colour interactions, psychological functioning, cultural association, language, Kansei, emotion, measuring methods

Tharangie K G D[*], Althaff Irfan C M[*], Young Im CHO[**], Shusaku NOMURA[*], Koichi YAMADA[*] and Ashu MARASINGHE[*]

COLOUR INTERACTION, PSYCHOLOGICAL FUNCTIONING AND KANSEI MEASUREMENT METHOD

Color is an inseparable element of our lives and is a part of everything we perceive. Colour has a strong impact on our decision making process. Therefore there is a direct connection between the colour and psychological functions. Kansei is a Japanese concept, which abstracts the subjective internal process in the brain, which is activated by external stimuli. Furthermore, Kansei is a function of the brain which integrates sensibility, sense, sensitivity, aesthetics, emotion, affection and intuition. Therefore measuring Kansei is a broader aspect of measuring psychological functioning of the brain. In this research, colour interaction and respective psychological functioning is measured using Kansei measurement method. Further the result of this research was compared with an circumflex model for personality and emotions to recognize the variability of colours in terms of emotional regions. The results indicate that colours have a variable nature and are associated with several different emotions in several different intensities. Colours which have longer wavelengths are more arousing and they generate more psychological functioning than the colours which have shorter wavelengths.

1. INTRODUCTION

There are many different ways and means of measuring psychological functions. Up-to date measuring instruments range from simple pen-and-paper rating scales to high-tech equipments as such: those which measure nerve impulse, brain waves, facial expressions, hart rates etc. As a result, both the number of reported instruments and the diversity in approaches to measure emotions are available in abundance. These different methods have their advantages and disadvantages.

If we consider the advantages in verbal methods, one of the prominent measuring method which come to the scene is the Semantic Differential Analysis methods. There are two important advantages of Semantic Differential (SD) Method compared to all the other measuring methods: the rating scales can be assembled to represent any number of emotion related adjectives, and it is possible to measure mixed emotions. On the contrary, the disadvantage of this method is that it comes across the difficulties when applied to intercultural research, due to that the translation problems which arise when one-to-one translation is unavailable. Some researchers believe it is difficult to compare cross-cultural results because of this reason. But, Osgood et al in his renowned book, "Cross-Cultural Universals of Affective Meaning" provides a solution to this problem. One can face this problem easily by coding the genre of the emotions and generalizing it [1]. On the other hand there are non-verbal self-report instruments which use pictograms instead of words to represent emotional responses. An example is the Self-Assessment Manikin (SAM). With SAM, users select the puppets from the system that best portrays their emotional state in their opinion. Although this method can be easily utilized for cross-cultural semantics problems, this kind of non-verbal scales also have a critical limitation, which is that they do not measure distinct emotions but only generalized emotional states (in terms of underlying dimensions such as pleasantness and arousal) [2].

This research focuses on measuring psychological functioning induced by colour. Colour has many different facets; colour has aesthetic aspect, it can have cultural aspect interims of carrying specific meaning and information etc. From infancy to adulthood, a given person encounters both explicit and subtle pairing between colour and particular messages, concepts and experiences in particular situations. With continuous repetition of these particulars, colours produce strong colour associations [3]. In this way a mere perception of colour in a particular situation is not sufficient to explain the overall experience gathered in the life time. The maturity level of a particular person strongly affects the psychological functioning of the brain. That is why Kansei measuring becomes a better candidate rather than other measuring methods of psychological functioning. Measuring Kansei is more than measuring emotions or excitation of nerve, measuring the beat of hart as an effect of external stimuli. Measuring Kansei is a measurement of all of them together. Kansei incorporates not only biological & psychological functioning of the brain but also the human social associations such as behaviour, knowledge, attitudes, feelings, which also contribute in generating one's Kansei towards a particular object.

[*] Department of Management and Information Systems Engineering, Nagaoka University of Technology, Japan
[**] Department of Computer Science, University of Suwon, Korea

2. WHAT IS KANSEI

Several scholars have given various definitions for Kansei. What is highlighted by many of them is that Kansei is a subjective internal process in the brain which is activated by external stimuli. Nagamachi in his research further explains this concept by articulating that "Kansei is an individual's subjective impression from a certain artefact, environment or situation, using all the senses of sight, hearing, feeling, smell, taste as well as recognition"[4]. Lee et al. further elaborating the word 'Kansei' says that the word Kansei is embedded with more semantics such as sensibility, sense, sensitivity, aesthetics, emotion, affection and intuition [5]. As mentioned above, Kansei is a broader aspect of psychological function in sensibility, sense, sensitivity, aesthetics, emotion, and affection. That is why Kansei measurement method is more useful to get a better knowledge and understanding about psychological functioning of colour rather than the other measurement methods.

