattern Guidelines

6.3 Recommendations for future research

Future research could focus on testing the patterns created in Experiment 3 on an actual human. It would be interesting to observe the outcomes of the MTPGs on actual human proportions to determine whether it would provide the same width perception as the 3D animated models. Also, future research could involve the acquisition of more data from additional participants to increase the power of the results. Furthermore, the same experiment could be conducted in a different part of the world to observe whether culture plays a role in determining pattern adjustments. Since this research only covers the Malaysian context, a wider scope of study could guide the direction of the proposed patterns toward the textile and fashion industries. If the findings of such future studies are congruent with the present research, the possibility of the proposed patterns being distributed beyond the Malaysian batik industry is likely higher. Additionally, it would be interesting to experiment using motifs constructed in the form of horizontal or vertical lines to determine whether the effect remains the same as with plain lines. The researcher suggests that motifs be constructed using the golden triangle as a mediator for pattern adjustments.

6.3.1 Using the manipulative textile pattern guidelines in a batik design competition

In 2019, the researcher entered an international batik competition named the Piala Seri Endon, which was part of the Malaysian fashion week programme. The researcher's entry became a top-12 finalist and a fashion show was held to showcase the collection in Kuala Lumpur, Malaysia. The researcher believes that the MTPGs represent a very useful tool for pattern manipulation. Images of the fashion collection used for the competition are attached in the Appendix. While the items created for the competition included floral motifs applied using the MTPGs calculations, the foundation of the design remained focused on horizontal and vertical lines as its foundation. The competition has proven that the MTPGs represent a functional and practical tool for body enhancement.

6.4 Confirmation of the thesis

To validate this thesis, it is necessary to:

- Investigate human visual perception regarding horizontal and vertical lines on 2D and 3D shapes.
- Investigate moving models with horizontal and vertical stimuli
- Create patterns that merge horizontal and vertical stripes to form patterns and study on their illusional effect.

As discussed in the research summary, the aforementioned goals have been accomplished. Thus, it is possible to conclude that the original thesis is well supported. Therefore, the contributions of this thesis can be concluded as follows:

- Psychophysical evidence supported by the results of a corresponding width quality assessment to demonstrate the effect of horizontal and vertical lines on 2D and 3D objects.
- Conclusions based on statistical data to claim the appearance of pattern adjustment on body shape.
- Textile surface patterns to help subjects appear wider.
- Evidence that the form of simulation determines the visual illusion of patterns.
- Confirmation of functional manipulative textile pattern guidelines.

REFERENCES

Ağaç, S. & Sakarya, M. Optical Illusions and Effects on Clothing Design. *International Journal of Science Culture and Sport (IntJSCS),* 2015, **3**(2), pp137-157.

Ahmad, M. F., Hassan, Z., & Romli, Z. 2014. Furniture design identity: Implementation of national identity into office chair design. In: *International Colloquium of Art and Design Education Research*, Singapore, i-CADER 2014. Singapore: Springer.

Akhir N.H.M., Ismail N.W., Said R., Kaliappan S.R.A. 2015. *Traditional Craftsmanship: The Origin, Culture, and Challenges of Batik Industry in Malaysia*. In: Omar R., Bahrom H., de Mello G. (eds). Islamic perspectives relating to business, arts, culture and communication. Singapore: Springer.

Anjana, & Nagar, V. 2010. A comparative study of traditional and modern batik. *Asian Journal of Home Science.* **4**(2), pp.390-391.

Antonio. 2011. *Dressing Taller: 10 Tips for Short Men* [Accessed 10 August 2017] Available from: https://www.artofmanliness.com/articles/dressing-taller-short-men/

Archer, L. B. 1965. [N. Cross edition]. *Systematic method for designers*. Chichester,London: John Wiley and Sons.

Ashida, H., Kuraguchi, K., & Miyoshi, K. 2013. Helmholtz Illusion Makes you Look Fit Only When you are Already Fit, But not for Everyone. *i-Perception.* **4**(5), pp.347-351.

Avery, G.C., & Day, R.H. 1969. Basis of the horizontal vertical illusion. *Journal of Experimental Psychology.* **81**(2), pp.376-380.

Aziz A. 2006. *Rupa dan Gaya: Busana Melayu*. Bangi: Penerbitan Universiti Kebangsaan Malaysia.

Bagozzi, R.P. 1977. Convergent and discriminant validity by analysis of covariance structures: the case of the affective, behavioural, and cognitive components of attitude, *Advances in Consumer Research*. **4**, pp. 11-18.

Bagozzi, R.P. 1981. Evaluating structural equation models with unobservable variables and measurement error: a comment, Journal *of Marketing Research (JMR).* **18**, pp.375-81.

Bayav, D. 2008. Işığın Bağımsızlık Yolculuğu ve Empresyonizmde Işık. e-dergi.atauni.edu.tr/ataunigsfd/article.

Becker, A.E. 1995 . *Body, self and society: The view from Fiji*. University of Pennsylvania Press, Philadelphia : University of Pennsylvania Press.

Behrens, R. 1988. The Theories of Abbott H . Thayer : Father of Camouflage. *The MIT Press.* **21**(3), pp.291-296.

Boone, L., Vansteenkiste, M., Kaap-Deeder V. D., Soenens, B., & Verstuyf, J. . 2014. Self-critical perfectionism and binge eating symptoms: A longitudinal test of the intervening role of psychological need frustration. *Journal of Counselling Psychology.* **61**(3), pp.363–373.

Boring, E.G. 1942. *Sensation and perception in the history of experimental psychology.* New York: Appleton Century Crofts.

Brewis and McGarvey, 2000. A.A. Brewis, S.T. McGarvey. Body image, body size and Samoan ecological and individual modernization. *Ecology of Food and Nutrition*. **39**(2), pp.105-120.

Brown, P., & Konner, M.J. 1987. An anthropological perspective of obesity. *Annals of the New York Academy of Science*. **499**(1), pp.29-46.

Bulatov, A., Bertulis, A., & Mickiene, L. 1997. Geometrical illusions: study and modelling. *Bio. Cybern.***77**(6), pp.395-406.

Çağlayan S, Korkmaz, M., Öktem, Ö., Sanatta, Görsel. 2014. Algının Literatür Açısından Değerlendirilmesi. *Eğitimve Öğretim Araştırmaları Dergisi*, Şubat. **3**(1), pp.160-173.

