Creating Sensory-sensitive Creative Spaces

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ABSTRACT
This paper gives some examples of the impacts of light and colour on building occupants and then highlights that these are only two out of many factors. A coordinating framework is then proposed, derived from the basics of brain functioning, which suggests the importance of: naturalness, individualisation and level of stimulation as key design principles. This is used to elucidate the interactive nature of light and colour considerations with other design parameters as they come together around practical options in the context of school buildings. Lastly, the appropriateness of different levels of stimulation is explored, using the example of the design of spaces to support processes of creativity.

Keywords: Colour, Creativity, Design, Implementation, Light

1. INTRODUCTION
It is well known that light and colours can have profound impacts on human functioning. It is equally significant that these aspects of the built environment cannot be seen in isolation given the holistic experience of spaces that humans inevitably confront in their lives. The next section highlights some of these tensions.

2. LIGHT AND COLOUR IMPACTS ON CREATIVITY AND LEARNING

2.1 Light impacts
A good example of the huge potential impact of light is contained within the work of The Heschong Mahone Group. In 1999 [1] they studied the impact of daylighting on learning in schools they looked at 21,000 elementary school pupils and classified 2000 classrooms for their daylighting levels. Controlling all other influences and using multiple linear regression analysis, they found positive correlations between the variables: that students with the most daylight progressed 20 per cent faster in mathematics and 26 per cent faster in reading compared with those with the least. However, where natural daylighting is not available special artificial lighting, if it emulates the full spectrum of sunlight, can be used to tap into natural circadian rhythms with powerful impacts on involuntary emotions, evidenced particularly in the medical domain [2-4].
2.2 Colour impacts
Even within one factor, such as colour, there are many complex considerations. Central to the impact of colour is the curvilinear issue of avoiding over- or under-stimulation through the degree of complexity or unity (uniformity) employed [5]. When selecting colours, the nature of the task is relevant. For example, in schools, cooler hues have been found to be good for concentration [2]. Other studies have shown that intensity of colour, unity of colour schemes [6] and contrasting end wall colour [7] are also influential. Considering personal preferences, Heinrich [8, 9] carried out psychological colour tests on 10,000 children in age bands from 5–19 years and found, for each band, their preferred colours for their school environment.

2.3 Tensions with other dimensions
The above considerations are important, but so too is the context within which design solutions seek to take into account these discrete factors. For example the very positive 1999 Heschong Mahone Group findings concerning light were reversed when there was glare from certain designs of skylight. Furthermore, another study by the same group in 2003 [10] of different schools in a different climate, found daylight was not significant in predicting performance. Further analysis showed that other characteristics associated with daylighting, which did not exist in the earlier studies, such as noise, were affecting performance through a counteracting negative effect. These examples highlight the interactivity and the fragility of impacts at a practical level.

Boyce et al. [11] compound this complexity when they argue that the ‘biophilia hypothesis’ ought to be investigated to understand better the role of windows and the relative impact of a view out versus letting daylight in (p68). A further consideration from the individual’s psychological point view is their position within the room such that there is often a battle between the desire to be close to a window versus the problem of glare [12].

Some of this complexity, around light especially, is evident in a recent survey by the authors of teachers in five UK
schools, which elicited views on various aspects of their schools’ performance as shown in Figure 1 below (where 5 is very positive and 1 is very negative).

It can be seen that they generally feel they have “sufficient” natural light, but actually do not have “good” lighting without a heavy dependence on artificial light. The issue of glare varies considerably and on further analysis is closely linked to ease of user control of blinds etc. The perception of air quality, and especially temperature, varies across the schools and is closely dependent on the orientation of windows, linked to heating controls, and the windows function as a source of fresh air. In practice every positive factor (eg natural light) carries possible negative implications (eg glare) and links to other practical issues (eg windows for ventilation as well as light) as well as the consequences of user behaviour (eg control of heating).

This interactivity poses both challenges and opportunities to the design process. To better support optimal design an overarching integrating model of the design implications of various options on human functioning would be beneficial.

3. HOLISTIC ANALYTICAL FRAMEWORK

To better understand the relationship between complex human sense experiences and their powerful effects on human functioning, we can turn to evidence from neuroscience for clues as to the mediation performed through brain functioning.

3.1 Neuro-science perspective

Rolls [13] argues that human behaviour is ultimately motivated by ‘primary reinforcers’, drawn from our external experience, that are related to survival needs, such as: for clean unputrified air, bounded temperature, the absence of natural dangers, light, shelter, reasonable stimulation and food hoards. This sensory information about the world is collected as raw data that then enters the orbitofrontal cortex of our brain where the value of the environmental stimulus is assessed. This appears to happen by a pattern-matching process (p148) against alternative strings of neuronal associations that are built up and progressively updated. This individual learning process links the elements of situations observed to the built-in primary reinforcers, so giving previously neutral inputs reward value as ‘secondary reinforcers’ (pp62–67), for example, the sight of food rather than its taste. Building on this basic architecture in the brain it is proposed that three design themes can be seen to emerge[14].