3. HOW KANSEI IS MEASURED

There are three focal points one should understand about Kansei. Firstly, how to understand Kansei, secondly how to reflect and translate Kansei, finally how to create a system and organization for Kansei Oriented Design. Even though it is very difficult to capture one's Kansei, it can be approximately measured using the following four different methods [4]: people's behaviours and actions; words (spoken), that is Semantic Differential Methods(SD); facial and body expressions; physiological responses as such heart rate, electromyography (EMG), electro encephalography (EEG), etc. Some Kansei researchers prefer physiological methods which can directly measure user's Kansei while a user is actively interacting with the setup. However, some researches believe that the physiological measurements are not exactly Kansei itself but rather a by-product of Kansei. Some Kansei researchers adopt both measuring methods and they compare and contrast the result to find better solutions. This study fully focuses on the SD method as the main component of Kansei measurement method and on the question how it can be utilised to understand the psychological functioning of the brain.

In Kansei measurement method, Kansei words are used to create bi-polar scales; Kansei words are emotion-related adjectives or phrases, combined with the trait words of the subject domain. In general people use adjectives to describe about personalities and to express their feelings or to reveal their personalities. Since the Kansei words used to design the bipolar scales are also adjectives, these Kansei words can be used as personality descriptors. Furthermore these Kansei words can precisely be used as a self expression of affectivity of a person towards an object. Bi-polar scales consist of opposite Kansei words in either extreme ends of the scale. Measurement done using these scales is restricted to semantic border of these oppositions. There are two typical lengths of bi-polar scales which are commonly used in SD scales: point 5 or 7 points. The method which uses SD data to quantify subjective impression to a particular object is called Semantic Differential Analysis [6]. There are many advantages of SD scales. One of them is the facilities that SD scales provides to quantify the levels of affectivity: subject can indicate whether his judgment is extremely by marking the extremities, or whether they have not formed an opinion by selecting a neutral position, and half way between the two extremes, or express intermediate opinion by selecting the positions between neutral and extreme.

After gathering SD data they are statistically analysed using multivariate statistical methods to derive the knowledge of Kansei. This process is done a number of times to measure the consistency of the result and finally statistically analysed to derive generalised or higher level Kansei. Kansei knowledge gaining process follows a hierarchical model. If collected Kansei data were represented by a pyramid, primary data belongs on the bottom level or the basement of the pyramid. When data are analysed further, according to its refined level, they go higher in the pyramid until they reach the peak of the pyramid where we find the highest level of Kansei or general Kansei. Lower degree of Kansei is more subjective or individual than higher levels of Kansei. Highest level of Kansei is more refined and generalised, and from that data new design principles can be derived. Utilising this Kansei Knowledge to design new applications or, in other words, to translate consumers' feelings towards a product into design elements is called Kansei Engineering. In the fallowing section an ongoing Kansei Engineering study that aimed at designing and developing a fuzzy inferencing engine for selecting better colour solutions to be applied in interactive learning environments is discussed in detail.

3.1. SUBJECTS & MATERIAL

Twenty male and female Sri Lankan undergraduate university students (Information Technology) have taken part in this research as subjects. Test subjects' age ranged between 20 and 30. No subjects reported in any colour deficiency. None of them were specially trained for any specific colour-related applications. Eleven colours were selected as the colour sample. These colours are generally known as the colours that were 'almost never confused' throughout the cultures: red, pink, purple, blue, green, yellow, orange, brown, white, grey, black [7].The RGB values of the colours are as follows; red (255,0,0), orange (255,165,0), brown (165,42,42), yellow (255,255,0), green (0,255, 0), blue (240, 100,100), purple (300,100,50), grey (128,128,128), pink (255,192,203), white (255,255,255) and black(0,0,0). In addition to that, Ten Kansei words were highly ranked by students from ranking 600 colour related Kansei words were selected to design bi-polar scales: angry–not angry, sad-not sad, fearful-not fearful, surprising-not surprising, bored-not bored, happy-not happy, exciting-not exciting, affectionate-not affectionate, pleasant-not pleasant. Finally a colour questionnaire was prepared consisting SD scales as well as other open ended questions to gather general and other related information. Colour Samples were presented in the questionnaire in the size of 1"x 1" squares.