Carlisle, H. (2002) Towards a New Design Strategy: A visual and cultural analysis of small-scale pattern on clothing, Ph.D thesis, Nottingham Trent University.

Charras, P., & Lupiáñez, J. 2009. Length perception of horizontal and vertical bisected lines. *Psychological Research Psychologische Forschung*. **74**(2), pp.196–206.

Chen, T.Y., & Peng, L.H. 2013. Zebra Effect in Fashion Design: Challenging Consumer Stereotype on Striped Clothing. *Fifth International Conference on Service Science and Innovation*. **13,** pp.100–107.

Choudhary, A. 2015. *A Study Of The Paisley Motif And Development Of A Template For The Motif.* Master's thesis, National Institute Of Fashion Technology Mumbai.

Clarke, W. 1887. *The Phenological miscellany*. New York : Fowler and Wells Pub.

Coren, S., and Girgus, J. S. 1978. *Seeing is deceiving: The psychology of visual illusions*. Hillsdale, N.J: Lawrence Erlbaum Associates.

Cormack, E.O. and Cormack, R.H. 1974. Stimulus configuration and line orientation in the horizontal-vertical illusion. *Perception & Psychophysics*. **16**, 208–212.

Cott, H, B. 1940. *Adaptive Colouration in Animals:* London, Metheun & Co.

Cross, N. 1990. The nature and nurture of design ability. *Design Issues*. **11**(3), pp.127–140.

C. Q. Howe and D. Purves. 2005. The Müller-Lyer illusion explained by the statistics of image–source relationships. *Center for Cognitive Neuroscience, Duke University*. **102**(4), pp.1234-1239.

Dawa N. Catan Batik Najib Dawa, *Jurnal Seni dan Pendidikan Seni*, 2014, **2**, pp62-68.

Delboeuf F.J. 1865. J*oseph Delboeuf on visual illusions: A historical sketch. The American Journal of Psychology.* **108**(4), pp.563-574

Djelic, Marie-Laure, and Antti Ainamo. 1999. The coevolution of new organizational forms in the fashion industry: A historical and comparative study of France, Italy, and the United States. *Organization Science*. **10**(5), pp.622-637.

Doyle, S.A., C.M. Moore, and L. Morgan. 2006. Supplier management in fast moving fashion retailing. *Journal of Fashion Marketing and Management*. **10**(3), pp.81-272.

D. Long and R. Marilyn. 1987. *The Way We Look,* Ames, IA: Iowa State University Press.

Eagleman, D. M. 2001. Visual illusions and neurobiology. *Nature Rev. Neurosci*. **2**, pp.920–926.

Ebbinghaus, H. 1908 Grundzüge der Psychologie. Vol.II, Part 1. Leipzig: Veit.

Ebbinghaus, H. 1930. Herman Ebbinghaus. *The American Journal of Psychology*. **42**(4), pp.505-518.

Eckman. M and Wagner. J. 1994. Judging the Attractiveness of Product Design: The Effect of Visual Attributes and Consumer Characteristics, The Association for *Consumer Research*. **21**, pp.560-564.

Engeldrum, G. 2000. *Psychometric scaling : A Toolkit For Imaging System Development*. Massachusetts USA : Imcotek Pr; F First Edition Used edition.

Eryayar E. 2011. Gestalt Theory Application in Industrial Design, Zeitschriftfürdie Welt der Türken Journal of World of Turks ZfWT. **3**, pp.2.

E. Molly and W. Janet. 1994. Judging the Attractiveness of Product Design: the Effect of Visual Attributes and Consumer Characteristics, in *NA - Advances in*

Consumer Research. 21, eds. Chris T. Allen and Deborah Roedder John, Provo, UT: Association for Consumer Research. pp.560-564.

Fechner G.T. 1966. *Elemente der Psychophysik, Holt (Rinehart & Winston). (transl.),* New York : Howes D.H., Boring E.C., Adler H.E. (Eds.),

Feldon, L. 2000. *Does This Make Me Look Fat*? New York : Villard.

Fermüller, C., & Malm, H. 2004. Uncertainty in visual processes predicts geometrical optical illusions. *Vision Research*. **44**, pp.727-749.

Finger, F. W., & Spelt, D. K. 1974. The illustration of the horizontal–vertical illusion. *Journal of Experimental Psychology*. **37**, pp.243–250.

Ford, C. S., and Beach, F. A. 1952. *Patterns of sexual behavior*. New York, NY: Harper.

Franks, J. 2000 . Supply chain innovation. *Work Study*. **49**(4), pp152–156.

Fraser, A. 2005. From the Critique of Institutions to an Institution of Critique. *ArtFORUM*. **44**(1), pp278-286.

Fraser, J. 1908. A new visual illusion of direction. *British Journal of Psychology*. **2**, pp.307-320.

Furnham, A., Hester, C. & Weir, C. 1996. Sex differences in the preference for specific body shapes. *Sex Roles*. **22**(4), pp.539-549.

.

Gale, C., and Kaur, J. 2004. *Fashion and Textiles: An Overview*. Oxford, UK: New York Berg Publisher.

Ghannam, F. 1997. Fertile, plump, and strong: The social construction of female body in low income Cairo. Giza, Egypt : The Population Council.

Gibson, G. 1992. Do tsetse flies 'see' zebras? A field study of the visual response of tsetse to striped targets. *Physiological Entomology*. **17**(2), pp.141-147.

Godfrey, D. Lythgoe, J. N. & Rumball, D.A. 2008. Zebra stripes and tiger stripes: the spatial frequency distribution of the pattern compared to that of the background is significant in display and crypsis. *Biological Journal of the Linnean Society*. **32**(4), 427–433.

Gombrich, E. H. 1960. *Art and Illusion: A Study in Psychology of Pictorial Representation.* London: Phaidon.

Gombrich, E. H. 1979. *The Sense of Order: A Study in the Psychology of Decorative Art*. London: Phaidon.

Gori, M., Sciutti, A., Burr, D., and Sandini, G. 2011. Direct and indirect haptic calibration of visual size judgments. *PLoS ONE*. **6**(10), pp.1-5.

Gregory R L. 1973. *The confounded eye. Illusion in Nature and Art.* London: Duckworth.

