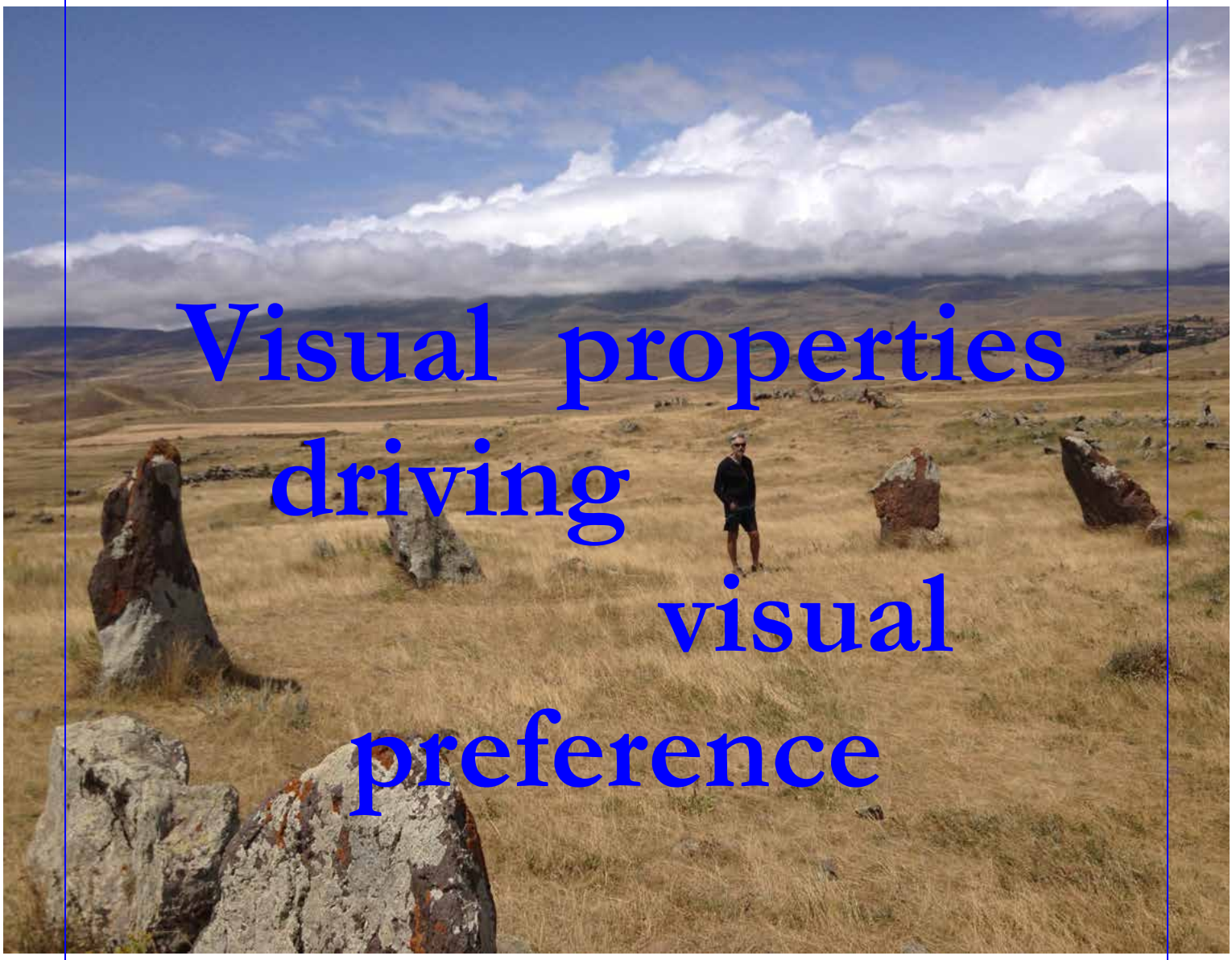

Visual properties driving visual preference

March 21st 2016

University of Liverpool
Academic Boardroom (room 2.35 2nd floor)
Eleanor Rathbone Building

Cover photo: This 7500 year old stone circle is in southern Armenia (Zorats Karer). Like many other remains from prehistory it shows something produced with care and attention to details, and the use of regular geometrical positioning of the stones. Humans appear to have a need to modify their environment not just in terms of mere functionality. Photo by Marco Bertamini.

