

The Art of Brain Imaging

Towards a Theory of Displaying the Ghost in the Machine

Dorothee Baumann, Haut Ecole d'Art et de Design, Genève
Markus Christen, UFSP Ethik, Universität Zürich

Overview

Context:

- Imaging: methods & concepts
- Using colors
- Imaging & Science Studies

Hypothesis:

- Problem

Images:

- Varieties of using colors
- Popularizing color-control: OsiriX
- Art & brain imaging

Outlook:

- Design of a study

Context – Imaging Methods

Neuroimaging: The use of various techniques to either directly or indirectly image structural or functional aspects in the brain or CNS. Most common techniques include:

- Computer Tomography (CT)
- Positron Emission Tomography (PET)
- Magnet Resonance Imaging (MRI)
- Functional MRI (fMRI)
- (EEG)
- (optical methods)

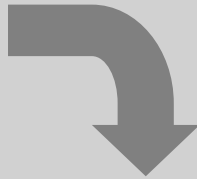
Some historical remarks:

- Imaging-techniques were mainly developed in the 1970
- The concept “Neuroimaging” appeared in the 1980s in papers of several independent groups.
- Early 1990s: Forming of the sub commission “Neuroimaging” within the organization of the “decade of the brain”.

Context – Imaging conceptualized

Experiment:

- Paradigm?
- Correlating what?
- Interferences?
- Ethics?



Data Processing:

- Modeling?
- Variability?
- Significance?
- Database?



Our focus

Presentation:

- Visualization?
- Choice?
- Target group?
- Popularization?

Context – Using colors

Using false colors (i.e. colors not intending to picture an actual situation) in scientific and medical images is a tricky issue due to several reasons:

- “Color often generate graphical puzzles” (Tufte 2001)
- “Color turn quantitative differences into categorial variables” (Beaulieu 2002)
- “Choosing a set of colors to represent linear activity is an arbitrary choice” (Dumit 2004)

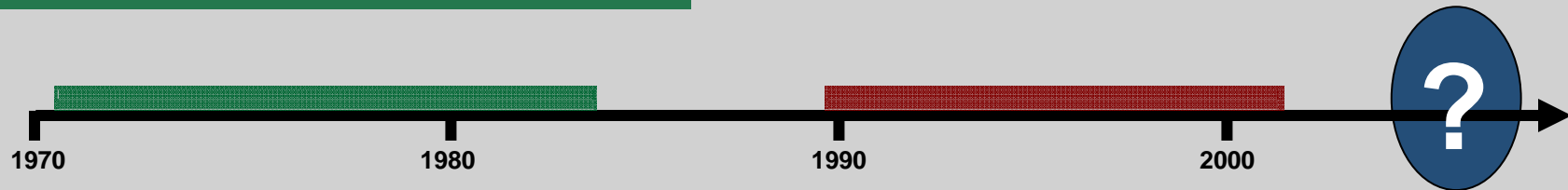
One important distinction (Funkhouser 1937):

- Using colors in the context of a (geographical) **plan / chart**
(the color is chosen explicitly, Tradition of cartography)
- Using colors in a **mapping of numbers to the color space**
(the mapping is chosen explicitly)

Context – Discussing Imaging (1)

Iconographic optimism:

Henry N. Wagner (1974): Once we agree on a color code and become practiced in it, the issue of arbitrariness disappears



Iconographic skepticism:

Anne Beaulieu (2002): “(functional) imagers seem to reject representations while also using them at multiple point in their work (...) the case of the iconoclastic imager

