Turning the spotlight on the role of light and colors in offices: How are performance, social interactions, and social perception affected?

by

Olga Kombeiz

A thesis presented to the University of Hohenheim in fulfillment of the thesis requirements for the degree of Doctor rerum socialium (Dr. rer. soc.) in Psychology

Supervisor and primary reviewer of the doctoral thesis: Prof. Dr. Anna Steidle
Secondary reviewer of the doctoral thesis: Prof. Dr. Sabine Trepte
Chair of the defense: Prof. Dr. Marion Büttgen
Dean of the Faculty of Business, Economics and Social Sciences: Prof. Dr. Dirk Hachmeister

Submitted on 27.07.2016 Thesis defense on 02.12.2016

Abstract

Previous research has shown that light influences psychological functioning and subsequent performance, perception, and behavior in the work context. However, an overarching model of the impact of light on psychological processes and work-related outcomes is still lacking. The current doctoral thesis introduces an overall framework that explains the effects of light in the work context. Thus, the present research attempts to clarify the effects of artificial lighting on individual performance (i.e., creativity), social interaction (i.e., collaboration in negotiations), and social perception (i.e., person perception), and to uncover the mediating psychological processes and possible moderators. Building on different theories explaining the effects of the physical environment on psychological processes and work-related outcomes, as well as based on previous research, the thesis brings new insight into this topic.

The first research project focused on clarifying the effects of light on conflict resolution. Building on research of light-induced cooperativeness, it was expected that self-oriented individuals would be influenced by the light in social situations. The results of two laboratory experiments confirmed that dim warm light promoted situative interdependent self-construal in self-oriented individuals, and, in turn, enhanced the preference for collaborative conflict resolution. These results contribute to the understanding of light-induced changes in social behavior. Limitations as well as practical implications for lighting design in social spaces are discussed.

The second research project addressed the question of how light influences one's judgment of others. Based on the notion of environmentally induced positive affect, the present study proposed that pleasant light induces satisfaction with light, which in turn leads to positive judgments of other persons. The results confirmed that satisfaction with light was higher in three pleasant lighting conditions than in an unpleasant one, which in

turn positively influenced the judgments of competence and warmth. Moreover, the explorative analyses showed that the positive effect of pleasant light on satisfaction with light only emerged for male participants. Theoretical contributions to lighting psychology and to the previous inconsistent findings of the role of sex in the affective consequences of light, and practical implications concerning the design of settings involving the evaluation of other individuals are discussed.

The third research project aimed at clarifying the motivational consequences of artificial light and its effects on creative performance. Previous research indicated that individuals automatically evaluate the room's atmosphere. These automatic appraisals evoke concomitant appetitive (e.g., promotion focus) or aversive (e.g., prevention focus) motivation and, in turn, may impact work performance. Based on this idea, we expected that red and blue (vs. white) accent lighting, which creates a pleasant and friendly room atmosphere, would elicit the strategic approach motivation and, in turn, promote creativity. The results of an experimental study confirmed our assumptions. Implications for future research on color and light, and practical implications are discussed.

Overall, these results provide insight into the effects of light on cognitive, affective, and motivational processes, and consequently, on work-related outcomes. The three research projects contribute to a deeper understanding of which psychological processes are activated in which situation, and what role is played by the individual differences. In addition to the theoretical contributions, the present findings show that optimal ambient conditions represent support for a set of competencies on the individual and organizational levels, such as promoting collaborative conflict styles or creativity.

Content

Chapter 1: General Introduction

In the work context, individuals interact with different types of organizational environments (Elsbach & Pratt, 2007), such as the social environment (e.g., social structures), the natural environment (e.g., surroundings constructed by nature), and the physical environment (material objects and stimuli). Physical environments in organizations include multiple physical and architectonical details like colors, light, temperature, furniture, and the spatial arrangement (Carnevale, 1992; Hedge, 1982; Sundstrom, Bell, Busby, & Asmus, 1996). Individuals are generally aware that they can shape and change their physical environment, and design their places of work and leisure, but such efforts are often based on personal preferences (e.g., aesthetic), without awareness of the possible effects of environmental features on psychological processes, performance, and behavior. However, since humans spend most of their time indoors, the impact of the environment and the human-environment interaction can no longer be neglected. Accordingly, recent reviews of the effects of the physical environment in work settings (e.g., Ashkanasy, Ayoko, & Jehn, 2014; Elsbach & Pratt, 2007) emphasize the importance of understanding the relation between the organizational physical environment and office workers' outcomes.

In light of these arguments, it is important to underline that while the choice of furniture and their arrangement as well as the personalization of the workspace can be changed due to plenty of available choices and configurations (Elsbach & Bechky, 2007), ambient conditions such as lighting are generally implemented based on technical standardizations (DIN 12464 / ISO 8995). Consequently, possible psychological effects of lighting conditions on several work-related outcomes have barely been taken into account. Hence, the core focus of the present thesis is on understanding the effects of light and the colors of light on performance and behavior, on the underlying processes of this relation, and on possible practical implications for work environments. In the following section, I will review the research over

the past decades of the effects of light and colors (of light) in the work context. After that, possible underlying processes will be introduced and the aim of the thesis presented. Next, the main part consists of the three manuscripts within the current thesis. The general discussion completes this work.

1 Light, Colors and Human Functioning: Research over the Past Decades

Almost a century ago, the Hawthorne studies (cit. in Zhong & House, 2012) aimed to show the effect that the physical environment can have on workers' productivity and came to the surprising conclusion that social relations are more important for performance and well-being than lighting conditions. This conclusion was the start of a remarkable social relations movement in organizational research (e.g., Cohen & Wills, 1985; Kaplan, Cassel, & Gore, 1977; Sparrowe, Liden, Wayne, & Kraimer, 2001). However, recent research indicates that concrete physical constructs, particularly light and color, are not just architectonic or physical details, but also form the psychological basis for abstract concepts (Barsalou, 2008) and send affective or motivational messages of the room atmosphere (e.g., Kuijsters, Redi, de Ruyter, & Heynderickx, 2015; Steidle & Werth, 2013). Thus, light and colors might activate cognitive (Steidle, Hanke, & Werth, 2013), motivational (Kolb, Gockel, & Werth, 2012), and affective states (Knez, 1995) that have been found to influence perception (Baron, Rea, & Daniels, 1992), performance (Choi, 2004), and behavior (Isen, 1987). This idea found support in previous research that showed that darkness triggers an abstract construal level and, in turn, promotes cooperation (Steidle et al., 2013). Other studies indicate that humans attribute different affective loadings to light (Knez & Enmarker, 1998) and colors (Adams & Osgood, 1973), whereas one's affective state has been shown to impact several work-related outcomes (Lyubomirsky, King, & Diener, 2005). Additionally, studies in color research demonstrate

that color may induce approach or avoidance motivation, which is linked to different performance outcomes (see for an overview Elliot, 2013).

Although light and color are closely related, since light shapes color perception (Boyce, 2014) and light consists of spectral distribution (i.e., colors), color and lighting research are typically known as separate areas of research. In contrast, modern lighting applications offer a host of new opportunities to combine light and color. For instance, dynamic and personalized lighting applications and colored light could be used to create an atmosphere based on subjective preferences and to optimize conditions according to the needs of the situation. However, the literature still has a lack of studies combining color and lighting research (Elliot, 2015). As a consequence, practical implications and recommendations for the development of technical standardization that integrates light and colors have yet to be determined. In the following, an overview of the effects of light and colors in the work context is presented and possible underlying processes are discussed.

1.1 Impact of Light in the Work Context

Since the beginning of the 20th century, lighting research has focused on identifying the optimal conditions for worker performance. A few theories that explain the effects of light have been put forth and plenty of laboratory and field experiments have been conducted. To understand the effects of light on human functioning, three pathways can be distinguished through which light reaches the retina and sends information to different brain areas: the circadian, visual, and perceptual pathways (Boyce, 2003). These pathways do not actually function independently from each other. Nevertheless, substantial parts of the research differentiate between the three pathways to demonstrate the relevance of all different routes for human functioning. First, many studies (e.g., Lockley, Brainard, & Czeisler, 2003; Mahoney, Liu, & Fogg, 1994; Pauley; 2004) have shown the effects of light on the human circadian rhythm, also known as the circadian clock, which is responsible for the activating

effects of light on alertness and on their biological markers (e.g., melatonin, core body temperature; Cajochen, 2007). Second, the visual pathway enables humans to form images of their surroundings by transmitting visual information (i.e., light) to the visual cortex. The visual performance as a consequence of physiological perception has thus far been well-investigated (Werth et al., 2013). Third, via the perceptual path, light signals information to the brain areas that are responsible for the regulation of affect, cognition, and behavior (Boyce, 2003). As the present thesis focuses on a psychological perspective of the effects of light on human functioning in the work context, the following insights of past research will concentrate on the perceptual pathway.

The effects of light on simple (office) tasks with a minimum of cognitive and motor components has been extensively investigated (Boyce, 2003), with the conclusion that performance tends to increase in bright (versus dim) light (Bennett, Chitlangia, & Pengrekar, 1977; Buchanan et al., 1991; Gifford, Hine & Veitch, 1997; McGuiness & Boyce, 1984). These results are not unusual because performance was measured using simple tasks that generally require a workspace that is bright enough (Boyce, 2003). To shed light on the effects of light on complex work performance, other researchers focused on tasks requiring creative performance. Steidle and Werth (2013) proposed that darkness sends a visual message of freedom from constraints, allowing an explorative, risky cognitive processing style that promotes creativity. In a series of experiments, the authors found support for this theory. Thus, depending on the tasks, different lighting conditions may be required for optimal performance. In contrast, the effects of light in social situations, including preferred behavior in conflict situations and judgment of others, are less clear. On the one hand, darkness has been reported to increase self-interested behavior and dishonesty (Zhong, Bohns, & Gino, 2010), as well as aggression (Page & Moss, 1976). On the other hand, dim light promoted cooperation (Steidle et al., 2013), a low preference for avoidance strategy in a

conflict situation (Baron et al., 1992), and a high preference for intimacy (Gergen, Gergen, & Barton, 1973).

Importantly, in the above mentioned studies, social interaction occurred in different contexts. For instance, whereas Zhong et al.'s (2010) study used a one-shot dictator game that does not require mutual cooperation, another study manipulated the behavior of a hypothetical interaction partner (Steidle et al., 2013). Thus, the context of social situations determines which behavior is perceived as suitable (Oskamp, 1971). Moreover, not only the situational context shapes the behavior in social interactions, but also individual differences. Accordingly, Steidle et al. (2013) proposed that the effect of dim light on cooperation would only emerge for persons low in social value orientation, and confirmed this assumption. The explanation provided was that darkness does not activate the interdependent self-construal of individuals who constantly feel close to others. However, the moderation effect was only examined in the relation between light and cooperation, but not on the underlying process.

Further, the sex of individuals represents another context that should be taken into account in studies where affective consequences of light are important. For example, previous studies demonstrated sex differences in the preference for lighting conditions in terms of brightness, color temperature, and a combination thereof. More specifically, researchers (Knez, 1995; Knez & Enmarker, 1998) suggest that men and women attribute different affective meanings to artificial light. For instance, women (when compared to men) tend to prefer a lower level of brightness (Leslie & Hartleb, 1990) and to perceive the same light as more glaring and too intense (Knez, 1995). Furthermore, some studies showed that women indicate more positive affect in warm than in cold light, while a reverse pattern was pronounced for men (Knez, 1995; McCloughan et al., 1999). However, these findings were not supported in another study (Knez & Enmarker, 1998). Thus, the effects of sex, especially the direction of possible effects, are still unclear due to previous inconsistent findings.

1.2 Impact of Colors in the Work Context

Color psychology in the work context is characterized by a lack of scientifically based research, apart from the last 10 years, most studies were based on applied questions and did not rely on a theory. Only a few years ago, Elliot and Maier (2012) proposed the "color-in-context" theory, which summarizes and explains color effects on psychological functioning, offering a framework for the relation between colors and affective, cognitive, motivational processes, and work-related outcomes. This theory suggests that colors carry psychologically relevant meanings that stem from societal learning, which starts in the early childhood and strengthens due to repetition over time. For example, the association of the color red with traffic lights signals danger, and is learned and acquired from a very young age. On the other hand, such associations might instead be based on biological tendencies, and serve as a function for adaptation and survival (i.e., detecting ripe fruits due to their color). The effect of colors, learned or biologically based, is automatic, as it begins at absorption of light by cones (a type of photoreceptor sensitive to color) and is transmitted from the retina to different areas of the visual cortex without requiring direct awareness (Conway, 2009; Gegenfurtner & Kiper, 2003).

One of the central ideas of the color-in-context theory is that a color's meaning and influence varies due to the context. For instance, the color red in a romantic context has been found to promote approach motivation (Elliot & Niesta, 2008), due to the association with a sexual signal for attracting mates (Andersson, 1994). In contrast, in an achievement context, red evokes avoidance motivation because of learned associations with the mistakes/errors in schoolwork and the danger of failure (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007). In the present thesis, the achievement context represents a particularly relevant topic as it refers to work-relevant outcomes. Thus, the research overview continues with studies in the achievement context.

Previous studies demonstrated that the brief perception of red worsens performance in an important test (e.g., general mental ability), because of negative associations with red (Elliot et al., 2007; Elliot, Payen, Brisswalter, Cury, & Thayer, 2011; Maier, Elliot, & Lichtenfeld, 2008). Further, investigating color effects on specific performance tasks such as creativity showed that red undermines creative performance relative to green (Lichtenfeld, Elliot, Maier, & Pekrun, 2012). An experimental series (Mehta & Zhu, 2012) compared different performance outcomes and different colors, and found that blue increased performance on a creative task, while red yielded higher performance in detail-oriented tasks. However, a recent study (Rook, 2014) emphasized the context specificity of colors in the achievement context, showing that red enhanced creativity relative to blue when it is presented in an appetitive (potential success) context. In line with that, using colors not in an immediate working area but on walls (including curtains in a corresponding color) showed no difference in performance, neither in routine clerical tasks, nor on creativity tasks (Küller, Mikellides, & Janssens, 2008). Similarly, Bakker, van der Voordt, de Boon, & Vink (2013) found no effects of red and blue environments on perceived productivity. In contrast, Kwallek, Lewis, Lin-Hsiao, and Woodson (1996) found wall colors to impact the amount of error in a proofreading task. In a room with white walls, participants made significantly more errors than in a room with red or blue walls. Hence, previous findings are still inconsistent and raise the question of whether presenting color as colored light would evoke different contextual meaning than an object color or a wall color. The research of the effects of colored light in the work context is in its initial stages, and there is only one study that investigated the effects of colored light on work performance. Hoonhout, Knoop and Vanpol (2009) found that participants were faster in completing a proofreading task when working in a room with a wall illuminated with blue (compared to red) light. However, the authors did not investigate possible mediators, so that the question is still open, why the performance was better in one

condition than in another. To understand this question and the general effects of colored light in the work context, it is essential to figure out how colored light influences human performance.

1.3 Psychological Consequences of Light and Colors

To understand why colors and light impact human performance and behavior, it is necessary to uncover the underlying processes. As noted previously, light and the color of light may activate cognitive (Steidle et al., 2013), affective (Knez, 1995), and motivational processes (Elliot & Maier, 2012) that influence several work-related outcomes (Choi, 2004; Isen, 1987). Below, the three psychological consequences of light with regard to different outcomes are presented.

1.3.1 The Cognitive Process

Environments shape how individuals perceive others and interact with them (Baron et al., 1992; IJzerman & Semin, 2009). To explain this effect, the processing of information coming from our surroundings can be taken into account. In line with this, the idea of the visual messages of light (Boyce, 2003) may clarify the effect of light in social situations. Accordingly, upon entering a room, humans perceive and spontaneously evaluate the room atmosphere (Vogels, 2008), which is associated with concomitant cognitive processes such as the construal of the social situation (Steidle et al., 2013), expectations about the appropriate processing style (i.e., a global versus a local processing style; Steidle, Werth, & Hanke, 2011) and about the suitable behavior in the given situation (Steidle et al., 2013). Thus, the notion of light's visual messages proposes automatic effects of light that occur without causing an affective shift (Friedmann, Fishbach, Förster, & Werth, 2003). Accordingly, a room's atmosphere might relate to a visual message of the sociality of light, for instance by triggering less accessibility of specific information about the self and high accessibility of interpersonal closeness (Steidle et al., 2013). Consequently, interdependent self-construal has been found to

lead to positive outcomes in social situations, for instance cooperativeness (Utz, 2004) and collaborative conflict strategies (Oetzel, Meares, Myers, & Lara, 2003). Steidle et al. (2013) found that interdependent self-construal mediated the link between light and cooperativeness. Their experiments demonstrated that dim light triggers interdependent self-construal, which in turn leads to cooperation, with color temperature held constant.

Although these findings contribute to the understanding of conceptual light (versus darkness) effects, it is important to note that bright and dim light may appear differently due to variations in color temperature (Kruithof, 1941; Manav, 2007; Viènot et al., 2009). Thus, this knowledge raises the question as to whether variations in color temperature and different combinations of brightness and color temperature would evoke other cognitive representations of social situations than darkness (vs. brightness). Especially interesting for the present thesis is a study (Baron et al., 1992) that varied brightness and color temperature (warm white versus. cool white) and found that in warm white light, participants preferred collaborative conflict strategies, and showed lowest preference for an uncooperative conflict strategy (i.e. avoidance) in dim warm light. The authors assumed the underlying process of positive affect, induced by dim warm light, but did not directly examine this idea. Thus, it is still unclear whether the activation of an affective process (i.e., positive affect due to pleasant light) or a cognitive process (i.e. self-construal) provides a better explanatory approach for light effects in social situations.

1.3.2 The Affective Process

As noted above, Baron et al. (1992) suggested the notion of environmentally induced positive affect as an explanation for the effects of light in social situations. The researchers proposed that pleasant light may induce positive affect, which in turn increases collaboration and the positive evaluation of others. This idea is based on research demonstrating several environmental features to cause changes in affective states. For instance, pleasant artificial

scents (Baron, 1990), watching of pleasant or unpleasant films (Arkes, Herren, & Isen, 1988), and a receipt of a gift (Isen, 1987) have been shown to change the affective state. On the other hand, even mild shifts in affective states have an impact on different work-related outcomes in social situations, such as the perception of others in the work context (Forgas & George, 2001), performance appraisals (Sinclair, 1988), and behavior in organizations (Park, Sims, & Montowidlo, 1986). However, Baron et al. (1992) found only partial support for this idea, while later studies (Boyce, Veitch, Newsham, Myer, & Hunter, 2003; Knez & Enmarker, 1998; Veitch & Newsham, 1998) could not replicate the effect of light on social perception and behavior. Despite these results, Baron et al. (1992) and Boyce et al. (2003) argued that the variations in lighting used in laboratory and field studies are too subtle to be recognized and to be reported in common affect questionnaires. Thus, the manipulation of lighting conditions might explain the previous inconsistent findings.

1.3.3 The Motivational Process

Although previous studies demonstrate the effects of color on approach (Mehta & Zhu, 2009; see also failed replication, Steele, 2014) and avoidance motivation (Moller, Elliot, & Maier, 2009), current research needs another theoretical perspective because colored light may have different effects than the color of other stimuli (e.g., screen backgrounds or words). First, to understand how colored light may evoke a specific motivational state, it is important to know how colored light is perceived and what atmosphere it creates. Thus, the explanatory approach relates closely to the notion of visual messages (Boyce, 2003). Accordingly, color (of light) represents an implicit affective cue (Friedman & Förster, 2010) that evokes positive or negative appraisals of the environment on an unconscious level. Consequently, such automatic appraisals evoke concomitant appetitive (e.g., hope, promotion focus) or aversive (e.g. fear, prevention focus) motivations that, in turn, may impact work performance. Thus, the color of light sends automatic visual messages (Boyce, 2003) of the room atmosphere that

are associated with either approach or avoidance motivation. Some studies (Kuijsters, et al., 2015; Kuijsters, Redi, de Ruyter, Seuntiens, & Heynderickx, 2014) focused on contributing to pleasant room atmosphere using colored light. The researchers showed that both blue as well as red accent lighting generates pleasant atmospheres due to the liveliness of blue and the coziness of red accent lighting (Kuijsters et al., 2015). Taken together, a pleasant room atmosphere created by colored accent lighting could foster approach motivation.

2 Need for Research and Aim of the Thesis

A perusal of the past research indicates that light and color may impact psychological functioning, performance and behavior. However, the context specificity of light due to the situation, to lighting aspects such as color or color temperature, and individual differences as well as underlying processes are still a little-studied area of research. Especially contextual effects of light on social interactions, social judgment, and on complex work performance are in need of a deeper understanding.

Regarding social interaction, the present thesis focuses on conflict-resolving strategies in negotiations because conflicts and effective conflict management determine organizational effectiveness on individual, group, and intergroup levels (Rahim, 2002). As mentioned previously, two theoretical frameworks might explain the effects of lighting. The current thesis suggests that the notion of visual messages that evokes a cognitive representation of social interaction would better explain the preferred behavior in a negotiation than environmentally induced positive affect. Since a negotiation offers the possibility to act for both parties, the construal of the situation as a potentially collaborative or competitive situation might shape the subsequent behavior. Furthermore, for the construal of social interaction, the moderation of individual social orientation is essential, and has previously been proposed but not examined (Steidle et al., 2013). Hence, investigating this path of the

relation between light and work-related outcomes requires individual differences to be taken into account.

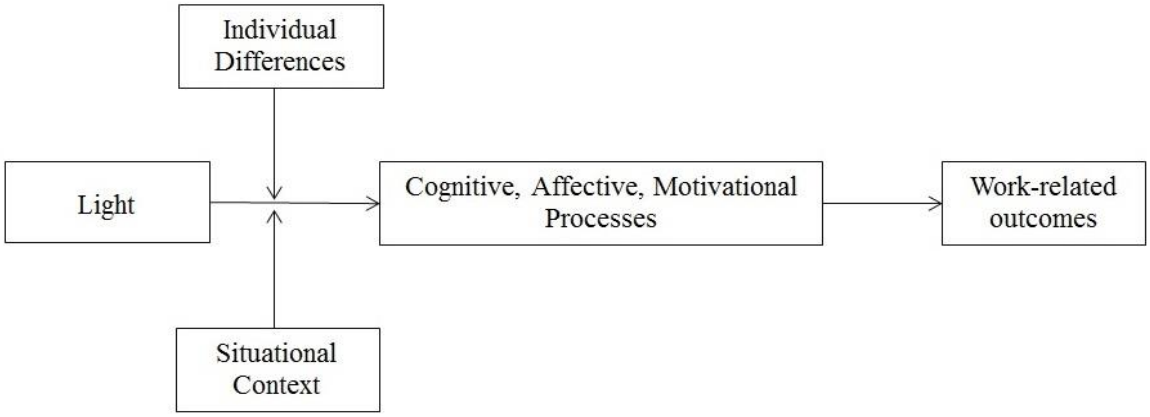
Further, to understand the effects of social judgment, it is important to consider that humans form impressions about others in an unconscious way, partly using only a small amount of available information (Niedenthal & Halberstadt, 2004). Sometimes, such spontaneous impressions could have decisive consequences, for instance in the hiring context (Riggio & Throckmorton, 1988). Since spontaneous social judgment is an one-way process that does not contain an interaction with another person, present research proposes that the notion of environmentally (i.e., pleasant light) induced positive affect (Baron et al., 1990) would explain the effects of light on social judgement. Moreover, as sex has been shown to impact individuals' affective meanings of light (Knez, 1995; Knez & Enmarker, 1998), the moderation effect of sex needs to be investigated in the affective consequence of light.

With respect to complex work performance, the current research focuses on creativity because individual's innovative performances determine to a large part the competitiveness of organizations (Florida, 2005). The motivational process is proposed as an underlying mechanism in the link between light and creative performance. Specific lighting conditions could evoke a pleasant room atmosphere that is concomitant with approach motivation. Consequently, approach motivation could promote creative performance (Baas, De Dreu, & Nijstad, 2008).

Taken together, the present thesis proposes a general model for the context-specific effects of light (see figure 1). Due to the situational context, the composition of components of light, and the investigated work-related outcomes, I expected that different processes would be activated. Thus, the first aim of the thesis is to uncover the underlying processes of the effects of light on outcomes in the work context. The second purpose is to determine the boundary conditions with reference to situations, individual differences and different aspects

of light. Third, the findings of the current research should shape the foundation for evidence-based recommendations for organizations and individuals.

Figure 1: The overall research model



2.1 Thesis Outline: An Introduction to the Studies

The current research is one of the few works bridging the gap between color and lighting research and suggesting a general model for the effects of light, including different components of light. In the first step, the influence of different variations of illuminance and color temperature on social interaction is examined in a framework of the experimental design (Chapter II). The second research project focuses on the experimental investigation of the influence of different lighting scenarios on social judgment (Chapter III). The third research project examines the impact of colored light as a common factor of two physical variables – light and color – on complex performance, which brings new insights into the lighting and color research (Chapter IV).

To answer the question of how light can facilitate conflict resolution, two experimental studies were conducted and should allow the identification of the optimal combination of brightness and color temperature for conflict situations. For generalizability of the effects of

light on conflict resolution, the variation of both components of lighting was different in two studies. Second, we focused on uncovering the underlying process in the possible relationship between light and conflict resolution. Based on previous research about light and cooperativeness, we expected positive effects of dim warm light in social situations. Third, we also focused on potential moderators: two traits of social orientation. More specifically, we hypothesized that self-oriented individuals (i.e., high social dominance orientation and/or low interdependent self-construal) would be positively influenced by dim warm light in social situations involving conflict. In self-oriented individuals, dim warm light should promote interdependent self-construal and, in turn, lead to a preference for collaborative conflict resolution strategies. The results contribute to the understanding of the effects of light in social situations, explain previous inconsistent findings, and allow practical implications for the design of social spaces.

