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| Institution: Birkbeck College |
| Unit of Assessment: Psychology, Psychiatry, and Neuroscience |
| Title of case study: A vision of destruction restored: Using eyetracking to guide the restoration of John Martin's "The Destruction of Pompeii and Herculaneum" (1821) |
| 1. Summary of the impact (indicative maximum 100 words) |

John Martin's painting '*Destruction of Pompeii and Herculaneum*' was damaged and considered lost until advances in conservation made a restoration feasible. The question remained of how to fill the lost section without generating attentional distraction. Together with TATE Britain, Tim J. Smith used eyetracking to identify restoration procedures that directed gaze towards the remaining content and allowed full comprehension of the painting's subject matter. The restored painting is now on permanent display at TATE. This study is the first to apply eyetracking and vision science to art conservation, and has been received with great interest by the international conservation community.

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| 2. Underpinning research (indicative maximum 500 words) |
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Whether we appreciate a work of art or a computer screen, we utilise the same sensory and cognitive apparatus. Understanding how visual mechanisms construct our experience of a painting is important for understanding how the composition of a painting can influence our experience. Until recently, scientific understanding of visual cognition has rarely been applied to visual art, and artists had to intuit viewer cognition through introspection. The work of Tim J. Smith aims to apply contemporary theories and methodologies from visual cognition to visual art and visual media. His research uses eye tracking to record eye movements and to determine how they are controlled both by a visual stimulus and by viewer cognition. Due to the limitations of the eye, we are only able to perceive detail in an area about 2 degrees around the centre of our gaze (where 360 degrees would encircle our head). We are unaware of the incomplete nature of our visual experience, as eye movements quickly bring any relevant object into this central region.

By recording eye movements and fixations, we can gain insights into what viewers are most likely to perceive and remember of a scene. Smith's research has shown that how long we fixate objects in a scene influences whether we later remember them (Rayner, Smith, Malcolm, & Henderson, 2009), and that fixation durations are determined by the currently fixated object and our previous fixations (Smith & Henderson, 2011). Smith has shown that image features such as colour, luminance, clutter and motion influence where we look (Henderson, Chanceaux, & Smith, 2009; Smith & Mital, in press). Manipulation of these features can be used by painters and film directors to guide attention (Smith, 2013). By using computer vision techniques to identify salient features of an image that might capture attention and computational modelling of attention and eye movements (Nuthmann, Smith, Engbert, & Henderson, 2010), Smith's research has provided detailed insight into the relationship between an image and how it is cognitively processed by a viewer. Particularly relevant for the work with TATE Britain is the fact that contours and edges involuntarily attract eye movements, while regions with low spatial frequency (i.e., uniform or blurred areas) tend to be avoided during visual exploration.

The restoration of the John Martin painting (section 4) presented a novel challenge for Smith. The loss of a large part of the painting's canvas raised the question how to fill the lost section in a way that would not distract from the existing content. The traditional approach initially favoured by the TATE conservation team was to fill the loss with a neutral colour, as proposed by Cesare Brandi ("Theory of Restoration", 1963) on the basis of gestalt principles. Smith's research into how visual features influence eye movements and attention suggested that such a neutral infill would be detrimental and distract from the main content. His work with TATE Britain employed a combination of eye tracking, computational analysis of image features and gaze to determine the optimal method of restoring Martin's painting.

Impact case study (REF3b)

3. References to the research (indicative maximum of six references)

Smith, T. J. (2013) Watching you watch movies: Using eye tracking to inform cognitive film theory. In A. P. Shimamura (Ed.), *Psychocinematics: Exploring Cognition at the Movies*. New York: Oxford University Press.

Smith, T. J., & Henderson, J. M. (2011) Looking back at Waldo: oculomotor inhibition of return foes not prevent return fixations. *Journal of Vision*, 11(1): 3, 1-11.

Nuthmann, A., Smith, T.J., Engbert, R., & Henderson, J.M. (2010). CRISP: A computational model of fixation durations in scene viewing. *Psychological Review*, 117, 382-405.

