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Can Art Promote Understanding? A Review of the Psychology and Neuroscience of Aesthetic Cognitivism

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Aesthetic cognitivism refers to the proposition that art promotes knowledge and understanding. Despite its intuitive appeal, few empirical investigations have tested the validity of this philosophical claim. In our review, we outline prior arguments for and against aesthetic cognitivism. Then, with a focus on visual art, we discuss how empirical aesthetics and neuroscience can contribute to conversations about aesthetic cognitivism. We propose that engagement, broadly defined as the ongoing thoughts, feelings, and actions of a person in response to viewing an artwork, is necessary to acquire new knowledge and understanding, describe motivational states associated with learning, and posit who is most likely to experience these states to gain knowledge and understanding from art. Throughout the article, we discuss how, when, and what knowledge derived from engagement might be measured and modeled. By grounding aesthetic cognitivism in empirical aesthetics, researchers can generate and test hypotheses about art's role in promoting knowledge and understanding.

Keywords: aesthetics, cognition, knowledge, understanding

Many scientists working in empirical aesthetics assume that art is valuable yet rarely investigate what makes art valuable. Instead, art's value is implicit or even regarded as self-contained. While discussion about art's value has been a topic of philosophical conjecture, scholars are divided over the nature of art's broader value (Aumann, 2014; Lamarque, 2006).

One possibility is that art can promote new knowledge and understanding, a notion referred to as *aesthetic cognitivism* (Baumberger, 2013; Gaut, 2005; Goodman, 1968). For some philosophers, art's value lies in its effects on cognition (Graham, 2005). Others acknowledge that art can promote knowledge but reason that such knowledge is also obtainable through other means of inquiry (e.g., history, science; Gaut, 2005; Lamarque, 2006; Stolnitz, 1992). The strongest proponents of aesthetic cognitivism argue that the arts should be "taken no less seriously than the sciences as modes of discovery, creation, and enlargement of knowledge in the broad sense of advancement of understanding" (Goodman, 1968, p. 102; Graham, 1996).[1]

Opponents of aesthetic cognitivism argue that "artistic truths" (i.e., facts that are internally consistent with the artwork) are merely suggestive of real-world knowledge (i.e., facts that are consistent with the real world) and therefore any knowledge gained from artworks aspires to, but does not generalize to, the real world (Stolnitz, 1992). Similarly, some suggest that artworks are experienced through already formed views and knowledge, rather than having a role in generating new knowledge (Diffey, 1995). Others maintain that artworks can express knowledge but that knowledge is irrelevant to the artwork's value (Lamarque, 2006).

These philosophical debates over aesthetic cognitivism, as we describe below, have persisted for centuries (e.g., Plato argued against aesthetic cognitivism and Aristotle argued for; Gaut, 2005). Can the question of whether art can promote new knowledge and understanding be approached empirically? Although the empirical literature has investigated whether people "understand" an artwork, find an artwork "meaningful," or have an "insight" when contemplating an artwork, evidence for the content of knowledge being gained is lacking.

Providing empirical evidence that art can promote new knowledge and understanding would support a conception of art's value beyond its immediate hedonic appeal. If art can promote the acquisition of new knowledge and understanding, then it can serve as a vehicle to convey information about the human condition and the world. Many lovers of art, including the present authors, are sympathetic to this proposition. If art only provides a limited hedonic experience with no appreciable downstream effects, then perhaps the arts need not be valued beyond the pleasures they provide, and art education can justifiably be cut when faced with budgetary constraints.

Despite the implicit view that art can promote new knowledge and understanding in the empirical aesthetics literature, we could start with the presumption that art does not promote new knowledge and

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[1] We conceptualize "knowledge" and "understanding" in this broadest sense and henceforth use them interchangeably.

understanding. This conjecture places the burden of proof on aesthetics researchers to provide evidence for how, when, and what knowledge can be gained from art. One challenge in empirically testing aesthetic cognitivism is to operationalize its claims. The tenets of aesthetic cognitivism need to be mapped onto psychological and biological processes. The goal of this article is to review relevant strands from empirical aesthetics that bear on aesthetic cognitivism. Along the way, we will mention relevant psychological and neuroscientific research and set the groundwork for future scientific inquiry into the hypothesis that art promotes knowledge and understanding.

