ENDNOTE

The Genome and Art: Finding Potential in Unlikely Places

As the Human Genome Project nears completion, we can anticipate having a map of the complete sequence of nucleotides in human DNA—without knowing many of their functions. It will be a little like having a list of every telephone number in the country, with only a vague idea of where they connect. The public's attention has generally been directed toward research into the protein-coding portions of the genome in hopes that, among other goals, this knowledge might be used in medical diagnoses and treatments. Accordingly, genomics is rapidly developing into a commercial enterprise. Much of our genetic code, however, consists of seemingly valueless sections referred to as "junk," such as Alu sequences and repetitive phrases, which do not participate in the production of proteins [1].

Junk sequences often consist of the same one or two letters repeated many times and tend to be easily distinguished from other genetic material. What could be the purpose of the great number of redundant elements interlaced within the otherwise information-rich framework of DNA?

In a 1994 *New York Times* article, Natalie Angier restated some geneticists' speculations that junk DNA sequences might act as gene enhancers, fine-tuning gene activities or acting as buffers against change and the impact of viruses. Angier recounted the history of scientists' beliefs about this boringly repetitive yet mysterious genetic substance as follows:

> Dr. Roy J. Britten of the California Institute of Technology, who first described junk DNA 26 years ago, said that some of the most familiar junk in primate DNA has all the signposts of [a] molecular raison d'être. These . . . Alu sequences, are short, repetitive strings of about 280 DNA bases apiece, which are scattered widely throughout the chromosomes of all primates, including humans. . . . Dr. Britten proposes however, that whatever their origin, the Alu sequences have since been drafted into duty by the primate host, perhaps to serve as subtle modulators of the genes they are near. . . . Dr. Ben F. Koop . . . and Dr. Leroy Hood . . . compared those coding parts of the sequence that actually dictate the construction of the receptor, as well as the parts that lay in between . . . the so-called introns that are normally edited out during the multi-step process of generating a protein. . . . "When we find this sort of conservation, we have to think that even introns are involved in chromosome structure or organization, or some regulatory function. . . ." [These] areas could be the caches of mutability and evolutionary change, a safe testing ground where new genetic ideas may arise without deactivating existing genes. . . . "I'm of the school of thought that junk DNA is absolutely necessary in evolution and recombination," said Dr. J. Craig Venter [2].

Angier's account of junk DNA provides a good example of how scientific hypotheses evolve. This little-understood genetic material is now posited as having value as a reservoir of flexible potential for future evolution. It appears that the coding, information-bearing portions of the genome that are already locked into specific functions lack that flexibility. Since Angier's article appeared, scientists have given increased attention to the non-coding portions, and as a result, all of us might discover more about properties and mechanisms involving the potential for new evolutionary functions. Even as a "space filler," non-coding DNA has value, since it punctuates the positions of functional DNA, marking intervals. For example, introns, or interruptions, subdivide genes, making it possible to specify different gene products [3]. When we shift attention from protein-coding DNA to the spaces in between, we are likely to open up unexplored areas.

These observations have some resonance with traditional figure-ground relationships, as well as with repetitive, background elements in many early two-dimensional or bas-relief artworks. We could view these elements as comparable to the "in-between" spaces in DNA. The unidentified faces of onlookers or crowds portrayed within Renaissance paintings may once have conveyed information about individuals alive at that time, but now they serve primarily as space-fillers, creating a context for the primary figures. In art, not only does the placement of minor elements matter, but these elements can also modify the concept of what constitutes significant information. If similar paintings of crowds were made now, the identities would be retrievable for years to come. Theoretically, unknown historical Renaissance figures might again be identified, and if so, the meaning of the total work might need reassessment.

The Parthenon frieze was once thought to represent a processional feast, but recently Joan Breton Connelly has reinterpreted it as arguably representing a sacrifice [4]. In this case, the key to the original code had been lost. To retrieve the meaning, Connelly formulated a new code, based partly on the assignment of greater significance to some of the elements previously considered minor, as well as to the repetition and placement of certain major units. As a result, the picture assumed a wholly different meaning.

The flexible model suggested by junk DNA bears analogy to a range of art, older and contemporary alike, that presents a repetitive background amid a matrix of information. We recognize the importance of the biological development of protein-coding genetic material. In contrast, although one does not expect art to be necessarily informative, the placement of information has always been a factor for artists employing systems to generate their art. Repeated phrases dividing the beginnings and ends of high-information sections are found both in non-functional genetic "junk" (e.g. CACA) and in system-derived art (e.g. repetitive background design units). These units secure particular positions within genetic material or artworks.

