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Pattern design preference based on symmetry

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Abstract

Repetition is one of the design principles employed to create decorative pattern on several products such as textiles, wallpaper, ceramic tiles and gift wraps. In this study costumer preference of pattern used in decorative textile design is investigated. It is believed that this will be useful for designers and merchandisers who need to analyze public preference for textiles products. However, symmetry is a fundamental aspect of pattern design, design grouping and classification of designs used in research studies concerned with pattern preference was based on design elements such as motif style and size. Therefore, this study is concerned with classifying stimuli used according to symmetry characteristics. This paper investigated the relation between textile design preference and pattern symmetry class of all-over designs using seventeen primary classes of all- over patterns developed by Woods, H. J.. Two groups of designs were used. In these designs black and white colours were used for background and foreground. These colours were inverted in each group of designs. Most of the subjects employed were found more likely to prefer the designs exhibited (around 40%), 30% of the subjects had neutral response and around 20% disliked the designs shown. The most preferred symmetry classes were characterized by hexagonal or square lattice of highest order of rotation 3 or higher, the generating region is 1/4, 1/6, 1/8 or 1/12 unit. However the most disliked symmetry classes were signified by parallelogram, rectangular or rhombic lattice of 1 or 2 highest order of rotation and the generating region is 1/4, 1/2 or 1. There was consistency in subjects' selection in both groups of designs which indicates that the subjects' preference was in sake of pattern symmetry class itself and not highly affected by colour distribution.

Keywords: all-over, class, colour, rank, subjective, triangle;

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1. Introduction

Decorative textiles are cloths made to embellish and decorate the interior of a room or building. Manufacturers have been developing their products using their design skills to get closer to their costumers' needs. Nowadays, in decorative textiles market, consumers are the driving force of the design and innovation process. This should meet companies' success in their creative use of design elements (Studd, 2002).

There are several factors make decorative textile products successful in the market place. Materials selection, marketing and design analysis in the form of a design manual are considered tools for product development including textile products (Ljungberg & Edwards, 2003).Decorative textile designers should be aware of these factors affecting their products purchase. However, it was found that decorative textile appearance including colour and other aesthetic attributes are the most important factors affecting decorative textile product choice and preference rather than its handle, performance and price.

Decorative textile designers use design elements i.e. space, line, shape, form, colour, value and texture to make creative designs. This is by applying design principles of balance, movement, repetition, emphasis, contrast and unity. Mostly in decorative textiles manufacture, design shapes are repeated automatically which accordingly make "patterns". Pattern and repetition are an integral part of most decorative textile designs, and how design elements repeat is very important to the decorative textile designer. Thus, a decorative textile designer must be able to use pattern and understand how designs can repeat. It is important to consider the repeat structure from an early stage in the design development, and various sketch plans of possible repeat structures should be evolved. The most common repeats are straight repeats, dropped and tile repeats, borders, and repeats that use reflection and mirroring. The way fabrics are manufactured and used will have an influence on the way sections are repeated. The finished fabric width will have a bearing on the repeat size and how the design is laid out (Wilson, 2001).

Decorative textile designers have been concerned with consumer preference of their products' visual characteristics including pattern design. Several research studies were carried out concerned with pattern preference. The first reviewed research dated back to 1939. In this study, Lark-Horovitz, B. studied textile pattern preference of school children. Samples assessed were grouped according to similarity of either arrangement or colour combinations, or type of design and motifs. Pattern preference was found related most to colour followed by arrangement and design and then subject interest. Appreciation of colour was found varying with age levels. Young children were attracted by brightness, variety of colours and favourite colours. Older children prefer few colours in more subdued shades. Modern patterns were chosen in larger numbers than patterns of the past, especially by specials. Comparison of the reasons given by averages and specials showed that specials interpret their pattern preferences in terms of aesthetic qualities such as technique, line and shape, texture, originality, while average children interpret their choices in terms of general, personal and associative qualities such as the subject of the pattern, emotional and other associations, and familiarity (Lark-Horovitz, 1939).