Gregory. R. L., Heard P. 1979. Border locking and the Café Wall Illusion, *Perception.* **8**(4), pp.365-380

Gregory, R. L. 1997. Knowledge in perception and illusion. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*. **352**(1358), 1121–1127.

Hann, M.A. 1991. *Classification and analysis of regular geometric patterns with particular reference to textiles*, PhD Thesis, University of Leeds.

Hann, M.A. 1992. *Symmetry in Regular Repeating Patterns. Case Studies from Various Cultural Settings*. Journal of the Textile Institute. **83**(4), pp.579-590.

Harris, J. 2000. *Surface Tension. The Aesthetic Fabrication of Digital Textiles*, Ph.D thesis, Royal College of Art.

Haron, H. Yusof, N. A., Taha, M., & Mutalib, N. A. (2014). Motifs of nature in malay traditional craft. *Middle-East Journal of Scientific Research*. **21**(1), pp.169-180.

Hampshire, M.,Stepehenson, K. 2006. *Communicating with Pattern Stripes*. Western Road UK : RotoVision.

Hering E. 1861. *Beitrage zur physiologie Englemann*, Leipzig: Heft 1.

Hewig J, Trippe RH, Hecht H, Straube T, Miltner WHR. 2008. Gender differences for specific body regions when looking at men and women. *J Nonverbal Behav*. **36**, pp.67–78.

H Helmholtz, H. 1867. *Manual of physiological optics (vol. 3) [Handbook of physiological optics]*. Leipzig, Germany: Barth.

How,M. J. and Zanker, J. M. 2014. Motion camouflage induced by zebra stripes. *Zoology*. **117**(3). pp.163-170.

Howe, C. Q., & Purves, D. 2005. The Müller-Lyer illusion explained by the statistics of image-source relationships. *Proceedings of the National Academy of Sciences of the United States of America*. **102**(4), 1234–1239.

Hewig, J., Trippe, R. H., Hecht, H., Straube, T., & Miltner, W. R. 2008. Gender differences for specific body regions when looking at men and women. *Journal of Nonverbal Behavior.* **32**(2), pp.67–78.

H. Dreyfuss. 1998. *Measure of Man and Woman: Human Factors in Design*. Wiley: Revised edition.

Imai, S. 1982. The mystery of the appearance of horizontally and vertically striped clothes. *Psychology*. **29**, pp.12.

İnceoğlu M. 2010. Attitude Perception Communication. Istanbul: Beykent University Press. **6**(5), pp.69

Ismail, S. Z. 1986. *Rekabentuk kraftangan melayu tradisi*. Kuala Lumpur: Dewan Bahasa Dan Pustaka.

Jasienska, G., Ziomkiewicz, A., Ellison, P. T., Lipson, S. F. & Thune, I. 2004. Large breasts and narrow waists indicate high reproductive potential in women. *Proceedings of the Royal Society B: Biological Sciences*. **271**(1545), pp.1213–1217.

Jinjingxingwu. 1988. *Visual Illusion*. Taipei City: Yuanliu Press.

Jones, C.J. 1992. *Design Methods*. New York: John Wiley & Sons.

Justema, W. 1976, *Pattern. A Historical Panorama*, Boston: New York Graphics Society.

Karaçalı B. 2008. *1960 Post-Art Effects in European Women's Clothing*, (Unpublished Master's Thesis) Marmara University, Institute of Fine Arts, Istanbul.

Kingsley, J., Phillips, R., Townsend, M. & Henderson-Wilson, C. 2010. Using a qualitative approach to research to build trust between a non-Aboriginal researcher and Aboriginal participants. *Qualitative Research Journal*. **10**, pp.2–12.

Künnapas, T. M. 1955. An analysis of the ‘vertical-horizontal illusion’. *Vision Research*. **49** (2), pp.134-160.

Künnapas, T. M. 1955. Influence of frame size on apparent length of a line. *Journal of Experimental Psychology*. **50**(3), pp.168–170.

Künnapas, T. M. 1957. Vertical horizontal illusion and surrounding field. *Acta Psychologica*. ***4***(13), pp.35–42.

Kundt, A. 1863. Annals of physics and chemistry. Investigations on eye-sight and optical exchanges. *Poggendorff Annalen*. **120**, pp.118-158.

Liu, J.V., Ashida, H., Smith, A.T., & Wandell, B.A. 2006. Assessment of stimulus-induced changes in human V1 visual field maps. *Journal of Neurophysiology*. **96**(6), pp.3398- 3408.

Livio, M. 2003. *The Golden Ratio: The Story of Phi, the World's Most Astonishing Number*. Broadway Books.

Long, G. M. & Murtagh, M.P. 1984. Task and size effects in the Oppel-Kundt and irradiation illusions. *Journal of General Psychology***. 111**(2)*,* pp.229-240.

Lovett. 1998. *The elements and principles of design*. Available from: https://www.johnlovett.com/elements-and-principles-of-design.

Marlowe, F., Apicella, C. & Reed, D. 2005. Men's preferences for women's profile waist-to-hip ratio in two societies. *Evolution and Human Behavior.* **26**(6), pp.458–68.

Mazlan Che Soh, M. & Omar, S. K. 2012. Journey of indigenous knowledge for sustainable livelihood: Story from East Coast, Malaysia*. Journal of Asian Behavioural Studies*. **2**(7), pp.23-36.

McGarvey S., 1991. Obesity in Samoans and a perspective in its aetiology in Polynesians. American Journal of Clinical Nutrition. **53**(6), pp. 86-94.

Merilaita S. 2001.Habitat heterogeneity, predation and gene flow: colour polymorphism in the isopod, Idotea baltica. *Evolutionary Ecology*. **15**, pp.103–116.

Mikellidou, K. 2012. *Illusions of filled extent: psychophysics and neuroimaging methods*. Ph.D thesis, University of York.

Mikellidou, K. & Thompson, P. 2013. The vertical-horizontal illusion: Assessing the contributions of anisotropy, abutting, and crossing to the misperception of simple line stimuli. *Journal of Vision*. **13**(8), pp.1-11.

Mikellidou, K & Thompson, P. 2014. Crossing the line: Estimations of line length in the Oppel-Kundt illusion. *Journal of Vision.* **14**(8), pp. 1–10.