If we consider system-based art, we realize that computers have made it increasingly easy to incorporate or convert data to visual equivalents; this trend indicates how technology has changed art's relationship to information. If our aesthetic goals were to provide information alone, artists would simply write (as some conceptual artists have done). Instead, many artists intersperse elements that are high in information in their artworks (e.g. statistics), with others providing no numeric information (e.g. qualia) that nevertheless inflect the content of the entire artistic statement. Ornamentation, patterning and material properties figure in the entire meaning and mood of a work of art.

The painter Alfred Jensen, active during the 1940s and 1950s, was known for integrating information systems as varied as the Mayan calendar, Goethe's color theory, Tantric diagrams and Pythagorean numerical relationships into his art. He also transformed information related to DNA molecules, interspersing writing and symbols (specific information) with blocks of pure color (inflection) [5]. Although his flourishes and multiple references tended to confound the information he presented, the original systems could presumably be reconstructed with the clues he provided.

Many contemporary artists use information derived from extra-artistic sources as the basis for a work of art. An example is Jack Ox's intermedial translations of music. Many of these system-based artists create "in-between spaces" that modify the information derived from their sources. Lyrical, arcing, linear gestures connect the participants in Mark Lombardi's political-intrigue drawings. Expressive color marks and grids inflect Michael Banicki's art, consisting of charts of questionnaires. Other artists, including Marilyn Emerson Holtzer and Suzanne Anker, expressly reinterpret genetic information. Holtzer modifies information derived from folded protein by using the qualities of her medium, weaving: producing repetitive stitches that highlight protein structure. Anker uses the refractive properties of water as a medium to modulate her sculpted chromosomes.

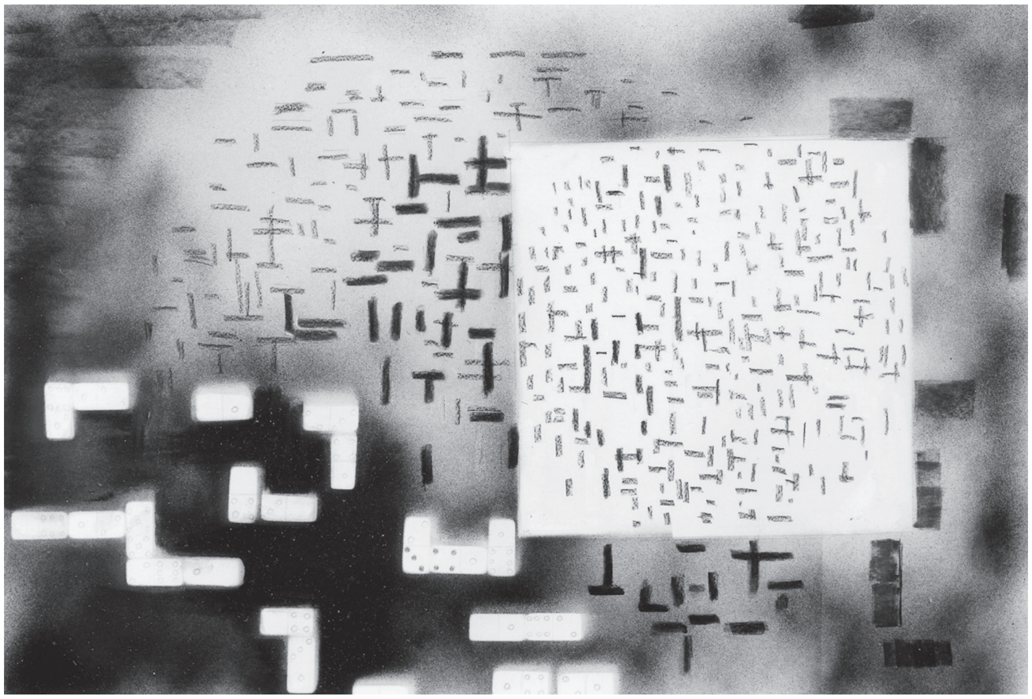

Fig. 1. ***After Mondrian, After Noll, Third Generation*****, mixed media on paper, 27 × 39.5 in, 2000. (© Ellen K. Levy) This drawing is made up of repetitive units that can be grouped in various ways. If the work is seen as fully abstract, the grouping will be made on the basis of similar visual qualities. If the units can be seen to form images (e.g. a portion of a Mondrian drawing or Michael Noll's computer interpretation of a Mondrian), the viewer will group the units as a representation. Figure/ground readings are influenced by cultural interpretations.**

I became increasingly aware of such modifications while reading about an experiment Meyer Schapiro conducted in 1966. Schapiro had Michael Noll of Bell Laboratories produce a computer version of Mondrian's *Composition with Lines* (1917). He then photocopied both images and asked subjects to identify the real Mondrian and also to state their preference. Schapiro was surprised to find that most identified and preferred Noll's computer version, which appeared to be more randomly constructed. This preference was attributed to the vogue for Abstract Expressionist art, identified at that time with spontaneity.