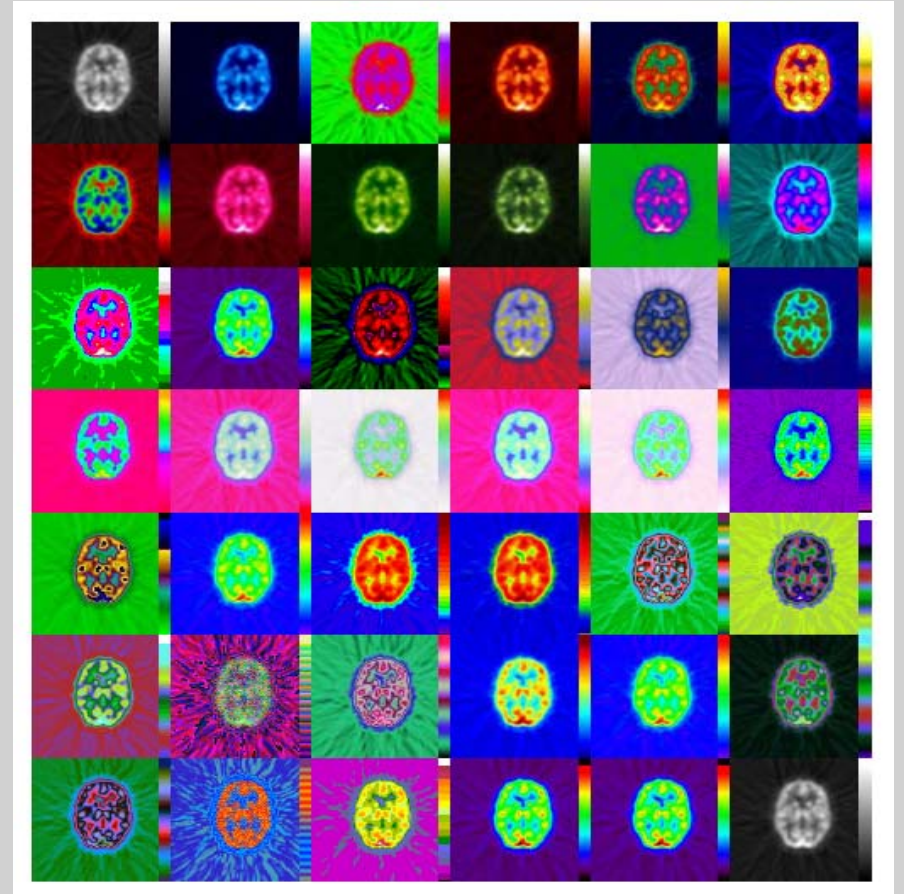
Context – Discussing Imaging (2)

Illustrating skepticism:

Brian Murphy (1996):

„The effects created by various color scales may be visually dramatic but may also cause one to see distinct boundaries where there are none. (...) it is possible to make almost any feature stand out with the right tweaking.“

*Cover of the “Journal of Nuclear
Medicine Technology” (Dec. 1996)*



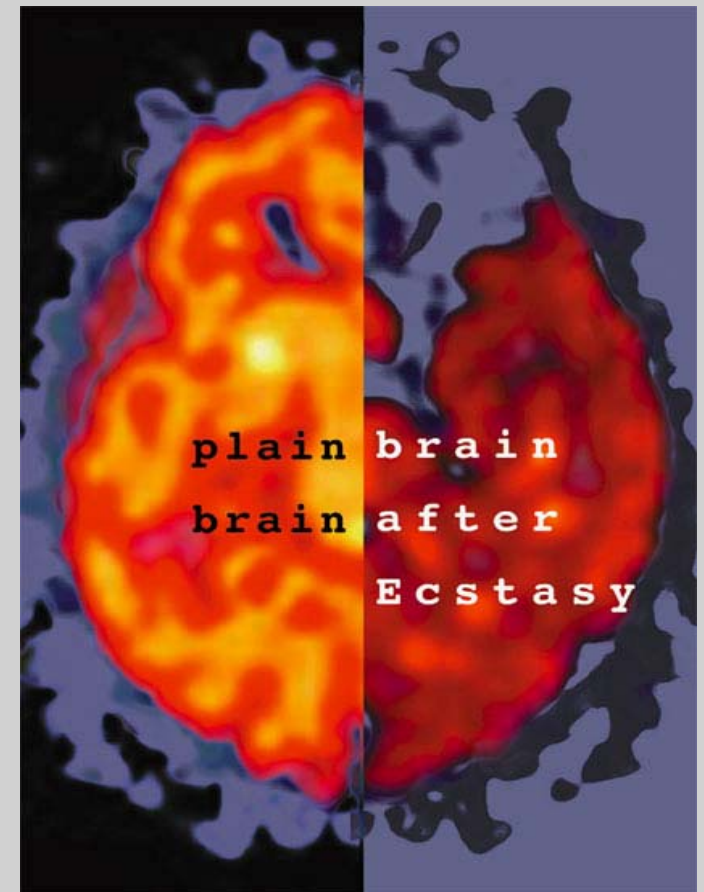
Context – Discussing Imaging (3)