In 1962, Compton, N.H. studied the relationship between colour and design preferences and individual personality. Preferences for all colour and design variables were independent of all personal physical characteristics (eye colour, hair colour, and weight/stature). Students preferring small and less bold designs scored significantly higher on the good impression personality measure (in other words desiring to make a good impression and present the self as unaffected, natural, and modest) than students preferring large designs. Students got high femininity scores preferred more small designs than students got low scores in femininity. This was considered as an evidence supporting the concept imply that the self is expressed through one's selection of clothing fabrics and that clothing items play a role in helping an individual to conform to the ideal self (Compton, 1962).

Paraskevopoulos, I. in 1968 investigated the preference of elementary school children of double, bilateral, horizontal symmetry, and asymmetry of dotted patterns and revealed similar developmental trends in expressed preference for the four modes. The older the subjects were, the more pronounced difference in preference for the various modes was. Early ages showed no differential preference for any mode. The first graders preferred distinctly double symmetry. The second graders, in addition to double symmetry, showed differential preference for bilateral symmetry. From the third grade on, children showed distinct differential preference for all modes (Paraskevopoulos, 1968). Later in 1969 Karmel, B.Z. in his study indicated that infants' preference of pattern decreased as the pattern began to contain greater details (amounts of contour and very small elements) (Karmel, 1969). In 1970, Miranda showed that newborns prefer patterned stimuli over plain ones. No reliable preference relative to the form of contour was evidenced (Miranda, 1970).

The common features of traditional Korean floral patterns have been reported in studies as stylized rendering, mono directional motif arrangement, high coverage and distinct contrasting colours. Joohyeon Lee in 1999 identified the modern meanings that apply to traditional Korean floral patterns and indicated that `grace', `individuality' and `restraint' had replaced the traditional Confucian meanings that had been applied to these designs during the Choson Kingdom period. Among the 15 design elements of traditional Korean floral patterns, hue and tone contrast were found to have a strong impact on the consumers' aesthetic evaluation. On the basis of the findings of this study, guidelines for successful modernization of traditional Korean floral patterns have been suggested (Lee, 1999).

In 2006, Homlong, S. in his thesis was concerned with the ways used to describe, judge and discuss aesthetic qualities of textile patterns with focus on Old Amish Quilts. This study showed that subjects make their judgment on the basis of formal (colour and pattern composition, including simple or complex expressions), functional (ideas related to products), cultural (cultural and social associations) and emotional (feelings and emotional associations) contents. It was suggested that these aspects should be in focus of design work and design education which is dependent on different dimensions of experience (Homlong, 2006). Later in 2013, he studied the aesthetic judgment on textile patterns using striped textile fabrics with blue colour (NCS: 3065-R90B) on white cotton fabric. This was to make the subject focusing on the patterns and reduce the influence of colour preference on pattern judgment. The patterns were all stripes, systematically designed and developed to result in patterns of different complexity. Homlong findings confirmed his previous results (Homlong, 2013).

Chattaraman and Rudd stated that previous studies confirmed that aesthetic attributes of apparel such as colour/pattern, styling and fabric type were the most important criteria affecting women's decision in apparel selection during the interest phase of their purchase. They found that 55% of the responses pertained to aesthetic factors (Chattaraman & Rudd, 2006).

From previous research studies concerned with pattern design preference, it was found that understanding the significance of pattern and its strong implications for selecting textile products (including decorative textiles) is essential. It is believed that this will be useful for designers and merchandisers who need to analyse public preference for textiles products (Compton, 1962). Pattern appearance is highly dependent on its symmetry. In other words, symmetry is one of the most important characteristics of pattern. Nevertheless, in research studies reviewed, samples tested for pattern preference were classified in a non-in-depth approach employing formal (colour and pattern composition, including simple or complex expressions, type of design and motifs, size and boldness of design, amount of details, contour and very small elements), functional (ideas related to products), cultural (Cultural and social associations) and emotional (feelings and emotional associations) contents rather than symmetry class.

On the other hand, research studies carried out focusing on pattern design classification utilized mathematical symmetries to describe the way design parts are arranged in a pattern. Researchers reported that this systematic and methodical process of classifying pattern symmetry in design structure is a significant and culturally sensitive analytical tool. This means that symmetry preference would be dependent on culture (M. Hann, 2003; Hann, 1992; M. A. Hann, 2003a, 2003b).

