On the Influence of Dynamic Illumination in the Perception of Translucency

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PROBLEM

Translucent materials are ubiquitous in our daily life, from organic materials, such as human skin or food, to inorganic ones, like plastic or rubber.

We focus on the effect of illumination on the appearance of translucent materials. In particular, we analyze the impact of static and dynamic illumination on it, through a psychophysical user study.

Previous works have shown how the perception of translucency can be influenced by external factors such as the main light position, material density or phase function [1, 2, 3].
Other studies have focused on the perception of glossiness, such as the influence of translucency on perceived glossiness [4] or how dynamic stimuli can improve appearance perception, e.g., glossiness constancy [5].

Building on these studies, we analyze whether motion of the illumination can affect the perception of translucency of an object, and alleviate constancy failures.

METHOD

The experiment is carried out in two separate sessions, one for the static condition, and another one for the dynamic condition. The sessions are separated by at least 24 hours, to avoid fatigue and learning effects. The order of the two conditions is randomized. We then compare users' error between the two sessions and see if there are different behaviours (Fig 3).

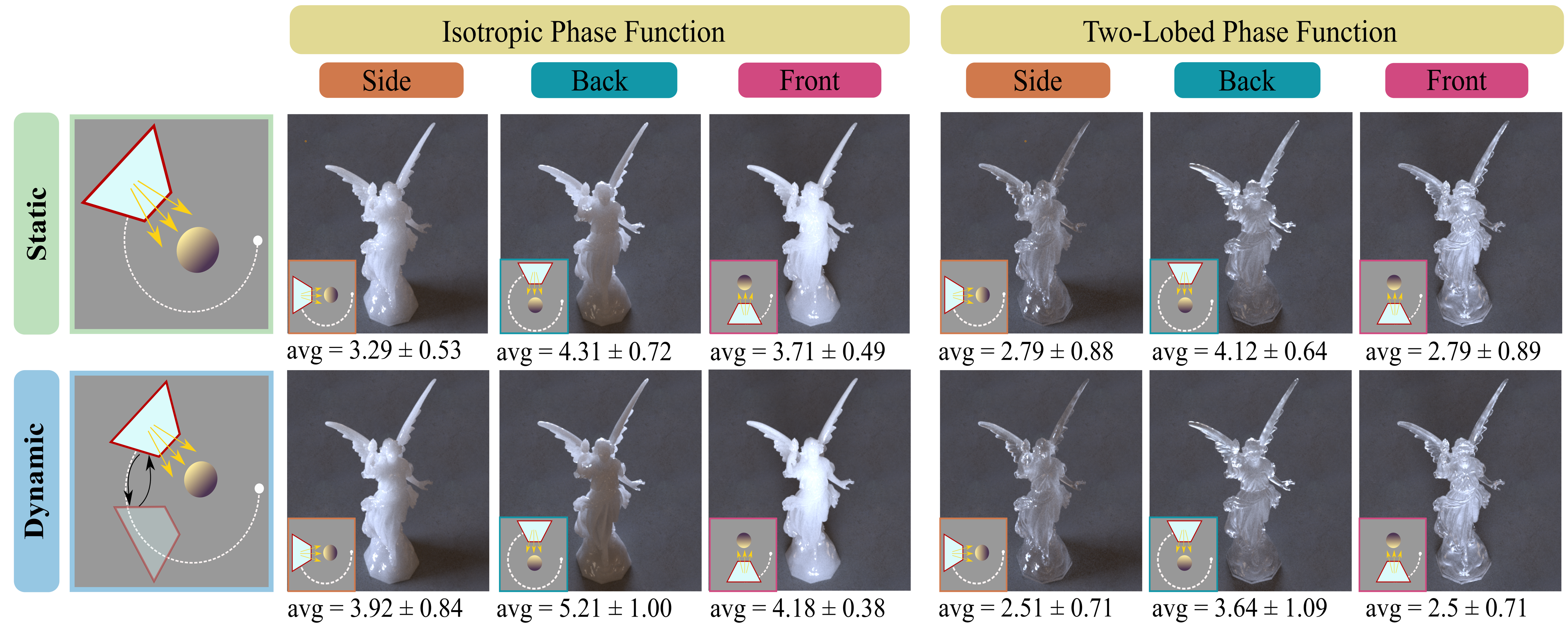


Fig 3. The images depict our test object, rendered with the average density estimated by participants for each condition, for a fixed reference optical density σ = 4.0 (below we report the average estimated mean along its standard deviation).