Illustrating skepticism:

Joseph Dumit (2004):

„(...) it is precisely these simplified “illustrations” that are valorized when these images travel from the laboratory into articles and into popular culture. (...) the risk that these pictures pose lies in their multivocal readings. They are both veridictory graphs and empathic illustrations.”

Poster of the National Institute on Drug Abuse on the occasion of its 20-year-anniversary (1999)



Hypothesis – The Problem

- Our basic question:** *Is iconographic skepticism towards neuroimaging still present within different communities that deal with images of the brain?*
- Our main focus:** The manipulation of colorization in neuroimaging
- Our hypothesis:** Skepticism disappeared in most communities, although basic problems like finding a generalized standard of using colors remained.
- Furthermore, we expect a broadening of the ways of using colors, as personal medical pictures become accessible and tools to manipulate them become more popularized.

Images – varieties of using colors (1)

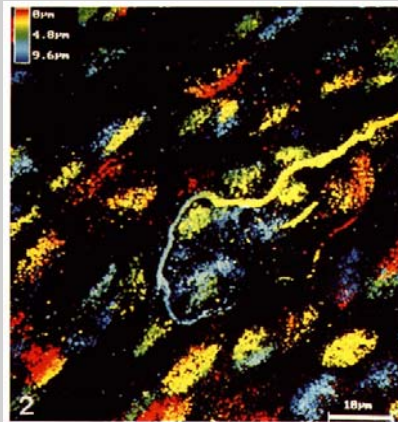
The phenomenology of Neuroimaging – results of a pilot study:

We compared the types of images (b/w, color, color spectra used, ways of displaying, etc.) in the Journal “NeuroImage”, issues 1&2 (1993-1995, 58 publications) and issue 39 (2007: 69 publications):

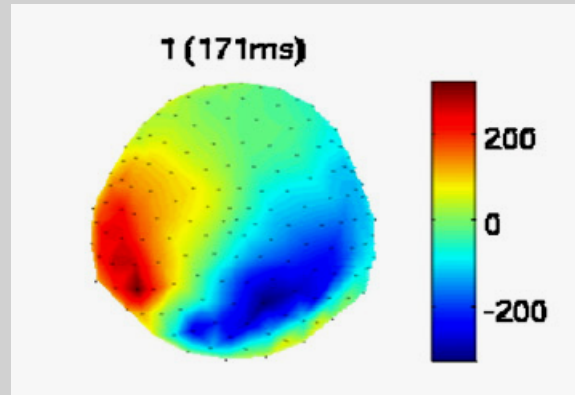
	<u>1993-95</u>	<u>2007</u>
# images / study	3.8	3.1
# images b/w / study	1.9	0.6
# images color / study	1.9	2.5
<i>False-color-images, no scale</i>	27%	28%
<i># of ways of using colors</i>	13*	26
<i># color photographs</i>	23	0
*dominating: rainbow spectrum (53%)		

Important remark: Printing color images in NeuroImage was free of charge until 2004!

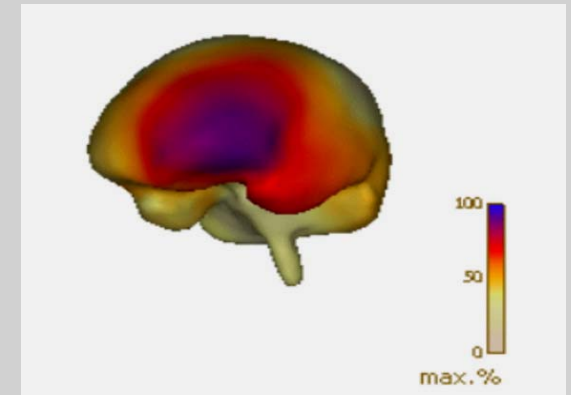
Images – varieties of using colors (2)



