

Light and the Perception of Cleanliness in Public Spaces

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Abstract

In public spaces to improve the public perception of cleanliness different lighting conditions can be utilized to dim or to light the littered areas. One would suggest to dim the light for the littered area, or the other way around, to improve the perceived cleanliness. It is however not clear how the lighting condition in the littered area would influence the perceived cleanliness. In this paper we report the result from an experiment in which a metro environment is set up to observe how people react to darkened and lightened litter. The result is somewhat supersizing. People perceive an environment as cleaner when attention is drawn to litter by focusing light on it. The causes of this observation are discussed.

Keywords: *public spaces, perception of cleanliness, lighting condition*

1. Introduction

The different lighting patterns appear to influence people inside [1, 2]. In sociology it is since long accepted that there is low empirical correlation between perceived cleanliness, and actual cleanliness [3]. In New York an experiment has been done to use a quality index based on parts of litter per meter, and how clean people perceive the street to be [4]. There was however no theoretical background on how light changes the perception of the space. Also no literature was available on this topic.

By hiding garbage with the absence of light, it seems like you are hiding the problem, which might make the space even more uncomfortable. By throwing more lights on the litter might draw too much of attention hence less perceived cleanliness. This dilemma often confuses the public services which measures to take in buses, trains and metros, in stations and in the cabins.

To investigate how people perceives the cleanliness when the lighting condition in littered area changes, a simulated metro environment was set up and an experiment was conducted therein.

The goal of this experiment is to find out how the different lighting scenarios (even, darkened and lightened litter) influence the subject's perception of cleanliness differently. Does hiding garbage by darkness result in a higher perceived cleanliness of the environment? And, the other way around does lighting the garbage mean that people perceive the environment less clean?

The research question thus is: Is it possible to use a balance between ambient light and focused light on litter, to enhance the perception of cleanliness?

The two sub questions focus on two situations: First, does darkening the litter makes people perceive the environment cleaner? Second, does lighting up the litter make people perceive the environment as dirtier?

Next the simulation setup is introduced, followed by the experiment. The result is then presented, followed by a discussion.

2. Simulated Metro environment

Cobes [5] is the simulation platform created to simulate a metro environment. It analyzes the physical presence of passengers in the metro over time with a neural network, this network will be able to identify and locate possible irregularities in the metro (Figure 1). Using this information Cobes adjusts the lighting in the metro cart accordingly.

Today's metro cart seats are evenly lit. For the experiment this is the control situation. Two variances on this are studied: Darkening the litter (lightening the clean spots), and lightening the litter (darkening the clean spots. Identifying dirty or broken chairs is not just a matter of looking at which chairs are being used and which chairs are not. For example, outside rush hour, the window seats

facing towards the rear of the metro are hardly used. However, if the chairs around them are often in use, this probably means that there is nothing wrong with these chairs. Therefore, the full pattern of an entire metro carriage needs to be taken into account in order to draw a proper conclusion.

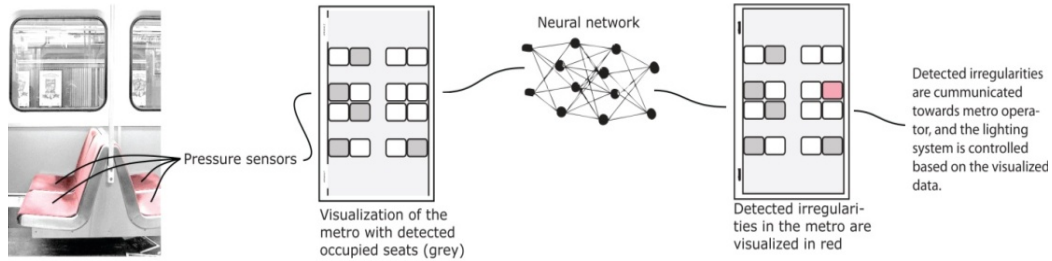


Figure 1. Visualization of data processing

When the metro is riding, all light intensities are equal (Figure 2, left image). When the metro stops, littered places are darkened, and empty seats are illuminated slightly more (Figure 2, middle image). When a seat is in use, the light also is also slightly dimmed, but only during stops (Figure 2, right image).



Figure 2. From left to right, even lighting, dirty chair, dirty chair and passenger

3. Experiment

The Cobes platform is quite elaborate in a sense that it includes neural network intelligence and has 16 chairs each with one sensor. For this paper however the quality of neither the neural network [6], nor the chair sensors [7] are relevant.

The goal is to investigate how people react on this environment. Therefore three lighting scenarios were created. These lighting scenarios were not based on the location of people, but by the location of the litter. The only thing the scenario did was change the relation between the ambient lighting and the focused light on the litter. A 'Wizard of Oz' set-up was to accomplish this. This ensured the greatest stability and repeatability for the test. This was chosen to minimize noise created by an awkwardly trained neural net, or a sensor in the chair performing poorly.