The purpose of the next project is to demonstrate how light might influence human judgment of other individuals. Building on the idea of environmentally induced positive affect, pleasant light was expected to promote satisfaction with light, which in turn leads to positive judgments of other persons. A laboratory experiment was conducted, where four lighting conditions were created, varying in brightness and color temperature. After random assignment to one of the four lighting conditions, participants evaluated six pictures of unknown faces regarding warmth and competence. The results contribute to the understanding of the notion of environmentally induced positive affect in situations involving social judgment. Moreover, additional explorative analyses with sex as a moderator shed light on previous inconsistent findings of the effects of light on mood and affective states. Theoretical and practical implications will be discussed.

The last research project aims to show the context specificity of light using colored accent lighting, and demonstrates the indirect effects on creativity. Color research in

achievement contexts demonstrated that red is associated with avoidance motivation that hinders creativity, while blue is related to approach motivation that increases creativity. Nevertheless, depending on the context of presentation, colors may convey a different message. In an experimental design, we compared three accent lighting conditions: blue, red, and white accent light. We expected that red and blue (versus white) accent light would promote strategic approach motivation due to concomitant pleasant visual messages of coziness (red) and liveliness (blue). Due to increased approach motivation, we expected a positive indirect effect on creative performance. Theoretical contributions as well as practical implications will be provided.

The following three chapters contain the three manuscripts in their original form. The manuscripts are currently under review or ready for submission at peer-reviewed psychological journals. The present thesis ends in Chapter V with a summary of the main findings, an overarching conclusion, and theoretical contributions. The need for further research as well as practical implications in light of the limitations of the current research will be presented.

Chapter 2: Light and Conflict Resolution

View it in a different light: Mediated and moderated effects of dim warm light on collaborative conflict resolution

Olga Kombeiz, Anna Steidle, Erik Dietl

Abstract

How can the physical environment, especially light, facilitate conflict resolution? Previous research has led to no clear answers about optimal lighting conditions in conflict situations and, until now, potential moderators and mediators have been scarcely investigated. Building on research on light-induced cooperativeness, we expected that self-oriented individuals would be influenced by the lighting in social situations such as conflict resolution. In self-oriented individuals, dim warm light should promote interdependent self-construal and, in turn, lead to a preference for collaborative conflict resolution strategies. Two studies confirmed our assumptions, with social dominance orientation and trait interdependent self-construal serving as indicators of individuals' social orientation. Overall, these results provide an explanation for inconsistent previous findings and contribute to the understanding of light-induced changes in social behavior. Limitations as well as practical implications for lighting design in social spaces are discussed.

Keywords: light, brightness, color temperature, conflict resolution strategies, social dominance orientation, interdependent self-construal

Introduction

Driving a hard bargain or yielding to an opponent's demands in a business negotiation? Obliging one's partner's vacation plans, asserting one's own wishes, or finding a compromise? Avoiding a confrontation with one's children regarding tidying up or negotiating an integrative solution? In all these situations and decisions, people can either pursue only their own interests or take into account others' wishes. It all depends on how they view the situation and their relationship with the other individual. Research from the areas of grounded cognition and environmental psychology indicates that environmental features such as lighting conditions (e.g., Baron, Rea, & Daniels, 1992; Knez, 1995; Steidle, Hanke, & Werth, 2013) and room temperature (e.g., Gockel, Kolb, & Werth, 2014; Ijzerman & Semin, 2009) can influence social perception. Since lighting conditions shape how much and what we see of another person, it should be particularly interesting to examine how light affects interpersonal processes, particularly conflict resolution. Although some studies have shown significant effects of lighting conditions on the preference for certain conflict resolution strategies, others have failed to replicate these findings (Baron, et al., 1992, Boyce, Veitch, Newsham, Myer, & Hunter, 2003). To clarify these inconsistent results, the present research investigated a cognitive process (self-construal) that may explain why some light settings are able to promote collaborative conflict resolution. Moreover, we focused on a possible moderator (social orientation) to enhance the understanding of preconditions that limit the emergence of the light-conflict resolution link (see Figure 1 for the hypothesized model). This knowledge could contribute to the creation of collaborative work environments, in which light is always present, but its influence scarcely considered.

Conflict resolution strategies have been widely researched in social (Pruitt, 1998) and organizational psychology (e.g., Rahim & Bonoma, 1979; Ross & Stittinger, 1991). During conflict resolution, individuals can focus on their own interests, the other person's interests, or

both, which yields five strategies (Rahim & Bonoma, 1979; Rahim, 1983): integrating (problem solving by exchanging information, looking for alternative solutions and aiming to reach a mutually acceptable solution), obliging (playing down the differences between two parties and accentuating commonalities), compromising style (a "give-and-take" strategy where both partners have to give up something to reach a decision that is acceptable for both), dominating (a win-lose orientation and rejection of needs and expectations of the other party), and avoiding (withdrawal). Integrating, obliging, and compromising incorporate at least some inclination to consider the interests of others, while dominating and avoiding are associated with a low regard for others' interests. Hence, the former three strategies can be interpreted as collaborative and the latter two as non-collaborative (Chanin & Schneer, 1984; Volkema & Bergmann, 1995).

To date two studies directly tested the effect of lighting conditions on conflict resolution strategies. In both studies, it was assumed that lighting conditions induce positive affect, which in turn should promote a preference for collaborative conflict strategies. In their laboratory studies, Baron et al. (1992) varied lighting in terms of illuminance level (150 vs. 1500 lx) and color temperature (warm white vs. cool white). Participants exposed to warm white light reported stronger preferences for conflicts resolution through collaboration (i.e., integration) and weaker preferences for conflict resolution through avoidance than those exposed to cool white light. The preference for the non-collaborative avoidance strategy was lowest in the dim warm light condition. In contrast to these light-induced changes in general preferences for collaboration, light did not lead to more lenient responses to a colleague who failed on a work task for different reasons in a scenario which served as an additional measure of conflict resolution strategies. However, Baron et al. (1992) did not directly test the mediation effect via positive affect. In two field simulation studies, Boyce et al. (2003, 2006) gave participants in two conditions control over light intensity, whereas participants in other

experimental conditions did not have dimming control. However, the illuminance levels did not influence the preference for certain strategies to solve hypothetical conflict situations at work and mood did not mediate the effect of light. The interpretation and comparison of these findings is complicated, since the participants in Baron's study may have not been conscious of the variations in light and certainly could not influence them, while some participants in Boyce's studies chose the illuminance levels according to their wishes. Moreover, Boyce et al. (2003) pointed out that the reliability of some measures was unacceptably low, which limits the interpretability of the results. Overall, the studies directly testing the light-conflict resolution link allow no clear conclusions which lighting may promote collaborative conflict resolution and about the underlying process.

Instead of investigating positive affect to explain the effect of light on conflict resolution, we focus on automatic effects of light that may occur without changing emotional state (Friedmann, Fishbach, Förster, & Werth, 2003). Light largely determines how we perceive a room, its atmosphere (Custers, De Kort, IJsselsteijn, & De Kruiff, 2010; Flynn, 1992), and automatic assessment of required behavior in the given situation. Hence, lighting conditions may well affect how individuals interpret a social situation and their resulting interpersonal behavior. Previous research showed that light can elicit a cozy and informal atmosphere, which should facilitate contact and openness among individuals. For example, one study showed that dimly lit rooms appear more intimate, relaxing, and romantic, and less tense, friendly, and threatening than brightly lit rooms (Custers et al., 2010). In addition to brightness, the warmth of the light affects its meaning: warm light creates a relaxing and cozy room atmosphere compared to neutral white (Theiss, 2000) and cold white light (Vogels, de Vries, and van Erp, 2008), which appears rather cool and formal. Particularly, the combination of relatively low color temperature (about 3000 K) and low illuminance level (about 150 lx) creates a cozy and relaxing room ambience (Kuijsters, Redi, de Ruyter,

Seuntiëns & Heynderickx, 2014). Thus, we believe that the informality and coziness of dim warm light would promote interpersonal closeness and, in turn, collaborative conflict resolution.

In line with this assumption, several studies revealed that dim and warm light can positively influence person perception and social interaction. For instance, one study (Baron et al., 1992) showed that dim light (150 lx) led to more favorable person evaluations than bright light (1500 lx), while warm white light resulted in more helping behavior than cool white light. Additionally, dim light promoted cooperativeness (Steidle, Hanke, & Werth, 2013) and intimate communication (Gifford, 1988). Similarly, individuals preferred low brightness in informal and social situations (e.g., romantic; Biner, Butler, Fischer, & Westergren, 1989). Moreover, other environmental cues of warmth or coldness (e.g., room temperatures) also influence social proximity and affiliation (IJzerman & Semin, 2009; Inagaki & Eisenberger; 2013). Due to the reported direct effects (Baron et al., 1992) and the indirect links between dim warm light and a cozy atmosphere and positive social interactions, it is reasonable to assume that dim warm light may facilitate collaboration during conflict resolution.

However, to understand the emergence of the light-conflict resolution link, it is important to consider the underlying mechanism and potential limiting conditions. Visual messages of the light exert their influence via concomitant cognitive and motivational processes (Steidle et al., 2013; Steidle & Werth, 2013). Self-construal represents a cognitive mechanism which is sensitive to small variations in light (Steidle et al., 2013) and temperature (IJzerman & Semin, 2009), and can help to explain light-induced changes in social behavior. Generally, self-construal distinguishes two ways of representing oneself in relation to other individuals (Cross, Hardin, & Gercek-Swing, 2011; Markus & Kitayama, 1991): independent (‘I’) and interdependent (‘we’). Independent self-construal is related to defining oneself being

apart from others (e.g., being exceptionally creative) and as a unique person with reference to stable internal traits (e.g., ambition). In contrast, interdependent self-construal is related to defining oneself in terms of group memberships (e.g., Asian) and to view the self as encompassing important relationships (e.g., as a friend).

Self-construal also affects conflict resolution. According to Ting-Toomey (1988), connection to others may result in additional effort for the maintenance of group harmony and high concern for others. A person with high interdependent self-construal would rather cooperate to achieve the goals of both parties than endanger the harmony of the group. In line with this idea, two studies showed that independent self-construal ('I') is positively related to a non-collaborative strategy of dominating, while interdependent self-construal ('we') is positively associated with collaborative strategies of integrating, compromising, and obliging (Oetzel, 1998; Oetzel, Meares, Myers, & Lara, 2003). In line with Rahim's conceptualization (Rahim, 1983; Rahim & Bonoma, 1979), integrating was related to both self- and other-concerns in one study (Oetzel, 1998). In contrast, avoidance showed an unexpected, inconsistent correlation pattern: it was positively related to interdependent self-construal, but only in one study (Oetzel, 1998). Previous studies indicate that contextual cues eliciting interdependent self-construal promote collaborative behavior. For instance, individuals primed with interdependent self-construal were more likely to surrender their own interests to those of the group than those primed with independent self-construal (Gardner, Gabriel, & Lee, 1999). Moreover, Steidle et al. (2013) showed that participants were more likely to include others into their self (interdependent self-construal) at dim compared to bright lighting conditions, which in turn increased participants' cooperativeness in a prisoner's dilemma game. Hence, interdependent self-construal may mediate the expected effects of dim warm light on collaborative conflict resolution.

Environment-behavior links depend on individual differences (e.g., Dijkstra, Pieterse, & Pruyn, 2008; Steidle et al., 2013). Since individuals differ in the way they perceive and construe social situations (Colbert, Mount, Harter, Witt, & Barrick, 2004; Funder, 1991; Varnum, Grossmann, Kitayama, & Nisbett, 2010), stable social orientations may be important moderators of light-induced changes in self-construal and conflict resolution. As individuals with high collective concerns are known to view the self as interconnected and defined in terms of important relationships (Markus & Kitayama, 1991; Triandis, 1989), their willingness to stay interconnected with others (e.g., by cooperation) should be stable and not affected by situational context. In line with this assumption, Steidle et al. (2013) showed in one study that the darkness-cooperation link depended on participants' social value orientations. Only those high in individualistic orientation cooperated more in dim than in bright light, whereas the cooperativeness of those low in individualistic orientation was not affected by the lighting conditions. However, the role of self-construal was not tested in this study. Overall, we believe that light-induced changes in self-construal will only occur in self-oriented individuals.

Regarding the effects of lighting on self-construal and conflict resolution, two individual difference variables should be of particular relevance: trait self-construal as individuals' proclivity towards independent or interdependent self-construal (Cross et al., 2011) and social dominance orientation (SDO) as an individual's desire for dominance in social situations, including situations of social conflict (Pratto, Sidanius, & Levin, 2006). Both trait interdependent self-construal (TSC) and SDO describe the perception of the self within a social context (Pratto et al., 2006; Singelis, 1994, Triandis, 1989). Whereas SDO refers to the basic attitude of superiority of one's own group over other relevant groups and affects social behavior towards other groups (Sidanius, 1993), TSC describes a general motivation to maintain group harmony (Ting-Toomey, 1988). Similar to low TSC, high SDO

may generally provoke independent self-construal in situations of conflict resolution because SDO has been shown to be negatively associated with empathy for others and positively related to callousness (e.g., Altemeyer, 1998; Duckitt, Wagner, du Plessis, & Birum, 2002). Hence, we believe that the light-induced changes in self-construal and its consequences for conflict resolution may only emerge for self-oriented individuals (low in interdependent TSC and/or low in SDO), while other-oriented individuals may not be affected by lighting conditions. Following this argumentation, individual differences in social orientation should moderate the effects of dim warm light on self-construal (direct effect) and on conflict resolution (indirect effect).

Overview of the present research

The aim of this research was to clarify the effects of lighting on conflict resolution. Based on the notion of automatic effects of light and in line with previous research, we expected that the relation between dim warm light and situative interdependent self-construal would be moderated by social orientation. At low levels of social orientation, (a) high social dominance orientation and (b) low trait interdependent self-construal, there would be a positive relation between dim warm light and situative interdependent self-construal (Hypothesis 1). Moreover, we hypothesized that situative interdependent self-construal would be positively related to the collaborative conflict resolution strategies, (a) compromising, (b) obliging, and (c) integrating (Hypothesis 2).

Integrating H 1 with H 2, we hypothesized that the indirect effects of dim warm light on collaborative conflict resolution strategies via interdependent self-construal would be conditional on (i.e., moderated by) social orientation (H 3), yielding a first-stage moderated mediation (Edwards & Lambert, 2007). This hypothesis was tested with SDO as an indicator of social orientation in Study 1 and with TSC and SDO as indicators of social orientation in Study 2. The proposed set of hypotheses provides a novel and parsimonious explanation for

the rather inconsistent effects of lighting conditions on conflict resolution. Moreover, the present studies test for the first time whether changes in self-construal mediate the interactive effects of dim warm light and social orientation on collaborative behavior.

To test the generalizability of the effects and to allow practical implications, the effect of light on preferences for collaborative conflict resolution strategies was tested at different combinations of illuminance levels and color temperature in the two studies. Most laboratory studies use rather extreme settings, which maximizes the likelihood of significant effects. However, some of these extreme lighting settings do not conform to the actual lighting standards (DIN 12464 / ISO 8995) and can scarcely be found in field situations. Hence, in Study 1, we aimed at mimicking realistic office conditions. To allow comparisons with previous studies, more extreme lighting settings were used in Study 2.

Furthermore, it has been previously proposed that light may induce positive affect, which in turn leads to more prosocial behavior (Baron et al., 1992). This notion of light-induced positive affect and its significance for collaboration has received mixed support (e.g., Baron et al., 1992; Boyce et al., 2006; Knez, 1995; Knez, 2001). In order to rule out this alternative explanation, we controlled for mood and satisfaction with lighting condition in both studies.

Study 1

Methods

Participants. One hundred and five German undergraduates (74 females and 31 males; mean age = 22.83 years; *SD* = 4.87) were recruited via university mailing lists and took part in exchange for course credit or for a payment of € 10. Participants were randomly assigned to one of the four lighting conditions. Sample sizes for specific analyses vary due to missing data on specific conflict scales from N = 100 – 105.

Setting and procedure. The experiment was conducted at [*location masked for blind review*] in a room that simulated an office and contained regular office furniture: four desks and chairs, a monitor and a keyboard on each desk, which were positioned in a way that allowed no reflections and glare for the participants sitting at the desk. The size of the room was 4.7 m x 4.32 m, and 2.35 m high. The windows were covered with blinds to ensure standardized artificial lighting conditions. The light was offered through six ceiling fluorescent light-based luminaires, 149.5 cm (length) x 20 cm (width) each, with a digital switching function. The luminaires were set to create either bright (1000 lx) or dim (300 lx) lighting conditions, combined with either neutral white (4200 K) or warm white (2800 K) color temperature (see supplementary material). Previous studies contrasting dim and bright lighting conditions used more extreme illuminance levels. The present study aimed at mimicking realistic scenes of office lighting and therefore narrowed the range of the investigated illuminance level down to 300 to 1000 lux and varied the color temperature between warm (2800 K) and neutral (4200), because according to Kruithof (1941) the combinations of illuminance and color temperature in this area are perceived as more natural and comfortable. Thus, the four lighting conditions were: bright neutral (1000 lx, 4200 K), bright warm (1000 lx, 2800 K), dim neutral (300 lx, 4200 K) and dim warm (300 lx, 2800 K). As artificial lighting may produce uncomfortable heat stress (Hygge & Knez, 2001), particularly in the bright lighting conditions, the room temperature was held constant at 23 °C using an air conditioning system.

On the day before the experimental sessions, participants received an email requesting them to answer an online survey assessing several personality traits. Individuals participated in groups of up to four and were guided by an instructor. Upon arrival, one of the four lighting conditions was already present. Participants were seated in front of a computer, approximately 60 cm from the screen, facing the wall. They completed several questionnaires and worked on

different tasks for one hour, including indication of mood, satisfaction with light, self-construal and conflict styles. At the end participants indicated their sex and age, were thanked, and fully debriefed.

Measures.

Collaborative conflict resolution strategy. To assess participants' inclinations towards different conflict resolution strategies, participants were requested to read through a scenario describing a business negotiation with a fictitious interaction partner and to assess how they would solve the presented conflict. To enhance the generalizability, we used different scenarios. Based on a pilot study, three scenarios were selected which elicited similar conflict resolution strategies: (1) buying a used car from a salesman, (2) selling a used car to a potential customer and (3) negotiating hiring conditions as a trade union member (for details see supplementary material). Due to time constraints, each participant answered one randomly assigned negotiation scenario.

After reading through the scenario, participants answered the German version of the conflict inventory (Rahim, 1983; Bilsky & Wülker, 2000). Participants rated 15 questions about their preferred behavior in the respective scenario (e.g., "During the negotiation, I would use 'give and take' so that a compromise can be made") on a five-point Likert type scale (1: strongly disagree – 5: strongly agree). Three items represented each of the five interpersonal conflict strategies: integrating, compromising, obliging, dominating, and avoiding. As different scholars proposed different taxonomies of conflict resolution strategies, varying between two and five styles (Putnam & Wilson, 1982; Pruitt, 1983; Thomas, 1976; Tjosvold, 1990), we conducted exploratory factor analysis which extracted four factors (compromising and integrating loaded on the same factor; see Table 1 for factor loadings). Consistent with these findings, confirmatory factor analyses showed that a four-factor model with four conflict strategies (compromising and integrating combined, alongside the

remaining three styles) fits the data well ($\chi^2(51, N = 98) = 109.28$, $p = .033$; $\chi^2/df = 2.14$, CFI = .93, TLI = .91, RMSEA = .055, SRMR = .075). According to Hu and Bentler (1999), CFI and TLI values close to .95, RMSEA value smaller than .06 and a SRMR value close to .08 suggest an acceptable fit. All items and facets had significant factor loadings on intended factors, except for one item of avoiding ($p = .10$). However, the avoiding conflict strategy was not a focal variable of this research, and the overall model fit was good. Hence, four conflict resolution strategies were computed: cooperating (items of the subscales integrating and compromising; $\alpha = .79$), obliging ($\alpha = .46$), dominating ($\alpha = .75$), and avoiding ($\alpha = .54$). Internal consistencies were similar to those reported in previous studies (e.g., Boyce et al., 2003). To avoid biases due to differences in the conflict resolution strategies between the three scenarios, the conflict resolutions strategies were z-standardized per scenario[1].

Situative self-construal. The situative self-construal in the conflict scenario was measured by the Inclusion of the Other in the Self scale (IOS; Aaron, Aaron, & Smollan, 1992). This scale consists of seven different overlapping pairs of circles that describe the relationship between the participant and the negotiation partner. Participants selected one of the seven pictures, representing a 7-point scale. Higher values indicate a higher perception of affiliation with the interaction partner and can be interpreted as situative interdependent self-construal (Steidle et al., 2013).

Social dominance orientation (SDO). Participants assessed their social dominance orientation ($\alpha = .84$) with the German version of the SDO-questionnaire (Cohrs, Kielmann, Moschner, & Maes, 2005; Jost, & Thompson, 2000). The SDO-questionnaire contains 12 self-report items with a response scale ranging from 1 (strongly disagree) to 7 (strongly agree). Sample items include “Some groups of people are just more worthy than others” and “All groups should be given an equal chance in life” (reversed).

Control variables. Previous research has proposed that light may elicit positive affect, which in turn fosters collaboration (e.g., Baron et al., 1992; Boyce et al., 2006; Knez, 1995; Knez, 2001). In order to control for this alternative explanation, we assessed mood as a general indicator of positive emotions and "satisfaction with lighting" as an indicator of positive affect associated with the light. Mood (α = .89) was measured using Nitsch's four-item Personal State Scale (Apenburg, 1986; Nitsch, 1976), which employs ratings ranging from 1 (strong rejection) to 9 (strong agreement). Satisfaction with the light (α = .86) was assessed with two items answered on a seven-point scale 1 (1: strongly disagree - 7: strongly agree): "The lighting is pleasant" and "I am satisfied with the lighting condition".

Analytic Strategy. We tested the moderation hypotheses using the moderated regression procedures recommended by Aiken and West (1991). We centered all lower-order terms involved in hypothesis testing and then multiplied them to create interaction terms. The focal warm dim lighting was represented by a dummy variable (dim warm = 1, other lighting conditions = 0). As all lighting conditions represented different manipulations, we included two additional dummy variables in all analyses: bright neutral light (bright neutral light = 1, other conditions = 0) and bright warm light (bright warm light = 1, other conditions = 0). We conducted OLS mediation analyses using a bias-corrected bootstrapping procedure with 10,000 bootstraps to test our moderated mediation hypotheses (Hayes, 2013). As recommended by Bing, LeBreton, Davison, Migetz, and James (2007), to increase statistical power, we used one-tailed tests for our interactions as they were predicted a priori. According to Preacher, Zyphur, and Zhang (2010), mediation hypotheses are directed hypotheses and therefore have to be tested on a one-tailed alpha level α = .05 corresponding to a 90% confidence interval. Thus, the proposed conditional indirect effects would be confirmed if the 90% bias-corrected bootstrap confidence intervals did not include zero.

Results

Table 2 presents descriptive statistics, correlations and reliabilities of all variables. As expected, SDO moderated the effect of dim warm light on situative self-construal (b = .90, p = .007, see Table 3, Model 2). Plotting the interaction at low and high levels (+/- 1 *SD* from mean; Figure 2) of the moderator shows that the relationship between dim warm light and interdependent situative self-construal was positive and significant for individuals high in SDO (b = 1.40, p = .002), but not for those low in SDO (b = -.22, p = .32). Hence, H1 was supported.

Consistent with H2, situative self-construal was positively related to both collaborative conflict resolution strategies: cooperating (r = .51, p = .00; b = .39, p = .00) and obliging (r = .20, p = .03; b = .18, p = .01), in correlation and regression analyses (see Table 3, Models 3-4).

To test H3, we used model 7 of Hayes' (2013) PROCESS macro for SPSS and compared the conditional indirect effect of dim warm light on collaborative conflict styles via interdependent situative self-construal for SDO at 1 *SD* above the mean and at 1 *SD* below the mean. The results revealed that the indirect effect of dim warm light on the preference for cooperating via situative self-construal was significant for individuals high in SDO (indirect effect = .54, *SE* = .21, 95% *CI* [.20, 1.04]; 90% *CI* [.25, .95]) and for mean levels of SDO (indirect effect = .28, SE = .16, 95% *CI* [.04, .67]; 90% *CI* [.07, .59]), but not for those low in SDO (indirect effect = .02, *SE* = .18, 95% *CI* [-.28, .43]); 90% *CI* [-.25, .36]). Similarly, the indirect effect of dim warm light on the preference for obliging via situative self-construal was significant for individuals high in SDO (indirect effect = .25, *SE* = .12, 95% *CI* [.06, .57]; 90% *CI* [.09, .51]) and for mean levels of SDO (indirect effect = .11, SE = .08, 95% *CI* [.002, .32]; 90% *CI* [.01, .28]), but not for those low in SDO (indirect effect on obliging = -.03, SE = .09, 95% *CI*[-.22, .13]); 90% *CI*[-.19, .09]). Further, the index of moderated mediation on the preference for collaborative conflict resolution strategies in dim warm light were positive and

their CIs did not include zero: cooperating (index =.29, *SE* = .13, 95% *CI*[.05; .57]; 90% *CI*[.10; .53]) and obliging (index = .16, *SE* = .08, 95% *CI*[.03; .37]; 90% *CI*[.05; .35]). Consequently, H3 was supported.

The interaction effect in Model 2 and the conditional indirect effects in Models 3 and 4 remained significant after controlling for age, gender, satisfaction with light, and mood (all *p*s < .05, CIs did not include zero). Hence, the reported effects cannot be attributed to differences in age, gender, satisfaction with light, or mood. Overall, these results confirm our assumption that dim warm light elicits interdependent self-construal for individuals with high social dominance orientation and, in turn, promotes the likelihood of choosing collaborative conflict resolution strategies.

