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# Vision and reality: relativity in art

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## Abstract

Artist and researcher, Robin Hawes, presents a recently completed art/science collaboration which examined the processes undertaken by the eye in providing sensory data to the brain and aimed to explore the internally constructive and idiosyncratic aspects of visual perception. With the physiology of the retina providing inconsistent quality of information across our field of view, the project set out to reveal the disparity between the visual information gathered by our eyes and the conscious picture of 'reality' formed in our minds. The paper will map out the psychological, physiological and philosophical basis for the research, as well as presenting images produced by the project. In essence, each time someone contemplates a work of art, the work of art is re-constructed 'internally'. This project set out, in part at least, to make 'visible' this hitherto internal, idiosyncratic, unique and unshared neurological event.

Keywords: contemporary art theory and practice, eye-tracking, evaluation, neurology, philosophy, psychology

## 1 Introduction

As an artist and researcher, I was particularly pleased to note that the call for papers which led to the present article included those who might want to question the very idea of 'evaluation' in the arts. While the reception afforded by an audience to any work of art is now an inescapable part of the modern practitioner's consideration, still the notion of 'value', and how this might be assessed, for me, raises questions that lie at the heart of my art practice and research interests. Indeed, it is the possibility of the playful unpicking and reconfiguring of our concepts of the subjective and the objective that motivates me to produce art in the first place.

My art practice was originally born of a fascination with psychology and, in particular, the ways in which our individual subjective experiences of an 'externalised' object world both influence and inform the construction of our identities and inner 'sense of self' as we develop from childhood. In essence, I wanted to explore the question: where, as individuals, can we really be said to exist; within our own unique internal world or the external world we share with others?

The research project I will describe here may, on the face of it, seem familiar, as it involves using the ubiquitous 'eye-tracker'. The use of such familiar technology should not, however, obscure the real motivations behind this particular art/science collaboration. The purposes of the project, rather than to evaluate the art I produce, was in fact to use my artwork as a medium, via which we might uncover some of the counter-intuitive ways in which we, as humans, go about constructing our individual, and cultural, notions of the 'outside world'.

In using this technology to record the visual information gathered by volunteers whilst looking at a series of photographic artworks produced as part of my art practice, the aim was to use this data to then challenge common assumptions we might make about our abilities to gather information visually; to contrast and compare; to ultimately evaluate what we see. I wanted to explore whether it was possible to incorporate aspects of scientific knowledge within the creative process and produce new artworks that both implicitly and explicitly questioned their own (and our) nature, to question our understanding of the nature of ‘reality’ itself.

In any attempt to evaluate a cultural artefact or our experience of it, we first need to have a clear understanding of the nature and extent of the information it is we are gathering and the ways in which we then go about making sense of it as humans. Without such an examination, it is unlikely we can begin to assign value or any amount of significance to the artefact with any real degree of confidence.

So, in describing just some of the ways in which evolution and the human brain have shaped the nature of our internal experience and our understanding of the external world, relative to our species, I hope to provoke interest in the nature of our internal experience and indeed the nature of ‘external reality’ itself. Obviously such big questions need careful introduction and require a clear context, so I will first briefly précis the role psychology has played for me, as an artist, in revealing the intimate connections that link our inner lives and the outside world. A short explanation of various aspects of our human physiology and brain function will then shed some light on how these elements ultimately direct our internal ‘world-view’. I hope this will provide for a better understanding of the methodology and philosophical perspective that underpin this cross-disciplinary collaboration.

In the last part of the paper, I will map out details of the research project entitled *Private*

*View: The Nature of Visual Process*. This was an art/science collaboration between myself and Dr Tim Hodgson, who is Associate Professor in Cognitive Neuroscience at the School of Psychology, University of Exeter, a project that ultimately resulted in the use of eye-tracking technology to create new works of art.

