Theoretical Issues in Ergonomics Science

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ttie20

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Published online: 20 Sep 2013.

To cite this article: Iris Bakker, Theo van der Voordt, Peter Vink & Jan de Boon, Theoretical Issues in Ergonomics Science (2013): The use of questionnaires in colour research in real-life settings: in search of validity and methodological pitfalls, Theoretical Issues in Ergonomics Science, DOI: 10.1080/1463922X.2013.815287

To link to this article: http://dx.doi.org/10.1080/1463922X.2013.815287

Theoretical Issues in Ergonomics Science, 2013
http://dx.doi.org/10.1080/1463922X.2013.815287

The use of questionnaires in colour research in real-life settings: in search of validity and methodological pitfalls

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(*Received 12 December 2012; final version received 11 June 2013*)

This research discusses the validity of applying questionnaires in colour research in real-life settings.
In the literature conclusions concerning colour influences on human performance and well-being are often conflicting. This can be caused by the artificial setting of the test process. Applying questionnaires could also be a cause. To avoid the disadvantages of an artificial setting, a colour research process was organised in a real-life setting. In order to get a better understanding of the validity and possible pitfalls in using questionnaires, the responses to the questionnaires were analysed and compared with findings from observations of respondents' behaviour and additional interviews with the respondents. Discrepancies were found indicating weaknesses of applying questionnaires in colour research. The findings suggest that questionnaires alone are not a fully appropriate tool to establish the colour influences.

Keywords: questionnaires; observations; methodology; validity; social psychology; colour influences

Introduction

Conflicting results in colour research

Much colour research analysing the influences of colour on human beings is being conducted in an artificial setting by employing students performing artificial tasks, using different test materials and measuring different effects by using questionnaires (Elliot et al. 2007; Elliot and Niesta 2008; Bellizzi, Crowley, and Hasty 1983; Maier, Elliot, and Lichtenfeld 2008; Stone 2001). The results are often conflicting (Elliot et al. 2007; Tofle et al. 2004). There are several possible reasons for these conflicting results.

Firstly, laboratory situations are a reduction of the complex physical and social contexts of real-life situations (Vonk 2003). The use of laboratory facilities (such as in Elliot et al. 2007; Moller, Elliot, and Maier 2009; Roberts, Owen, and Havlicek 2010; Bellizzi, Crowley, and Hasty 1983) is often criticised (Tofle et al. 2004), because the effects of colour are highly dependent on its context (Crowley, 1993; Elliot et al. 2007, Maier, Elliot, and Lichtenfeld 2008; Conway 2009; Beach, Wise, and Wise 1988). The effects of colours are for instance dependent on physical context variables such as daylight, space dimensions and textures, and on social context variables, i.e. social interactions are

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different in a natural environment compared with a laboratory situation. Secondly, most colour research is conducted with subjects who are students (such as in Elliot et al. 2007; Elliot and Niesta 2008; Zentall et al. 2000; Read, Sugaware, and Brandt 1999; Roberts, Owen, and Havlicek 2010; Maier, Elliot, and Lichtenfeld 2008; Mehta and Zhu 2009, Wilson 1966, Claessen 1995; Moller, Elliot, and Maier 2009). Colour testing with students' results in selection bias (Sears 1986, in Vonk 2003) as students are not representative for the overall population. The intrinsic motivation of students often differs from subjects in a real-life situation. For example employees are motivated by social and organisational dependencies, whereas students are more interested in having fun (Bellizzi, Crowley, and Hasty 1983) or in getting course credits (Mehta and Zhu 2009; Elliot et al. 2007). Thirdly, it is difficult to compare artificial tasks with real-life task performances, where social interdependencies and organisational responsibilities are involved. Fourthly, in the laboratory settings different coloured test materials are used such as virtual colouring with screens (Mehta and Zhu 2009; Kaya and Epps 2004; Dijkstra 2009); clothing (Roberts, Owen, and Havlicek 2010), slides (Bellizzi, Crowley, and Hasty 1983), colour photographs (Sivik 1973), colour samples like pegs (Claessen 1995) and colour pictures (Wilson 1966). Materials and devices with different characteristics may influence colour research results. An example are the studies of Kwallek et al. (1996) who delivered evidence for the colours red and green as being preferred colours for walls in a physical test environment. Schloss, Strauss, and Palmer (2012) used screens and found evidence for light colours such as white as preferred colours for walls.

