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THE ASSESSMENT OF ART ATTRIBUTES

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ABSTRACT

Neuropsychological investigations of art production and perception have the potential to offer critical insight into the biology of visual aesthetics. Thus far, however, investigations of art production in patients have been limited to anecdotal observations and investigations of art perception are non-existent. Progress in the field is hampered by the lack of an adequate instrument to provide basic quantification of artwork attributes. Motivated by the need to move neuropsychology of art beyond the fascinating anecdote, we present the Assessment of Art Attributes (AAA). The AAA is an instrument designed to assess six formal-perceptual and six conceptual-representational attributes using 24 paintings from the Western canon. Both artistically naïve and experienced participants were given the AAA. We found high degrees of agreement in the assessment of these attributes in both groups and few differences between the groups. We expect that the AAA's componential and quantitative approach will be useful in advancing neuropsychological studies as well as any investigations in which style and content of art works need to be quantified and compared.

Since the time of Broca and Wernicke, the study of individuals with brain damage has provided unique insights into the biological basis of behavior. Thus, by the

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early 20th century much about language, vision, emotion, and motor control had been learned from careful observations of patients. The question we raise, a century later, is: Can neuropsychological studies provide insight into the biology of art? In this article, we identify the kinds of problems facing such a research program. We then introduce the Assessment of Art Attributes (AAA). We believe this instrument offers a partial solution to the problems we identify. We conclude with a discussion of the merits, possible uses as well as the limits of the approach that we are advocating.

Artists with brain damage and visual-spatial disturbances express their deficits in their artwork (Bogousslavsky, 2005; Bogousslavsky & Boller, 2005; Chatterjee, 20204a, 2004b; Rose, 2006; Zaidel, 2005). Thus, disturbances of visual attention, object recognition, and color processing are all expressed in the work of artists that continue to paint or draw after the onset of their neurological disease (Jung, 1974; Sacks, 1995; Wapner, Judd, & Gardner, 1978). Interestingly, the work of some artists, rather than being diminished by their brain damage, is paradoxically regarded as "improved" (Chatterjee, 2006).

One might expect that the nature of the work produced by artists with brain damage could advance our understanding of brain-behavior relationships in the production of art. Surely, changes in the style and content of this art offers a window into the biology of representational structures and processes used by artists. However, such investigations to date have been rudimentary at best. Most neuropsychological observations of artists remain fascinating anecdotes, catalogues of intriguing phenomena, capped with post-hoc speculations.

In our view, two things are needed for the neuropsychology of art to mature as a science. First, we need an overall framework within which to consider art (Chatterjee, 2004a; Nadal, Munar, Capo, Rosselo, & Cela-Conde, 2008) (for a related model, see Leder, Benno, Andries, & Dorothee, 2004). Like the study of any complex cognitive domain, such as language or attention, artistic perception and production needs to be decomposed into its component parts, so that these components can be examined. For visual art, aspects of visual processing, its emotional and reward links, and decisions about artistic merits would be subsumed in such a framework. Second, we need a way to quantify these components. Without quantitative measures, it would be difficult to assess change in an individual's artwork or test hypotheses with any formal rigor. Other measures of aesthetic sensitivity have been proposed (Child, 1962; Eysenck, 1983). However, these measures take aesthetic sensitivity to be a general attribute and do not examine different possible components of artwork. For example, the Visual Aesthetic Sensitivity Test (VAST) assesses sensitivity to visual harmony in abstract black and white images. Harmony is an attribute most closely related to balance. Thus, the VAST does not permit componential analyses and restricts its assessment to a narrow range of kinds of artwork. Similarly, our own test, the Assessment for Preference for Balance (APB) is a quantifiable tool that assesses sensitivity to balance (Wilson & Chatterjee, 2005), perhaps a critical

feature of aesthetic perception. But the APB does not assess other components of artworks and makes no attempt at being comprehensive.

