

IN THE EYE OF THE BEHOLDER: THE PERCEPTION OF INDETERMINATE ART

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Introduction

How do we interpret an object, a scene, or a painting? Perception research and art illuminate from different views how the vast amount of information in our visually perceived environment is processed by the viewer to form a coherent and consistent interpretation of the world. Using paintings by the artist Robert Pepperell, this paper outlines some scientific research that attempts to connect these different world views. Pepperell's paintings may at first glance appear as baroque frescoes, expressionist still-lives, or cubist collages. Taking a closer look, however, these concrete interpretations vanish and we are left with indeterminate images [1]. Using psychophysical experiments and eye tracking measures, in this work we seek to illuminate the visual processing of information in Pepperell's paintings. More specifically, we investigated how the pattern of fixations — the loci of interest — change as a function of the task (e.g. 'What is depicted in this scene?' vs. 'Does this image contain people?') and of the image content. The interpretation of the experimental results in the context of perceptual research offers insights into the perception of indeterminate art. At the same time, the results may contribute to the development of the artist's project, as they provide some measurable validation of his intentions.

Eye tracking and Behavioural Experiments

As is known from the early experiments by Yarbus [2], eye fixations are critically dependent on the task, i.e. how one looks at an image differs depending on what is being looked for. In our experiment, we were interested to investigate the difference between local and global processing of Pepperell's paintings. To do this we asked participants to view a set of paintings and to solve two different visual tasks while recording their eye activ-

ity. In order to test local information processing strategies we asked whether a person could be found on the painting (person task), whereas global information processing was tested by asking subjects to categorize the painting into one of seven pre-defined categories (categorization task).

Methods

A total of 30 indeterminate drawings and paintings were shown to 20 participants. These 30 works of art were split into two sets of 15 paintings that were used in each task. The first 10 participants saw the first set for the person task and the second set for the categorization task, whereas for the remaining 10 participants we changed the sets for each task in order to counterbalance for possible order effects. Afterwards, a behavioural task was set in which a question relating to each of the two tasks was shown on the screen and participants had to answer by selecting the appropriate item from a list. For the person task, the question was 'Was there a person in this image?' and for the categorization task the question was 'To which of the following categories does this image belong?' Here the choice consisted of seven categories: 'Biblical scenes', 'Landscapes with person', 'Landscape without a person', 'Portrait', 'Still-life', 'Battle scene', and 'None of the above', these categories having been determined in prior pilot experiments. Their response time to answering these questions was also measured.

Overall Results

In general, the behavioural data shows that participants were able to consistently categorise some images whereas some images could not be classified consistently at all. The results showed that overall the paintings, indeed, correspond closely to Pepperell's artistic intention of providing indeterminacy. In addition, participants used the 'none-of-the-above' category for 26% of all responses, again showing that some paintings defy easy categorization. Taken together, these results provide a rough, yet very consistent validation of Pepperell's indeterminate paintings in terms of their category membership.

The eye tracking data shows a difference in activity between the two tasks — person spotting and scene categorization. The top pair of images in Fig. 1 shows a much more centered distribution of fixations when undertaking the person spotting task, whereas the bottom pair in

Fig. 1 shows a broader, more localized spread when doing the categorization task [3]. The processed images on the right, showing the fixation clusters, demonstrate this effect even more clearly. The average number of fixation clusters in the categorization task is 288, whereas for the person detection task it is much higher at 413 unique clusters. In summary, the averaged fixation maps and the cluster analysis have shown that global information seems to be more important for the categorization task than local information.

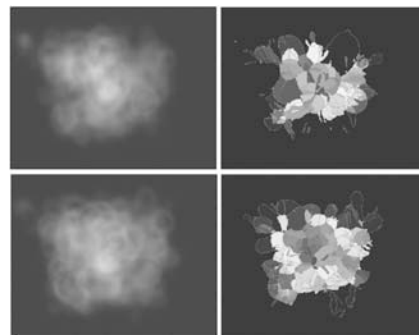


Fig. 1 Averaged eye tracking fixation maps (left pair) and fixation clusters (right pair) for both tasks (person spotting and categorization) on all the images in the study [3]. © C. Wallraven

Image Analysis

In the following section we will take a closer look at three selected paintings — Fig. 2 A, B and C — from the 30 used in the study that are representative of the general trends we observed in the data and interpret the fixation patterns and behavioral results for each [3].

Fig. 2A. Categorization task: This image was classified as a landscape (with or without a person) in the categorization task. The fixation pattern clearly reflects the search strategy discussed above: during categorization participants scanned nearly all of the area of the painting compared to the person task which shows a much more localized distribution.