Next to these four causes of the conflicting results, using questionnaires could also be a cause. Often questionnaires are used for testing the colour influences on diverse cognitive, emotional and affective aspects (Bellizzi, Crowley, and Hasty 1983; Coad and Coad 2008; Yoto et al. 2007; Lichtenfeld et al. 2009; Stone 2001). Focussing on different topics such as anxiety and pleasure (Verhoeven, Rompay, and Pruyn 2008), stress, attractiveness and professional quality (Dijkstra 2009), and mood, arousal, vigilance and eagerness (Elliot et al. 2007), makes comparison of research findings difficult.

Furthermore, the validity of questionnaires might be questioned. Answers are mixtures of individual opinions influenced by psychological phenomena and contexts (Vonk 2003; Ekman 2008). The question is whether the responses to questionnaires are sufficiently valid in order to be able to draw sound conclusions concerning the influence of colour. In 2004, Hancock and Szalma wondered how we can verify the empirical evidence (Hancock and Szalma 2004). Next to quantitative methods, in addition, qualitative methods have limitations due to, among other things, attitudes of the subjects. Research concerning the application of questionnaires as an appropriate means to analyse the truth indicates that questionnaire findings may have limited validity, e.g. due to a lack of interest of respondents, the fact that respondents not always tell the truth and the unwillingness of respondents to admit certain attitudes or behaviour (Foddy 1993).

In summary, the main drawback of current studies on the influence of colour is that most studies are conducted in an artificial setting using questionnaires as a main method to measure effects.

Testing the validity of completing questionnaires in a real-life setting

From a methodological point of view, an interesting question is whether the influence of colour as a complex phenomenon and as an integral part of the environment, influencing all human senses, can be analysed in an artificial environment with questionnaires. Because people experience colour in real life, the optimal approach to test the influence

of colour is testing in a real-life setting. However, in real-life situations there are other factors that may influence the process of completing questionnaires and the results. Hignett (2001) shows in her human interaction model the complexity of among other things cognitive, emotional, social and physiological influences. Differences in outcomes may be caused by context factors related to the test environments, the test situations and the test processes on the one hand and human characteristics on the other hand. A human characteristic could be a certain level of sensitivity (e.g. Mehrabian and Russell 1974) or being affected by psychological phenomena such as unconsciousness of the environment. These three types of impact factors can be identified as contextual factors, personal characteristics and psychological phenomena.

Contextual factors

Mental processes can only be understood within the context of the interaction between human beings and their situation (Damasio 2006). The way of experiencing the test environment depends on the physical environment subjects are accustomed to. When people work, for instance, in a white-coloured work environment, every new colour will be conceived as irregular and approached rather critical. Also the organisational and social context with their organisational and social norms might affect the process of completing questionnaires. Rafaeli and Vilnai-Yavetz (2004) show the multiplicity of relationships between among other things social, psychological and organisational aspects. Tasks, responsibilities and attitudes influence the way employees observe and perceive the physical environment (Küller 1973). For instance, when an employee with serious responsibilities is involved in a meeting process, his attention is primarily directed to the meeting's topics and not to environmental aspects (Appleyard 1973).

Another serious contextual factor is the test process. Involvement in a specific test process is a special event, which probably might activate attention and enlarges personal status and feelings of importance. As a consequence the test process itself can affect the attitude of the subject and the existing social context.

Personal characteristics

Personal characteristics determine the way subjects experience the physical environmental and the social and organisational context and how they express these experiences in completing questionnaires. In real-life settings differences in environmental sensitivities may result in different experiences of the environment (Mehrabian and Russell 1974).

Psychological phenomena

Psychological phenomena influence the process of completing questionnaires. People are, for instance, unconscious of their physical environment (Dijksterhuis 2007; Schneider 1987), do not tell everything in questionnaires (Vonk 2003) and are unconscious of their own cognitions about the environment (Vonk 2003). In human behaviour 'cognitive dissonance' may play a role: people do not like to have cognitions that are conflicting with each other and try to bring their cognitions into harmony (Festinger 1957). The phenomenon of social desirability bias might have an impact as well. Some respondents' answers to questions may be related to their perception of the social desirability of their answers (Bryman 2012).

The factors and phenomena described earlier are clearly mentioned in the environmental and psychological literature. However, in the literature on the influence of colour, no reflections were found that these factors and phenomena influence the process of completing questionnaires and as such might influence the results and conclusions. The question can be asked if reported results based on completed questionnaires can be conceived as clear and true facts that directly can be connected to the research topic: the impact of colour.

