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BRINGING RECENT SCIENTIFIC UNDERSTANDING OF HUMAN VISION, TO THE EDUCATION OF DESIGNERS – A NEW AREA OF FUNDAMENTAL KNOWLEDGE IN THE ARTS?

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ABSTRACT:

Historically, scientific understanding about vision has helped to explain some aspects of how images work but given the complexities involved, this has been on a limited scale. However, much more is now known about the processes of perception and cognition and the question arises as to the extent to which this growing body of knowledge can contribute to creativity in art and design. Whilst traditional approaches to art and design practice remain as important as ever there is now an opportunity for knowledge about vision to be used more proactively.

This paper outlines an approach to establish clearer connections between vision science understanding and pictorial design practice using interactive multimedia and specially designed digital tools to make such knowledge more accessible to arts minded individuals. Examples are provided including two studies that demonstrate the bridging of visual science and visual art.

Key words: art: design: visual science

1 INTRODUCTION

1.1 SOME BACKGROUND

In recent years there has been a phenomenal expansion in knowledge about the human visual system (Solso, 1994: viii) and as much more becomes understood about the selective ways that the human visual system acquires information about the world, so the opportunity to use this understanding proactively in design also increases.

Developments across the visual sciences as a whole mean that considerably more is now known about how the human brain tries to make sense of signals it receives from the eye, and it is increasingly clear that what we see as ‘reality’ is not necessarily an accurate picture of the physical world, but rather an interpretation based on our own internal codes and experiences. ‘*We think that it is the world itself we see in our "mind's eye", rather than a coded picture of it*’ (Nicholls 1981:11-12)

Zeki has defined the purpose of vision simply as that of acquiring information about this world, based on a view that ‘the brain is no mere chronicler of the external physical reality but is an active participant in generating visual images according to its own rules and programmes' (Zeki 1999: 68). Research has shown perception to be a far from uniform process, being subject to the limitations of the eye and the ‘rules and programmes’ of the visual brain, a concept taken a stage further by Ramachandran in his Reith lecture on ‘The Emerging Mind’ (Ramachandran 2003). In this, he controversially, proposed a neurobiological hypothesis of aesthetics based on our responses to imagery being ‘hard wired’ into the brain’s circuitry (Ramachandran and Hirstein 1999). This paper however, is concerned with more established findings that are relevant to the processes of pictorial design. In general such findings relate to early image processes that involve form and organisation where David Hubel, Professor of Neurobiology at Harvard and Nobel Prize winner, in the foreword to Livingstone's Vision and Art' has gone as far as to say 'we now know in broad outline, if not in detail, how the brain begins to deal with the basic components of vision' (Livingstone 2002). The higher levels of aesthetics and cultural interpretation associated with subject matter and meaning are for the time being where 'the neurological trail goes cold' (Solso 1994: 254). Figure 1, based on the useful arts theory of an image comprising subject, form and meaning (Ocvirk 2002: 33-34) shows the relationships.

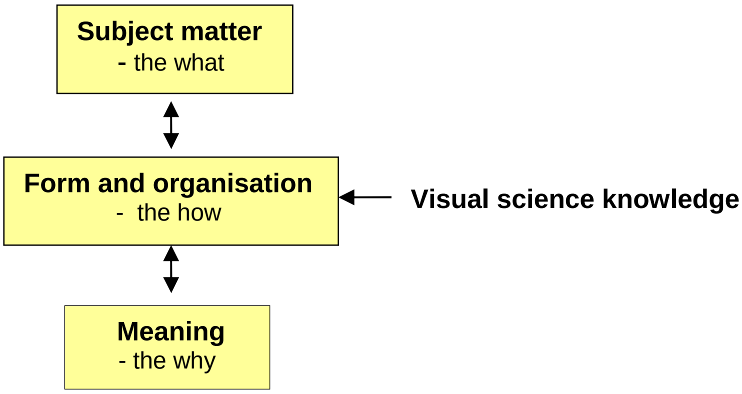

Figure 1: Visual science knowledge and image design

1.2 THE CONCEPT OF VISUAL GRAMMAR

In referring to 'visual grammar' in this paper we use the words in the sense implied by Zeki's 'rules and programmes' in so far as they apply to the processes of perception and cognition. Figure 2 provides a well known example of what might be considered as visual grammar in

Figure 2 : Gregory's Dalmatian

action. This image when first viewed may be seen as a meaningless collection of blots. However, as the brain searches automatically for meaningful relationships between its components, so a greater meaning can be inferred. In this process first outlined by the Gestalt theorists Koffka, Wertheimer and Kohler, the viewer adds value to the basic visual input so that the whole is greater than the sum of the parts – and in this case a dalmation can be distinguished. Whilst the study of such Gestalt mechanisms is well established, the example demonstrates just one of the automatic processes that are at work in vision. It is however, important to differentiate between well established knowledge such as this and the more recent understandings emerging from vision science where potential for use in pictorial design has yet to be fully realised. New findings are of particular interest although it can also be argued that a better understanding of established visual principles could also be usefully bought to the education of designers.