We designed the AAA with the two needs of componential analysis and quantification in mind. The AAA assesses six formal attributes and six conceptual-representational attributes in any piece of visual art. These attributes were selected based on a review of the literature with special consideration to the kinds of attributes thought to have changed in individuals with brain damage. The formal-perceptual attributes correspond to early and intermediate vision (Chatterjee, 2004a). The conceptual-representational attributes correspond to higher/late vision and its contact with other domains like emotional systems. We familiarized each participant on each attribute before they assessed the target paintings. Their assessments were made using a Likert scale, giving quantitative form to these descriptive attributes. The paintings were selected from the Western canon, covering different time periods. Each painting was created by a well known artist, ensuring a reasonable threshold for aesthetic quality. However, the paintings selected were not the artists' most popular works (e.g., Hopper's *Nighthawks*), those that might be familiar to even artistically naïve participants.

In trying to understand the way the AAA might be used, we enrolled both artistically naïve and experienced subjects. Experience with art can certainly influence preferences in art (Cupchik & Gebotys, 1988; Hekkert & van Wieringen, 1996a). For example, naïve people rarely enjoy structural aspects of art in the same way that artistically experienced people do (Augustin & Leder, 2006; Hekkert & van Wieringen, 1996b). What is less clear is whether art experience changes how one perceives art. Eye movement studies find that people with art experience gaze differently at artworks (Nodine, Locher, & Krupinski, 1993) presumably because of a greater sensitivity to underlying compositional structure. Such results generate the hypothesis that art experience alters the perception of art and that the AAA could capture these differences.

While our motivation in developing the AAA is to create an instrument to advance the neuropsychology of art, nothing about the AAA confines its use to neuropsychological studies. It is simply an instrument that allows one to quantify attributes of a given work of art and can be used to assess differences of any kind. For example, one could use such an instrument to assess differences in artwork across different cultures, or different time periods within a culture or to chart the evolution of artistic styles over time within a single artist.

METHOD

Participants and Screening Questionnaire

Ninety participants were recruited from the student population at the University of Pennsylvania and all gave informed consent to participate in the study. We constructed a screening questionnaire to ascertain all subjects' art experience (see Table 1). The artistic experiences queried were: classroom experience in

Table 1. Art Experience Questionnaire

1. How many studio art classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

2. How many art history classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

3. How many art theory or aesthetics classes have you taken at the high school level or above?
   0 1 2 3 4 5 6 or above

4. On average, you visit art museums about once every:
   Almost never (0) year (1) 6 months (2) 2 months (3) month (4) week (5)

5. On average, you visit art galleries about once every:
   Almost never (0) year (1) 6 months (2) 2 months (3) month (4) week (5)

6. In the average week how many hours do you spend making visual art?
   0 1 2 3 4 5 6 or more

7. In the average week how many hours do you spend reading a publication that is related to visual art?
   0 1 2 3 4 5 6 or more

8. In the average week how many hours do you spend each week looking at visual art?
   0 1 2 3 4 5 6 or more

9. What is your gender?
   M F

10. What is your age?
    _____

11. What is the highest level of education that you have completed?
    _____

12. Do you have any visual impairments?
    _____

studio art, art history, art theory, and aesthetics, approximate frequency of visits to museums and galleries, and average weekly time committed to making, reading about, and looking at art. Based on the screening questionnaire, 60 participants (average age 21.4 years, 37 men, 23 women) were considered artistically-naïve; while 30 subjects (average age 24.9 years, 4 men, 26 women) were considered artistically experienced. The artistically experienced participants were drawn primarily from the art and art history departments.

The naïve and experienced groups differed significantly from each other (Table 2) in their art experience based on our screening questionnaire (6.07 vs. 27.45, $t(88) = 19.29$, $p < 0.005$). While there is no principled way to establish a categorical cut-off for experience, based on these distributions, we suggest that people with scores of 0 to 14 be considered artistically naïve, and those with scores greater than 14 be considered artistically experienced. We note that our participants did not include people with deep artistic experience like mature professional artists, art critics or museum curators.

Stimuli

We used images of actual works of art as probe stimuli. All 24 paintings were from the Western canon produced by recognized artists; the artists and titles are listed in Table 3. Images were converted into bitmap files and presented using E-Prime Software (Psychological Testing Inc.).