The purpose of this paper is to determine whether decorative textile design preference is linked to pattern symmetry. This paper argues the analytical prospective of symmetry classification as a tool for cultural analysis. The objective of this paper is to present a consideration of the possible relationship between symmetry preferences and culture itself. As few research studies concerned with analysing gulf countries' culture, the scope of this paper is gulf countries with special focus on Sultanate of Oman.

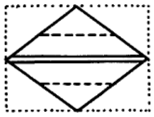
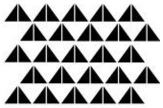
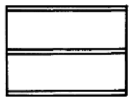
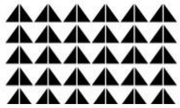
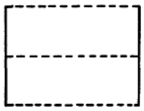
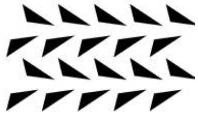
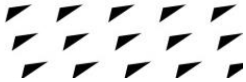
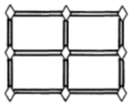
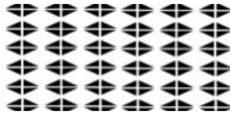
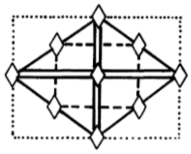
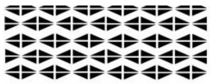
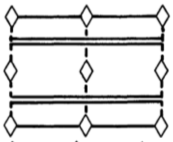
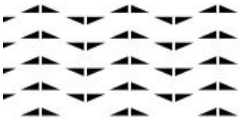
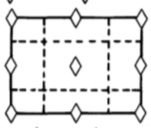
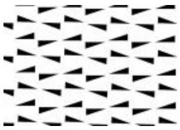
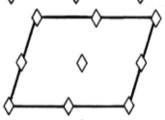
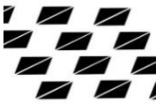
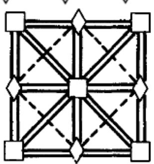
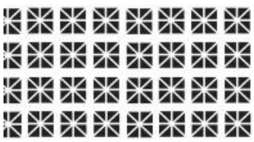
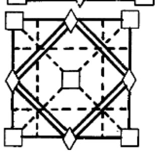
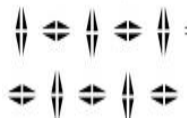
2. Method

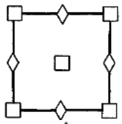
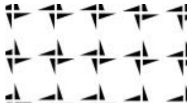
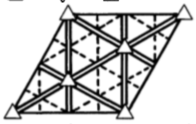
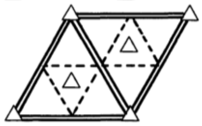
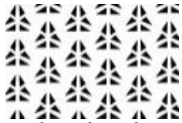
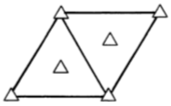
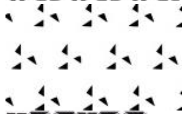
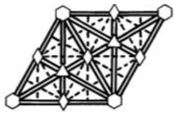
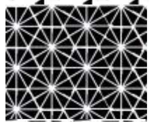
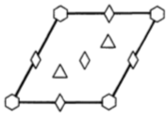
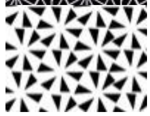
2.1. Stimuli

Studying pattern design symmetry is dated back to the 1930s, when H.J. Woods published a series of papers presenting complete and explicit enumeration of the two-colour, one- and two-dimensional patterns (i.e. two colour counter-change border and all-over patterns) (Woods, 1935a, 1935b, 1935c, 1936). Since then, several research studies were focused on pattern symmetry and aimed at understanding the parameters of pattern structure based on Woods work (M. Hann, 2003; Hann, 1992; M. A. Hann, 2003a, 2003b; Paraskevopoulos, 1968). These studies showed that "Motif" is the fundamental unit of all patterns (including symmetrical and asymmetrical motifs). Patterns have symmetry characteristics including four geometrical actions (i.e. symmetry operations): translation, rotation, reflection and glide-reflection. Patterns could be classified into border and all-over pattern. The first exhibit translation of a motif at regular intervals in one direction only, however the second exhibit translation in two independent directions across the plane. For the all-over pattern design, combinations of the four symmetry operations yield 17 possibilities.

