A hidden message: Decoding artistic intent

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Abstract: Understanding how art makes impressions upon the perceiver has been a fundamental topic of philosophical interest since the time of ancient Greece. However, the extent of artistic perception and aesthetic appreciation has been the topic of empirical studies only recently, following the emergence of psychology as an independent field of science. The present study discusses the hypothesis that the impression created by artwork on the viewer can be predicted by examining activity of neuronal networks. In particular, we focus on neural activity evoked by abstract stimuli that matches elements of the viewers' previously learned conceptual dictionary. We show that artistic appreciation fundamentally depends on how easily the author's intent expressed in his or her artwork can be abstracted and decoded, on a neuronal level, into new or merged concept networks. More diverse intellectual and personal experiences—and their corollary neural networks—may facilitate the creation of new networks. These new networks, in turn, modulate the extent to which art can be apprehended and appreciated.

Since classic antiquity, philosophers have sought to address fundamental questions regarding the nature of beauty and artistic appreciation. However, artistic perception and aesthetic appreciation emerged as a topic of empirical investigation relatively recently, following the recognition of psychology as a distinct scientific field. The pioneering experimental psychologist Fechner (1876) was one of the first to consider aesthetics as a distinct area of scientific inquiry. Beauty and other aesthetic properties, however, do not need to be identified within the art. On one hand, nature itself possesses aesthetic values; on the other hand, art may express other attributes such as balance, dynamism, and harshness (Zangwill, 2003). In addition, the creative intent of the artist does not necessarily express itself through the language of beauty and aesthetics (Zangwill, 1999). Artistic examples that do not invoke aesthetic value include the majority of contemporary art from the 20th and 21st centuries (Kimball, 1997). Moreover, the ubiquity and popularity of art pertaining to negative emotions (Sachs, Damasio, & Habibi, 2015) and the intercultural differences in aesthetic perception (Marcus & Myers, 1995) preclude the identification of common mechanisms of the art experience that are based solely on aesthetic values.

At the same time, the same masterpiece can evoke similar sensations across different continents and cultures. For example, the popularity of Chopin's music in both Europe and East Asia highlights the existence of some common perceptual mechanisms across continents and cultures (Fung, 2007; Mlodawska-Bronowska, 2015). Indeed, contemporary psychological investigations show that art can elicit both cognitive and emotional reactions (Silvia, 2006)

and that understanding art can enhance an individual's experience and enjoyment (Millis, 2001). As demonstrated in research by Silvia (2005), the experience of interest in a given artwork is highly correlated with its apprised understanding. Subsequent research on the interdependence between perception and subsequent decoding of art was conducted by Russell and Milne (1997). In their work, Russell and Milne demonstrated that the ability to understand abstract paintings is enhanced by providing titles as well as the artist's biography or the work's context of creation (Russell, 2003). In this article, we posit that the original assumption of Gestalt psychology that every subjective phenomenon embedded within a frame of emotional evaluation (Pöppel, 1982; Zeki, 1998) is likely accompanied by cognitive processes.

Sending the message

Psychological investigations have indicated that the experience evoked by an artwork may evolve during the decoding of the encrypted artist's message (Leder, Belke, Oeberst, & Augustin, 2004). This decoding occurs in the same way that information is passed from sender to receiver via an information channel, as described in the information theory proposed by Shannon (1948). The first applications of the information theory to art research date back to the middle of the 20th century. At that time, Bense (1969) described artwork using definitions of chaos and order that were derived from Shannon's information theory (Shannon, 1948). Both Bense and Shannon applied this theory to the creative process to characterize the transfer of information between the author and the artwork. In particular, Bense (1969) combined the information theory with Birkhoff's (1933) mathematical analysis of aesthetic measure as well as with Noam Chomsky's (1966) generative grammar. Bense's (1969) new theory stated that in contrast to the physical world, the world of art progresses from disorder (i.e., a low level of information) toward order (i.e., a high level of information). Thus, according to this theory, aesthetic value is defined by the relationship between chaos (or complexity) and order.