The following examples illustrate the distinction between established and new understandings that are relevant to creative design. Firstly, Ron Gonsalves's *Autumn Cycling* shown in figure 3 (Seckel 2004:115-119) demonstrates an interesting misuse of the tried and tested 'rules of perspective' (one of the many visual cues involved in the interpretation of depth). In this image, the artist has combined two views of the same scene from different perspectives that share a

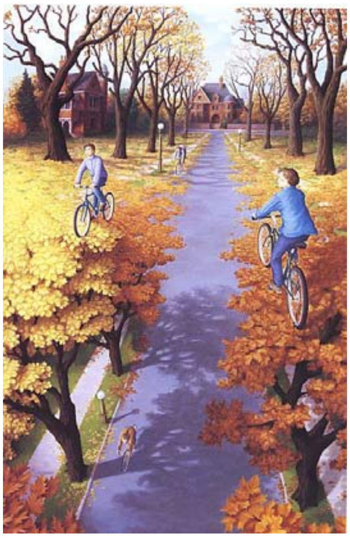

Figure 3 : Autumn cycling

common vanishing point. As can be seen the result is an impossible representation of reality that confronts the inbuilt mental models of visual grammar. The viewer is presented with an anomaly that conflicts with the established norms of reality and which therefore demand to be reconciled. The artist has knowingly misused the rules of visual grammar to create a mischievous but charming composition.

Figure 4, shows Ashiokii Kitaoka's 'Rotating Snakes' - a design that powerfully demonstrates the use of more recent understandings about vision into creative design that manipulates the visual system. Kitaoka, who is a respected visual psychologist, also happens to be a highly creative designer whose illusion art images have a growing following amongst scientists and artists alike. This is because they combine detailed understanding about vision with well crafted design (Kitaoka, 2007). In figure 4, knowledge about colour and design has been used to create illusion art where the image components seem to slowly rotate. This genre of illusion art is new and may be regarded as a bridge between visual science and the arts.

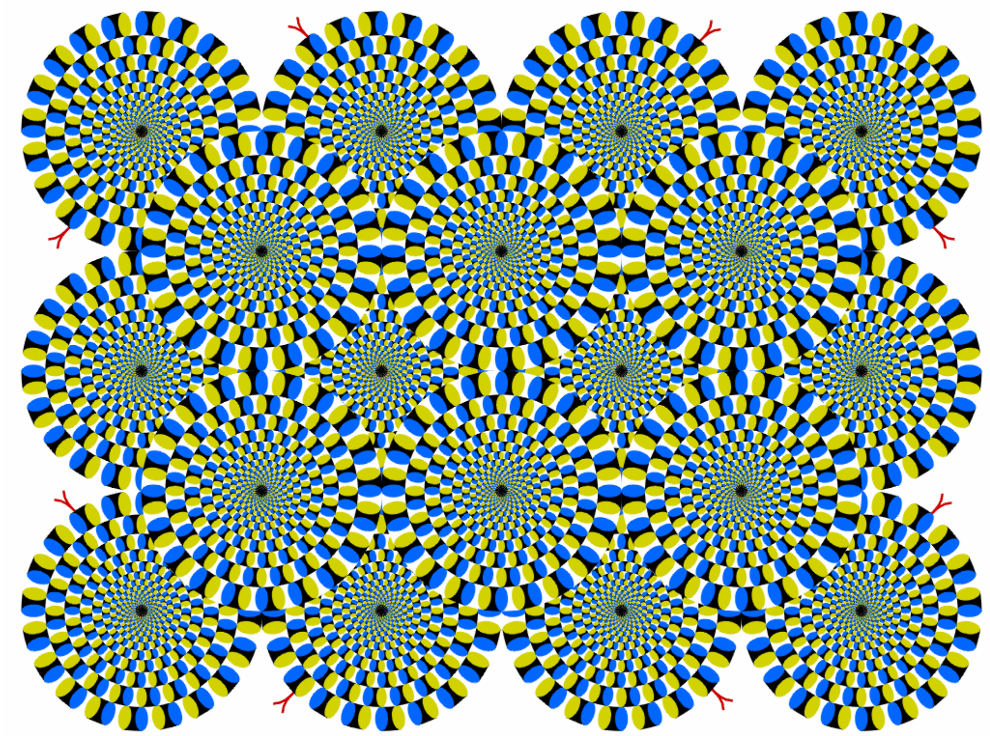

Figure 4 : 'Rotating snakes' - illusion art by Akiyoshi Kitaoka

1.3 THE NEED TO ESTABLISH A CLEARER BASIS OF UNDERSTANDING BETWEEN VISUAL SCIENCE AND VISUAL ART

It might be supposed that knowledge of the human visual system would be regarded as useful in design and even as a potential source for creativity. However, whilst designers use knowledge about form and organisation to control meaning and interest, understanding the visual processes behind this and how they might be adapted and used more proactively is in our experience, modest (Pickard 2004:10-19). Given the seemingly obvious connection between seeing and design, the question arises as to why this should be so.

The answer relates partly to the position of vision science within the traditional development of basic art theory and practice. The time honoured techniques and approaches that have evolved over the years are based on intuition, experience, experimentation and a blend of skills that do not rely on detailed scientific knowledge about vision in order to produce stunning results. Ockvirk's edited '*Art Fundamentals*' provides many examples illustrating this and the importance of visual awareness (Ocvirk, Stinson, 2002). Therefore, historically, vision science understanding has had only a modest contribution to make towards creativity, but given the rapid expansion in knowledge and technical advances seen in recent times this is unlikely to remain the case. So perhaps a more appropriate question now should be: what enabling steps are required to allow designers to make better use of science?

