

Zilverackers lighting solution

Research results – January 2013

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Introduction

The **municipality of Veldhoven** aims to introduce an innovative lighting concept at Zilverackers, that differs from traditional lighting installations as it aims not just to reduce the energy use but at the same time to increase life quality in the ecological zone while not sacrificing safety of the road users.

The Lux Lab designed a smart lighting solution that uses different lighting settings (varying in color and intensity) at different times to accommodate different stakeholders. The proposed solution offers four settings.

Before implementing the innovative solution, the municipality is interested to hear the opinion of their citizens. Therefore this research project is initiated to explore whether people will accept new lighting solutions.

LightHouse/ solution partner of the **Intelligent Lighting Institute of TU/e** conducted the research, focussing on 2 research questions:

Do people accept (dimmed) lighting scenario's for ecological purposes?

Can we explain the acceptance by measurements of perception and visual performance?

Zilverackers lighting solution

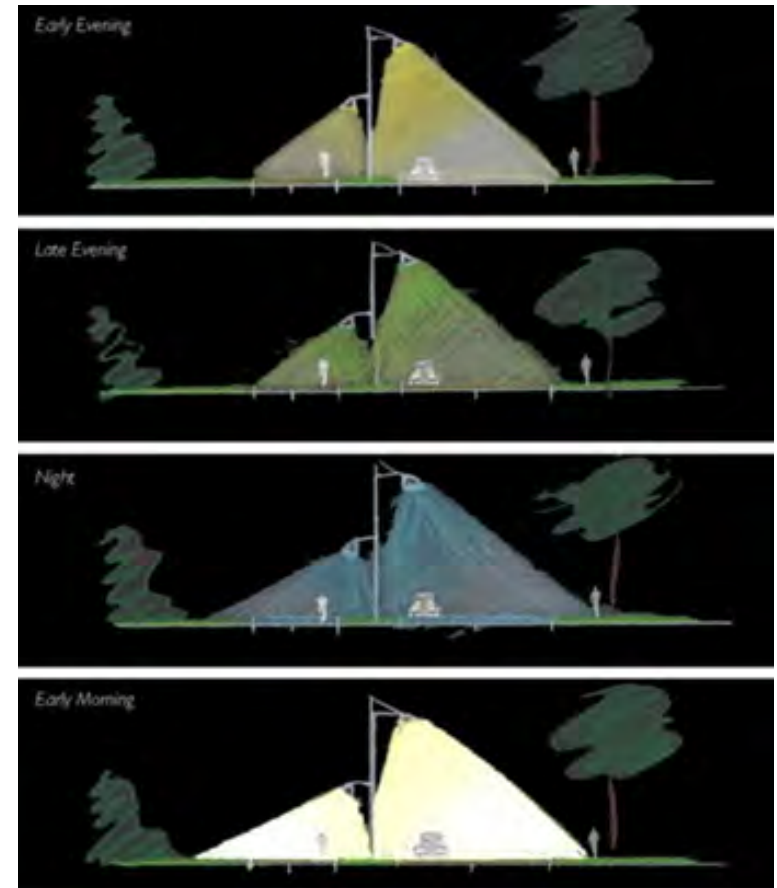
The Lux Lab designed a smart lighting solution that uses different lighting settings (varying in color and intensity) at different times to accommodate different stakeholders (Figure 1). The proposed solution offers four settings:

In the early evening the path is intensely used by commuters, particularly children heading home. This is why lighting was placed in that zone in the first place. Cyclists' feelings of comfort and safety are increased with more light, as people need more light when dusk is setting. Thus white, 5 lux light is proposed for this time of day (setting A).

Later in the evening as traffic ceases the light dims to a light that is less disturbing for animals and plants but still provides good visibility for cyclists (setting B: yellow-greenish, 3,5 lux). The yellow-greenish light offers good visibility at significant lower energy use caused by led efficiency in such color range combined with high sensitivity of people's eyes to these wavelengths.

