A Review: The Influence of Colours in Work Environments

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ABSTRACT
Understanding the influences of colour on individuals is essential for creating better work environments that result in higher employee performance. The effects of interior colour on employees' mood and wellbeing, which affects their performance, are undeniable and crucial. Many studies indicate that correctly applying colour in indoor work environments can increase employee satisfaction and productivity, increasing company profits. Job performance is defined as behaviours or activities carried out to achieve goals, and it is a behavioural outcome that is influenced by psychology, physiology, and individual preferences. The influence of colours on these issues has received a lot of attention. Therefore, this article examines existing colour literature to provide information on the impact of colours in work environments. The review includes 35 studies from 1959 to 2020, which are discussed in terms of psychology, physiology, preference, and behaviour outcomes to gather the information that can be applied to any environment where individuals perform work activities. The findings suggest that the influence of colours in work environments is unavoidable and requires further investigation and comprehension.
Keywords: work environment, colour psychology, colour perception, colour preference, task Performance

1 INTRODUCTION
Job performance is defined as the behaviours or actions taken to achieve goals (Motowidlo et al., 1999). It is a critical factor in company profitability (Bevan, 2012) and individual task achievement (Muchhal, 2014). Many people spend a significant amount of their waking hours at work. Therefore, the physical structure of a work environment has a substantial impact on employees' job performance, motivation, social relationships, and health (Al-Omari & Okasheh, 2017; Crouch & Nimran, 1989). An ideal work environment allows employees to work in a healthy and comfortable environment. Colour, as an environmental factor, is a powerful design element that can provide these aspects. Understanding how colours affect human psychology and physiology is essential for creating better work environments.

Colour research in the work environment focuses mainly on appraisals such as psychology, physiology, behaviour, and preference. The findings indicate that colour not only has a strong influence on individuals' moods and emotions but has also been shown to improve health and wellbeing. As a result, effective colour use can enhance employees' creativity, productivity, and performance. In addition to the factors mentioned above and individuals' preferences, their perceptions of the environment as a result of colour usage should be evaluated to achieve this improved job performance. This article aims to review the existing related studies to provide information on the influence of colours in work environments.

Mood, emotions, job satisfaction, and individuals' comments on their performance, as well as perceived performance, are classified as 'psychology', while stress level, comfort, and heart rate studies are classified as 'physiology'. The influence of colours on the perception of the environment and individual colour preferences are classified as 'preference', and

outcomes such as productivity, creativity, and overall job performance are classified as 'behaviour'. The research was chosen to fit the subjects mentioned above, with studies in various settings such as laboratories, meeting and hospital rooms, libraries, and virtual reality environments. According to the studies reviewed, colour was applied on multiple surfaces and in various proportions in these environments. While some of the experiments used projection methods to apply colour schemes to an entire room or wall, others examined the effects of colour manipulations on smaller scales such as workstation partitions, computer frames, test backgrounds, and covers. It is also discovered that the effects of different colour properties, such as hue, saturation, and value, as well as different colour schemes, such as chromatic/achromatic and warm/cool schemes, were investigated in these studies. Hue is the characteristic of colour that is determined by wavelength (Öztürk, 2010). Saturation determines a colour's purity, which influences whether it appears pure or pale (Agoston, 1979; Cochrane, 2014). The illuminance level is measured by its value, which is the amount of light reflected from a specific hue (Agoston, 1979). Achromatic colour schemes use only neutral colours such as white, grey, black, and beige (Öztürk, 2010). Warm colours include red, yellow, and orange, while cool colours include blue, green, and purple (Hard and Sivik, 1981).

In some of the studies, the effects of colour were investigated while other factors such as gender and stimulus screening ability were also taken into consideration. The ability to automatically screen less essential aspects of stimulation in various sensory modalities is referred to as stimulus screening (Kwallek et al., 1997). High screeners are those who are best adapted to screening less relevant stimuli in their environments, while low screeners are those who cannot. While high screeners improve their performance in a task when irrelevant stimuli occur, low screeners are distracted by irrelevant stimuli, resulting in a decrease in performance (Kwallek et al., 1997). Differences in an automatic screening of habituation to irrelevant stimuli in the environment can be measured using Mehrabian's Stimulus Screening Questionnaire (SSQ; Mehrabian, 1976), a 40 questions instrument with a 9-point scale (Kwallek et al., 1997). The colour blindness test is another pre-test used in colour research. The Ishihara Colour Blindness Test (ICBT: Ishihara, 1980) is used as an instrument to provide an accurate assessment of colour vision deficiency. It consists of 14 plates, each with a circular image of coloured dots representing numbers (Kwallek et al., 1997). Individuals with normal colour vision can see numbers; however, if they are unable to see the numbers, these individuals are classified as colour vision deficient in colour studies.