## 2 The psychological picture

My initial interest in psychology was born of a life-long personal struggle with anxiety and depression, and subsequently, in a fascination with the therapeutic processes that helped me gain a better understanding of this emotional disorder. What I learned from this process is that it is the *conflict*, between our interior lives and the external world, which drives the moulding of our identities as we develop from childhood. That is to say, it is largely our experiences that shape who we are and how we view the world outside (Beck 1989).

So, for me at least, speaking as an artist, it was the science of psychology that introduced me to the idea that my life-long need to *create* was, in fact, a direct consequence of the need to make sense of the world, to produce some order from chaos, a way to explore what it is to be human (Ehrenzweig 1967; Gombrich 1979; Storr 1972).

### 2.1 Art as a means of exploration

My early art practice initially centred around the production of a series of surrealist objects which explored the inherent human need to continually define the world that surrounds us (Craib 1998; Ehrenzweig 1967; Storr 1972). In using the cube or square as a metaphor for identity or the individual, I quickly started to cement the idea that we are all in some way containers, with an interior and an exterior.

The art I began to produce at this point, could perhaps best be described as an expression of this divided world, an exploration of inner and outer, and the dynamics of this

relationship. I began to produce a body of work that contained an implicit reference to an internal space, the ‘unlimited within the limited’ (Kapoor 2000). I was aiming, in essence, to unravel the paradox that existing in two realities presents us with, whilst also evidencing the frustration and futility of a life spent trying to bridge the gap between these two worlds.

The developmental nature of our internal experience as set out by the psychologists, becomes more significant when we realise that our mental resources share the same vital properties as all organic life. “Not only do neurons develop new connections as part of [our] normal growth. . . but their connectivity continues to change under the influence of experience” (Onians 2007, p.3). New neurons grow and strengthen and old ones die back, depending on the frequency with which they are stimulated. The organ that constructs our internal world view has its very physical structure affected by our everyday actions, feelings and thoughts, indeed, by all our sensory experiences, whether conscious or unconscious (Llinas 2002). So given this picture of a divided world provided by psychologists, my inevitable next step in this exploration was to go on to learn more about the *physiological* means via which our ‘internal’ experience and the ‘external’ world are separated — the brain and its various modes of sense perception.

### 3 The physiological picture

At first glance, it is easy to see our brain as some sort of container, into which these highly developed senses simply pour information about the external world, so recreating a highly accurate mirror image of ‘reality’ in the conscious mind; a reality with which we interact directly from moment to moment.

Yet, we need only start to examine how the brain processes external sensory information and we can begin to reveal a rather more

complex and unnerving picture of what our everyday existence may consist of (Hoffman 2000; Motluk 2005).

On the face of it, to assume that the primary goal of vision is to recover as many properties of the external world as possible and so recreate a complete replica of it inside our heads, may seem perfectly plausible. Yet, if we take a moment to view the human brain within the context of an evolving species, then the notion that evolution would produce such a vast and all encompassing functionality, for just one species, starts to seem much less plausible. “It’s as well to remember our minds have not fallen ready-made from the sky. . . they have a history that weds them to the nature of the environment in deep and influential ways” (Barrow 1997, p. 5).

Far from being a passive chronicler of what happens outside of us, the brain is an aggressively active participant in generating our experiences — in creating reality (Hoffman 2000; Phillips 2005).

Indeed, rather than mirroring the world outside, the various aspects of visual information, such as colour, depth, motion and form, are all processed separately and at different rates in different parts of the visual cortex before being combined and available to the conscious mind (Zeki 1993). In understanding this, it soon becomes inescapable that the notion we exist within a ‘commonly experienced’ reality is in fact an illusory one. Two aspects of the physiology of vision can be used to illustrate this.