During the night as there is hardly any traffic the wild life becomes the most important stakeholder. Therefore, the light is dimmed to the equivalent of 'full moonlight' (setting C: cool white, less than 1 lux), which does not disturb animals and at the same time requires significantly less energy while stays aesthetically pleasing.

In the morning bright cool white lighting setting (setting D: cool white, 7 lux) is used to increase alertness of the cyclists.



Background

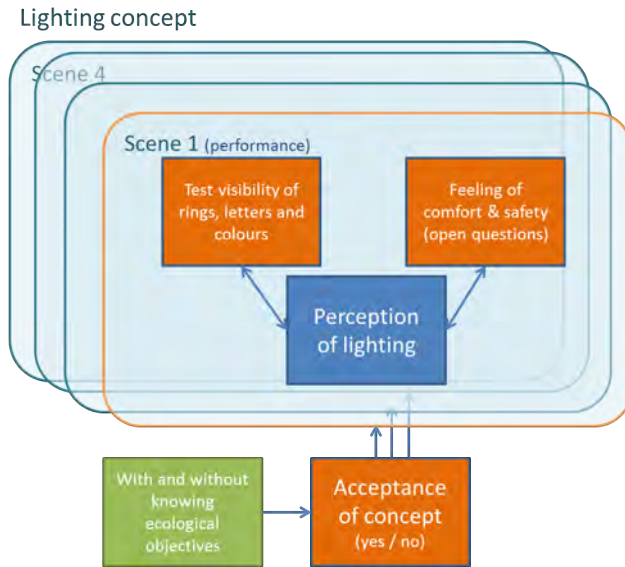
Researching the perception of lighting

Capturing perception, acceptance and performance of innovative lighting solutions faces several challenges:

- Light is intangible. It is difficult to ask people directly about light, because they are not aware of it. If you ask people to qualify lighting they will probably say something about the design of the armature. Lighting perception has to be measured through indirect variables.
- Lighting solutions are innovative. People are used to a certain lighting standard, which is 'white' and 'high lux' and static. All light scenes we design will produce dynamic settings including lower lighting levels. This may cause the effect of measuring 'we don't know, so we don't like'
- Perception is personal. People's perception and acceptance are built up of a set of subjective variables, such as likes, emotions and earlier experiences. This makes it hard to separate facts from emotions, and to distinguish cause and effect.
- Performance in real context. The performance of lighting always has to be tested in real life situations. On the street, on a road, etc. This makes it difficult to control the context variables (like weather, surroundings, crowds, etc.)
- There are no new standards yet for testing lighting performance of innovative LED-solutions.

Despite these difficulties there is a growing awareness that measuring perception and acceptance is necessary in order to understand the new possibilities and challenges of lighting design. LightHouse and The LuxLab join their effort to design and test a new method. We are interested in the influence of different light scenario's on human's perception and designed different light contexts to test these perceptions. Zilverackers is one of the experiments in this joint interest.

Research Zilverackers



Measuring the acceptance of the concept:

We want to know the acceptance of the concept by people. However, we cannot let them spend the entire night at Zilverackers. For the experiment we designed a set up in which people are experiencing 2 scenes of the lighting concept. After the test with these 2 scenes we explain them that the concept consists of 4 scenes and we ask them if the lighting concept is, in their perception, acceptable. Half of the participants are provided with knowledge on the ecological objectives of the concept, the other half is not given any further information.

Measuring the perception of lighting:

To be able to explain the level of acceptance we want to know the people's perception of the lighting scenes. People's perception of lighting is built up of their visibility capacity and their personal experience.