Study 2

Study 2 aimed at substantiating and extending the effects found in Study 1. We tested the same set of hypotheses. However, two alterations were made. First, in contrast to previous studies, Study 1 only used a very small variation of illuminance levels (300 vs. 1000 lx) and color temperature (2800 vs. 4200 K). Hence, in line with previous studies (Baron et al., 1992, Knez, 2001; Steidle et al., 2013), a larger variation of brightness (150 vs. 1500 lx) and color temperature (2500 vs. 5500 K) was used in Study 2. Second, in Study 1, social dominance orientation served as an indicator of participants' social orientation. However, the important process revealed in Study 1 was the self-construal level, which mediated the effect of lighting conditions on the preference for conflict resolution strategies. Hence, to take a more direct approach, we additionally included trait interdependent self-construal as a measure of social orientation.

Methods

Participants. One hundred and fifty seven German students were recruited via university mailing lists and took part in exchange for course credits or for a payment of 15 €. Five participants were excluded from further analyses because they did not understand the survey questions (two individuals) and because of knowing the scenarios of conflict styles due to participation in a previous study (three individuals). Finally, data of one hundred and fifty two students (75 females and 77 males; mean age = 23.64 years; *SD* = 5.69) were used for statistical analyses. Participants were randomly assigned to one of the four lighting conditions. Sample sizes for specific analyses vary due to missing data on conflict strategies scales from N = 150 – 152.

Setting and procedure. The experiment was conducted at the [*location masked for blind review*] as part of a larger research project on lighting effects on behavior. The size of the room was 5.10 m x 3.50 m, and 3.00 m high in size and the windows were covered with blinds. The light was offered through 3 pendant ceiling LED light-based luminaires, 116 cm (length) by 8.5 cm (width) each, with 50 cm distance from the ceiling (see supplementary material). The luminaires were set to produce either bright (1500 lx) or dim (150 lx) direct-indirect lighting, combined with either cold white (5500 K) or warm white (warm, 2500 K) color temperature, yielding four lighting conditions labeled bright cold (1500 lx, 5500 K), bright warm (1500 lx, 2500 K), dim cold (150 lx, 5500 K), and dim warm light (150 lx, 2500 K). The additional setting arrangement and procedure was identical to Study 1.

Measures. Conflict resolution strategies, situative self-construal, SDO and control variables were assessed using the instruments described in Study 1.

As in Study 1, the confirmatory factor analysis revealed, that a four-factor measurement model displayed a good fit to the data ($\chi^2(51, N = 150) = 112.92$, $p = .019$; $\chi^2/df = 2.21$, CFI = .92, TLI = .90, RMSEA = .048, SRMR = .059) and all items had significant factor loadings on intended factors. Thus, we averaged the items of compromising and

integrating into an overall cooperating score (α =.75), and all other items into their respective dimensions, obliging (α=.45), dominating (α=.63) and avoiding (α=.49)[2].

Trait interdependent self-construal (TSC). TSC (α = .56) was assessed via the German version of the Self-Construal Scale (Singelis, 1994) prior to the lab experiment. The reliability was comparable to previous studies (e.g., Escalas, & Bettman, 2005). The scale contains 12 self-report items with a response scale ranging from 1 (strongly disagree) to 7 (strongly agree). Sample items include "It is important for me to maintain harmony within my group" and "My happiness depends on the happiness of those around me".

Analytic Strategy. We used the same analytic strategy as in Study 1. In the first step, we tested the interaction between dim warm light and SDO on situative self-construal, in the second step, the interaction effect of dim warm light and TSC on situative self-construal, and in the third step, both moderators at once: SDO and TSC (Model 2 of PROCESS; Hayes, 2013).

Results

Table 4 presents descriptive statistics, correlations, and reliabilities of all variables. As expected, SDO moderated the effect of dim warm light on situative self-construal (b = .39, p = .03, see Model 2a, Table 5). Plotting the interaction at low and high levels (+/- 1 SD from mean; Figure 3) of the moderator shows that the positive relationship between dim warm lighting and interdependent situative self-construal was only significant for individuals high in SDO (b = .64, p = .04), but not for those low in this trait (b = -.17, p = .32). Consistent with H1, interdependent TSC also moderated the effect of light on situative self-construal in dim warm lighting (b = -.88, p = .01, see Model 2b, Table 5). Plotting the interaction at low and high levels (+/- 1 SD from mean; Figure 4) of the moderator shows that the positive relationship between dim warm lighting and interdependent situative self-construal was only

significant for individuals low in interdependent TSC (b = .73, p = .02), but not for those high in this trait (b = -.33, p = .19). Testing both moderators at once using Model 2 of Hayes (2013), the interactive effect of TSC and dim warm light on situative self-construal remained significant (b = -.69, p = .03), but the interactive effect of SDO and dim warm light was only marginally significant (b = .31, p = .08). The incremental variance of 4.6 % due to both interactions was significant (p=.01, see Model 2c, Table 5). These results support H1.

Consistent with H2, situative self-construal was positively related to the collaborative conflict resolution strategies: cooperating (r = .19, p = .02; b = .15, p = .02) and obliging (r = .18, p = .02; b = .15, p = .02), in correlation (see Table 4) and regression analyses (see Table 5, Models 3-6).

To test H3, we compared the conditional indirect effect of dim warm light on collaborative conflict resolution strategies via interdependent situative self-construal for SDO at 1 SD above the mean and at 1 SD below the mean. The results revealed indirect effects on cooperating (indirect effect = .09, *SE* =.08, 95% *CI* [-.02, .34]; 90% *CI* [.002, .29]) and on obliging (indirect effect = .09, *SE* =.08, 95% *CI* [-.01, .35]); 90% *CI* [.004, .30] via situative self-construal that were significant for high SDO, but not for low SDO (indirect effect on cooperating = -.02, *SE* =.06, 95% *CI* [-.17, .07]; 90% *CI* [-.14, .06]; indirect effect on obliging = -.02, *SE* =.06, 95% *CI* [-.17, .07]; 90% *CI* [-.14, .05]) nor for mean levels of SDO (indirect effect on cooperating = .03, *SE* =.05, 95% *CI* [-.04, .17]; 90% *CI* [-.02, .14]; indirect effect on obliging = .04, *SE* =.05, 95% *CI* [-.04, .17]; 90% *CI* [-.02 .15]). Further, the index of moderated mediation on cooperating (index = .06, *SE* = .05, 95% *CI* [-.01; .19]; 90% *CI* [.003; .17]) and obliging (index = .06, *SE* = .05, 95% *CI* [-.007; .21]; 90% *CI* [.003; .17]), were positive and their CI did not include zero.

In line with H3, the moderated mediation using TSC as moderator revealed that the indirect effects of dim warm light on cooperating (indirect effect = .11, *SE* =.08, 95% *CI* [-

.0002, .33]; 90% *CI* [.02, .29]) and on obliging (indirect effect = .11, *SE* =.07, 95% *CI* [.01, .31]; 90% *CI* [.03, .28]) via situative self-construal were only significant for individuals low in interdependent TSC, but not those high in interdependent TSC (indirect effect on cooperating = -.05, *SE* = .06, 95% *CI* [-.22, .04]; 90% *CI* [-.18, .02], indirect effect on obliging = -.05, *SE* = .06, 95% *CI* [-.21, .04]); 90% *CI* [-.18, .02]), nor for those with mean levels in TSC (indirect effect on cooperating = .03, *SE* = .05, 95% *CI* [-.05, .15]; 90% *CI* [-.03, .13], indirect effect on obliging = .03, *SE* = .05, 95% *CI* [-.04, .15]); 90% *CI* [-.02, .13]). Moreover, the index of moderated mediation on cooperating (index = -.13, *SE* = .08, 95% *CI* [-.37; -.01]; 90% *CI* [-.32; -.03], and obliging (index = -.13, *SE* = .08, 95% *CI* [-.34; -.02]; 90% *CI* [-.30; -.04]) were negative and their CIs did not include zero. Consequently, H3 was supported.

In addition, the interaction effects in Models 2a-2c and the conditional indirect effects in Models 3 and 4 remained significant after controlling for age, gender, satisfaction with light, and mood (all *p*s < .05, CIs did not include zero). Hence, the reported effects cannot be attributed to differences in age, gender, evaluation of lighting conditions, or mood. Overall, these results support our assumption that dim warm light elicits situative interdependent self-construal for individuals with low levels of trait interdependent self-construal and with high levels of social dominance orientation and, in turn, promotes a preference for collaborative conflict resolution strategies.

Discussion

Lighting conditions can shape the way some individuals see themselves and others, and thus influence the way they interact. In two studies, we investigated how brightness and warmth of light affect conflict resolution alongside mediating and moderating variables. Overall, the results revealed that self-oriented individuals were more likely to include their negotiation partner into the self in dim warm light than in other lighting conditions, which, in

turn, promotes collaborative conflict resolution. Three moderation analyses showed that the effect of light on self-construal and, indirectly, on conflict resolution only emerged for individuals high in social dominance orientation and/or low in trait interdependent self-construal. Apparently, an individual's social orientation limits the light's potential to induce collaboration. The similarity in the moderation effects of two different measures assessing traits related to social orientations as well as the consistency of the effects across the two studies (smaller or greater variations of illuminance level and color temperature) suggest some generalizability of the reported effect. Changes in self-construal mediate the interactive effect of dim warm light and social orientation, while other explanations (mood and light preference) could be rejected. Overall, we conclude that light can prompt self-oriented individuals to collaborate by inducing a sense of "we".

The present findings supplement previous research on the effects of the physical environment on social perception and behavior, and explain previous inconclusive findings. Environmental stimuli, like illuminance levels (Steidle et al., 2013; Zhong, Bohns, & Gino, 2010) and color temperature (Baron et al., 1992), have been shown to impact social interaction, but the underlying processes as well as the limiting conditions of this effect, which could possibly explain inconsistent findings, are largely unknown. Hence, we first discuss how this research contributes to the understanding of the impact of lighting on social behavior. Moreover, if lighting conditions are able to foster social-supportive atmospheres, this has practical implications for architecture and the design of social spaces. Finally, the limitations of the research will be discussed.

One major contribution of this research is that it helps to explain why previous research on the impact of lighting on conflict resolution yielded mixed findings (Baron et al., 1992, Boyce et al., 2003). One study suggested that warm (and dim) light induced a general inclination towards collaboration in conflict situations (Baron et al., 1992), but this result was

not replicated using a different measure of conflict resolution in the same study (Baron et al., 1992). Moreover, in two other studies merely adapting the brightness did not affect the reported preferences for certain conflict resolutions (Boyce et al., 2003, 2006). However, in line with Baron's first result, our two studies clearly support the assumption that dim warm light fosters collaborative conflict resolution. The apparent inconsistency in the findings can be explained by three considerations.

First, and most obviously, Boyce only varied illuminance levels while our studies show that a combination of dim and warm light is needed to promote collaborative conflict resolution. Second, and most importantly, our moderation analyses revealed that the light-conflict resolution link depended on individual differences. As in a previous study by Steidle et al. (2013) on cooperativeness in a prisoner's dilemma game, only individuals high in individualistic orientation were positively affected by the light. While social value orientation was conceptualized to explain individual differences in cooperation in prisoner's dilemmas (Kuhlman & Marshello, 1975), in the present research, we investigated two personality traits that are crucial in situations of conflict resolution (e.g., Derlega, Cukur, Kuang, & Forsyth, 2002; Sidanius, 1993; Ting-Toomey, Oetzel, & Yee-Jung, 2001). SDO may affect a host of behavioral outcomes towards other groups and individuals in social situations (Sidanius, 1993), whereas TSC involves an emphasis on connectedness to others and results in a need for harmony (Ting-Toomey, 1988). Thus, both may explain individual differences in conflict situations. Since these individual differences were not taken into account in the studies by Baron and Boyce, the interaction effect may have been neglected. Third, from the description in the articles (Baron et al., 1992; Boyce et al., 2003, 2006), it cannot be determined whether the presented conflicts provide an opportunity for mutual gains through collaboration. As discussed previously (Steidle et al., 2013), light-induced interdependent self-construal should lead to more collaboration and cooperation in situations in which mutual gains are possible

(e.g., cooperative partner) but not when mutual gains are impossible (e.g., uncooperative partner). In the presented scenarios in our studies, participants imagined meeting a person willing to negotiate and could see gains for both sides from sealing the bargain. This presents a situation in which collaboration helps to reach individual and mutual goals, while it remains unclear whether the conflicts represented in previous studies offered this possibility. Overall, light-induced collaboration in conflict situation depends on multiple environmental, situational, and individual context factors.

The second important contribution is the interaction effect of light and an individual's stable social orientation on situative self-construal which has been shown, as far as we are aware, for the first time. As situative self-construal represents the underlying process leading to prosocial behavior and a previous study indicated an interaction effect between light and a trait of social orientation on cooperation (Steidle et al., 2013), these results provide a consistent understanding of how and why individuals low in social orientation are influenced by light: dim warm light apparently does not directly influence collaborative behavior, but is instead an anteceding cognitive process, in particular the construal of the social situation, of the self, and others. In this context, it is important to consider that self-construal relates to a number of behavioral outcomes. For instance, activated interdependent self-construal has been shown to lead to negative evaluations of others' selfish behavior (Gardner et al., 1999) and to a preference for smaller spatial distance during an interaction (Holland, Roeder, van Baaren, Brandt, & Hannover, 2004). Moreover, individuals with an independent (versus interdependent) self-construal tend to present themselves in terms of their individual skills and expertise (versus in terms of their social skills; Lalwani & Shavitt, 2009) and show more verbal self-promotion (e.g., not admitting others' contributions to their own success; Ellis & Wittenbaum, 2000). Furthermore, self-construal is related to context-specific risk-taking: activated interdependent self-construal results in high risk-seeking in financial contexts, but

less risk-seeking in social contexts (e.g., potentially embarrassing situations; Mandel, 2003). Hence, via the activation of a situative interdependent self-construal, dim warm light may have indirect effects on impression management, self-disclosure, social risk-taking, and moral judgment, especially for individuals low in social orientation. This may be a fruitful area for future research.

Further research is also needed on the interaction effects between light and other physical features like a room's temperature, space, or spatial layout. Due to the automatic link between the experience of physical temperature and feelings of psychological warmth (Ijzerman & Semin, 2009, 2010, Bargh & Shalev, 2011), room temperature can influence social perceptions (e.g., social exclusion; Zhong & Leonardelli, 2008) and interpersonal behavior (e.g., customer orientation; Kolb, Gockel, & Werth, 2012). Therefore, it would be highly interesting to investigate the combined effect of light and room temperature on social behavior. Would warm light reduce the feelings of loneliness and the associated affiliation motivation in a cold room, which would speak for a supplementary effect? Or would warm temperature and warm light, both of which promote the inclusion of others in the self, lead to additive or multiplicative effects on self-construal and social behavior?

Space represents another important environmental condition in interactions, as all spatial and interpersonal distance dimensions are interrelated (Bar-Anan, Liberman, Trope, & Algom, 2007). Consistently, interdependent self-construal is also linked to interpersonal closeness (Lee, Draper, & Lee, 2001). Thus, spatial proximity like negotiation partners sitting close to each other could promote interpersonal proximity and boost the effect of dim warm light on interdependent self-construal. In contrast, too much closeness (not enough space) induces a feeling of crowding and, in turn, decreases self-disclosure (Okken, Rompay, & Pruyn, 2013) and communicative behavior (Sundstrom, 1975). Thus, in small rooms, warm dim light may in some situations be experienced as coherent because of the intimate

atmosphere it creates, while in other situations a cooler light may help to create some interpersonal distance. In large rooms, warm dim light could potentially be used to reduce interpersonal distance and serve as an invitation for contact. Merely dimming the light in a large room without simultaneously reducing the color temperature might instead create a threatening and anonymous atmosphere (McCloughan, Aspinall, & Webb, 1999), which would be detrimental to cooperation. As interesting these ideas may be, they need to be tested before being recommended to or by practitioners.

The contributions of the present research should be qualified in light of its limitations. First, although different levels of illuminance and color temperature have been used, we did not investigate the effect of variations in daylight on self-construal and conflict-resolution strategies. However, reduced brightness has been shown to promote more positive social evaluations in both artificial and natural light. Compared to a brightly lit room, participants in a study by Baron et al. (1992) assigned higher performance evaluations to a fictitious employee in a dim room. Similarly, cloudy weather (i.e., reduced natural brightness) led to more positive reactions by women to mens' assured behavior in another study (Rauthmann, Kappes, & Lanzinger, 2014). It may well be that the soft warm light of a sunset increases the likelihood of feeling like a "We", as frequently suggested by kissing scenes in many romantic movies. However, more research is needed to answer these questions.

Second, related to this point, further research would help to determine what kind of lighting is optimal for collaboration. In addition to color temperature and illuminance levels, important features of artificial light comprise: the spatial distribution of the light (uniformity), personal control over the lighting conditions, and the color of the light. In our studies, we varied different combinations of brightness and color temperature using direct (Study 1) and direct-indirect (Study 2) light. Although direct and direct-indirect light lead to similar effects, we did not directly compare different spatial distributions and did not replicate the study using

only indirect light. Similar to dim and bright light, individuals prefer non-uniform to uniform light for informal or social activities (Kobayashi, Inui, & Nakamura, 2001). Hence non-uniformity may boost the positive effects of warm dim light on collaboration. In addition, personal control strongly impacts satisfaction with the light and well-being (Flynn, 1977; Veitch, Newsham, Boyce, & Jones, 2008), but as previously described, Boyce et al. (2003) reported no influence of personal control on conflict resolution strategies. Finally, the color of the light may affect self-construal and the preference for collaborative conflict resolution strategies. Since red colored light has been linked to a warm and cozy room atmosphere (Kuijsters, Redi, de Ruyter, & Heynderickx, 2015) and to interpreting conversations in a friendly way (higher perceived scores of friendliness, positivity and sensitivity of conversation partners than in white light; Takahashi, 2009), this lighting condition could also promote interpersonal closeness and interdependence with others. Due to these considerations, it is also important to take into account the light's spatial distribution (proportion of direct and indirect lighting, accent vs. general lighting) and color, as well as the user's perceived control in future research on "collaborative light".

Third, in the current studies, conflict resolution was measured in the form of questionnaires covering different conflict resolution strategies, but without observing actual behavior. Although the reported preferences for certain conflict resolution strategies produce consistent behavior in negotiations (e.g., Ajzen, 1991; Psenicka & Rahim, 1989; Volkema & Bergmann, 1995), it is necessary to investigate actual behavior in real negotiations to be able to generalize the reported effects to real world situations at work or at home.

Finally, in two studies, we found slightly different results in the conditional indirect effect for individuals with medium levels of social dominance orientation. The indirect effects on conflict resolution strategies were only observed in Study 1. These effects cannot be attributed to different variations of brightness or the color temperature of dim warm light, but

rather depend on the correlation between self-construal and collaborative conflict strategies, which are high in Study 1 and moderate in Study 2. More importantly, the results for individuals with high and low levels of SDO are similar in both studies.

The current results also have practical implications. When designing work places where collaboration is important (e.g., conference and meeting rooms in organizations, group learning spaces at schools and universities, therapeutic settings), lighting should be taken into account. It may not be enough to install lights that meet the requirements specified by the regulations or to simply opt for the brightest or most energy-efficient solutions. Dim warm light or dynamic light with the option to set "collaborative light" in such rooms could contribute to cooperative decisions and discussions. Furthermore, looking outside of the work context, other rooms where cooperation takes place (e.g., living rooms, restaurants, speed dating locations) can be designed accordingly in order to promote collaborative and intimate communication. Independent of the occasion, both color temperature and illuminance levels need to be adjusted to create "collaborative light". In contrast, warm but bright or dim but cold light should not elicit the desired responses. Moreover, in field situations, the intended positive effect of dim warm light on collaboration may depend on, or be reduced or overshadowed by numerous contextual factors: environmental conditions, (e.g., room temperature, air quality, window view), social variables (e.g., relationship of the negotiators), and other individual traits (e.g., stimulus screening ability; Dijkstra et al., 2008).

Conclusion

The current studies broaden the exploration of environmental conditions that support collaborative conflict resolution strategies and suggest that the effect of light may be complex because light affects people differently depending on social orientation. The results provide support for the idea that among self-oriented individuals, dim warm light activates interdependent self-construal, which in turn promotes collaborative conflict styles. In

conclusion, to facilitate collaborative conflict resolution, it may be good to allow individuals to view each other in a different light.

Endnotes

[1] We conducted all analyses using the original five conflict styles and essentially replicated the reported results. Results can be obtained from the first author.

[2] As in Study 1, we conducted all analyses using the original five conflict styles and essentially replicated the results reported below. Results can be obtained from the first author.

References

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of Personality and Social Psychology, 63*,596-612. http://dx.doi.org/10.1037//0022-3514.63.4.596

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211. http://dx.doi.org/10.1016/0749-5978(91)90020-T

Altemeyer, B. (1998). The other "Authoritarian Personality". In M. P. Zanna (Hrsg.), *Advances in Experimental Social Psychology* (Bd. 30, S. 47-92). San Diego, CA: Academic Press.

Apenburg, E. (1986). Befindlichkeitsbeschreibung als Methode der Beanspruchungsmessung. Psychologie und Praxis. *Zeitschrift für Arbeits- und Organisationspsychologie, 30*, 3-14.

Bar-Anan, Y., Liberman, N., Trope, Y., & Algom, D. (2007). Automatic processing of psychological distance: Evidence from a Stroop task. *Journal of Experimental Psychology: General, 136,* 610–622. http://dx.doi.org/10.1037/0096-3445.136.4.610

Bargh, J. A., & Shalev, I. (2011). The substitutability of physical and social warmth in Daily Life. *Emotion, 12(1),* 154-162. http://dx.doi.org/10.1037/a0023527

Baron, R. A., Rea, M. S., & Daniels, S. G. (1992). Effects of indoor lighting (illuminance and spectral distribution) on the performance of cognitive tasks and interpersonal behaviors: The potential mediating role of positive affect. *Motivation and Emotion, 16,*

1-33. http://dx.doi.org/10.1007/BF00996485

Bing, M. N., LeBreton, J. M., Davison, H. K., Migetz, D. Z., & James, L. R. (2007). Integrating implicit and explicit social cognitions for enhanced personality assessment: A general framework for choosing measurement and statistical methods. *Organizational Research Methods, 10,* 346–389. http://dx.doi.org/10.1177/1094428107301148

Boyce, P.R., Veitch, J.A., Newsham, G.R., Jones, C.C., Heerwagen, J., Myer, M. & Hunter, C.M. (2006). Lighting quality and office work: two field simulation experiments. *Lighting Research and Technology, 38,* 191-223. http://dx.doi.org/10.1191/1365782806lrt161oa

Boyce, P. R., Veitch, J. A., Newsham, G. R., Myer, M., & Hunter, C. (2003*). Lighting quality and office work: A field simulation study* (PNNL 14506). Richland, WA, USA: Pacific Northwest National Laboratory.

Biner, P. M., Butler, D. L., Fischer, A. R., & Westergren, A. J. (1989). An arousal optimization model of lighting level preferences: An interaction of social situation and task demands. *Environment and Behavior, 21,* 3-16. http://dx.doi.org/10.1177/0013916589211001

Bilsky, W., & Wülker, A. (2000). *Konfliktstile: Adaptation und Erprobung des Rahim Organizational Conflict Inventory (ROCI-II).* Berichte aus dem Psychologischen Institut IV, Universität Münster.

Carr, S. J., & Dabbs Jr, J. M. (1974). The effects of lighting, distance and intimacy of topic on verbal and visual behavior. *Sociometry, 37,* 592-600. http://dx.doi.org/10.2307/2786430

Chanin, M.N., & Schneer, J.A. (1984). A study of the relationship between Jungian

personality dimensions and conflict-handling behavior. *Human Relations, 37,* 863-879. http://dx.doi.org/10.1177/001872678403701006

Colbert, A. E., Mount, M. K., Harter, J. K., Witt, L. A., & Barrick, M. R. (2004). Interactive effects of personality and perceptions of the work situation on workplace deviance. *Journal of Applied Psychology, 89,* 599-609. http://dx.doi.org/10.1037/0021-9010.89.4.599

Cross, S. E., Hardin, E. E., & Gercek-Swing, B. (2011). The what, how, why, and where of self-construal. *Personality and Social Psychology Review, 15(2),* 142-179. http://dx.doi.org/10.1177/1088868310373752

Custers, P., de Kort, Y., IJsselsteijn, W., de Kruiff, M. (2010). Lighting in retail environments: Atmosphere perception in the real world. *Lighting Research and Technology, 43,* 331–343. http://dx.doi.org/10.1177/1477153510377836

Derlega, V. J., Cukur, C. S., Kuang, J. C., & Forsyth, D. R. (2002). Interdependent construal of self and the endorsement of conflict resolution strategies in interpersonal, intergroup, and international disputes. *Journal of Cross-Cultural Psychology, 33,* 610-625. http://dx.doi.org/10.1177/0022022102238272

Dijkstra, K., Pieterse, M. E., & Pruyn, A. T. H. (2008). Individual differences in reactions towards color in simulated healthcare environments: The role of stimulus screening ability. *Journal of Environmental Psychology, 28,* 268-277. http://dx.doi.org/10.1016/j.jenvp.2008.02.007

Duckitt, J., Wagner, C., du Plessis, I., & Birum, I. (2002). The psychological bases of ideology and prejudice: Testing a dual process model. *Journal of Personality and Social Psychology, 83,* 75 – 93. http://dx.doi.org/10.1037/0022-3514.83.1.75

Druckman, D., & Boome, B.J. (1991). Value Differences and Conflict Resolution Familiarity

or Liking? *Journal of Conflict Resolution, 35,* 571-593. http://dx.doi.org/10.1177/0022002791035004001

Edwards, J. R., & Lambert, L. S. (2007). Methods for integrating moderation and mediation: a general analytical framework using moderated path analysis. *Psychological Methods, 12,* 1-22. http://dx.doi.org/10.1037/1082-989X.12.1.1

Ellis, J. B., & Wittenbaum, G. M. (2000). Relationships between self-construal and verbal promotion. *Communication Research, 26,* 704-722. http://dx.doi.org/10.1177/009365000027006002

Escalas, J. E., & Bettman, J. R. (2005). Self-construal, reference groups, and brand meaning. *Journal of Consumer Research, 32,* 378-389. http://dx.doi.org/10.1086/497549

Flynn, J. E. (1977). A study of subjective responses to low energy and nonuniform lighting systems. *Lighting Design and Application, 7,* 6-15.