Lighting scenarios

The three scenarios are implemented. One is the control situation where the relation between the ambient and focused light is even (Figure 3), and all lights are on normal intensity. This is most comparable to a normal metro lighting situation. Assuming no light is broken.



Figure 3. Even lighting

The second scenario darkens the litter (Figure 4), as to hide it. This means the ambient light, or clean chairs are much brighter than the garbage. The hypothesis is that this is considered cleaner, as the litter doesn't draw your attention.



Figure 4. Litter is darkened

The third scenario puts focus on the garbage (Figure 5). This is to see how people react when you turn down the ambient light, and let the litter stand out. The hypothesis here is that this is considered dirty.



Figure 5. Litter is lightened

By comparing these three static light scenarios the experiment is executed to find out how the second and third scenario relates to an evenly lit room.

Measurement instrument

Previously a study on perceived cleanliness is done to compare different neighborhoods [8]. To do this properly the researchers used a Principal Component Analysis. This resulted in over 60 verified questions. Since these questions are often related to certain situations (parks, trees etc.), 11 questions that made sense in this environment were selected

Setup

To use the static situation, an environment with 16 chairs positioned in a way used in metro carts. One chair is littered with bread, cheese and old newspapers (Figure 6). This is the situation that stayed the same throughout the test. When taking this environment, and taking the three lighting situations the actual cleanliness will stay the same, searching for differences to be found in the perceived cleanliness.



Figure 6. Litter with bread, cheese and old newspapers

18 subjects were involved in the experiment. The average age is 26 years old. Seven females are included and eleven males. By showing the subjects the scenarios in random order the noise is eliminated that comes in when showing one scenario after another. This removes a bias from the results that might influence that data. The second and third time the subjects enter the environment, they have more knowledge about the questions, environment and their expectations. Also the subjects might compare the scenario with a previous scenario set as a benchmark.

The within-subjects study is used to compare three scenarios. The rating for scenario 1 might be totally different for three people, yet the difference with scenario 3 might be the same for all. And these differences in scenarios within people are useful to answer the research question. The sample size of 18 subjects is sufficient since a within-subjects study is used. This eliminates the noise for different people.

Procedure

Before the test the subjects were told that they were entering a metro environment with three different lighting scenarios. They were asked to go in, look and walk around, come outside, and fill out a form. After doing this two more times they had seen all lighting scenarios. In the end 11 questions were filled out three times, one for each scenario. Afterwards subjects were given the chance to elucidate their experiences.

Analysis

A verified scale is used on which people can rate their perceived cleanliness (Table 1). For all three situations the results from those scales are compared.

To look at the within-subjects test a Wilcoxon test is used. This compares two scores and doesn't look at the mean, but looks at the differences between the control and one situation (either darkened or lightened litter) for each person. Then by looking at these differences (Figure 7) for all 18 subjects, it gives the differences between two groups based on their perception.

Table 1. Subject scores

Total score even lighting	Total score darkened litter	Total score lightened litter
35	55	66
31	40	68
37	32	51
40	42	70
62	39	62
61	31	46
45	56	67
36	49	38
49	29	60
32	39	64
47	53	46
40	40	69
50	58	60
27	48	72
37	31	59
49	37	62
48	49	66
48	48	63

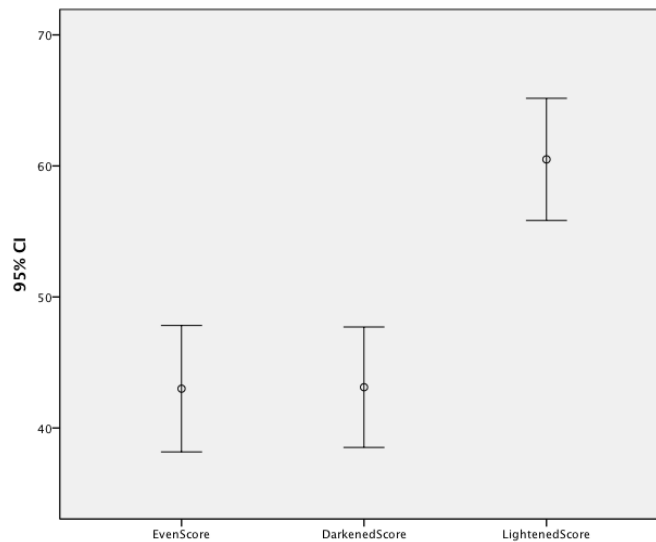


Figure 7. Subjects scores error graph

Table2. wilcoxon results

Ranks				
		N	Mean Rank	Sum of Ranks
DarkenedScore - EvenScore	Negative Ranks	6 ^a	10.17	61.00
	Positive Ranks	10 ^b	7.50	75.00
	Ties	2 ^c		
	Total	18		
LightenedScore - EvenScore	Negative Ranks	2 ^d	4.25	8.50
	Positive Ranks	15 ^e	9.63	144.50
	Ties	1 ^f		
	Total	18		