Table 2. Artistically Naïve and Experienced Participants Average Responses to the Art Experience Questionnaire

Category	Naïve group	Experienced group
Studio Art Classes Taken	1.37	4.62
Art History Classes Taken	0.54	4.14
Aesthetics/Theory Classes Taken	0.17	1.97
Art Museum Visit Frequency	1.54	3.17
Art Gallery Visit Frequency	1.37	3.03
Hours/Week Spent Making Art	0.25	3.31
Hours/Week Reading Artistic Publications	0.14	3.10
Hours/Week Spent Looking at Art	0.68	4.10
Total	6.07 (±3.63)	27.45 (±6.93)

Note: The two groups were significantly different in their level of art experience, $t(88) = 19.29$, $p < .005$.

Table 3. Paintings Used in AAA

Vermeer, *The Letter*	Holbein, *Portrait of Dirk Tybis*	Hopper, *The Gas Station*
Pollock, *Number One*	Henri, *Laughing Child*	Garsia, *Apocalypse of Saint-Server*
Cassatt, *Self Portrait*	Heda, *Still Life With Oysters, Rum Glass, and Silver Cup*	Brueghel, *Netherlandish Proverbs*
Kahlo, *Two Fridas*	Dali, *Gala and Tigers*	Newman, *Eve*
Cassatt, *On the Balcony During Carnival*	Matisse, *The Blue Room*	Van Eyck, *Man in a Turban*
Cezanne, *Still Life with Kettle*	Rothko, *Red and Orange*	de Kooning, *Woman*
Buoninsegna, *Virgin and Child Enthroned*	Picasso, *Reclining Nude*	Pissaro, *Landscape with Flooded Fields*
Dewing, *The Piano*	Eakins, *The Gross Clinic*	Matisse, *Seated Riffian*

The AAA Description and Procedure

The AAA assesses six formal-perceptual attributes and six conceptual-representational attributes of a work of art. The formal attributes were: Color temperature (warm-cold), Color saturation (calm-vibrant), Stroke style (controlled-loose), Depth (flat-deep), Balance (low-high), and Complexity (simple-complex). The conceptual attributes were: Representational accuracy (less-more), Abstractness (less-more), Realism (less-more), Animacy (less-more), Symbolism (less-more), and Emotionality (less-more). These are all described in Table 4.

The administration of the AAA involved the following steps. First, subjects were familiarized with an attribute of interest. Each block began with an introductory screen with written instructions followed by a training image with a hand-drawn illustration that depicted examples of the extremes of the relevant art attribute (see example, Figure 1). These hand-drawn illustrations were designed to isolate the relevant attribute. Participants were allowed to ask questions to ensure that they understood the nature of the attribute being queried. Participants then rated each of the 24 paintings presented randomly with respect to the particular attribute (the scale remained on display at the bottom of the screen).

Table 4. Description of 12 Attributes of the AAA

	Description
Formal-Perceptual Attributes	
Balance	Visual harmony or visual "rightness"
Color saturation	Calm (more pastel) or vibrant (brighter) color palate
Color temperature	Warm (reds, oranges, yellows) or cool (blues, purples) color palate
Depth	Flat (two-dimensional) or depth (sense of three dimensions)
Complexity	Simpler (contained fewer elements) or more complex
Stroke	Loose or tightly controlled brush strokes
Content-Representational Attributes	
Abstraction	Abstract or concrete (representational) images
Animacy	More or less sense of the objects being alive
Emotion	More or less emotional expressivity
Realism	Realistic or fantastic images (e.g., horse versus unicorn)
Objective accuracy	Degree of depictive realism (how much like a photograph)
Symbolism	Literal or symbolic content (e.g., a set of bones versus skull and cross bones)

Thus, there were 12 blocks in the task, one for each of the 12 attributes. No time limit was imposed; subjects were allowed to take as long as they liked to read the instructions and respond to the stimuli by rating each on a 5-point Likert scale. The numerical ratings (from 1 to 5) by the participants were recorded automatically.