Flynn, J. E. (1992). Lighting-design decisions as interventions in human visual space. In: J.L. Nasar (Ed.) *Environmental Aesthetics: Theory, Research and Applications.* (pp. 156 170) New York: Cambridge University Press.

Friedman, R. S., Fishbach, A., Förster, J., & Werth, L. (2003). Attentional priming effects on creativity. *Creativity Research Journal, 15,* 277-286. http://dx.doi.org/10.1207/S15326934CRJ152&3_18

Funder, D. C. (1991). Global traits: A neo-Allportian approach to personality. *Psychological Science, 2,* 31-39.

Gardner, W. L., Gabriel, S., & Lee, A. Y. (1999). "I" value freedom, but "we" value relationships: Self-construal priming mirrors cultural differences in judgment. *Psychological Science, 10,* 321-326. http://dx.doi.org/10.1111/1467-9280.00162

Gifford, R. (1988). Light, decor, arousal, comfort and communication. *Journal of Environmental Psychology, 8,* 177-189. http://dx.doi.org/10.1016/S0272-4944(88)80008-2

Gockel, C., Kolb, P.M., Werth, L. (2014). Murder or not? Cold temperature makes criminals appear to be cold-blooded and warm temperature to be hot-headed. *PLoS ONE 9,* e96231. http://dx.doi.org/10.1371/journal.pone.0096231

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis*. New York: Guilford.

Holland, R. W., Roeder, U. R., Brandt, A. C., & Hannover, B. (2004). Don't stand so close to me the effects of self-construal on interpersonal closeness. *Psychological Science, 15,* 237-242. http://dx.doi.org/10.1111/j.0956-7976.2004.00658.x

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: a Multidisciplinary Journal, 6,* 1-55. http://dx.doi.org/10.1080/10705519909540118

Hygge, S., & Knez, I. (2001). Effects of noise, heat and indoor lighting on cognitive performance and self-reported affect. *Journal of Environmental Psychology, 21,* 291-299. http://dx.doi.org/10.1006/jevp.2001.0222

IJzerman, H., & Semin, G. R. (2009). The thermometer of social relations: mapping social proximity on temperature. *Psychological Science, 20,* 1214–1220. http://dx.doi.org/10.1111/j.1467-9280.2009.02434.x

IJzerman, H., & Semin, G. (2010). Temperature perceptions as a ground for social proximity. *Journal of Experimental Social Psychology, 46,* 867–873. http://dx.doi.org/10.1016/j.jesp.2010.07.015

Inagaki, T. K., & Eisenberger, N. I. (2013). Shared neural mechanisms underlying social

warmth and physical warmth. *Psychological Science, 24,* 2272-2280, http://dx.doi.org/10.1177/0956797613492773

Kaufmann (1967). Similarity and cooperation received as determinants of cooperation rendered. *Psychological Science, 9,* 73-74. http://dx.doi.org/10.3758/BF03330765

Knez, I. (1995). Effects of indoor lighting on mood and cognition. *Journal of Environmental Psychology, 15,* 39-51. http://dx.doi.org/10.1016/0272-4944(95)90013-6

Knez, I. (2001). Effects of colour of light on nonvisual psychological processes. *Journal of Environmental Psychology, 21,* 201-208. http://dx.doi.org/10.1006/jevp.2000.0198

Kobayashi, S., Inui, M., & Nakamura, Y. (2001). Preferred illuminance non-uniformity of interior ambient lighting. *Journal of Light and Visual Environment, 25,* 64-75. http://dx.doi.org/10.2150/jlve.25.2_64

Kolb, P., Gockel, C., & Werth, L. (2012). The effects of temperature on service employees' customer orientation: an experimental approach. *Ergonomics, 55,* 621-635. http://dx.doi.org/10.1080/00140139.2012.659763

Kruithof, A.A. (1941). Tubular Luminescence Lamps for General Illumination. *Philips Technical Review 6,* 65–96.

Kuhlman, D., & Marshello, A. (1975). Individual differences in game motivation as moderators of preprogrammed strategy effects in prisoner's dilemma. *Journal of Personality and Social Psychology, 32,* 922–931. http://dx.doi.org/10.1037/0022-3514.32.5.922

Kuijsters, A., Redi, J., de Ruyter, B., & Heynderickx, I. (2015). Lighting to make you feel better: Improving the mood of elderly people with affective ambiences. *PloS ONE 10,* 1-22. http://dx.doi.org/10.1371/journal.pone.0132732

Kuijsters, A., Redi, J., de Ruyter, B., Seuntiëns, P., & Heynderickx, I. (2014). Affective ambiences created with lighting for older people. *Lighting Research and Technology, 47,* 859-875. http://dx.doi.org/10.1177/1477153514560423

Lalwani, A. K., & Shavitt, S. (2009). The "me" I claim to be: Cultural self-construal elicits self-presentational goal pursuit. *Journal of Personality and Social Psychology, 97,* 88-102. http://dx.doi.org/10.1037/a0014100

Lee, R. M., Draper, M., & Lee, S. (2001). Social connectedness, dysfunctional interpersonal behaviors, and psychological distress: Testing a mediator model. *Journal of Counseling Psychology, 48,* 310-318. http://dx.doi.org/10.1037/0022-0167.48.3.310

Mandel, N. (2003). Shifting selves and decision making: The effects of self-construal priming on consumer risk-taking. *Journal of Consumer Research, 30,* 30-40. http://dx.doi.org/10.1086/374700

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98,* 224-253. http://dx.doi.org/10.1037/0033-295X.98.2.224

McCloughan, C. L. B., Aspinall, P. A., & Webb, R. S. (1999). The impact of lighting on mood. *Lighting Research and Technology, 31,* 81-88. http://dx.doi.org/10.1177/096032719903100302

Nitsch J. R. (1976). Die Eigenzustandsskala (EZ-Skala) – Ein Verfahren zur hierarchisch mehrdimensionalen Befindlichkeitsskalierung. In: I.U.J.R. Nitsch (Ed.). *Beanspruchung im Sport. Beiträge zur psychologischen Analyse sportlicher Leistungssituationen,* 81–102. Bad Homburg, Germany, Limpert.

Oetzel, J.G. (1998). The effects of self-construals and ethnicity on self reported conflict styles. *Communication Reports, 11,* 133-144.

http://dx.doi.org/10.1080/08934219809367695

Oetzel, J., Meares, M., Myers, K. K., & Lara, E. (2003). Interpersonal conflict in organizations: Explaining conflict styles via face negotiation theory. *Communication Research Reports, 20,* 106-115. http://dx.doi.org/10.1080/08824090309388806

Okken, V., van Rompay, T., & Pruyn, A. (2013). Room to move on spatial constraints and self-disclosure during intimate conversations. *Environment and Behavior, 45,* 737-760. http://dx.doi.org/10.1177/0013916512444780

Pratto, F., Sidanius, J., & Levin, S. (2006). Social dominance theory and the dynamics of intergroup relations: Taking stock and looking forward. *European Review of Social Psychology, 17,* 271-320. http://dx.doi.org/10.1080/10463280601055772

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15,* 209 – 233. http://dx.doi.org/10.1037/a0020141

Pruitt, D. G. (1983). Strategic choice in negotiation. *American Behavioral Scientist, 27,* 167-194. http://dx.doi.org/10.1177/000276483027002005

Pruitt, D. G. (1998). Social conflict. In: D.T.Gilbert, S.T.Fiske, G.Lindzey (Eds), *The handbook of social psychology* (Vols. 1 and 2, 4th ed. pp. 470-503). New York, NY, US: McGraw-Hill.

Psenicka, C., & Rahim, M. A. (1989). Integrative and distributive dimensions of styles of handling interpersonal conflict and bargaining outcome. In M. A. Rahim (Ed.), *Managing conflict: An interdisciplinary approach* (pp. 33–40). New York:

Putnam, L. L., & Wilson, C. E. (1982). Communicative strategies in organizational conflicts: Reliability and validity of a measurement scale. In M. Burgoon (Ed.), *Communication Yearbook,* (Vol. 6, pp. 629-652). Beverly Hills, CA: Sage.

Rahim, M. A. (1983). A measure of styles of handling interpersonal conflict. *Academy of Management Journal, 26,* 368-376. http://dx.doi.org/10.2307/255985

Rahim, M. A., & Bonoma, T. V, (1979). Managing organizational conflict: A model for diagnosis and intervention. *Psychological Reports, 44,* 1323-1344. http://dx.doi.org/10.2466/pr0.1979.44.3c.1323

Rauthmann, J. F., Kappes, M., & Lanzinger, J. (2014). Shrouded in the veil of darkness: Machiavellians but not narcissists and psychopaths profit from darker weather in courtship. *Personality and Individual Differences, 67,* 57-63. http://dx.doi.org/10.1016/j.paid.2014.01.020

Ross, L., & Stittinger, C. (1991). Barriers to conflict resolution. In K. J. Arrow, M. H. Mnookin, L. Ross, A. Tversky, R. B. Wilson (Eds.) *Negotiation Journal* (Vol.7, pp 389-404). New York. London.

Sidanius, J. (1993). The psychology of group conflict and the dynamics of oppression: A social dominance perspective. In S. Iyengar & W. McGuire (Eds.), *Current approaches to political psychology* (pp. 173-211). Durham, NC: Duke University Press.

Steidle, A., Hanke, E., & Werth, L. (2013). In the dark we cooperate: The situated nature of procedural embodiment. *Social Cognition, 31,* 275-300. http://dx.doi.org/10.1521/soco.2013.31.2.275

Sundstrom, E. (1975). An experimental study of crowding: Effects of room size, intrusion, and goal blocking on nonverbal behavior, self-disclosure, and self-reported stress. *Journal of Personality and Social Psychology, 32,* 645-654. http://dx.doi.org/10.1037/0022-3514.32.4.645

Takahashi, S. (2009). Effects of coloured lighting on judgement of emotional expression.

Journal of the International Colour Association, 4, 1-9.

Theiss, E. (2000). *Beleuchtungstechnik: neue Technologien der Innen- und Außenbeleuchtung.* Oldenbourg Industrieverlag.

Thomas, K. W. (1976). Conflict and conflict management. In M. D. Dunnette (Ed.), *Handbook of Industrial and Organizational Psychology* (pp. 889-935). Chicago: Rand McNally.

Ting-Toomey, S. (1988). Intercultural conflict styles: A face-negotiation theory. In Y.Y. Kim & W. Gudykunst (Eds.), *Theories in intercultural communication* (pp. 213-235). Newbury Park, CA: Sage.

Ting-Toomey, S., Oetzel, J. G., & Yee-Jung, K. (2001). Self-construal types and conflict management styles. *Communication Reports,* 14, 87-104. http://dx.doi.org/10.1080/08934210109367741

Tjosvold, D. (1990). The goal interdependence approach to communication in conflict: An organizational study. In M. A. Rahim (Ed.), *Theory and Research in Conflict Management* (pp. 15-27). New York: Praeger.

Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review, 96,* 506-520. http://dx.doi.org/10.1037/0033-295X.96.3.506

Varnum, M. E., Grossmann, I., Kitayama, S., & Nisbett, R. E. (2010). The origin of cultural differences in cognition the social orientation hypothesis. *Current Directions in Psychological Science, 19,* 9-13. http://dx.doi.org/10.1177/0963721409359301

Veitch, J. A., Newsham, G. R., Boyce, P. R., & Jones, C. C. (2008). Lighting appraisal, well-being, and performance in open-plan offices: A linked mechanisms approach. *Lighting Research and Technology, 40,* 133-151. http://dx.doi.org/10.1177/1477153507086279.

Vogels I.M.L.C., de Vries M., & van Erp, T.A.M. (2008). *Effect of coloured light on atmosphere perception: Proceedings of the AIC Interim Meeting, Swedish Colour Centre Foundation*. Stockholm: AIC, pp.15–18.

Volkema, R. J., & Bergmann, T. J. (1995). Conflict styles as indicators of behavioral patterns in interpersonal conflicts. *The Journal of Social Psychology*, 135, 5-15. http://dx.doi.org/10.1080/00224545.1995.9711395

Zhong, C.-B., Bohns, V. K., & Gino, F. (2010). Good lamps are the best police: Darkness increases dishonesty and self-interested behavior. *Psychological Science, 21*, 311-314. http://dx.doi.org/10.1177/0956797609360754

Zhong, C. B., & Leonardelli, G. J. (2008). Cold and lonely: does social exclusion literally feel cold? *Psychological Science*, *19*, 838–842. http://dx.doi.org/10.1111/j.1467-9280.2008.02165.x

Table 1

Factor Loadings and Variance Explained for Principal Components Analyses in Study 1

	Cooperating factor	Obliging factor	Dominating	Avoiding factor
Compromising item 1	.76	.06	-.32	.16
Compromising item 2	.65	.26	-.34	-.06
Compromising item 3	.73	.07	.08	.03
Integrating item 1	.47	-.13	-.47	.40
Integrating item 2	.64	.09	.03	-.43
Integrating item 3	.80	.15	-.15	.12
Obliging item 1	-.02	.56	-.26	.09
Obliging item 2	.10	.69	-.13	-.06
Obliging item 3	.33	.67	.06	.13
Dominating item 1	-.09	-.16	.71	-.14
Dominating item 2	-.12	-.02	.88	.07
Dominating item 3	-.12	-.28	.73	.21
Avoiding item 1	.03	-.22	.16	.59
Avoiding item 2	.18	.39	-.10	.57
Avoiding item 3	-.05	.28	-.03	.74
Variance explained (%)	19.9	11.6	15.9	11.4

Table 2

Descriptive Statistics and Correlations in Study 1

Variables	Dim warm condition	Dim neutral condition	Bright warm condition	Bright neutral condition	Mean (*SD*)	1	2	3	4	5	6
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)							
1. Situative self-construal	3.20 (0.91)	2.62 (1.44)	2.64 (0.99)	3.23 (1.52)	2.94 (1.28)	-					
2. SDO	3.14 (0.75)	2.07 (0.95)	3.05 (1.08)	3.33 (0.79)	3.13 (0.89)	-.14	**.84**				
3. Cooperating	3.81 (0.61)	3.59 (0.66)	3.48 (0.61)	3.73 (0.76)	3.66 (0.67)	.51**	-.06	**.79**			
4. Obliging	2.54 (0.70)	2.53 (0.59)	2.51 (0.70)	2.34 (0.48)	2.47 (0.56)	.20*	-.08	.32**	**.46**		
5. Dominating	3.95 (0.80)	3.92 (0.73)	4.04 (0.63)	3.84 (0.82)	3.93 (0.75)	-.25*	.09	-.38**	-.21*	**.75**	
6. Avoiding	2.89 (0.86)	3.05 (0.73)	2.84 (0.71)	2.81 (0.68)	2.90 (0.74)	-.01	-.04	.16	.25*	-.08	**.54**

Note. N = 100-105; SDO = Social Dominance Orientation. To facilitate the interpretation of the values of the conflict styles, raw mean values are presented. For correlations, we used standardized values of conflict styles. *$p < .05$, **$p < .01$.

Table 3

Hierarchical Regressions on Situative Self-Construal and on Conflict Resolution Strategies in Study 1

	Situative self-construal		Cooperating	Obliging	Dominating	Avoiding
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Bright neutral	.59* (.34)	.74* (.33)	-.09 (.24)	-.45 (.26)	.06 (.27)	-.26 (.28)
Bright warm	.00 (.36)	.03 (.34)	-.19 (.24)	-.05 (.27)	.18 (.27)	-.24 (.29)
Dim warm	.56† (.36)	.62* (.35)	-.02 (.25)	-.07 (.28)	.21 (.28)	-.13 (.29)
SDO		-.18† (.13)				
SDO x dim warm		.90** (.36)				
Situative self-construal			.39** (.07)	.18* (.08)	-.19* (.08)	.003 (.08)
R^2	.05†	.14*	.27**	.08†	.07	.01
ΔR^2		.05**				

Note. N = 100-105. Missing values were excluded via pairwise deletion. Values are unstandardized regression coefficients; standard error estimates are in parentheses. All lower-order terms used in interactions were centered prior to analysis. SDO = Social Dominance Orientation. $^{\dagger}p < .10$; $*p < .05$; $**p < .01$.

Table 4

Descriptive Statistics and Correlations in Study 2

	Variables	Dim warm condition	Dim cold condition	Bright warm condition	Bright cold condition	Mean *(SD)*	1	2	3	4	5	6	7
		Mean *(SD)*	Mean *(SD)*	Mean *(SD)*	Mean *(SD)*								
1.	Situative self-construal	2.37 (1.49)	2.14 (1.07)	2.21 (1.17)	2.33 (1.19)	2.26 (1.23)	-						
2.	SDO	2.93 (1.16)	2.43 (0.64)	3.08 (0.98)	3.06 (1.15)	2.88 (1.03)	.07	**.88**					
3.	TSC	4.55 (0.63)	4.62 (0.59)	4.68 (0.57)	4.63 (0.62)	4.62 (0.60)	.09	.16†	**.56**				
4.	Cooperating	3.93 (0.62)	3.78 (0.71)	3.89 (0.64)	3.90 (0.60)	3.88 (0.64)	.19*	-.29**	.27**	**.75**			
5.	Obliging	2.50 (0.52)	2.58 (0.69)	2.60 (0.60)	2.53 (0.53)	2.55 (0.58)	.18*	-.06	.28**	.37**	**.45**		
6.	Dominating	3.62 (0.64)	3.79 (0.79)	3.73 (0.66)	3.74 (0.67)	3.72 (0.68)	-.06	.12	-.09	-.24**	-.28**	**.63**	
7.	Avoiding	2.84 (0.91)	3.05 (0.83)	2.97 (0.78)	3.05 (0.79)	2.97 (0.82)	.06	-.05	.17*	-.01	.30**	.12	**.49**

Note. N = 150-152. Missing values were excluded via pairwise deletion. SDO = Social Dominance Orientation, TSC = Trait interdependent Self-Construal. To facilitate the interpretation of the values of the conflict styles, raw mean values are presented. For correlations, we used standardized values of conflict styles. $^{\dagger}p < .10$; $*p < .05$; $**p < .01$.

Table 5

Hierarchical Regressions on Situative Self-Construal and on Conflict Resolution Strategies in Study 2

	Situative self-construal				Cooperating	Obliging	Dominating	Avoiding
Variable	Model 1	Model 2a	Model 2b	Model 2c	Model 3	Model 4	Model 5	Model 6
Bright cold	.19 (.29)	.22 (.30)	.19 (.28)	.21 (.29)	.08 (.23)	-.21 (.22)	-.09 (.23)	.04 (.23)
Bright warm	.07 (.29)	.10 (.30)	.04 (.28)	.06 (.29)	.19 (.23)	.04 (.22)	-.08 (.23)	-.07 (.23)
Dim warm	.23 (.29)	.24 (.29)	.20 (.29)	.21 (.29)	.18 (.23)	-.14 (.23)	-.22 (.23)	-.24 (.23)
SDO		.05 (.10)		.05 (.10)				
SDO x dim warm		.39* (.21)		.31† (.22)				
TSC			.21 (.17)	.25† (.17)				
TSC x dim warm			-.88** (.37)	-.69* (.39)				
Situative self-construal					.15* (.06)	.15* (.06)	-.04 (.07)	.05 (.07)
R^2	.01	.03	.05	.07	.04†	.04†	.01	.02
ΔR^2		.02*	.04**	.05*				

Note. N = 151-152. Missing values were excluded via pairwise deletion. Values are unstandardized regression coefficients; standard error estimates are in parentheses. All lower-order terms used in interactions were centered prior to analysis. SDO = Social Dominance Orientation, TSC = Trait Interdependent Self-Construal. $^{\dagger}p < .10$; $*p < .05$; $**p < .01$.

Figure 1

Hypothesized Model

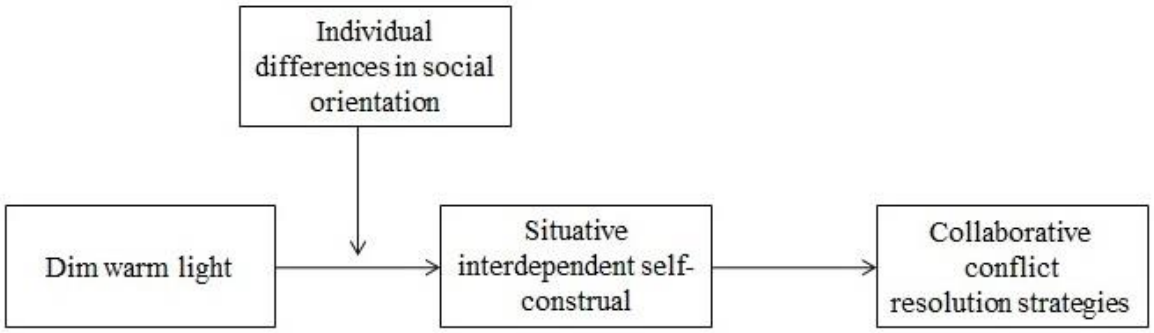
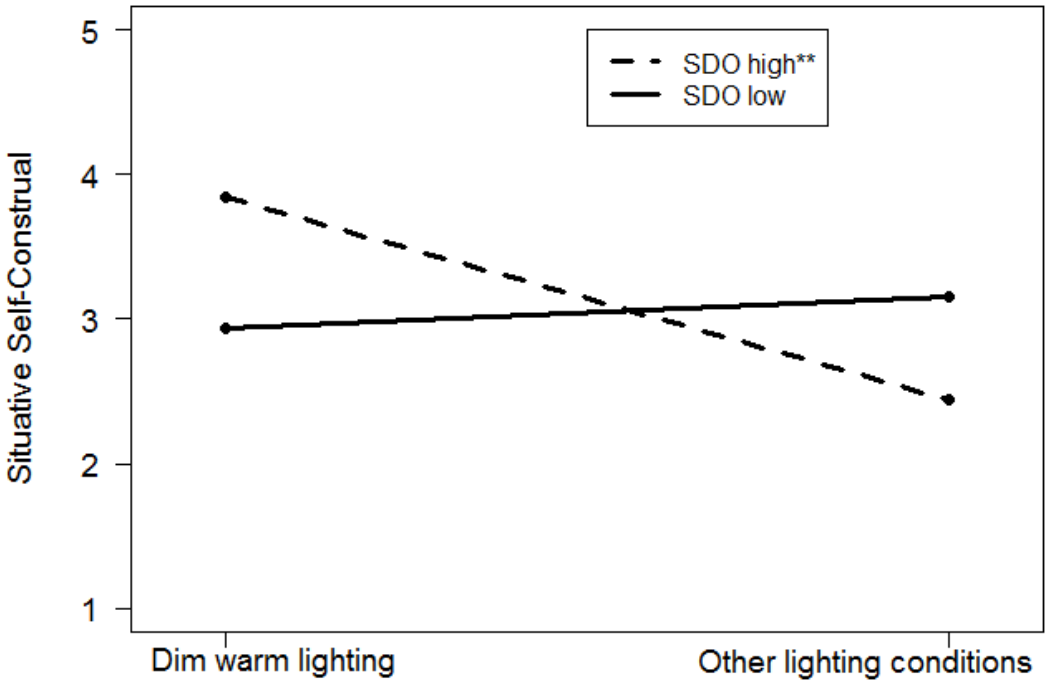


Figure 2

Interactive Effects of Lighting Condition and Social Dominance Orientation on Situative Self- Construal in Study 1

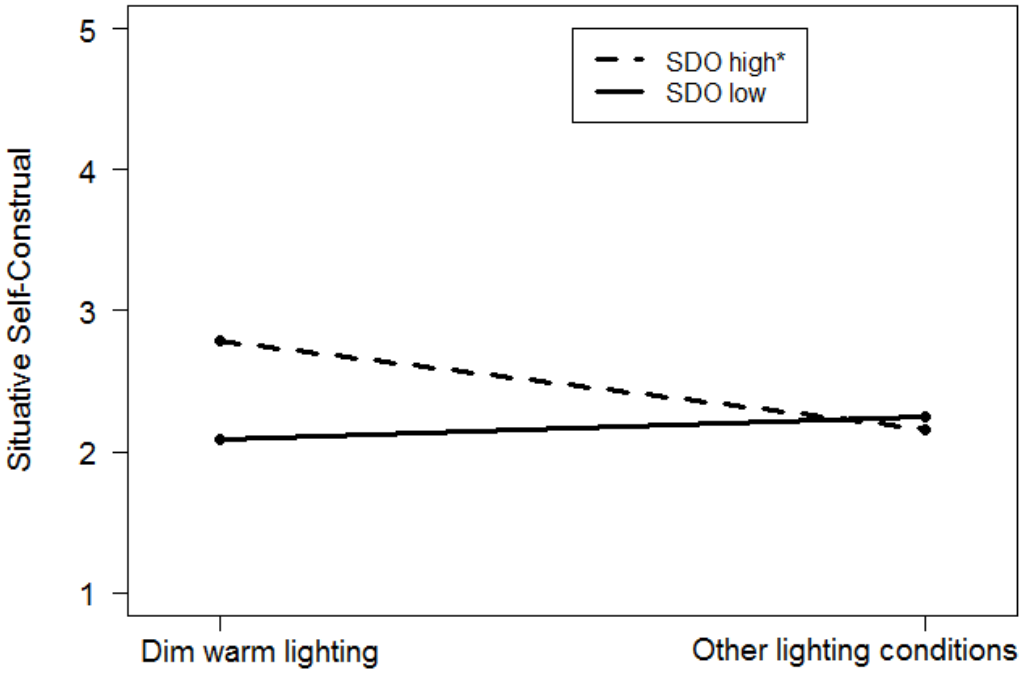


Note. N = 105. SDO = Social Dominance Orientation; Values are predicted values from Model 2 in Table 2;

**p (slope) < .01.

Figure 3

Interactive Effects of Lighting Condition and Social Dominance Orientation on Situative Self- Construal in Study 2

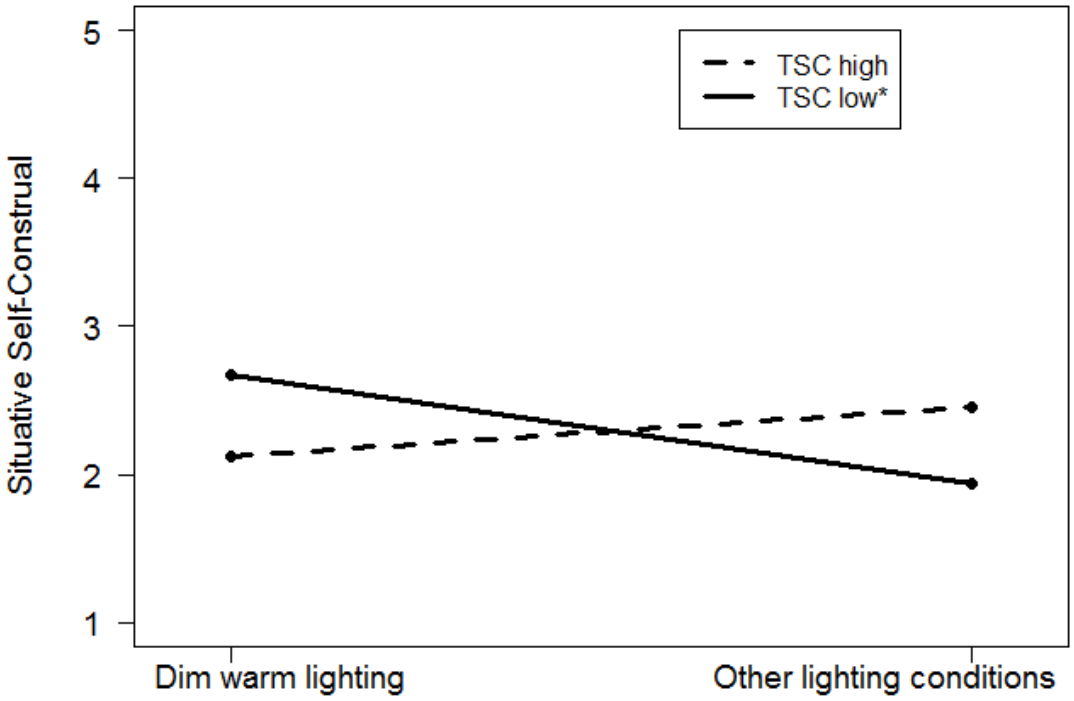


Note. N = 152. SDO = Social Dominance Orientation; Values are predicted values from Model 2a in Table 4;

*p (slope) < .05.