The questionnaire method is commonly used to collect subjective data. This technique has been widely used in research on psychological outcomes, preferences, and perceptions. Psychological data is collected to measure the level of arousal, distraction, anxiety, satisfaction, and confusion. Some of the questionnaires used in the colour studies discussed in this paper include the Jenkins Achievement Striving Activity Scale (JA-SAS: Helmreich et al., 1988) and the Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1968). Individual colour preferences, work environment colour preferences and work environment perceptions such as pleasantness, privacy, spaciousness, cosiness, and attractiveness were among the subjects considered to determine colour perception and preference. It has been observed that studies focusing on physiological outcomes include measurement methods such as EEG and EKG, which are used to measure brain activity and heart rate. Behavioural effects were examined under various conditions and evaluated using different methods. Studies show that the level of demand and the task type influence behaviours. Some of the tasks used to assess creativity included story writing, essay writing, drawing and designing, and juries usually measure the level of creativity. Listening, proofreading, anagram solving, word and number-based tasks, visual tasks, typing tasks, clerical tasks, and IQ tests are among the more detailed tasks used to assess productivity and performance in terms of their speed and accuracy.

2 METHOD and PROCEDURE

The search was conducted in various databases, using keywords and phrases related to colour, colour effects, job performance, and work environments to search for titles and abstracts of possible literature. Papers were first eliminated by reviewing the introduction and conclusion chapters, and then full texts were evaluated to exclude documents that did not fit the scope of current research. Finally, 35 papers from 1959 to 2020 that met the criteria were chosen. Selected studies were reviewed regarding the number of participants, duration, methods, colour scheme, colour properties, and findings. Following that, categories and their relationships were determined based on assessments. Finally, four major categories for discussion were developed: psychology, physiology, preference, and behaviour. Table 1 summarises the evaluations of studies and the colours used in these studies.

3 RESULTS

As previously stated, the findings are discussed in four major categories: psychology, physiology, preference, and behaviour. Behaviour outcomes are a result of a combination of other factors.

3.1 Psychology

Sixteen of the 35 research studies examined had psychological outcomes. According to research, red environments are the most arousing (Wilson, 1966; Xia et al., 2016), and orange hospital rooms are more arousing than green rooms (Dijkstra et al., 2008). While red offices have been shown to cause anxiety (Kwallek et al., 1997; Kwallek et al., 1988), another study found that achromatic colour schemes are rated as tenser than chromatic schemes (Öztürk, 2010). Offices with chromatic colour schemes are placed more satisfactorily than those with achromatic schemes (Öztürk, 2010). Participants in blue-green and white offices rate them more satisfying and vigorous than those in red offices (Kwallek, 2005). Furthermore, Kwallek (2005) and Bakker et al. (2013) discovered that the perceived performance is higher in white and blue-green offices and lower in red offices. According to the studies, participants in white offices are the least distracted (Kwallek & Lewis, 1991; Kwallek et al., 1996). Kwallek (1996), on the other hand, found that purple and yellow offices are the most distracting.

Another study discovered that males are more distracted in the red office, while females are most distracted in the green office (Kwallek & Lewis, 1991). Kwallek et al. (1996) indicate that while males exhibit higher levels of depression and anger in high-saturated offices, as well as higher levels of tension in high-value offices, whereas females exhibit higher levels of depression and anger in low-saturated offices, as well as higher levels of stress in low-value offices.

Küller et al. (2009) found that a grey office provides more emotional control than a chromatic office. Red offices are associated with a more positive mood (Stone, 2001; Küller et al., 2009), whereas white offices are associated with a lower level of anger (Kwallek et al., 1997). Research reveals that low screeners rate white offices as more disturbing, negative and depressive (Kwallek et al., 1997), while people in red offices experience depression and dysphoria (Kwallek et al., 1997). While some studies found that blue offices cause sleepiness, drowsiness, and depression (Küller et al., 2009), others found that blue offices are less depressing than red offices (Stone & English, 1998) and provided a more positive mood in private offices (Stone, 2001).

