

Exploring Mediation Effect of Mental Alertness for Expressive Lights

Preliminary Results of LED Light Animations on Intention to Buy Hedonic Products and Choose between Healthy and Unhealthy Food

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ABSTRACT

Expressive light has been explored in a handful of previous studies as a means for robots, especially appearance-constrained robots that are not able to employ humanlike expressions, to convey internal states and interact with people. However, it is still unknown how different light expressions can affect a person's perception and behavior. In this poster, we explore this research question by studying the effects of different expressive light animations on people's intention to buy hedonic products and how they choose between healthy and unhealthy food. Our preliminary results show that participants assigned to a positive and low arousal light animation condition had a higher intention of purchasing hedonic products and were inclined to choose unhealthy over healthy food. Such findings are in line with previous literature in marketing research, suggesting that mental alertness mediates the effect of external stimuli on a person's behavioral intentions. Future work is thus required to evaluate such findings in a human-robot interaction context.

ACM Classification Keywords

H.1.2. Models and Principles: Human factors

Author Keywords

Expressive light; perception; hedonic product; healthy and unhealthy food choice; human robot interaction (HRI); human agent interaction (HAI).

INTRODUCTION

It is a trend for robots to act socially, and appearance-constrained robots are no exception. Due to their constrained embodiments, these robots have to rely on subtle expressions

to convey their internal states rather than humanlike expressions such as facial expressions and gestures. Among the many subtle expressions, expressive light has been explored in a handful of previous studies [10, 1, 4, 9, 7] and as shown to be promising due to its extensive design space, intuition, and ease to employ. However, many significant research questions remain unexplored. In this poster, we explore how expressive light can affect human perceptions and decision-making. In particular, we investigate how different expressive lights can influence people's intention to buy hedonic products and how they choose between healthy and unhealthy food. Crowd sourcing was used as the method for obtaining experimental data due to its ease in hiring a large number of participants and dramatically low cost. We report that the participants who were exposed to a positive and low arousal light animation liked hedonic products more and were more inclined to buy them compared with the participants who were exposed to either a negative and high arousal light animation or no light animation. Moreover, a higher proportion of the participants who were exposed to the positive and low arousal light animation preferred to choose unhealthy food over healthy food. We are currently working on installing a LED lighting system to an iRobot Create 2 robot and going to use it as a robotic platform to further evaluate our findings in human-robot interaction scenarios such as service robot-customer scenario.

EXPERIMENT

Expressive Light Design

In this work, we attached a programmable LED strip (Adafruit NeoPixel LED strip) to the front-bottom of a computer monitor. We defined two parameterized light animation patterns: square and sinusoidal. Previous studies [5, 6, 8, 9] suggested a relationship between color and perceived affection. Particularly, they suggested that red is associated with negative emotions and green is associated with positive emotions. Accordingly, we designed two light animations, low intensive triangle waveform in green color and high intensive square waveform in red color. The intension (frequency) and waveform are introduced to amplify the color effects and manipulate the perception of light animation in the arousal level. We hypothesize that the *positive and low arousal (PL)* light animation can relax

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a person and thus decrease his or her mental alertness, while the *negative and high arousal (NH)* one can cause a person to become tense and thus increase his or her mental alertness.

Experiment Design

Two experiments were designed to explore how expressive lights can affect people's intention to buy hedonic products and how they choose between healthy and unhealthy food. For the hedonic product experiment, 300 Japanese participants (89 female; 221 of them aged between 30 to 49) were recruited; for the food choice experiment, 300 Japanese participants (90 female; 222 of them aged between 30 to 49) were recruited. Every participant who completed our study was paid 5 Japanese yen.

A pre-design session was held to decide the hedonic products and healthy and unhealthy food. The products that we chose for the hedonic category were Haagen-Dazs ice cream, Apple Watch, Sony headphones, and Kobe beef, the food products in the healthy category were baked potato [2], granola bar [2], and salmon salad, and the food in the unhealthy category was fried potato [2], Snickers[2] and fried pork rice covered with cheese.

Hedonic Products

The independent variable was the *LED light animation* (positive and low arousal, negative and high arousal, no light animation; between-participant). The dependent variables were the *perceived valence*, *likeness of the product*, and the *purchase intention*. A seven-point Likert scale was provided for each dependent variable (ranging from 1, strongly disagree, up to 7, strongly agree). Each participant was assigned to one of the three conditions of LED light animation. Overall, each condition involved 100 participants.

Healthy vs. Unhealthy Food

Similar to the hedonic product experiment, the independent variable was the *LED light animation* (positive and low arousal, negative and high arousal, no light animation; between-participant). The dependent variables were the *perceived valence* and *choice of food* (either healthy or unhealthy one, out of the two). A seven-point Likert scale was provided for each dependent variable. Each participant was assigned to one of the three conditions of LED light animations. Overall, each condition involved 100 participants.