Programme

09:00-09:10	**Welcome**
09:10-09:20	**Marco Bertamini** "What is an aesthetic primitive"
09:20-09:35	**Neil Harrison** "Systematic spatial distortions in drawings of faces and non-face objects: the influence of graphic long-term memories"
09:35-09:50	**Galina Paramei** "The role of art expertise in aesthetic appraisal of representational and abstract artwork"
09:50-10:05	**Alexis Makin** "Does perceptual goodness equal aesthetic merit?"
10:05-10:40	**Discussion over coffee**
10:40-11:10	**CC Carbon** "Visual Properties Driving Visual Preference: is such a research agenda possible at all? Doubts and attacks on the object-related aesthetics approach"
11:10-11:40	**Johan Wagemans** "Aesthetic responses to computer-generated and man-made art"
11:40-12:10	**Geoff Cole** "The role of natural image statistics in preference and aversion"
12:10-13:00	**Discussion over lunch**
13:00-13:15	**Luca Ticini** "A causal role for action observation in object valuation"
13:15-13:30	**Letizia Palumbo** "Implicit and explicit measures of visual preference and approach response for curvature"
13:30-13:40	**Enric Munar** "Could preference for visual curvature be considered as affect?"
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13:55-14:20	**Discussion over coffee**
14:20-14:50	**Christoph Redies** "Statistical properties of artworks"
14:50-15:20	**Paul Hibbard** "Modelling the Art of the Receptive Field"
15:20-15:50	**George Mather** "What can image statistics tell us about paintings?"
15:50-16:10	**Additional guest contributions**
16:10-16:45	**Discussion**
16:45-17:30	**Lab visits**

What is an aesthetic primitive

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The term "aesthetic primitive" was introduced to refer to a stimulus that is "intrinsically interesting, even in the absence of narrative meaning, because it resonates with the mechanisms of the visual system processing it" (Latto, 1995). This idea has been developed by others, for instance Redies used the expression "efficient coding" (2008) and Ramachandran that of "peak shift" (Ramachandran & Hirstein, 1999). On the one hand we can use vision science to find out what stimuli are processed efficiently. A good example is symmetry, which is known to be processed quickly, efficiently and robustly, but other principles include orientation, curvature and slope of amplitude spectrum. But what do we mean that these stimuli are "interesting"? We have to find a link between perception and emotion, does efficient processing lead to arousal, or to an association with positive valence? In addition, we need to find emotional response that emerge automatically. If they are not generated automatically an indirect route is possible, where ease of processing is misattributed to the stimulus. I will illustrate these issues with respect to symmetry. Symmetry is spontaneously associated with positive concepts, and is valued as beautiful by most people, yet no evidence exists of an automatic link with an emotional response (Makin et al., 2012). Aesthetic responses may never qualify as intrinsically interesting because human interest is not an automatic approach response but rather a type of classification of the world (including a classification of our internal processes).

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Visual Properties Driving Visual Preference: is such a research agenda possible at all? Doubts and attacks on the object-related aesthetics approach

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Empirical aesthetics is mostly based on object-related properties like many other domains of the perceptual sciences. Here I present data and theory on the relativism of any object-related perspective. First of all, objects are always part of a physical and social context. Second, they are framed by situation. Third, objects are processed specifically by the given capabilities and cognitive and affective traits and state of the beholder. Fourth, by Zeitgeist and cultural factors, the relation to objects change furthermore. Taking these major factors together, it is rather difficult to accept the object-related view at all, although by explicitly specifying these factors undeniable and interesting object-related effects can be tested and reliably shown.