Figure 4

Interactive Effects of Lighting Condition and Trait Self-Construal on Situative Self-Construal



Note. N = 152. TSC = Trait Interdependent Self-Construal; Values are predicted values from Model 2b in Table 4;

*p (slope) < .05.

SUPPLEMENTARY MATERIAL

Scenarios used in both studies

Scenario 1: The object of negotiation is a 15-year-old Opel Corsa

Imagine that you are an amateur mechanic looking for a used Opel Corsa. Your goal is to install parts of the used car in your car in order to save money for spare parts. The new spare parts for your car would cost 600 euros. In a few minutes, you will meet the seller of an Opel Corsa to negotiate the price with him.

In preparation for today's meeting, you have obtained an expert opinion on the value of the car. A good friend of yours runs a used car dealership. When you contact her to find out about the value of the Opel, she laughs because an owner of an Opel Corsa had recently made a similar inquiry. As your friend describes the person, you immediately realize that it is the seller that you are about to meet. Once you have told your friend about this coincidence, she replies, "Go ahead, buy yourself the car, you need it more than I do. But you should know that the seller has called back today to ask if my offer of 300 euros is still valid. I said yes. So if you want the car, you should take into account that the seller probably won’t agree to anything less than 300 euros."

Scenario 2: The object of negotiation is a 15-year-old Opel Corsa

Imagine that your son has recently started a job, and is able to obtain a company car. For this reason, you intend to sell his car. A nearby car dealer has offered you 300 euros for it. In a few minutes, you will meet another prospective buyer to negotiate the price. It is your last hope of getting more than 300 euros for the car.

In preparation for today's meeting, you have obtained an expert opinion on the value of the car. A good friend of yours runs a used car dealership. When you contact her to find out about the value of the Opel, she laughs. She tells you that one of her clients recently mentioned that he was considering buying a used car to take it apart for spare parts.

According to your friend, the customer wanted to find out how much it would cost in total to buy all spare parts new. As your friend describes the customer, you immediately realize that it is your prospective buyer. Once you have told your friend about this coincidence, she replies, "Just so you know, I informed him that the new parts would cost 600 euros. So if you want to sell him the car, you should take into account that your prospective buyer will not pay more than 600 euros."

Scenario 3: The object of negotiation is the set of conditions for new hires

In the table below you can see the different conditions for negotiation. The points in brackets indicate points for you (the trade union).

You represent the role of the trade union. In a few minutes you will meet a member of the management to negotiate six conditions for the hiring of employees: salary, start of hiring, contract period, annual salary increase, health care, and annual leave. You negotiate for "points". Before we start, you get an overview showing how many points you can obtain for each negotiation result. As a member of the trade union, your goal is to negotiate as many points for the trade union as possible. If you would agree, for example, on a salary of 19,000 euros, you would have obtained 450 points for the union. If, however, no agreement is reached, both you and the management get zero points. Please study the table now.

salary (€)	start of employment (in weeks)	contract duration (years)	annual salary increase (%)	health care (%)	annual leave (days)
20.000 (540 p)	**2** (270 p)	**2.5** (120 p)	**7** (90 p)	**50** (240 p)	**22** (80 p)
19.000 (450 p)	**4** (225 p)	**2** (90 p)	**6** (75 p)	**40** (180 p)	**19** (60 p)
18.000 (360 p)	**6** (180 p)	**1.5** (60 p)	**5** (60 p)	**30** (120 p)	**16** (40 p)
17.000 (270 p)	**8** (135 p)	**1** (30 p)	**4** (45 p)	**20** (60 p)	**13** (20 p)
16.000 (180 p)	**10** (90 p)	**0.5** (0 p)	**3** (30 p)	**10** (0 p)	**10** (0 p)
15.000 (90 p)	**12** (45 p)		**2** (15 p)		
14.000 (0 p)	**14** (0 p)		**1** (0 p)		

Lighting conditions in Study 1

Lighting conditions in study 2

Chapter 3: Light and Social Judgment

Light and Social Judgment: The Mediating Role of Satisfaction with Light

Olga Kombeiz

Abstract

Do people judge others differently in different light? Based on the notion of environmentally induced positive affect, I propose that pleasant light induces satisfaction with light, which in turn leads to positive judgments of other persons. In a laboratory experiment, participants were randomly assigned to one of four lighting conditions varying in light intensity and color temperature and were engaged in judgments of warmth and competence based on viewing faces. Results showed that satisfaction with light was higher in three pleasant lighting conditions than in an unpleasant one (dim and cold light). Moreover, pleasant light had a positive indirect effect on competence and warmth judgments of others via satisfaction with light. Furthermore, additional explorative analyses showed that the positive effect of pleasant light on satisfaction with light only emerged for male participants. These findings highlight the importance of light for social perception and judgment. Theoretical contributions to lighting psychology and practical implications concerning the design of settings involving the evaluation of other individuals will be discussed.

Keywords: light, brightness, color temperature, satisfaction with light, social perception, person perception

Introduction

As social creatures, humans are almost constantly in contact with others. The perception and evaluation of other individuals is ubiquitous and occurs automatically (Bargh & Pietromonaco, 1982). Even in situations where only a very short amount of time is available for judgment, for instance during a blind date or when meeting a new colleague that accidentally crosses one's way, individuals are quick to form an opinion about others. This tendency is also true for evaluations with far-reaching consequences, such as in hiring decisions, which may be influenced by the first impression of a person's physical appearance (Riggio & Throckmorton, 1988), by one's mood (Baron, 1987), or by situational cues such as the presence of others (Rowe, 1967) and the physical environment (Baron, Rea, & Daniels, 1992). Whereas social perception has been widely investigated in social (Ross, Greene, & House, 1977), organizational (Hamilton, Katz, & Leirer, 1980), and personnel psychology (Schmitt, 1976), there are still a lot of open questions about whether and how the physical environment may impact social perception and the evaluation of others.

A few studies have shown that light (Baron et al., 1992) and room temperature (IJzerman & Semin, 2010; Kolb, Gockel, & Werth, 2012) can influence social perception. Baron et al. (1992) proposed the idea of environmentally induced positive affect as the underlying process in the relation between light and social perception. This idea is based on previous research indicating that even mild shifts in affective states can influence work-related perception (Forgas & George, 2001) and behavior (Park, Sims, & Montowidlo, 1986), and that pleasant light could cause such an affective shift (Knez, 1995), which in turn may influence the evaluation of other people (Baron et al., 1992). For instance, affective states have been shown to influence performance appraisals (Cardy & Dobbins, 1986; Sinclair, 1988) or managers' reactions to poor subordinate performance (Dobbins & Russell, 1986). Such mild shifts in affective states may be created by several situational and environmental

factors, like exposure to pleasant or unpleasant films (Arkes, Herren, & Isen, 1988), receipt of a small gift (Isen, 1987), or pleasant artificial scents (Baron, 1990) and light (Knez, 1995). Most procedures (e.g., a gift; Isen, 1987) are rather unusual and more obvious in the working context than ordinary environmental conditions, such as lighting (Baron et al., 1992). Accordingly, Baron et al. (1992) examined whether positive affect elicited by light may impact the evaluation of an imaginary employee and found indirect confirmation for this theory. In their study, dim (vs. bright) light led to positive ratings of a fictitious employee, and the same aspects of cognition were influenced by an unexpected receipt of a gift that was previously shown to induce positive affect (Isen, 1987). This analogy was interpreted by Baron et al. (1992) as support for the notion of environmentally induced positive affect. However, other studies (e.g., Boyce et al., 2003; Knez & Enmarker, 1998; Veitch & Newsham, 1998) failed to replicate the effects of light on the evaluation of other persons.

To clarify these inconsistent findings, the present research focused on a more direct approach of environmentally induced positive affect: satisfaction with light, which may mediate the effect of the light on the judgment of others. We propose that satisfaction with light would be higher in pleasant than in unpleasant light, which should indirectly influence the judgment of other individuals. Furthermore, due to prior contrary interaction effects of light and sex on affective processes and satisfaction with light (Knez, 1995, 2001; Knez & Enmarker, 1998; Knez & Kers, 2000), we explored the possible moderating effect of participants' sex on their satisfaction with the different lighting conditions, and the conditional indirect effect on their judgments of others (see Figure 1 for the research model). Our study offers several contributions. First, we directly examined whether environmentally induced positive affect leads to positive social perception that has not been successfully shown in a mediation model before. In particular, we propose satisfaction with light, which represents an affective reaction to pleasant light, as the mediating variable. Second,

investigating sex as a moderator between pleasant light and satisfaction with light should provide some insight into the previous inconsistent findings of lighting effects on satisfaction with light and on social perception. Finally, the results could allow practical implications for the design of environments in which the judgment of others is important (e.g., rooms for job interviews).

Satisfaction with Light

Satisfaction with light describes a subjective level of comfort with lighting conditions that includes a cognitive component due to conscious or unconscious appraisals and preferences of lighting (e.g. Veitch et al., 2008) and an affective component that relates to how individuals feel in the room (Veitch & Newsham, 1998). The more satisfied an individual is with the lighting conditions, the more positive affect he or she experiences due to the light. Consequently, satisfaction with light could serve an indicator of positive affect associated with light.

Previous research indicates that positive affect may be produced by environmental conditions. Some kinds of music (May & Hamilton, 1980), pleasant artificial scents (Baron, 1990), and pleasant room temperature (Bowman, Giuliani, & Minge, 1981) may elicit positive affective states. Lighting is another important characteristic of indoor environments that may induce positive affect. Up to now, several studies found only indirect support for this proposition (e.g., Baron et al, 1992; Boyce et al., 2006; Veitch, Newsham, Boyce, & Jones 2008). For instance, individuals who are satisfied with the lighting rate the room as more attractive, which in turn leads to positive mood (Veitch et al., 2008). The lack of reported direct effects on affect or mood in the literature may be explained by the variations in lighting that have been used in past laboratory studies, which are too subtle to be recognized and to be reported in common affect questionnaires (e.g., PANAS scales, Baron et al., 1992). Similarly, more recent studies showed that lighting conditions directly impact the appraisal of lighting

and only indirectly that of mood (Boyce et al., 2006; Veitch, Stokkermans, & Newsham, 2013). We integrated components of previous studies that focused on: light quality as a sign of light's pleasantness (Boyce et al., 2006; Veitch et al., 2008), preferences for specific lighting conditions (Veitch et al., 2008) and/or mood and affect (Baron et al, 1992; Boyce et al., 2006; Veitch et al., 2008), and directly examined the satisfaction with light as an indicator of positive affect associated with light. We suggest that satisfaction with light involves affective appraisals (pleasantness of light) and preferences (subjective satisfaction with light; see for an overview Veitch et al., 2008), and therefore indicates the affective state. This idea receives support from previous studies, as the satisfaction with environmental conditions (e.g., light) includes an affective component (Veitch & Newsham, 1998) and has been well predicted by lighting conditions (Veitch et al., 2008; 2013). Thus, in the present study we focus on satisfaction with light as a direct approach to environmentally induced positive affect.

The question of which lighting conditions are perceived as most pleasant is complicated and depends on several different characteristics of light, like brightness, color temperature, light distribution (Flynn, 1977), and personal control (Boyce et al., 2006). As the subjective comfort with lighting conditions may largely vary due to light intensity, whether it is cast directly or indirectly, and many other characteristics (Veitch, 2008; Veitch & Newsham, 1998), it is important to consider which lighting conditions may be pleasant for most individuals. Kruithof's (1941) work showed that the combination of brightness and color temperature is crucial to the perception of light as being pleasant or unpleasant. His conclusion was that a combination of high brightness and low color temperature appears unnatural, and a lighting condition with low brightness and high color temperature is perceived as too cold and dark. However, when the color rendering index (CRI)[1] is high (R_a > 80, mostly in LED-based luminaires), a combination of cold color temperature with high

brightness is perceived as pleasant as warm color temperature with high brightness (Viénot, Durand, & Mahler, 2009). Thus, for the usage of LED light, Viénot et al. (2009) only partly replicated Kruithof's pattern. Whereas the combination of dim light and cold color temperature was perceived as the least comfortable condition, which is consistent with past studies employing fluorescent light-based luminaires, the combination of bright and warm light was assessed as pleasant; apparently, at high CRI, bright warm light does not appear unnatural. A similar pattern was found by Nakamura and Karasawa (1999), who showed that warm light at different luminance levels (between 100 and 800 lx) and high CRI (R_a = 88) was preferred to cold light. Taken together, we propose that three LED lighting conditions (in the following called 'pleasant') – dim warm, bright cold, and bright warm – would lead to higher satisfaction with the light than a dim cold lighting condition (Hypothesis 1).

Indirect Effects of Pleasant Light on Social Perception

Social perception can be defined as evaluation or judgment of different characteristics of others, and how individuals shape impressions about others using available information, like physical appearance, verbal and nonverbal communication, and behavior (Niedenthal & Halberstadt, 2004). Basic dimensions for spontaneous judgment of others are warmth and competence (Fiske, Cuddy, & Glick, 2007). Accordingly, warmth reflects traits like friendliness, helpfulness, and trustworthiness, whereas competence is related to perceived ability, skill, efficacy, and intelligence. Both dimensions are fundamental to social perception (Fiske et al., 2007) and are equally important in impression formation (Nauts, Langner, Huijsmans, Vonk, & Winboldus, 2014). Moreover, judgments of warmth and competence impact several cognitive and behavioral outcomes. For instance, previous research showed that judgments of warmth and competence are crucial for: the construal of one's own and others' behavior (Wojciszke, 1994), the perception of leadership style and quality (see for an

overview Cuddy, Glick, & Beninger, 2011), and subsequent behavioral responses, for instance, helping behavior or cooperation (Cuddy, Fiske, & Glick, 2007).

As stated previously, social perception in general, and person perception in particular, may depend on an observer's actual affective state (Forgas, 1995; Forgas & George, 2001). Such mood-based distortions in person perception proceed due to information processing as a consequence of mood (Forgas & Bower, 1987). Accordingly, perceiving a person is an act of categorization (Bruner, 1957), and affective states bias person perception by distorting the spontaneous associations and interpretations we make (Clark & Isen, 1982). In line with this idea, previous research showed that individuals in a positive mood rate others as more attractive (Clark & Waddell, 1983), more competent, and more likable (Forgas & Bower, 1987). Similarly, Baron (1987) and Baron et al. (1992) showed that inducing positive affect leads to positive job candidate evaluations in simulated job interviews. Building on this research, I hypothesized that the satisfaction with light would be positively associated with judgments of warmth (Hypothesis 2a) and with judgments of competence (Hypothesis 2b). As satisfaction with light represents the positive affect associated with light, I expected that this positive feeling would transfer to the first impressions of unknown faces, and therefore be responsible for positive judgments of warmth and competence. Integrating H1 and H2, I proposed that pleasant lighting conditions would have an indirect effect on positive judgments of warmth (Hypothesis 3a) and competence (Hypothesis 3b) via satisfaction with light

The Moderating Role of Sex

Previous research shows a trend suggesting that men and women prefer different lighting (Knez, 1995; Knez & Enmarker, 1998; Knez & Kers, 2000; Leslie & Hartleb, 1990; McCloughan, Aspinall, & Webb, 1999). The presumed reasons for the sex differences are different affective meanings of color temperature and of combinations of brightness and color temperature for both sexes (Knez, 1995; Knez & Enmarker, 1998). However, the reported

effects are inconsistent and partly contradictory. Whereas some studies (e.g., Knez, 1995; McCloughan et al., 1999) claimed that men felt better in cold than in warm light, while women felt better in warm than in cold light, at least one study found a reversed pattern (Knez & Enmarker, 1998). Thus, these results do not allow conclusions about the effect of sex on the satisfaction with light in pleasant and unpleasant lighting conditions in this study. Moreover, female participants were shown to prefer a lower level of brightness (Leslie & Hartleb, 1990) and to rate lighting as more intense and glaring (Knez, 1995) than male participants. Hence, women may perceive the dim light in the unpleasant condition as less unpleasant than men, which should lead to stronger differences in the satisfaction with pleasant and unpleasant lighting conditions among men compared to women. To contribute to this ongoing discussion, I explored whether participants' sex moderated the positive relation between pleasant light conditions and satisfaction with light. Integrating this moderation with the previously hypothesized mediation, I investigated the conditional indirect effects of pleasant light on judgments of warmth and competence via satisfaction with light for men and women. The model is referred to as a first-stage moderated mediation (Edwards & Lambert, 2007, see Figure 1).

Method

Participants

One hundred and sixty-six German students were recruited via university mailing lists and took part in exchange for course credit or for a payment of €15. Two persons were excluded from the analysis because they did not understand the instructions. Data of 85 females and 79 males (mean age = 23.62 years; *SD* = 5.52) were used for the analyses.

Procedure

The experiment was conducted at the [*location masked for blind review*] as part of a larger research project[2] in a laboratory. The room contained regular office furniture: two

desks and chairs for participants and one for the experimenter, a monitor and a keyboard on each desk for the participants, which were positioned in a way that allowed no reflections and glare for persons sitting at the desk (see Figure 2). The room (5.10 × 3.50 meters and 3.00 meters high) was equipped with protection from the daylight. The light was offered through 3 pendant-mounted ceiling LED-based luminaires, 116 cm long and 8.5 cm wide each. In line with previous studies (Baron et al., 1992, Knez, 2001), the luminaires were set to create either bright (1500 lx) or dim (150 lx) direct-indirect lighting, combined with either cold white (5500 K) or warm white (2500 K) color temperature. In the following, the first three lighting combinations are all called 'pleasant' (Kruithof, 1941; Nakamura & Karasawa, 1999; Viénot et al., 2009): bright cold (1500lx, 5500K), bright warm (1500lx, 2500K) and dim warm (150lx, 2500K); while one combination represents the 'unpleasant' condition: dim cold (150lx, 5500K).

The participants were randomly assigned to one of the four lighting conditions. They were tested up to two at a time in the laboratory at a computer, approximately 60 cm from the screen facing the wall. The experiment lasted for one hour and consisted of different tasks on the computer. The room temperature was held constant at all four lighting conditions (23 °C) using an air conditioning system.

Material

Satisfaction with light. Satisfaction with light (α = .86) was assessed with two items on a seven-point Likert-type scale (1: strongly disagree – 7: strongly agree): "The lighting is pleasant" and "I am satisfied with the lighting condition".

Judgments of warmth and competence. In a pilot study (N = 30), participants rated a set of pictures of 20 male and 19 female Caucasian persons from the Radboud Faces Database (RaFD, Langner et al., 2010), with neutral emotional expressions from a frontal view, on

attractiveness, warmth, and competence. The database provides high-quality stimuli, created under strictly controlled conditions. All pictures were taken under the same luminance level and show female and male individuals with a straight gaze. From 39 pictures overall, we selected three pictures of female and three pictures of male persons for the main study that possessed medium levels of attractiveness, warmth, and competence. In the main study, I assessed participants' judgments of warmth and competence of the six preselected pictures on a seven-point Likert-type scale (1: strongly disagree – 7: strongly agree). Based on previous studies (Fiske et al., 2002; North & Fiske, 2014), three items were used to measure warmth (warm, friendly, trustworthy) and four items for the measure of competence (competent, intelligent, confident, assertive). Warmth and competence ratings were first averaged for each picture (all αs > .81 for warmth and all αs > .77 for competence) and then averaged across all pictures (warmth: α = .74, competence: α = .71) to create an aggregated warmth and competence score for each participant.

Analytic Strategy

I dummy coded the lighting conditions (dim warm, bright cold, bright warm = 1, dim cold = 0) and conducted OLS mediation analyses using a bias-corrected bootstrapping procedure with 10,000 bootstraps to test the (moderated) mediation hypotheses (Hayes, 2013). I followed the procedures recommended by Edwards and Lambert (2007). First, I examined the main effect on satisfaction with light and the mediation hypotheses (Hypotheses 1-2). Second, I examined the moderation and the conditional indirect effects using recommended moderated (mediation) regression procedures (Aiken & West, 1991; Edwards & Lambert, 2007). As previous studies showed an effect of age on the preference for lighting conditions (e.g., Hughes & McNelis, 1978; Knez & Kers, 2000) and satisfaction with light, I controlled for age[3]. For the research model, see Figure 1.

Results

Table 1 presents descriptive statistics and correlations of all variables. As expected, pleasant lighting conditions (dim warm, bright cold, and bright warm) led to higher satisfaction with light than dim cold light (r = .15, p = .05, see Table 1; b= .63, p = .04, see Table 2, Model 2). Hence, H1 was supported. Consistent with H2a and H2b, satisfaction with light was positively related to judgments of warmth (r = .21, p = .03; b = .09, p = .008) and competence (r = .23, p = .00; b = .09, p = .003) in correlation and regression analyses (see Table 2, Models 5 and 7). To test H3a and H3b, I used the mediation model (model 4) of Hayes (2013). The results revealed significant positive indirect effects of pleasant light on judgments of warmth (indirect effect = .06, *SE* = .04, 95% *CI* [.003, .18]) and competence (indirect effect = .06, *SE* = .04, 95% *CI* [.004, .17]) via satisfaction with light. Consequently, H2a, H2b, H3a, and H3b were supported.

Moreover, I explored the interaction effect of light and sex on satisfaction with light. Sex moderated the positive relation between pleasant light and satisfaction with light (b = 1.41, p = .02; .03% additional variance explained, see Table 2, Model 3). Plotting the interaction for men and women (Figure 3) shows that the relationship between pleasant light and satisfaction with light was positive and significant for men (b = 1.36, p = .002), but not for women (b = -.05, p = .90). Furthermore, I used model 7 of Hayes (2013) and compared the conditional indirect effect of pleasant light on judgments of warmth and competence via satisfaction with light for men and women. The results revealed that the indirect effect of pleasant light on judgments of warmth via satisfaction with light was significant for men (indirect effect = .13, *SE* = .08, 95% *CI* [.02, .32]), but not for women (indirect effect = -.005, *SE* = .05, 95% *CI* [-.12, .09]). Similarly, the indirect effect of pleasant light on judgments of competence via satisfaction with light was only significant for men (indirect effect = .13, *SE* = .07, 95% *CI* [.03, .31]), but not for women (indirect effect = -.005, *SE* = .05, 95% *CI* [-.11, .08]). Further, the index of moderated mediation for warmth and competence judgments were

positive and their CIs did not include zero (warmth: index = .13, *SE* = .09, 95% *CI* [.01; .39]; competence: index = .13, *SE* = .09, 95% *CI* [.01; .38]).

Discussion

Light may influence social perception and, particularly, the way individuals judge others. In a laboratory study, I investigated whether pleasant lighting conditions induce satisfaction with light, which in turn promotes positive person evaluations. The results suggest that individuals are more satisfied with pleasant than with unpleasant light. Moreover, pleasant light indirectly influenced social judgment. Individuals in pleasant lighting conditions felt more satisfied with the light, and, in turn, judged ambiguous individuals as warmer and as more competent than those in the unpleasant lighting condition. Furthermore, the explorative investigation showed that the reported effects only emerged for male participants. Men were more satisfied with pleasant than with unpleasant light and that, in turn, led to more positive social judgments. Lighting condition affected neither women's satisfaction with light nor their social judgments. Overall, I conclude that, among men, pleasant light may induce positive feelings, which then yield positive social judgments.