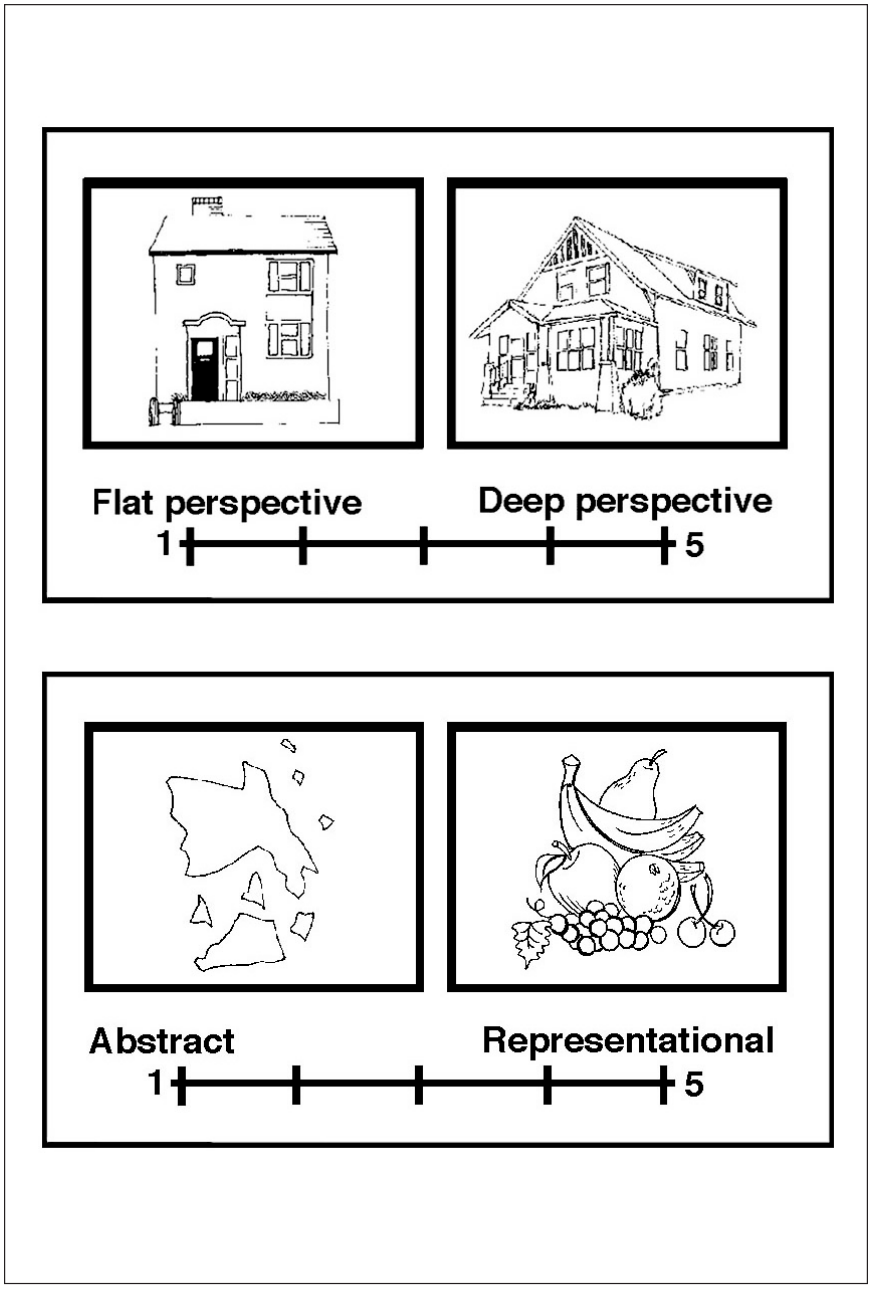

Figure 1. Examples of training slide used to familiarize participants with the attributes of Depth and Abstraction.

Data Analysis

For each painting we calculated the mean scores for all 12 attributes reported by the naïve and by the experienced groups. Figure 2 shows examples of scores on the attributes of Depth and Abstraction as judged by the experienced group. Using the mean rating, all 24 paintings were rank ordered from lowest to highest for each attribute. Figure 3 shows this rank ordering of the attributes of Depth and Abstractness, again as judged by the experienced group. Thus, each attribute was designated by a unique order of the 24 paintings for the two participant groups. We then used Spearman's Rho, as a non-parametric measure of correlation, to assess how well an individual participant's ratings for a given attribute correlated with the group mean. Thus, we were able to quantify the extent of agreement within each group, the higher the correlation coefficient the greater the agreement.