Recent writing about visual science has demonstrated that it is not difficult for scientists to communicate their subject to the non specialist reader. (Solso 1994; Gregory 1995; (Hubel 1988; Livingstone 2002 et al). David Hubel (the Nobel prize winning neuroscientist) believed that '*given two hours (he) could make anyone with a good high school education fully aware of the main accomplishments in the last half century of visual science*'. Whilst this might be an optimistic view, it is not difficult to envisage more attention usefully being given to the prominence of vision basics in design education. For this to happen we believe that there are a number of enabling steps that need to be addressed.

The first step is to be able to demonstrate more clearly that there is value for artists and designers in understanding the processes of vision and that such knowledge can be used creatively. A second step is to establish a conceptual framework that connects knowledge about vision with art and design practice. Such a framework also needs to addresses the dispersed and sometimes seemingly obtuse nature of scientific writing that sits across a variety of disciplines and which can seem far removed from art and design practice. A third step is to develop ways of making vision knowledge more accessible to artists and designers, so that fits with their intuitive mindsets and work practices. This paper outlines an overall approach to addressing these difficulties that is part of an ongoing programme at Sunderland University to establish vision science more clearly as a new area of fundamental understanding in the arts and particularly in design.

2 THE VISUAL SCIENCE AND VISUAL ART DIVIDE

Vision science research is by its nature a slow and methodical process that, ‘provides a neat, well defined but rather narrow beam of data in the light of which one attempts to explain much broader aspect of human behavior’ (Deregowski 1984: 8). Whilst some vision scientists such as Zeki may regard artists and designers as ‘experimenters’ in their own right, in reality the subjective nature of art is far removed from the objectivity of the scientific approach.

2.1 VISUAL SCIENCE UNDERSTANDING AND ITS RELATIONSHIP TO DESIGN

In examining the relationship between visual science and pictorial design practice, the authors set out to compare the ways that artists and designers use visual grammar in their work, with the scientific levels of visual understanding that underpin the principles involved. Figure 5 illustrates the basis of the different ways that designers can use visual grammar in their work where understanding of vision is only one of a number of factors that would to be brought to bear on design problems).

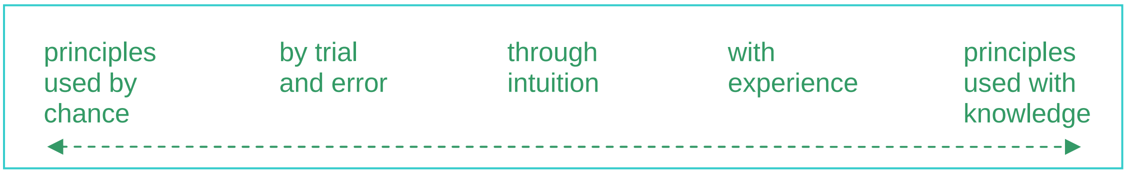

Figure 5 : The ways designers use visual grammar

Similarly, there are different levels of scientific understanding as to how the approaches to pictorial design work (figure 6). As can be seen, this can vary from a minimal (or non existent) to full understanding. By way of example it has long been thought that the use of ‘golden ratios’ in composition can improve visual aesthetics. However, this cannot readily be explained scientifically, whereas the rules of perspective are clear and can be rigorously applied.

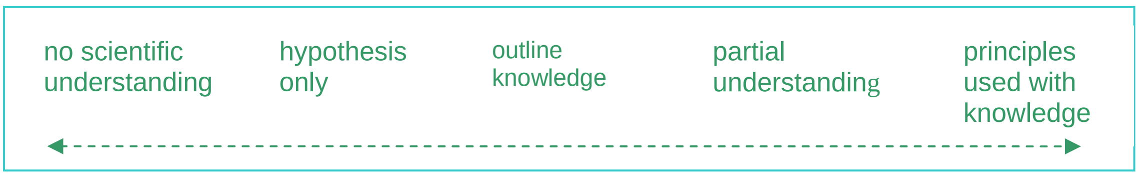

Figure 6: Scientific understanding of design approaches

2.2 VISUALISING THE GAP

When these two approaches are combined (figure 7), the applicability and relevance of visual science to design practice becomes clearer. *The unpremeditated, effortless spark of creativity does not arrive in an unprepared mind. It is the outcome of extensive learning and experience – a precondition for accurate intuition*' (Sadler 2007).There are many design practices that have a degree of scientific basis and these might in theory be plotted on this chart to show the current relationship between knowledge and use. By way of example, two such principles, 'golden ratios' and the 'rules of perspective' are shown plotted on figure 7. The difficulty of accurately locating these (and other design principles such as contrast, perceptual balance, alignment, grouping, etc) is immediately apparent. However, this is not the purpose of the chart which instead, is intended to indicate theoretically, the widely different levels of understanding behind the use of design principles and the potential for new understanding. As visual understanding grows, design principles can change their position and move toward the upper right quadrant of the chart where designers use principles that are underpinned with scientific understanding in a knowledgeable way. The quadrant diagram has its limitations, but is a way of visualising the gap between visual science and design and has provided a very wide (but not exhaustive) range of science-art related topics. In order to better understand how the two fields link together, there is a need to organise these topics into a framework which classifies where each area of knowledge is operating.