Empirical Approaches Relevant to Aesthetic Cognitivism

The core claim of aesthetic cognitivism is that art can promote new knowledge and understanding. Its claims are based primarily on philosophical discussion of the narrative arts (e.g., Carroll, 2004; Gaut, 2005; Lamarque, 2006). These discussions focus on how knowledge is defined and whether knowledge about the real world is gained (Diffey, 1995; Stolnitz, 1992). Knowledge can mean demonstrable truths or facts about the world or knowledge that applies to an approach to life (i.e., understanding; Baumberger, 2013; Ryle, 1946; Shaw, 2001).

Most aesthetic cognitivists accept that art can provide insights into the human experience and change how we perceive the world (e.g., attitudes, emotions; Mouriki-Zervou, 2011), with the strongest proponents advocating that art can deliver facts about the world (Baumberger, 2013; Carroll, 2004). Those opposed argue that artworks rarely transmit knowledge about the real world, such as Paris being the capitol of France; instead, they argue that art merely provides the feeling of knowing something that is consistent with the real world (Diffey, 1995; Stolnitz, 1992). A general difference between philosophers is how knowledge is defined. Cognitivists tend to take a broader, more expansive view of knowledge (e.g., how something feels, appreciation of a different worldview), whereas anticognitivists tend to define knowledge in a strict sense of facts about the world. Although these discussions are based on the narrative arts, their claims generalize to other forms of art.

When investigating aesthetic cognitivism scientifically, we start with a broad question before narrowing our focus into more specific ones. Do people gain new knowledge or understanding from artworks? Here, we approach knowledge in a broad sense, consistent with cognitivists. Investigation in empirical aesthetics tends to focus on evaluative appraisals in the experience (e.g., beauty, liking, emotions; Wassiliwizky & Menninghaus, 2021; but see Panero et al., 2016). Reports of feeling curiosity, interest, and wonder signal the potential to acquire new knowledge but do not necessarily indicate that knowledge was in fact gained (Fingerhut & Prinz, 2020; Silvia, 2013; Vogl et al., 2020). By contrast, reporting an "aha" moment or insight suggests that new knowledge was gained (Konečni, 2005; Muth & Carbon, 2013; Muth et al., 2015; Pelowski, 2015).

Such evaluations of an immediate aesthetic experience do not typically address how or what knowledge is gained. Are there specific contexts or visual properties of artworks, for example, that make people more likely to report insight? What about a person makes them prone to acquiring new knowledge? Evaluations of aesthetic experiences (such as liking and interest) touch on these questions, but they are often used as end-point dependent measures in experiments and do not assess the downstream consequences of the experience. Illuminating how artworks can promote new knowledge and uncovering the content of that knowledge requires going beyond simple evaluations.

To organize the processes of art engagement relevant to aesthetic cognitivism, we use as a guiding model the Vienna integrated model of top-down and bottom-up processes in art perception (VIMAP; Pelowski, Markey, et al., 2017), an update on Leder and colleagues' aesthetic episode model (Leder et al., 2004; Leder & Nadal, 2014). The VIMAP articulates the time course of different aesthetic experiences and outcomes when encountering art. Key processes in the model that relate to aesthetic cognitivism include cognitive mastery (i.e., gaining understanding about the artwork; Leder et al., 2004), secondary control (i.e., resolving mismatches between expectations and experience), and metacognitive self-reflection (i.e., restructuring of cognitive representations; Pelowski, Markey, et al., 2017). While the VIMAP emphasizes a linear order of these processes, they may occur simultaneously or iterate with one another (Chatterjee & Vartanian, 2014, 2016). Some outcomes in the model that relate to gaining new knowledge and understanding from art are insight, emotional resonance, and transformation.