This study is concerned with and limited to all-over pattern designs. Therefore, 17 designs representing all variable possibilities of the all-over pattern designs were employed. The motif used is an asymmetrical one "triangle". This is because it is a simple motif. The 17 possibilities constructed from this motif were reproduced from Crowe, Donald W. 2001 (Crowe, 2001) which is originally presented in Washburn, D.K. and D.W. Crowe (1988) (Washburn & Crowe, 1988). The motif used in two possibilities (pattern structures) was found Trapizium. So, these were replaced by triangle shape as the researchers aimed at maintaining the motif characteristics and shape. Table 1 lists the seventeen classes/designs of all-over patterns used as stimuli, schematic illustration, full and short form of the notation of each class. These designs were made of black triangles on white background. These colours were chosen in order to obviate the impact of colour preference on pattern symmetry preference. Foreground and background colours were swapped to make another group of seventeen designs of white triangles on black background. This is in order to test the reliability of subjects' choice and their independence from colour distribution.

Table 1 The seventeen classes/designs of all-over patterns used as stimuli. Source: Crowe, Donald W. 2001 (Crowe, 2001) which is originally presented in Washburn, D.K. and D.W. Crowe (1988) (Washburn & Crowe, 1988).

Short Form of notation	Full notation	The smallest rotation	Reflection (R)	Glide Reflection GR		Rotation centres on reflection axis	Schematic illustration	Design
cm	c1m1	×	✓	GR axis not R axis	✓			
pm	p1m1	×	✓		×			
pg	p1g1	×	×		✓			
p1	p	×	×	GR	×			
pmm	p2mm	180°	✓		✓	✓		
cmm	c2mm	180°	✓		✓	×		
pmg	p2mg	180°	✓	R in 2 directions	×			
pgg	p2gg	180°	×		✓			
p2	p211	180°	×	GR	×			
p4m	p4mm	90°	✓		✓			
p4g	p4gm	90°	✓	R in lines which intersects at 45°	×			

p4	p4	90°	×				
p3m1	p3m1	120°	✓	Rotation centres on R axes	✓		
p31m	p31m	120°	✓		×		
P3	p3	120°	×				
p6m	p6m m	60°	✓				
p6	p6	60°	×				

2.2. Subjects

Fifty female under graduate students in graphic design department were employed in this study. The purpose of choosing female participants approximately of similar age, culture and educational background is to obviate the impact of these variables on participants' response.

2.3. Experiment

The participants were asked to respond to 17 all-over pattern designs (black triangles on white background) listed in Table 1. Each design was displayed for one minute. Each subject was asked to rate her preference to pattern symmetry on 5 point Likert scale. These were: strongly dislike- dislike- neutral- prefer- strongly prefer.

Another experiment was carried out employing these subjects in order to rate similar 17 designs of white triangles on black background.

3. Results and discussion

3.1. Assessment of all-over designs _ black foreground- white background

Figure 1 presents rating results of subjects' preference for pattern symmetry class using black triangles on white background. In this test, the total number of ratings carried out was 850. Generally, responses for symmetry class preference were 30% for neutral, 22% for dislike; 49% for preferred. The dislike ratings were constituted of 4% strongly dislike and 18% dislike. The preferred ratings were constituted of 29% preferred and 20% strongly preferred. This means that subjects were likely to prefer the designs shown. This is because most of the choices went for neutral followed by preferred, strongly preferred, dislike and strongly dislike was the least choice.