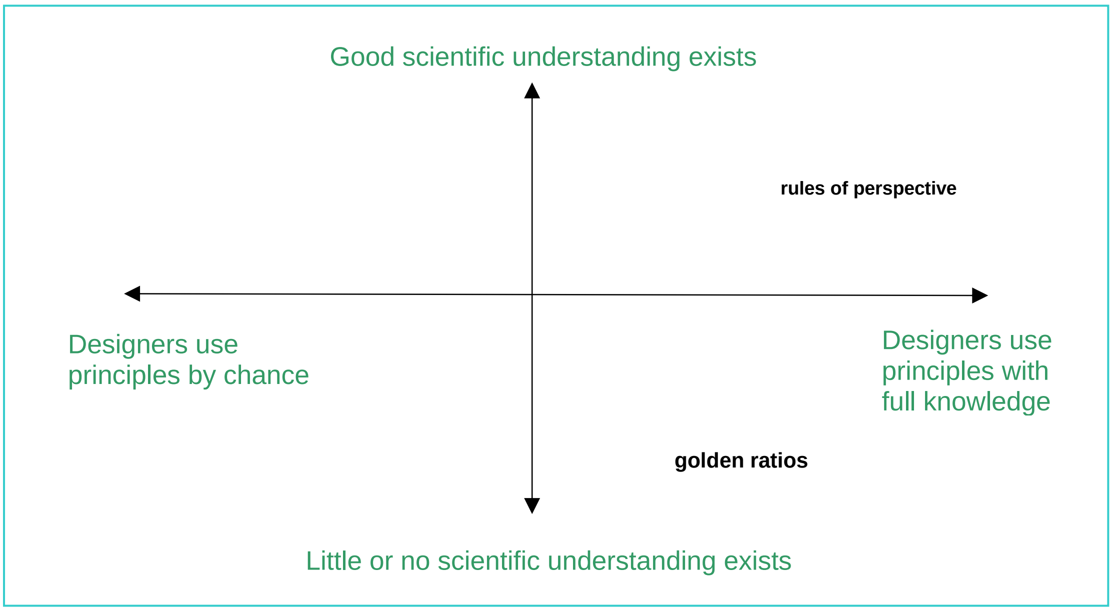

Figure 7: Positioning design practices with scientific understanding

3 BUILDING A FRAMEWORK TO LINK VISION KNOWLEDGE AND PICTORIAL DESIGN PRACTICE

The second enabling step to bring scientific understanding of human vision to the education of designers outlined in section 1.3 is concerned with the need for a framework against which the scattered and wide ranging (but useful) knowledge emerging from the visual sciences could be linked with how images are ‘taken in’ and with pictorial design practice.

3.1 THE FRAMEWORK

A conceptual framework is proposed in table 1 that connects visual art and design practice more clearly with visual science understanding, and which links to interactive multimedia examples, demonstrations and digital tools that make such knowledge more accessible to arts minded people. As can be seen from the column headings in the table, a number of stages of perception and cognition (relevant to objective design) are linked to properties of the visual system that have a bearing on the way that images are ‘taken in’. The headings in column three are largely about form and composition, and represent growing areas of established and new knowledge that has potential for guiding objective design. The language of these headings may also be seen to connect to that found in traditional pictorial art and design theory where however it’s precision and objectivity can be seen to vary considerably across disciplines (Ocvirk and Stinson, 2002; Lidwell and Holden and Butler. 2003; Mullet and Sano, 1995; Schneiderman 1998)

3.2 HOW THE FRAMEWORK CONNECTS UNDERSTANDING TO PRACTICE

Whilst the precise format of table1 may leave room for debate, its potential usefulness lies in its ability to link the processes of vision, research and practical design. The keys to this are the links between the table headings and suites of interactive multimedia demonstrations, examples and toolsets. These interactive movies and tools explain, show or analyse different aspects of visual grammar in action as well as containing more detailed references from research papers, journals, books and other source of information about established and new vision science findings. To date a considerable number have been created.

	Stages of perception and cognition	Visual aspects relevant to objective design	Related visual system properties
1	Initial impression	**First impressions are** initially concerned with spatial organisation, recognition, differentiation of subject and background, and in determining what is to be looked at in detail.	• foveal vision • peripheral vision • image resolution • perceptual effort • figure ground sort • connectiion
2	Discerning the elements of form	**Establishing the essential detail** in an image can be achieved through the use of the elements of form. These are the building blocks that register strongly in early visual image processing.	• colour recognition • line and contour sensitivity • contrast detection • texture recognition • shape recognition • movement detection
3	Seeing meaningful relationships	**Making use of visual hierarchy:** Structure and organisation in an image is sought out by the visual system in order to make sense and add meaning. This can be used purposefully in design.	• grouping • symmetry, • continuation • orientation sensitivity • proximity • scale • common fate • closure
4	Picking up visual cues	**Enhancing recognition**: The visual brain uses visual cues to help facilitate recognition of object and their properties. Many of the rules and codes for this (eg. depth perception) are effectively 'hard wired' into the visual system and so can be manipulated to enhance effects.	• perspective • Shading • occlusion • haze, • texture • reflectivity • horizon • steriopsis
5	Leading the eye	**Guiding the eye:** It is possible to influence or direct a viewer's eye to look at specific areas of an image. This can be achieved by a variety of techniques that point, start of stop gaze travel. Overall image organisation can be designed to direct the viewer's attention to relevant content and to influence perception of it.	• alignment, • connectedness • grouping • use of space • visibility • colour • hierarchy • emphasis • scale
6	Enhancing meaning	**The meaning** or message in an image can be further enhanced by the overall way that form and composition is used to connect subject matter to intended interpretation.	• law of pragnanz • signal noise ratios • use of icons • emphasis • visibility • organisation • others from above
7	Control of interest	**Response to expressive content:** can be influenced by aspects of form and composition. These can be used proactively in design to influence aesthetic appreciation of the subject matter.	• rule of thirds • use of ratios • fibonacci series • symmetry, • aesthetic illusion • balance • perceptual effort • visual puzzle