Moreira-Santos M., Donato, C., Lopes, I., Ribeiro, R. 2008 Avoidance tests with small fish: determination of the median avoidance concentration and of the lowest-observed-effect gradient*. Envi- ron Toxicol Chem*. **27**(7), pp.1576–1582.

Marian, Davis. 2004. *Visual Design in Dress*. Pearson College: Prentice Hall**.**

Miura, K. & Taya, S. 2001. New size illusion: Does the increase of perceived depth lead to the decrease of perceived width?. **30**, pp.22–23.

Norman, J. F., Lappin, J. S. & Norman, H. F. 2000. The perception of length on curved and flat surfaces. *Perception & Psychophysics*. **62**, pp.1133–1145.

Newark, T., Newark, Q., & Borsarello, J. F. 2002. *Brassey's book of camouflage*. London: Brasseys UK Limited.

Noubikko, 2007. *Body Camouflage*, **2,** USA: Noubikko Corporation

Oakley, M. 1990. *Design Management: A Handbook of Issues & Methods*, Basil Blackwell: Oxford.

Özel, Z. 2007.Op Art and Use of Digital Technology. *Anadolu University Journal of Social Sciences*. Üniversitesi Sosyal Bilimler Dergisi. **7**(2), pp.395-418

Obonai, T. 1954. Induction effects in the estimates of extent. *Journal of Experimental Psychology.* **47**(1), pp.57-60.

Oppel, J. J. 1855. Uber geometrisch-optische Tauschungen. *Jahresbericht des Frankfurter Vereins*. pp.37-47.

Osei-Poku, P. & Adu-Agyemang, J. 2008. Achieving a goal of distinction in your dress. *Journal of Science and Technology*. **28**(2), pp.135-150.

Oyama, T. 1960. Figure-ground dominance as a function of sector angle, brightness, hue, and orientation. *Journal of Experimental Psychology*. **60**(5), pp.299–305.

Pastoureau, M. 2001. *The Devil's cloth: a history of stripes and striped fabric*. New York: Columbia University Press.

Patricia, C., & Cert, T. M. A. 2006. *Digital Imaging: its current and future influence upon the creative practice of textile and surface pattern designers.* Ph.D. thesis, University of Wales.

Piaget, J. & Osterrieth, P. A. 1953. Recherches sur le développement des perceptions: x v i i. L'évolution de l'illusion d'Oppel–Kundt en fonction de l'âge. *Arch de Psychol.* **34***,* pp.1–38.

Postrel, V. 2004. *The Substance of style: how the rise of aesthetic value is remaking commerce, culture, & consciousness*. New York: Harper Collins.

Pollock, N. J. 1995. Cultural elaborations of obesity: Fattening processes in Pacific societies. *Asia Pacific Journal of Clinical Nutrition*. **4**(4), pp.357–360.

Poulton, E., Thayer, A. 1902. The Meaning of the White Under Sides of Animals. Nature. **65,** pp.596-597.

Prantl, L. & Gründl, M. 2011. Males Prefer a Larger Bust Size in Women Than Females Themselves: An Experimental Study on Female Bodily Attractiveness with Varying Weight, Bust Size, Waist Width, Hip Width, and Leg Length Independently. *Aesthetic Plastic Surgery.* **35**(5), pp.693–702.

Prinzmetal, W., & Beck, D. M. 2001. The Tilt-Constancy Theory of Visual Illusions, **27**(1), pp.206–217.

Powdermaker, H. 1960. An anthropological approach to the problem of obesity. *Bulletin of the New York Academy of Science*. **36**(5), pp.286–295.

Renier, L., Bruyer, R. & De Volder A. G. 2006. Vertical-horizontal illusion present for sighted but not early blind humans using auditory substitution of vision.

Perception & Psychophysics. **68**, pp.535–542.

Rohaida Nordin, R., Abu Bakar, S., S., Malaysian batik industry: protecting local batik design by copyright and industrial design laws. *International Journal of Business and Society*, 2012, **13** (2), pp117- 32.

Rohrmann, B. 2003. Verbal Qualifiers for Rating Scales: Sociolinguistic considerations and psychometric data. Working paper.

Ronald, E. I. 2012. *Patterns of Identity: dyed textiles of rural Rajasthan*. Ph.D thesis, De Montford University,Leicester.

Rothko, M. 1970. Early career. *Writings on Art*, Miguel Lopez-Remiro. 2006, New Haven, Connecticut: Yale University Press.

Rothkopf, C. A. & Pelz, J. B. 2004. Head movement estimation for wearable eye tracker. *In Proceedings of the Eye Tracking Research and Application symposium (ETRA 2004)*, *San Antonio, Texas: ACM*. Pp. 123-130.

Roy R. Behrens, 1988. The Theories of Abbott H. Thayer: Father of Camouflage. *The MIT Press*. **21**(3), pp. 291–296.

Roy R. Behrens. 2002. *The Meaning of the White Undersides of Animals: Abbott H. Thayer and the Laws of Disguise*. 1st ed. Art, Design and Modern Camouflage. Iowa: Bobolink Books.

Rudd, N. & Carter, J. 2006. Building positive body image among college athletes: A socially responsible approach. *Clothing and Textiles Research Journal*. **24**, pp.363.

Ruxton, G.D., Sherratt T.N. & Speed M.P. 2004. *Avoiding attack: the evolutionary ecology of crypsis, warning signals and mimicry*. Oxford, UK: Oxford University Press

Saliha, A. & Menekşe, S. 2015. Optical Illusions and Effects on Clothing Design. *International Journal of Science Culture and Sport*. **3**(2), pp.137-157.

Sanders A. F. J. & Kappers A. M. L. 2009. A kinematic cue for active haptic shape perception. *Brain Res.* **1267**, pp.25–36.

Santos, D. L., Tones, E. D., Pytricio, R. G. & Winterhalte, A. C. 2004. *Camouflage U.S Marine Cops Utility Uniform: Patern, Fabric, and Deisgn*. US 6,805,957 B1. United States Patent

Savacool, J. 2009. *The World Has Curves: The Global Quest do the Perfect Body*. New York: Rodale Bools.

Scott-Samuel, N. E. Baddeley, R. Palmer, C. E. & Cuthill, I. C. 2011. Dazzle camouflage affects speed perception. *PLoS One.* **6**(6), e20233.