The present findings complement previous research on the effects of the physical environment – especially light – on social perception, and clarify previous mixed findings. One major contribution is the demonstration of the underlying process linking light and judgment of others. While at least one previous study showed that light may have an impact on the evaluation of others (Baron et al., 1992), various other studies did not replicate this effect (Knez & Enmarker, 1998; Boyce et al., 2006). Moreover, previous research indicated that social perception may be influenced by affective states (e.g., Clark & Waddell, 1983; Forgas & Bower, 1987), and that inducing positive affect by using pleasant scents leads to positive evaluations of others (Baron, 1987). However, the effect of light on the judgment of other individuals via environmentally induced positive affect has not been shown up until

now. This finding is important as social perception – particularly judgments of warmth and competence – relates to a host of cognitive and behavioral consequences. For instance, warmth and competence judgments are essential for impression formation in general (Fiske et al., 2007) and in the organizational context, specifically (Cuddy et al., 2011). The interpretation of one's own and others' behavior (Wojciszke, 1994), and the behavior itself (Cuddy et al., 2007) might be influenced by the judgment of these basic dimensions as well. Furthermore, the very important components of social judgment are spontaneous attributions (Ross, 1977), as well as preconceived stereotypes and prejudices that may lead to negative judgments of others, and as an extreme, to discrimination (Sritharan & Gawronski, 2010). Knowing that positive affect may shift this social bias in a positive direction could be a step against it. However, before implementing such idealistic suggestions, the theory behind it has to be investigated.

The second important contribution of the present research is the empirical evidence for the notion of environmentally induced positive affect. In the area of lighting research, this idea has, to our knowledge, found direct support for the first time. Previous studies yielded a basis for this theoretical perspective, showing pleasant scents (Baron, 1990) or room temperature (Bowman et al., 1981) to trigger positive affect. In contrast, the notion of environmentally induced positive affect due to lighting conditions has found only indirect support (Baron et al., 1992). Apparently, the variations in lighting should be much bigger to produce reportable changes in mood (Baron et al., 1992; Boyce et al., 2003), but can barely be found in real work situations due to lighting standards (e.g., DIN 12464 / ISO 8995). In contrast, satisfaction with light includes an affective component (Veitch & Newsham, 1998) and is a good alternative to demonstrate shifts of affective state due to lighting conditions. The present results corroborate the hypothesis that generally pleasant lighting conditions (Viénot et al., 2009) lead to higher positive affect associated with light. Thus, based on this

idea and on the present results, we conclude that affective states closely associated with environmental conditions, for instance satisfaction with light or also room atmosphere, could be more appropriate mediators for the testing of environmentally induced positive affect than mood in general. This knowledge is important as positive affect has been shown to relate to a host of work-related behaviors besides social perception, like helping behavior (Levin & Isen, 1975; Salovey, Mayer, & Rosenhan, 1991), cooperation (Barry & Oliver, 1996), and performance on tasks requiring creativity (Isen et al., 1987). However, the idea whether positive affect related to light would lead to these behavioral and performance outcomes needs to be examined.

Furthermore, the present study showed that sex moderates the relation between pleasant light and positive affect associated with light, and indirectly, the positive effect of light on the judgment of others via satisfaction with light. These results present further explanations for previous inconsistent findings. In the current study, the effect of light on satisfaction with light was only significant for men. In the only study that found an effect of light on comparable evaluations, twice as many men as women participated (Baron et al., 1992). Other studies that did not find this effect counted about twice as many women as men (Boyce et al., 2003) or solely female participants (Veitch & Newsham, 1998). An equal number of men and women participated only in Knez & Enmarker's (1998) experiment. However, the researchers compared two lighting conditions that can be both be seen as pleasant (Viénot et al., 2009) due to a high color rendering index (CRI = 95, similar to LED based luminaries), neutral color temperature (3000 K vs. 4000 K), and high brightness (both 1500 lx). As Kruithof (1941) and Viénot et al. (2009) did not report the sex of participants, it is still unclear if satisfaction with light due to specific combinations of brightness and color temperature may be pronounced for both sexes. It is possible that the use of additional light characteristics that are known to heighten satisfaction with light (e.g., personal control, Boyce et al., 2006) could be essential

for women's satisfaction with lighting conditions. Thus, the present findings offer an interesting avenue for future research. The investigation of affective meanings of different lighting components and their combinations for both sexes could provide answers to the open questions about sex differences in satisfaction with light. These components could include accent light, colored light, uniform (versus non-uniform) light, outside views, and personal control.

Future research is also needed to examine whether the present results are transferable to further domains of judgment of others. For instance, if short CVs in addition to photos of individuals' faces would decrease, strengthen, or eliminate the positive effect of light on perceived warmth and competence. As I only investigated neutral emotional expressions, it would be interesting to learn whether judgments of warmth and competence would vary due to the interaction of light with different emotional expressions of presented faces. Furthermore, the current study only included the evaluation of Caucasian faces of young adults. Thus, at this stage of research, our findings cannot be transferred to individuals of other ethnic and age groups. Apart from these stimulus-based considerations, due to the close link between social judgment and stereotyping (Jussim, 2012), the investigation on shifts of stereotyping due to environmentally induced positive affect could be a fruitful area for future research. Since individuals tend to stereotype more in positive moods (Bodenhausen, Kramer, & Süsser, 1994), it could be speculated that high satisfaction at pleasant lighting conditions may increase stereotyping.

One limitation of the current research and a potential for future research regards other variations of brightness and color temperature, as well as variations of daylight. As daylight has been shown to impact mood (see for an overview, Beute & de Kort, 2014), indirect effects on social perception could be different in artificial and natural light and need to be examined in further research. Moreover, in the present study I used mixed direct-indirect light, which

has been shown to be preferred in general (Houser, Tiller, Bernecker, & Mistrick, 2002) and for social activities specifically (Kobayashi, Inui, & Nakamura, 2001). Whether the effect of direct light on satisfaction with light and indirectly on social perception would be the same is still unclear and has to be investigated. Finally, the interaction effects of light with other indoor features (e.g., room temperature, acoustics) on positive affect and, in turn, on social judgment could be examined as well. For instance, pleasant room temperature or pleasant scents in combination with pleasant lighting could promote satisfaction with the room and have similar effects on the judgment of others, as has been separately shown for room temperature (Bowman et al., 1981), artificial scents (Baron, 1990), and light.

The present study also provides practical implications for the design of environments in which the evaluation of others is important. For instance, offices where applications of job candidates will be evaluated, or rooms for job interviews could be equipped with optimal lighting that is constant across evaluations of all job candidates, to reduce possible negative distortions in social perception due to unpleasant light. Moreover, since warmth and competence relate to comprehensive characteristics like trustworthiness and intelligence, this study also provides practical implications for lighting design beyond the hiring context. For instance, pleasant lighting in the healthcare context could promote trust in the skills and empathy of the medical staff. Furthermore, lighting conditions have to be chosen carefully in courtrooms and in schools, as spontaneous judgments of others could be crucial in these contexts. It is also important to note that the actual lighting standards (e.g., DIN 12464 / ISO 8995) provide guidelines for luminance, brightness, and glare, but not for the combinations of brightness and color temperature. As the current study showed, the combination rather than brightness alone could be essential for the user's satisfaction with the lighting. In addition, the pleasantness of light can be perceived differently by each individual. Thus, personal control

of dimming or adjusting the warmth of the light according to subjective preferences could be an appropriate solution for most indoor environments.

Conclusion

The idea of environmentally induced positive affect was proposed years ago (Baron, 1990). Systematic consideration and investigation of its role in the lighting domain, however, has been lacking. Current results call for continued research of environmentally induced positive affect as a process underlying the relation between light and social perception. Satisfaction with light as an affective state provides the theoretical framework for the interpretation of light's effects on perceived warmth and competence of others. Although there is still much to be understood about which lighting conditions lead to satisfaction with light, and about the moderation effect of sex on satisfaction with light, the present study deepens the understanding of these effects, suggesting that pleasant light may influence positive affect associated with light and, in turn, shape human's judgments of others.

Endnotes

[1] A color rendering index (CRI) refers to faithful color appearance of object in a test light compared to the standard light source.

[2] The data presented in this article were part of a broader data collection effort. However, I confirm that only one of the substantive variables in this research report (the variation in the lighting conditions) partly overlaps with the other research project in the context of this data collection. However, that study addresses a different research question using a different theoretical framework than the present study.

[3] I conducted all analyses without controlling for age and essentially replicated the results reported here. The results can be obtained from the author.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions.* Newbury Park, CA: Sage.

Arkes, H.R., Herren, L.T., & Isen, A.M. (1988). The role of potential loss in the influence of affect on risk-taking behavior. *Organizational Behavior and Human Decision Processes, 42,*181-191. http://dx.doi.org/10.1016/0749-5978(88)90011-8

Bargh, J. A., & Pietromonaco, P. (1982). Automatic information processing and social perception: The influence of trait information presented outside of conscious awareness on impression formation. *Journal of Personality and Social Psychology*, *43,* 437-449. http://dx.doi.org/10.1037/0022-3514.43.3.437

Baron, R. A. (1987). Interviewer's Moods and Reactions to Job Applicants: The Influence of Affective States on Applied Social Judgments1. *Journal of Applied Social Psychology, 17,* 911-926. http://dx.doi.org/10.1111/j.1559-1816.1987.tb00298.x

Baron, R. A. (1990). Environmentally Induced Positive Affect: Its Impact on Self-Efficacy, Task Performance, Negotiation, and Conflict. *Journal of Applied Social Psychology, 20,* 368-384. http://dx.doi.org/10.1111/j.1559-1816.1990.tb00417.x

Baron, R. A., Rea, M. S., & Daniels, S. G. (1992). Effects of indoor lighting (illuminance and spectral distribution) on the performance of cognitive tasks and interpersonal behaviors: The potential mediating role of positive affect. *Motivation and Emotion*, *16,* 1-33. http://dx.doi.org/10.1007/BF00996485

Barry, B., & Oliver, R.L. (1996). Affect in dyadic negotiation: A model and propositions. *Organizational Behavior and Human Decision Processes*, *67,* 127-143. http://dx.doi.org/10.1006/obhd.1996.0069

Beute, F., & Kort, Y. A. (2014). Salutogenic effects of the environment: Review of health

protective effects of nature and daylight. *Applied Psychology: Health and Well-Being, 6, 67-95*. http://dx.doi.org/10.1111/aphw.12019

Bodenhausen, G. V., Kramer, G. P., & Süsser, K. (1994). Happiness and stereotypic thinking in social judgment. *Journal of personality and social psychology, 66,* 621-632. http://dx.doi.org/10.1037/0022-3514.66.4.621

Boyce, P.R., Veitch, J.A., Newsham, G.R., Jones, C.C., Heerwagen, J., Myer, M. & Hunter, C.M. (2006). Lighting quality and office work: two field simulation experiments. *Lighting Research and Technology, 38,* 191-223. http://dx.doi.org/10.1191/1365782806lrt161oa

Boyce, P. R., Veitch, J. A., Newsham, G. R., Myer, M., & Hunter, C. (2003*). Lighting quality and office work: A field simulation study* (PNNL 14506). Richland, WA, USA: Pacific Northwest National Laboratory.

Bowman, T.F., Giuliani, G.A., & Minge, M.R. (1981). *Finding your best place to live in America.* New York Red Lion.

Bruner, J. S. (1957). On perceptual readiness. *Psychological Review, 64,* 123-152. http://dx.doi.org/10.1037/h0043805

Cardy, R.L., & Dobbins, G.H. (1986). Affect and appraisal accuracy: Liking as an integral dimension in evaluating performance. *Journal of Applied Psychology, 71,* 672-678. http://dx.doi.org/10.1037/0021-9010.71.4.672

Clark, M. S., & Isen, A. M. (1982). Towards understanding the relationship between feeling states and social behavior. In A. Hastorf & A. M. Isen (Eds.), *Cognitive Social Psychology* (pp. 73-108). New York: Elsevier.

Clark, M. S., & Waddell, B. A. (1983). Effects of moods on thoughts about helping, attraction and information acquisition. *Social Psychology Quarterly, 46,* 31-35.

http://dx.doi.org/10.2307/3033658

Cuddy, A.J.C., Glick, P., & Beninger, A. (2011). The dynamics of warmth and competence judgments, and their outcomes in organizations. *Research in Organizational Behavior, 31,* 73–98. http://dx.doi.org/10.1016/j.riob.2011.10.004

Cuddy, A.J.C., Fiske, S.T., & Glick, P. (2007). The BIAS Map: Behaviors from intergroup affect and stereotypes. *Journal of Personality and Social Psychology, 92,* 631–648. http://dx.doi.org/10.1037/0022-3514.92.4.631

Dobbins, G.H., & Russell, J.M. (1986). The biasing effects of subordinate likableness on leaders' responses to poor performers: A laboratory and a field study. *Personnel Psychology, 39,*759-777. http://dx.doi.org/10.1111/j.1744-6570.1986.tb00593.x

Edwards, J. R., & Lambert, L. S. (2007). Methods for integrating moderation and mediation: a general analytical framework using moderated path analysis. *Psychological Methods, 12,* 1-22. http://dx.doi.org/10.1037/1082-989X.12.1.1

Fiske, S. T., Cuddy, A. J., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences, 11,* 77-83. http://dx.doi.org/10.1016/j.tics.2006.11.005

Fiske, S. T., Cuddy, A. J., Glick, P., & Xu, J. (2002). A model of (often mixed) stereotype content: competence and warmth respectively follow from perceived status and competition. *Journal of Personality and Social Psychology, 82,* 878-902. http://dx.doi.org/10.1037//0022-3514.82.6.878

Flynn, J. E. (1977). A study of subjective responses to low energy and nonuniform lighting systems. *Lighting Design and Application, 7,* 6-15.

Forgas, J.P. (1995). Mood and judgment: The affect infusion model (AIM). *Psychological*

Bulletin 117, 39–66. http://dx.doi.org/10.1037//0033-2909.117.1.39

Forgas, J.P., & Bower, G.H., (1987). Mood effects on person-perception judgments. *Journal of Personality and Social Psychology, 53,* 53-60. http://dx.doi.org/10.1037/0022-3514.53.1.53

Forgas J.P., & George, J.M. (2001) Affective influences on judgments and behavior in organizations: An information processing perspective. *Organizational Behavior and Human Decision Processes, 86,* 3–34. http://dx.doi.org/10.1006/obhd.2001.2971

Hamilton, D. L., Katz, L. B., & Leirer, V. O. (1980). Cognitive representation of personality impressions: Organizational processes in first impression formation. *Journal of Personality and Social Psychology, 39,* 1050-1063. http://dx.doi.org/10.1037/h0077711

Houser, K. W., Tiller, D. K., Bernecker, C. A., & Mistrick, R. G. (2002). The subjective response to linear fluorescent direct/indirect lighting systems. *Lighting Research and Technology, 34,* 243-260. http://dx.doi.org/10.1191/1365782802li039oa

Hughes, P. C., & McNelis, J. F. (1978). Lighting, productivity, and the work environment. *Lighting Design and Application, 8,* 32-39.

IJzerman, H., & Semin, G. (2010). Temperature perceptions as a ground for social proximity. *Journal of Experimental Social Psychology, 46,* 867–873. http://dx.doi.org/10.1016/j.jesp.2010.07.015

Isen, A.M. (1987). Positive affect, cognitive organization, and social behavior. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 21, pp. 203-253). New York: Academic Press.

Isen, A.M., Daubman, K., & Kowicki, G. (1987). Positive affect facilitates creative problem

solving. *Journal of Personality and Social Psychology, 52,* 1122-1131. http://dx.doi.org/10.1037/0022-3514.52.6.1122

Jussim, L. (2012). *Social Perception and Social Reality: Why Accuracy Dominates Bias and Self-Fulfilling Prophecy*. Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195366600.001.0001

Knez, I. (1995). Effects of indoor lighting on mood and cognition. *Journal of Environmental Psychology, 15,* 39-51. http://dx.doi.org/10.1016/0272-4944(95)90013-6

Knez, I. (2001). Effects of colour of light on nonvisual psychological processes. *Journal of Environmental Psychology, 21,* 201-208. http://dx.doi.org/10.1006/jevp.2000.0198

Knez, I., & Enmarker, I. (1998). Effects of office lighting on mood and cognitive performance and a gender effect in work-related judgment. *Environment and Behavior, 30,* 553-567. http://dx.doi.org/10.1177/001391659803000408

Knez, I., & Kers, C. (2000). Effects of indoor lighting, gender, and age on mood and cognitive performance. *Environment and Behavior, 32,* 817-831. http://dx.doi.org/10.1177/0013916500326005

Kobayashi, S., Inui, M., & Nakamura, Y. (2001). Preferred illuminance non-uniformity of interior ambient lighting. *Journal of Light and Visual Environment, 25,* 64-75. http://dx.doi.org/10.2150/jlve.25.2_64

Kolb, P., Gockel, C., & Werth, L. (2012). The effects of temperature on service employees' customer orientation: an experimental approach. *Ergonomics, 55,* 621-635. http://dx.doi.org/10.1080/00140139.2012.659763

Kruithof, A.A. (1941). Tubular luminescence lamps for general illumination. *Philips Technical Review 6,* 65–96.

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D.H.J., Hawk, S.T., & van Knippenberg, A. (2010). Presentation and validation of the Radboud Faces Database. *Cognition & Emotion, 24,* 1377-1388. http://dx.doi.org/10.1080/02699930903485076

Leslie, R. P., & Hartleb, S. B. (1990). *Human response and variability in the luminous environment.* Proceedings of the CIBSE National Lighting Conference, Cambridge, England, pp. 87-99. London, UK: Chartered Institution of Building Services Engineers.

Levin, P.V., & Isen, A.M. (1975). Something you can still get for a dime: Further studies on the effect of feeling good on helping. *Sociometry, 38,* 141-147. http://dx.doi.org/10.2307/2786238

McCloughan, C.L.B., Aspinall, P.A., & Webb, R.S. (1999). The impact of lighting on mood. *Lighting Research and Technology, 31,* 81-88. http://dx.doi.org/10.1177/096032719903100302

May, J.L., & Hamilton, P.A. (1980). Effects of musically evoked affect on women's interpersonal attraction and perceptual judgments of physical attractiveness of men. *Motivation and Emotion, 4,* 217-228. http://dx.doi.org/10.1007/BF00995420

Nakamura, H., & Karasawa, Y. (1999). Relationship between illuminance/color temperature and preference of atmosphere. *Journal of Light & Visual Environment, 23,* 29-38.

Nauts, S., Langner, O., Huijsmans, I., Vonk, R., & Winboldus, D.H.J. (2014). Forming Impressions of Personality. A Replication and Review of Asch's (1946) Evidence for a Primacy-of-Warmth Effect in Impression Formation. *Social Psychology, 45,* 153 163. http://dx.doi.org/10.1027/a000001

Niedenthal, P. M., & Halberstadt, J. B. (2004). Top-down influences in social perception. In

W. Stroebe & M. Hewstone (Eds.), *European Review of Social Psychology* (Vol. 14, pp. 46-76). London: J. Wiley & Sons.

North, M. S., & Fiske, S. T. (2014). Social categories create and reflect inequality: Psychological and sociological insights. In: *The psychology of social status* (pp. 243-265). Springer New York.

Park, O.S., Sims, H.P., & Motowidlo, S.J. (1986). Affect in organizations. In H. Sims & D. Gioia (Eds.), *The Thinking Organization* (pp. 1-44]. San Francisco: Jossey Bass.

Riggio, R. E., & Throckmorton, B. (1988). The Relative Effects of Verbal and Nonverbal Behavior, Appearance, and Social Skills on Evaluations Made in Hiring Interviews. *Journal of Applied Social Psychology, 18*, 331-348. http://dx.doi.org/10.1111/j.1559-1816.1988.tb00020.x

Ross, L., Greene, D., & House, P. (1977). The "false consensus effect": An egocentric bias in social perception and attribution processes. *Journal of Experimental Social Psychology, 13*, 279-301. http://dx.doi.org/10.1016/0022-1031(77)90049-X

Ross, L. (1977). The intuitive psychologist and his shortcomings: Distortions in the attribution process. *Advances in Experimental Psychology, 10*, 174–214.

Rowe, P.M. (1967). Order effects in assessment decisions. *Journal of Applied Psychology, 51*, 13-22. http://dx.doi.org/10.1037/h0024346

Salovey, P., Mayer, J.D., & Rosenhan, D.L. (1991). Mood and helping: Mood as a motivator of helping and helping as a regulator of mood. In M.S. Clark (Ed.), *Review of Personality and Social Psychology* (Vol. 12, pp. 215- 237). New York: Sage.

Schmitt, N. (1976). Social and situational determinants of interview decisions: implications for the employment interview. *Personnel Psychology, 29*, 79-101.

http://dx.doi.org/10.1111/j.1744-6570.1976.tb00404.x

Sinclair, R.C. (1988). Mood, categorization, breadth, and performance appraisal: The effects of order of information acquisition and affective state on halo, accuracy, information retrieval, and evaluations. *Organizational Behavior and Human Decision Processes, 42*, 22-46. http://dx.doi.org/10.1016/0749-5978(88)90018-0

Sritharan, R., & Gawronski, B. (2010). Changing implicit and explicit prejudice: Insights from the associative-propositional evaluation model. *Social Psychology 41*, 113–123. http://dx.doi.org/10.1027/1864-9335/a000017

Veitch, J.A., & Newsham, G.R. (1998). Lighting Quality and Energy-Efficiency Effects on Task Performance, Mood, Health, Satisfaction, and Comfort. *Journal of the Illuminating Engineering Society, 27*, 107-129. http://dx.doi.org/10.1080/00994480.1998.10748216

Veitch, J. A., Newsham, G. R., Boyce, P. R., & Jones, C. C. (2008). Lighting appraisal, well-being and performance in open-plan offices: A linked mechanisms approach. *Lighting Research and Technology*, *40*, 133-151. http://dx.doi.org/10.1177/1477153507086279

Veitch, J. A., Stokkermans, M. G., & Newsham, G. R. (2013). Linking lighting appraisals to work behaviors. *Environment and Behavior, 45*, 198-214. http://dx.doi.org/10.1177/0013916511420560

Viénot, F., Durand, M.-L., & Mahler, E. (2009). Kruithof's rule revisited using LED illumination. *Journal of Modern Optics, 56*, 1433–1446. http://dx.doi.org/10.1080/09500340903151278

Wojciszke, B. (1994). Multiple meanings of behavior: Construing actions in terms of competence or morality. *Journal of Personality and Social Psychology, 67*, 222-232. http://dx.doi.org/10.1037/0022-3514.67.2.222

Table 1

Descriptive Statistics and Correlations

	Variables	Mean *(SD)*	Dim warm condition Mean *(SD)*	Bright warm condition Mean *(SD)*	Bright cold condition Mean *(SD)*	Dim cold condition Mean *(SD)*	1	2	3	4	5	6
1.	Age	23.62 (5.52)	-	-	-	-	-					
2.	Pleasant (vs. unpleasant) light	-	-	-	-	-	-.06	-				
3.	Satisfaction with light	4.34 (1.77)	4.19 (1.54)	4.70 (1.60)	4.56 (2.02)	3.89 (1.80)	.09	.15†	**.86**			
4.	Sex	-	-	-	-	-	.01	.01	-.10	-		
5.	Judgments of warmth	3.77 (0.70)	3.85 (0.76)	3.70 (0.76)	3.88 (0.98)	3.67 (0.74)	.03	.08	.22**	-.16*	**.74**	
6.	Judgments of competence	4.34 (0.71)	4.52 (0.65)	4.17 (0.65)	4.38 (0.80)	4.29 (0.71)	.05	.04	.23**	-.15†	.68**	**.71**

Note. *N*=164. Lighting conditions dummy coded, pleasant (1: dim warm, bright cold, and bright warm) versus unpleasant light (0: dim cold). Sex 1: female, -1: male. Reliabilities are marked in bold. †$p < .10$; *$p < .05$; **$p < .01$.

Table 2

Hierarchical Regressions on Satisfaction with Light and on Judgments of Warmth and Competence

	Satisfaction with Light			Warmth		Competence	
Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Age	.03 (.03)	.03 (.02)	.04 (.02)	.01 (.01)	.002 (.01)	.01 (.01)	.003 (.01)
LC		.63* (.32)	.63* (.31)	.15 (.14)	.09 (.14)	.07 (.13)	.01 (.13)
Sex			.36 (.27)				
LC x Sex			1.41* (.63)				
Satisfaction with Light					.09** (.04)		.09** (.03)
R^2	.007	.03†	.07*	.01	.05*	.004	.06*
ΔR^2		.03*	.03*		.04**		.06**

Note. N=164. Values are unstandardized regression coefficients; standard error estimates are in parentheses. All lower-order terms used in interactions were centered prior to analysis. LC = Pleasant lighting conditions (1: dim warm, bright cold, and bright warm) versus unpleasant (0: dim cold). $^{\dagger}p < .10$; $*p < .05$; $**p < .01$.