#### 3.1 Human vision

While vision may be commonly experienced as a smooth and steady scanning motion, by the eyes, of the complete panorama before us, the actual physiology of vision reveals something very different (Barlow and Mollon 1982; Gregory 1997; Hoffman 2000). Ganglion cells in the retina send their signals through long nerve fibres to the brain. These fibres lie *in front*

of the light-sensitive rods and cones and converge to leave the retina through a single spot just offset from the centre of our visual field. This part of the retina contains no rods and cones, so creating a ‘blind spot’ in our visual fields (Barlow and Mollon 1982).

If our vision was of the same high definition throughout our visual field there would have to be so many ganglion cells that the blind spot would be half a metre or so in diameter! (Hodgson 2007) So instead, it is only in the very centre of our retina — known as the fovea — where these cells are densely packed. Visual resolution tails off rapidly from this central region, which amazingly, covers no more than one degree of our visual field. This is equivalent to looking at something the size of one’s thumbnail at arm’s length (Gregory 2005).

Also, rather than smoothly scanning the outside world, our eyes, using this high-resolution centre of the retina are, in fact, largely engaged in a continual point-to-point staccato sampling of small sections of the visual world. We can make up to five of these rapid movements or *saccades* per second (Barlow and Mollon 1982).

It is the brain, rather than the eye, that constructs the consistent, smooth and continuous high-resolution visual experience that we seem to experience. This has been described as the brain producing an internal ‘hypothesis’ of what lies outside of us, often getting things wrong and even filling in the blind spot, for example, by making its best guess about what should be there based on past experience and our current surroundings (Gregory 1980). Inherent in this hypothesis, which is under continual revision, there remains a large degree of assumption about our immediate environment. Should this internal hypothesis be challenged in any significant way, then our brain’s attentional capacity to investigate triggers these saccadic eye movements which confirm or revise our internal assumptions.

The brain’s direction of our visual attention is a pre-conscious process (Ellis 1999) and

therefore never affords us the opportunity to ‘experience’ the paucity of our vision outside of the central point of focus, or indeed the continual interruption of vision inherent in the eyes’ saccadic movements. That is why our internal assumptions never feel like assumptions and our illusion of seeing a wide-field of view in detail, never feels like an illusion (Dennett 1993).

If we look at other ways in which the brain processes and interprets external information, we start to see that this example is not just a small quirk of human vision, but is actually symptomatic of the illusory nature of our everyday perception (Ramachandran and Blakeslee 1999). While I have highlighted aspects of our visual sense, this can and should be seen to apply to any means via which humans, or any other organism for that matter, gain information about their environment.

### 3.2 Perceptual illusions

Visual perceptual illusions are one way that cognitive scientists have begun to uncover the brain’s functionality, but they also serve the non-scientist in demonstrating how visual experience is a construction inside our heads, rather than a passive ‘reflected’ picture of what exists outside. A basic example of this phenomenon is the Necker Cube, which demonstrates that while a flat two-dimension line drawing of a cube remains unchanging in the object world, our brains present the conscious mind with more than one ‘three-dimensional perception’ of the cube – flipping, quite spontaneously, from one spatial orientation to the other (Barrow 1997, p. 12; Gregory 1987, p. 508).

## 4 The philosophical picture

For me it is this description of the brain’s functionality as providing no more than a hypothesis of what lies beyond (Gregory 1980) — one that is unique to the individual and constructed separately from any true nature of

reality — that must foreground any meaningful discussion of what we each perceive, and subsequently evaluate, be it in the arts or just going about our everyday lives. The necessary illusion of a ‘common experience’ that has enabled our species to survive successfully over millennia is still, nonetheless, an interpretation that produces a reality which is unique and relative to the individual. In any discourse about art and artefacts it is, in fact, ourselves (our internal universes) that we are contrasting and comparing, that we are ‘evaluating’. The artwork that we choose to contemplate and imbue with meaning and value, for each of us exists only in the chemical and electrical exchanges of our brains and the unique and fleeting world of conscious experience.