As a biological complement, we use the aesthetic triad model to organize these processes and outcomes. The aesthetic triad proposes that aesthetic experience emerges from the interactions between sensory-motor (e.g., salient sensory properties of artworks; Thakral et al., 2012), emotion-valuation (e.g., beauty, pleasure, curiosity; Belfi et al., 2019; Kidd & Hayden, 2015), and meaning-knowledge neural systems (e.g., knowledge about the artist or artwork's intent; Brielmann & Pelli, 2017; Chatterjee & Vartanian, 2014, 2016). These systems interact with and affect one another (e.g., meaning making can influence emotion valuation; Kirk et al., 2009). Neuroscientific inquiries into aesthetic cognitivism would be fruitful if they examine the time course associated with the learning processes as they occur and corroborate experiences predicted by the VIMAP for when knowledge might be learned (e.g., novel understanding of an artwork's meaning).

For a scientist investigating aesthetic cognitivism, three questions arise: What are the contextual factors that promote knowledge and understanding? Who is most inclined to have these experiences? What is the nature of the knowledge and understanding acquired? Each art domain is likely to vary in the contextual and dispositional factors as well as the type of knowledge it promotes. We focus on visual art but recognize that research in any art, such as music, dance, and narrative arts, is relevant to aesthetic cognitivism (e.g., Jacobs, 2015; Wassiliwizky et al., 2017). We discuss these three questions as they relate to visual art, use the VIMAP and the aesthetic triad models to frame empirical aesthetics and neuroaesthetics inquiries, and offer research directions to test aesthetic cognitivism.

What Contextual Factors Predispose a Person to Gain Knowledge and Understanding From Art?

At a minimum, a person must be engaged with art to gain knowledge and understanding. Engagement broadly refers to paying attention to the art and the ongoing thoughts, feelings, and actions of a person viewing an artwork. This process starts when viewing an artwork and ends once a person has stopped viewing or thinking about it. Early in processing, salient perceptual and

semantic features capture attention (e.g., shapes, colors; Chatterjee & Vartanian, 2014; Seeley, 2015), with meaning-making systems interacting with these features (e.g., knowledge about an artwork directing attention; Chatterjee & Vartanian, 2016; Seeley, 2013) or influencing the experience later in the process (e.g., new understanding about the meaning of the artwork; Pelowski, Markey, et al., 2017).

Environmental Features

The VIMAP starts with environments where artworks are viewed and proposes that these environments set expectations for experience. People have different motivations to seek out art, but a common motivation is a general interest to know more about the art (Trainer et al., 2012). According to Falk (2006, 2008), these motivations describe "explorers" or people who seek information that captures their attention and allows them to learn. When people's expectations are met, they report greater satisfaction and spend a longer time with art, when assessed in museums (Cotter et al., 2021; Muth, 2017).

These reports are consistent with the predictive coding model where expectations or predictions of experience are compared against actual experience, with mismatches potentially leading to worse or better than expected outcomes (e.g., confusion, pleasant surprise; Clark, 2018; Friston et al., 2010; Van de Cruys & Wagemans, 2011). From this perspective, visitors to museums typically expect that they will enjoy engaging with novel work. People seek out more challenging artwork in a museum than in a lab (Muth et al., 2017), and first-time museum visitors experience a greater range of emotions than those who are familiar with an exhibit (Rodriguez-Boerwinkle, Fekete, et al., 2021). These experiences align with the people's expectations of going to museums for novel experiences (Cotter et al., 2021).

Museums are only one example of where artworks are experienced in their "natural habitat" and thereby set up people's anticipation to engage with them and have an enriching aesthetic and cognitive experience (Carbon, 2020; Muth et al., 2017; Pelowski, Forster, et al., 2017; Specker et al., 2017). Studies of aesthetic cognitivism would benefit by using ecologically valid methods to evaluate artworks in their diverse environments, including in public and informal spaces. Experience-sampling methods, such as using smartphone apps, can directly assess what people are thinking and feeling in the moment of viewing artworks in their natural spaces (Silvia & Cotter, 2021). Viewing artworks in museums or murals on the street heightens the viewer's experience by setting expectations of experience, which raise the potential to acquire new knowledge and understanding. Murals, for example, can operate as a communication device, expressing the values, history, and culture of a local community. Viewers of a mural may gain a better understanding of the community through their interaction with the artwork and its surrounding environment in which it is situated.