Person task: 7 out of 10 participants recognized a person in this painting. As this painting was unanimously classified as a landscape scene, we assume that participants looked for persons in the image that were 'at a distance', i.e., objects that occupied only a small image area. The center of the image, which gathered the largest amount of fixations in this task, does indeed contain a few possible items of interest. This area is

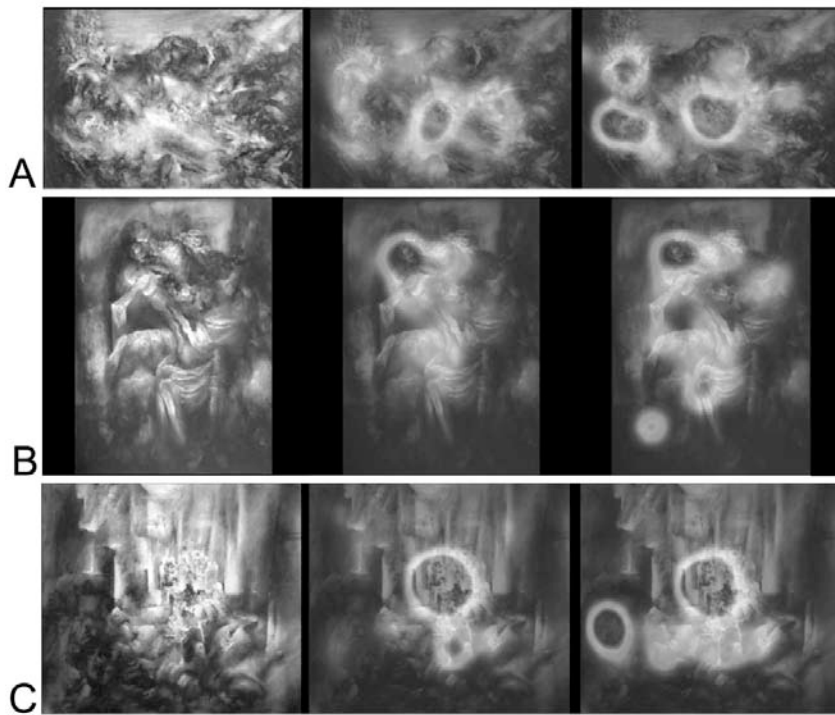


Fig. 2. Three samples from the data set and associated eye tracking data, A, B and C. The first image in each row is a monochrome version of the original painting, the second shows the distribution of eye activity for the categorization task, and the third shows the eye activity for the person spotting task [3]. (© C. Wallraven)

especially salient as its immediate neighborhood only contains rather low-contrast areas. Fixated areas also do not contain high differences in contrast. Taking into account, however, the context of this landscape scene, persons in the image might also be expected to be rendered in low contrast due to distance to the virtual observer.

Fig. 2B. Categorization task: This image was categorized as a portrait. Here, the pattern of fixations shows one of the few deviations from the general trend: the categorization task results in a less global scan pattern than the person task. The observed local pattern of fixations, however, can be explained by the unambiguous classification as a portrait resulting in a strong focus on the 'face' of the person. The category decision therefore had been possible already at a very early stage making an exhaustive search in the image unnecessary.

Person task: 8 out of 10 participants detected a person in this painting. The main focus of fixations lies in a contrast-rich region of the painting, which contains very salient features such as curves and edges. The interplay of these image features, indeed, bear resemblance to a human skull (eye sockets and nose). A

second focus area is put on the lower corner of the painting: this area is located at a location where one would expect a human hip given the scale of the scene. The full pattern of fixations can be seen as describing the outline of a person - elbows and shoulders are further loci of attention showing that observers tended to follow a full outline of the imagined figure in the image.



Fig. 3. Suggestion of human face found in the lower left of Fig. 2C (© R. Pepperell)

Fig. 2C. Categorization task: This painting was classified as a biblical scene. The main focus lies in the centre of the painting, which is an area with high contrast surrounded by border regions that are more 'blurred'. Surprisingly, the high-contrast 'columns' in the image do not draw much attention which shows that the categorization task could be solved

using high-resolution information of the centre alone.

Person task: 6 participants recognized a person in this image. Again, the main focus of fixations for this task falls in the centre of the painting which contains the highest density of 'people-like' features. Interestingly, another main focus is on an area in the dark shadows at the left border of the image. Closer examination of this area reveals that, indeed, this could be interpreted as the face of a person (Fig. 3) This small but very consistent effect again demonstrates the crucial differences between the types of information needed for both tasks.

Conclusions

Analysis of the eye movements has revealed clear differences between the two tasks: a preference for a more global search strategy in the categorization task compared to the person detection task was found, which is in accordance with current theories of scene processing. In addition, we have confirmed earlier findings on selection of fixation regions: on average high-contrast regions are preferred over low-contrast regions, and it seems that only immediately relevant parts of the scene are fixated.

In these experiments, we have taken the first steps towards characterizing the visual information in the processing of indeterminate art for two specific tasks. Using the behavioral data, we have been able to validate Pepperell's artistic intentions of visual indeterminacy to a certain degree: participants' consistency in determining a genre for a painting or drawing was on average neither high nor low. In addition, participants made use of the 'none-of-the-above' option for a quarter of all responses. For a more objective validation, of course, one will need to compare these responses to a set of representational and fully abstract images, and these experiments are currently underway.

References and Notes

1. R. Pepperell, Seeing Without Objects: Visual Indeterminacy and Art, *Leonardo* 39, No. 5. (2006) pp. 394-400. See also <<http://www.robertpepperell.com>> for examples of indeterminate paintings.
2. A. Yarbus, *Eye Movements and Vision*, (New York U.S: Plenum, 1967).
3. For online colour versions of the figures please see: <<http://www.robertpepperell.com/leotran.html>>