Keywords: Empirical Aesthetics; Object-related processing; framing; reference; context; preference

The role of natural image statistics in preference and aversion

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Aversion and discomfort when viewing certain geometric patterns has been known for many years (Wilkins et al., 1984) and a number of authors have examined the spectral properties associated with such aversion. One particular property identified is the deviation from image statistics present in the natural world in which contrast energy increases systematically as a function of spatial frequency. Work on the common but relatively unknown condition referred to as 'trypophobia' ('fear of holes') will be discussed as a notable example. A central finding is that the inducing images tend to have high contrast at mid-range spatial frequencies, a characteristic not usually found in natural image statistics. Interestingly, one class of objects that do possess this property are poisonous animals with aposematic warning colours, suggestive of a possible evolutionary basis. Deviation from natural image statistics will also be discussed with respect to other object preferences including face attraction.

Systematic spatial distortions in drawings of faces and non-face objects: the influence of graphic long-term memories

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Studies of the production of art may be able to give us insight into the skills that artists use to generate aesthetic qualities in artworks. One theory of artistic production claims that artists are able to produce accurate depictions of objects because they have developed the capacity to inhibit the activation of graphic long-term memories (gLTMs), and hence their depictions are more informed by bottom-up perceptual processes related to the to-be-depicted object. A crucial part of accurately depicting portraits is the correct spatial placement of the features. Non-experts typically place the eyes higher on the head than they are actually located, and this systematic spatial bias has recently been confirmed experimentally (Carbon & Wirth, 2014; Ostrofsky, Cohen, & Kozbelt, 2014). Here we tested the influence of gLTMs on drawing errors in non-artists, by asking participants to draw faces and objects from memory and to directly copy them from photographs. We confirmed a systematic spatial bias for eyes (i.e., drawn higher on the head compared to their real locations in the photographs or from memory), and found similar vertical spatial biases for non-face objects. Associations in spatial errors between observation and memory-based drawings supports the theory that long-term graphic memory representations may influence drawing more than the actual appearance of the object that is to be drawn.

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Modelling the Art of the Receptive Field

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Zeki (1999) argued that abstract artists such as Mondrian and Malevich were searching for the fundamental 'building blocks' of images. Consistent with this, we recently showed that photographs of their paintings produce sparse, highly efficient responses in the visual cortex (Hibbard & O'Hare, 2015a). Other research has argued that attractive faces also tend to elicit more efficient neural responses (Renoult, Bovet & Raymond, 2016). These results can be contrasted with those from other studies that have shown that uncomfortable images elicit excessive, and inefficient responses (Huang et al, 2011; Hibbard & O'Hare, 1015b). Here, we consider the extent to which aesthetic responses can be accounted for in terms of the early encoding of visual information (Redies, 2008).

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Does perceptual goodness equal aesthetic merit?

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'Perceptual goodness' is a old idea from the Gestalt School, which roughly means the perceptual strength or salience of a pattern. More recently, Helm and Leeuwenberg (1996) developed a *holographic weight of evidence model* that quantifies the goodness of different visual regularities. The *W score* from the holographic model predicts detection speed and accuracy in psychophysical regularity discrimination tasks. In recent work, we have found that W also predicts the amplitude of the neural response to symmetry (measured with EEG, Makin, Wilton, Pecchinenda, & Bertamini, 2012). But does W predict preference? Some eminent neuroscientists have proposed that people like maximal activation of visual modules, and that super-stimuli are the essence of art (Ramachandran & Hirstein, 1999; Zeki, 1999) Meanwhile psychologists have claimed people like patterns that are fluently processed (Reber, 2012). These accounts suggest that people should like high W patterns most. Conversely, other researchers have considered the aesthetic value of indeterminacy or perceptual challenge (e.g. Van de Cruys & Wagemans, 2011). These imply that people should prefer regularities which are not so obvious, with mid level W scores. To test these diverging theories we measured explicit preferences for a range of abstract regularities used in previous EEG research. We found a strong linear relationship between preference and the W goodness metric (and SPN amplitude, detection speed and error rate). This is consistent with the super-stimuli and fluency models, but not with the indeterminacy/perceptual challenge accounts. The later may capture slower, more cognitive aspect of aesthetic experience, which was measured by our simple experiment.

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What can image statistics tell us about paintings?