Results

Hedonic Products

To investigate the effects of the factor *LED light animation*, we conducted a one-way analysis of variance (ANOVA) for each dependent variable. Regarding *perceived valence*, the ANOVA yielded significant difference [$F(2, 1197) = 6.1406, p < 0.01$]. Post-hoc independent-sample t-tests with Holm's correction revealed that the participants assigned to the PL condition perceived the stimuli videos more positively (or pleurably) than those who were assigned to the NH condition ($M_{positive} = 3.54, SD_{positive} = 1.74; M_{negative} = 3.13, SD_{negative} = 1.60; p < 0.01$). Regarding *perceived valence*, significant difference was found [$F(2, 1197) = 4.4667, p < 0.05$]. Post-hoc test revealed that the participants assigned to the PL condition

liked the products more than those who were assigned to the NH condition ($M_{positive} = 3.59, SD_{positive} = 1.75; M_{negative} = 3.25, SD_{negative} = 1.77; p < 0.05$). Regarding *purchase intention*, the ANOVA analysis showed significant difference [$F(2, 1197) = 5.8041, p < 0.01$]. Post-hoc test revealed that participants assigned to the PL condition had a higher purchase intention than those who were assigned to the NH condition ($M_{positive} = 3.52, SD_{positive} = 1.87; M_{negative} = 3.11, SD_{negative} = 1.78; p < 0.05$).

Healthy vs. Unhealthy Food

We conducted a one-way ANOVA for the dependent variable *perceived valence*. To analyze the *choice of food* between healthy and unhealthy food, we applied Pearson's chi-squared test. Regarding *perceived valence*, the ANOVA yielded significant difference [$F(2, 897) = 19.125, p < 0.001$]. Post-hoc independent-sample t-tests with Holm's correction revealed that participants assigned to the PL condition perceived the stimuli videos more positively than those who were assigned to the NH condition ($M_{positive} = 3.46, SD_{positive} = 1.56; M_{negative} = 2.83, SD_{negative} = 1.65; p < 0.001$). In addition, the participants assigned to the *no light animation* condition perceived the stimuli videos more positively than those who were assigned to the NH condition ($M_{neutral} = 3.59, SD_{neutral} = 1.63; M_{negative} = 2.83, SD_{negative} = 1.65; p < 0.001$). Regarding *choice of food*, Pearson's chi-squared test suggested a significant difference ($\chi^2(2) = 7.4516, p < 0.05$). Post-hoc independent-sample t-tests with Holm's correction showed that a higher proportion of participants assigned to the PL condition chose unhealthy food over healthy food than those who were assigned to the *no light animation* condition (71.67% vs. 61.67%; $p < 0.05$).

DISCUSSION

Our results show that the participants assigned to the textit-positive and low arousal condition had a higher intention of purchasing hedonic products. In addition, a higher proportion of them chose unhealthy over healthy food. Such findings are in line with previous studies in marketing research, suggesting that **mental alertness** may mediate the effect of external stimuli on a person's behavioral intentions. In particular, D. Biswas et al. found that consumers tend to choose less healthy food options when ambient lighting is dim (vs. bright)[2]. G. Guido et al. propose that consumers who are exposed to certain conditions of blue lighting are more inclined to purchase hedonic products rather than utilitarian ones [3]. Both of these studies indicate the mediation effect of mental alertness, claiming that a lower level of mental alertness drives people to take risks and reduce their ability of self-control, which in turn would reduce the likelihood of making rational purchase decisions on hedonic products and choosing healthy options. In this work, we observed similar behaviors from the participants, which implies that the *positive and low arousal* light animation successfully reduced the participants' mental alertness and thus caused them to be inclined to buy hedonic products and choose unhealthy food. This phenomenon was observed strongest between the *positive and low arousal* condition and the *negative and high arousal* condition.

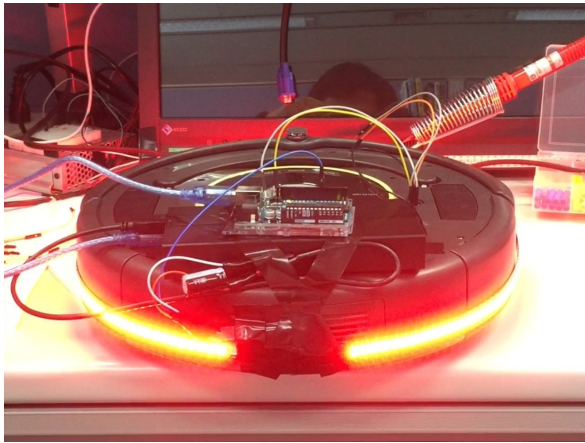


Figure 1. An iRobot Create 2 robot that equipped with a LED strip showing red light.

We are now working on installing an LED lighting system to an iRobot Create 2 robot (see Fig. 1) and going to use it as a robotic platform to further evaluate our findings in human-robot interaction scenarios.

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