As the philosopher Immanuel Kant concluded over two hundred years ago – without the aid of neuroscience, it has to be said — things which we see, are not by themselves what we see. It remains completely unknown to us what the objects may be by themselves. In actuality, we can know nothing, but our manner of perceiving them (Guyer and Wood 1998).

## 5 The research project

The research project *Private View* sets out to express these essentially philosophical ideas ‘visually’, yet in terms that also embody current scientific knowledge within the creative process.

Part of the process was to explore just how limited the information is that the brain

is presented with from moment to moment via the retina, revealing how much of what we see and therefore perceive of the outside world might actually be grounded in previously acquired, idiosyncratic and internally generated knowledge. At just two degrees away from the central point of focus, visual acuity (sharpness) across the retina is already more than halved, and beyond that, falls away even more rapidly. So what does all this mean in real terms, when applied to looking at the outside world?

The left side of Figure 1 shows a Vincent van Gogh painting as the detailed image we all recognise. However, if we then apply the loss of visual acuity, as mapped across the retina, we then begin to see something more akin to the actual quality of visual information, processed by the retina during each foveal fixation, if our eyes were to fixate on one particular point at the centre of the image. The size of this central point of focus will of course depend on how close the eye is to the picture and what degree of the visual field it covers.

Using an *Eyelink II* eye-tracking headset, we recorded a number of individuals whilst they viewed a series of images for ten seconds. The readings were taken at a size and distance akin to a gallery setting, with the image covering 40° of the viewers’ field of view.

We did a number of test viewings in the initial part of the project, using portraits and landscapes as well as more abstract images. We used about 40 images in total throughout the project.

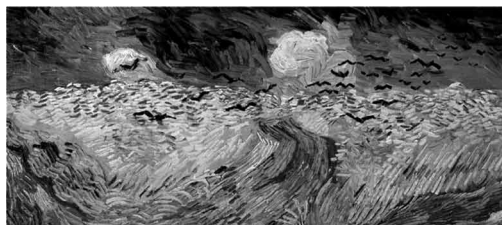


Figure 1. Left image: Van Gogh: *Wheatfield With Crows Under Threatening Skies* (Van Gogh Museum, Amsterdam, used with permission). Right image: a simulation of the extent of the picture that is gathered at any one moment by the retina — the white circle indicates the point of focus.

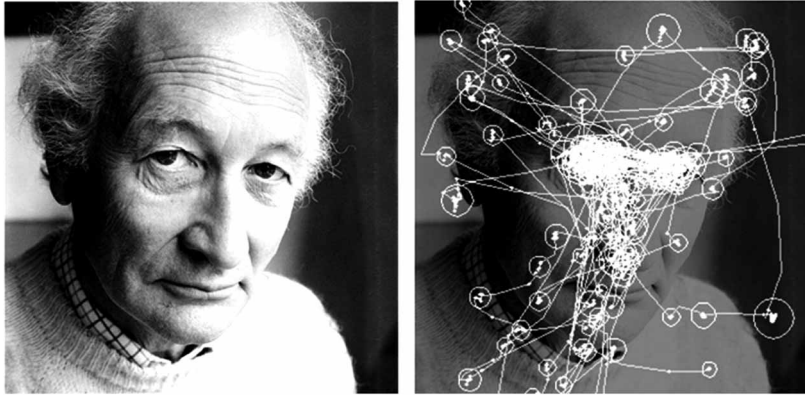


Figure 2. Six combined viewings of one test image. Photograph by Robin Hawes.