To test the hypothesis that artistic experience affects perception of art, we examined how well the rank order of these paintings for each attribute as judged by the naïve and the experienced groups correlated. Low correlation coefficients would suggest that the groups differed in their sensitivity to parametric variations of these attributes across the paintings. Additionally, we examined whether the mean correlations differed across the groups in two ways. First, participants' Spearman rank correlations for each attribute were compared using independent-sample *t*-tests. If the mean correlations were higher for the experienced than the naïve group, one would infer that experience with art confers greater agreement in the assessment of attributes in these paintings. Second, Spearman rank correlations were treated as Pearson coefficients and Fisher transformations were applied to test for group correlation differences (Myers & Sirois, 2006).

RESULTS

We found high degrees of agreement based on Spearman's Rho correlation coefficients for each of the attributes in the AAA (Table 5). For the naïve group correlation coefficients ranged from a high of 0.807 in assessing Abstractness to a low of 0.486 for balance. Similarly, for the experienced group, correlation coefficients ranged from a high of 0.850 in assessing abstractness to a low of 0.587 for balance.

Reliability of all the scales was verified by comparing the first 30 naïve subjects' ratings and the second 30 naïve subjects' ratings using Cronbach's alpha test of reliability, $\alpha = 0.961$.

Comparison of the ratings by the naïve and experienced groups were correlated highly, ranging from 0.982 for color saturation to 0.775 for emotionality. The two groups were also tested for significant differences in their mean agreement scores. A direct test for differences between the groups on each attribute revealed only minimal differences. When controlled for multiple comparisons,