3.2. METHODOLOGY

Experiment was conducted in a quiet room in normal day light conditions using a questionnaire. It consisted of three consecutive sessions: preliminary data acquisition, detailed data gathering, and final questionnaire testing with bipolar scales. Medium of the questionnaire is the subjects' native language (Sinhala). When the Kansei words of the subject domain are selected they should be ranked and categorised and short-listed according to the research essentials. This can be done in two ways: firstly, categorisation by prospective subjects themselves, secondly by expert judgement. In this study subjects were asked to rank the 10 Kansei words from 600 Kansei words those best describe their feelings towards colour. Using these 10 Kansei words 10 pairs of 5 point bi-polar scales were designed. Since these words were selected by test subjects themselves, it was believed that it is easier for subjects to understand the semantic border of the Kansei words and thereby quantify their affect in terms of them.

Individual colours in the colour sample were tested using the selected 10 bi-polar scale set. This test was conducted for second and third time in the interval of two weeks for the purpose of keeping the consistency of data. Results of those three experiments were statistically analyzed and mean values of finalized SD results were taken as final result of the SD data. This data was further analyzed to find the significance of the correlation among the Kansei words and colours accordingly. Furthermore principal component analysis was performed as the data reduction method to identify the basic factors in the study. Thus for this paper only finalized SD data and significance of the correlations were used to illustrate the graphs of variability of colour for the Kansei words. The result of the second section of the questionnaire: colour associations were analyzed and would be discussed briefly in section 5.2.

4. RESULTS

In this section Kansei colour variability graphs are presented as the results (Fig. 1, Fig 2.). Colours were spread among Kansei words according to there minimum and maximum values. Order of the Kansei words were arranged according to the significance of their correlation with reference to a circumplex model which is illustrated in Fig 3a. Adjacent Kansei words are highly correlated. Except in the case of peasant and boring that graph starts from pleasant and end with bored. Although graph appears to have equidistance the distant between adjacent Kansei words vary. Single Kansei words represent a single bi-polar scale and from centre to perimeter mark the two ends of individual bi-polar scales. The values in the graph represent the generalized mean value of the Kansei for respective Kansei word. Centre point represents the minimum value (-2) and the maximum value is 1.5. Figure 3a was a circumplex model which was introduced by Russell in Plutchik and Conte's book on "Circumplex Models of Personality and Emotion" as an attempt to abstract the various different abstract models introduced by various researchers [8]. Figure 3b is an attempt to associate some selected colours in to emotional regions according to their highest intensity towards Kansei words in the Kansei variability graphs. Genre of Kansei words were compared with the emotions in the circumplex model of emotion and recognized the seminaries to compare the intensity of colours in the emotional regions.

