Evaluation of Diagnostic Indices Underlying the Recognition of Visual Objects

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Introduction & Aims

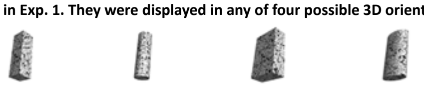
Shape perception and object recognition are among the last frontiers for vision research. Thus, a consensual theory of the mechanisms and codes through which the human visual system represents shapes and connects these representations to identity labels remains elusive.

The purpose of the present study is to determine, in normal human adults, without theoretical a priori or bias, the information that underlies the discrimination and recognition of visual shapes. For that purpose we will compare the results obtained with human participants with those of an ideal observer.

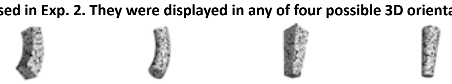
Material & Method

1 – Classification image techniques

- **Bubbles method** : mask concealing the object and presenting areas of the stimulus through circular apertures placed at random locations over the image. The correlation between these masks and performance reveals areas that are more or less diagnostic to recognize the object ([1]). The experiments reported have 2 phases. First the participants learn to associate every object, fully visible, with its assigned name (letters z, x, c or v). This learning phase is followed by the experimental phase in which the stimuli are masked. The task in each phase is to identify the object.
- Objects used in Exp. 1. They were displayed in any of four possible 3D orientations.



- Objects used in Exp. 2. They were displayed in any of four possible 3D orientations

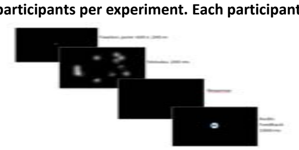


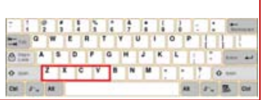
2 – Ideal observer model

- Optimal execution of the task by a computer, with no capacity limitation
- The program compares the stimulus to each original image and selects the best match

4 – Experiment

- 12 participants per experiment. Each participant performed a total of 7200 trials



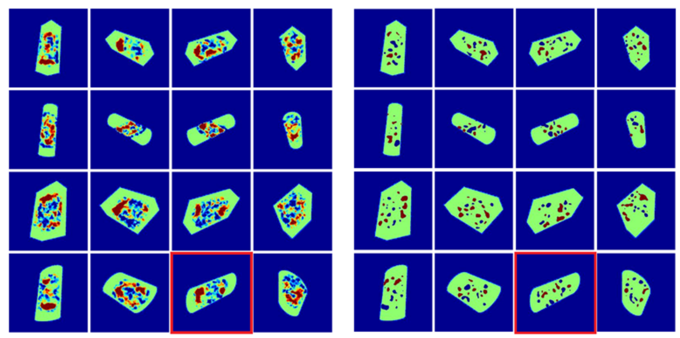


Results

Classification images for the human participants and the ideal observers for Experiments 1 and 2. The points significantly different from zero (Pixel test; Chauvin et al., 2005 [2]) are marked in blue/yellow/red. The yellow/red indicate the diagnostic zones on the object surface. Their availability is associated with improved recognition performance. In contrast, the dark blue regions are associated with increased error rates when revealed.

Experiment 1

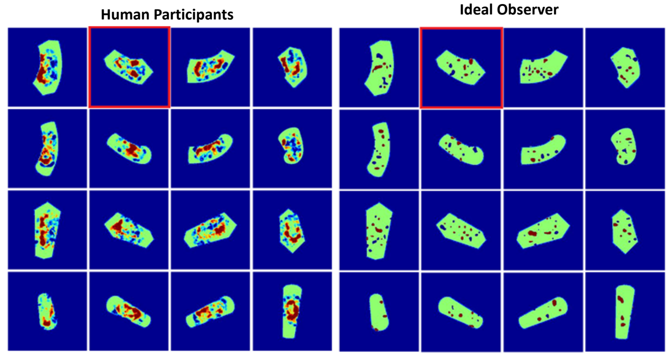
Human Participants — Ideal Observer



The largest degree of correlation between the statistically significant human vs ideal observer classification images is of 0.16. The item concerned is framed in red (see above)

Experiment 2

Human Participants — Ideal Observer



The largest degree of correlation between the statistically significant human vs ideal observer classification images is of 0.24. The item concerned is framed in red (see above)

Conclusion & Perspectives

- There are important divergences between the diagnostic areas of the ideal observer and the human participants. These divergences indicate biases in human vision which move the focus of processing away from the most informative stimulus regions. These biases are a reflection of the mechanisms and codes implemented by the visual system to represent shape.
- Future perspectives: A new experiment is under way which uses two objects from experiment 1 and two other from experiment 2 in order to determine if diagnostic regions for an object are altered by the stimulus context within which it must be recognized. Future experiments will assess other classes of objects as well as complex objects made of two or more components

References

[1] Gosselin, F., & Schyns, P. G. (2001). Bubbles: A technique to reveal the use of information in recognition tasks. *Vision Research*, **41**, 2261–2271.

[2] Chauvin, A., Worsley, K. J., Schyns, P. G., Arguin, M., Gosselin, F. (2005). Accurate statistical tests for smooth classification images *Journal of Vision*. October 5;5(9):659–67. 10.1167/5.9.1

Acknowledgements

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