Surveying Aesthetics & Astronomy: A Project Exploring the Public's Perception of Astronomical Images and the Science Within

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Summary

Every year hundreds of astronomical images are released to the general public from the many telescopes both on the ground and in space that observe the Universe. These images cover both data gathered at visible wavelengths and other phenomena at wavelengths that cannot be detected by the human eye, so that the entire electromagnetic spectrum is represented. The release of astronomical images raises major questions about the dissemination and communication of that knowledge, including: how do non-experts (i.e., the public) perceive these images? In 2008, the Smithsonian Astrophysical Observatory began a unique research study — dubbed the Aesthetics & Astronomy (A&A) project — to examine the perception of multi-wavelength astronomical imagery and the effects of the various scientific and artistic choices in processing astronomical data. This article provides a brief synopsis of the results of the initial A&A study and its possible implications for astronomy outreach professionals. This article concludes with an overview of the latest study (in progress, 2010).

Aesthetics is the study of how human beings react in a sensory and emotional fashion to the things we encounter in life, especially as being appealing or not appealing. (Smith & Smith, 2010)

Introduction

Aesthetics — from a psychological perspective — is the study of all things beautiful, whether art or not, and all things art, whether beautiful or not.

Astronomy is one of the most visual of the sciences. Modern astronomy images capture the Universe not only with the narrow range of wavelengths that humans can detect with their eyes, but also with radio, infrared, X-ray electromagnetic radiation and more. From small telescopes wielded by amateurs to multi-billion dollar observatories controlled by professionals, astronomy has the capacity to lure us in by the sheer aesthetics of its data.

Every year, hundreds of astronomical images are released to the public by telescopes of all kinds both on the ground and in space. This represents a considerable investment — in both human and monetary terms — by the astronomical community. A small cottage industry, so to speak, straddling the worlds of astronomy and science communication has grown to

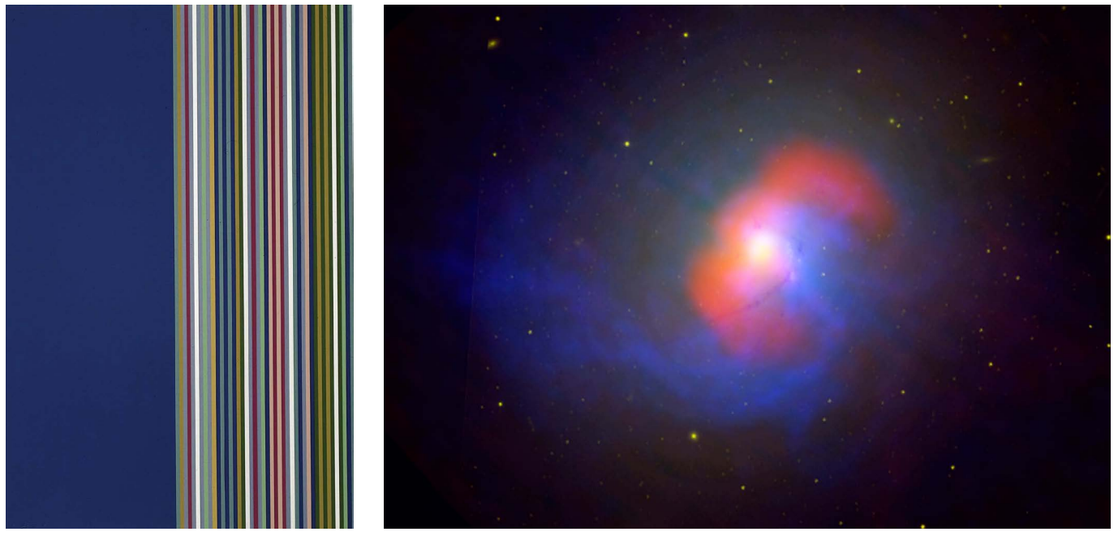

Figure 1. Beautiful art or not? Left: Untitled, serigraph on paper by Gene Davis, 1974. Credit: Smithsonian American Art Museum, Bequest of Florence Coulson Davis; Right: Multi-wavelength NGC4696 in X-ray, Radio and Infrared, Credit: X-ray: NASA/CXC/KIPAC/S. Allen et al; Radio: NRAO/VLA/G. Taylor; Infrared: NASA/ESA/McMaster Univ./W. Harris (used in 2008 online survey).