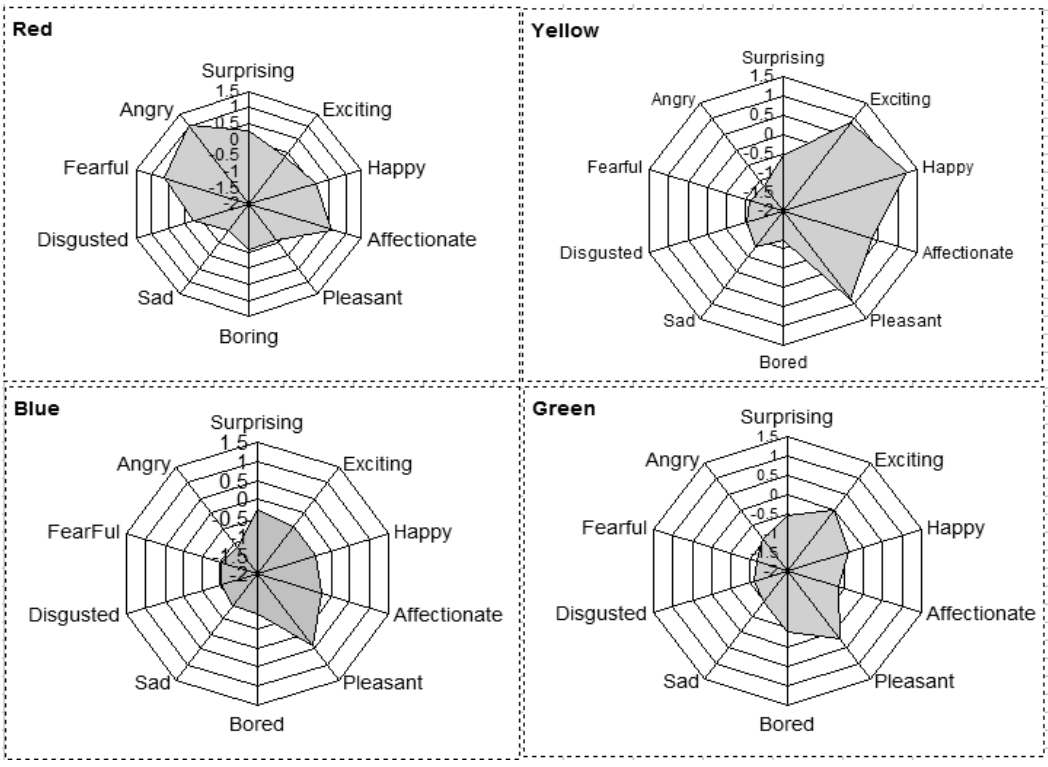


Fig. 1. Illustrate the variability of colours for the selected Kansei words

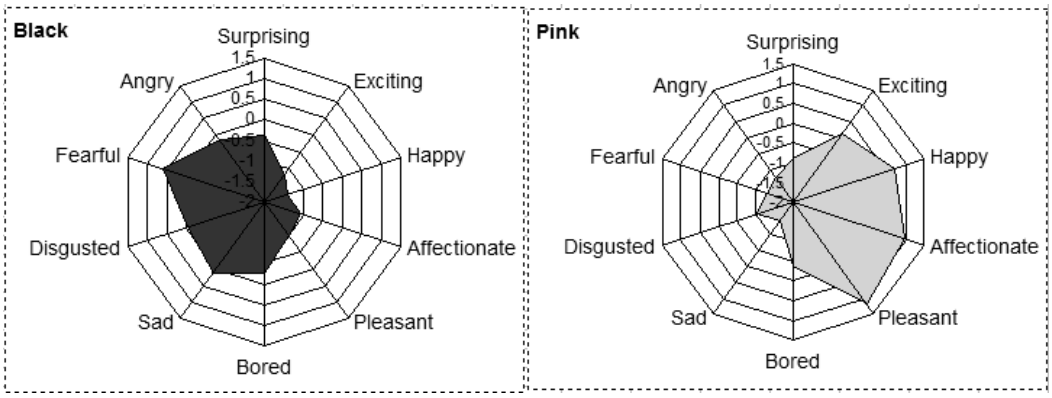


Fig. 2. The variability of colour black and pink. Examples for psychological functioning of colours change according to cultural associations as well as for perceptual appearance

5. DISCUSSION

5.1. VARIATION OF COLOUR ACCORDING TO PSYCOLOGICAL REGIONS

If the results illustrated in the Fig.1 are examined, it can be seen that selected Kansei words have similarities with the emotions that depicted in the circumplex model for emotion [8] Illustrated in the (Fig.3a). Further if Kansei graphs (Fig.1) are compared to Fig.3a, Kansei words can be approximately associated to the regions of the circumplex. Associating Kansei words to the emotional regions make it easer to understand the psychological functioning of the colours. Red and yellow have longer wavelengths. The red colour graph Illustrates (Fig. 1), the variability of red colour for the Kansei words in Kansei variability graph and it is also clear that red colour has a wide spread among Kansei words than the other colour samples which is it is spread in among negative as well as the positive Kansei words. Moreover red colour is more intense towards Kansei word angry and fearful and also it is intense towards Kansei word affectionate. Hence, studying the higher intensity of the colour towards Kansei word angry and in comparison to the figure 3a it can be assumed that red can be assigned to the region of Arousal – Displeasure (Fig. 3b). Furthermore yellow also is a warm colour and has scored higher value for Kansei words in descending order happy exciting and pleasant, which makes yellow more intense towards a positive region of Arousal-Pleasure.