In light of Schapiro's experiment, I constructed a drawing (Fig. 1) consisting of repetitive plus/minus units to explore some issues of figure-ground interpretation. The piece reproduces Noll's computer version of the Mondrian composition within a large white square. The square is superimposed over part of a depiction of Mondrian's composition. I then scattered dominoes over the paper, placing the images near some of the smaller depictions of the plus/minus units. Domino pips can represent the complementarity of DNA base pairs (e.g. abutting two dominoes when the pips of two half-dominoes arbitrarily total seven). In fact, dominoes have been used to create models by scientists studying complexity and can be thought of as containing information related to the number of pips and placement [6]. Without knowledge of the references to Mondrian and Noll, a viewer would identify the white square and white domino forms as key visual forms in my drawing, viewing the repetitive, smaller, plus/minus elements as background to the larger forms. If, however, a viewer identified the plus/minus units as constituting not individual elements but images of a Mondrian and a Noll (themselves composed of small elements), the emphasis would shift. The drawing would then become yet another interpretation of the original Mondrian.

Several years ago, Nancy Chunn annotated the front page of the *New York Times* every day for a year, displaying them all together at the Ronald Feldman Gallery in New York [7]. Three aspects of Chunn's work are of special interest. First, she left a good deal of the original text unmarked by her annotations, creating a sea of low information, in which islands of annotated areas were prominent. Second, the underemphasized information in these unchanged areas can be thought of as a reservoir for potential use; someone else could make quite a different presentation of the same original material. Finally, Chunn created an installation in which original information was presented all at once rather than as a daily ritual, redirecting attention away from the newspaper's original content and toward the ebb and flow of different kinds of information over time.

For all artists (especially those who do not rely on information-based systems or realist models to generate their art), basic attributes such as color, size, texture and medium serve as information and provide clues to content. For art based on realist models, the iterative depiction of trees or windows can constitute areas of low information. In general, these intervals are not neutral in either art or in science. In art, such visual noise may provide context and placement for other, highlighted elements while also securing breathing room for the major elements. In science, negative findings are often considered as significant as positive results, since they influence the direction of future research.

As Koop stated in Angier's article, "'Junk' to me is just a euphemism for 'I don't know'" [8]. Junk DNA may have evolutionary potential for new functions as well as the role of occupying spaces in between the coding genetic material. The term "junk DNA" can also be viewed in a more literal way. From a cultural (but not scientific) standpoint, the designation "priceless" or "worthless" is periodically in flux for genetics as well as art.

In art, positive values like "flexibility" and "content" are sometimes provided by elements that are themselves deemed insignificant or abject. Artists such as Schwitters, Gris and Picasso incorporated cast-off materials in their art, changing refuse into valuables. More recently, Nancy Rubins has transformed vast amounts of trash into sculpture while Nancy Chunn has gone to great lengths to de-acidify newsprint, the art student's perennially discardable material. Just as a mutation within junk DNA could provide biological advantage to new organisms, a changing discourse can suggest a new value for a previously overlooked or devalued feature. One can think of visual culture as an open-ended system, since by reinterpreting earlier images and methods we extend work into the present and future. As a result, the perception of content fluctuates and is shown to be dependent on a prior framework of associations that establishes a context. When artists recast earlier ideas, visual culture, like biology, would seem to exhibit an evolutionary dimension.

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References and Notes

1. Robert Shapiro, *The Human Blueprint: The Race to Unlock the Secrets of our Genetic Script* (New York: St. Martin's Press, 1991) pp. 204, 315.

2. Natalie Angier, "Keys Emerge to Mystery of So-Called Junk DNA," *New York Times,* 28 June 1994, Medical Science section, pp. C1, C3.

3. Shapiro [1] p. 122.

4. Joan Breton Connelly, "The Parthenon Frieze," part of a seminar, "How History Lies" (moderated by Lenore Malen), presented at the New School for Social Research in 1996.

5. Ellen K. Levy, "Repetition and the Scientific Model in Art," in "Contemporary Art and the Genetic Code," guest editor E.K. Levy with B.M. Sichel, *Art Journal* **55**, No. 1 (Spring 1996) p. 81.

6. For discussion of domino models and complexity theory see Sara Lynn Henry (art historian, Drew University), "Ellen Levy's Disorder and Early Sorrow," catalogue essay, for traveling exhibition at Drew University, 1993.

7. Nancy Chunn, *Front Pages,* exhibition at Ronald Feldman Gallery, New York (1996).

8. Angier [2] p. C3.