produce and disseminate these images. Today, more than ever, these images are shared via traditional media (like newspapers, magazines, books, prints, etc.), planetariums and science museums, but also through websites, Twitter and the blogosphere, directly with the public.

But the question is: how good are we at what we are intending to do?

To our knowledge, there has never been a rigorous academic study to answer how well our choices in our image pipelines — from processing to dissemination — do in reaching the widest possible audience. We conceived the A&A to begin to tackle this void. The original A&A study was designed to probe how effective these choices (or compromises) are when it comes to science versus aesthetics in astronomical images.

The A&A team consists of a unique combination of professional astronomy communicators, astrophysicists and aesthetics experts from the discipline of psychology. In late 2008, the A&A team conducted both online studies (see Figure 2) and a series of in-person focus groups. The research questions were designed to test:

- How much do variations in terms of presentation of colour, explanation and scale affect comprehension of astronomical images?
- What are the differences between various populations (experts, novices, students) in terms of what they learn from the images?
- What misconceptions do the non-experts have about astronomy and the images they are exposed to?

Highlights from the 2008 study

It was a pleasant surprise, when over 8000 usable responses were collected in just over a week in the online survey. The full results from the project were accepted by the *SAGE Journal of Science Communication* in August 2010 (see Smith at al., 2010, for more detail on the methodology, data limitations, descriptive statistics of the study and a full reference list).

The online participants ranked themselves along a scale from "novice" to "expert". There were some predictable differences among the groups. For example, the novices indicated that variations in terms of presentation of colour, explanation and scale affected their comprehension of the imagery. Those who identified themselves as expert, on the other hand, wanted shorter, more technical explanations (with scale information). Other less obvious results also emerged, including that the novices said that their aesthetic enjoyment increased solely based on their ability to access the information in the accompanying caption.

Some additional outcomes include:

- Providing a context for the image is critical to comprehension, particularly for novices.
- Experts prefer text that is shorter and to the point; novices prefer a more narrative expository style for the text that accompanies images.
- Providing a sense of scale to go with objects is helpful for comprehension at all levels of expertise.
- Experts and novices view space images very differently. Novices begin with more of a sense of awe and wonder, and focus first more on the aesthetic qualities of the image. Experts wonder how the image was produced, what information is being presented in the image, and what the creators of the image wanted to convey.
- Experts are much more likely to see blue as hot than are novices; about 80% of novices see red as hot compared to 60% of experts.

Putting the preliminary results into practice

Since this A&A group is led by members of the Chandra X-ray Observatory's Education and Public Outreach (EPO) group we could implement the study's results almost immediately. As two of us *(Arcand & Watzke)* are responsible for a major observatory's public website and other outreach materials, the A&A outcomes to could go quickly from preliminary academic research to field-tested practices on a website that receives 250 000-300 000 visits per month.

What changes did we make? First, we added bulleted text for each new image, interactive labelling and put "Wikipedia-style" links in the body of the text. Each of these changes came out of the feedback we received during the online survey and focus groups.

The next, more involved implementation of the A&A results was to develop an interactive multi-wavelength image feature that allows the user to move from one energy band to another, and ultimately "build" the composite themselves. A sample of this can be found online .

The feedback on these relatively simple changes to the website from the public through our comment and rating sections has been overwhelmingly positive. Our next step is to implement a questionnaire on the Chandra website to ask users specifically how these new features affect their enjoyment and comprehension of an image and the science behind it.