Henderson, J.M., Chanceaux, M., & Smith, T.J. (2009) The Influence of clutter on real-world scene search: Evidence from search efficiency and eye movements. *Journal of Vision*, 9(1):32, 1-8.

Rayner, K., Smith, T.J., Malcolm, G.L., & Henderson, J.M. (2009). Eye movements and visual encoding during scene perception. *Psychological Science*, 20, 6-10

Smith, T. J., & Mital, P. K. (2013). Attentional synchrony and the influence of viewing task on gaze behaviour in static and dynamic scenes. *Journal of Vision*, 13(8):16, 1-24.

4. Details of the impact (indicative maximum 750 words)

John Martin was a British artist whose epic painting, *Destruction of Pompeii and Herculaneum* (1821) was a central work of his *apocalyptic sublime* style, which has influenced popular representations of catastrophes such as Lord Of The Rings and Hollywood disaster movies. Ironically, the painting suffered its own catastrophe when it was extensively damaged following the 1928 Thames flood, including the loss of approximately one-fifth of the canvas (Figure 1, left).



Figure 1: Left = John Martin’s *The Destruction of Pompeii and Herculaneum* before treatment. Right = Tate conservator hand-restoring the painting based on the life-sized digital composite (displayed to the right). Photograph courtesy of Sunday Times (published Sunday 4th September, 2011).

The painting was considered lost until advances in conservation techniques made a restoration feasible. However, the question of how to fill the lost section without distracting from the remaining portion remained. To answer this question, Dr. Smith was consulted. He worked with the conservation department of TATE from October 2010 to September 2011. Together with the lead conservator, Smith created a digital reconstruction of the complete canvas by integrating a digitized version of a smaller intact copy by the artist. Digital manipulation of the reconstructed version created a “best guess” of what the full original might have looked like. The lost section was digitally altered to create several alternative infill options, including a neutral colour infill (Figure 2, left), a lower-contrast version, and an “abstracted” version with less edge information. Computational saliency analysis by Smith predicted that viewer attention would be undesirably attracted to the edge of the loss in all versions, except for the full restoration and the “abstracted”

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version. To validate these predictions, each version was presented to twenty viewers. Eye movements were recorded using a Tobii TX300 head-free eyetracker to approximate the conditions under which the painting would be viewed in a gallery. Eyetracking illuminates which parts of the painting attract attention (dots in Figure 2 indicate where the eyes stopped during fixations), and how attention is shifted (Figure 2, lines). Analysis of eye movements for the full digital restoration (Figure 2, right) revealed that viewers spent most time fixating the mouth of the volcano and the characters in the foreground. With the neutral colour infill (Figure 2, left), the edges of the loss distracted from the original content, and viewers failed to comprehend the subject matter of the painting when quizzed afterwards. Prior to this eyetracking evidence, TATE conservators were considering the traditional technique of using a neutral infill to replace the loss. Demonstrating the destructive impact this would have on attention and comprehension led them to take the bolder step of a full restoration with abstracted features in the restored section, to bias attention towards the original content (Figure 1, right).

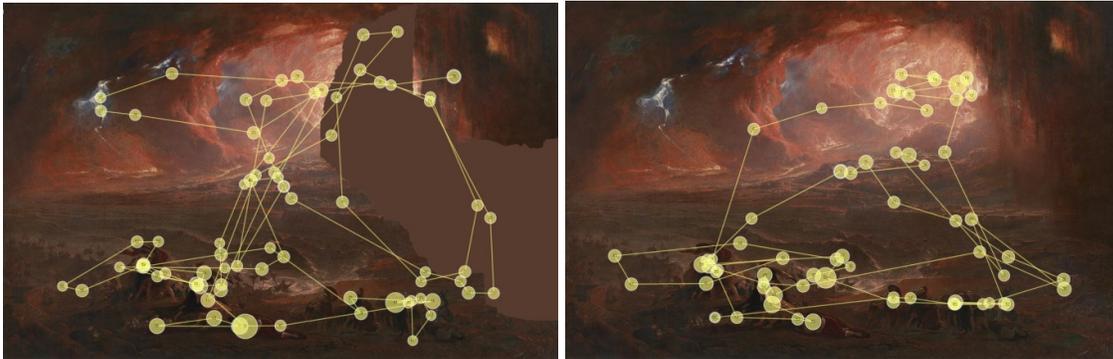


Figure 2: Gaze scanpaths for one participant viewing the Neutral Infill restoration (left) and full restoration (right) of the painting. Dots represent fixations; lines represent saccades.

