Assessments and Eye Movements Compared between Photographs and Visualizations of Logged Forest Vistas – For What Kind of Assessments are Visualisations a Good Representation of Photographs?

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Abstract

The present study investigated if some of the techniques commonly used today in landscape assessment visualizations are similar enough to photographs of the environment they try to depict to not cause disturbances in behaviour or in assessment. The results show that there are key differences in the assessment of species richness and stewardship between the modalities. The study is performed as an experimental study, recording viewing behaviour through eye-tracking and values given by respondents when assessing stewardship and species richness based on digitally created visualizations, compared to photographs of real world scenes. The conclusions of the study are that we need to understand the components and the cognitive functions that are at work during landscape assessments, since there are differences in assessing photographs and visualisations, and that visualisations can work as surrogate to photographs, but not in a mix with photographs.

1 Introduction

As rendering technology gets more advanced and faster, more and more perception and assessment studies of landscape are carried out using rendered visualizations instead of photographs or other stimuli (SHEPPARD 2001). Using visualisations has the benefit, compared to photographs, of being able to show the future or alternative futures based on the outcome of different landscape planning and management strategies. Visualisations have lately also been accepted as a substitute to photographs in preference studies (DANIEL 2001; MEITNER et al. 2005; RIBE 2005) as well as being discussed to be a substitute in acceptance studies (FORD et al. 2009). Several studies have also shown the usefulness of visualisations for assessing consequences of different scenarios of change (TAHVANAINEN et al. 2001; LEWIS 2006; TYRVÄINEN et al. 2006).

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However, when using visualisations there is ethical aspects to consider such as the risk of making the proposed environment nicer or worse than the actual outcome, and hence ethical guidelines, as SHEPPARD (2001) points out for when creating visualisations for policy and management purposes.

There is a trade-off in either making advanced, detailed visualisations, that are time consuming in construction or the abstract, simpler visulisations that takes less time to render. The more detailed the visualisations get, the more similar they become the environment they depict. As is known from robotics, there is a certain point at where an obviously inanimate object imitating a human turns from abstract and safe into something scary and weird. This phenomenon is called “the uncanny valley” and is a common problem when designing robotic faces for instance (MORI 1970). The phenomenon in itself would not pose any real difficulties to landscape assessment studies, other than that the outcome of the study might be skewed towards the negative scale of an assessment. There is however a large risk that a similar phenomenon might disturb the behaviour used when assessing the images, for instance causing irritation or wonder at certain details of the image that is not that attention catching in a photograph of the environment itself. When behaviour is disturbed, the assessor would not get the same input from the stimulus as when looking at a photograph, and would therefore make the assessment on other terms for the visualization than the photograph.

The reason for this effect might be that certain aspects of the visualization are different in bottom up input (sensory input from the surroundings) than photographs or other representations, and that we know from previous studies in other fields could affect eye movements. There is also top down effects (memories, experiences and values) that could be affected by aspects of the visualization, e.g. repetition of plants in the field layer (MALCOLM & HENDERSON 2010; HENDERSON et al. 2009; TATLER et al. 2011).

The present study investigated if visualizations developed using some of the techniques commonly used today in landscape assessment are similar enough to photographs of the environment they try to depict to not cause disturbances in behaviour or in assessment. This is done as an experimental study, recording viewing behaviour through eye-tracking and value given by respondents when assessing stewardship and diversity based on digitally created visualizations, compared to photographs of real world scenes. The tasks given to the participants were informed from FRY et al. (2009) and ODE et al. (2009), modifying and using two of their proposed concepts, species richness and stewardship.

Eye tracking is an established method in psychology, linguistics, neuropsychology and human computer interaction studies and is based on technology used to monitor where a participant is directing its gaze, and other properties of the eye that can be of interest (tremors, blinks, pupil size etc.) (HOLMQVIST et al. 2011). In this study we use it to gather information on how much time participant spent viewing certain areas of the stimuli, Areas of Interest (AOI). This measure considered to correspond to processing of information in that particular AOI (HOLMQVIST et al. 2011).

Hypotheses:

- Participants should have less dwell time in the field layer and more in retention areas (retention tree crowns) in the visualisations compared to the photographs, due to the ‘unnatural’ feel of the tree crowns that would draw attention away from the field layer.

- Lower species richness value for visualisations, due to less actual species in the visualization.
- Lower rating of stewardship for photographs, due to fewer branches, leafs etc. in the visualisations and this would put the visualisations as more cared for, less messy.

2 Material and Methods

2.1 Visual stimuli – Development of visualisation

Six photographs were taken in the field and matching visualizations where constructed using ArcGIS and Visual Nature Studio (VNS). The area depicted was a forest harvest area outside Umeå, Sweden. All images were taken so that different uses of retention were visible in the photographs. The visualizations where created out of the GIS material for the site, and then matched manually to be as precise a match as possible, including field layer and position of single standing trees.