Table 1: Connecting understanding about vision with design practice

In practice, these multimedia movies would be accessed by clicking directly on a heading in the table or from an accompanying DVD. This use of multimedia is discussed in more detail below but two examples can be viewed on the World Wide Web here, so that if you are reading an electronic version of this text with access to the web, then click on 'Depth cues' or 'Orientation sensitivity' or refer to the website addresses in the bibliography (Pickard 2007; Pickard 2006)

4 USING INTERACTIVE MULTIMEDIA – THE VISUAL APPROACH

The third enabling step in bringing scientific understanding to the education of designers is that of making such knowledge accessible in ways that fit with their intuitive mindsets and work practices. To this end interactive multimedia is used in a number of different ways.

4.1 MAKING VISION SCIENCE FINDINGS ACCESSIBLE

We felt it was important to show how both established and new findings in visual science can be used in creative design through multimedia demonstrations of visual principles and image case studies for each of the vision stages in the table. These are intended to show how 'visual grammar' works and has actually been used in practice, and how the stream of new findings about vision (combined with new technologies such as eye tracking), can guide objective creativity. An example that demonstrates the application of new understanding about vision in explaining unusual visual effects is provided in figure. 8. This shows Richard Anuszkiewicz's

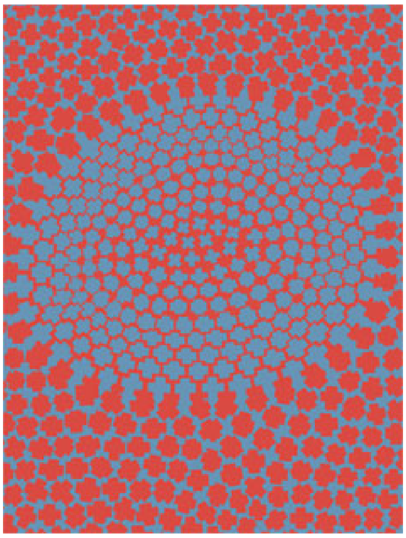

Figure 8 : Anuszkiewicz's *Plus Reversed*

‘Plus Reversed’ an image whose aesthetic depends on the use of closely equiluminant colour. When viewed at larger size and true colour, this picture appears highly unstable with the image seeming to float around in an uncomfortable, jittery way (equiluminant colour demo 2007). The explanation for this unusual effect lies in the use of closely equiluminant colour. In the human visual system, light hitting the retina generates separate signals for colour and luminance, subsequently using the former for recognition purposes and the latter for spatial location purposes (Livingstone and Hubel 1988; Livingstone 2002: 46-52). At equiluminance (when colours have equal brightness), whilst objects are clearly visible by virtue of their colour, difficulties occur in locating them precisely because luminance related spatial data has been lost (Livingstone 2002: 66, Hubel and Livingstone 1987; Cavanagh 1991). It is this that gives rise to unusual visual effects variously described by three renowned vision scientists as “jelly like, colloidal” (Cavanagh, 1991: 234), “unstable in contrast and jazzy” (Gregory, 1977: 113-119) and “pulsating and eerie” (Livingstone,2002: 38).

4.2 MAKING MORE COMPLEX SCIENCE CONCEPTS ACCESSIBLE

Whilst some new vision science findings can be readily explained to non scientists using a visual approach, others can be more complex. In the example of Anuszkiewicz's ‘Plus Reversed’ above we were able to demonstrate the visual effect very powerfully by use of interactive controls to change the luminance values of one of the colours and with it the stability of the picture. However, many designers would in practice, want to take this further, perhaps to experiment with equiluminant colours themselves in a ‘hands on’ way and this requires a different approach.

4.2.1 The approach

Our approach to this has been to create digital tools that act as interfaces between narrow scientific principles and the realities of practice. These can be used for analytical or for creative work. In setting out to design prototype interface tools we elected to use Adobe’s Director software (Adobe 2006) which is an industry standard creative package used extensively in multimedia, animation and graphic design. It has its own powerful ‘Lingo’ programming language, an ability to store data, and can be used to manipulate imagery in ways that are generally user friendly and highly adaptable. The overriding concept was to make the tools easy to use by ordinary individuals without the need for advanced computing skills and some examples of the tools created to date are provided below.

4.2.2 Some examples: The equiluminant colour analysis and creative toolsets

The unusual visual effects of equiluminant colour previously described, can be found to have been used in artwork even though many artists and designers may have been unaware of it. The equiluminant tools are therefore designed for two different purposes. Firstly, for use in analysing existing images to see how equiluminant colour has been used, and secondly, for creating colour palettes that can be used in creative work. With the first of these, the tool can be used to reveal luminance and colour values in digital images in a number of different modes. Data can be read directly from the mouse or along predetermined paths and tabulated for subsequent analysis. A strikingly visual approach is also provided whereby luminance contours are displayed on screen for any values selected by the user. This visual presentation is achieved by removing pixels from the picture, above and below luminance levels set by the user, when at the push of a button the computer removes those pixels that are outside the limits. The remaining image shows islands of the original picture as can be seen in figure 9.