We have also built an interactive, question-based text script into the Chandra photo pages with click-tracking methods to count the user clicks per question and per image, and to compare totals. We have also created a similar implementation for a series of print products that includes posters featuring multi-wavelength astronomical images (see Figure 3). Here, we use the tried and true series of questions: who, what, when, where, why and how to engage the viewer in an approachable manner. The text addresses some of the questions that were commonly asked during the focus groups, including how the images were made, the historical importance of the object, the location in the night sky, etc. Data collection and a brief summative evaluation of these six posters are being conducted to analyse the impact of the improved features on the public's understanding.

Other recommendations from the original A&A findings showed that it is useful (and not overwhelming for the reader) to provide colour code keys and physical scales in images intended for the public. Another useful finding has been that many novices want to understand how the experts — the astrophysicists — view the images. This type of information could be provided with images in the future by having a "rollover" on the image that annotates, "Here is what astronomers see…", or by including video or audio commentary from astronomers, available as supplementary digital material.

Current & future plans

We are currently conducting a series of studies, funded in part by a grant from the Smithsonian Institution, that ask viewers to evaluate astronomical images with their corresponding descriptions across different media platforms: web, mobile, traditional print and large format print. The images being used include some from the Chandra X-ray Observatory, Hubble Space Telescope, Spitzer Space Telescope, Solar Dynamics Observatory and others. Working with museum professionals and science centre partners we have produced a travelling exhibit of the material. Touring through six locations in 2010, this exhibit allows participants to access the astro-