From Figure 1, the most strongly preferred symmetry class is p4m (28 subjects), followed by p6m (23 subjects), p6 (20 subjects).The most preferred symmetry class was p4 (24 subjects), followed by p4g (23 subjects) and then p3m1 (21 subjects). For neutral preference, p2 was the highest choice (23 subjects) followed by p1 and pmm (22 subjects for each class) and then p3 and cm (21 subjects for each class). The most disliked symmetry class was p1 and pg (18 subjects), pgg (17 subjects each), and then pm (14 subjects). However, the most strongly disliked symmetry class was pgg (9 subjects), p3 and pg (4 subjects) and then cmm (3 subjects). See Table 1for symmetry classes' characteristics.

The sum scores of each symmetry class were used to order rank the symmetry classes' preference from the most preferred to the least. This was as follows: p4m> p6> p3m1> p6m> p4> p31m> cmm> p4g> pmg> pmm> p3> pm> p2> cm> pg> p1> pgg.

"p4m" symmetry class is characterized by: square lattice, a rotation through an angle of 90° (i.e. the highest order of rotation is 4), there are reflections in lines which intersect at 45° and the generating region is 1/8 unit. It was followed by "p6" which is signified by the hexagonal lattice employed and applying rotation through an angle of 60° (i.e. the highest order of rotation is 6). In this class the generating region is 1/6 unit.

The most strongly disliked class was "pgg" having rectangular lattice, using rotation through an angle of 180° (i.e. the highest order of rotation is 2), no reflection, but there is glide reflection and the generating region is 1/4 unit.

It is evident that the preferred symmetry classes (p4m, p6, p3m1, p6m, p4, p31m) are characterized by hexagonal or square lattice of highest order of rotation 3or higher, the generating region is 1/4, 1/6, 1/8 or 1/12 unit. However the disliked symmetry classes (pmm, p3, pm, p2, cm, pg, p1, pgg.) were characterized by parallelogram, rectangular or rhombic lattice of 1 or 2 highest order of rotation and the generating region is 1/4,1/2 or 1.

3.2. Assessment of all-over designs -white foreground/black background

This experiment was carried out to ensure that subjects' choices were not affected by the colour of pattern and background. Therefore, the colours of the foreground and background were inverted to be white triangles on black background. Figure 2 presents the rating results of subjects' preference for pattern symmetry class using white triangles on black background. In this test, the total number of ratings carried out was 850. Generally, responses for symmetry class preference were: 30% for neutral, 28% for dislike; 43% for preferred. The dislike ratings were constituted of 5% strongly dislike and 22% dislike. The preferred ratings were constituted of 28% preferred and 15% strongly preferred.

From these percentages, it is evident that subjects still likely to prefer the designs shown. However, slight differences in percentages of the results between pervious assessment and this one were noticed. These results show that subjects' neutral attitude is maintained however the disliked rates are higher in this experiment than the previous one and the preferred rates are less than the previous assessment. This means that subjects' tendency and inclination for disliking designs shown was higher than previous assessment.

From Figure 2, the most strongly preferred symmetry class is p4m (19 subjects), followed by p6 (18 subjects) and then p31m and p6m (13 subjects for each class).The most preferred symmetry class was p4m and p3m1 (23 subjects for each class), followed by p4 (22 subjects) and then p4g (19 subjects). For neutral preference, pg was the highest choice (24 subjects) followed by pmm (21 subjects) and then p2 and cm (19 subjects for each class). The most disliked symmetry class was pgg (20 subjects), p1 (18 subjects), and then pg (16 subjects). However, the most strongly disliked symmetry class was p1 (10 subjects), pgg and p6m (7 subjects) and then pm (5 subjects). See Table 1for symmetry classes' characteristics.

The sum scores of each symmetry class were used to order rank the symmetry classes' preference from the most preferred to the least. This was as follows: p4m> p6> p4> p31m> cmm> p3m1> p4g> p6m> pmm> cm> p3> pmg> pm> p2> pg> pgg> p1.

It is noticed from the order ranking in this experiment that there are some differences between the previous assessment using black triangles/white background and this assessment of inverted colours. However, "p4m" symmetry class is still the most preferred followed by "p6".

The most strongly disliked class is "p1". This symmetry class uses a parallelogram lattice, applies rotation through an angle of 360° (i.e. the highest order of rotation is 1), have no reflection or glide reflection and the generating region is 1 unit. It is evident that the "pgg" symmetry class most disliked in the previous assessment is moved only one rank to be before the most disliked class in this assessment.

