A Meta-Analysis of Color Effectiveness in Designed Environments

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ABSTRACT
What constitutes “color effectiveness” in built environments? To address this question we developed a Meta Analysis of color in built environments reflective of color evolution across history intent and application. From early notions of color as enabler of navigating the physical and social environment, color has evolved into a conscious tool used to maximize diverse interests, including enhancing productivity, fostering healing and manipulating desire. Once culturally contextualized and geography dependent color now addresses cross-cultural needs and is influenced by technical advancements that dramatically alter its use and perception in what is becoming quasi-universal man-made environments in global markets. We examine color use in a cross-section of environments: work, education, healing, and retail and hospitality typifying the effectiveness goals that color attempts to support in each of these settings, and proposing a framework to assess color intent usability and efficacy. (998 characters with spaces).

1. INTRODUCTION
A comprehensive literature review was conducted to identify the state and strength of knowledge regarding the role of color in healing, learning, retail, hospitality and working environments (workplace and learning environment to be presented here)¹. While the notion of color impact enjoys tremendous appeal, the limited empirical research on the subject portrays ill-supported and inconclusive evidence that color actually does matter. This discrepancy between collective wisdom and scientific perspective on color effect is intriguing and begs questions regarding the conceptualization and methodologies employed for researching color. Interest in the topic of environmental design and specifically the effect that color might have in such context has grown steadily over the years in the field of environmental psychology. Environmental psychologists studied physical environments and their effect on human emotions and behaviors such as work performance or social interaction (Mehrabian & Russell [73]). At its early days, environmental psychology was nothing more than an intuition-driven, small-scale research program. As Proshansky, Ittelson, and Rivlin [85] commented, as a field, environmental psychology suffered from no conceptual definition or adequate theory. Yet with the years, this area began to attract considerable research attention. For example, in studies of hospital environments, patient recovery rates, social behavior, and sense of well-being have been discussed as functions of special arrangement of patients, architecture, room decoration and furniture arrangement (Goffman [50], Proshansky, Ittelson, & Rivlin [84]). Such works and many others (Babin, Hardesty, & Suter [10], Basoglu [13],
Bitner [20], Harleman, Werner, & Billger [55], Izumi [58], Kotler [60], Pelgrim et al. [81], Pritchett argued for psychological or social stimuli in the environment that directly impact the emotional state of a person, thereby influencing his responses to and behaviors in it [84]). Mehrabian [72] turned first to studies of perception identifying basic emotional responses to environments along three dimensions: pleasure-displeasure, degree of arousal, and dominance-submissiveness. Such a finding was powerful in that it presented emotions as the common denominator of response to environments relevant both to any aspect of environments and to most aspects of human behavior. This significant breakthrough gave researchers an anchor on which to build the argument for environmental impact; it legitimated the interface between design and psychology; and it brought to the fore the question of how to design for desired emotionality and, several decades later, the question of how to design for experience given that most experiences are (also and mostly) emotional. Within that context, the search for design levers led some to identify color as the most appropriate design lever to attract and affect emotions (Mehrabian & Russell [73]).

Our inquiry mapped considerable volumes of literature pertaining to working, healing, and learning environments for the possible role that color might play in these contexts. While reviewing the various works, it occurred to us that in order to understand the value color brings to these environments, we also must understand what constitutes “effectiveness” in these three different contexts—what effectiveness means for healing, learning, and working. We therefore also reviewed literatures that discussed the current state of knowledge pertaining to this question.

II. WORKING ENVIRONMENTS

a. Overview: Most of the literature in this area begins with the presupposition that the world of business is changing and so is the way we work; yet most of the work environments in which we perform our jobs have not made the necessary adjustments to reflect these contextual changes (ASID [5], Barber, Laing, & Simone [11], Becker, Tennessee, & Dahi [17], Budd [29], Pollack [82], Schweitzer, Gilpin, & Frampton [92]). Researchers discuss, and at times debate, the relative advantage and/or relevance of open versus private spaces (Becker & Simms [18], Bencivenga [18], Christian [37], Kupritz [61], Lohr [66], Maher & Vonhippel [68], Vanecko [104]). It is believed that both open and private spaces are required and their usability is largely contingent on the type of task performed. The literature further discusses workplace elements identified as essential. These elements include accessibility to resources, knowledge and ideas; privacy for individual work; emergent interactions to foster exchange; the appropriate integration and use of technology; and, flexibility and configurability of furniture to support collaboration (ASID [3][5][6], Asirvatham [7], Augustin & Brand [8], Becker, Quinn, Rappaport, & Sims [15], Lane [64], Sunstrom, Burt, & Kamp [98], Veitch [105], Veitch & Gifford [106]).

b. Color: Research on color in work environments is very limited in volume and contribution. For example, effectiveness was tested under different color conditions in three studies only to generate inconclusive and at times contradictory findings (Chou et al. [36], Kwallek, Lewis, Lyn-Ahsiao, & Woodson [62], Kwallek, Woodson, Lewis, & Sales [63]). In another set of studies, subjects were surveyed to identify color impact opinions (ASID [2], Avery-Office-Products [9], Stone [96]) again no conclusive results emerged as to the perceived impact of color. The literature describes in broad terms cases where companies redesigned their office environment using mute, bright and/
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or corporate colors but provides no further specification of color notation used and/or effectiveness measurements employed to trace the potential impact of certain color selections (ASID [4], Henderson [57], McGuire [70], Southerst [94], Tetlow [100], Webb [108]). These descriptive accounts provide only limited insight into the actual power of color. Furthermore, while the empirical research on color impact is limited, the majority of accounts reviewed were classified as “commentary” and lacking rigor (for example, (Nayar [77], Nebenzahi [78], Trent [103], Ward [107], Weder [109]).