In each lighting scene we measure the visibility capacity in 3 standardized ways:

- Visual acuity (Landot ring)
- Contrast threshold (Pelli-Robson)
- Colour identification

And we measure the personal experience in 3 ways:

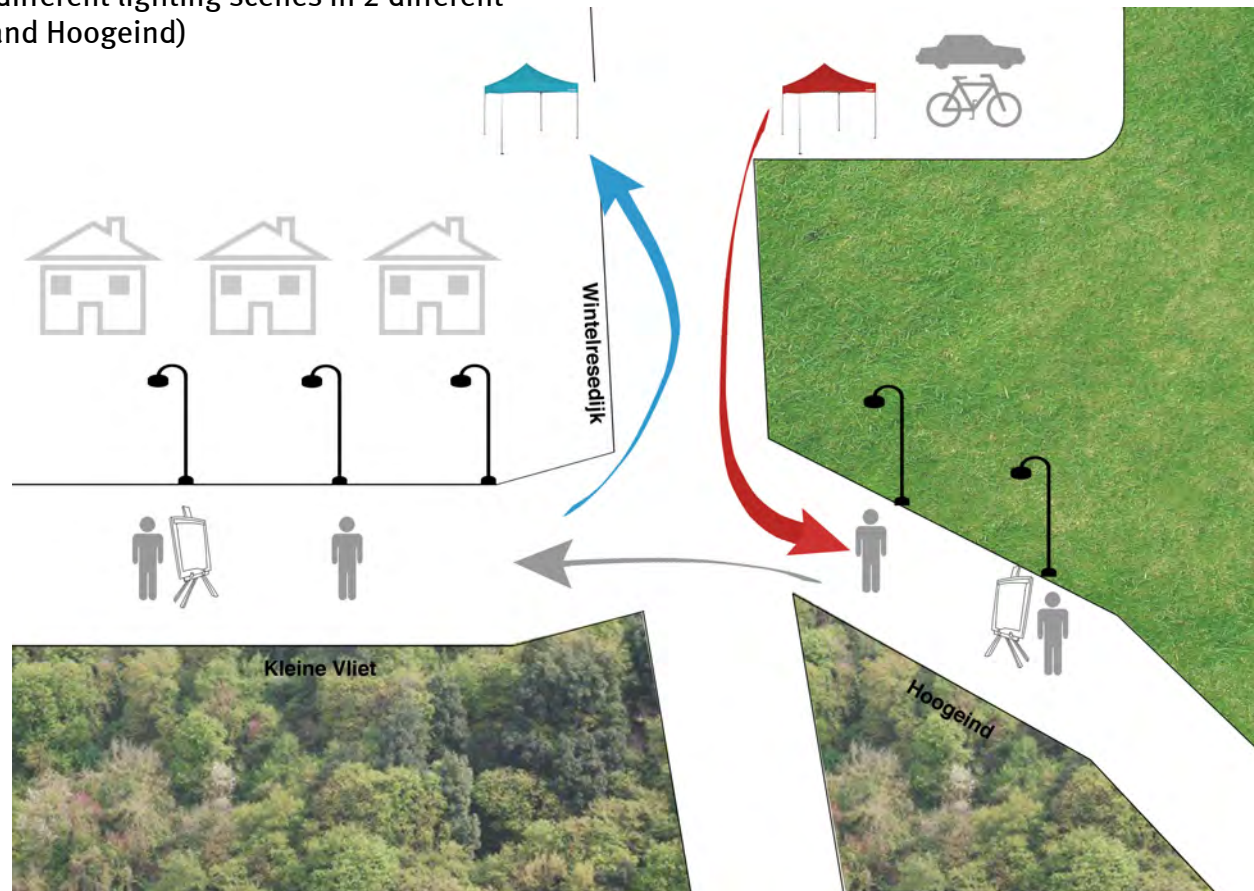
- Feeling of safety and comfort through a questionnaire on experience with open questions
- Scaling questions on comfortable/uncomfortable, on safe/unsafe feeling, and open questions on characteristics of comfort and safety
- Questionnaire on actual behaviour (what would you do if ...)