These findings show that subjects' responses to the most preferred class of the 17 all-over one colour symmetry classes were similar in both experiments with background and foreground colours (black and white) swapped. However, there were differences in some classes' order ranking. This indicates that subjects were not highly affected by colours used.

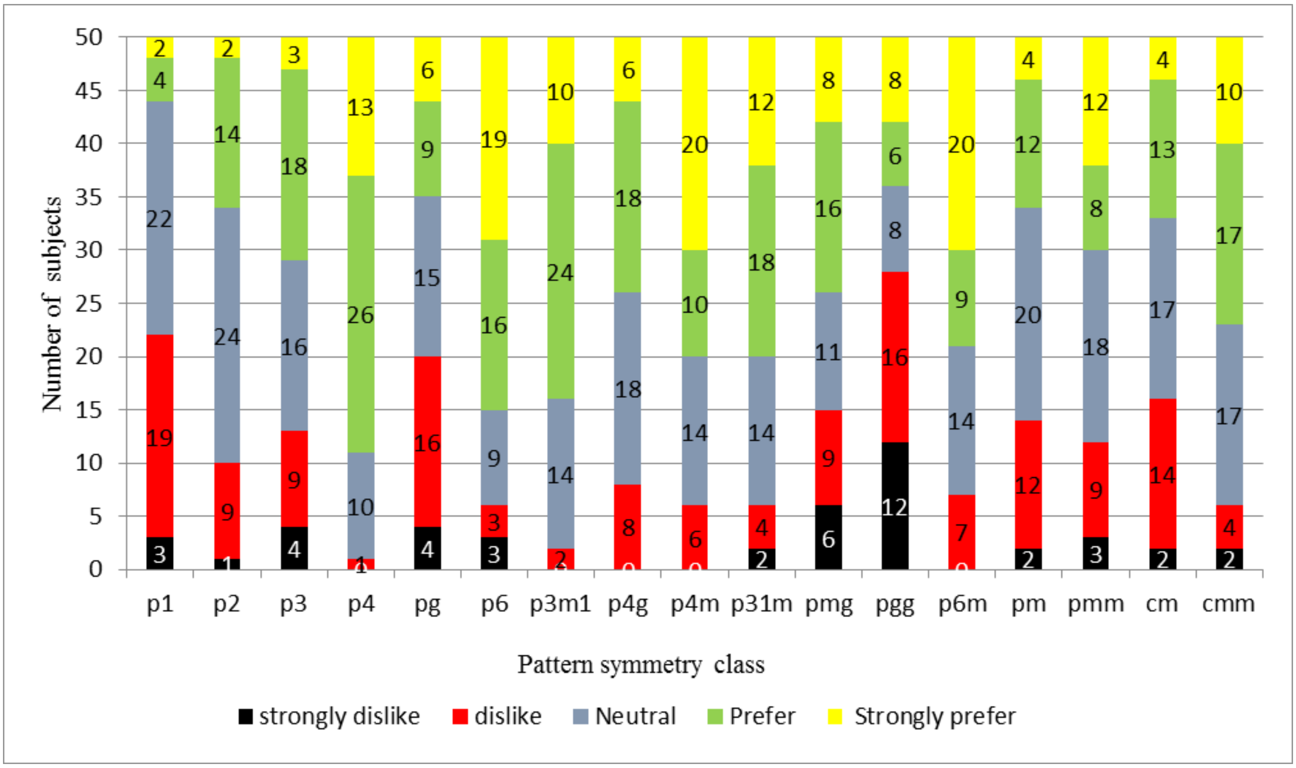


Figure 1 Pattern symmetry prefences for designs of (black foreground- white background)