Considering the critical remarks on using questionnaires in the present study, the influence of differently coloured meeting rooms was tested in an existing office and not in a laboratory, with governmental employees and not with students, conducting usual tasks – regular team meetings – and no artificial tasks, and with real coloured walls in a real-life setting instead of artificial materials in a laboratory setting. In order to test the validity of questionnaires to collect opinions about perceived productivity, social cohesion and well-being, the meeting process and the process of applying questionnaires was observed and monitored and analysed so that the aforementioned phenomena could be discerned. The present paper discusses whether the findings from questionnaires were consistent with observed behaviour in order to answer the question: are questionnaires an appropriate measurement to collect the data that can be used to draw clear conclusions concerning the influences of colour in a real-life situation? Due to the complexity of the surrounding environment and more specifically the phenomenon colour, the complexity of the human psyche and psychological processes related to the transformation processes of affect into cognitive verbalisation of perceptions, the hypothesis was that questionnaires alone do not give a valid understanding of the influences of colour.

Method

Test setting

The influence of colour was tested in a real working situation, with two coloured meeting rooms (a red and a blue one) and a standard reference room in a government building in Rijswijk, the Netherlands. Seven regular meeting teams with totally 52 members were observed, each during seven formal routine meeting sessions (in total 49 test sessions). Standard questionnaires were systematically composed based on both former colour research and research on productivity. The government employees completed the questionnaires with statements on a seven-point scale (ranging from strongly disagreeing to strongly agreeing) concerning the meeting productivity, social cohesion and well-being, appraisal of room aspects (including colour) and preferred rooms. The results of this test are published in a separate paper (Bakker et al. 2013) and not presented here because this paper focuses on the validity of using questionnaires in a real-life setting.

Test process: data collection

For collecting data, four questionnaires were used. One questionnaire was administered directly before the meeting (questionnaire Q1), one directly after the meeting (Q2), both in the meeting room. A third questionnaire was disseminated two to three days after the meeting by e-mail (Q3). Two to three weeks after the last meeting session, a fourth end-questionnaire was sent out by e-mail (Q4), asking for personal opinions related to the three meeting rooms (the two coloured test rooms and the standard reference room), such as room preferences and the relative importance of interior elements (among other things

Table 1. Contextual, personal and psychological factors and phenomena that may appear during colour research using questionnaires.

Factors and phenomena	Types	Examples
Contextual	Physical	Being accustomed to the physical environment
	Organisational	Norms and culture
	Social	Social desirability
	Test related	Personal interest
Personal	Personal characteristics	Sensitive to the environment
Psychological	Cognitive dissonance	Reducing differences between two cognitions such as avoiding discrepancies between made remarks and new opinions
	Unconsciousness of the environment	Not knowing the colour of the wall
	Unconsciousness of the own cognitions	Not realising the relation between cognitions and stimuli, such as positive feelings of space not realising what is the cause
	Do not tell everything	Not telling about personal dissatisfaction

colour, inner climate and comfortable chairs). The first three questionnaires Q1, Q2, Q3 were completed by the participants seven times (once per meeting session). The end-questionnaire Q4 was completed only once.

Test process: completing questionnaires

To get a clear insight into the subjects' considerations while completing questionnaires on the impact of colour during the test process, data were systematically analysed on possible bias according to the next table (see Table 1).

Because of the particular interest in methodological validity and possible pitfalls, the full research process was watched closely to be able to establish the validity of the answers mentioned in the questionnaires. Therefore, during the 49 test sessions, the researcher was present. In a research process document, the researcher listed subjects' positions at the table and their behaviour such as communication patterns, duration and number of questions subjects asked during the meeting, time for giving information, laughing and posture. Comments and remarks of subjects and incidents before, during and after the meetings were recorded in a logbook. Directly after the meeting, these data were compared with the data in the questionnaires Q1, Q2 and Q3. Discrepancies between the observed behaviour and statements of the participants during the meeting session and their responses to these questionnaires were captured in the logbook. In four cases showing discrepancies between the observed behaviour and their answers in the questionnaire that were difficult to explain, subjects were personally interviewed regarding the background of their responses. These interviews were conducted one or two days after the meeting session at their private office. Subjects were told that the research was focused on the influence of colours, but that also the processes such as forming opinions

constituted a serious part of it. In summary, three types of documents were used during the test process: questionnaires, a research process document per meeting session and a logbook. As such, the possibility was created to discern any discrepancies between responses to the questionnaires Q1, Q2 and Q3, observations of actual behaviour and findings from additional interviews, which might be caused by the psychological factors and phenomena mentioned in Table 1.