Figure 1

Research Model

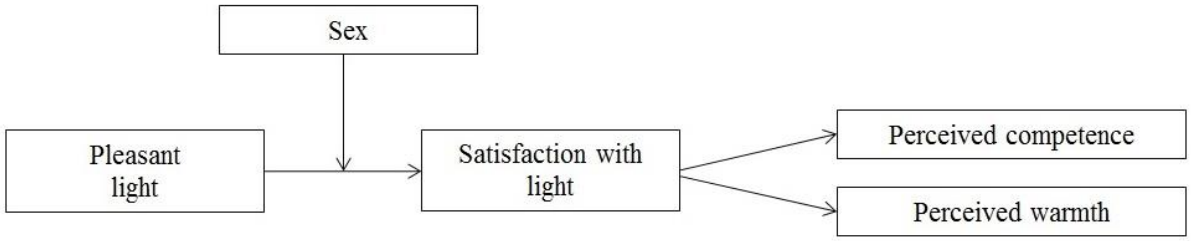
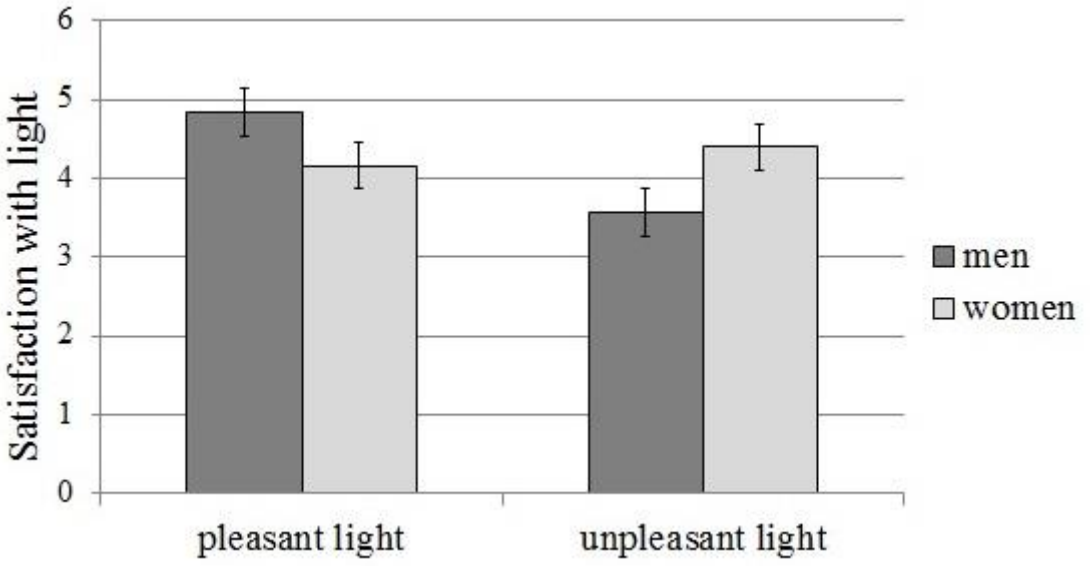


Figure 2

The lighting conditions used in the study

Figure 3

Interactive Effects of Lighting Condition and Sex on Satisfaction with Light



Note. N = 164. Pleasant lighting conditions: dim warm, bright cold and bright warm; Unpleasant lighting condition: dim cold. Standard errors are represented in error bars.

Chapter 4: Colored Light and Creativity

Colorful Visions: Blue and red accent lighting promote approach motivation and indirectly creativity

Olga Kombeiz, Anna Steidle

Abstract

Research has shown that colors influence motivation and cognitive performance. In achievement contexts, red evokes avoidance motivation that hinders creativity, while blue elicits an approach motivation that facilitates creativity. However, due to their position and mode of presentation, colors may convey a different message. Red accent lighting creates a cozy, friendly room atmosphere that may, even in an achievement context, elicit an approach rather than an avoidance motivation. Results (N = 146) showed that both blue and red accent light increased strategic approach motivation compared to white accent light. Moreover, through the heightened approach motivation, colorful accent light indirectly improved creative performance. Implications for future research on color and practical implications for color usage are discussed.

Keywords: colored light, color in context, creativity, approach motivation

Can exposure to colored light influence approach motivation and, as a result, increase an individual's creativity? It is widely acknowledged that context stimuli, like colors, can indicate safety and positive outcomes, or potential threats and negative outcomes, which in turn elicits either a creativity-supportive approach or a creativity-hindering avoidance motivation (Friedman & Förster, 2010; Elliot & Maier, 2012). Indeed, colors have been shown to trigger different motivational orientations (e.g., Elliot, Maier, Moller, Friedman, & Meinhardt, 2007) and to impact creative performance (e.g., Mehta & Zhu, 2009[1]). Despite these promising findings, the idea of creativity-supportive colors has up till now not been transferred to the lighting domain. Nevertheless, colored light for creativity promises to be a fruitful endeavor for theoretical reasons – both light (Steidle & Werth, 2013) and colors (Mehta & Zhu, 2009) can foster creativity – and for practical reasons – the development of creativity-supportive systems is a very hot topic these days (e.g., Siemon & Bissantz, 2016). Hence, building on the framework of the color-in-context theory (Elliot & Maier, 2012), the present research explores the idea that colored light activates approach or avoidance motivation and indirectly promotes colorful visions (i.e., creative ideas).

Colors and Approach Motivation

According to the color-in-context theory (Elliot & Maier, 2012), colors convey specific meanings that can evoke motivational orientations. Previous research on color-associations suggests that red is related to avoidance motivation because of a "danger" signal stemming from associations with red ink in school assessments or red traffic lights (Elliot et al., 2007; Maier, Elliot, & Lichtenfeld, 2008), whereas blue is related to approach motivation (Elliot & Maier, 2012; Mehta & Zhu, 2009) because of its association with tranquility and openness (Kaya & Epps, 2004). However, according to the color-in-context theory, the context can change a color's meaning and consequences because the context determines which color associations are activated. Hence, depending on the activated meaning, red may activate

approach rather than avoidance motivation (Meier, D'Agostino, Elliot, Maier, & Wilkowski, 2012). For instance, in dating situations, red conveys a romantic meaning that is related to approach (Elliot & Niesta, 2008). Moreover, in achievement contexts, red may evoke approach motivation if the situation is framed as appetitive (potential success) rather than threatening (potential failure; Rook, 2014).

Colors and Creativity

Several studies indicate that the use of specific colors can increase creativity (e.g., Lichtenfeld, Elliot, Maier, & Pekrun, 2012; Mehta & Zhu, 2009). In line with the color-in-context theory, approach and avoidance motivation have been proposed and investigated as underlying processes of the color-creativity effect (Elliot & Maier, 2012; Mehta & Zhu, 2009). In most laboratory studies, colors were displayed at a work-related location (e.g., on a computer display or a work folder), activating an achievement context in which red (blue) should trigger an avoidance (approach) motivation. Accordingly, Mehta and Zhu (2009) showed that a blue computer display improves creative performance compared to a red or a neutral screen. However, when red signaled potential success rather than potential failure in an achievement situation, seeing a red folder led to more creativity than seeing a blue or white folder (Rook, 2014). Other research investigated wall colors that give the colors a decorative value rather than signaling success or failure and found no differences in creative performance between employees in offices with blue vs. red walls (Küller, Mikellides, & Janssens, 2009). These partly inconsistent findings suggest that creativity may depend on color meanings and the associated motivation to a greater degree than on the color itself.

Meaning of Colors as Part of the Room Design

Although light and color are closely related – light shapes color perception (Boyce, 2014) and both have been used for room design – color and lighting research has typically been performed separately. In recognition of this state of affairs, only recently researchers

(e.g. Elliot, 2015) pointed out that the role of light should be considered in color research. To understand which light colors may evoke a creativity-supportive approach motivation, it is important to consider how colored light is perceived and which atmosphere and feelings it evokes. These perceptions indicate the underlying visual messages associated with a specific colored light and may evoke approach or avoidance motivation. Previously, colored light served primarily decorative purposes and has been used as accent light to create specific atmospheres. While cold colored accent lighting (e.g., blue, cyan) contributes to a lively and activating ambience, warm colored accent light (e.g., red, orange) contributes to a cozy and relaxing ambience (Kuijsters, Redi, de Ruyter, & Heynderickx, 2015). Both lively and cozy rooms provide a pleasant atmosphere that may foster approach motivation.

Moreover, colored accent lighting directed at a wall may create a similar impression as a colored wall. Several studies indicate that blue and green walls elicit more pleasant feelings than red or orange (Dijikstra, Pieterse, & Pruyn, 2008; Kwallek, Woodson, Lewis, & Sales, 1997), while other studies found opposing results, recording more pleasant feelings in red than in blue rooms (Küller et al., 2009), or no effects at all (Bakker, 2013). Importantly, Küller and colleagues (2009) also reported more positive feelings among employees in colorful than in neutral or colorless offices. This again hints at the possibility that both red and blue accent light directed at a wall may create a positive ambience that triggers approach motivation.

Building on previous research that shows that blue *and* red accent lighting and wall colors may create a more pleasant ambience than their colorless counterparts, we expected that blue and red colored accent light would lead to a stronger approach motivation than white accent light (Hypothesis 1). Moreover, due to the link between approach motivation and creativity (Mehta & Zhu, 2012; Rook, 2014; Smith, Ward, & Finke, 1995), we proposed that

the heightened approach motivation in the colored accent lighting conditions would also indirectly increase creativity (Hypothesis 2).

Method

Participants

One hundred-forty-six individuals (77 women, 68 men, 1 unspecified; M_{age} = 21.33 years, *SD* = 2.77) with no color vision deficiency participated in the study for a small gift. The target sample size was calculated using an estimated effect size, *f*, of 0.33, the average value of previously reported effect sizes for the color-motivational process link (Elliot et al., 2007; Mehta & Zhu, 2009; Rook, 2014). This would require a sample size of 147 participants for the study to be powered at 95%. Participants were randomly assigned to the blue (N = 46), red (N = 49), and control (N = 51) conditions.

Procedure

The experimental room at [*location masked for blind review*] was 9.7 x 4.6 x 2.9 meters in size. The walls and the ceiling were white and the linoleum-covered floor was dark grey. The windows were blinded in order to prevent the influence of natural light during the experiment. The room was furnished with four lines of desks and chairs as a regular lecture room. Functional white lighting was provided by fluorescent lamps and was held constant in all conditions (see Table 1). Blue, red, and white (control) accent lighting was provided using a 50 W LED-based wall washer (see Supplementary Material 1 for pictures).

Participants (up to eight at once) were asked to take a seat at the desk, in a position facing the wall on which the accent colored light was projected (the respective lighting condition was set up prior to their arrival). Participants first answered control questions regarding their current mood on a 9-point scale (1 = very, 9 = very good). Then, participants completed a task measuring their regulatory focus[2] and a task assessing their approach

motivation, after which their creative performance was measured. After the completion of the approach motivation and the creativity blocks, participants rated the difficulty of the tasks, how motivated they were, how much fun it was completing the tasks (1 = not at all, 9 = very much), and reported their current mood. All tasks were completed by paper and pencil. Finally, participants indicated their age and sex, after which they were debriefed and thanked. The overall experimental session lasted 15 minutes.

Measures

Building on regulatory focus research (Higgins, 1997), approach and avoidance motivation were measured strategic means via a "connecting-the-dots" task (Förster, Higgins, & Bianco, 2003). This task requires participants to draw pictures by connecting numbered dots within a given time. Participants were informed to connect the numbered dots in each of the four presented pictures as quickly and as thoroughly as possible. The time limit per picture was 30 seconds and this was monitored with a stopwatch by the experimenter. The number of dots that participants connected in each picture was summed up and indicated their speed. High speed reflects eagerness, a typical approach strategy. The number of dots that participants missed (e.g., that were not connected or wrongly connected) was summed up across the three pictures and divided by the number of connected dots. High accuracy reflects vigilance, a typical avoidance strategy.

Creativity was assessed with two standard tests of creative generation: the "unusual uses" task (Guilford, 1967) and the structured imagination task (Ward, 1994). In the unusual uses task, participants were given two minutes to generate as many alternative uses for an empty beverage can as they could. In the structured imagination task, participants were instructed to imagine traveling to another planet anywhere in the universe and to spend 3 minutes drawing a picture of an alien creature that is local to this planet on a blank sheet of paper. Three independent coders who were blind to the conditions coded participants'

alternative uses of the beverage cans in terms of creativity (on a scale of 1 (= *not creative at all*) to 9 (= *extremely creative*; Friedman et al., 2003) and the originality of the drawings from the structured imagination task on a scale of 1 (= *not at all*) to 5 (= *very strongly*; see also Maddux & Galinsky, 2009). The inter-rater reliability was very good for the alternative uses ratings (ICC (2, 3) = .93; Landers, 2015) and reached an acceptable degree for ratings of the drawings (ICC (2, 3) = .88) and were hence averaged in both cases. Measures of creative performance were the number of creative answers (with ratings above 5) in the alternative uses task and the average originality rating for the structured imagination task. To obtain one measure of creative performance from both tests, the creativity scores were z-standardized and averaged.

Results

Lighting condition significantly affected speed in the connecting-the-dots task (F (2, 143) = 4.21, p = .01), but not accuracy (F (2, 143) = .08, p = .92). Planned contrasts (white, λ = -2; red, λ = 1; blue, λ = 1) showed that participants in the white light condition were slower (connected fewer dots) than participants in the blue (t (95) = 2.64, p = .01, d = .52, 95% *CI* [0.11, 0.92]) and red (t (98) = 2.43, p = .01, d = .48, 95% *CI* [0.10, 0.88]) conditions. To test our second hypothesis, we conducted OLS mediation analyses using a bias-corrected bootstrapping procedure with 10,000 bootstraps (Hayes, 2015). As we have three different lighting conditions, we conducted the analysis with a multicategorical independent variable, where k-1 variables (D1 = red, D2 = blue) are automatically constructed and the group with the smallest numerical code (here the control condition, white) is treated as the reference category (Hayes, 2015; Hayes & Preacher, 2014). The results revealed that approach strategy (speed) was positively related to creativity (r = .20, p = .01) in correlation (see Table 2) and regression analyses (b =.02, p = .006). Results also supported the hypothesized mediational model. Specifically, the indirect effects of red (indirect effect = .09, *SE* = .06, 95% *CI* [.01;

.24]) and blue (indirect effect = .09, *SE* = .05, 95% *CI* [.02; .23]) on creativity via approach strategy were positive and the confidence intervals did not include zero.

The effects of lighting on task difficulty, task motivation, fun, and mood were not significant ($p > .10$).

Discussion

The results show that colorful accent lighting triggers approach motivation, which indirectly improves creative performance. In particular, participants sitting in front of walls accented by blue or red light were faster at a connecting-the-dots task than participants sitting in front of a wall accented by white light. This heightened speed can be interpreted as a strategy of eagerness typical for approach motivation. No differences were found regarding accuracy, an avoidance strategy, and the regulatory orientation towards approach or avoidance goals. Together, this indicates that, compared to white accent light, blue and red accent lighting elicits stronger approach behavior. This is in line with previous research indicating that both blue and red colored accent light (Kuijsters et al., 2015) and walls (Dijikstra et al., 2008; Küller et al., 2009) may evoke pleasant feelings. However, this finding is not in line with previous research indicating that red should prompt avoidance motivation in an achievement context (Elliot et al., 2007). Apparently, being employed in colored accent lighting provided the color red with positive meaning, presumably due to coziness and relaxation cues, instead of sending a danger signal. Overall, this highlights the importance of considering the contextualized meanings and messages associated with specific colors in order to predict the consequences for motivation and behavior.

The present results provide implications for future research on colors and practical implications for color usage. The present study was the first one to test the effect of colored accent light on approach motivation and creativity. Despite the promising finding of the positive value of colored light, it is far too early to generalize the findings or generally

recommend using colored light to enhance creativity. Future research is needed to investigate whether other forms of colored lighting like accent lighting directed at another part of the room (e.g., the ceiling) or colored general illumination (e.g., only blue or red light) could lead to similar results. Moreover, there may very well be situations in which perceiving no colors (i.e., only black-white) may be more beneficial for creativity because black-white perception can promote a creativity-supportive abstract information processing style (Lee, Deng, Unnava, & Fujita, 2014). If, despite of the lack of evidence, lighting planners and designers today think about using colored light to enhance creativity, it would be reasonable to consider how colored light may contribute to a pleasant, lively, and cozy ambience. Indirectly through the pleasant ambience, colored light could then trigger approach motivation and creativity. Overall, this research confirms the importance of the associated meanings and atmosphere in order to understand the effects of both object colors and light colors.

Endnotes

[1] It is important to note that Steele (2014) failed to replicate the color-priming effects on avoidance and approach motivation.

[2] Lighting condition did not affect participant's regulatory focus and regulatory focus was not related to creative performance. Analyses can be obtained from the first author.

References

Boyce, P. R. (2014). *Human factors in lighting.* Crc Press. London. New York.

Elliot, A.E. (2015). Color and psychological functioning: a review of theoretical and empirical work. *Frontiers in Psychology, 6,* 368-376. http://dx.doi.org/10.3389/fpsyg.2015.00368

Elliot, A. J. & Maier, M. A. (2012). Color-in-context theory. In: Plant, A., Devine, P.: *Advances in Experimental Social Psychology*. Volume 45, S. 61- 125. http://dx.doi.org/10.1016/B978-0-12-394286-9.00002-0

Elliot, A.J., Maier, M.A., Moller, A.C., Friedmann, R., & Meinhard, J. (2007). Color and psychological functioning: The effect of red on performance attainment. *Journal of Experimental Psychology: General, 136*, 154-168. http://dx.doi.org/ 10.1037/0096-3445.136.1.154

Elliot, A. J. & Niesta, D. (2008). Romantic red: Red enhances men's attraction to women. *Journal of Personality and Social Psychology*, *95*, 1150-1164. http://dx.doi.org/10.1037/0022-3514.95.5.1150

Friedman, R. S., Fishbach, A., Förster, J., & Werth, L. (2003). Attentional priming effects on creativity. *Creativity Research Journal*, *15*, 277-286. http://dx.doi.org/10.1080/10400419.2003.9651420

Friedman, R. S., & Förster, J. (2010). Implicit affective cues and attentional tuning: An integrative review. *Psychological Bulletin, 136,* 875-893. http://dx.doi.org/10.1037/a0020495

Förster, J., Higgins, E. T., & Bianco, A. T. (2003). Speed/accuracy decisions in task performance: Built-in trade-off or separate strategic concerns? *Organizational*

Behavior and Human Decision Processes, 90, 148-164. http://dx.doi.org/10.1016/S0749-5978(02)00509-5

Guilford, J. P. (1967). *The nature of human intelligence.* New York, NY: McGraw-Hill.

Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology, 67,* 451-470. http://dx.doi.org/10.1111/bmsp.12028

Hayes, A. F. (2015). An index and test of linear moderated mediation. *Multivariate Behavioral Research, 50,* 1-22. http://dx.doi.org/10.1080/00273171.2014.962683

Higgins, E.T. (1997). Beyond pleasure and pain. *American Psychologist, 52,* 1280-1300. http://dx.doi.org/10.1037/0003-066X.52.12.1280

Kaya, N. & Epps, H.H. (2004). Relationship between color and emotion: a study of college students. *College Student Journal, 38,* 396–405.

Kuijsters, A., Redi, J., de Ruyter, B., & Heynderickx, I. (2015). Lighting to make you feel better: Improving the mood of elderly people with affective ambiences. *PloS ONE 10*(7): e0132732. http://dx.doi.org/10.1371/journal.pone.0132732

Küller, R., Mikellides, B., & Janssens, J., (2009). Color, arousal, and performance – a comparison of three experiments. *Color Research and Application*, 34, 141–52. http://dx.doi.org/10.1002/col.20476

Kwallek, N., Woodson, H., Lewis, C.M., Sales, C. (1997). Impact of three interior color schemes on worker mood and performance relative to individual environmental sensitivity. *Color Research and Application, 22,* 121-132. http://dx.doi.org/10.1002/(SICI)1520-6378(199704)22:2<121::AID-COL7>3.0.CO;2-V

Landers, R.N. (2015). Computing intraclass correlations (ICC) as estimates of interrater reliability in SPSS. *The Winnower, 2*: e143518.81744. http://dx.doi.org/10.15200/winn.143518.81744

Lee, H., Deng, X., Unnava, H.R., & Fujita, K. (2014). Monochrome forests and colorful trees. The effect of black-and-white versus color imagery on construal level. *Journal of Consumer Research, 41*, 1015-1032. http://dx.doi.org/10.1086/678392

Lichtenfeld, S., Elliot, A.J., Maier, M.A. & Pekrun, R. (2012). Fertile green: green facilitates creative performance. *Personality and Social Psychology Bulletin, 38*, 1-14. http://dx.doi.org/10.1177/0146167212436611

Maddux, W. W., & Galinsky, A. D. (2009). Cultural borders and mental barriers: The relationship between living abroad and creativity. *Journal of Personality and Social Psychology, 96*, 1047-1061. http://dx.doi.org/10.1037/a0014861

Maier, M.A., Elliot, A.J., & Lichtenfeld, S. (2008). Mediation of the negative effect of red on intellectual performance. *Personality and Social Psychology Bulletin, 34*, 1530–1540. http://dx.doi.org/10.1177/0146167208323104

Mehta, R. & Zhu, R. (2009). Blue or red? Exploring the effect of color on cognitive task performances. *Science, 323*, 1226-1229. http://dx.doi.org/10.1126/science.1169144

Meier, B.P., D'Agostino, P.R., Elliot, A.J., Maier, M.A., & Wilkowski, B.M. (2012) Color in context: Psychological context moderates the influence of red on approach and avoidance-motivated behavior. *PLoS ONE 7(7):* e40333. http://dx.doi.org/10.1371/journal.pone.0040333

Rook, L. (2014). Exposure to the color red enhances creative thinking depending on appetitive-aversive cues. *Creativity Research Journal, 26*, 124-130. http://dx.doi.org/10.1080/10400419.2014.873672

Siemon, D., & Robra-Bissantz, S. (2016). Design guidelines for context-aware creativity support systems. *Journal of Creativity and Business Innovation, 2*, 5-19.

Smith, S. M., Ward, T. B., & Finke, R. A. (1995). *The creative cognition approach*. Cambridge, MA: MIT Press.

Steele, K.M. (2014). Failure to replicate the Mehta and Zhu (2009) color-priming effect on anagram solution times. *Psychological Bulletin Review, 21*, 771–776. http://dx.doi.org/10.3758/s13423-013-0548-3

Steidle, A., & Werth, L. (2013). Freedom from constraints: Darkness and dim illumination promote creativity. *Journal of Environmental Psychology, 35*, 67-80. http://dx.doi.org/10.1016/j.jenvp.2013.05.003

Ward, T. B. (1994). Structured imagination: The role of category structure in exemplar generation. *Cognitive Psychology, 27*, 1-40. http://dx.doi.org/10.1006/cogp.1994.1010

Willis, G.B., & Rodríguez-Bailón, R. (2010). When subordinates think of their ideals: Power, legitimacy and regulatory focus. *The Spanish Journal of Psychology, 13*, 777-787.

Table 1

Brightness, Color Temperature (CT), Correlated Color Temperature (CCT) [1]*, and (x, y) Chromaticity in Three Lighting Conditions*

	Accent colored wall[2]				Workstation[3]							
	Brightness (lx)	CCT (K)	x	y	Brightness (lx)		CT (K)		x		y	
					horizontal	vertical	horizontal	vertical	horizontal	vertical	horizontal	vertical
red	300	< 2000	.491	.330	640	200	3800	3600	.330	.330	.320	.320
blue	280	> 10000	.208	.230	640	200	3800	3600	.330	.330	.320	.320
white	300	4000	.330	.320	640	200	3800	3600	.330	.330	.320	.320

Note. [1]CCT was calculated using (*u',v'*) chromaticity space; [2]measurements were conducted on the colored wall approximately 30 cm above the wallwasher; [3]brightness, color temperature, and chromaticity at all workstations similar

Table 2

Descriptive Statistics and Correlations

Variables			Blue	Red	White	Mean *(SD)*	1	2	3
			Mean *(SD)*	Mean (*SD)*	Mean (*SD)*				
1.	Creativity	Task 1	3.42 (2.28)	3.51 (2.22)	3.97 (1.78)	3.64 (2.10)			
		Task 2	2.99 (1.39)	3.14 (1.07)	3.07 (1.02)	3.07 (1.16)			
		Average (z-value)	-0.09 (0.97)	0.00 (0.82)	0.08 (0.70)	0.00 (0.83)	-		
2.	Speed		41.32 (7.72)	41.20 (8.45)	37.41 (7.41)	39.91 (8.03)	.20*	-	
3.	Accuracy		10.02 (19.34)	9.30 (17.29)	8.48 (19.67)	9.24 (18.68)	-.05	-.05	
4.	Regulatory Goals		0.89 (2.36)	1.19 (1.93)	1.12 (2.82)	1.07 (2.39)	-.09	.06	.03

Note. N = 143-146; Task 1 = Unusual Uses Test, Task 2 = Structured Imagination Task. To facilitate the interpretation of the creativity values, raw mean values for separate creativity tasks are presented. For correlations, we used standardized values of creativity. *$p < .05$.

Supplementary Material 1

Accent lighted wall. Left to right: blue, red, white accent lighting

Chapter 5: General Discussion

Light shapes, to a large extent, how people see the world and each other, and therefore how they interact and perform in work contexts. In particular, light might change individuals' affect, cognition, motivation, as well as subsequent behavior and performance. However, an overarching framework explaining the effects of light on psychological processes and work-related outcomes has still been lacking. The aim of the present thesis was to explain the effects of light in the work context, considering different psychological processes that might be activated in different lighting conditions and under different circumstances. Based on experimental studies, three research questions were addressed: How does light impact conflict resolution and what are the boundary conditions? How does light influence social judgment? How can light promote creative performance? To answer these questions and to provide an overall explanatory approach for the effects of light in the work context, empirical investigations were conducted based on different theoretical approaches. A short overview of the present results follows this section.

5.1 Summary of Overall Results

To answer the question of how light may impact conflict resolution, two experimental studies were conducted. We proposed that only self-oriented individuals would be influenced by dim warm light in a situation of social conflict via situative self-construal. Based on two laboratory experiments, we confirmed that self-oriented individuals showed higher interpersonal closeness with their negotiation partner in dim warm light, but not in other lighting conditions, which in turn promoted collaborative conflict resolution. The generalizability of the present findings was demonstrated by using different measures assessing traits related to social orientation (i.e., social dominance orientation and trait interdependent self-construal) and by different variations of brightness and color temperature in two experiments.

The second research question aimed at clarifying the effect of light on social judgment due to an affective shift. The results confirmed that satisfaction with light was higher in pleasant than in unpleasant light. The pleasant light indirectly promoted positive judgments of competence and warmth via satisfaction with light. The explorative moderating effect of sex on the relation between pleasant light and satisfaction with light provided a further contribution by offering an explanation for the inconsistent results reported in previous studies. These results revealed that the proposed effect of light only emerged for men.

The third research question aimed at clarifying the effects of light on motivational processes and creative performance. In line with the expectation, strategic approach motivation increased in red and blue (versus white) accent lighting. The results also confirmed that colored accent lighting indirectly leads to higher creative performance via approach motivation.