Test protocol

Dates of test: 10 & 11 September 2012

Weather: partially cloudy, dry

People experienced 2 different lighting scenes in 2 different contexts (Kleine Vliet and Hoogeind)



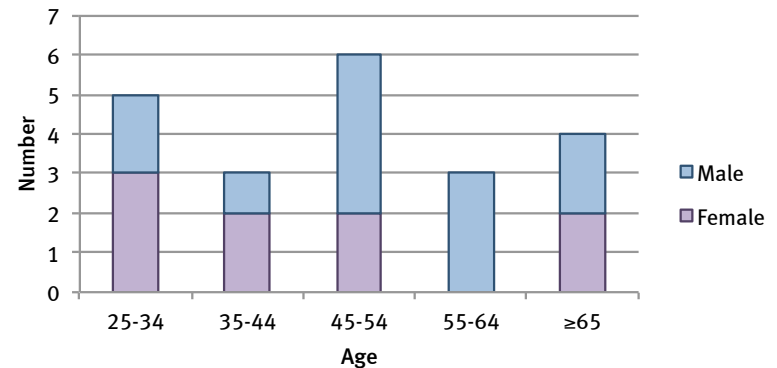
Test results - 21 Participants

Demographic information of the 21 Participants:

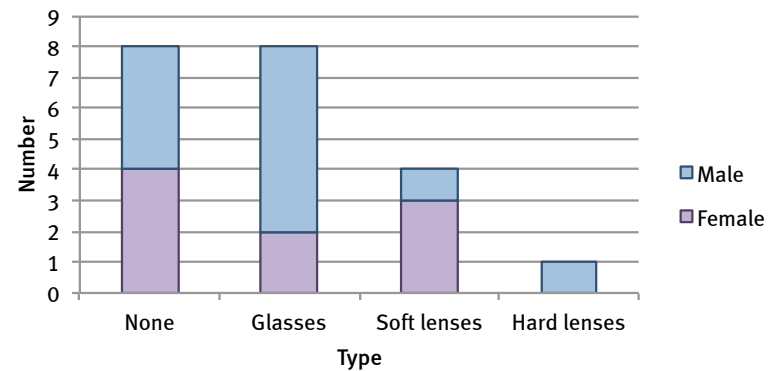
- 9 female, 12 male
- age 25 to 76 years
- visual aids (wearing glasses or contact lenses)
- other visibility problems: non of the participants is color blind, 1 participant has night blindness.



Age & Gender of participants



Use of visual aids



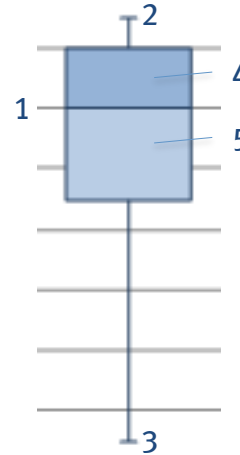
How to read the test results

This research is explorative in nature. 21 participants do not provide enough data to measure statistically profound, however the research can provide insights to support or reject pre-assumptions.

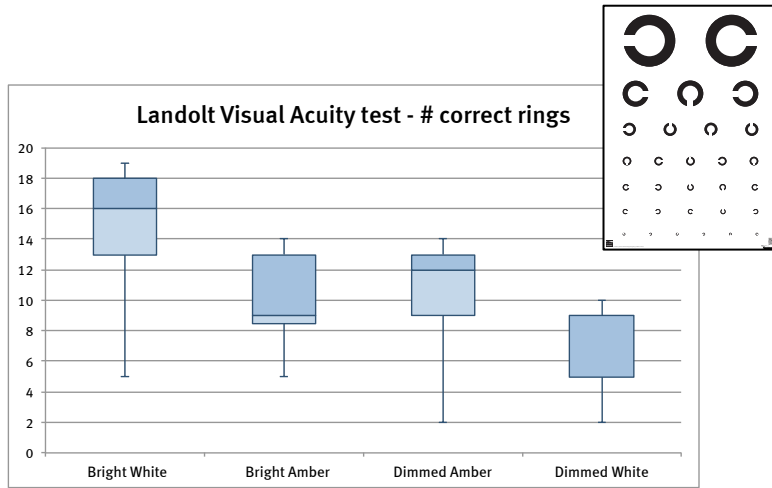
The results are presented as box plots.