Results

The research findings pointed to ambivalence about the impact of colour that was intended to measure. After analysing the questionnaires Q1, Q2 and Q3, research process documents and logbooks, thirteen discrepancies were recorded between subject's responses to the questionnaires and observed behaviour (see cases below) and/or the interview results, showing ambiguous relationships. Various cases represent discrepancies that refer to more than one person or to a whole team.

Case 1: Light-dark contrast with the previous environment
A meeting team had to wait a while in the sunny corridor before the meeting started. The team members entering the red test room had a discussion about the darkness of the room. They were unanimously convinced of the darkness of the red coloured room. However, the discussion did not have any influence on the mentioned scores in the questionnaires Q1, Q2 and Q3, neither on the rating of the room, the wall colour or the light. The fact that only this time the darkness of red room was discussed was caused by contextual factors: a short period in the sunny corridor caused an enlarged experience of darkness in the room. A possible explanation for not observing any effect in the responses to the questionnaires is that subjects are not aware of the connection between cognition (it is dark) and stimulus (the darkness) and that they pay no further attention to the environment because they were primarily focused on the meeting.

Case 2: Discrepancies in appraisal of the furniture
Many subjects spontaneously made positive remarks about the round shape of the table in the coloured rooms. According to them this shape stimulated human movement and created a pretty space. However, the scores on importance for this item in the end questionnaire Q4 were remarkably low. A possible explanation for the enthusiasm about the shape and the low rating in the questionnaire Q4 is that subjects are not actively focussed on elements of the physical environment and don't remember relations between cognitions and stimuli.

Case 3: Dissatisfaction with the meeting topic
Directly after one of the meetings subject A told that he was not satisfied about the approach of the meeting topic. Nevertheless in questionnaire Q2 and Q3, the scores regarding satisfaction about the meeting, the meeting process, results and productivity were all positive. When asked about his answers, he admitted that he gave high scores although he was not satisfied. Because he could not change the situation in the complex government organisation, he opted for the scores he thought as being generally accepted in connection with his function, job responsibility and organisation culture. He chose the scores as he thought other people expected him to make that did not necessarily correspond with his personal opinion. The effect is related to several factors and phenomena: impact of the organisational culture and generally accepted norms, social desirability and the phenomenon that people don't tell everything.

Case 4: Irritation about unclear decisions during the meeting
Subject B several times asked the chairman to make more clear decisions; however, no decision was made. Surprisingly subject B completed both questionnaires Q2 and Q3, with positive scores regarding the meeting results, meeting process and productivity. In an interview later on, subject B told that he was not satisfied but he could not change either the person or the situation. Low scores would not change this situation, so he decided to choose what he called 'normal' scores. These scores were not a valid representation of his personal opinion but were influenced by organisational culture, generally accepted norms, social desirability and the phenomenon that people do not tell everything.

Case 5: Dissatisfaction with the team process and the results
After a meeting, subject C told that he was not satisfied about the team process, the meeting and the results and more specific the input of his colleagues. Nevertheless the scores in questionnaires Q2 and Q3 were positive. In an interview with him later on, he told that his opinion did not matter at all and that he could not change the quality of the organisational process. He filled out high scores corresponding to his perceived job context and job responsibility. His responses can also be conceived as a result of organisational culture, generally accepted norms, social desirability and as such did not show his personal opinions.

Case 6: Interruptions
During a meeting, subject D could not accomplish his own presentation because one of the team members took over. An analysis of the answers of subject D did not show any differences with his scores in other meetings on the items 'I felt respected by the others' and 'They listened to me well'. No clear correlation exists between the incident during this particular meeting and the scores filled out in the questionnaires Q2 and Q3. Possible explanations are that he was used to being treated this way in the organisation and the person who interrupted him or personal characteristics such as being a shy.