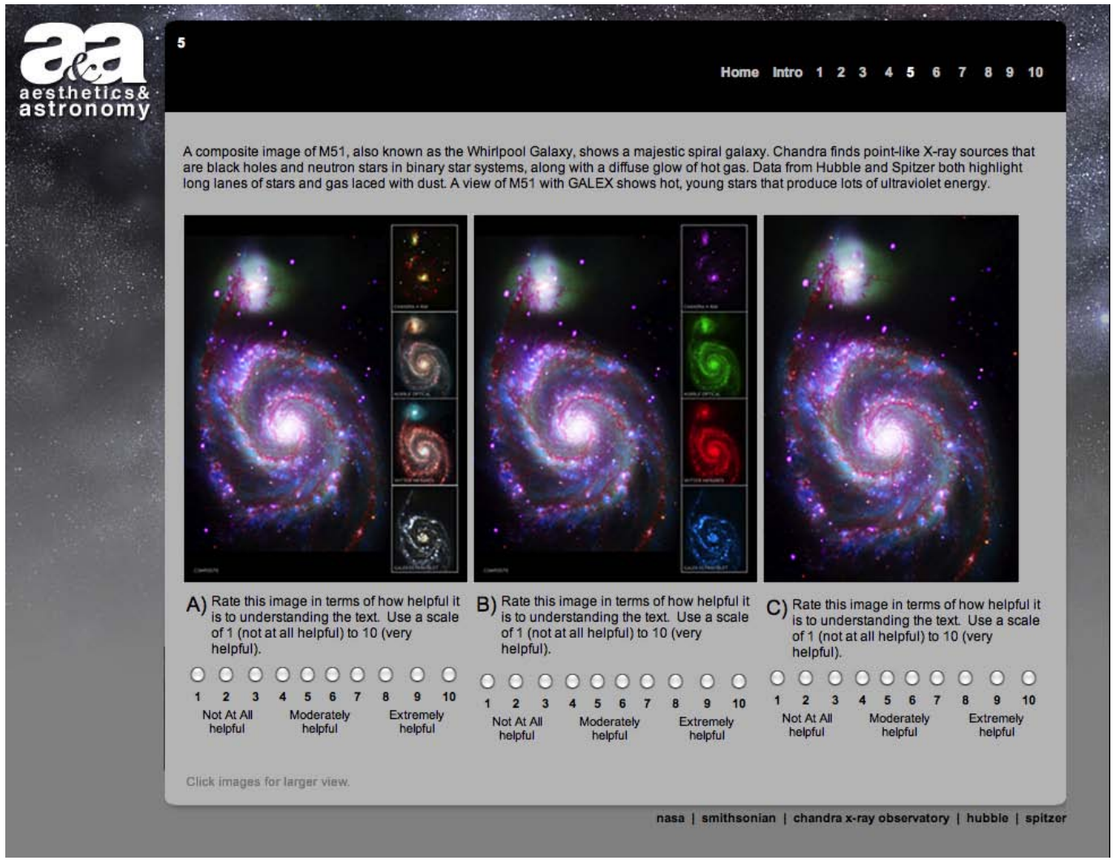

Figure 2. A sample page from the online survey at http://astroart.cfa.harvard.edu/ showing M51. Credit: NASA/Chandra/Hubble/Spitzer/GALEX

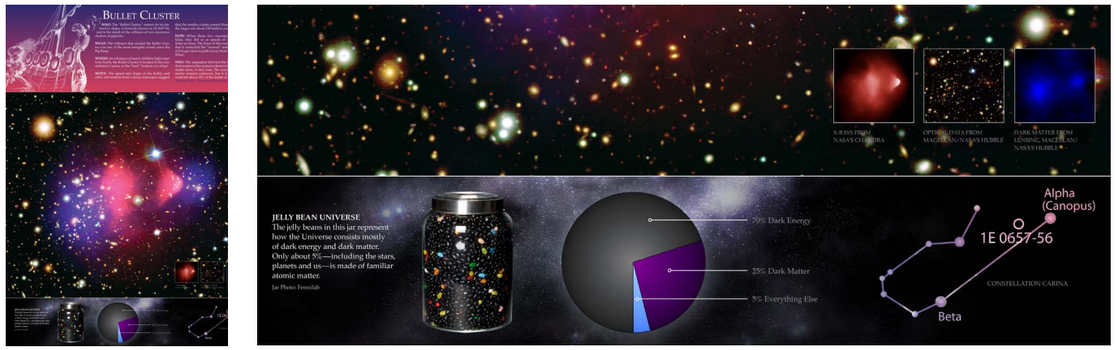

Figure 3. Sample of poster created using who, what, when, where, why and how questions (left) and a close-up of colour coding and supporting informational graphics from that poster (right).

nomical imagery and text through traditionally sized and large-scale prints. The schedule of locations is available online .

An online study of the same material tests the user's perceptions on mobile devices in comparison with traditional online platforms. We will also be employing in-person focus groups this autumn to explore the aesthetics-context correlation further, across all four of the platforms. Questions on the interpretation of scientific principles (perception of temperature, for example), aesthetic appeal, and the interpretation of unfamiliar (meaning non-terrestrial) objects are being included in all forms of the study.

Conclusion

We believe that we, the professional astronomical community, are operating in an unusual age. At the moment, we are the beneficiaries of a multitude of fantastic telescopes and observatories. It is our goal to communicate these exciting discoveries to the public, and, quite often, the images are our greatest asset in doing this. At the same time, however, there is much discussion about "false colour" and what is "real" in this age of Photoshop and other digital manipulation. With so much data and so many tools at our disposal, not to mention the potential wide reach of the internet, are we employing all of the possible best practices? Can studies such as A&A uncover ways to help dispel some of the misinformation that exists about the veracity and legitimacy of what we distribute to the public? There are many lines of research we can follow and many unknowns to explore. We invite anyone who is interested in these issues to contact us.

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Links

[1] http://chandra.si.edu/photo/2009/galactic/
[2] http://astroart.cfa.harvard.edu/
[3] http://chandra.si.edu/mobile/aa.html

Biographies

Kimberly Arcand is the visualisation & media production coordinator for NASA's Chandra X-ray Observatory. She is PI and project lead in the Aesthetics & Astronomy group.

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