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Images of natural visual scenes are very diverse and complex but represent only a small sub-set of all possible images. A number of studies have attempted to derive a simple summary statistic that captures the statistical regularities of natural images and can be used to assess whether the visual system is optimized for processing them. These statistical measures can also be applied to artworks in order to investigate whether the regularities observed in natural images are reflected in the marks made by artists, and if so, why. This project studied three different summary statistics:
(a) Relative spatial scale (Fourier spectral slope, SS);
(b) Spacing-filling (box counting dimension, BC);
(c) Randomness (entropy, E).
The following issues were addressed:
1) How do the statistics of abstract paintings compare to natural photographic scenes? All three statistics show good correspondence between the two image sets.
2) How do the statistics of abstract paintings compare to randomly generated control images? This begs the question of how to generate a random control image. Arguably there is no single, random mark-making algorithm that can act as a baseline for judging the statistics of abstract artworks. The algorithms used in the project produced images that varied in their correspondence with the statistics of artistic abstracts. SS was relatively uninformative, while BC and E indicated that abstracts tend to possess a moderate level of complexity that is not evident in random images.
3) How do aesthetic ratings compare to statistics? Participants made aesthetic ratings of all the random images. BC offered the best account of ratings, though it could explain only 12% of the variance. Ratings may be partly determined by the formal properties of the images. Correlations between the statistics themselves, and between luminance and colour statistics, also yielded interesting results.
4) How do different statistics compare to each other (correlations)? There was good agreement between Slope and BC scores, moderate agreement between BC and entropy, but weak or no correlation between entropy and Slope.
5) Are colour statistics similar to luminance statistics? Slope values for a and b in landscapes peak at shallower slopes, especially so for a (R/G). Entropy scores also peak at much lower values for all image types.
The frequency distributions show some marked differences.
Distributions of slope values are similar for all image types, apart from the peak at shallower slopes for landscapes. Distributions of Box count values are similar for landscapes, but peak at very low values for both abstracts and generative images. Distributions of entropy values are similar for generative images, but markedly different for both landscapes and abstracts. In both cases they peak at lower values.

Could preference for visual curvature be considered as affect?

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In the last decade, quite a few experimental results showed robust visual tendency for curvature against sharpness (Leder & Carbon, 2005; Bar & Neta, 2006, 2007; Jadva et al, 2010; Carbon, 2010; Silvia & Barona, 2010; Leder et al, 2011; Westerman 2012; Vartanian et al, 2013; Hess et al, 2013; Palumbo et al, 2015; Bertamini et al, 2015; Munar et al, 2015). In the scientific literature about the construction of preference, most researches deal with preference as an analytical, deliberative, and rational process. This seems to be due to most of these researches are from the fields of decision making and economics. However, there is another way -more intuitive, automatic, natural and experiential- that gives rise to preferences too. As Zajonc (1980) said, this is the way of the affect. Then, if tendency towards curved lines and contours is a preference, the empirical studies suggest that this preference is closer to affect than rational thinking. Could be useful to verify if the tendency for curvature is affect? Trying to answer to this question, it could be interesting Peters' (2013) proposal. She states that affect can act in four ways in the construction of preference: as information, as spotlight, as motivator of behaviour, and as common currency. Does tendency for curvature match any of these ways?

Implicit and explicit measures of visual preference and approach response for curvature