Case 7: Getting compliments from colleagues
In one meeting a substitute chairman (subject E) was asked to chair the meeting, because the regular chairman could not be present. At the end of the meeting one of the members told him that he was so happy because now he had felt someone was really listening to him and this had never happened before. The other team members agreed. However, the substitute chairman, who is a regular team member, filled out neutral scores in questionnaire Q2 and Q3, on the item 'I felt respected by the others'. In comparison to his scores in the questionnaires Q2 and Q3, regarding all other meetings, no difference was found although this time he got many compliments. Probably subject E, being the chairman only once, mainly paid attention to the process as being his responsibility. Another cause could be a personal characteristic (for instance being modest) or that subject E is unconscious of his own cognitions.

Case 8: Negative opinions versus positive scores
After a meeting in the blue room, subject F told that he was fond of the colour blue but he did not like the light. In contrast with this opinion, both scores in questionnaire Q2 and Q3, regarding light intensity and light colour were positive and did not differ from the scores in the other rooms. In an interview afterwards, subject F told he was satisfied about the meeting so he also mentioned satisfaction concerning the environment, although on a conscious level he was not content with this environment. His score is primarily based on his focus on the meeting and has nothing to do with the environmental conditions.

Case 9: Lack of interest: copying of responses
It turned out that some subjects did not complete all questionnaires Q1, Q2 and Q3 quite seriously. For instance, subject G copied his scores in questionnaire Q1 into questionnaire Q2. He got critical comments from his team members and his data was not used in the analysis. This example is related to his attitude to the research: subject G is not seriously committed to the research, or there is no personal interest.

Case 10: Responding (too) quickly
Subject H completed the questionnaires Q1, Q2 and Q3 rather quickly and after a check by the researcher it appeared that during the complete test process subject H used almost the same scores. It is questionable whether these answers really reflect his opinion or are more or less standardised because he was not seriously committed to the research, or there is no personal interest.

Case 11: Apologies for not having any colour preference
Subject I told the researcher that he was very sorry that he had no colour preference and that he mostly liked the reference room. The reason for apologising could be that he felt affection for the researcher and/or assumed that the researcher expected him to have a colour preference or that he thought the researcher tried to find evidence for colour preferences. In the additional interview, subject I told that he was convinced that the researcher had a colour preference and expected him to have one as well. This seems to refer to the so-called interviewer effect, trying to please the interviewer, in this test the researcher. In many types of researches, the interviewer effect seems to have influenced the findings (Davis et al. 2010; Dykema et al. 2012; Johnson and Parsons 1994; Huddy et al. 1997).

Case 12: Mentioning colour perception
While completing the questionnaires Q1, Q2 and Q3 during the meetings, at least 30% of the subjects looked up and around. May be these subjects recorded their individual colour perceptions and not their actual experiences and actual feelings. People may be not sensitive for their environment, unconscious of the environment or unconscious of their own cognitions.

Case 13: Impact of the chairman
For the first time entering the test room (in this case the red room), one chairman called out loudly ‘what an awful colour’. Consequently, he gave the red wall a low score and the blue wall a high score. Maybe his scores were influenced by cognitive dissonance reduction: it is possible that during the meeting the chairman realised that the colour red was not as bad as he at first thought. However, because he was aware of the fact that the other team members had heard his remarks, he may have felt forced to mention that red was awful. Although this possibility exists, it cannot be proven with any certainty. Furthermore, the remark of the chairman may have influenced the opinions of the other team members as well and as such made employees being inclined to give the same ‘socially desirable’ answers.

These cases can be related to the contextual, personal and psychological factors and phenomena that were discussed in Section ‘Introduction’ (see Table 2).

Per case the specific contextual, personal and psychological factors and phenomena are marked (black) that may be a cause why answers in the questionnaire Q1, Q2 and Q3 are not in accordance with subjects’ behaviour and/or interview results. Three aspects – marked grey – play a role in all cases. Firstly, the physical environment the subjects are accustomed to determines how people judge their new environment (Vonk 2003). Next, two test related issues always play a role: the attitude of the subject (whether the subject

Table 2. Contextual, personal and psychological factors and phenomena that may have influenced the responses to the questionnaires.