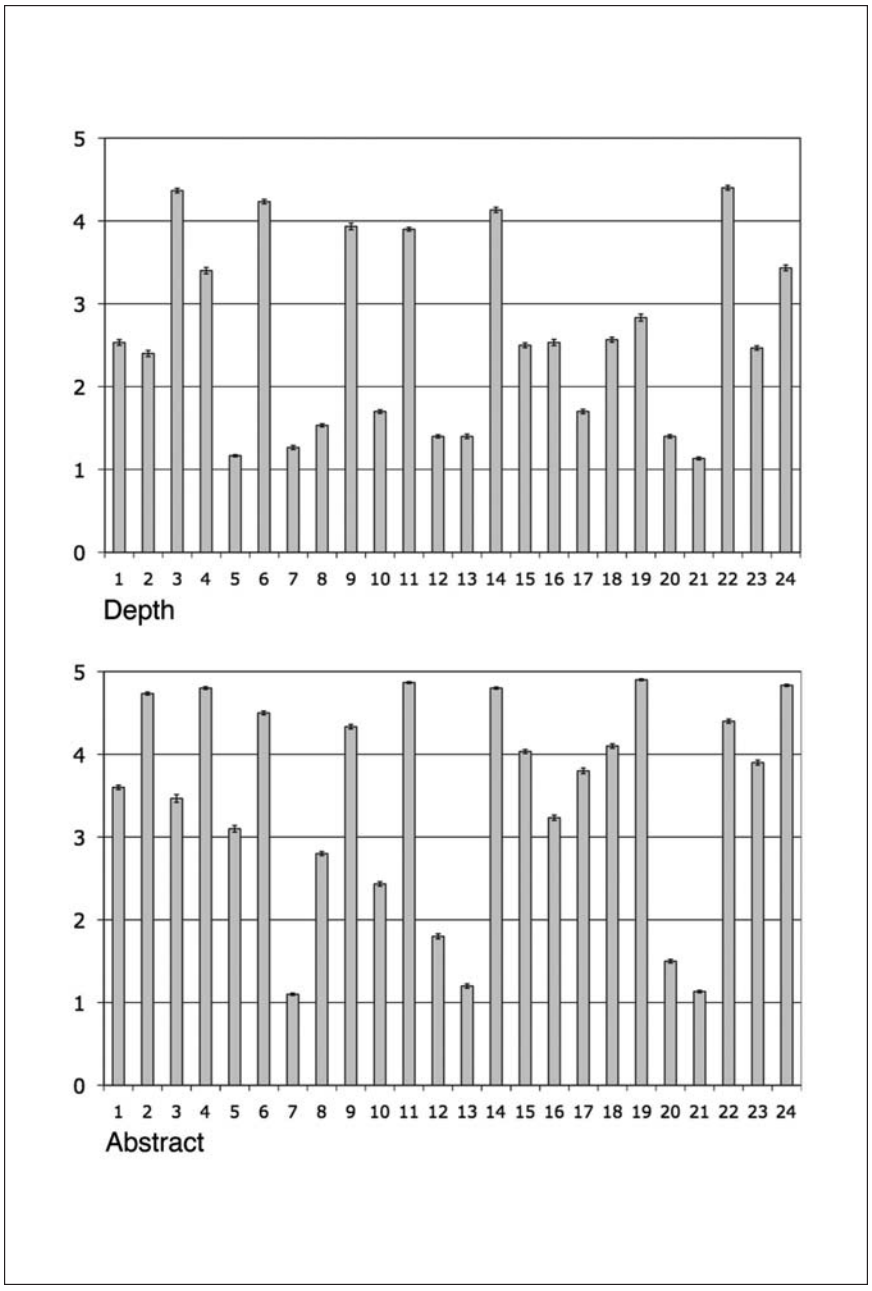

Figure 2. The average ratings for the attributes of Depth and Abstraction made by art experienced participants on the set of 24 paintings.