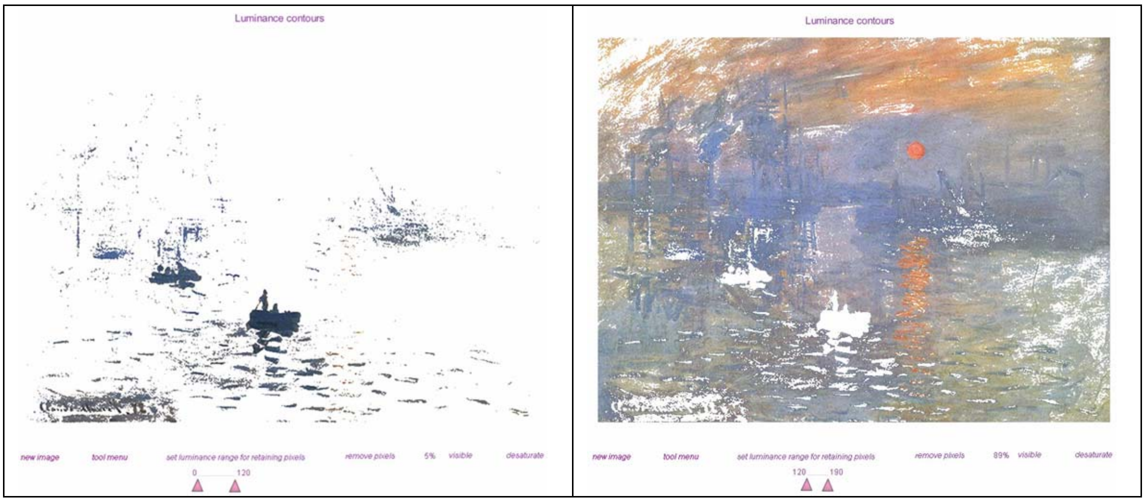

Figure 9 : pixels removed above luminance range 0-120: pixels removed outside luminance range 120 -190

A second toolset has been designed to address the difficulty faced by designers wishing to use closely equiluminant colour in their own work, because assessing the relative brightness of colours and creating equiluminant colour is difficult to achieve (Livingstone 2002: 66). This tool presents the user on screen with a colour mixing facility so that any range of colours can be created and blended on screen into suitable colour swatches. On completion of this a luminance level is chosen and at the press of the button the colours created in the palette are processed by the computer to be digitally equiluminant. Any number of different ‘palettes’ can be created and exported as images containing the necessary colour and luminance information for use elsewhere. An important additional facility is provided to add ‘noise’ to these colours whereby a tolerance can be added to the selected equiluminance range. The reason for this is to accommodate slight differences in individual responses as '*the degradation of image quality that accompanies equiluminance occurs in a fairly broad range of contrasts near equiluminance*' (Cavanagh 1991).

5 TWO STUDIES DEMONSTRATING USE OF THE EQUILUMINANT COLOUR TOOLSETS

5.1 USING THE EQUILUMINANCE ANALYSIS TOOL

In this first study we used the analysis tool to examine the extent of the use of equiluminant colour in Monet's '*Impression Sunrise*' (figure 10). This well known picture which heralded the start of the Impressionist movement, seems to have an elusive and atmospheric quality that goes way beyond its broad brush strokes and basic composition centered on the sun. For some people, the sun has a strange vibrant quality, seeming to 'flicker and pulsate'.

Margaret Livingstone, in 'Vision and Art' accounts for this in neurobiological terms where she was able to show (using a photometer) that the colour of the sun and its surrounds are closely equiluminant. We were interested to examine the picture with our new digital toolset in order to see how extensive the use of closely equiluminant colour really was, across the painting as a whole. In our preliminary study we used the data extraction tool shown in figure 10 to horizontally track through the sun and its surrounds, yielding the data and screen plot shown in figure11. The chart shows that the luminance values of the colours of the sun and sky are within a similar close range of 156 +/- 7% where the position of the sun is clearly not distinguishable within this data.

