Nudging pedestrian choice behavior with light color in a station

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Abstract This study focuses on the effect of light color on pedestrian choice behavior in a station hall. Lights are added into the existing environment and dynamically switched between different light conditions, consisting of white, green and red lights. Preliminary findings show promising results with respect to use of lights to nudge pedestrians.

Keywords Pedestrian choice behavior, lights, crowd management, field study,nudging

Background

Crowd management becomes more important over time in order to manage larger crowds in their pedestrian infrastructures. Light is one of the potential crowd management measures and an ideal solution for many crowd operators. Since light is already present in most environments, it offers a cost-effective and easily adoptable solution compared to other measures. Additionally, it can be dynamically changed, highlighting an advantage for real-time crowd management. Previous works indicate that light affects pedestrian choice behavior [1, 2, 3]. Their findings show that pedestrians prefer pathways with brighter lights, and [1] also highlights the potential of using light color to nudge pedestrians to a particular path.

This study aims to build on these insights by conducting a large-scale field study at a train station. Because of regulations at the station, this study is limited to the effects of light color on pedestrian choice behavior. Within the train station, two different experimental designs were used to study whether the effects of the lights are universal in context.

Methodology: Description of the field study

This field study takes place at train station Amsterdam Bijlmer-Arena in the Netherlands. The station is well-known for its proximity to three large event venues, but it also serves thousands of daily commuters for work purposes. This makes the station an ideal environment to study crowd management, given its diversity in crowd population and variety in density.

This field study uses two experimental designs within the station. Firstly, an experimental set-up with two lights is used to investigate whether pedestrians can be nudged with light color when they only need to make a slight deviation from their path. Figure 1a shows that both doors are less than one meter apart. Thereafter, a second experimental set-up is used to study whether the effect observed in the first set-up remains when the deviation from their path becomes larger. This design employs lights above four adjacent doors with 2-5 meters between each, as shown in Figure 1b. The first set-up was used from 5 November 2024 to 5 February 2025, whereas the second set-up started on 5 February 2025 and is still ongoing.

In both experimental designs, we installed Philips Hue LED strips above the exit doors of the station hall. These lights were added to the existing environment and did not serve as ambient lighting. The first set-up employed three different light conditions - white (W), green (G), and red (R) - resulting in seven different conditions. These conditions included WW, WG, WR, GW, GR, RW, and RG, where the letters represent the light color enforced above door 1 and door 2, respectively. See Figure 1a for light condition GR. These conditions are dynamically changed, ensuring that each light condition is systematically shown at different moments of the day and week. Additionally, the second experimental set-up includes seven different conditions as well, which were determined based on the preliminary findings of the first set-up.

The data is collected by the crowd operator, NS, the Dutch railway operator. An overlapping system of stereo-vision and depth-sensors is used to derive anonymous trajectory data of pedestrians within the field of view of the sensor network. The dataset regarding the first set-up consists of approximately

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(a) Set-up 1, condition: Green - Red.   (b) Set-up 2, condition: White - White - White - White.
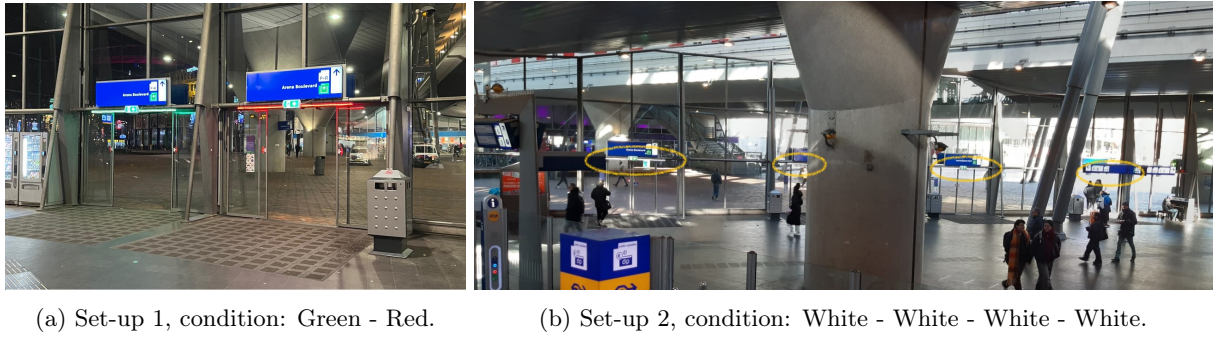
Figure 1: The experiment uses two different set-ups: (a) lights installed above two exit doors, and (b) lights installed above four adjacent exit doors, highlighted with yellow contours.

1,125,000 pedestrian trajectories, excluding pedestrians only transferring between platforms. Since the lights are installed inside the station hall, the authors argue that nudging is more likely for pedestrians leaving the hall. Therefore, the preliminary findings focus solely on the leaving pedestrians, consisting of almost 500,000 trajectories.

Preliminary findings and conclusion

Figure 2a indicates the percentage of pedestrians that left the station hall through door 1 - which is the left door in Figure 1a - for each light condition individually. Here, light condition WW is used as the baseline scenario, consisting only of standard colored lights. Figure 2b shows the variation in door usage for every condition compared to the baseline condition WW.
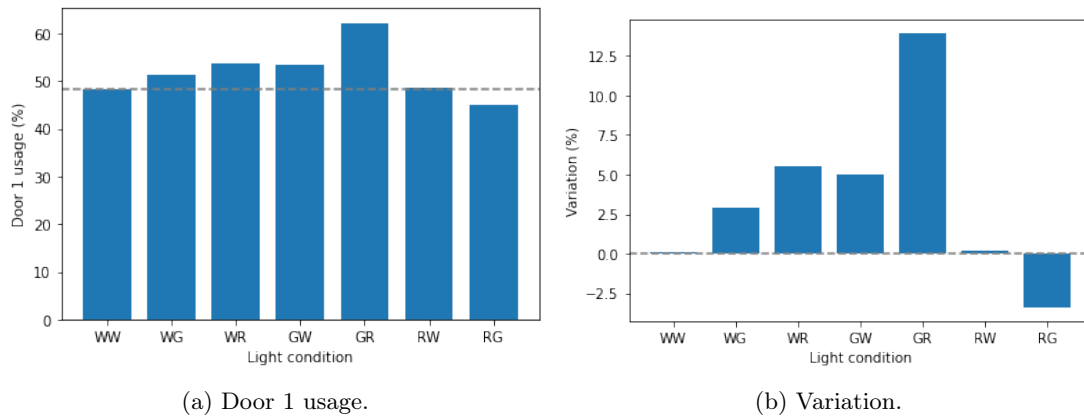

(a) Door 1 usage.   (b) Variation.

Figure 2: (a) Door 1 usage for every light condition, (b) the variation to the baseline condition WW.

The figures highlight an apparent effect of light color on the pedestrian exit choice. Specifically, when the light condition GR is used, there is a variation of more than 10% compared to the baseline condition. This highlights the potential of light color to nudge crowds; however, further data analysis is needed before drawing definitive conclusions.

In the upcoming period, we will analyze the gathered experimental data more in-depth, for instance, studying the impact of crowd density, time of day, type of crowd, and origin location. Thus, does the efficiency of light color intervention change due to external parameters? At the conference, we will present the findings of both set-ups at the train station.

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