Visual Properties

Investigating visual features can clarify the objective properties of artworks that draw people in to start the process toward gaining new knowledge. The Assessment of Art Attributes was designed to study some of these properties empirically (Chatterjee et al., 2010). The instrument assesses six formal-perceptual (depth, stroke, balance, complexity, color saturation, and temperature) and six conceptual-representational (realism, emotion, animacy, abstraction, symbolism, and objective accuracy) attributes of paintings. Formal-perceptual properties are likely to capture the viewer's attention initially, while conceptual-representational properties may influence initial perceptions or be processed later (Chatterjee & Vartanian, 2014, 2016; Pelowski, Markey, et al., 2017).

Once in front of an artwork, models of aesthetic engagement usually begin with processing these low-level features (Chatterjee, 2003; Leder et al., 2004). The aesthetic fluency hypothesis proposes that ease of processing an artwork's visual properties enhances its appreciation (Reber, Schwarz, & Winkielman, 2004). Objective properties (e.g., contrast and symmetry; Reber, Wurtz, & Zimmermann, 2004; Wurtz et al., 2008), repeated exposure (Bornstein & D'Agostino, 1994), exposure duration (Smith & Smith, 2001; Smith et al., 2017), and perceptual priming (Reber et al., 1998) can all increase liking of an artwork. Bottom-up processing of these features occurs at first sight and may interact with knowledge structures such as familiarity and knowledge about the artwork (Chatterjee & Vartanian, 2014, 2016; Pelowski, Markey, et al., 2017).

Certain properties of artworks may bias attention to specific features such as colors, brush stroke, or subtle meanings (Seeley, 2013). In the aesthetic triad, aesthetic properties and knowledge of artworks relate to the sensory-motor and meaning-making systems, respectively. Increased activation in brain networks associated with these two systems, such as attention (frontal eye fields, intraparietal sulcus, ventral frontal cortex, and temporoparietal junction regions) and cognitive control (lateral prefrontal and inferior parietal regions) networks, is related to increased liking of artworks (Cela-Conde et al., 2013; Vossel et al., 2014). These findings suggest that the sensory-motor and meaning-knowledge systems may coordinate attention and interact with the emotion-valuation system to support liking (Belfi et al., 2019).

The emotion-valuation system is associated with the liking, pleasure, and emotional content of aesthetic experiences. Liking and pleasure are associated with reward-processing areas of the brain, which include the ventromedial prefrontal, anterior cingulate, striatum, and insular regions. Several of these brain regions correspond to cortical midline, medial temporal, and posterior inferior parietal regions that constitute the default mode network (DMN; Buckner et al., 2008). Activation in parts of the DMN (ventromedial prefrontal and medial prefrontal cortex) reflect a domain-general connected pattern of neural activity associated with aesthetic appreciation (Belfi et al., 2019; Vessel et al., 2019), corresponding to pleasure in different art domains such as images (Vartanian & Goel, 2004), music (Ishizu & Zeki, 2011), and architectural spaces (Vartanian et al., 2013). Despite domain-general reward processing, similar elemental features (e.g., balance, complexity, symmetry) in different art forms are not liked equally, suggesting that the sensory-motor system may differentially interact with the emotion-valuation system depending on the modality and properties of the artwork (Clemente et al., 2021).

One challenge for aesthetic cognitivism studies is to identify features that capture people's attention (Hayn-Leichsenring et al., 2020; Lyssenko et al., 2016). Each person might be drawn to different features, making the task of selecting artworks to use in studies difficult (Chen et al., 2022). Brightness (color saturation), for example, may be commonly experienced as positive (Specker & Leder, 2018; Specker et al., 2018), but other properties, such as warmth (color temperature) and happiness (affect), may be person

and artwork specific (Specker, Forster, Brinkmann, Boddy, Immelmann, et al., 2020).

Empirical work has used descriptive terms associated with artworks to connect them to their aesthetic properties. One study recorded the frequency of terms people used to describe abstract artworks and related them to statistical image properties of the artworks (e.g., color, complexity, aspect ratio; Lyssenko et al., 2016). Another study used network science methods to examine how artworks were related to one another using these image properties as well as verbal descriptions people provided about the artworks to map the relationships between artworks (Hayn-Leichsenring et al., 2020). The verbal descriptions were more closely related to people's preferences than the image properties. Key takeaways from these studies were that people had different preferences for art that were apparent in the way they described artworks.