**c. Effectiveness:** Together with the empirically oriented literature, many commentaries were noted describing real-life cases, primarily throughout the 1990s, where companies redesigned the work environment (mainly their headquarters) to enable and/or support strategic change (Bencivenga [18], Blum [22], Bouteille [23], Cameron [31], Christian [37], Hamilton, Baker, & Vlasic [54], Henderson [56], Lohr [66], Millford [74], Morris [76], Russell [89], Southerst [94], Tofle et al. [102], Webb [108], Wright [114]). These accounts show a growing recognition of a workplace as a strategic lever yet no metrics were offered to evaluate effectiveness of such redesign efforts.

**D. Critical Analysis:** While the increasing awareness of workplace as an important enabler of strategic change and adaptation is evident by the growing number of studies and redesign efforts of companies’ headquarters, most of the work attends to the functional and instrumental aspects of work; less attention is given to the symbolic and aesthetic of the workplace environment, and the roles color might play in achieving effective workplace design. Challenging issues, such as measurements of effectiveness and design for experience, are largely neglected. Moreover, the research methodology itself is not growing in sophistication to enable studying more complex, intangible issues. Very few research works venture to fields outside of the design and architecture domains to integrate diverse knowledge bases into a comprehensive workplace design perspective. Rarely does research in this area leapfrog the present to deal with future challenges with the exception of ASID Workplace 2020 research program (ASID [5]). Furthermore, most of the research conducted is descriptive rather than prescriptive.

### III. Learning Environments

**a. Overview:** The literature on learning environments is geared heavily towards discussing learning effectiveness concepts and methodologies (Bradley [26], Brooks & Khandker [27], Brown [28], Cavallo [33], Dickey [45]). Only a side stream within this literature is focusing on the physical environment (also referred to as visual environment) and the role it may play in supporting or inhibiting learning (Burruss [30], Cherry [34], Drew [47]). The term “design” is often used to describe structuring curriculum choices and learning experiences; that is, the conceptual arena for learning (Tanner & Jago [99]). Researchers describe a shift away from traditional frontal instruction methods to collaborative methods of learning that are experiential, interactive, activity-based, peer-supported, and emotionally and cognitively engaging where immersion and exploration are promoted (Cavallo [33], Chin & Carroll [35], Gokhale [51], Kezar [59]). The literature is descriptive more so than prescriptive and speaks in a preliminary and tentative tone (for example, the works of (McLoughlin [71], Mishra & Girod [75]). Discussions of environmental design often center on issues such as the effects of size, shape and scope of learning spaces, acoustical and thermal qualities, illumination and view conditions, and the activity type that the environment enables, specifically as it pertains to collaboration, privacy, versatility, play, and exercise (Neilsen, Winter, & Saatcioglu [79]). Most of the empirical work samples elementary school children with only few accounts using college students (Schaal & Bogner [91]). Little or
no attention is given to adult learners in advanced age groups.

b. **Color**: Color is identified as a promising area for research even though only limited research has been conducted on the subject of color impact on learning (Basoglu [14], Boyatzis & Varghese [25], Cler & Schindler [38], Cockerill & Miller [39], Cohn & Trotle [40], Cunningham [44], Eroglu [48], Read [86], Rice & Mitchell-Ketzes [88], Yazici [115]). Color in classroom environments is assumed to generate emotional experience, which may or may not support/enhance learning. Teachers believe that color enhances classroom learning (Stone [95]) and facilitate memory (Anonymous [1]). Environments that generate approach-behavior are assumed to support learning. Such environments are positive also because of the way they were designed, hence the potential role of color. Other works focus on the functional role of color as embedded in the classroom walls suggesting that colors of these walls should complement the functional role walls serve to display various communications and students’ works. Children displayed emotional associations to color with a tendency to associate positive emotions with bright colors, especially girls, and negative emotions with dull ones (Read [87]). Girls also desired and were able to process a greater color variation than boys but this finding was refuted by another study (Boyatzis & Varghese [25], Cockerill & Miller [39]). In one instance, it was found that negative mood was affected by the task while positive mood was affected by environmental variables (Cohn & Trotle [40]). The limited volume of preliminary research on color’s impact on learning and the different voices and conflicting findings leave much room for thorough investigation.