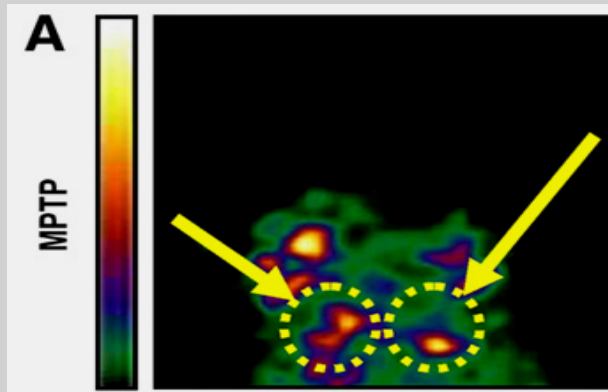
Spectrum “classic”
(Rumio et al 1995)



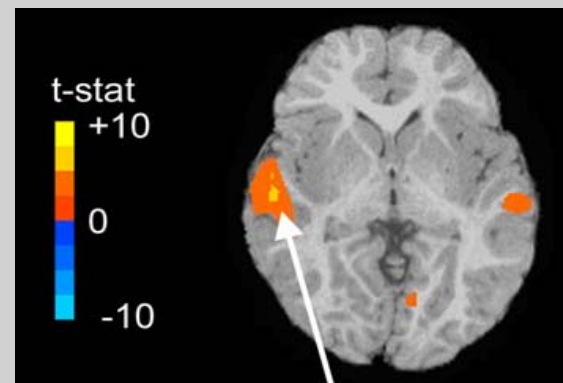
Spectrum “classic”
(Henson et al 2007)



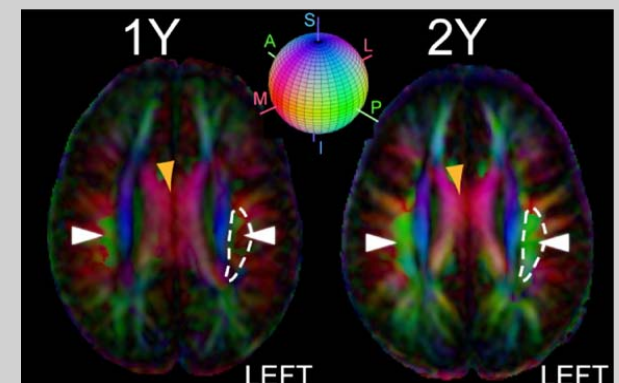
Spectrum reverted
(Bender et al 2007)



Spectrum enlarged
(Alvarez-Fisher et al 2007)



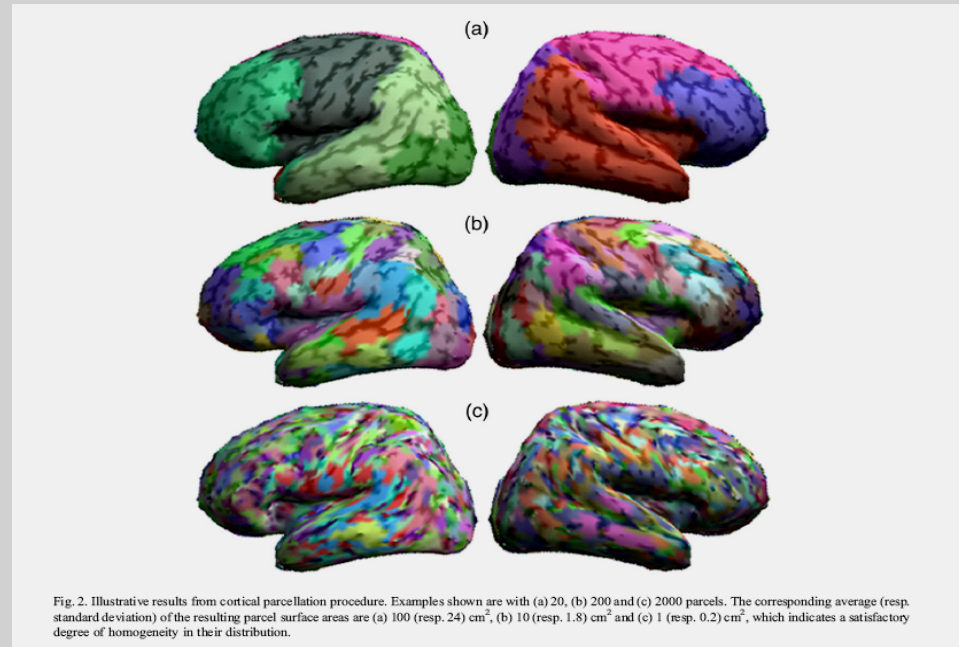
Spectrum rearranged
(Redcay et al 2007)