Factors and Phenomena	Types	Observed factors and phenomena	Cases 1	2	3	4	5	6	7	8	9	10	11	12	13
Contextual	Physical	Being accustomed to the physical environment	■												
	Organizational	Norms and culture		■	■	■	■	■							
		Attention to performances	■						■	■					
	Social	Social desirability			■	■	■								
	Test related	Attitude	■	■	■	■	■	■	■	■	■	■	■	■	■
		Affection to the interviewer											■		
		Personal interest	■	■	■	■	■	■	■	■	■	■	■	■	■
Personal	Personal characteristics	Psychological factors						■	■						
		Sensitive to the environment												■	
Psychological	Cognitive dissonance	Reducing differences between two cognitions Such as avoiding discrepancies between made Remarks and new opinions													■
	Unconsciousness of the environment	Not knowing the color of the wall												■	
	Unconsciousness of the own cognitions	Not realising the relation between cognitions and stimuli, such as positive feelings of space not realising what is the cause	■	■					■					■	
	Do not tell everything	Not telling about personal dissatisfaction			■	■	■								

■ Influencing factors and phenomena described in the cases

■ Factors influencing all cases

is serious, interested or involved) and personal interest (do subjects attach any importance to the research).

Time of responding

The correlation between the overall appraisal of the meeting room and the appraisal of the interior elements directly after the meeting was highest for wall colour and lowest for temperature and air quality (see Table 3). Directly involved in the research process and knowing the research topic, the subjects related their appraisal above all to wall colour, and least at the aspects of the inner climate such as temperature and air quality.

However, asking subjects after all test meeting sessions to rank the relative importance of 12 different interior aspects (Q4), subjects assigned a low score to wall colour (see Table 4) and highest scores to temperature and air quality. Male subjects ranked wall colours at the tenth position and female subjects at the eighth. These data are comparable with the work environment factors analysed by Dul, Ceylan, and Hendriks (2007).

Valuing the room is based on valuing elements or parts of it. High correlations with the test aspects colour of the light and colour of the wall indicate that the appraisal of the room is influenced by these test aspects and that subjects attach importance to these aspects. However, the same subjects attached opposite importance at the room after all sessions. Apparently, the moment of completing the questionnaires affects the opinion about the importance of the interior elements.

Discussion

Analysing the research process carefully, evidence is found for confirmation of the hypothesis that questionnaires alone do not give a valid understanding of the influences of colour. Causes are probably due to the complexity of the surrounding environment, the complex phenomenon colour itself and the complexity of psychological processes regarding the transformation process of affect into cognitive verbalisation of perceptions. Remarkably, most subjects did not show any colour preference at all. When at the end of the test process all subjects were asked to mention their colour preferences in the end

Table 3. Inter item correlation matrix. Appraisal of the meeting room and wall colour showed highest correlations.

Interior elements	Correlation between appraisal of the meeting room and appraisal of interior elements directly after the meeting
Top desk table	0.551
Wall colour	0.789
Light intensity	0.569
Temperature	0.385
Air quality	0.402
Light colour	0.720

questionnaire Q4, 63% of the male subjects and 61% of the female subjects admitted they had no favourite wall colour.

Time of responding: influence of the test process

At the moments that the subjects were present in the test environment and more directly involved in the research process, the responses to the questionnaires showed a high correlation between the appraisal of the room and the appraisal of the wall colour and a low correlation with the appraisal of the inner climate. On the contrary, two to three weeks after all test meeting sessions, when subjects had more distance to the research process, wall colour did not play an important role in valuing the room (see Table 4) and temperature and air quality got highest scores (Q4). Apparently, the test setting influences the results. When participants completed the questionnaires Q1, Q2 and Q3 they were in the test room with the researcher being present as well that both accentuated the colour issue of the research. The end questionnaire Q4 was completed in their own room at a distance from the test rooms and without the presence of the researcher. In this situation colour being the research topic was less accentuated or partly forgotten. Moreover, in the existing building some problems existed on the inner climate. When completing Q1, Q2 and Q3 specific attention was paid to the research topic and not to the regular inner

Table 4. Relative positions subjects assigned to interior elements.

Order	Men	Women	Total
1st	Air quality	Air quality	Air quality
2nd	Temperature	Temperature	Temperature
3rd	Chairs	Daylight	Daylight
4th	Light intensity	Light intensity	Light intensity/chairs
5th	Daylight	Light colour/chairs	Light intensity/chairs
6th	Acoustics	Light colour/chairs	Acoustics
7th	Light colour	Acoustics	Light colour
8th	Shape table	Wall colour	Shape table
9th	Colour tabletop	Shape table	Wall colour
10th	Wall colour	Plants	Colour tabletop
11th	Plants	Art	Plants
12th	Art	Colour table-top	Art

climate problems, while at the time of completing Q4, the regular office situation with the inner climate problems got more attention.