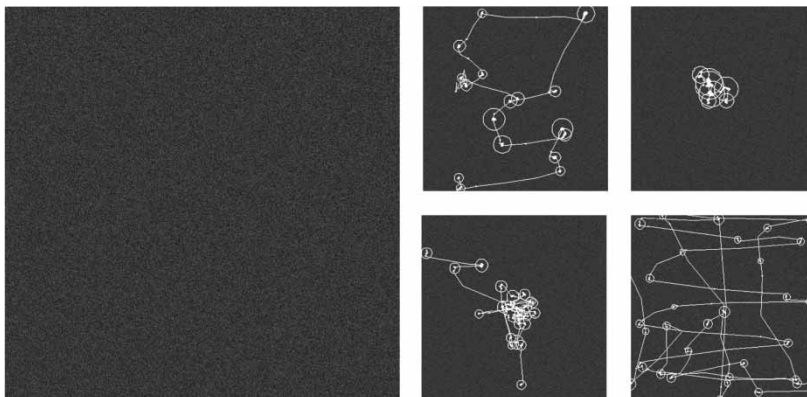


Figure 3. An image of a plain red square, plus four different individual viewings recorded by the eye-tracker.

It is interesting to note at this point that pictures that might be said to depict some commonly agreed and understood external representation such as a portrait or landscape, produced very similar patterns of exploration by each individual. An overlay of six different viewings of one portrait (Figure 2) shows a very common triangular pattern of viewing between the eyes and the mouth (the circles show the foveal fixations and the lines between them the connecting saccades).

When we presented images of a more ambiguous or abstract nature where no definitive external representation was apparent,

viewing patterns started to reveal the idiosyncrasies of each viewer (Figure 3).

### 5.1 Creating art with the eye

The next stage of the project was to record individuals' eye movements as they viewed a new image which had been specifically produced in response to the ongoing research findings. The early part of the project, for me as an artist, was in establishing what type of image would work well under this process. It became clear from early tests that the image needed to be detailed and colourful, to evidence the loss of resolution across the retina, yet abstract or

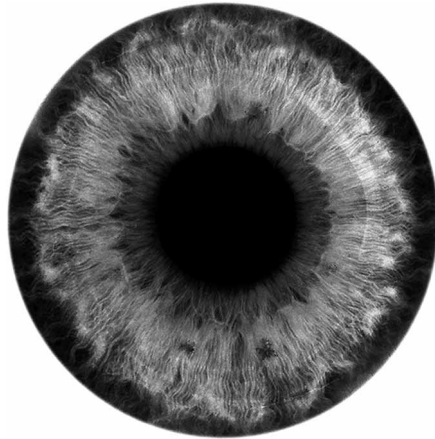


Figure 4. *Iris*, 2007. Photograph by Robin Hawes.

ambiguous enough to demonstrate idiosyncratic results from viewer to viewer. After much experimentation, I created the original photographic artwork *Iris* (Figure 4) specifically for use in the project.

Six volunteers were recorded while contemplating this image for ten seconds and the data was then used to simulate the actual visual information accumulated and processed by the retina over those ten seconds. Figure 5 shows one person's point of focus mapped by the

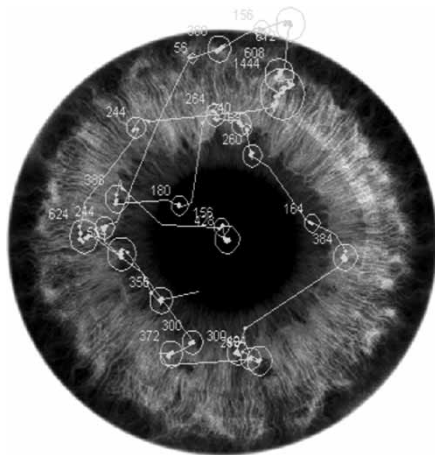


Figure 5. A 'trace' pattern recorded by the eye-tracker, over a ten second viewing.