A box plot is a way of graphically depicting groups of numerical data through their five-number summaries:

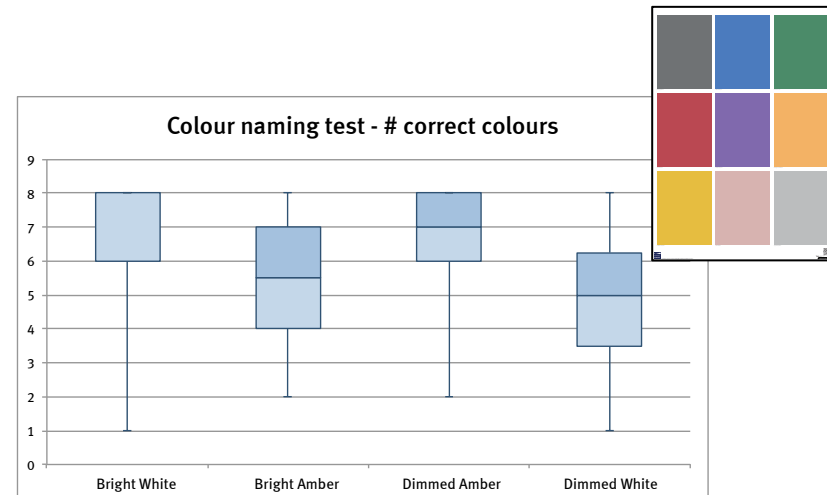
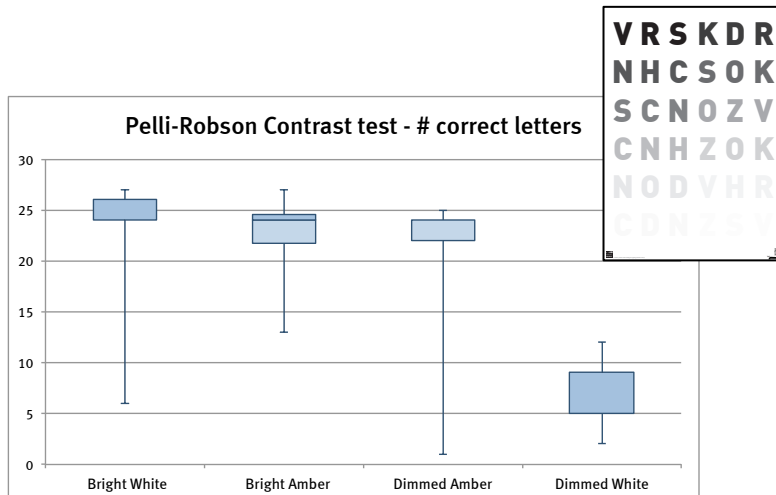
1. median (Q2),
2. largest observation (sample maximum).
3. the smallest observation (sample minimum),
4. upper quartile (Q3),
5. lower quartile (Q1),



Test results – Visibility capacity



- The (extreme) sample minimum in the scenes *bright white* and *dimmed amber* in the visual acuity test and contrast test is caused by the night blindness participant
- Contrast visibility decreases (statistically significant) in the *dimmed white* scene
- Colour recognition is hardly influenced by the *amber scenes*
- All colours are named incorrectly, there is no specific error type