Note that Bense's theory does not define how the information encoded in the artwork is received by the audience and subsequently affects aesthetic and emotional judgments. Furthermore, contemporary studies that adopt information theory measures to art research have not included

decoding, which is inherent to the process of perceiving art. For instance, Rigau, Feixas, and Sbert (2008) applied elements of the information theory to analyze paintings created by different artists in the period of 1880 to 1939. Using the approach proposed originally by Bense, the authors interpreted the creative process as encoding of information, which can be described by the transition from the initial repertoire of colors to its selection and distribution in artistic object (i.e., canvas). By applying three different measures of order and complexity (i.e., Shannon's entropy, Kolomorgov complexity, and Shannon's mutual entropy) to the progressively partitioned image, the researchers were able to capture the image's spatial order. In another information-theoretic study, Lopes and Tenreiro Machado (2019) adopted complexity measures (e.g., entropy, Kolomorgov complexity, and fractal dimensions) to analyze 457 works by graphic artist M.C. Escher. The researchers' work showed that the evolution of the complexity of the artworks correlated with the periods of Escher's artistic career. None of these studies, however, examined the perception and decoding of the artwork by the audience.

Receivers: Understanding the message

The transfer of information from the author to audience is critical for the reception of artistic intent as well as the full understanding of the experience of art. To our knowledge, however, no studies have examined the transfer of information from author to audience. The information embedded in art, along with its reception, is often implicit ("implicit learning;" Reber, 1989) or tacit ("tacit knowledge;" Reber, 1989). Neuroimaging studies have provided some evidence for the presence of implicit information in abstract art. One study by Kawabata and Zeki (2004) examined brain activity while participants viewed representational (e.g., landscape or portrait) versus abstract art. These researchers found no difference in brain activity in response to viewing representational versus abstract art (Kawabata & Zeki, 2004). This result may suggest that the same features and compositional elements are present in both representational and abstract paintings (Kawabata & Zeki, 2004).

A study of electrical brain activity carried out by Umilta, Berchio, Sestito, Freedberg, and Gallese (2012) suggests that the information embedded in artwork may also be implicitly decoded by the audience. Results of this research

are consistent with the notion that traces of the artist's gestures on the canvas (e.g., brush strokes) activate motor areas in the viewer's brain (Freedberg & Gallese, 2007). In an experiment conducted by Umilta et al. (2012)), researchers compared activity of the motor cortex in participants viewing either high-resolution digitized images or simplified versions of artworks by Lucio Fontana by showing cuts on the canvas. The experiment was conducted with two groups: (a) participants who were already familiar with Fontana's artworks and (b) participants who were exposed to Fontana's paintings for the first time. Results revealed in both groups a decrease of the amplitude of the mu rhythm (8–14 Hz), as compared to baseline, recorded by electrodes clustered around sites C3 and C4 located over the motor cortex. This amplitude decrease occurred only when subjects were viewing high-resolution digitized images of the original artworks and not when they viewed simplified versions. Importantly, previous studies have reported a suppression of mu rhythm on the same clusters of electrodes when subjects viewed hand grasping (Muthukumaraswamy & Johnson, 2004a, 2004b; Streltsova, Berchio, Gallese, & Umilta, 2010) or meaningless gestures (Babiloni et al., 2002; Streltsova et al., 2010). Together, these similarities suggest that the viewer's brain (intentionally or not) decodes detailed information about the artist's strokes in the original artwork.

According to the information theory, successful decoding of transferred information can occur only if the same encoding/decoding mechanism is at work in both the sender and the receiver (Shannon, 1948). However, it is unlikely that developmental rules that are embodied in the nervous network are sufficient for encoding and/or decoding culturally conditioned information. Mechanisms of individual plasticity and contextual information should also be included in this process. The notion that individual plasticity and contextual information play a role in encoding and decoding processes is supported by several psychological studies on contextual information processing, conducted in Eastern Asia, Western Europe, and the United States. Behavioral investigations have shown that people from East Asia detected changes in contextual information more often than individuals from Europe and the United States. East Asians also paid attention to a broader display spectrum and were more capable of detecting color changes in the periphery of a scene whereas Westerners detected mostly central changes (Boduroglu, Shah, & Nisbett, 2009). Furthermore, in studies of emotional perception, Japanese

subjects used facial expressions of the surrounding people to establish the target person's emotions whereas Westerners did not use this approach (for a review, see Mesquita, Boiger, & De Leersnyder, 2016). Intercultural differences in brain information processing have also been detected using brain imaging. One neuroimaging study by Ma et al. (2014) has compared brain activity of subjects from China and Denmark while they made attribute judgments across three dimensions: social roles, personality traits, and physical attributes. The analyses showed greater activity in the medial prefrontal cortex during self-reflection in Western subjects as compared to subjects from East Asia. These results suggest greater encoding of self-relevant stimuli and less interdependence among Western individuals versus individuals with East Asian cultural experiences.