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A plethora of studies has reported a consistent preference response for curvature (smooth vertices), as opposite to angularity (or "sharpness"), for a variety of visual stimuli: familiar and unfamiliar objects (Bar & Neta, 2006, 2007) abstract, irregular shapes (Bertamini et al., 2015; Silvia & Barona, 2010) and complex interior design environments (Vartanian et al., 2013; Leder & Carbon, 2005). Recently the origin of this phenomenon has been presented in relation to biological and culturally-based factors (Gomez et al., 2015).
In the current studies visual preference for curvature has been explored using explicit and implicit tasks (Bertamini et al., 2015; Palumbo et al. 2015, Palumbo & Bertamini, 2016). In explicit tasks, Palumbo & Bertamini (2016) showed that the complexity of cognitive operations instantiated by stimulus time exposure and type of response (rating scale vs. forced choice or "gut" response) did not modulate such preference.
In relation to implicit tasks, Palumbo et al. (2015) found that preference for curvature might result from an automatic association of curved shapes with positive (or "safe") concepts and angular shapes with negative (or "dangerous") concepts (Implicit Association Task - IAT; Experiment 1). However, angular shapes did not elicit any affective avoidance reaction, whereas curved shapes triggered approach (Stimulus Response Compatibility Task - SRCT; Experiment 2). Recently, this pattern of result has been replicated employing an emotional regulation paradigm (Bamford et al., 2015; Experiment 3). Next, the use of the electroencephalography (EEG) technique will reveal whether the neural basis of emotion action regulation, namely the late positive potential (LPP), is sensitive to curvature.
Taken together these results support the multidimensional character of preference for curvature, and propose that affect might be crucial. Future research should clarify the nature of the affective component involved and its relation with context, individual differences and expertise.

The role of art expertise in aesthetic appraisal of representational and abstract artwork

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Paintings can exhibit a quality of 'visual rightness' or optimality, but they also present visual problems for the observer to solve in the process of grasping that optimality. Thus observer's expertise is a factor in aesthetic appraisal. Expertise also complicates the question of the dimensionality of aesthetic judgement. Berlyne and Ogilvie (1974) favoured a framework in which three general properties underlie such judgements, of which *Uncertainty* (Complexity) and *Arousal* are clearly influenced by expertise. A more elaborate scheme (Marković, 2011) organised 12 aesthetic dimensions into three broad domains – perceptual, cognitive / semantic, affective. To examine the question further, we asked 30 expert and 34 non-expert judges (Arts and Psychology students respectively) to rate 24 paintings on six evaluative / affective semantic differential scales. Twelve paintings were *Representational* (e.g. Bellow, Dix, Hopper, Petrov-Vodkin) and 12 *Abstract* (e.g. Braque, Klee, Leger, Marc), all from 1900-1930s Western art. Relative to experts, non-experts rated *Abstract* artworks as less *Interesting, Beautiful, Informative* and *Sophisticated*, distinguishing them more markedly from *Representational* works. When the data were represented as prototypal expert and non-expert ratings, factor analysis reduced these to a two-factor solution. The first factor, contrasting *Abstract* and *Representational* paintings, appeared more salient for non-experts. The second factor, *Warm-Cool*, conveyed a chromatic palette quality, separating warm, vibrantly-coloured paintings from those with a cool, blue-dominated or dull palette, and was more salient for experts. An alternative factor-analytical pathway, representing the data as prototypal profiles of painting ratings, confirmed that experts used the scales to make sharper distinctions: While non-experts focused on qualities discriminating *Abstract* from *Representational* paintings, experts appraised these two types of art similarly. We conclude that appreciation of art by experts involves 'cognitive mastery', more complex, higher-dimensional schemata which equip them with more sophisticated strategies for parsing 'visual rightness' from an image (Leder et al., 2004).

Statistical properties of artworks

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Large sets of artworks are characterized by a specific pattern of statistical image properties, for example, a scale-invariant Fourier spectrum, which resembles that of natural scenes, intermediate complexity, intermediate to high self-similarity, and low anisotropy of luminance gradient orientations. In my talk, I will review these findings and diverse experiments that are designed to test whether some of these statistical properties are perceptually relevant. First, electrophysiological experiments suggest that face learning and representation is facilitated if face images possess the Fourier spectra of natural scenes. Second, faces in front of random noise with natural Fourier statistics are perceived as more attractive. Third, we compared a set of original abstract artworks with counterparts, in which the pictorials elements were shuffled; the original artworks, which are perceived as more harmonious, are more self-similar than the shuffled versions. Last but not least, preferences of individual observers for abstract artworks can be related to the statistical properties of the artworks. These results suggest that the statistical image properties observed in visually pleasing stimuli, such as artworks, play a role in (aesthetic) perception.