Spectrum: 3 dimensional
(Zhang et al 2007)

Images – varieties of using colors (3)

Colorful, but puzzling
(Cottereau et al 2007)



Not so colorful, but contradicting
(Reverberi et al 2007)

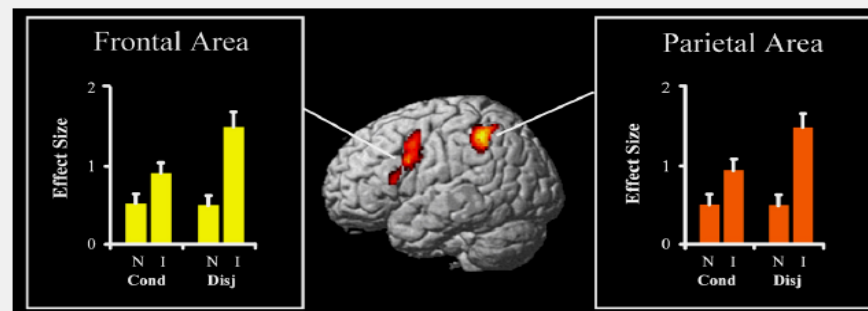


Fig. 2. Brain areas that fulfilled all three theoretically based criteria for a neural substrate of propositional deductive inference. In the middle: activated areas rendered onto the canonical T1-weighted brain image of SPM2 ($P < 0.05$ corrected for multiple comparisons at cluster level). On the left and on the right: Parameter estimates (averaged across subjects and across clusters) for the height of the hemodynamic response during non-integrable sentences (N) and integrable sentences (I), in conditional (Cond) and disjunctive problems (Disj). Error bars indicate standard errors.

Images – OsiriX

Standard for distributing medical images: DICOM

OsiriX: An image processing software dedicated to DICOM images produced by medical equipment (MRI, CT, PET, PET-CT, ...) and confocal microscopy (LSM and BioRAD-PIC format). It can also read many other file formats: TIFF (8,16, 32 bits), JPEG, PDF, AVI, MPEG and QuickTime.

OsiriX has been specifically designed for navigation and visualization of multi-modality and multi-dimensional images.