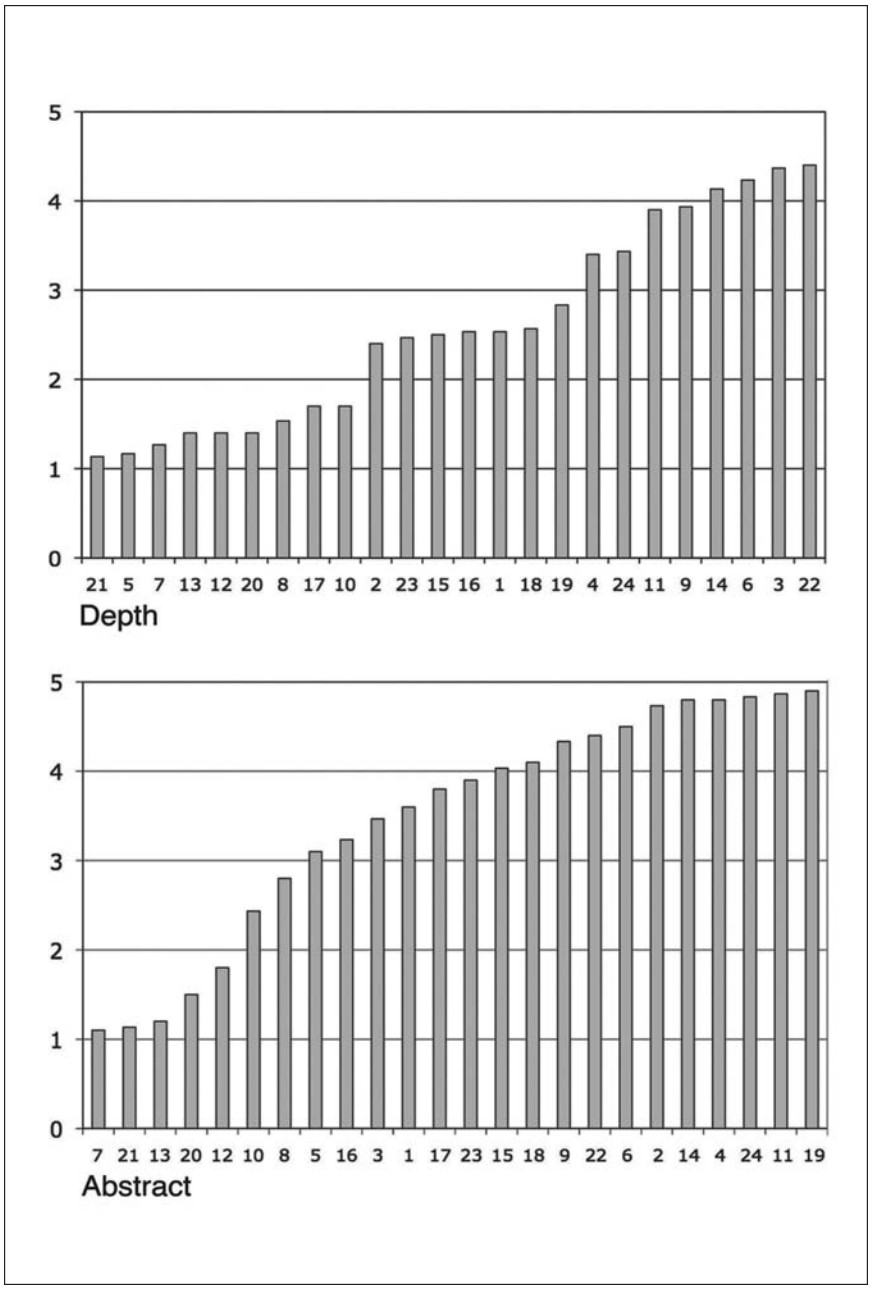

Figure 3. The rank order of 24 paintings on the attributes of Depth and Abstraction as judged by art experienced participants.

Table 5. AAA Results Showing Correlations of Judgment on Each Attribute and Comparisons of Naïve and Experienced Participants

Attribute	Spearman Rho with Std. Error (naïve participants)	Spearman Rho with Std. Error (experienced participants)	Rank order correlations between the two groups, all at $p < 0.001$ significance	T statistic ($df = 88$) testing for differences between groups	Z-scores for test for differences between group correlations using Fisher transformations
Balance	0.49 (±0.03)	0.59 (±0.04)	0.92	–1.99 ($p = 0.05$)	–0.31
Color Saturation	0.61 (±0.04)	0.74 (±0.03)	0.98	–1.98 ($p = 0.05$)	–0.51
Color Temp.	0.63 (±0.02)	0.72 (±0.03)	0.95	–3.11 ($p = 0.003$)	–0.36
Depth	0.76 (±0.02)	0.81 (±0.02)	0.97	–1.96 ($p = 0.05$)	–0.32
Complexity	0.61 (±0.03)	0.64 (±0.03)	0.97	–0.8 (NS)	–0.11
Stroke	0.69 (±0.05)	0.78 (±0.06)	0.98	–1.12 (NS)	–0.41
Abstract	0.81 (±0.02)	0.85 (±0.02)	0.98	–1.79 (NS)	–0.30
Animacy	0.71 (±0.02)	0.725 (±0.02)	0.83	–0.38 (NS)	–0.60
Emotion	0.67 (±0.02)	0.64 (±0.03)	0.78	1.09 (NS)	0.13
Realism	0.80 (±0.01)	0.74 (±0.03)	0.98	1.43 (NS)	0.30
Objective Accuracy	0.74 (±0.02)	0.75 (±0.02)	0.95	–0.34 (NS)	–0.05
Symbolism	0.63 (±0.03)	0.71 (±0.03)	0.95	–1.90 (NS)	–0.34

the artistically experienced had higher levels of agreement only for color temperature. Three other formal-perceptual properties, color saturation, perspective and balance revealed trends in the direction of higher agreement levels among the experienced than the naïve participants. Using Fisher transformations, no statistically significant differences were found between the correlations of the naïve and the experienced participants on any of the attributes (Z values for differences ranging from –0.51 to 0.30).

DISCUSSION

The motivation in developing the AAA was to provide an instrument that can be used to quantify attributes of visual art and advance programmatic research in the neuropsychology of art. Such quantification would permit comparisons across different artworks that could be subjected to rigorous analyses. The AAA distinguishes formal-perceptual and conceptual-representational attributes and has many potential uses.