Sekuler, R., Sekuler, A. B. & Lau, R. 1997. Sound alters visual motion perception. *Nature*, **23**(385), pp.308.

Sherrow. V., 2001. *For Appearance' Sake: the historical encyclopedia of goods looks, beauty and grooming*. Wesport: The Oryx Press.

Shipley, W. C., Nann, B. M. & Penfield, M. J. 1949. The apparent length of tilted lines. *Journal of Experimental Psychology*. **39**(4), pp.548–551.

Simon, H.A. 1996. The Sciences of the Artificial. 3rd Edition. Cambridge, MA: The MIT Press.

Sinha, P. 2001. The Mechanics of fashion, in Hines, T. and Bruce, M. (Eds), *Fashion Marketing*: *Contemporary Issues*, Oxford: Butterworth-Heinemann.

Sobal, J., & Stunkard, A. J. 1989. Socio-economic status and obesity: A review of the literature. *Psychological Bulletin*. **105**(2), pp.260–275.

Spencer, M. www.kickstarter.com. 2014. *DRES: Clothing for Your Body Shape*. [Online]. [Accessed 25 January 2017]. Available from: https://www.kickstarter.com/projects/1635539719/dres-clothing-for-your-body-shape

Stevens, M., & Merilaita, S. 2009. Animal camouflage: current issues and new perspectives. **362**(1516), pp.423–427.

Surhone, L.M., Tennoe, M.T. & Henssonow, S.F eds. 2010 *Affective design*, Beau Bassin, Mauritius: Betascript Publishing

Sulaiman R, Rahim A, Halim Husain: Analisis Simetri Reka Bentuk Kesenian Melayu dalam Perspektif Etnomatematik, *Journal of Science and Mathematics Letters*. 2019, **7**, pp72-84.

Swami, V. 2015. Cultural influences on body size ideals. *European Psychologist,* **20**(1), pp.44–51.

Swami, V. & Harris, A. 2012. The Effects of Striped Clothing on Perceptions of Body Size. *Social Behavior and Personality*. **40**(8), pp.1239-1244.

Syed Mahdzar, S. S., Chuah, P. J., & Safari, H. 2013. Development of historical culture tourism industry through batik art to attract the local and tourist. *International Journal of INTI.* **22**, pp.76-83.

Sylvanus, N. 2007. The fabric of africanity: Tracing the global threads of authenticity. *Anthropological Theory*. **7**(2), pp.201-216.

Taya, S. & Miura, K. 2007. Shrinkage in the apparent size of cylindrical objects. Perception, *PubMed*. **36**(1), pp.3-16.

Thayer, G. H. 1909. *Concealing Coloration in the Animal Kingdom.* US: Macmillan.

Thompson, P. 2008. Does my butt look big in this? Horizontal stripes, perceived body size, and the Oppel-Kundt illusion. *Journal of Vision*. **8**(6), pp.822.

Thompson, P., & Mikellidou, K. 2009. The 3-D Helmholtz square illusion: More reasons to wear horizontal stripes. *Journal of Vision*. **9**(8), pp.50.

Thompson, P. 2011. *Applying the Helmholtz illusion to fashion: horizontal stripes won't make you look fatter*. **2**(1), pp.69–76.

Thompson, P., & Mikellidou, K. 2013. *The vertical-horizontal illusion: Assessing the contributions of anisotropy, abutting, and crossing to the misperception of simple line stimuli*. **13**(8), pp.1–11.

Thompson, J.K., & Stice, E. 2001. Thin-ideal internalization: Mounting evidence for a new risk factor for body image disturbance and eating pathology. *Current Directions in Psychological Science*. **10**(5), pp.181-183.

Tortora, P.G. and Merkel, R.S., 2005. *Fairchild's Dictionary of Textiles*, 7th ed. New York: Fairchild Publication.

Townsend, K. 2003. *Transforming Shape: A simultaneous approach to the body, cloth and print for textile and garment design (synthesising CAD with manual methods.* Ph.D. thesis, Nottingham Trent University.

Treloar, C., Porteous, J., Hassan, F., Kasniyah, N., Lakshmandu, M., Sama, M. & Heller, R. F. 1999. The cross-cultural context of obesity: An INCLEN multicenter collaborative study. *Health and Place*. **5**(4), pp.279-286.

Tuğal, A. 2018. *Oluşum Süreci İçinde Op Art*. İstanbul: Hayalperest.

Peter, T. & Kyriaki, M. 2009. The 3-D Helmholtz Square illusion : more reasons to wear horizontal stripes. *Journal of Vision*, **9**(8), pp.50.

Vithanage, P. C. & Kumanayake D. T. 2017. Enhancing Feminine Look through Optical Illusion. *IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE)*. **4**(5), pp.36-43.

V.Sarah and S.Lewis 2008. The Times journalist, Scientist explodes myth about Big Bum Theory and the wrong type of stripes. [Online]. Available from: http://acs.thetimes.co.uk/

Warren, R. M. 1969. Visual intensity judgments: An empirical rule and a theory. *Psychological Review, 76*(1), pp.16-30.

Wan Hashim W.t. 1996. *Malay Handicraft: Industries Origins and Development.* Kuala Lumpur: Dewan Bahasa Pustaka.

Watham, V. 2012. Vertixal Stripes have slimming effect, research shows. [Online]. Available from: http://www.bbc.co.uk/news/science-environment-18450602

Wheelright, S., & K. Clark. 1992. *Revolutionizing product development: Quantum leaps in Speed efficiency, and quality*. New York: The Free Press.

White, T. E. 2018. *Cryptic Coloration : Encyclopedia of Animal Cognition and Behavior.* Vonk, Jennifer, Shackelford, Todd K. (Eds). Switzerland: Springer, Cham.

Wichmann, F. A. & Hill, N, J. 2011. The psychometric function: I. fitting, sampling and goodness of fit. *Percept, Psychophys*. **62**(8), pp.1293-1313.

Wilkinson, J., Tovim B, D., M. Walker. 1994. An insight into the personal significance of weight and shape in large Samoan women. *International Journal of Obesity*. **18**(9). pp. 602-606.