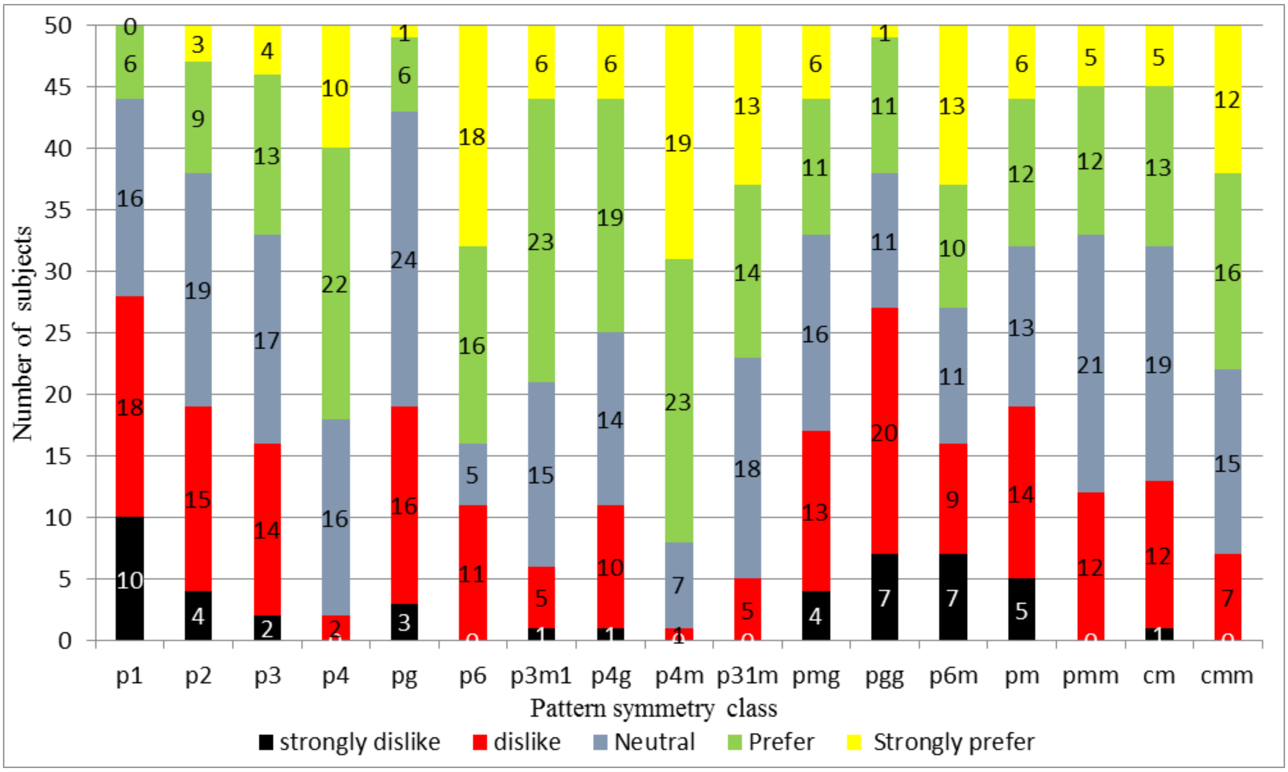


Figure 2 Pattern symmetry prefences for designs of (white foreground- black background)

4. Conclusions and implications

In this study, the preference of the symmetry class of all-over pattern design (one colour) was investigated. Two experiments were conducted evaluating pattern design. The first group was of black pattern on white background and the other group was of white pattern on black background.

In both experiments, it was found that 30% of the subjects were neutral for the assessed symmetry classes; around 40% preferred the symmetry classes shown, and around 20% disliked the exhibited symmetry classes. This means that the subjects employed were more likely to prefer the designs shown.

The most preferred class was p4m followed by p6. This shows that the preferred symmetry classes are characterized by hexagonal or square lattice of highest order of rotation 4or higher, the generating region is 1/6 or 1/8 unit. However the most disliked symmetry classes were pgg and p1. This indicates that the disliked symmetry classes are characterized by parallelogram or rectangular lattice of 1 or 2 highest order of rotation and the generating region is 1/4 or 1 unit.

It is important to notify that there were similarities between both groups with regard to the most preferred and disliked pattern symmetry class. However, there were insignificant differences in the order rank of the 17 classes assessed. Further work is proposed investigating the impact of colour and motif symmetry class on consumer preference.

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