Drawing on these studies, identifying properties of artworks that are relevant to aesthetic cognitivism can be discovered in a similar manner. Network science methods can map the semantic space of how people describe properties of artworks as well as their impacts. By crowdsourcing evaluations across different people, a normed stimulus set of artworks could be derived based on their properties and cognitive-affective impacts. With such a normed stimulus set, researchers could manipulate the expected impacts of artworks and identify specific regions of the brain associated with impacts relevant to aesthetic cognitivism (e.g., curiosity, insight; Cervera et al., 2020; Kidd & Hayden, 2015; Kounios & Beeman, 2014).

Challenging Artworks

For easy to process artworks (e.g., a representational landscape painting), comprehension happens quickly and easily. Emotionally connecting with an artwork or wanting to know more about it, however, may trigger a search to uncover new knowledge and understanding (Graf & Landwehr, 2015; Leder et al., 2004; Pelowski, Markey, et al., 2017). Searches for meaning related to the self, others, or the intent of the artist promote opportunities for new understanding; wanting to know more about an artwork stimulates searches for information related to the artist, artwork, and historical context (Lachapelle et al., 2003; Wiersema et al., 2012).

Within the VIMAP model, artworks that are challenging (e.g., an abstract painting) can trigger a search for meaning (Leder et al., 2004; Pelowski, Markey, et al., 2017). Failing to comprehend a challenging artwork could make the viewer lose interest (Graf & Landwehr, 2015; Wiersema et al., 2012), while acquiring insight about an artwork's meaning can increase interest (Muth & Carbon, 2019). The predictive coding model suggests that violations of expectations can produce surprise that is experienced as negative initially but can become a positive experience (one potentially greater than without the negative experience; Van de Cruys & Wagemans, 2011). Both positive and negative experiences may elicit learning. Positive experiences might lead people to seek out similar artworks (Leder et al., 2006), whereas negative experiences might lead people to avoid similar artworks, learning that that style is not their taste. More importantly, provoking or challenging artworks might evoke negative emotions that are themselves opportunities to gain new understanding. For example, Robert Capa's famous photograph from the Spanish Civil War, *The Falling Soldier*, is not a pleasant image. It is regarded by many as the greatest war photograph in conveying the moment of this soldier's death and the human costs of war.

Work examining semantic instability, the process of resolving artworks with vague meanings, builds on the predictive coding model positing that our perceptual (e.g., sensory-motor) and cognitive (e.g., meaning-knowledge) systems seek to adapt themselves when confronted with challenging artworks by minimizing surprise (Muth & Carbon, 2016). Abstract and ambiguous artworks promote semantic instability using detailed images that invoke familiar objects while resisting identification (Pepperell, 2011). These artworks take longer to process and are typically more challenging than straightforward representational art (Ishai et al., 2007; Muth et al., 2015). When experienced in an art gallery, these artworks may increase the expectation of a challenge but lead to more pleasure than in the laboratory (Muth et al., 2017).

People feel challenged when they are unable to understand the meaning of an artwork (Seeley, 2013, 2015). When confronted with an artwork that challenges the viewer's expectations, people try to reconcile differences between what they are seeing and their mental model derived from previous knowledge and experience (Pelowski, Markey, et al., 2017). Pleasure derived from resolving these differences may indicate that new knowledge has been acquired (Jepma et al., 2012; Perlovsky et al., 2010; Schoeller, 2015). Consistent with this finding, intensity of an "aha" moment when discovering new meaning related to an artwork relates proportionally to liking that artwork (Muth & Carbon, 2013).

A person's curiosity may drive their need to resolve challenging artworks such as wanting to know for knowing's sake (joyous exploratory) or because they are frustrated (deprivation sensitivity; Kashdan et al., 2018). Neuroimaging studies link curiosity to regions associated with the emotion-valuation systems of the brain such as reward (ventral striatum and ventromedial prefrontal cortex) and salience of reward (posterior cingulate cortex; Daw et al., 2006; Heilbronner et al., 2011; Heilbronner & Platt, 2013; Kidd & Hayden, 2015). Satiating curiosity and discovering new insights may involve both emotion-valuation and meaning-knowledge systems such as regions of the brain that implement reward (e.g., striatum and orbitofrontal) and cognitive control (e.g., dorsolateral prefrontal; Kizilirmak et al., 2016; Levine, 2012).