Table 1. Categorization of the research articles

Author(s)	Colour Sample								Assessment			
	red	white	blue	green	grey	blue-green	yellow	other	Psychology	Physiology	Behaviour	Perception
(Ainsworth et al., 1993)	x	x				x			x		x	
(Bakker et al., 2013)	x	x	x						x			x
(Ceylan et al., 2008)							x				x	x
(Cha et al., 2020)	x	x	x	x						x	x	x
(Dijkstra et al., 2008)		x		x				x	x	x		x
(Elliot & Maier, 2007)	x			x	x			x			x	
(Elliot et al., 2007)	x	x		x	x			x			x	
(Ganaw, 2018)	x	x	x					x			x	
(Gnambs, 2010)	x		x	x							x	
(Guilford & Smith, 1959)												x
(Goodfellow & Smith, 1973)	x		x	x	x		x				x	x
(Hatta & Yoshida, 2002)	x		x					x		x	x	
(Jacobs & Hustmyer, 1974)	x		x	x			x			x		
(Kamaruzzaman & Zawawi, 2010)												x
(Küller et al., 2009)	x		x		x				x	x	x	x
(Kwallek, 2005)	x	x				x			x			
(Kwallek & Soon, 2005)	x	x										x
(Kwallek et al., 1997)	x	x				x			x		x	
(Kwallek et al., 1996)	x	x	x	x	x		x	x	x		x	x
(Kwallek, 1996)	x	x		x								x
(Kwallek et al., 2005)	x	x				x			x		x	
(Kwallek & Lewis, 1991)	x	x		x					x		x	x
(Kwallek et al., 1988)	x		x						x	x	x	
(Kwallek et al., 2007)	x	x				x					x	
(Liu et al., 2014)												x
(Mehta & Zhu, 2009)	x	x	x								x	x
(Öztürk, 2010)							x		x		x	x
(Öztürk & Yilmazer, 2010)							x		x		x	
(Öztürk et al., 2012)							x		x		x	x
(Rahman et al., 2017)		x	x	x			x	x			x	
(Stone, 2001)	x	x	x						x			x
(Stone, 2003)	x		x								x	
(Stone & English, 1998)	x		x						x		x	
(Wilson, 1966)	x			x					x			
(Xia et al., 2016)	x		x						x		x	
Total: 35	26	17	16	12	5	5	4	3	17	6	24	17

3.2 Physiology

Electroencephalogram (EEG) and electrocardiogram (EKG) measurements of brain and heart rate activities are used in studies on the physiological and psychological effects of colours. Six of the 35 research studies examined physiological outcomes. Red environments are rated as more stressful than blue environments (Kwallek et al., 1988), and while some research found that red environments increase heart rate, others do not (Cha et al., 2020; Jacobs & Hustmyer, 1974). Küller et al. (2009) found that heart rate is lower in a red environment than in a blue environment and that heart rate increase in a grey environment compared to a chromatic environment. In their study, Jacobs and Hustmyer (1974) revealed that blue environments reduced heart rate more than red, green, and yellow environments. Dijkstra et al. (2008) found that white hospital rooms were rated more stressful by low screeners than green and orange environments.

3.3 Preference

Colour influences how people perceive and prefer spaces. Eighteen of the 35 research studies examined colour preference for work environments, individual colour preferences, and colour perception. Research shows that white and beige are the most preferred colours for work environments (Bakker et al., 2013; Kwallek & Lewis, 1991; Kwallek et al., 1996; Kwallek, 1996; Kwallek & Soon, 2005). In contrast, Goodfellow and Smith (1973) found that blue is preferred as a work environment colour over green, red, yellow, and grey in their study. While red is the least preferred colour for the work environment, purple, yellow, and orange are also not preferred (Bakker et al., 2013; Kwallek et al., 1996). Mehta and Zhu (2009) state that participants in their study preferred blue backgrounds to red backgrounds for both creative and detail-oriented tasks. In accordance, colour preference studies show that blue and green are the most preferred colours over the other colours (Guilford & Smith, 1959; Kamaruzzaman & Zawawi, 2010; Kwallek et al., 1996; Liu et al., 2014).

According to Stone (2001), red and blue private offices are perceived to have more privacy than white, while white open-plan offices are perceived to have more privacy than blue and red open-plan offices. White offices are perceived to be more spacious and pleasant than red and green offices (Kwallek, 1996), whereas blue offices are perceived to have greater potency and social status than red offices (Küller et al., 2009). According to Küller et al. (2009), the grey office is higher in unity, less complex, and less arousing than the chromatic office. Dijkstra et al. (2008) state that white rooms are perceived as more professional, while orange rooms are perceived as more positive.

A study by Ceylan et al. (2008) found that offices with cool colour schemes are more relaxing than offices with warm colour schemes. Chromatic schemes are perceived as more attractive, dynamic, cosy, restful, and pleasant, whereas achromatic schemes are perceived as more organized, simple, monotonous, boring, formal, and harmonious (Öztürk, 2010; Öztürk et al., 2012). Participants in a virtual reality study rated red environments as tense and unpleasant but exciting (Cha et al., 2020), whereas in other experiments, red environments are rated as less dull and brighter (Kwallek & Soon, 2005).