The data input for the visualisations was a high resolution digital elevation model (DEM), the management plan for the area and an inventory of retention groups as well as remote sensing for potential retention areas using unmanned aerial vehicle (UAV) and IR-photographs. The ground texture is created using UAV photographs for the specific type of forest. The field layer consists of harvest debris, rocks, low stumps, flowers, grass, and shrub vegetation. The tree layer was controlled using input variables such as stem density, species and average height of the trees for each parcel. The tree models were a combination of existing 3D models and models created from scratch in XFrog. From these 3D models 2D models (billboards) were created and modified in Photoshop. Dead trees and high stumps are created using living individuals that have been defoliated and adding a bark texture from photographs. The field layer consists of photographs edited in Photoshop. The camera angles from the photographs were accommodated by hand in placing the point of regard in the visualization as close as possible to match the photographs. High stumps and other solitary trees were manually given individual coordinates to match the position in the photograph. In the retention areas all individual tree positions was randomly assigned. The field layer has been exaggerated to match the photographs.

Fig. 1: Example of Photograph – visualisation pair (Photograph to the left)

2.2 Survey

22 participants were asked to assess species richness and stewardship level by viewing the images one at a time for five seconds. The answer, as well as the participant's eye movement during the image viewing prior to the assessment, was recorded. The participants' task during the experiment was to simultaneously assess both species richness and stewardship level. The participant was informed that after each image they would be asked to assess species richness or stewardship on a five level scale, but they would not know beforehand which question would be asked.

Eye movements were recorded at 250Hz with a RED system from SensoMotoric Instruments, SMI (Berlin, Germany), connected to a PC running Windows XP® and controlled by iView X® with default settings.

The experiment was implemented with SMI Experiment Center (version 3.1.112.31328) and data was processed with SMI BeGaze. The screen used for presenting stimuli was a 22 inch flat screen with a refresh rate of 60 Hz and a 1680 x 1050 pixel resolution.

2.3 Analysis of data

The assessments for photographs and visualizations where compared between visualization and photograph using a paired t-test.

The eye tracking data were analysed using AOI analysis and a paired t-test was used to establish pairwise significant differences between dwell time in AOI in photograph and visualisation.

3 Result

There are significant difference between visualizations and photographs with regards to assessment of species richness (Photographs $M=2.77$, $SD=0.26$, Visualisations $M=3.11$, $SD=0.31$, paired t-test $p=0.023$) and stewardship assessments (Photographs $M=3.01$, $SD=0.19$, Visualisations $M=3.29$, $SD=0.09$, paired t-test $p=0.029$), where the visualizations in both cases were rated higher than the photographs.

In terms of response time for the assessments, no significant differences were found between photographs and visualisations in either species richness or stewardship assessments. The AOI analysis showed no significant difference in dwell time within the image pairs.

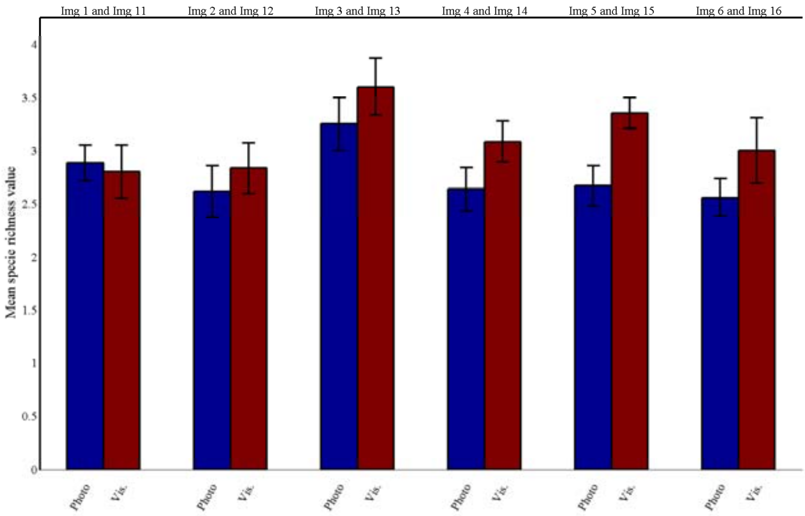

Fig. 2: Bar plot with error-bars (representing one standard deviation around the mean) presenting mean species richness assessments for visualisations and photographs