Williams, L. M., Senior, C., David, A. S., Loughland, C. M., & Gordon, E. (2001). In search of the 'Duchenne' smile: Evidence from eye movements. *Journal of Psychophysiology*. **15**(2), pp.122–127.

Wilson, J. 2001, *Handbook of textile design: principles, processes and practice*. Cambridge: Woodhead.

Yalom. M. 1997. *A History of the breast*. Alfred A. Knopf.

Yoshioka, T., Ichihara, S. & Akutsu, H. 2004. Effects of illusory stripes on the Helmholtz illusion. *Perceptual Motor Skills*. **99**(2), pp.495-500.

Y. Qingtian, 2007.The Investigation of Taiwan Art and Non-art Majors' Reaction and Error Rate to Visual Illusion. *Report on the Project of the National Science Council Research, NSC 87-2415-H-144-002*. New Taipei City: Technology Department of the National Taiwan University of Arts.

Zanker, J. M. 2004. "Looking at Op Art From a Computational Viewpoint", Spatial Vision. *Journal of Experimental Psychology.* **17**(1-2), pp.75-94.

Appendix

Ethical Consideration

The Secretariat
University of Leeds
Leeds, LS2 9JT
Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

UNIVERSITY OF LEEDS

Sarah Wahida Hasbullah
School of Design
University of Leeds
Leeds, LS2 9JT

**Faculty of Arts, Humanities and Cultures Research Ethics Committee
University of Leeds**

16 October 2020

Dear Sarah

Title of study **Manipulative textile design pattern**
Ethics reference **PVAR 17-082**

The above research application has been retrospectively reviewed by the Chair of the Faculty of Arts, Humanities and Cultures Research Ethics Committee. The following documentation was considered:

Document	*Version*	*Date*
PVAR 17-082 Ethical_Review_Form_V3FINAL.doc	1	12/02/18
PVAR 17-082 ethics Malaysia.pdf	1	12/02/18
PVAR 17-082 poster.jpg	1	12/02/18
PVAR 17-082 Information sheet (3D) .doc	1	12/02/18

This is a retrospective evaluation and as such the committee has not had the opportunity to amend the ethical dimension to the project should it have been necessary. Given this consideration, the committee Chair was satisfied that the necessary procedures had been put in place and are consistent with the University's guidelines on ethical conduct within research. The Chair made the following comments:

This is approved, the work having already occurred. Your methodology, especially around selection and management of participants, would have benefited from further strengthening, though we can see that it has improved since the advice you received in 2016.

Consent is a crucial issue. Reading a consent form, as you report in C14, is not acceptable. It is crucial that consent is informed, even in cases were the research does not immediately address controversial or sensitive issues. The consent form should have been provided in a form or language participants could understand.

Please ensure that all data is stored in line with University of Leeds protocols and guidelines.

It is expected that the researchers involved will seek to provide the opportunity for ethical review in a timely manner in future and certainly before the research has commenced.

Yours sincerely

Jennifer Blaikie
Senior Research Ethics Administrator, the Secretariat
On behalf of Prof Robert Jones, Chair, AHC FREC

CC: Student's supervisor(s)

Questionnaire for Pilot study and Experiment 1

VERTICAL AND HORIZONTAL LINES : GOLDEN RATIO : DIFFERENT HUMAN FORMS

Hello:
You are invited to participate in our survey on horizontal and vertical lines on different human forms. In this survey, approximately 100 people will be asked to complete a survey that asks questions about perceptions on different body forms. It will take approximately 20 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions.

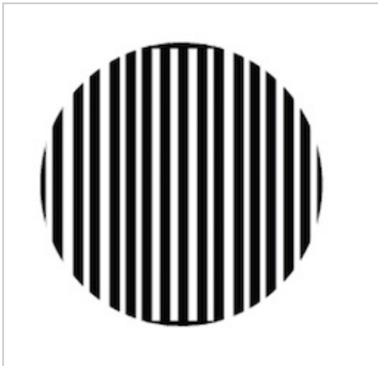
Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact Sarah Hasbullah by email at the email address specified below.

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

☐ **I Agree**

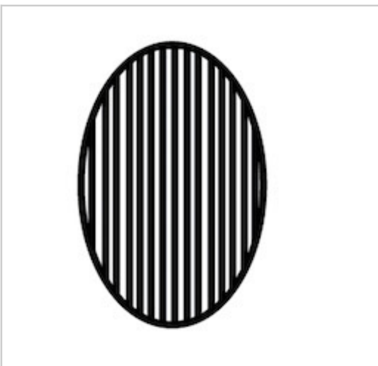
Select the image that seems WIDER?
Is it image CH or CV ? *