c. **Effectiveness**: Researchers often reference the works of Piaget, Gardner and, more recently, Vygotzky’s Constructionism approach as theoretical anchors (Gokhale [51], Stone [95]). These learning theories differ in their perspective on how learning occurs, whether by internal cognitive process or by social interaction. These two views have important implications for both teaching and environmental design considerations and effectiveness. For Piaget and Gardner, psychology of cognition and emotion serves a critical role: positive emotions that generate engagement, interest, and support creative thinking, secure states of mind that allow exploration with no fear of failure (Basoglu [14], Mishra & Girod [75], Neilsen, Winter, & Saatcioglu [79]), order that foster cognitive processes of clarity and sense making (Cohn & Trotle [40], Price [83]), variety that stimulate thinking and innovativeness (Read [87]), and concentration and immersion that enable understanding (Brown [28]). Still Vygotzky’s Constructionism approach presupposes that learning emerges through a sense-making dialogue between the learner and his environment (Cavallo [33]). As such, the social and visual contexts in which learning takes place become critical enablers or impediments of effective learning. Specifically, collaboration with others through teamwork, brainstorming, and peer-to-peer learning is regarded as essential (Mishra & Girod [75]).

d. **Critical Analysis**: Discussions regarding learning environment design are descriptive and, for the most part, express practitioners’ experiences rather than evidence based insights. Similarly, the notion that color in classroom enhances students’ learning performance is for the most part assumed but not substantiated in empirical research. There seems to be an inherent and interesting connection between designing environments for learning and designing for creativity. While learning literature does not differentiate between learning as acquiring existing knowledge and learning as generating new knowledge, the principles outlined as necessary for learning from social to psychological and physiological can inform design considerations of learning environments where innovation and creativity are sought.
IV. ANALYSIS AND FUTURE DIRECTION

While color inquiries in general have been conducted for more than a century, the body of knowledge pertaining to color impact in the investigated environments is relatively young and has emerged over the last four decades. Throughout this time, environmental psychologists were able to generate both interest and empirical support around the dynamic interface of environments and emotions. This aspect of the literature gave enhanced legitimacy to the investigation of color impact as color is considered a design lever most suitable to affect emotions. Yet, despite this conceptual evolution and the intuitive appeal that the “color impact” argument enjoys, research on color influence in environments is sparse, fragmented, often lacking rigor and empirical basis, and, as such, is limited in its explanatory power.

To further aggravate the challenge, two other factors add to the conceptual fog: First, the environments studied are undergoing significant transition. The working environment has shifted to become global, semi-virtual, collaborative, technologically enhanced, and innovation-driven; and, the learning environment has seen significant shift in teaching and learning methodologies away from curriculum and teacher-centric to collaborative, immersive, peer-oriented, and student-centric solutions. Second, and perhaps consequently, identifying effectiveness criteria in these environments has become a monumental challenge that researchers still sort out in what seems like a glacier-like pace, limited dedication, and with only limited success. As a result, the study of effective environmental design (in general) and the use of color in such environments (in specific) suffers and existing knowledge seems reactive, limited, obsolete at times, and overall narrow.

While the abovementioned changes experienced in the studied environments generate a considerable degree of complexity, the study of environmental design in general is still silo-oriented and does not seem interested in exploring white spaces that emerge naturally between disciplines such as architecture, psychology, medicine, education, and technology. Only limited efforts have made active attempts to pave roads into these complex interfaces. Lastly, although the general question of how environmental design affects human response is inherently complex, and subsequent questions about the role of color in such contexts are equally challenging, often the methodologies used to study these issues are less sophisticated and unjustly simplistic. This discrepancy raises questions about the generalizability quality of findings and insights produced.

Future research on color in environment has a number of critical questions to explore:
1. "Within environments" color efficacy questions pertaining to color impact in specific environments taking into account variables identified as important by previous research such as audience type (including student, patient, teacher, guest, employee, team) and characteristics (age, gender); task type (creative, repetitive, service, peer-learning); effectiveness measurements (how is color impact measured and isolated from all other variables that co-act within an environment); and, color choices (hue, value, chroma, number of colors tested, color in artifacts, surfaces). (See Figure 1 for schematic presentation of this research agenda applied to the Healing Environment).
2. "Between environments" color efficacy questions pertaining to broad "color lessons" relevant to different built environments (workplace, learning, healing, retail, hospitality and residential); identifying principles for the use of color to generate desired experience; examining the cross-cultural context of color use; mapping the contingency of color effectiveness when color is embedded in artifacts, vertical or horizontal surfaces; and, theorizing about the role of color as an enabler. Existing color knowledge allows us to approach many of the above questions with preliminary
understandings and tested assumptions. Theories developed in other disciplines with regard to the psychology of emotions, change methodologies, performance measurement dashboards, learning and collaboration frameworks, to name a few provide a rich context within which to examine the role of color. The opportunity to add color to existing white spaces across environments and disciplines is there to seize.

(Endnotes)
1 Discussion and findings re the healing, retail and hospitality environments were omitted from this submission due to scope constraints. A complete version of the paper can be obtained directly from the authors.

Figure 1: Color Research Efforts Linked to Critical Contingencies in Healing Environments - Example