Aesthetics of tangible interaction

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Most of the studies on aesthetics focus on simplified perceptual characteristics of the stimuli, in static conditions, and primarily centres on the visual sense. However, aesthetic experience derives from a combination of factors and it is related to the full hedonic experience. We suggest that to unveil aesthetic primitives it may be convenient to study stimuli involving more than one sense at the time, in compound stimulation, and the aesthetics primitives may be derived by analysing the interactions among the stimulations. To do this we measured the aesthetic experience of Hybrid Objects (HOs); which are physical artefacts that exhibit behaviour when handled. The aim of the research was twofold, firstly to test whether the aesthetic features found in simple stimuli, stimulating each sensory modality in isolation, also emerge in compound stimulation; and secondly to explore whether there exist aesthetic preferences for specific objects' behaviours. The following variables were systematically manipulated: 1) HOs' contour (rounded vs. angular); 2) HOs' size (small vs. large); 3) HOs' surface texture: (rougher vs. smooth); and 4) HOs' behaviour (Emit a light, Play a sound, Vibrate, and Quiescent). The results showed that vibrating objects are preferred over lighting and sounding objects. An overall look at all the interactions reveals that HOs' behaviour is the dominant factor as it influences aesthetics more than any other object characteristics and underlies the relative importance in aesthetics preference of haptic processing. The results did not confirm the size and smoothness effects previously reported in vision and touch, respectively; suggesting that for some stimulation the aesthetics primitives that emerge in isolated conditions may be different in compound stimulation. Results however corroborate the smooth curvature effect emerged in isolated conditions and are in support of the hypothesis that this is a genuine preference for curvature rather than a dislike for angular shapes.

A causal role for action observation in object valuation

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We like an object more when we see someone else reaching for it. To what extent is such a preference for that object causally linked to the brain activity triggered by the observed action? We set out to answer this question by comparing participants' preference for items that were (or were not) reached out for by other individuals, while the inferior parietal node of the action-observation network (AON) was stimulated by means of repetitive transcranial magnetic stimulation (rTMS). As neuroimaging research implies that the AON is critical for the representation of others' actions, we tested its involvement in mediating subjective preference with rTMS. Results showed that the effect of rTMS varied depending on whether objects were or were not reached-for: rTMS changed the preference for objects reached or grasped by another individual, while it had no effect when the same objects were not the target of someone else's actions. This outcome functionally relates activity of the action-observation network to object valuation, thus providing first evidence that the former plays a causal role in defining human subjective preference.

Aesthetic responses to computer-generated and man-made art

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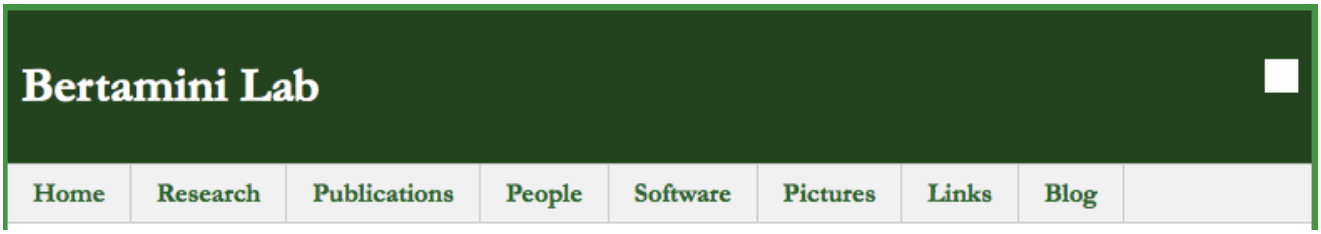
As artificial intelligence (AI) technology increasingly becomes a feature of everyday life, it is important to understand how creative acts, regarded as uniquely human, can be valued if produced by a machine. The current studies sought to investigate how observers respond to works of visual art created either by humans or by computers. Study 1 tested observers' ability to discriminate between computer-generated and man-made art and then examined how categorisation of art works impacted on aesthetic preference, revealing a bias against computer-generated art. In Study 2 this bias was reproduced in the context of robotic art, however it was found to be reversed when observers were given the opportunity to see robotic artists in action. These findings reveal an explicit prejudice against computer-generated art, driven largely by the kind of art observers believe computer algorithms are capable of producing. These prejudices can be overridden in circumstances in which observers are able to infer anthropomorphic characteristics in the computer programs, a finding which has implications for the future of artistic AI.