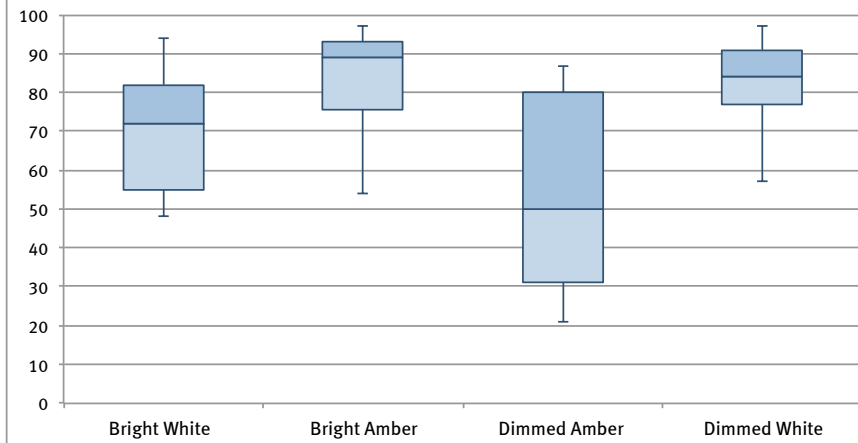
Test results – Feeling of safety and comfort tests

Can you indicate how you feel at this moment:

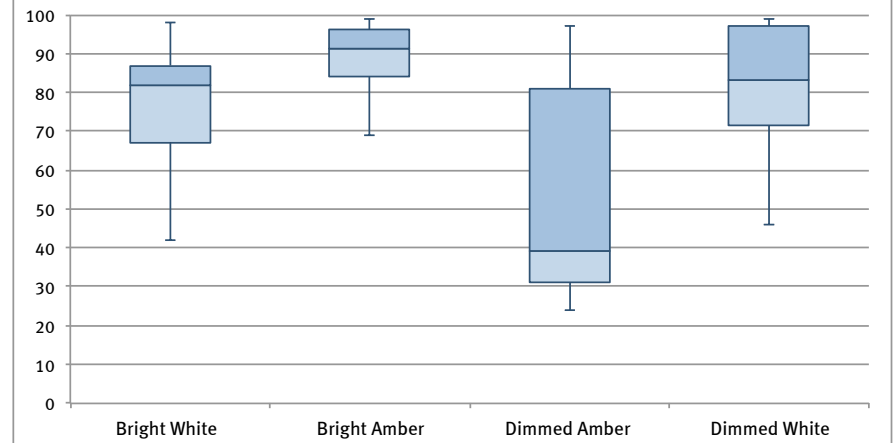
Comfortable ———— X ———— Uncomfortable
100 0

Safe ———— X ———— Unsafe
100 0

Feeling of comfort (scale 0-100)



Feeling of safety (scale 0-100)