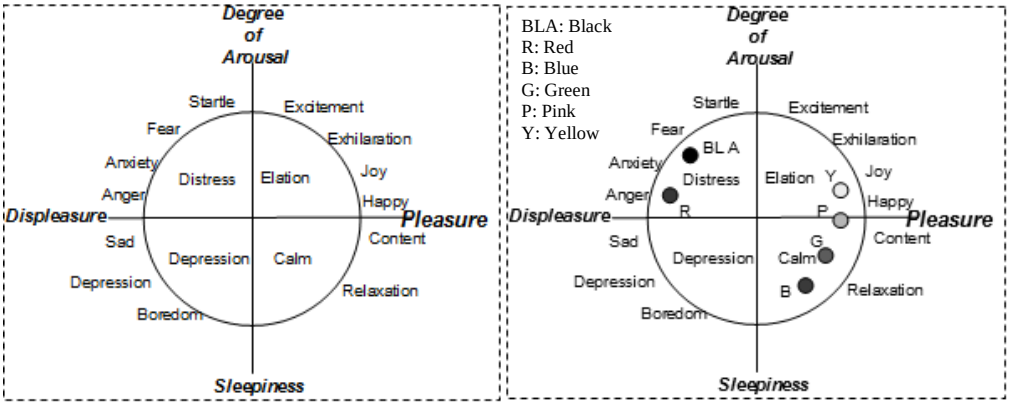
Blue and green have shorter wavelengths; though these colours do not have a prominent spread as similar to yellow and red, they are more intense in between the regions of Arousal-Sleepiness (Fig.3b). Although there is no Kansei word has been selected to represent the region of pleasure and sleepiness, by tilting towards pleasant a Kansei word which has a relaxing nature it can be assumed that blue and green belong to Pleasure-Sleepiness region which is also the region of Calm. Belonging to the Calm region denotes that these colours have a calming effect. Goldstein found out that red and yellow are stimulating and disagreeable colours and that these colours draw attention of people on outward environment and also these colours are forceful, expressive and provocative behaviour. On the contrary, he found that green and blue are restful colours; quieting and agreeable. These colour associations draw people's attention on inwardness and cause reserved and stable behaviours. Therefore, Goldstein's remarks without any alterations confirm the significance of this research. Furthermore Goldstein's idea about nature of colour red, yellow, green and blue justify the variability of colour towards Kansei words in Kansei variability graph. Moreover, verifying the result of this study and the Goldstein's remarks Stone & English say that the colours represented by long wavelengths are arousing whereas the colours represent by short wavelengths are calming [3].

The empirical research which adopts physiological measurement methods also provide evidence that the result of the Kansei test is positive; warm colours in the red colour range arouse genial, positive, active feelings, and neutral colours such as green promote moderate, calm, ordinary feelings, while the cool colours in the blue colour range produce cold, passive, quiet feelings [9]. Another team of researches measured the effect of coloured lights using electroencephalogram (EEG). Responses were monitored while a subject was viewing different colours on a personal computer screen. It was found that in comparison with white and red, beta wave intensity in the occipital areas was inhibited when the subject was viewing blue, which reveals that blue has a more relaxing effect than other colours [10]. Under different coloured illuminations, blood pressure and alpha band power displayed the highest values under the blue condition, while pulse rate and skin temperature were taking the lowest values under a blue light, with the degree of arousal increasing in the order of blue green red light.

The physiological effects of object colour have also been recently reported. The significant skin temperature differences were discovered when the subjects exposed to red, blue, black and white paper (A2 sized). While subjects are viewing the blue papers, the researchers observed beta2 waves in the parietal region and alpha1 waves in the occipital and parietal regions. But when the subjects viewed red paper, beta2 waves were mainly observed in the frontal region [9]. This means that colour causes these reactions due to either the exciting or the calming effect of the colours. All the empirical research knowledge, contributed by different research groups measuring different attributes of the human biological system for psychological functioning of colour interaction is highly related with Kansei result in this research.