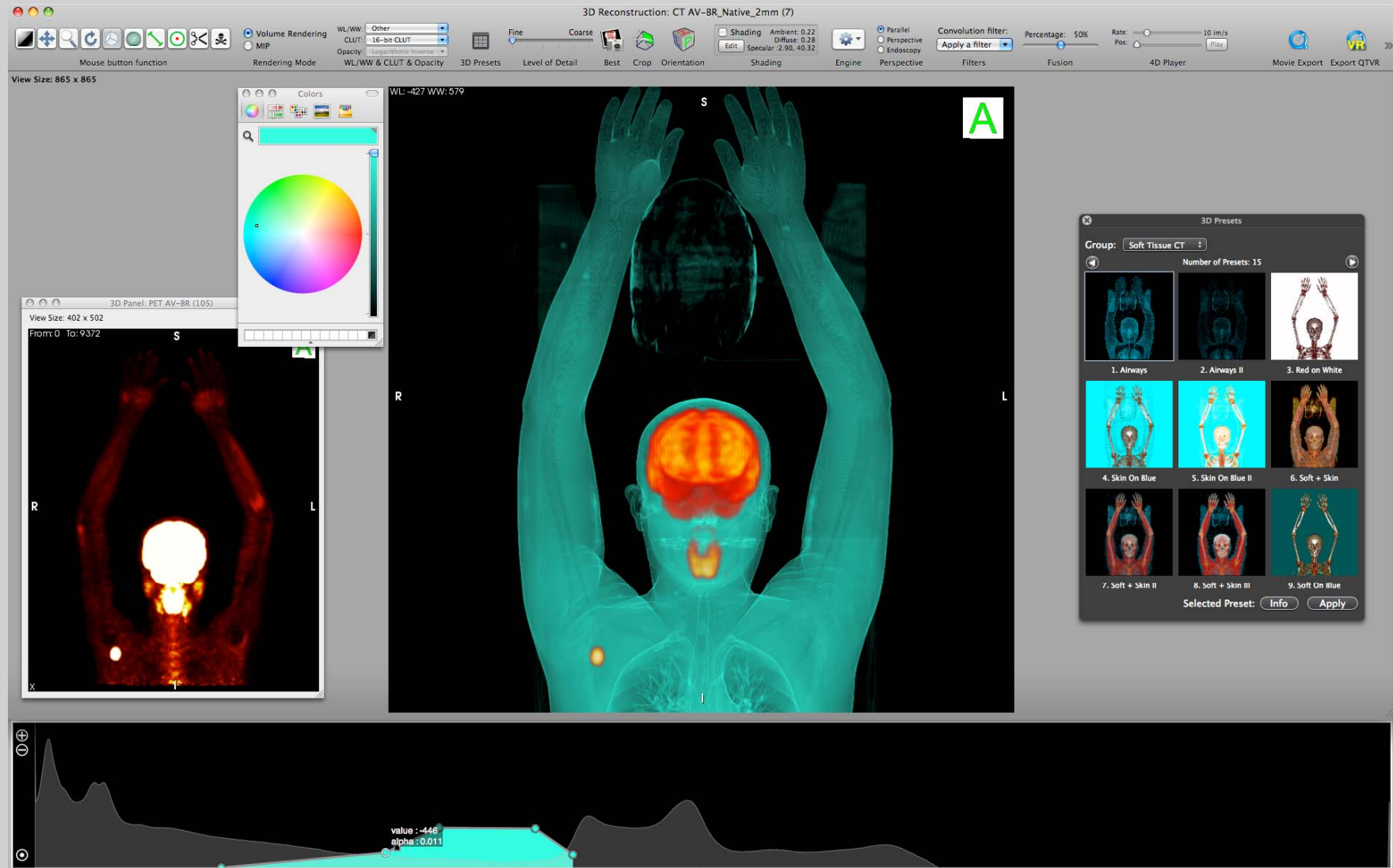
Created in 2003

Freeware

“I use my iPod to store medical images”

Osman Ratib, OsiriX-founder (CNN, 26.10.05)

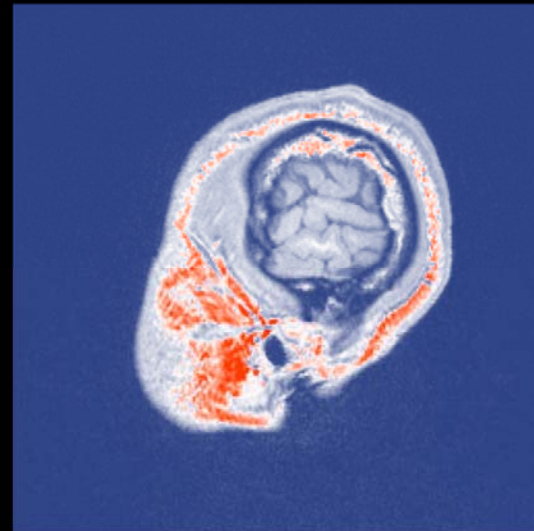
Images – OsiriX: example (screenshot)



Edward Munch (1863-1944)