Our main findings were the following. Artistically naïve and experienced groups both assessed art attributes with a high degree of agreement. The relative assessments by the artistically naïve and experienced were also highly correlated with each other. These robust correlations suggest that both naïve and experienced individuals are similarly sensitive in perceiving parametric variations of these attributes in artwork. Furthermore, there were no substantial and systematic differences between the inter-rater agreements on these attributes between the artistically naïve and the experienced participants. The experienced participants were in higher agreement with color temperature, and there were hints that they might have higher degrees of agreement for other formal attributes. Thus, in this context in which the artistically naïve were familiarized to each attribute using training slides, the hypothesis that experience would alter the perception of paintings was not generally confirmed. As a practical matter, these results suggest that in future studies one need not be greatly concerned about enrolling experienced rather than naïve raters to assess descriptive attributes. That is not to say that artistically experienced individuals might not weigh these attributes differently than naïve individuals in determining their preference or interest in artwork.

Given the high inter-rater agreement in assessing art attributes we think the AAA will be a useful instrument in neuropsychological studies addressing both the production and perception of art. At the production end, studies are underway to assess changes in artistic styles and content following focal brain injury. For example, Katherine Sherwood has continued to paint following a left hemisphere stroke. Her paintings following her stroke are thought to be more abstract and have been highly regarded by critics (Waldman, 2000; see Chatterjee, 2006, for other examples of change in artistic styles and content following neurological disease). Our strategy is to use the AAA as a way to familiarize individuals on the assessment of these attributes and then have them rate her paintings on each of these

attributes while they are blinded to whether a given painting was done before or after her brain injury. Thus, one could then test the hypothesis that specific attributes in her artwork changed following brain damage.

In addition to assessing change in artistic styles and content following stroke, one could also assess change over time in artists with gradually progressive disease (Halpern, Ly, Elkin-Frankston, & O'Connor, 2008). For example, de Kooning continued to paint after the onset of his Alzheimer's disease. These later works were considered by some to be pared down examples that retained the essence of his abstraction style (Garrels, 1995). Other people with Alzheimer's disease have been observed to produce more abstract paintings as their disease advances (Crutch, Isaacs, & Rossor, 2001; Maurer & Prvulovic, 2004; Miller & Hou, 2004). By contrast, people with fronto-temporal dementias have been observed to continue to produce highly representational work (Miller, Cummings, Mishkin, Boone, Prince, Ponton, et al., 1998). The AAA could easily be applied to assess longitudinal changes of such attributes of artwork as disease progresses or to compare the stylistic changes across different dementia types.

Almost nothing is known about the perception of artwork in individuals with neurologic disease. Certainly, brain damage would affect the perception of art. We are currently enrolling groups of individuals with focal brain damage and having them take the AAA. The fact that naïve participants were sensitive to parametric variations of these attributes is helpful, given that most people with brain damage are unlikely to be artistically experienced. The degree of deviation from healthy participant's ratings on these attributes would be a measure of their perceptual "deficit." Quantifying these deficits would allow us to determine which brain structures when damaged are most closely associated with these deficits. Such analysis will let us test the hypothesis that the perception of art involves distributed brain networks and start identifying what those networks might be.

We have emphasized the merits of the AAA (componential analysis, quantification, potential applications). However, we should also be clear about it limits. Four limits come to mind. The first is one of comprehensiveness. We chose specific attributes to be assessed in this instrument. Some might object to these choices and feel that other important attributes have been ignored. While we cannot guarantee the comprehensiveness of our assessment, the approach we have outlined could easily be used to incorporate additional attributes. Second, the quantitative properties of the AAA are probably influenced by the specific 24 paintings we chose. A different set of paintings might have different statistical properties. For example, agreement among participants for this set of paintings was lowest for balance. We suspect that the lower agreement was because the distribution of balance ratings was relatively compressed as compared to other attributes. Selecting artwork by accomplished artists meant that few pieces were very poorly balanced. Third, our finding that art experience did not substantially or systematically influence the perception of these attributes, as we have alluded to, may be a function of the level of experience in our group. It remains

possible that very highly experienced individuals, such as museum curators, professional artists and art critics, might rate these attributes differently than naïve subjects.

The final limitation is really an objection to the entire research program and its underlying assumptions. One might consider the componential analysis, quantification, and desire to map art to its biology an abomination. On this view, the merging of art and science is a category mistake. The very reduction and quantification of behavior needed for science robs art of its animating spirit. This objection is not specific to the AAA. Rather it is a deep objection to all of empirical and experimental aesthetics, dating back to Fechner (1876).

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