Decoding mechanisms

Based on the aforementioned studies, the proposed encoding/decoding mechanism for understanding an artwork should also include sociocultural factors, as these factors are necessary for the emotional processing and enjoyment of art. Here, we posit that this encoding/decoding mechanism could be based on the set of internal concepts shaped by common sociocultural factors such as shared values, education level, social role, culture, and personal experience. This approach is similar to "conceptual schemes," as proposed by Davidson (1973), that can be used to organize personal experience into points of view. This notion is consistent with the previously reported correlation between understanding and appreciating an artwork (Silvia, 2005, 2006). Similarly, psychological and sociological investigations have shown that more sophisticated and complex musical genres (e.g., folk, bluegrass, blues, jazz, opera, classic) that require more experienced composers with more musical education are preferred by audiences with higher social or professional positions (Mellander, Florida, Rentfrow, & Potter, 2018; Peterson, 1992), higher education (Mellander et al., 2018), and greater intellectual openness (Rentfrow & Gosling, 2003). An analogous relationship also has been found between age and musical preferences; in particular, older people with more experience have been shown to prefer more complex genres (North & Hargreaves, 1997; Rentfrow & Gosling, 2003). Thus, the reported high popularity of Chopin's music in Europe, China, and Japan may be explained by a relatively large ratio of highly educated

individuals in all three of these regions (https://ourworldindata.org/quality-of-education; http://worldpopulationreview.com/countries/education-rankings-by-country; https://en.wikipedia.org/wiki/Education_Index).

One key question should be investigated: What is the neural basis of the aforementioned concepts? Further, it is unknown how the information embedded in artwork is decoded by the perceiver. One key candidate mechanism is the idea of concept cells or networks, as proposed by Quiroga (2012). Quiroga found that concept cells integrate and store all information pertaining to one concept, regardless of the modality of the inducing stimulus. The concept described by multimodal stimuli could include the encoding of people, events, or more complex cases (e.g., family, television show). Neurons of the same concept network are activated regardless of the modality of the stimulus, as long as the stimulus is associated with that concept. For example, take the case of a *Star Wars* movie (Kurtz, Lucas &Lucas, 1977). Neurons encoding the concept of *Star Wars* will be activated by a movie excerpt, a picture of a movie character, or even the spoken or written name of the film (Quiroga, 2012). We hypothesize that concept networks, which integrate multimodal information, may also store abstract stimuli that are common across less culturally dependent concepts. These abstract stimuli may also constitute part of a conceptual dictionary that is composed of putative concept networks that store information common to many concepts.

Premises for concept networks and dictionaries were laid out in an article by Mitchell et al. (2008), who investigated brain activity associated with the meaning of nouns. To examine brain activity related to meaning (or the "associated concept") of a given noun, researchers created a map of activations for 60 word–picture pairs of selected nouns. Then, each map was decomposed into activations that were associated with intermediate features of that noun, modeled as the activations of its corresponding n-grams. The n-grams were composed of contiguous sequence of n items from a large text corpus, in which a given text can be found in a large corpus of text. Such meaning maps were then used to predict brain activation for newly presented nouns. Results showed a mean prediction accuracy of 70%, suggesting that brain activity associated with specific concepts can be identified using neuronal constituents of elements from a conceptual dictionary. We hypothesize that this conceptual dictionary is comprised of brain areas activated by n-grams of a given noun.