5.2 Contributions, Limitations and Future Research

The present findings contribute to previous research in several ways. The main contribution is the introduction of an overarching model that explains the effects of light in the work context. This model contains affective, cognitive, and motivational processes that may be activated due to the situational context and, in turn, influence work-related performance, perception, and behavior. Moreover, individual differences, such as social orientation and sex, are considered as possible moderators. Previous research focused mainly on one of a few possible explanatory approaches for the effects of light. For instance, Baron et al. (1992) investigated the effects of light in a social context based on the idea of environmentally induced positive affective, but did not find direct confirmation for a mediation of the affective state. Steidle et al. (2013) focused on cognitive processes evoked by light in social situations. The authors found support for the effects of darkness on cooperation. However, other social contexts that do not contain an interaction with others

(e.g., social judgment) were not investigated. Motivational processes have thus far been examined in color research (Moller et al., 2009) or among other features of ambience (i.e., room temperature; Kolb et al., 2012), but not as a consequence of light. In the present research, the use of colored light showed that motivational processes might be activated by light.

In addition to the situational context (i.e., social interaction versus individual performance), individual differences complete the research model and show that the effects of light might be stronger for some individuals than for others. In the context of social interaction, we demonstrate that the social orientation of an individual is an essential boundary condition for the cognitive construal of the social situation, as evoked by light. In another context, where interaction with others does not take place but an affective change associated with light occurs, the sex of the individuals could moderate the relation between pleasant light and individual's satisfaction with light, which indirectly impacts social judgment. Thus, the current research integrates different psychological mechanisms explaining the effects of light and limiting individual and contextual conditions, as well as providing an overall model of the effects of light in the work context.

Another important contribution of the present research is that it provides a basis for the integration of color and lighting research. As noted previously, color research has up until now not been integrated in lighting research and vice versa (Elliot, 2015). By using colored light as an ambient characteristic that influences motivational processes and, in turn, work performance, the present research contributes to the color-in-context theory and lighting research. Colored light in lighting research has mainly been investigated as an element contributing to the room atmosphere (Kuijsters, et al., 2015). Only a few studies have focused on colored light's effects on outcomes related to the work context (Hoonhout, et al., 2009; Takahashi, 2009). However, these studies did not investigate the underlying processes in the

effects of colored light on work performance (Hoonhout, et al., 2009) or social perception (Takahashi, 2009). Compared to colored light, the impact of object colors on work-related outcomes has been much better researched. Hence, color-in-context theory (Elliot & Maier, 2012) summarizes this knowledge and findings proposing that (object) colors unfold their influence on psychological processes due to the situational context, such as a romantic versus an achievement context. The current research demonstrates that the perceived meaning of a color might be different even in the same context (e.g., in an achievement context), depending on the mode of color presentation. Thus, the effects of object colors cannot be directly transferred to the colored light's effects and the context of color presentation should be taken into account when designing work spaces.

The present findings should be interpreted with consideration of the limitations that at the same time offer avenues for future research. The presented overall model of the effects of light contains different psychological consequences of light and different light characteristics that were investigated separately in different research projects. However, previous research indicates that these mediators are not independent. Thus, positive affect positively relates to approach motivation (Elliot & Thrash, 2002) and global processing style (Gasper & Clore, 2002). Similarly, subjective appraisals of environmental stimuli as pleasant (versus unpleasant) are associated with appetitive affect, global processing, and approach motivation (for an overview, Elliot & Maier, 2012). Therefore, it could be reasonable to investigate different mediators simultaneously. For instance, global processing style (Steidle & Werth, 2013), approach motivation (Mehta & Zhu, 200; Rook, 2014), and positive mood (Baas et al., 2008) have been shown to promote creative performance. As the present findings indicate that light can result in affective, cognitive, and motivational consequences, further research could focus on the creation of lighting conditions that may influence all three psychological processes. It would be interesting to know which process better predicts creative performance.

Furthermore, in the current thesis we limited the investigated outcomes to three work-related behaviors or performance. Further research is needed to complement the introduced model, for instance, by exploring other work-related outcomes, such as team creativity and analytical performance, customer orientation, and job satisfaction. For instance, team creativity contains both, collaboration and cognitive performance. Hence, it is possible that team creativity would benefit from approach motivation as well as interdependent self-construal induced by lighting conditions that convey a message of coziness and sociality. Moreover, the present thesis focused on the outcomes in the work context. The effects of light on human functioning in other research domains could be an interesting area for further research. For instance, the generalizability of the present findings could be investigated using a private context and by focusing on the resolution of marital or family conflicts. Hence, the expansion of the current model to a context of privacy in addition to the work context would contribute to the understanding of the effects of light on human functioning.

Moreover, the present thesis focused on individual differences in the social context and on participant's sex due to previous inconsistent findings of the effects of light on affective states and lighting preferences. It is possible that other individual differences apart from one's social orientation and sex, such as stimulus screening ability (Mehrabian, 1977), could supplement the findings of the present research. The concept of stimulus screening ability describes the ability of individuals to automatically sort out less important surrounding elements. Such individuals are called high-screeners (versus low-screeners) and demonstrate less aroused responses to the environment (Mehrabian, 1977). In line with this finding, Dijkstra, Pieterse, and Pruyn (2008) showed that the reduction of stress or the induction of arousal by room colors were more pronounced for low-screeners than for high-screeners. It is possible that high-screeners would be less influenced by light in the work context as well. For instance, this could mean that low-screeners would benefit from colored accent lighting more

than high-screeners, in the form of higher approach motivation and subsequent performance. These ideas could be examined in further research.

Focusing on the technical side of the current research, it should be highlighted that we varied specific aspects of light: brightness, color temperature, direct-indirect mode (i.e., direct white lighting in social situations versus accent lighting in performance situation) and light color. These characteristics provide an important framework for the understanding of psychological light effects. However, there are still other lighting features that should be investigated in further research. For example, luminance distribution within the rooms could be explored, as it has previously been shown to influence attention and distraction (see for an overview Veitch, 2001). Thus, this aspect of light could be especially important for the investigation of light's impact on cognitive performance because of the close relation between attention and performance (Graydon & Eysenck, 1989). Furthermore, glare could cause discomfort (Veitch & Newsham, 1998) and have an impact on satisfaction with light. Therefore, it could be useful to include the perception of glare in further research or to control for it, because glare could negatively influence the satisfaction with light. Moreover, using daylight in addition to artificial light could be an interesting avenue for further research because such rooms reproduce the reality more closely. Additionally, rooms containing windows and daylight have been shown to be generally preferred for most work activities (Boubekri & Haghighat, 1993). Hence, the satisfaction with light could increase when daylight is available in a room.

Moreover, the main part of the current research focused on brightness and color temperature, whereas the color of light was investigated in one study. Thus, the present research allows conclusions only for the motivational effects of red and blue colored light, as well as white light. Further research is needed to investigate the effects of green light, as green has been found to facilitate creativity (Lichtenfeld, et al., 2012) and have positive

effects on mood (Akers, Barton, Cossey, Gainsford, Griffin, & Micklewright, 2012). Even the effects of other colors of light on motivational processes could be explored, as colors such as orange have been shown to induce a cozy room atmosphere (Kuijsters et al., 2015). Last but not least, the application of colored light can be considered in several different forms: direct light, ceiling accented colored light, or as a combination of daylight and colored light. Whereas indirect colored light and a combination of daylight and colored light could increase the perception of a pleasant room atmosphere, "coloring" a room by applying direct colored light could have similar effects to object colors. Together, the proposed and investigated research model provides explanations for the effects of different characteristics of light on psychological functioning, but also serves as a guide for future research.

5.3 Practical Implications

The current research also provides practical implications for workplace design. The present findings indicate that having the right lighting condition could potentially benefit multiple aspects of human functioning (e.g., performance, perception, and behavior), with the right condition being dependent on the context of the situation and the desired outcome. Thus, before giving general recommendations, it is reasonable to create specific room atmospheres that trigger psychological processes and, in turn, influence work-related outcomes. For the purpose of promoting creative performance, a pleasant room atmosphere that relates to approach motivation should be created. In situations of social interaction and possible social conflict, dim warm light that promotes the self-perception of "we/us" is more suitable than other combinations of brightness and color temperature. When the work activity is characterized by the evaluation of other individuals, it is necessary to ensure that the same lighting condition is used for evaluation and comparison of others. Thus, different activities require different lighting conditions.

Therefore, it could be appropriate to establish dynamic lighting that can be changed according to the situation, task, and subjective preference. For instance, it could be an option to select dim warm light for a situation involving collaboration and switching it to an accent lighted, cozy room atmosphere to increase creativity-supportive approach motivation. Hence, simply adhering to current technical standardizations is not enough, because these standards mainly target satisfactory light intensity, without considering optimal psychological functioning for different work-related outcomes. The optimization and corresponding adaptation of artificial light for different performance types can increase individual performance and professional fulfilment, but also help to increase the competitive advantage of companies.

Besides evidence-based recommendations for individuals and organizations, the knowledge gained in the present research can also be used for the development of technical standardizations. Up until now, the international guidelines contain only few recommendations for the combinations of different light aspects, while the current findings emphasize the importance of brightness, color temperature, and colored light for human functioning.

References

Adams, F. M., & Osgood, C. E. (1973). A cross-cultural study of the affective meanings of color. *Journal of Cross-Cultural Psychology, 4,* 135-156. http://dx.doi.org/10.1177/002202217300400201

Andersson, M. (1994). *Sexual Selection.* Princeton, NJ: Princeton University Press.

Ashkanasy, N. M., Ayoko, O. B., & Jehn, K. A. (2014). Understanding the physical environment of work and employee behavior: An affective events perspective. *Journal of Organizational Behavior, 35,* 1169-1184. http://dx.doi.org/10.1002/job.1973

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin, 134,* 779-806. http://dx.doi.org/10.1037/a0012815

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59,* 617–645. http://dx.doi.org/10.1146/annurev.psych.59.103006.093639

Bakker, I., van der Voordt, T. J., de Boon, J., & Vink, P. (2013). Red or blue meeting rooms: does it matter? The impact of colour on perceived productivity, social cohesion and wellbeing. *Facilities, 31,* 68-83. http://dx.doi.org/10.1108/02632771311292527

Baron, R. A. (1990). Environmentally induced positive affect: Its impact on self-efficacy, task performance, negotiation, and conflict. *Journal of Applied Social Psychology, 20,* 368-384. http://dx.doi.org/10.1111/j.1559-1816.1990.tb00417.x

Baron, R. A., Rea, M. S., & Daniels, S. G. (1992). Effects of indoor lighting (illuminance and spectral distribution) on the performance of cognitive tasks and interpersonal behaviors: The potential mediating role of positive affect. *Motivation and Emotion, 16,*

1-33. http://dx.doi.org/10.1007/BF00996485

Bennett, C.A., Chitlangia, A. & Pengrekar, A. (1977). Illumination levels and performance of practical visual tasks, *Proceedings of the Human Factors Society*, 21st Annual Meeting, San Francisco, CA.

Boyce, P. R. (2003). *Human Factors in Lighting* (2nd ed.). New York: Taylor &Francis.

Boyce, P. R., Veitch, J. A., Newsham, G. R., Myer, M., & Hunter, C. (2003). *Lighting quality and office work: A field simulation study* (PNNL 14506). Richland, WA, USA: Pacific Northwest National Laboratory.

Buchanan, T.L., Barker, K.N., Gibson, J.T., Jiang, B.C. & Pearson, R.E. (1991). Illumination and errors in dispensing. *American Journal of Hospital Pharmacy, 48,* 2137– 2145.

Cajochen, C. (2007). Alerting effects of light. *Sleep Medicine Reviews, 11,* 453-464. http://dx.doi.org/10.1016/j.smrv.2007.07.009

Carnevale, D. G. (1992). Physical settings of work: A theory of the effects of environmental form. *Public Productivity and Management Review*, *15,* 423-436. http://dx.doi.org/10.2307/3380628

Choi, J. N. (2004). Individual and contextual predictors of creative performance: The mediating role of psychological processes. *Creativity Research Journal, 16,* 187 199. http://dx.doi.org/10.1080/10400419.2004.9651452

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98,* 310-357. http://dx.doi.org/10.1037/0033-2909.98.2.310

Conway, B. R. (2009). Color vision, cones, and color-coding in the cortex. *The Neuroscientist, 15,* 274–290. http://dx.doi.org/10.1177/1073858408331369

Elliot, A.E. (2015). Color and psychological functioning: a review of theoretical and empirical work. *Frontiers in Psychology*, *6*, 368-376. http://dx.doi.org/10.3389/fpsyg.2015.00368

Elliot, A. J. & Maier, M. A. (2012). Color-in-context theory. In: Plant, A., Devine, P.: *Advances in Experimental Social Psychology*. Volume 45, S. 61- 125. http://dx.doi.org/10.1016/B978-0-12-394286-9.00002-0

Elliot, A.J., Maier, M.A., Moller, A.C., Friedmann, R., & Meinhard, J. (2007). Color and psychological functioning: The effect of red on performance attainment. *Journal of Experimental Psychology: General*, *136*, 154-168. http://dx.doi.org/ 10.1037/0096-3445.136.1.154

Elliot, A. J. & Niesta, D. (2008). Romantic red: Red enhances men's attraction to women. *Journal of Personality and Social Psychology*, *95*, 1150-1164. http://dx.doi.org/10.1037/0022-3514.95.5.1150

Elliot, A. J., Payen, V., Brisswalter, J., Cury, F., & Thayer, J. F. (2011). A subtle threat cue, heart rate variability, and cognitive performance. *Psychophysiology*, *48*, 1340-1345. http://dx.doi.org/10.1111/j.1469-8986.2011.01216.x

Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: approach and avoidance temperaments and goals. *Journal of Personality and Social Psychology*, *82*, 804-818. http://dx.doi.org/10.1037/0022-3514.82.5.804

Elsbach, K. D., & Bechky, B. A. (2007). It's more than a desk: Working smarter through leveraged office design. *California Management Review*, *49*, 80–101. http://dx.doi.org/10.2307/41166384

Elsbach, K.D. & Pratt, M.G. (2007). The physical environment in organizations. *The Academy of Management Annals*, *1*, 181-224, http://dx.doi.org/10.1080/078559809

Florida, R. (2005). *The flight of the creative class: The new global competition for talent*. New York, NY: Collins.

Forgas J.P., & George, J.M. (2001) Affective influences on judgments and behavior in organizations: An information processing perspective. *Organizational Behavior and Human Decision Processes, 86,* 3–34. http://dx.doi.org/10.1006/obhd.2001.2971

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science, 13*, 34–40. http://dx.doi.org/10.1111/1467-9280.00406

Gegenfurtner, K. R., & Kiper, D. C. (2003). Color vision. *Annual Review of Neuroscience, 26,* 181–206. http://dx.doi.org/10.1146/annurev.neuro.26.041002.131116

Gergen, K. J., Gergen, M. M., & Barton, W. H. (1973). Deviance in dark. *Psychology Today, 7*, 129-130.

Graydon, J., & Eysenck, M. W. (1989). Distraction and cognitive performance. *European Journal of Cognitive Psychology, 1*, 161-179. http://dx.doi.org/10.1080/09541448908403078

Hedge, A. (1982). The open-plan office a systematic investigation of employee reactions to their work environment. *Environment and Behavior, 14*, 519-542. http://dx.doi.org/10.1177/0013916582145002

Hoonhout, H.C.M., Knoop, M., & Vanpol, R. (2009). Colored lighting in offices the new caffeine? Looking into performance effects of colored lighting. *Proceedings of the Human Factors and Ergonomics, Society Annual Meeting 2009, 53*, 502-506. http://dx.doi.org/10.1177/154193120905300804.

IJzerman, H., & Semin, G. R. (2009). The thermometer of social relations: Mapping social proximity on temperature. *Psychological Science, 20,* 1214-1220. http://dx.doi.org/10.1111/j.1467-9280.2009.02434.x

Isen, A.M. (1987). Positive affect, cognitive organization, and social behavior. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 21, pp. 203-253). New York: Academic Press.

Kaplan, B. H., Cassel, J. C., & Gore, S. (1977). Social support and health. *Medical Care, 15,* 47-58. http://dx.doi.org/10.1097/00005650-197705001-00006

Knez, I. (1995). Effects of indoor lighting on mood and cognition. *Journal of Environmental Psychology, 15,* 39-51. http://dx.doi.org/10.1016/0272-4944(95)90013-6

Knez, I., & Enmarker, I. (1998). Effects of office lighting on mood and cognitive performance and a gender effect in work-related judgment. *Environment and Behavior, 30,* 553-567. http://dx.doi.org/10.1177/001391659803000408

Kolb, P., Gockel, C., & Werth, L. (2012). The effects of temperature on service employees' customer orientation: an experimental approach. *Ergonomics, 55,* 621-635. http://dx.doi.org/10.1080/00140139.2012.659763

Kruithof, A.A. (1941). Tubular luminescence lamps for general illumination. *Philips Technical Review 6,* 65–96.

Kuijsters, A., Redi, J., de Ruyter, B., & Heynderickx, I. (2015). Lighting to make you feel better: Improving the mood of elderly people with affective ambiences. *PloS ONE 10*(7): e0132732. http://dx.doi.org/10.1371/journal.pone.0132732

Kuijsters, A., Redi, J., de Ruyter, B., Seuntiëns, P., & Heynderickx, I. (2014). Affective ambiences created with lighting for older people. *Lighting Research and Technology, 47,* 859-875. http://dx.doi.org/10.1177/1477153514560423

Kwallek, N., Lewis, C.M., Lin-Hsiao, J.W.D., & Woodson, M. (1996). Effects of nine monochromatic office interior colors on clerical tasks and worker mood. *Color Research and Application, 21,* 448-458. http://dx.doi.org/10.1002/(SICI)1520-6378(199612)21:6<448::AID-COL7>3.0.CO;2-W

Lichtenfeld, S., Elliot, A. J., Maier, M. A., & Pekrun, R. (2012). Fertile green: Green facilitates creative performance. *Personality and Social Psychology Bulletin, 38,* 784-797. http://dx.doi.org/10.1177/0146167212436611

Lockley, S. W., Brainard, G. C., & Czeisler, C. A. (2003). High sensitivity of the human circadian melatonin rhythm to resetting by short wavelength light. *The Journal of Clinical Endocrinology and Metabolism, 88,* 4502-4502. http://dx.doi.org/10.1210/jc.2003-030570

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: does happiness lead to success? *Psychological Bulletin, 131,* 803-855. http://dx.doi.org/10.1037/0033-2909.131.6.803

Mahoney, M. P., Liu, L., & Fogg, L. F. (1994). Shift work dark goggles and bright light improve circadian rhythm adaptation to night-shift work. *Sleep, 17,* 535-543.

Maier, M. A., Elliot, A. J., & Lichtenfeld, S. (2008). Mediation of the negative effect of red on intellectual performance. *Personality and Social Psychology Bulletin. 34,*1530-1540. http://dx.doi.org/10.1177/0146167208323104

Manav, B. (2007). An experimental study on the appraisal of the visual environment at offices in relation to colour temperature and illuminance. *Building and Environment, 42,* 979-983. http://dx.doi.org/10.1016/j.buildenv.2005.10.022

McGuiness, P.J. & Boyce, P.R. (1984) The effect of illuminance on the performance of domestic kitchen work by two age groups, *Lighting Research and Technology, 16,* 131-136. http://dx.doi.org/10.1177/14771535840160030601

Mehta, R. & Zhu, R. (2009). Blue or red? Exploring the effect of color on cognitive task performances. *Science, 323,* 1226-1229. http://dx.doi.org/10.1126/science.1169144

Moller, A. C., Elliot, A. J., & Maier, M. A. (2009). Basic hue-meaning associations. *Emotion, 9,* 898-902. http://dx.doi.org/10.1037/a0017811

Niedenthal, P. M., & Halberstadt, J. B. (2004). Top-down influences in social perception. In W. Stroebe & M. Hewstone (Eds.), *European Review of Social Psychology* (Vol. 14, pp. 46-76). London: J. Wiley & Sons.

Oetzel, J., Meares, M., Myers, K. K., & Lara, E. (2003). Interpersonal conflict in organizations: Explaining conflict styles via face negotiation theory. *Communication Research Reports, 20,* 106-115. http://dx.doi.org/10.1080/08824090309388806

Oskamp, S. (1971). Effects of programmed strategies on cooperation in the prisoner's dilemma and other mixed-motive games. *The Journal of Conflict Resolution, 15,* 225-259. http://dx.doi.org/10.1177/002200277101500207

Park, O.S., Sims, H.P., & Motowidlo, S.J. (1986). Affect in organizations. In H. Sims & D. Gioia (Eds.), *The Thinking Organization* (pp. 1-44]. San Francisco: Jossey Bass.

Pauley, S. M. (2004). Lighting for the human circadian clock: recent research indicates that lighting has become a public health issue. *Medical Hypotheses, 63,* 588-596. http://dx.doi.org/10.1016/j.mehy.2004.03.020

Rahim, A. M. (2002). Toward a theory of managing organizational conflict. *International Journal of Conflict Management, 13,* 206-235. http://dx.doi.org/10.1108/eb022874

Riggio, R. E., & Throckmorton, B. (1988). The Relative Effects of Verbal and Nonverbal Behavior, Appearance, and Social Skills on Evaluations Made in Hiring Interviews. *Journal of Applied Social Psychology, 18,* 331-348. http://dx.doi.org/10.1111/j.1559-1816.1988.tb00020.x

Rook, L. (2014). Exposure to the color red enhances creative thinking depending on appetitive-aversive cues. *Creativity Research Journal, 26,* 124-130. http://dx.doi.org/10.1080/10400419.2014.873672

Sinclair, R.C. (1988). Mood, categorization, breadth, and performance appraisal: The effects of order of information acquisition and affective state on halo, accuracy, information retrieval, and evaluations. *Organizational Behavior and Human Decision Processes, 42,* 22-46. http://dx.doi.org/10.1016/0749-5978(88)90018-0

Sparrowe, R. T., Liden, R. C., Wayne, S. J., & Kraimer, M. L. (2001). Social networks and the performance of individuals and groups. *Academy of Management Journal, 44,* 316-325. http://dx.doi.org/10.2307/3069458

Steele, K.M. (2014). Failure to replicate the Mehta and Zhu (2009) color-priming effect on anagram solution times. *Psychological Bulletin Review, 21,* 771–776. http://dx.doi.org/10.3758/s13423-013-0548-3

Steidle, A., Hanke, E., & Werth, L. (2013). In the dark we cooperate: The situated nature of procedural embodiment. *Social Cognition, 31,* 275-300. http://dx.doi.org/10.1521/soco.2013.31.2.275

Steidle, A., & Werth, L. (2013). Freedom from constraints: Darkness and dim illumination promote creativity. *Journal of Environmental Psychology, 35,* 67-80. http://dx.doi.org/10.1016/j.jenvp.2013.05.003

Steidle, A., Werth, L., & Hanke, E. (2011). You can't see much in the dark: Darkness affects construal level and psychological distance. *Social Psychology, 42,* 174-184. http://dx.doi.org/10.1027/1864-9335/a000061

Sundstrom, E., Bell, P. A., Busby, P. L., & Asmus, C. (1996). Environmental Psychology 1989-1994. *Annual Review of Psychology, 47,* 485-512. http://dx.doi.org/10.1146/annurev.psych.47.1.485

Veitch, J.A. & McColl, S.L. (2001). A critical examination of perceptual and cognitive effects attributed to full-spectrum fluorescent lighting, *Ergonomics, 44,* 255-279. http://dx.doi.org/10.1080/00140130121241

Viénot, F., Durand, M.-L., & Mahler, E. (2009). Kruithof's rule revisited using LED illumination. *Journal of Modern Optics, 56,* 1433–1446. http://dx.doi.org/10.1080/09500340903151278

Werth, L., Steidle, A., Hubschneider, C., de Boer, J., & Sedlbauer, K. (2013). Psychologische Befunde zu Licht und seiner Wirkung auf den Menschen – ein Überblick. *Bauphysik, 35,* 193-204. http://dx.doi.org/10.1002/bapi.201310058

Zhong, C., Bohns, V.K. & Gino, F (2010). Good lamps are the best police darkness increases dishonesty and self-interested behavior. *Psychological Science, 21,* 311–314. http://dx.doi.org/10.1177/0956797609360754

Zhong, C. B., & House, J. (2012). Hawthorne revisited: Organizational implications of the physical work environment. *Research in Organizational Behavior*, *32*, 3-22. http://dx.doi.org/10.1016/j.riob.2012.10.004

Acknowledgment

I would like to express my appreciation to all committee members who supported my efforts in writing the doctoral thesis. First, I would like to thank Lioba Werth for the opportunity to work on the interdisciplinary research project and to express my sincere gratitude to my supervisor Anna Steidle. Anna, thank you for your support and enthusiasm for research throughout all this time.

I'd also like to extend my gratitude to my (former) colleagues at Graduate Program "People Inside" and at University of Hohenheim, who have become my friends. I enjoyed the pleasant work atmosphere, your valuable feedback on my work, the social activities, and the laughter we shared. Special thanks go also to Konrad Senf for proofreading my works and to Erik Dietl for professional, technical, and emotional support.

In addition, many thanks to the students who run some of the studies as part of their Bachelor course and all participants of the laboratory studies.

Finally, I am grateful for the unwavering support of my family, who provides me with unconditional love. Thank you for always believing in me.

Eidesstattliche Versicherung

gemäß § 8 Absatz 2 der Promotionsordnung der Universität Hohenheim zum Dr. oec und Dr. rer. soc vom 13.02.2015

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig angefertigt und dabei nur die angegebenen Quellen und Hilfsmittel verwendet habe. Wörtlich oder inhaltlich aus anderen Arbeiten übernommene Stellen habe ich als solche gekennzeichnet. Ich habe keine unerlaubte fremde Hilfe in Anspruch genommen und die Arbeit weder in der vorliegenden noch in einer anderen Fassung einer in- oder ausländischen Hochschule als Dissertation oder sonstige Arbeit zur Erlangung eines akademischen Grades vorgelegt.

Stuttgart, 27.07.2016

Olga Kombeiz