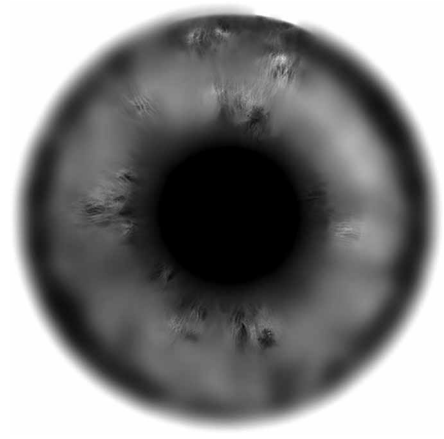


Figure 6. *Iris (after Tim Shear)*, 2007. Artwork by Robin Hawes.

eye-tracker while contemplating the photographic artwork *Iris*. Figure 6 is the same image, but degraded specifically to match the physiological information provided by the retina to the brain, effectively creating the next new artwork of the project.

The same process was then applied to a series of other individuals' viewings, producing the project's main outcomes — six newly created versions of the original *Iris*, 40 cm × 40 cm. As each viewer gathers a unique and idiosyncratic experience, each creates a new and unique version (Figure 7).

In addition to these one-off artworks, a set of animations revealing the ten-second creation process were also produced in the form of digital animations and six flicker books.

## 6 Conclusion

In essence, each time someone contemplates a work of art, that work of art is re-constructed internally. This project set out, in part at least, to make 'visible' this hitherto internal, idiosyncratic, unique and unshared neurological event. The outcomes are to some extent of course, an artistic conceit, as the project plays upon just one small aspect of the long and complex process we undergo to perceive the



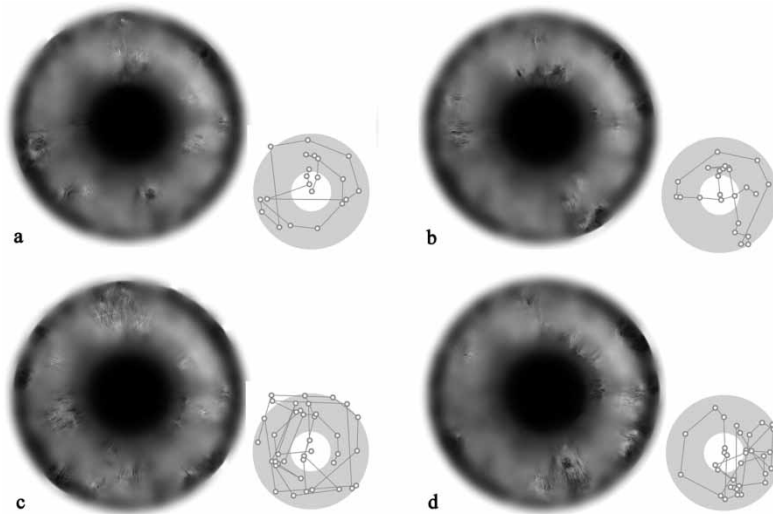


Figure 7. Four of the final artworks from *Private View* by Robin Hawes. a: *Iris (After Andrew Currie)*, 2007; b: *Iris (After Paul Ridout)*, 2007; c: *Iris (After Kate Southworth)*, 2007; d: *Iris (After Ravi Bains)*, 2007. The diagrams beside each artwork are maps of the 'point of focus' recorded by the eye-tracker.

world 'visually'. Indeed, many crucial elements of this neurological journey still remain a mystery to science (Dennett 1993; Hoffman 2000; Zeki 1999). However, I hope the project helps to reiterate the point that in the process of evaluating anything we perceive, we must first appreciate the extent to which we are not modelling a 'replica' of the external world or any artefact within it, but our 'species specific' and more importantly 'organism specific' *hypothesis* of it.

At the beginning of this paper I described how one of the aims of my art practice was to highlight the paradox that existing in two realities (internal and external) presents us with, whilst also evidencing the frustration and futility of attempting to bridge the gap between these two worlds. And of course the ultimate paradox of this project, is that having, in part at least, made 'visible' the relative and unique creations constructed by six different viewers and viewings of one original artwork, these new artworks, rather than being perceived and evaluated directly, can only now serve to prompt a further creative

process. One which will be undertaken by any new audience within their own unique 'neurological universes'.