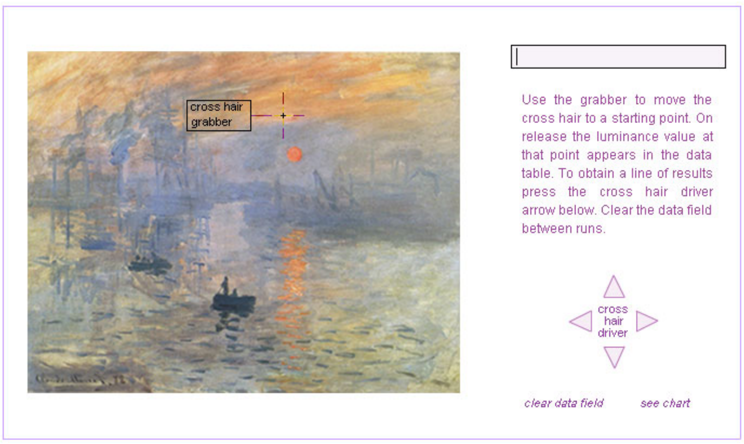

Figure 10 : Screenshot extracting luminance data

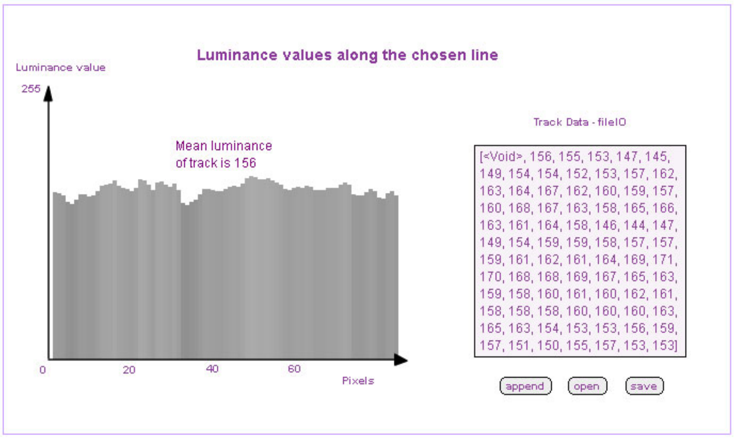

Figure 11: Screenshot plotting luminance data

We then went further and used our new toolset to plot the digital luminance value distribution of all the pixels in the picture (figure12). As can be seen, this again shows the extensive use of mid tone colours throughout the painting. Furthermore, the average digital luminance of the whole painting was seen to be very close to that of the sun alone (154 vs 156). Subsequently, the most interesting result of the study came from use of our luminance contour mapping tool

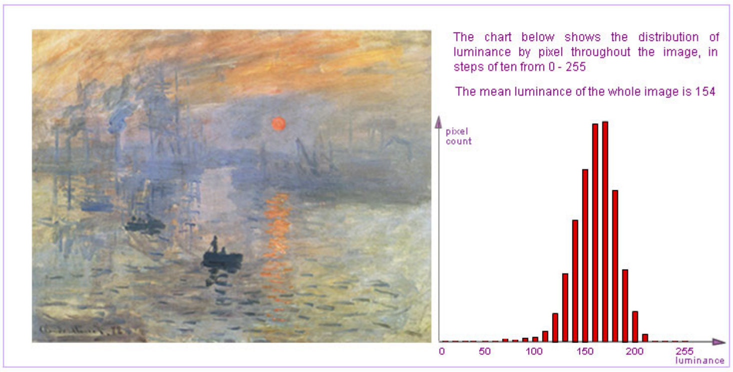

Figure 12: Screenshot showing luminance distribution

Figure 13 : Screenshot of amount of picture in luminance range 142-176

showing just how much of the colour lies within a close luminance range that is not just restricted to the area around the sun. This can be clearly seen in figure13, where out of a possible luminance range of 0-255 (black to white), pixels below digital luminance values of 142 and above 176 have been removed. 61% percent of the picture is seen to remain in this narrow band of luminance (13.3% of the available range).

The significance of this was revealed when we subsequently attempted to test the picture using psycho physical techniques to see whether the use of equiluminant colours around the sun actually contributed to the aesthetics of the painting. This involved changing only the luminance value of the sun whilst leaving all else constant, an exceedingly difficult undertaking in artwork. In the event, the results obtained were interesting but not conclusive. However during testing, an unexpected effect was observed. When viewed in peripheral vision, the sun could indeed flicker and fade from view (whereas when viewed directly, no such effect was observed). This illusion effect can be tested informally by anyone viewing the picture on screen by fixating on Monet’s signature whilst maintaining awareness of the sun. We found that for a majority of viewers the orange sun can disappear altogether!

This is a related but somewhat different interpretation from the one suggested by Livingstone and is based on a well established effect known as Troxler fading. In this, a stimulus that is viewed in peripheral vision can fade from view where ‘the effect is enhanced if the stimulus is small, of low contrast or blurred’ (Lou 1999). As can be seen in figure13, and from comparison of the average luminance of the picture to that of the sun (154 vs156), these conditions are easily met in ‘Impression Sunrise’ and can explain the visual illusion present in the painting.

5.2 USING THE EQUILUMINANT COLOUR CREATION TOOL TO BRIDGE VISUAL SCIENCE AND VISUAL ART

Illusion art can provide examples of the bridging of visual science and visual art (Neural Correlate, 2007). This study provides an example of this in showing how our equiluminant colour creation tool was used in the production of anillusion called ‘Steel Magnolias’ (figure14) in which equiluminant colours contribute to the illusion of motion.

The induced sense of motion seen in the illusion is created by the manipulation of colour values that are changed in special ways without altering the positions of any of the image components. However, because the colours are manipulated the illusion needs to be seen ‘live’ on screen. If you are reading an electronic version of this text, you can view it by clicking on see the illusion. Alternatively, it may be viewed at the following web address http://newton.sunderland.ac.uk/~aa2mpi/illusion_index.html. When viewing the illusion, the magnolias appear to move and wave around as if in a strong breeze, yet nothing is actually moving. All of the edges and fills are stationary and the apparent motion is a figment of the viewer's visual system and imagination.

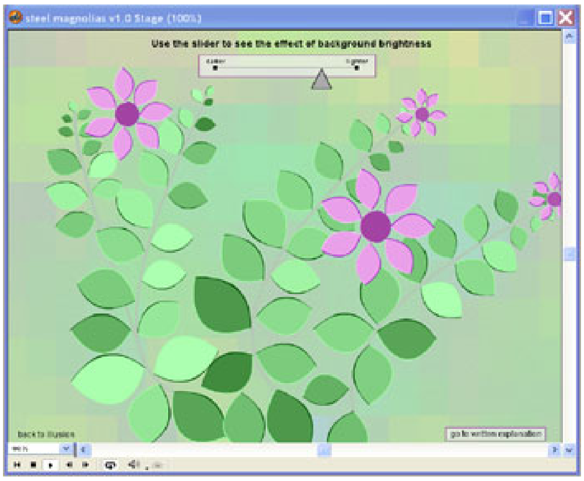

Figure 14 : Steel Magnolias illusion

5.2.1 How the illusion works:

The illusion works in a number of different ways that depend on the properties of the visual system. The first of these makes use of the visual system's sensitivity in detecting lines and contours over fills. The leaf fill shown in figure. 15 is morphed between the two different colour values used for the leaf edge that are a dark and a light green (table 2). Since the visual system is highly selective in distinguishing these edges rather than fills between (Zeki 1999), a small impression of movement is easily detected as the fill colour combines with one edge or the other. This small impression of movement is however amplified in a number of other ways that involve the manipulation of colour.