CH
○

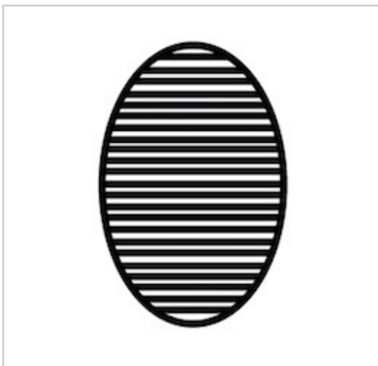


CV
○

Select the image that seems WIDER?
Is it image OV or OH ? *

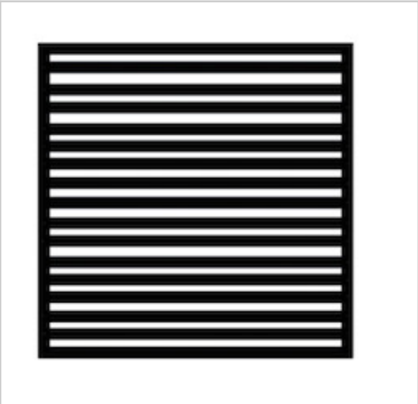


OV

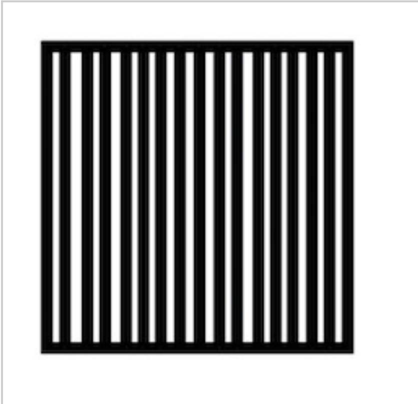


OH

Select the image that seems <u>WIDER</u>?
Is it image SH or SV ? *

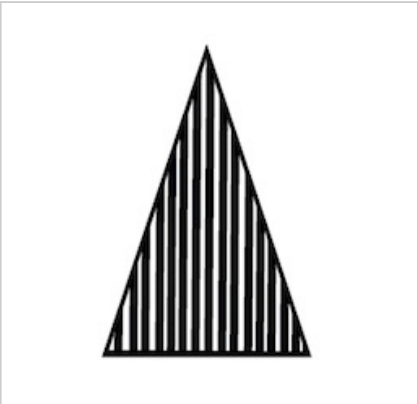


SH

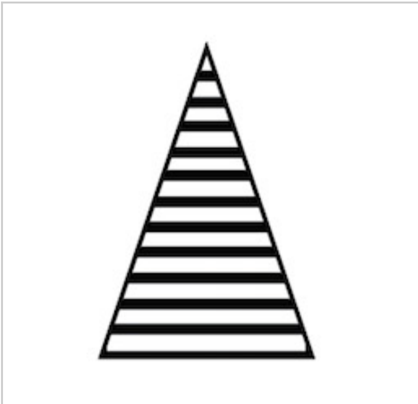


SV

Select the image that seems <u>WIDER</u>?
Is it image TV or TH ? *



TV



TH

Select the image that seems <u>WIDER</u>?
Is it image fhb or fhs ? *

fhb

fhs

Select the image that seems <u>WIDER</u>?
Is it image fhs or fvs ? *

fhs

○

fvs

○

Select the image that seems <u>WIDER</u>?
Is it image fBhb or fBhs? *

fBhb

○

fBhs

○

Select the image that seems <u>WIDER</u>?
Is it image fBhs or fBvb? *

fBhs

○

fBvb

○

Select the image that seems <u>WIDER</u>?
Is it image mBhb or mBhs? *

mBhb

○

mBhs

○

Select the image that seems <u>WIDER</u>?
Is it image mShs or mSvs? *

mShs

○

mSvs

○

Questionnaire for Experiment 2

Survey: Golden ration: vertical & horizontal lines

VERTICAL AND HORIZONTAL LINES : GOLDEN RATIO : DIFFERENT HUMAN FORMS

Hello:
You are invited to participate in our survey on horizontal and vertical lines on different human forms. In this survey, approximately 50 people will be asked to complete a survey that asks questions about perceptions on different body forms. It will take approximately 20 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions.

Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact Sarah Hasbullah by email at the email address specified below.

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

☐ **I Agree**

Which image is <u>WIDER</u>? Is it image 1a or 1b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 1a atau 1b ? *

1a
○

1b
○

Which image is <u>WIDER</u>? Is it image 1c or 1d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 1c atau 1d ? *

1c
○

1d
○

Which image is WIDER? Is it image 1b or 1d ?
Gambar mana yang paling LEBAR? Adakah gambar 1b atau 1d ? *

1b

1d

Which image is WIDER? Is it image 2a or 2b ?
Gambar mana yang paling LEBAR? Adakah gambar 2a atau 2b ? *

2a

2b

Which image is WIDER? Is it image 2c or 2d?
Gambar mana yang paling LEBAR? Adakah gambar 2c atau 2d ? *

2c

2d

Which image is <u>WIDER</u>? Is it image 2b or 2d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 2b atau 2d ? *

2b

2d

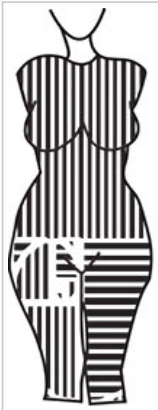
Which image is <u>WIDER</u>? Is it image 3a or 3b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 3a atau 3b ? *

3a

3b

Which image is <u>WIDER</u>? Is it image 3c or 3d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 3c atau 3d ? *

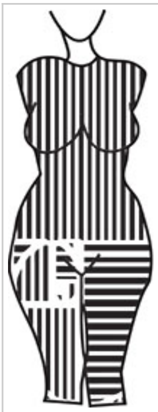
3c



3d

Which image is <u>WIDER</u>? Is it image 3b or 3d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 3b atau 3d ? *

3b



3d

Which image is <u>WIDER</u>? Is it image 4a or 4b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 4a atau4b ? *

4a
○

4b
○

Which image is WIDER? Is it image 4c or 4d ?
Gambar mana yang paling LEBAR? Adakah gambar 1a atau 1b ? *

4c
○

4d
○

Which image is WIDER? Is it image 4b or 4d ?
Gambar mana yang paling LEBAR? Adakah gambar 4b atau 4d ? *

4b
○

4d
○

Which image is WIDER? Is it image5a or 5b ?
Gambar mana yang paling LEBAR? Adakah gambar 5a atau 5b ? *

5a
○

5b
○

Which image is WIDER? Is it image 5c or 5d ?
Gambar mana yang paling LEBAR? Adakah gambar 5c atau 5d ? *

5c
○

5d
○

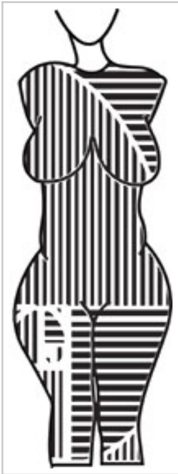
Which image is WIDER? Is it image 5a or 5c ?
Gambar mana yang paling LEBAR? Adakah gambar 5a atau 5c ? *

5a
○

5c
○

Which image is WIDER? Is it image 6a or 6b ?
Gambar mana yang paling LEBAR? Adakah gambar 6a atau 6b ? *

6a
○



6b
○

Which image is WIDER? Is it image 6c or 6d ?
Gambar mana yang paling LEBAR? Adakah gambar 6c atau 6d ? *

6c
○

6d
○

Which image is WIDER? Is it image 6a or 6d ?
Gambar mana yang paling LEBAR? Adakah gambar 6a atau 6d ? *

6a

○

6d

○

Which image is WIDER? Is it image 7a or 7b ?
Gambar mana yang paling LEBAR? Adakah gambar 7a atau 7b ? *

7a

○

7b

○

Which image is WIDER? Is it image 7c or 7d ?
Gambar mana yang paling LEBAR? Adakah gambar 7c atau 7d ? *