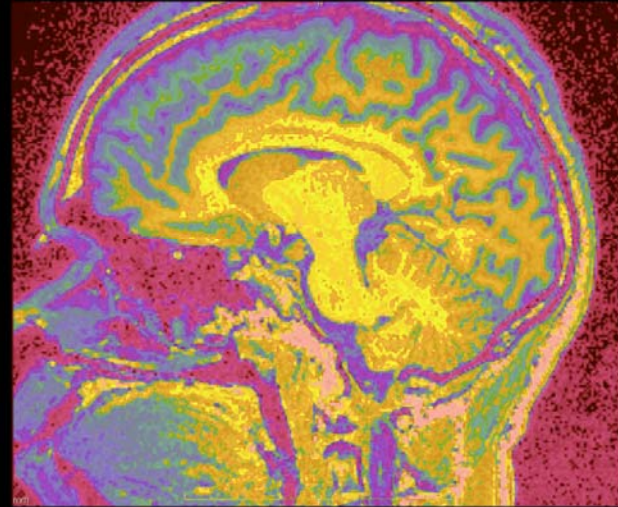
Vampire (1893-94)



Wassily Kandinsky (1866-1944)



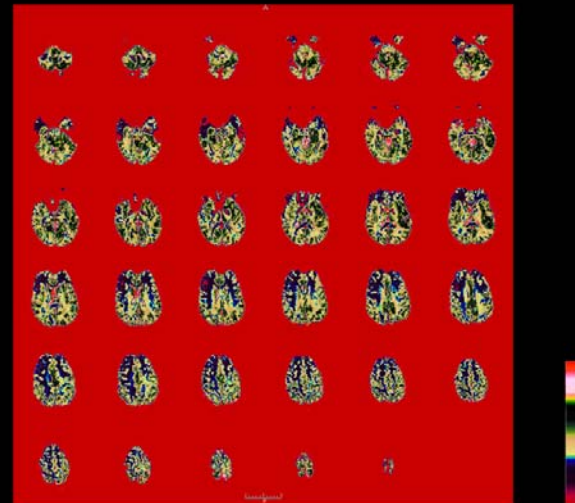
Lady in Moscow (1912)



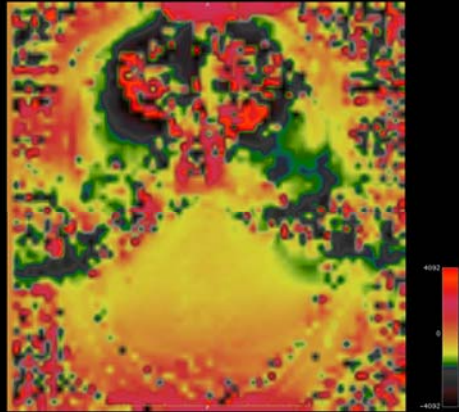
Henri Matisse (1869-1954)



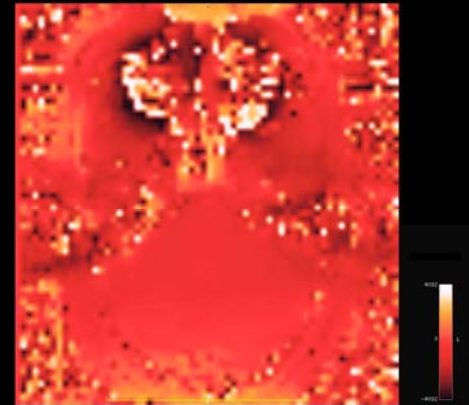
Das rote Atelier (1911)



Vincent van Gogh (1853-1890) vs. Mark Rothko (1903-1970)



Nachtcafé in Arles (1888)



Orange and Yellow (1956)

Outlook – Design of a study

Step 1:

Extend the analysis of the phenomenality of brain images in major neuroimaging Journals and over a larger time span.

What are the main “artistic iconographies” used?

Ask scientists on the logic of their choices (dependence on software).

Step 2:

Create paradigmatic pictures using different ways of colorization and evaluate interpretation and impact in different focus groups:

- Cognitive neuroscientists
- Clinicians
- Patients
- Research subjects
- Science Journalists
- Artists

Evaluate effect and interpretation of different “artistic iconographies” and iconologies.