OUR APPROACH

We analyze how well human observers estimate the optical density of translucent objects for static and dynamic lighting setups.

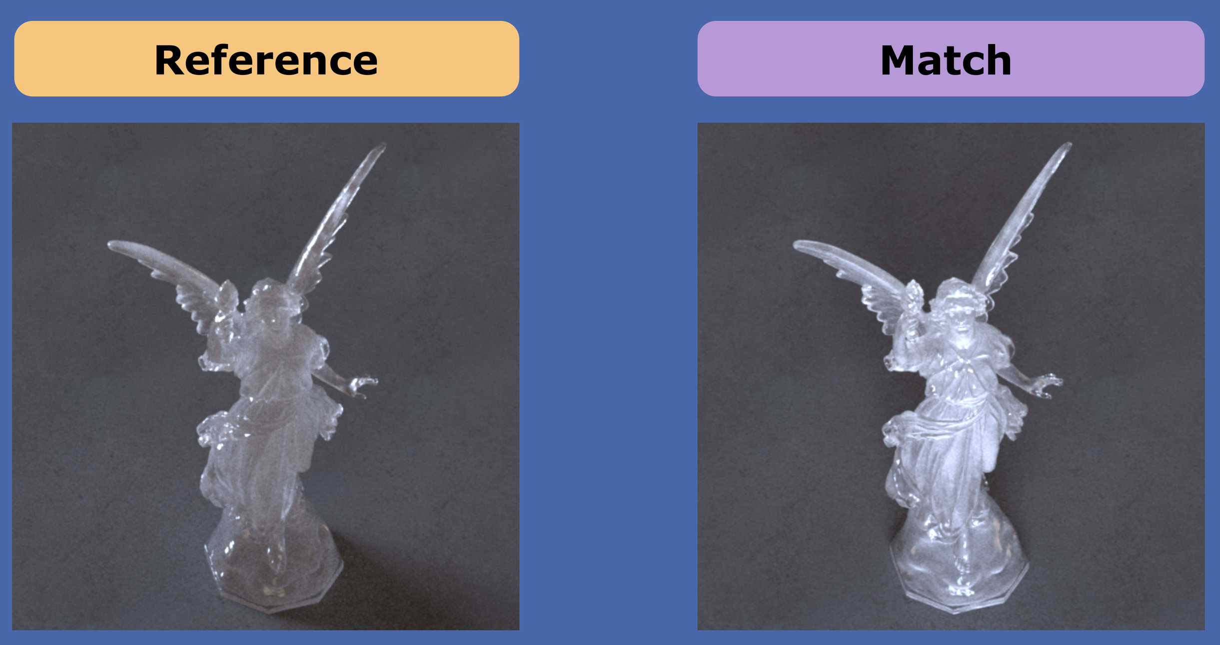
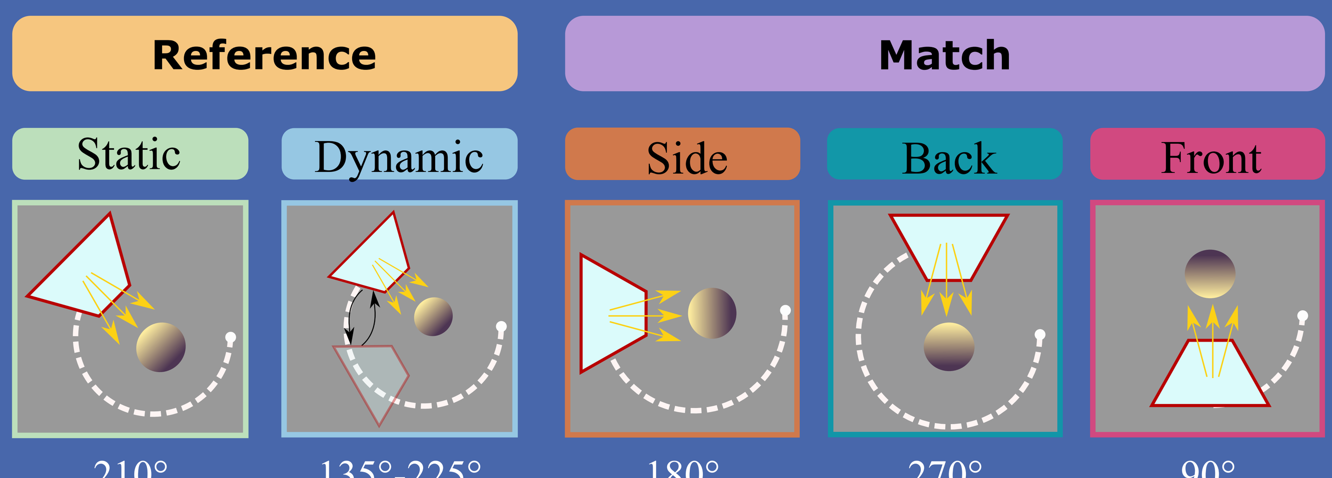