7c

○

7d

○

Which image is <u>WIDER</u>? Is it image 7b or 7d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 7b atau 7d ? *

7b

○

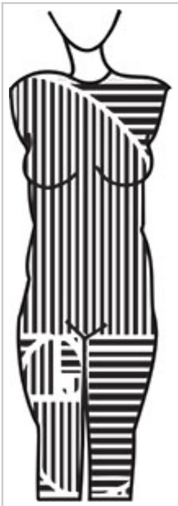
7d

○

Which image is <u>WIDER</u>? Is it image 8a or 8b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 8a atau 8b ? *

8a

○



8b

○

Which image is <u>WIDER</u>? Is it image 8c or 8d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 8c atau 8d ? *

8c

8d

Which image is <u>WIDER</u>? Is it image 8a or 8d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar 8a atau 8d ? *

8a

8d

Which image is <u>WIDER</u>? Is it image M1a or M1b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M1a atau M1b ? *

M1a

M1b

Which image is <u>WIDER</u>? Is it image M1c or M1d ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M1c atau M1d? *

M1c

○

M1d

○

Which image is <u>WIDER</u>? Is it image M1a or M1c ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M1a atau M1c ? *

M1a

○

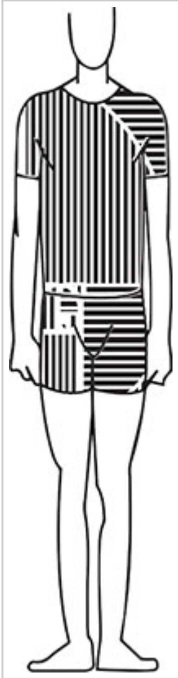
M1c

○

Which image is <u>WIDER</u>? Is it image M2a or M2b ?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M2a atau M2b ? *

M2a

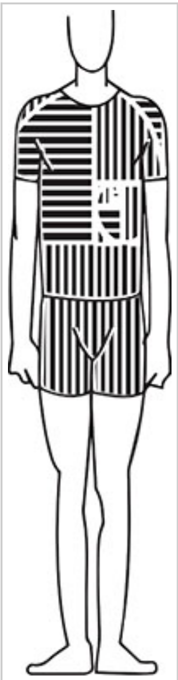
○



M2b

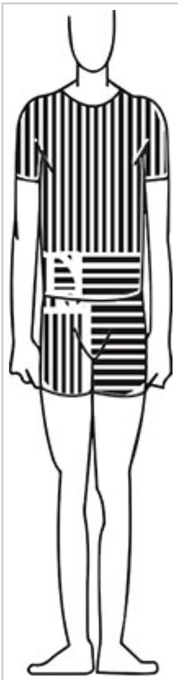
○

Which image is <u>WIDER</u>? Is it image M2c, M2d or is it the same?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M2c, M2d atau sama? *



M2c

○

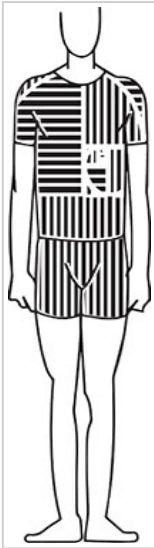


M2d

○

Which image is <u>WIDER</u>? Is it image M2a, M2c or is it the same?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M2a, M2c atau sama? *

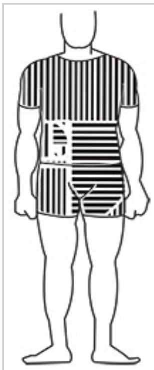
M2a



M2c

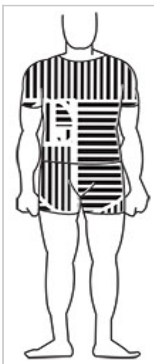
Which image is <u>WIDER</u>? Is it image M3a, M3b or is it the same?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M3a, M3b atau sama? *

M3a



M3b

Which image is <u>WIDER</u>? Is it image M3c, M3d or is it the same?
Gambar mana yang paling <u>LEBAR</u>? Adakah gambar M3c, M3d atau sama? *



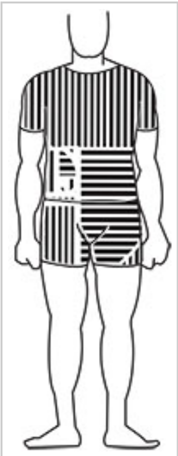
M3c

○

M3d

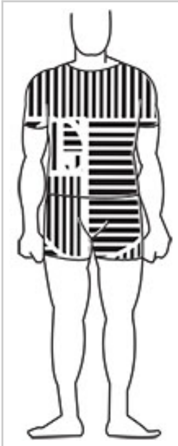
○

Which image is <u>WIDER</u>? Is it image M3b, M3d or is it the same?
Gambar mana yang paling <u>BESAR</u>? Adakah gambar M3b, M3d atau sama? *



M3b

○



M3d

○

POWERED BY QuestionPro

Questionnaire for Experiment 3

QUESTION 1

QUESTION 2

QUESTION 3

QUESTION 4

QUESTION 5

QUESTION 6

WHICH IMAGE SEEMS THE **WIDEST**?

IMEJ MANAKAH YANG KELIHATAN **LEBIH LEBAR**?

QUESTION 7

QUESTION 8

QUESTION 9

QUESTION 10

QUESTION 11

QUESTION 12

WHICH IMAGE SEEMS THE **WIDEST**?

IMEJ MANAKAH YANG KELIHATAN **LEBIH LEBAR**?

QUESTION 13

QUESTION 14

QUESTION 15

QUESTION 16

QUESTION 17

QUESTION 18

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IMEJ MANAKAH YANG KELIHATAN **LEBIH LEBAR**?

QUESTION 19

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QUESTION 20

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QUESTION 24

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WHICH IMAGE SEEMS THE **WIDEST**?

IMEJ MANAKAH YANG KELIHATAN **LEBIH LEBAR**?

QUESTION 25

QUESTION 26

QUESTION 27

QUESTION 28

QUESTION 29

QUESTION 30

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QUESTION 1

QUESTION 2

QUESTION 3

QUESTION 4

QUESTION 5

QUESTION 6

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Using the manipulative textile pattern guidelines in a batik design competition.

FORMAL MALE

CASUAL MALE

CASUAL

FEMALE