The restored painting went on display at TATE Britain as part of a John Martin retrospective in September 2011. Critics of the painting restoration plans were universally appreciative of the finished product: *“Should the canvas be made good and the missing portion left bare? ...Or should a full restoration be attempted, with the missing portions repainted, exactly as they were...? Happily, the Tate chose the latter.”* (Waldemar Januszczak, Sunday Times, 2011). This view is mirrored by the curator of the exhibition *“The whole process behind making this [restoration] decision was ... exemplary of how technical research, experiment and curatorial and conservation can productively be brought together.....A painting which has been in storage and neglected for over 80 years can be brought back to public view, and then not as a ‘artefact’ or technical curiosity, but as a powerful work of art.”*

The painting has now been re-entered into the TATE catalogue and again serves to illustrate John Martin’s role in British art history. The experimental and computational techniques used in this project have been positively received by the painting conservation community at an international conference (Maisey et al., 2011). This novel approach to restoration has obvious potential for future application in a domain where decisions are usually based on intuition rather than empirical fact. According to TATE’s lead curator *“What would have been a curatorial hunch was bolstered in very important ways by [the] empirical evidence.”* For the lead conservator of the painting, the project with Smith *“has changed the way I work on a day to day basis”* (sources 2 and 3 below).

5. Sources to corroborate the impact (indicative maximum of 10 references)

(Full URLs and additional tinyurl links have been provided for all weblinks. Copies of all source materials are available upon request if external weblinks are no longer operational.)

1. Maisey, S., Smithen, P., Vilaro-Soler, A., & Smith, T. J. (2011) Recovering from destruction: the conservation, reintegration and perceptual analysis of a flood-damaged painting by John Martin. *International Council of Museums: Committee for Conservation. Published Proceedings*. Lisbon, Portugal, September 19-23, 2011. PDF version of this article:http://www.bbk.ac.uk/psychology/our-staff/academic/tim-smith/documents/1320_459_MAISEY_paper_EN1.pdf/view
<http://tinyurl.com/prba49e>
2. Lead conservator on Martin painting whilst at TATE Britain. Contact details are provided separately. A copy of a letter from the conservator describing the restoration project and the importance of using eye tracking measures is available upon request.
3. Lead Curator pre-1800 British Art, Tate. Curator on John Martin, Apocalypse exhibition September 2011 – January 2012. Contact details are provided separately. A copy of a letter from the lead curator describing the restoration project and Smith's central role in this project is available upon request.
4. Guardian Online, article on restoration. Monday 19th September, 2011
<http://www.guardian.co.uk/artanddesign/2011/sep/19/john-martin-pompeii-painting-restored>
<http://tinyurl.com/5wkdjyy>
5. Guardian Online, Science Blog. Article by Dr Tim J. Smith on experiment and painting restoration. Monday 3rd October, 2011.
<http://www.guardian.co.uk/science/blog/2011/oct/03/vision-science-john-martin-destruction>
<http://tinyurl.com/owuqhu5>
6. BBC Breakfast, BBC1. Report on Smith's experiment at TATE and painting restoration. Broadcast 25th October, 2011
7. Channel 4 News, Channel 4. Report on Smith's experiment at TATE/ Broadcast 19th September, 2011.
8. Sunday Times, Culture magazine. Sunday 4th September, 2011.
<http://www.thesundaytimes.co.uk/sto/Magazine/Features/article762110.ece>
<http://tinyurl.com/ou5o6ay>