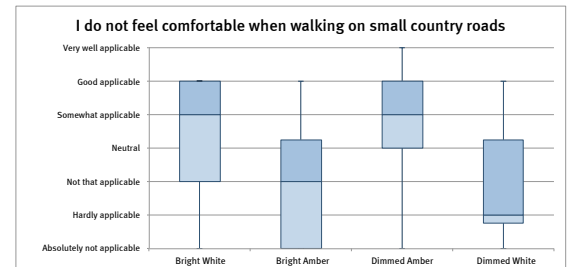
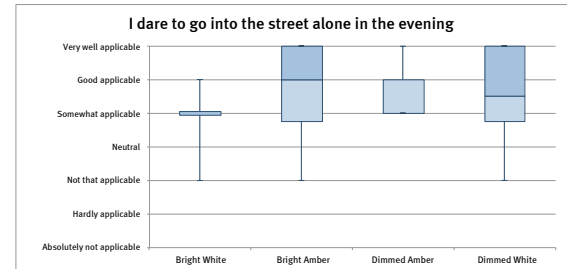
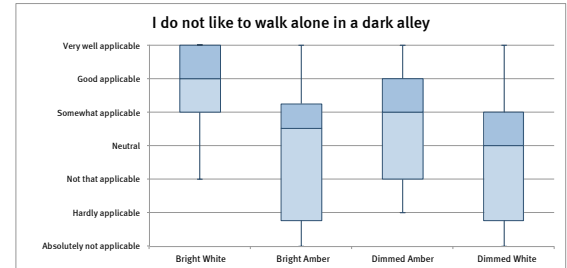
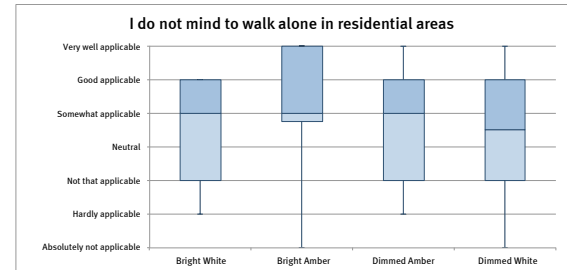
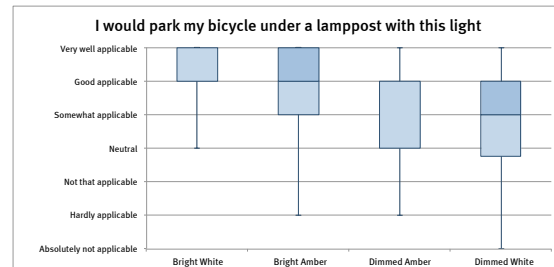
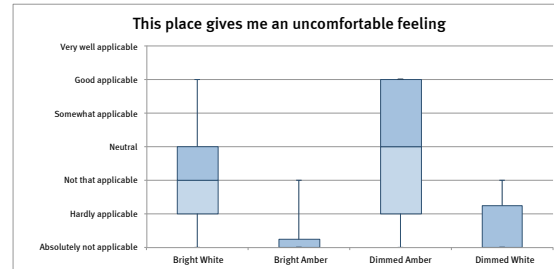
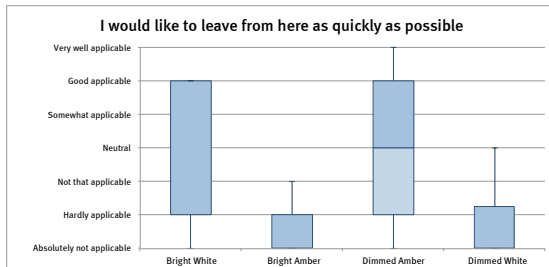
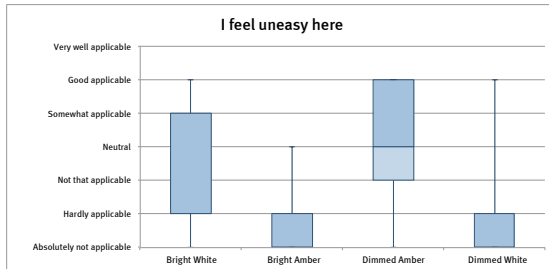
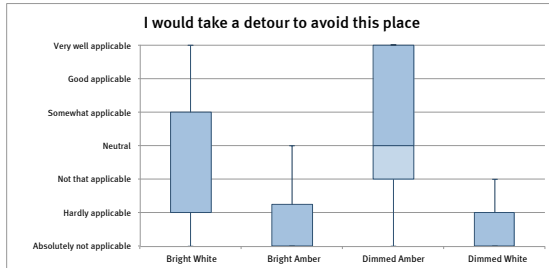
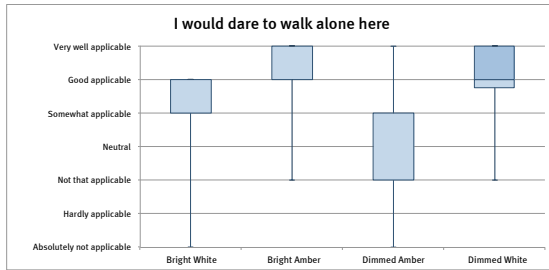


- Noteworthy is the relative high feeling of comfort in the *dimmed white* scene (even higher than in the *bright white* scene). Participants indicate that they have a wide view, whereas participants in the *bright white* scene indicate that the surrounding area is unclear.

- The (relatively) low scores for feeling of comfort and safety in the *dimmed amber* scene are supported by explanations on relatively dark context, directly associated with unpleasant areas and the perception of being in a rural area (and far away from help if anything happens).

Test results - Statements

Questionnaire on actual behaviour were asked to check people's perception of what they think to what they actually would do. The questions on the left and below are context specific. Questions on the right are personal indicators in general.



