Always look on the bright side of life : ego-replenishing effects of daylight versus artificial light

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Introduction

Vitality is an important indicator of wellbeing and feeling vital is something we often strive to achieve. Vitality not only entails feeling energetic but is also about experiencing positive affect. In other words, subjective vitality concerns the amount of positive energy you experience (Nix, Ryan, Manly & Deci, 1999). Vitality is influenced by both somatic and psychological processes and has been linked to both mental and physical health (Ryan & Deci, 2008). When people feel vital they are better able to cope with stress, or even viruses (Ryan & Deci, 2008). Moreover, it has also been suggested that people who feel vital are more able to self-regulate (Muraven, Gagné and Rosman, 2008; Ryan & Deci, 2008).

The world around us is full of temptations. To resist these temptations, we need self-control. Self-control, or self-regulation, is also needed to control attention or impulses, guide behaviors, decisions, and thoughts for instance to achieve long-term goals, or to act in a socially desirable way. Ego-depletion Theory (Baumeister, et al., 1998) suggests that exerting self-control temporarily depletes a common resource, a process labeled ego-depletion, resulting in a temporary decrease in capacity to exert self-control. Earlier research has indicated some ways to overcome ego-depletion as consuming glucose, positive affect and autonomy (see: Hagger, Wood, Stiff & Chatzisarantis, 2010). These three ways to restore depleted resources are all related to vitality, either by directly increasing vitality (autonomy, see Ryan & Deci, 2000) or by increasing energy (glucose) or positive affect. Indeed, it has been found that vitality mediates ego-depletion (Muraven et al., 2008). Thus, finding ways to increase vitality might help us deal better with temptations and help us achieve long-term goals. In the present research we focused on how light - daylight in particular - can help restore self-regulation capacity.

Exposure to light might also be a good candidate for ego-replenishment. First of all, exposure to bright artificial light has been found to directly increase vitality (Partonen & Lönnqvist, 2000) and increase mood (Kaida, Takahashi & Otsuka, 2007). The opposite phenomenon, a lack of exposure to daylight, can cause symptoms of Seasonal Affective Disorder (Rosenthal, et al., 1984). Therefore, we expect exposure to bright light can help overcome depleted resources.

We further expect that natural light exposure will have an additional replenishing effect compared to artificial light exposure. People generally believe that exposure to daylight is beneficial for many aspects of wellbeing, such as health, mood and performance (Veitch & Gifford, 1993). People also prefer environments that are sunny and bright (Beute & de Kort, under review). In turn, preference for environments has been found related to the replenishing potential of these environments (Van den Berg, Koole & van der Wulp, 2003). In a different line of research, it has been found that humans can recover from stress and resource depletion in natural environments as opposed to the more artificial urban environments - effects often attributed to evolutionary adaptation and information processing (Kaplan, 1995 & Ulrich, Simons, Losito, Fiorito, Miles & Zelson, 1991). Furthermore, studies have shown that natural environments can increase vitality (Ryan, Weinstein, Bernstein, Brown, Mistretta & Gagné, 2009) as well as help replenish diminished self-regulatory resources (Beute & de Kort, in preparation). Thus, we expect that the naturalness of daylight will cause an

increase in recovery as compared to artificial light through affective and evolutionary processes, and due to beliefs about daylight and preferences for daylight.

In the present study we will therefore investigate whether light can help overcome ego-depletion. We will compare the replenishing effectiveness of daylight with that of artificial light matched in brightness. Data-collection and analyses for this study are still ongoing, but are planned to finish in June.

Method

This study consists of four conditions. The first condition was a control condition without ego-depletion and light exposure (non-depletion no-light condition). The other three conditions were all with ego-depletion followed by respectively no light change (depletion no-light condition), or exposure to daylight (depletion daylight condition) or artificial light (depletion artificial light condition).

Participants

We plan to run eighty participants in total. At present, sixty-two participants have already participated.

Setting

Ceiling luminaires provided basic lighting throughout the whole experiment. The lighting level was 200 lux at 4000 K measured at eye-level.

Ego-depletion Manipulation – Typing task

Participants had to blindly retype a paragraph. In the non-depleting condition no restrictions were given. In the depleting conditions, participants were instructed not to type the spacebar, 'e', or 'p' and the number of errors made was displayed on the screen.

Light Manipulations

No-light condition: In the no-light condition, no additional light was added after the ego-depletion induction.