First, as our emotional systems have evolved over the millennia in response to our natural environment, it does not seem unreasonable to suggest that our comfort is likely to be rooted in key dimensions of ‘naturalness’ that are reflected in primary reinforcers in our brains and should, therefore, infuse the design process. The stress here is, of course, on the positive aspects of naturalness, such as clean air. Second, the brain functioning described above highlights the personal way in which individuals build connections between primary reinforcers and complex representations of secondary reinforcers. Taken together with the situated nature of memory, these personal-value profiles lead to highly individual responses to space. This provides a sound basis to raise the potential importance of ‘individualization’ as an additional, key, underlying design principle. Third, lying behind the detail of design elements for
3.2 Design implications for light and colour

Using this broad framework Barrett and Zhang [15] developed the table of design implications for primary schools shown as Fig 3. The process for this was first to create a theoretical x-axis based on the above design principles, amplified into design parameters, such as light and colour amongst others. This was set against a theoretical y-axis of practical options and the cells of the table so created were populated from an extensive range of exemplar case examples gathered from the literature. This process highlighted various dimensions of the axes that did not actually appear to be important in practice as they linked only to blank cells in the table. Through an iterative process the axes were simplified and refined to represent just the major relationships, and only dimensions linked to at least one of the exemplars in the body of the table (the decimal numbers in the table are cross-references to more detailed sections in the report).

This process resulted in a broad arrangement of the “practical options” into a list that follows the design process from the selection of location onwards, split into decisions about plan and envelope and then decisions about the spaces within. The arrangement of the three design principles with subsidiary design parameters also became more focused. In the context of this paper the aspect to be highlighted is the positioning of “light” and “colour”, as this is a practical example of how these aspects are contributors to broader design principles, but also how they need to be synergized with other design elements as practical design options are chosen.
Thus, the design element of “light” comes within the design principle of “naturalness” and calls for early choices to be made about the location and orientation of the building and the design of the fenestration. Related design elements relevant to the particular practical option are highlighted, for example decisions about windows also concern temperature and air quality. The design element of “colour” comes within the design principle of “level of stimulation” and links to choices about the external appearance of the building and the internal spaces of rooms and circulation areas. Again there are cross-connections in realizing practical designs, in this case between colour choices and the level of complexity desired and alongside decisions about individualization.

This process was orientated specifically at primary schools and their performance as places that support learning. It would be interesting to carry out a similar exercise for other building types and to compare the results. It is hoped that the explicit location of light and colour amongst other parameters, and against common practical options, can contribute to these aspects more positively contributing to important human needs within the design process.

3.3 Levels of stimulation for creative spaces

More than the other two design principles, “levels of stimulation” is not simply a good thing, but depends on the sort of activity being supported. This is now briefly explored, using the example of the design of spaces to support processes of creativity. It would seem intuitively obvious these spaces should be stimulating.

However, the innovation literature indicates that, for effectiveness in practice, cycles of chaotic, divergent and stable, convergent behaviour should be supported [16]. It is suggested that these cycles repeat at various stages, and that the ability to switch gears is intrinsic to successful innovation. In simple terms the divergent phase would seem to call for a stimulating environment, but the convergent phase for a more calming and deliberate context. Ideally switching of behaviour would be “enabled” by cues in the built environment. An interesting perspective on this is given by Nasar’s [17] criteria for building design competitions and their likely impact on occupants’ perception of pleasantness, relaxation and excitement (see Fig 4: where +5 is v positive and -5 is v negative)).

From this it can be proposed that light and colour can have significant design roles by contributing in different ways to:

a) environments for stable, convergent behaviour where – access to natural lighting links to views of deflected vistas. In addition colour is used to reinforce: familiarity and coherence, whilst both lighting and colour are used to minimize the prominence of built elements.

b) environments for chaotic, divergent behaviour where – lighting and colour
are actively used to undermine coherence, contribute variety / atypicality, and to accentuate built elements and visual nuisance

This sort of thinking is central to the current design of a Think, Play Do Zone at the centre of MediaCityUK (http://www.firm-innovation.net/), where a coherent facility that links these diverse requirements is being created.

5. CONCLUSIONS

Light and colour are very important design parameters with distinctive impacts on human functioning. For these to be optimally realized in practical design solutions they have to be seen in the context of a wide range of other parameters. And these need to come together around the practical options available to provide safe, comfortable, sustainable and stimulating environments as called for in the European Construction Technology Platform Strategic Research Agenda [18]. It is hoped the design principles of: naturalness, individualisation and level of stimulation will be found to have utility in addressing this challenge. The author would be pleased to receive feedback on this approach and, more specifically, any suggestions for the on-going design of the Think, Play, Do Zone.

REFERENCES