The active inference account, which proposes that the brain actively generates representations of the world based on past experience, suggests that challenging artworks test these representations against incoming sensory inputs (Clark, 2018; Friston et al., 2010; Kesner, 2014). Sensory signals arrive through the thalamus, which has projections to other subcortical and cortical regions of the brain. These sensory signals are corroborated against prior experiences that are represented in the cortical regions. Mismatches between the representation and sensory signals produce a prediction error that propagates to changes in attention and cognition through the thalamus's projections to cortical regions such as the anterior insula (Barrett & Simmons, 2015; Menon & Uddin, 2010). The striatum has a mediating role in the coding and valuation of prediction error (Pagnoni et al., 2002; Schultz et al., 1997).

Based on this account, the propagation of errors from the sensory-motor (i.e., thalamus) and emotion-valuation (i.e., striatum) systems to the meaning-making system may represent the positive (curiosity) or negative (confusion) minimization of the mismatch between sensory input and previous experience (Kesner, 2014; Seth & Friston, 2016; Van de Cruys & Wagemans, 2011). These observations

suggest that researchers could use functional magnetic resonance imaging (fMRI) paradigms to investigate whether increased thalamic and striatum activity, potentially indicating valued prediction error, corresponds to increases in feelings of curiosity or confusion. Activation of emotion valuation (e.g., orbitofrontal and ventromedial prefrontal cortex) after increased activity in these regions might reflect the evaluation of the mismatch resolution, which could be the result of acquiring desired knowledge or disengaging from the artwork (Jepma et al., 2012; Kang et al., 2009; Kesner, 2014).

Understanding meaning-making processes is fundamental to the investigation of aesthetic cognitivism. These processes are perhaps the most difficult to capture empirically. Approaches would require obtaining information about people's experiences as they process an artwork. One approach might be to use "think-out-loud" paradigms paired with experience-sampling methods. People could verbalize their thoughts about an artwork out loud while they are processing it and record them. State-of-the-art natural language processing models, called transformer models, could be used to convert the audio recordings to text and then classify people's experiences based on specific terms related to aesthetic cognitivism (e.g., feeling curious, gaining new understanding, having a new perspective on life; Hsu et al., 2021; Tunstall et al., 2022; Vaswani et al., 2017). In addition, experience-sampling responses about the properties of the artwork and self-reported experiences could be combined to provide a circumspect understanding of the before, during, and after experience with an artwork. Such an approach would provide insights into the processes underlying people's concurrent experiences with an artwork.

What About a Person Makes Them Prone to Gain Knowledge and Understanding From Art?

Context and aesthetic properties are unlikely to be the only determinants of whether a person gains knowledge and understanding from an artwork. Motivational states also signal people's willingness to engage with art (Menninghaus et al., 2019; Skov & Nadal, 2020). States of curiosity, interest, and confusion may trigger the desire to acquire new knowledge and understanding (Silvia, 2013; Vogl et al., 2020).

Curiosity, Interest, and Confusion

Curiosity is both a state and a trait (Kashdan et al., 2018; Silvia & Christensen, 2020). As a state, curiosity motivates a search for information (Cervera et al., 2020) and a desire to learn (Berlyne, 1978). Curiosity thus has direct links to aesthetic cognitivism; being curious about an artwork triggers a drive to understand and seek knowledge (Berlyne, 1960). This knowledge can be directed at the meaning of the work or about the creator and historical context of the work. For the latter, the artwork itself need not provide the knowledge but instead could inspire the desire to seek new knowledge. Curiosity is therefore a vehicle through which art can stimulate the search for new knowledge and understanding (Berlyne, 1978).

Moderate prior knowledge, rather than too much or too little, is optimal to spark curiosity and interest (Grossnickle, 2016). Knowledge about an artist or artwork, for example, increases appreciation and a desire to seek out similar art (Csikszentmihalyi & Robinson, 1990; Lachapelle et al., 2003; Leder et al., 2004, 2012). Interest can be defined as having some knowledge with a sustained desire to learn more (Silvia, 2008). Curiosity and interest are similar in that both drive a search for new information (e.g., finding new meaning in art). They differ in that curiosity is operationally defined as short term and specific, whereas interest refers to ongoing and sustained development of knowledge (Hidi & Renninger, 2020). Although curiosity may motivate the discovery of new knowledge and understanding, interest sustains engagement, retention, and expansion of these discoveries (Renninger & Hidi, 2020).