Fig 1. Experiment design. We show the user two images, or a video and an image, side-by-side. The user is asked to edit the Match image density (right) until it visually matches the Reference (left).

Our study is based on an asymmetric matching task, where each participant has to match the optical density of the Match image to the corresponding Reference stimulus, which may be an image (static condition) or a video (dynamic condition).
Reference and Match stimuli are presented side by side, and they both show the same object (Fig 1). The experiment is performed for a variety of optical parameters of the material and lighting conditions (Fig 2).



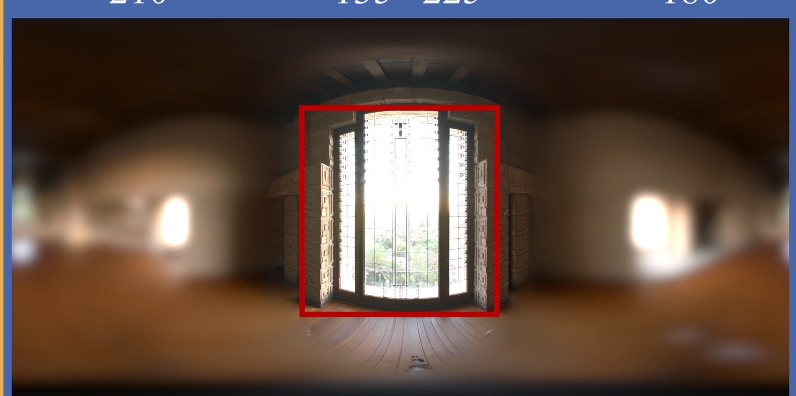


Fig 2. Top: Schematic representation of the different illumination conditions for the Reference and Match conditions.
Left: Ennis environment map used to render our stimuli.
We highlight in a red box the window used as a reference for the rotation.

RESULTS AND DISCUSSION

Twelve participants with normal or corrected-to-normal vision perform a matching experiment, in random order and in two separate sessions (static reference and animated dynamic illumination).

We analyze our data using a repeated measures ANOVA. Surprisingly, we find no statistically significant differences ($p > 0.05$) between the static and dynamic illumination of the Reference (Fig 4).

A possible explanation is that users are not able to leverage the extra information provided by the dynamic motion of an uncontrolled light source. Still, further research is needed to fully understand which factors affect translucency perception.

The results for the static case are consistent with previous work [3]. However, while Xiao et al. used low-frequency synthetic illumination we proved that these results hold with a more realistic environment map.