Keywords: image statistics, computer art, intentionality, edge distribution



There has been visual research in Liverpool since the 1890s when Charles Sherrington, in between Nobel prize-winning experiments revolutionising our conception of the nervous system, did work on the interactions of simultaneous contrast, critical flicker fusion frequency and binocular fusion. While Sherrington's visual experiments were narrowly focused, he established the significance of their results for understanding of the nature of vision and human behaviour. It is this tradition of using laboratory research to provide insights into the nature of perception and action in the real world which we are continuing into the twenty-first century.

For more information about work in the Bertamini lab please visit: www.bertamini.org/lab

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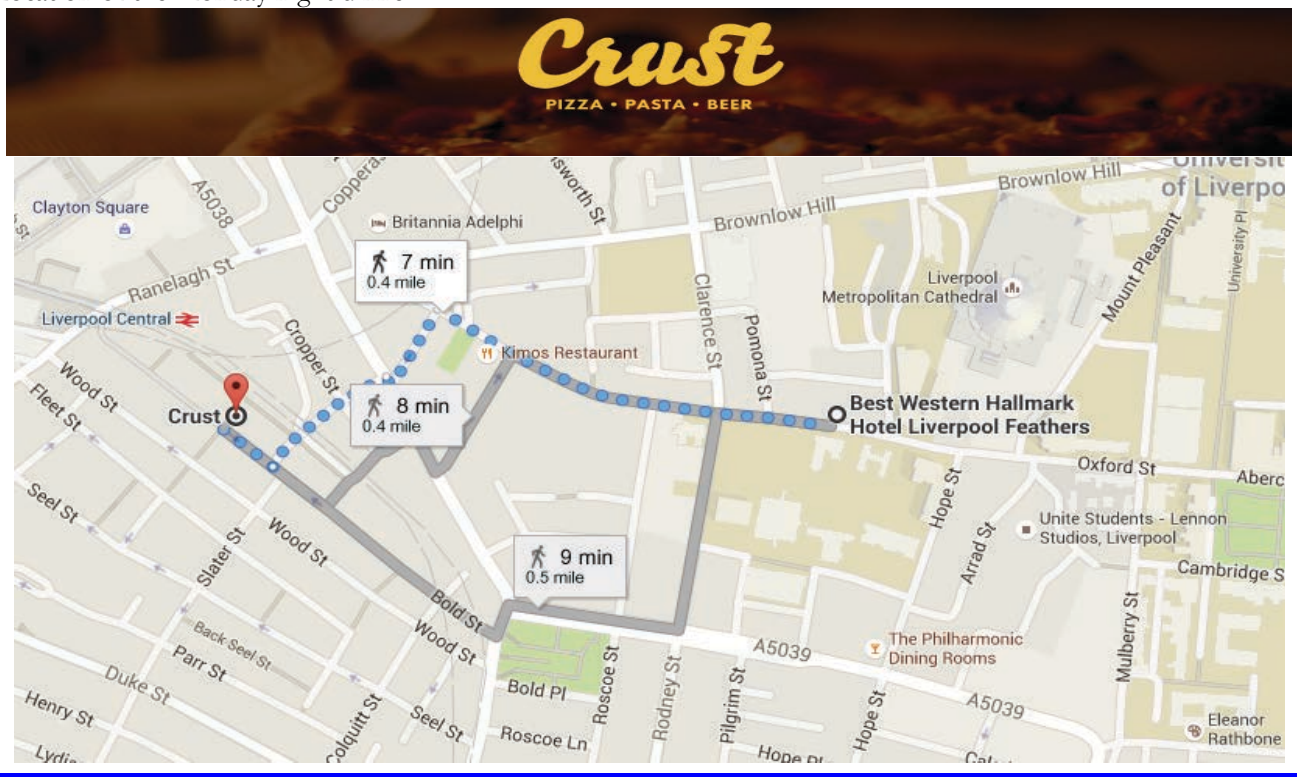

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