People develop interest in topics that are both novel and comprehensible (Silvia, 2013). Not being able to comprehend a topic can lead to confusion and loss of interest (Silvia, 2010). Researchers can use abstract and ambiguous artworks that are intended to engage deeper perceptual and cognitive processing to try to identify when and how people become confused or whether they develop new understandings about the artworks. People can report on when they reach these conclusions, providing an opportunity to probe their thoughts and feelings in that moment. Whether these probes are written or verbal, transformer models could then be used to identify key components of the artwork that contributed to their confused or interested state.

Some researchers have applied a novel approach to track these outcomes while people watched short videos using joysticks to indicate their level of confusion and interest as a video progressed (Fayn et al., 2022). The joysticks increased bars displayed on the left and right side of the video that were labeled "confusion" and "interest." Such a dynamic, viewer-directed approach allows researchers to tap into the time course of when confusion and interest arise.

Within the VIMAP, outcomes such as curiosity, interest, and confusion occur at critical junctions in the aesthetic experience. These motivational states tend to occur as people are reconciling mismatches between expectations and experience (Clark, 2018). Confusion and loss of interest might set in when it becomes apparent that the mismatch between expectations and experience cannot be resolved (Van de Cruys & Wagemans, 2011). In contrast, curiosity and interest signal the potential for knowledge to be gained with insight, and pleasure potentially signals the acquisition of desired knowledge (Kizilirmak et al., 2016; Levine, 2012).

The meaning-knowledge and emotion-valuation systems of the aesthetic triad support the search for and acquisition of new knowledge and understanding. These systems are implicated in the integration between parts of the DMN and reward systems that are associated with curiosity and satiation of curiosity (Jepma et al., 2012; Kang et al., 2009; Kizilirmak et al., 2016; Levine, 2012). These brain regions associated with knowledge acquisition are also associated with aesthetic appreciation (Belfi et al., 2019).

Understanding the temporal dynamics of these brain regions will be key to dissociate knowledge acquisition from aesthetic appreciation. The temporal course of knowledge acquisition and aesthetic appreciation may start with the sensory-motor system. Prediction errors propagating from the thalamic projections to emotion-valuation and meaning-knowledge systems suggest that aesthetic appreciation may occur earlier in processing relative to knowledge acquisition (Graf & Landwehr, 2015; Pelowski, Markey, et al., 2017; Reber, Schwarz, & Winkielman, 2004). The time course of these activations is likely to occur rapidly and may be missed when using fMRI. Other modalities such as magnetoencephalography

(MEG) or electroencephalography (EEG) might be more appropriate to track the time course, which can then be corroborated with the spatial resolution of fMRI. Beauty of an object, for example, typically occurs 400–900 ms after its presentation, which is much faster than the temporal resolution of fMRI (usually 2 s; Cela-Conde et al., 2004). Leveraging different neuroimaging modalities will be required to track the time course of aesthetic experiences, which will be fundamental to understand the mechanisms of when knowledge can be expected to be gained.

Disposition

In addition to transient, stimulus-specific motivational states, some people may be predisposed to engage with art and be more motivated to learn than others. Whether someone responds with interest or confusion to an artwork depends on several factors such as their knowledge of art and their personality (Fayn et al., 2019; Silvia, 2010, 2013).

Expertise is a frequently studied and important modulator of aesthetic experience. People with art training know more about different artists, styles, and techniques than people with less experience (Cotter et al., 2021; Specker, Forster, Brinkmann, Boddy, Pelowski, et al., 2020). Knowledge may interact early in the perceptual analysis stage and influence experience going forward. Relative to nonexperts, experts focus their attention on different features of an artwork when appraising aesthetic quality (e.g., beauty and technique; Chamberlain & Wagemans, 2015; Hekkert & Van Wieringen, 1996). Prior knowledge can also aid in understanding the artist's intent or interpretation of the work (Csikszentmihalyi & Robinson, 1990; Lachapelle et al., 2003). These examples show how the meaning-knowledge system can modulate sensory-motor processing (Chatterjee & Vartanian, 2016).