Impact of a close contact between the researcher and subjects

In order to be able to understand the answers in the questionnaires Q1, Q2 and Q3 and to interpret the thinking processes of the subjects translating their opinions into the questionnaires, the researcher had to be present during all meeting sessions. Due to the continuous presence of the researcher, a kind of relationship developed between the researcher and the subjects. For instance, some test persons apologised for not having any preference for a specific colour or for preferring the neutral 'reference' room (see case 11). It seems that these subjects assumed that the researcher was expecting them to have a colour preference or that the researcher had a colour preference herself. Indeed, when the researcher asked subjects if they thought that the researcher expected that colour had any effect, all subjects answered positively. Probably these ideas have influenced the opinion of the subjects and the responses to the questionnaires. It is possible that more subjects mentioned a preferred colour than they otherwise would have done. This phenomenon is known as the interviewer effect (Choi and Comstock 1975).

These considerations have to be taken into account in colour research. The colour research process itself is complex and process aspects such as time and role of the interviewer, both possibly influence the results.

Conclusions and recommendations

It can be concluded that the responses to questionnaires are not always a clear representation of subjects' opinions. Using these answers in colour research, it is not in all cases possible to draw valid conclusions on the colour influences. The responses to the questionnaires Q1, Q2 and Q3 can be considered as a contamination of feelings, cognitive thinking and psychological considerations by the subjects.

All mentioned factors and phenomena have influenced the answers subjects completed in the questionnaires. It can be concluded that responses to questionnaires used in colour research in real-life settings are a result of complex considerations, which makes it difficult to draw clear, reliable and valid conclusions about the influences of colour. The present research in a real-life situation showed evidence about the risks of wrong interpretations of data from questionnaires. Questionnaires alone are no valid instruments to give a clear insight into the influences of colours applied in the physical environment in real-life situations.

A general recommendation concerning both colour research and other research using questionnaires is to include other sampling techniques. For instance making use of beeping from a pager to define the moments that participants are asked questions with relatively quick responses reduces the effects of influences of context factors (Csikszentmihalyi 1999). Some specific recommendations can be given to conduct colour research in real-life situations that more clearly indicate influences of colours. The context has to be kept simple. It is important to locate the test rooms in the inner space of the building in order to avoid the impact of changeability of daylight.

Real-life settings within an organisational context can bring a range of emotional, social and organisational aspects that may influence the answers to questionnaires. Hignett and Wilson (2004) emphasise in their model showing the interactions between multiple dimensions, the importance of social influences. As such, questions that could

be related to the complex social context should be avoided while questions concerning personal aspects are more preferable. Due to the often white (Kwallek and Lewis 1990) and colourless environments in offices, a period of at least three months is necessary to get accustomed to the test colours. The chance that subjects will guess the research topic will be smaller and subjects will experience the surrounding colours in a more natural way and less as a special test event.

The influence of the presence of the researcher – to be able to observe what is going on – could be avoided by using cameras. However, this also could influence respondents' behaviour. Physiological measurements, which easily can be applied without any bodily irritations or barriers, like measurement of Galvanic Skin Response, could be added for reasons of triangulation. If these kinds of measurements and responses to questionnaires result in similar findings, reliability and validity of the conclusions will be improved. When using questionnaires, it is recommended to interview subjects directly after completing the questionnaires to get a better understanding about motives. Taking all these recommendations into account, the validity of the findings, i.e. the possibility of finding the real influences of colour, will be increased.

Acknowledgements

We especially want to thank all 52 employees of the government organisation in Rijswijk, the Netherlands, who completed questionnaires during seven meetings. We realise people have a serious workload and we sincerely appreciate their help. Moreover, we want to thank the employees of the Facility Management Department who arranged all meeting sessions in the proper test meeting room and who helped us with the furniture, light and equipment. We are also grateful to Gerry Hofkamp from the Government Building Agency and Adrian Smith, housing advisor at the Government organisation where the test was carried out. Three enterprises have helped us to arrange the test meeting rooms: PPG painted the two rooms, Philips advised on the lighting systems and Ahrend placed different tables with different top desks. Especially, we want to thank Leo Faasen, colour specialist at PPG for his colour advice. Finally, we want to thank the specialists Gabrielle den Hengst, TNO Hoofddorp, and Gwendolyn Kolfschoten, Delft University for Technology, for advising us concerning meeting processes and the set-up of questionnaires.

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