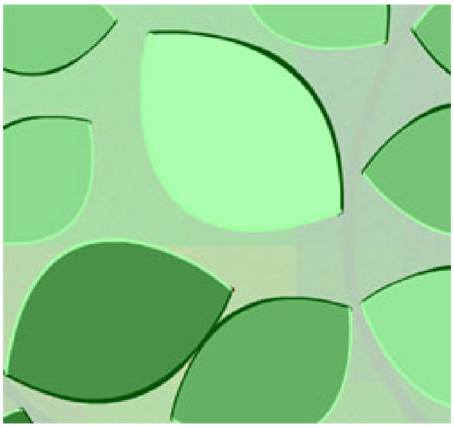

Figure 15 : showing leaf edge colours

Image component	Colour	Digital luminance
leaf edge 1	rgb(170, 255, 174)	200
leaf edge 2	rgb(0, 81, 0)	40
fill	rgb(170, 255, 174) - rgb(0, 81, 0)	200-40
background	various	120 +/- 5%

Table 2 : Illusion colour and luminance values

The illusion background shown in figure 16 is designed using equiluminant colour to confuse the visual system in the way described by Livingstone, so that a sense of spatial uncertainty arising adds to the sense of movement. This image was made in Photoshop using an imported palette of colours created using our new toolset where the luminance of these colours was carefully designed to be midway between that of the leaf edges, +/- 5%. The tolerance was added using the noise tool in order to allow for any variation in viewer response (Cavanagh 1991). The degree to which background luminance affects the impression of movement is marked and can be viewed interactively in the online version. Some additional movement enhancing effects are also designed into the illusion: as each leaf colour cycles from dark to light, at some point their individual colour and luminance values merge with the background creating spatial uncertainty. In addition the cycling of the leaf fill colour is phased differently between leaves to create a directional impression of movement along the path of certain groups of leaves. The combined effect of all of these creates an astonishing sense of movement.

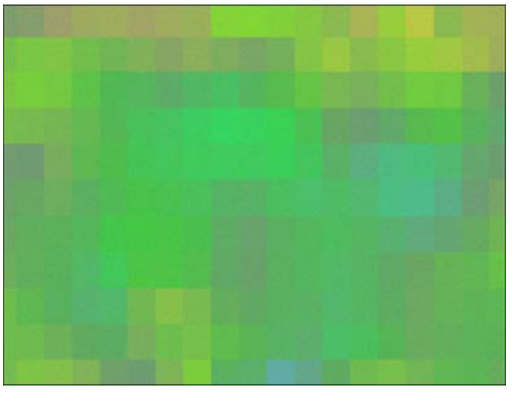

Figure 16 : The equiluminant background

6 SOME CONCLUSIONS

In this paper we posed a question as to whether the time has now come to regard knowledge about human vision as a new area of fundamental knowledge in the arts. In addressing the question we have provided background and examples to show the creative use of vision science knowledge in art and design, outlined some of the obstacles that need to be overcome for vision science to be perceived more positively as a creative resource, and outlined an approach using interactive multimedia to make vision science understanding more accessible to artists and designers.

Making connections between the growing body of understanding about perception and cognition with art and design practice is far from straightforward due to the very broad nature of the subject and the range of academic boundaries involved. One of the fundamental difficulties is the seemingly disconnected nature of scientific findings to art and design practice which we see as an obstacle to a more prominent role for visual science in art and design education.

Whilst we have been able to assemble a large collection of images that demonstrate the proactive use of established and new vision science findings in successful artwork, this by itself is not enough. To further close the gap between visual science and visual art there needs to be a conceptual connecting framework, coupled with a means of demonstrating visual principles that fits with the intuitive approach of arts minded individuals.

The framework proposed in this paper is a step towards this, and whilst it may be further developed and refined, its strength is apparent in the powerful connections made between stages of vision that are important in design, understanding about the properties of the visual system and design practice. The key to all of this we believe lies in the development the multimedia based visual approach in allowing learning to be ‘hands on’ and proactive through interaction rather than passive through demonstration or description.

Our studies have indicated that as vision science understanding increases, its potential for application in objective design will also increase. From a designer’s perspective, the intuitive approach may no longer be sufficient and so it is therefore important that a number of things happen.

Firstly we plan to build on the framework and related multimedia for seeing where and how the science connects to art and design practice so that design professionals can position their own work in relation to it.

Secondly, we plan to continue developing software tools to enable their use and to share ideas so that an increasing number of applications can be found for the new knowledge.

Thirdly, we need to begin introducing into design schools, formal tuition about the areas where vision science and design overlap. Vision science should not be seen as something separate to creative endeavor, but rather something that can potentially enhance it. In future, communicating ideas more effectively through images by having a better understanding of the science that makes them work should mean more effective design.

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