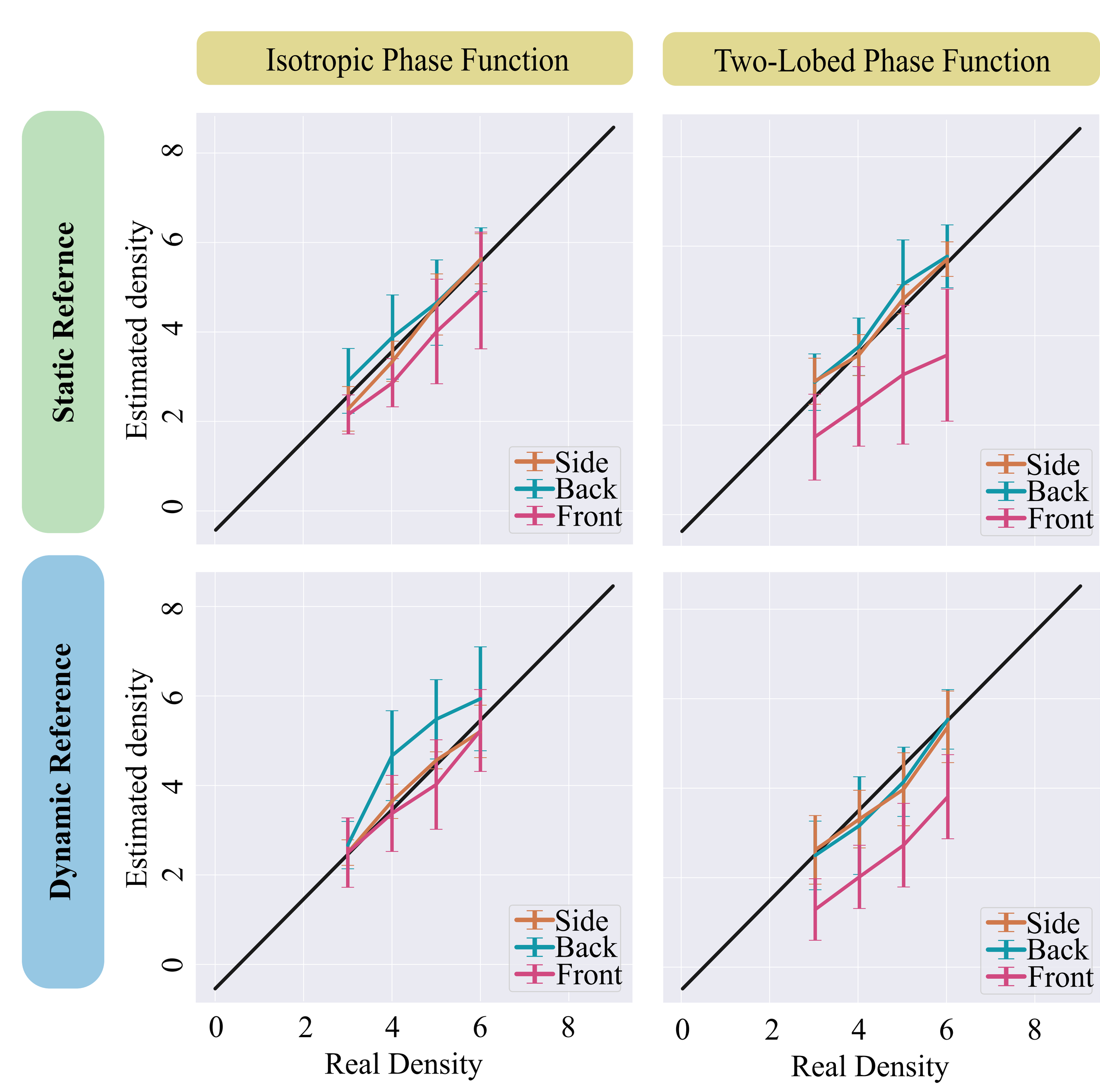


Fig 4. Mean estimated optical density with respect to the groundtruth reference density for each match light position, phase function, and for both the static (top row) and dynamic (bottom row) illumination configurations.

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