Daylight condition: In the daylight condition, daylight was allowed to enter the room after the ego-depletion induction by opening an automatic sunblind. A translucent foil on the window prevented a view to the outside. The sunblind remained open until the end of the experiment. Illuminance was measured continuously using two lux-meters (Hagner detector SD) placed on the desk and at eye-level. After the experiment, colour temperature was measured using a jeti spectro-radio meter (specbos 1201).

Artificial light condition: In the artificial light condition, lighting conditions were matched in average light intensity and colour temperature to the daylight condition with an additional wall-mounted luminaire, which remained on until the end of the experiment. Intensity and colour temperature were matched to the daylight conditions.

Measures

Psycho-physiological measures. During the experiment, heart rate and heart rate variability were measured continuously with a sampling rate of 2048 Hz. For the heart rate measures, electrodes were placed according to the lead-II placement using Kendall Arbo H124SG elecrodes.

Mood was assessed three times in the no-light conditions (at baseline, after the typing task, and after the dependent tasks, see below) and two times in the daylight and artificial light conditions (at baseline and after the dependent tasks). Four dimensions of mood were included: sadness, positive affect, energy, and tension. Participants were asked to indicate their feelings at that moment on five-point scales (not at all, a little, moderately, quite a bit, extremely).

Stroop Task. During the Stroop task, the words 'red' and 'blue' were displayed on the screen with red or blue font colours. Participants were asked to indicate the font colour. In congruent trials the font colour and word were similar, in incongruent trials the font colour and word differed. This task requires inhibition of the written text. The baseline Stroop task consisted of 80 trials (16 incongruent) and the dependent Stroop task consisted of 200 trials (40 incongruent). Dependent variables were reaction times on incongruent trials and number of errors made.

Backwards Digit Span Task (BDS). A series of digits (0-9) were displayed sequentially on the screen and participants were asked to report the digit sequence in

backward order. In total 14 series of digits were displayed, with lengths differing from three to nine digits. Dependent variables are the longest set remembered correctly and the total number of digits in correct sets.

Lighting Beliefs and Room evaluation. Lighting beliefs were assessed concerning effects of daylight on health, mood, vitality, and tension. The room was evaluated on lightness and to what extent participants would like to stay in the room for one more hour.

Procedure

After signing the informed consent form, ECG-electrodes were attached. They first received general instructions on the computer after which the experiment started with baseline mood questionnaire, psycho-physiological measures (three minutes) and Stroop performance. After the baseline measurements, participants performed the typing task. After the typing tasks, the procedure differed between Part One and Part Two, see figure 1. Participants in Part One rated their mood (time 1) and waited for the next task to begin. For participants in part Two, either the automatic sunblind was opened (daylight condition) or a wall luminaire was turned on (artificial light condition) while participants waited for the next task to begin. In both parts, the total time elapsed between the typing task and the next task was one minute. The next part of the experiment the same for both parts and consisted of the Stroop task followed by a one-minute break and the backwards digit span task, after which they filled out the last mood questionnaire (time 3) and some further questionnaires. After the experiment had finished, they were thanked and paid (€7,50) for their participation.

Results

In Part One effects of Ego-depletion (depletion vs. non-depletion) as between-subjects variable and Time (baseline versus time 1) as within subjects variable on mood, performance, and heart rate will be tested. In Part Two ego-replenishing effects of Light source (daylight vs. artificial light) as between-subjects variable and Time (baseline versus time 2) as within subjects variable on mood, performance, and heart rate will be tested.

General Discussion

In the present study we empirically investigated ego-replenishing effects of light. More specifically, we tested whether daylight has an additional beneficial effect over artificial light. Characteristics of daylight and artificial light were matched as closely as possible, however spectral differences can't be ruled out. Furthermore, as daylight conditions were always run before the artificial light conditions (this was necessary as daylight intensities were first measured, then matched) possible temporal effects can't be ruled out either. However, we did make sure that light intensities were matched per condition and per part of the day, resulting in similar exposure in the morning and afternoon and between the two conditions. Differences in replenishment between daylight and artificial light will most likely be caused by psychological mechanisms as light intensities were matched in both conditions, ruling out any biological mechanisms. Possible underlying mechanisms as mood, beliefs about lighting, and preference for the lighting setting have been included in the study and enable further data analysis into the underlying process(es). If daylight can overcome ego-replenishment, this can have major implications for everyday life as self-regulation is related to many beneficial outcomes in life as for instance academic success, interpersonal effectiveness, and health.

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