Despite our innate intuitions to the contrary, modern neuroscience can provide us with no evidence of any kind of 'Cartesian theatre' (Dennett 1993), no magic corner of the brain where these snapshots of a visual puzzle are pieced together; no internal canvas where the artist's creation can become whole!

Seen in these terms, might it perhaps be more useful for us to begin to understand 'visual' art in terms of process; a temporal experience for both artist and viewer, much like that of 'performance' art or indeed music? This project then is presented as a starting point to explore these questions further and as the beginnings of a new approach or methodology with which to challenge our intuitive assumptions about our sense of the 'real'.

### 6.1 The bigger picture

How then might we best describe and embed our current notion of the 'real', as part of a bigger picture of our human nature? On a

species level, it is possible to see how evolution, over millennia, has resulted in humans being able to survive successfully within the terms dictated by Earth's environment, where the brain's inherent plasticity enables it to adapt to ongoing experience (Barrow 1997). In a similar way, yet at the level of a single organism, it could be said that for the individual to 'survive' successfully, both socially and culturally, they will inevitably adapt and develop a 'world view' that appears to chime with the cultural and social environment in which they have been raised. Indeed, these accepted meanings and values, determined by culturally negotiated rules of interpretation that we each acquire over the course of our lives are what makes it possible for our societies to function.

So what place for the artist in this evolving cultural jungle? The cubist painters Gleizes and Metzinger captured the sense of shifting cultural sands in their 'manifesto' when stating that

*...objective or conventional reality – this world intermediate between another's consciousness and our own – never ceases to fluctuate according to the will of race, religion, scientific theory, etc., although humanity has laboured from time immemorial to hold it fast.* (Gleizes and Metzinger 1964, p. 15)

Writing in 1912, they were mindful of the limits of influence artists might have in overturning concepts of 'reality' but hoped that "into the occasional gaps in the cycle, [they could insert their] personal discoveries and contribute surprising exceptions to the norm". Indeed, for me at least, to question and perhaps undermine culturally embedded views is where the role of the modern artist now lies.

Contemporary artists such as Richard Serra, whose towering curves of oxidised steel are now his artistic signature, or James Turrell and his explorations in light, personify the modern practitioner attempting to embody 'experience as art' (Noë 2000), where the viewer's perceptual experience becomes the 'content'

(Serra 2008). In describing his work Turrell (2008) reveals that counter to our intuitions, "we are part of constructing or building [the] reality in which we live, so — that which we behold, is actually something that we create". Seen in these terms, perception is best described as a kind of 'toolbox', which each of us then uses to manufacture our own reality (*ibid.*), and the work of an artist as not really about the making of paintings or objects at all, but in dealing with the state of our consciousness and the shape of our perceptions (Irwin 1972).

Representational art throughout history may have provided us with glimpses of mankind's unique and individual internal perceptions, yet it is perhaps because of the 'ease' with which we still recognise these diverse 'representations' of reality that they serve only to reinforce the idea that somehow the separateness of our experience is just a 'psychological' one. That beyond this, there remains some single physical truth that we might experience, even if we still then go on to *mis*-represent it in our artistic creations. This obscures and belies the evidence that modern neurological knowledge now provides. Far from being merely psychological or 'conceptual', the true extent of the separation of one human's existential 'reality' to another's can now be demonstrated as essentially a physical one (Greenfield 2000; Onians 2007). As Einstein remarked

*...physics treats directly only of sense experiences and of the 'understanding' of their connection. . . [indeed] even the concept of the 'real external world' of everyday thinking rests exclusively on sense impressions.* (Einstein 1936, p. 349)

So whilst it is in our very nature to evaluate what we experience, we must constantly remind ourselves that this purely functional process can never lead us to anything more than a *relative* truth. In falling for the illusion that the reality we inhabit is common to all of us, we deny and obscure the relative nature that lies at the heart of what it means to be human.

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