3.4 Behaviour

It has been discovered that environments with low value, high saturation (Kwallek et al., 1996), and chromatic colour schemes have a positive effect on worker performance when compared to high value, low saturation, and achromatic colour schemes (Öztürk, 2010; Öztürk et al., 2012; Öztürk & Yilmazer, 2010). In their experiment, Rahman et al. (2017) tested the influence of colour on memory, using blue, green, yellow, pink, and white backgrounds, and discovered that colour improves retention rate. Except for pink, participants performed better with chromatic backgrounds than with white backgrounds. Pink and white had the lowest recall rates, while green and yellow had the highest (Rahman et al., 2017). Researchers state that workers' speed and performance decrease in black (Ganaw, 2018) and purple work environments while improving in orange workplaces

(Kwallek et al., 1996). While some experiments show that error rates increase in white environments (Kwallek et al., 1996; Kwallek & Lewis, 1991; Rahman et al., 2017), others claim the opposite (Cha et al., 2020; Ganaw, 2018). It has been discovered that, while red has a positive effect on high demand tasks and blue has a negative effect, the opposite is true for low demand tasks, and low demand tasks are better performed with blue and beige (Hatta & Yoshida, 2002; Stone & English, 1998). Experiments show that red has positive effects on detail-oriented tasks, such as increasing speed and accuracy (Küller et al., 2009; Kwallek et al., 2007; Kwallek et al., 1997; Mehta & Zhu, 2009; Xia et al., 2016), while blue has adverse effects, such as decreasing speed and accuracy (Cha et al., 2020; Kwallek et al., 1996; Stone, 2003; Stone & English, 1998). Studies also indicate that blue positively affects creative tasks (Küller et al., 2009; Mehta & Zhu, 2009; Xia et al., 2016).

While high screeners perform better in accuracy and speed in red and white environments, low screeners perform better in blue-green environments (Kwallek et al., 1994; Kwallek et al., 1997; Kwallek et al., 2007) and worse in red environments (Kwallek et al., 2005). After performing a mood test and then a proofreading test, Küller et al. (2009) found that people with negative moods checked longer text but made more errors in a red environment. Red is determined to elicit avoidance motivation, which leads to a decrease in performance (Elliot et al., 2007; Elliot & Maier, 2007; Gnambs, 2010). Gnambs (2010) found that red has a more significant impact on men than on women in their study. Elliot and Maier (2007) found in their experiment using green, grey, black, and red test covers that participants with red test covers knocked on the test room door fewer times on arrival and moved their body to a wider angle from the test when it began. When asked to select the ratio of hard and easy questions they would like to solve, participants with green and grey test covers chose more straightforward questions, whereas participants with green and grey test covers chose more complicated questions (Gnambs, 2010). Mehta and Zhu (2009) found in their study, which was conducted on a computer with a red, blue, or white background, that participants with red backgrounds solved avoidance-related anagrams faster than those with blue or white backgrounds.

4 DISCUSSION and CONCLUSION

There are both consistent and contradictory findings in this current review. According to the researchers, there could be several reasons for the conflicting results. First, duration may not be sufficient in some experiments because it takes time for individuals to form an impression on the effects of their environments, particularly when work environments are subjected to colour, so long-term effects of colour should be investigated. However, individual differences, such as age, gender, and background, may influence participants' perceptions and preferences about their surroundings. Although many studies exist on literature about the influence of colour in work environments, there is a lack of research conducted in natural work environments with actual employees. During this review, it is observed that most researchers experimented with student participation in laboratory settings rather than existing employees in natural working environments. Students' experiences may not be comparable to those of employees, and laboratory environments may not represent the work environment. Almost all experiments were conducted by assigning participants tasks with specific purposes, which may not accurately portray the work environment. Existing research has also focused on a small number of colours, primarily red, blue, and green, leaving a gap in knowledge about other colours and combinations. More research is needed, including studies conducted with actual employees, with more realistic tasks and longer duration, and performed in accurate and specific work environments, during working hours, with varying colour influences.

This review investigated and discussed the influences of colours on employee wellbeing, psychology, and performance. According to previous research, there is a strong correlation between colour and performance. The findings obtained can be applied to any environment where individuals perform a working activity. Colour strongly influences human life; therefore, more research is needed, particularly in work environments. This is because

many people spend a significant amount of time at work and are exposed to the effects of colour, both psychologically and in terms of wellbeing, which has a strong and absolute impact on individual performance and productivity.

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