Test results – Acceptance of concept

Is this lighting concept acceptable to you?

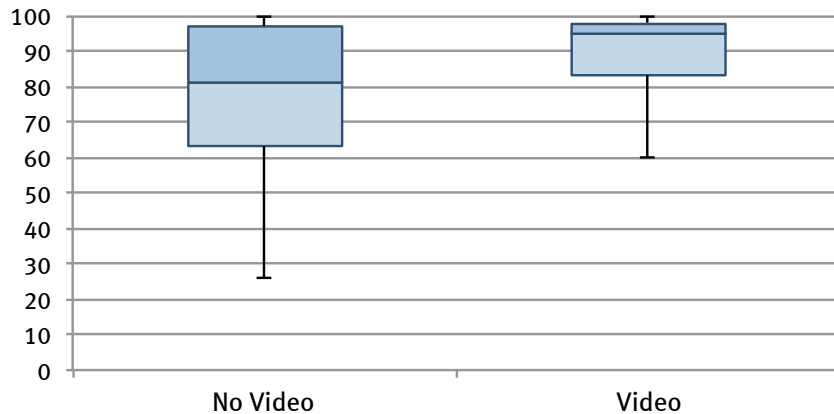
Unacceptable ————— X ————— Acceptable
0 100

After having experienced 2 lighting scenes, participants received a short written explanation of the total lighting concept, consisting of 4 scenes.

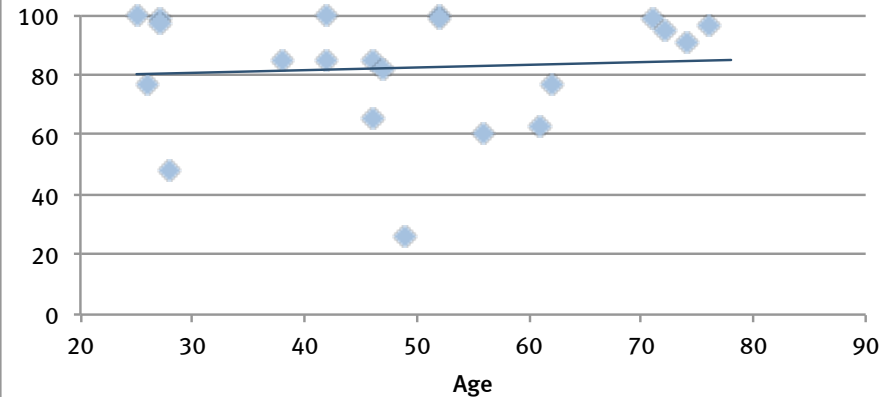
- 10 of the participants then scored the acceptance of the concept.
- 11 of the participants also watched a 7 minutes video explaining the ecological principle behind the concept before scoring the acceptance.

The acceptance is very high and ample influenced by the video. The (extreme) sample minimum in 'no video' is caused by the night blindness participant.

Acceptance of total concept



Acceptance of total concept



Conclusions

The research was explorative in nature, and the number of data is not enough to be able to statistically found the conclusions. However the research does provide a general idea and some interesting insights. Regarding the research questions we can conclude:

Do people accept (dimmed) lighting scenario's for ecological purposes?

The participants accepted the lighting concept:

- Participants gave on average 80 points on a 100-point scale.

Participants gave more points after seeing the video that explained the concept. However, the video did not influence the acceptance significantly. This difference may be investigated in further studies, to find more optimal ways to positively introduce people to new concepts.

Can we explain the acceptance by measurements of perception and visual performance?

The acceptance can be partially explained by three variables:

- Gender:
 - Female participants gave a higher score than male participants.
- The average feeling of safety during the experiment
 - The safer the participants felt, the higher their acceptance to the concept.
- The contrast visibility
 - Less contrast visibility influenced the acceptance significantly.
 - The color perception test and the Landot Ring test did not influence the acceptance significantly in our study.