- a. DarkenedScore < EvenScore
- b. DarkenedScore > EvenScore
- c. DarkenedScore = EvenScore
- d. LightenedScore < EvenScore
- e. LightenedScore > EvenScore
- f. LightenedScore = EvenScore

Table 3. Wilcoxon Signed Ranks Test

Test Statistics ^b		
	Darkened Score - EvenScore	Lightened Score - EvenScore
Z	-.362 ^a	-3.220 ^a
Asymp. Sig. (2-tailed)	.717	.001

- a. Based on negative ranks.
- b. Wilcoxon Signed Ranks Test

There is no significant (0.717) difference between the darkening of the litter and the even situation (Table 3). This means that the control situation has the same influence on the perception of cleanliness. These situations are essentially the same; for this test the darkening of the garbage made no significant difference. Subjects stated darkening the garbage made them feel like somebody tried to hide it. It had a negative feel to it.

Lightening the garbage had a fascinating influence on the subjects. That situation was rated significantly higher (0.001) in perceived cleanliness (Table 3).

This suggests that lightening the garbage does help to improve the perceived cleanliness in this environment. Subjects said afterwards that by lighting the garbage they are convinced something is going to be done soon about it. They feel like it takes guts to focus on garbage like this. It makes them feel like litter on the already dirty chair is ok, but it enhances the clean feel of the rest of the train.

Even so, by putting such focus on garbage, subjects feel confronted with their behavior. This might make them think twice about littering.

Summary of the results

Darkening littered places has no significantly different impact on how people perceive the cleanliness of that environment compared to an evenly lit situation.

Putting light on littered places significantly increases the perceived cleanliness of people compared to an evenly lit situation.

4. Discussion

Feel of Safety

Most subjects were familiar with the space in which the experiment was conducted. This might have influenced their feel of safety in the environment. The feel of safety is often based on three aspects: quality of overview, easy escape possibilities and freedom of location and route. Since they are all known, there is no reason for a threat. The situation is relatively safe, and there is no need for an overview. This makes this test different from a real situation where there is more need for overview of the situation. This feeling of safety might make the influence of the darkened ambient light less invasive in the aspect of safety. Usually when a space is darkened to such an extent people tend to feel unsafe very quickly. This means that it might only work on situations where people feel safe. On the other hand one could continue this project and apply this notion of putting focus on litter, by applying it in a way less intrusive for the ambient lighting.

The challenge is to apply focus on the litter, still allowing people to grasp the overview. They might feel safe and still perceive the environment as clean.

Another aspect of safety and perceived cleanliness is that they are related according to the broken window theory [9]. So it might also be that people feel safe in a darkened ambient light, as the environment is perceived as clean. These are aspects open for research in the future.

Noise

By using a within-subjects test the subjects are used in all situations. This is to level out the noise.

Since the results are ordinal and based on perception, the score itself doesn't mean a lot in small sample sizes. This is why looking at differences between the control and another scenario is preferred. Even though this takes out a lot of personal noise, still subjects are expected to fill out the scale different next time. Perceived cleanliness might be, for a part, based on how subjects feel and enter the room at that moment. By enhancing the sample size, and spreading over more time, results will become more accurate.

Applications

Designers might help people feel more comfortable in work environments, or at home. In ambient intelligence for example, the environment may notice something is not working properly. By focusing on this it keeps the user satisfied and creates a feeling of empathy. This is an example of a situation of possible interest for this research finding [10].

Let's assume that it can be taken in a broader sense, even though this is tested in this very specific situation. Maybe one could clean their house less often, or the front desk of your company might change their cleaning habit. By using light to show litter, these activities might have to occur less often.

When people feel the focus is on litter, this is not only a reminder, but also a virtual trash point. Litter is thus concentrated on certain areas; making it easier to clean it in the first place.

This can and should have a number of effects on how people design such environments right now. Even though I am not saying we must throw out all trashcans, and make piles of litter in our home with a beam of light on top of it. It does make one think.

5. Conclusion and future research

Instead of trying to hide failures and uncomfortable space, we can use sensors and dynamic lighting systems to enhance the feeling of perceived cleanliness in the metro. This enables designers to create scenarios that can deal with people littering in an environment.

It would be interesting to see how lighting litter applies in situations that are potentially less safe to people. By testing this one could get a feel for how darkening the ambient light works in these situations. Safety changes the design brief when working with light and litter.

Another aspect is how the improved perceived cleanliness works in the long run. People stated they would throw their litter on the littered enlightened pile, instead of the ground. Is this actually true? Does the litter stay concentrated longer, and for how long?

Also an important question in the end is how does it tie to the broken windows theory [9]. Does it actually make people litter less? Does the environment stay clean for an extended period of time?

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