5.2. EFFECT OF COLOUR SSOCIATIONS ON PSYCHOLOGICAL PERFORMANCE FOR COLOUR

Some researchers believe, that the colour interaction highly relies on cultural and natural associations rather than an intuitive reaction to colour stimuli. Different colours are presumed to have different associations, and viewing a colour is thought to trigger psychological responses consistent with these associations. I.e. for example researchers found out that black is associated with evil and death in the western culture and therefore lead to aggressive behaviour [3].



a b

Fig. 3. Figure 3a shows the Circumplex model for emotion; Structure that is capable of capturing continuously varying emotions. The model illustrates how emotions, feelings, mood, and related status falls into continuous order around the two dimensional spaces. Adjacent categories are similar categories, categories that are 180 apart are opposite. Center of the space establishes a neutral point. The shortest distance from the neutral point to the location of a particular emotion represents the intensity of that emotion [8]. Fig 3b Illustrates the abstract circumplex model with selected sample colours approximately assigned in to regions.

The clues for this statement can be drawn from Sri Lankan culture, as well. Thus in Sri Lankan culture although black is considered as an evil and dark colour, it was not considered as aggressive, colour but a fearful, mysterious and sad colour. Black is more intense towards Kansei word fearful and it can be associated anti-clockwise to the Arousal-Sleepiness region (Fig. 2). Since the Kansei word fearful has scored higher value for black colour (Fig. 2) it can be considered that black is associated more with Arousal-Displeasure region (Fig. 3b). Red is recognised as a colour which generates warm feelings. (Fig. 1) The warm nature and the cultural connotations of this colour let it have an ambivalent nature. According to the result of this study, red has strong association with negative connotations such as blood, violence, danger, etc. This must be the reason why it is associated with Kansei words such as Angry and fearful. On the contrary, being a warm intense colour red also associates with cultural symbolism for love and affection. This must be the reason why it associates with positive Kansei word affectionate. Hence, cultural as well as natural association of this highly energetic colour might have influenced the selection of Kansei values for these colours (Fig. 1).

On the contrary, Osgood says the relationship between colour and emotion is closely tied to colour preferences, i.e. whether the colour elicits a positive or a negative emotion. Particular colours have been found to be preferred regardless of age, ethnicity, or culture. The perceptually beautiful colour is pink (Fig. 2) and its psychological associations are a better candidate for Osgood's suggestions [1]. Although some researchers point out that colour preference is cultural and even completely individual, the similarity of result of this research and previous empirical studies which accommodated different subject samples and different measuring methods align with each other to greater extent. Therefore this phenomenon should draw the attention to the fact that although there are differences between cultures and personal tastes there are also similarities between them as all of us are human beings. This results obtained from the second section of the questionnaire provides evidence to prove the argument that Kansei is not only measuring individual psychological function but the affectivity which matured through the socialisation.

6. CONCLUSION

In general Kansei measurement methods incorporate both psychological and physiological methods. Thus in this research psychological method, Semantic Differential Analysis was used. The advantages of this method are: it is simple and easy to implement, no expensive high-tech equipments are necessary to use, subjects' can focus on the expected dimensions since the categories are already provided, relatively easily implemented and it is not a difficult concept for lay persons to interact with. Finally it is a more self expressive method compared to other measurement methods, more the bi-polar scales more expressive and up to the point it can be. Therefore although it is an easy and simple method, similar results produced by the other measurement methods discussed in this study reveals that Kansei measurement method in also a strong measurement method to capture psychological functioning of the brain together with sociological influence.

Results reveal that colours show various psychological functioning to variety of emotions. Responses to different colour stimuli are different and some interactions are more affective than the others depending on the nature of the colour. Moreover subjects' affect towards colour is influenced by the cultural and natural association in the subjects' experience background. Colours are used through out many design and other different disciplines. The results obtained from physiological

measurement are not sufficient to understand variability of colour in terms of psychological point of view. This is where more elaborative Kansei psychological measurement methods can be more helpful.

One of the implications of this study is that subjects' affects should be limited to the Kansei words being selected. By allowing subjects to select Kansei words that they think best describe the subject domain, Kansei words were not only restricted to their preferences but also not covering the basic emotional representations as represented in circumplex model for emotion. Furthermore the test subject sample chosen for this study is a group of Information Technology students. Therefore, one of the expected implications is that result should be influence to some extend by their experience and education background. But similar nature of results in comparison to emphatically studies proves that selected samples considerably represent the general affect towards colour interaction.

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