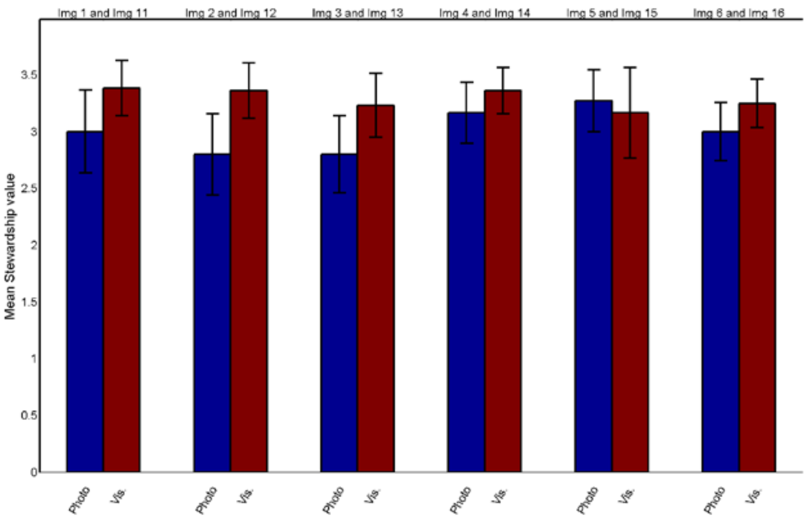

Fig. 3: Bar plot with error-bars presenting mean stewardship assessments

4 Discussion

The results show significant differences for assessments of species richness and stewardship between photographs and visualisations. These results are surprising in a sense, that they go against the hypothesis we set up, that the species richness would be assessed to be higher in the photographs than in the visualisations, and that the stewardship should be rated lower in the photographs. The latter was true for this study, but the fact that the visualisations that are known to entail less species than the photographs (since only a few species were digitalized and repeated in the visualisations were to receive higher species richness assessments are interesting. One explanation could be that the task to assess species richness and stewardship is entangled with specific objects and the quality of those objects in the image, and that the visualization technique somehow scrambled that connection. Another possibility could be that there are brighter colours and / or contrast in the visualisations, making them more "vibrant" than the photographs, creating an exotic feel of the visualization, and therefore providing them with a higher baseline. It could also be that the photographs are filled with information that makes them blurry and hard to find the information needed to make distinctions between species in the field layer.

DANIEL (2001) concluded that photo realistic visualisations might not provide equal response as the actual environment depicted, and by that prove not to be a valid representtation of that environment. Our study would support this, thereby emphasizing problems that could occur when blending different type of stimuli for landscape assessments. Most previous studies have been assessing scenic beauty, preference or acceptance, concepts that are considered to be unaffected by change of media representing the environment. FORD et al. (2009) present the idea that when it comes to acceptance assessments, it might be the values behind the assessment that are most important to tend to, not the visual management of the environment. Compared to a lot of previous studies (cf. FORD et al. 2009; RIBE 2005; RIBE 2002; LEWIS 2006) we try to go deeper than preference and acceptance, two concepts that most surely are composite of several different values and concepts. The species richness and stewardship assessments could be concepts that handle such values that FORD et al. (2009) are discussing.

As the assessments themselves are interesting, we also used eye tracking to get into the behaviour leading up to the assessment, in form of dwell time analysis. The dwell time in AOIs were predicted to be smaller for visualisations in the field layer AOI, and larger for the retention AOIs in the visualisations compared to the photographs. The results showed no significant difference, suggesting that the processing of both tasks were equally hard for the participant with regards to information processing and that the artificial tree crowns of the visualization did not impact on the attention of the participants, in comparison to the photographs. We further expected less processing time needed in the field layer of the visualizations compared to the photographs, since the field layer of the visualisations is scarcer and should therefore not need as much attention. However, we found no significant differences between visualisations and photographs. JOHANSSON et al. (2011) found similar result in a study conducted to explore how reading comprehension and reading in itself is affected by music listening. They found that the comprehension is severed by music listening at the same time as you read a text, but the reading behaviour is not affected. If we would translate those finds to our study we could speculate that the change in stimuli did not affect the behaviour used when doing the assessment viewing, but it did affect the assessment in itself. The lack of difference in response time between photographs and visualisations supports this, in that the behaviour was unaffected, and the response time thusly is the same for both visualisations and photographs.

The study used only one eight of camera, just below eye level, to match the tripod height of the camera. There could be other elevations of the point of regard that could have other effects on assessments as well, and where certain types of assessments are unsuitable, for instance a birds-eye view of a landscape might be unsuitable to make species richness assessments.

5 Conclusion and Outlook

The implications of the result from this study suggests that visualizations can be used as a substitute to photographs in landscape assessments, as long as there is no comparison between the two modalities, and there is need to research more what aspects it can be used as a substitute for, since not all aspects can be represented in the same manner as in photographs. There is also a need to test for different types of visualisations, as the one used in this experiment was deliberately as close to the photograph as possible in likeness.

Eye tracking is a relatively new method in landscape analysis and landscape research, and provide valuable information about perceptual and cognitive processes leading to up to a certain assessment or judgment about the landscape.

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