We propose that elements of the conceptual dictionary are encoded in concept networks, which can induce similar subjective sensations that are mediated by common brain networks. Support for this notion comes from the work of Vessel, Starr, and Rubin (2012), who asked participants to apprise works of art from a variety of cultural traditions and historical periods, as aesthetically moving or not. The researchers found large individual differences in aesthetic ratings; for example, an image that was highly recommended by one observer was given a low recommendation by another. However, the brain activations maps showed a consistent pattern, such that there was a linear association between recommendation level and blood-oxygen level-dependent response in occipitotemporal regions (left inferior temporal sulcus, left parahippocampal cortex, and right superior temporal gyrus) and hubs of the default mode network.

A more diverse dictionary would allow for more connections between elements, and thus a greater ability to describe more complex objects and relations. We hypothesize that higher levels of education and more varied personal experiences encourage a more diverse conceptual dictionary. Support for this notion comes from the previously cited investigations that have examined the popularity of different genres of music among individuals with different levels of education and of different ages (Mellander et al., 2018; Peterson, 1992).

The hypothesis presented here proposes that the impact of art depends on activation of neuronal networks that encode elements of the conceptual dictionary of one or many concepts. When many different and originally disconnected concept networks are simultaneously activated, a new network may emerge. This new network may, in turn, lead to new associations or concepts, which is similar to a recent model of memory consolidation (Klinzing, Niethard, & Born, 2019). A diverse conceptual dictionary that allows for many new associations (including abstract associations) could elucidate sensations evoked by abstract or complex art. In contrast, a poor dictionary, associated with lower education and/or a narrower personal experience, could limit perception to less complex art (e.g., pop, rap, representational paintings). Thus, perception is directly associated with the experience and knowledge of a given individual. A poor dictionary may impede comprehension of the artistic intent embedded in more sophisticated art or in art that originates from different cultures, thus undermining artistic value. These data imply that the

recognition of an artwork depends upon the individual's conceptual dictionary.

The sender's perspective

Interestingly, our hypothesis regarding the value of the presence of an audience is in line with the opinion of artists across different genres (e.g., film, ballet, theater). In a letter to Edward Alden Jewell, an art critic from the *New York Times* (1943), Mark Rothko and Adolph Gottlieb wrote:

There is no such thing as good painting about nothing. We do not intend to defend our pictures. They make their own defense. We consider them clear statements. Your failure to dismiss or disparage them is prima facie evidence that they carry some communicative power. It is our function as artists to make the spectator see the world our way – not his way. (as cited in Clearwater, 2006, p. 181)

In another piece by Stanisław Dróżdż, a creator of concrete poetry, stated the following in a review:

Concrete poetry works are informative. I send a message and leave it for the audience to read. […] Information is not always designed by me from the beginning to the end. It sometimes surfaces by itself. And I don't know how this happens. (as cited in Dawidek, 2012, p. 312)

Finally, the following statement was delivered by the sculptor Tony Cragg during the 2016 "Sculpture Today" conference:

The point of exhibiting a pissoir may well have initially been to shock a bourgeois French public, but giving an industrial object a context in which it was given other meanings did have another far-reaching significance. We know that all things have their physical four-dimensional extension in space and time but they also exist in the form of memories and mental pictures in our minds every object or thing not only has a physical existence but also has a cloud of meaning – words and pictures – associated to it. Artists realized that it was possible to manipulate the terms associated to a thing so as to effect changes in its meaning. Enabling banal objects, like a soup can, to take on a new existence. In fact it was possible to completely transform something without even having to change its form. (Cragg, 2016, p. 152)

To summarize, we hypothesize that the impression created by an artwork on the audience is based on the process of decoding the message imparted by the author. For the successful decoding of transferred information, the authors and the audience must share similar encoding/decoding

mechanisms. These mechanisms are modulated by sociocultural factors such as personal experience, education, and cultural tradition. The neurophysiological basis of this mechanism may include activation of the neuronal networks evoked by the set of encoded abstract stimuli. These mechanisms are common for many concepts that comprise an individual's conceptual dictionary.

Interestingly, abstract drawings prepared by any type of automated process do not evoke interest of the audience. Similarly, experiencing natural phenomena (e.g., mountains, stormy ocean views) does not require an encoding/decoding process, which appears to be an indispensable component of experiencing an artwork. These observations suggest that what makes art fascinating is the possibility of insight into the mind of an artist.

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest.

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