The meaning-knowledge system can also influence the emotion-valuation system (Kirk et al., 2009). People with more general art knowledge tend to experience more nuanced emotions expressed in art (Fayn et al., 2018) and categorize artworks based on style rather than content (Augustin & Leder, 2006). The consequence of these more differentiated experiences culminates in greater flexibility of aesthetic appreciation (Leder et al., 2012). Specifically, experts use different determinants of liking such as nuanced emotional experiences, levels of arousal, and comprehension for appreciating art rather than sensory qualities alone.

A person's openness to novel experience is a recognized influence on whether they gain new knowledge and understanding from art. People more open to experience tend to know more about art (Atari et al., 2020), make different interest-confusion appraisals (Fayn et al., 2019; Silvia, 2010), appreciate compositional attributes (Clemente et al., 2021), and are more likely to have profound experiences (e.g., awe, wonder, curiosity; Fayn et al., 2015; Pelowski, Markey, et al., 2017; Silvia et al., 2015). Open people's preference for novelty may extend into their general "aesthetic taste" across the arts, too, such as preferring abstract art and a variety of music genres (Chen et al., 2022).

Open people perceive and think about art differently. They experience stronger mixed emotions (i.e., simultaneous positive and negative evaluations) when viewing visual art (Barford et al., 2018) and make more interconnected and flexible associations between concepts in their semantic memory (Christensen et al., 2018). Such cognitive flexibility can connect propositions that lead to new knowledge when interacting with art (Baumberger, 2013). Taken together, open people may approach artworks differently (e.g., seeking challenges) and may engage with them in a way that increases their likelihood of gaining new knowledge and understanding.

Religiosity and spirituality may also have roles in people's inclination toward gaining knowledge from art. Religious traditions use art to convey knowledge, using symbols in both textual and visual art (Bautch, 2013). Paintings related to the Gospel of Matthew, for example, enhance the written text and bring forward "the multivalency of the text in a more immediate way" (Boxall, 2019, p. 28). Impressive paintings and architecture such as the Sistine Chapel evoke awe and provide immersion in the theological experience, encouraging viewers to contemplate the art's significance (Brown, 2017). Visual art is a vehicle for transferring theological understanding through aesthetic experience, offering new understanding of religious traditions (González-Andrieu, 2012).

Having a religious background may prime the meaning-knowledge system to interact with the emotion-valuation system. When viewing an artwork that depicts a familiar religious scene, such as the sermon on the mount, knowledge about the passage in the religious text becomes activated and interacts with the emotional experience of the artwork. The interaction can also work in the reverse direction where emotionally connecting to a theological painting evokes new meaning and understanding about the events that took place in text. Religious and spiritual traditions that emphasize the importance of humility might predispose their acolytes to being more open to experience. While art may provide a vehicle for believers and nonbelievers to engage with religious teachings in a different modality, revelatory experiences might occur more frequently in believers (Brown, 2014). Regardless of belief, art can be a catalyst to understand broader sociocultural ideas (Johnson, 2020; Quash, 2013).

Individual differences in art knowledge, openness to experience, and religiosity are factors that people bring to the art experience before they are in front of the artwork. Once in front of an artwork, these viewer characteristics interact with each stage of processing, making them important factors to consider in aesthetic cognitivism studies. Work on aesthetic cognitivism could incorporate these and other individual differences (e.g., need for cognition, tolerance for ambiguity) in studies to better understand how they moderate experience. In some cases, it might be of greater interest to control for these differences, using regression or mixed-effect models, to try to understand which aesthetic properties or contexts have consistent impacts across all people.

What Is the Nature of the Knowledge and Understanding That Can Be Gained From Art?

This question lies at the heart of aesthetic cognitivism and is the one least addressed in empirical aesthetics. Under some circumstances, especially for an illiterate audience, it is self-evident that visual art can transmit facts about the world. Mythological and biblical stories were a staple of visual narrative in Western art, such as depicting Zeus's exploits or Jesus's life. Travelers in the 19th century provided artistic depictions of distant lands. Sweeping images (e.g., Albert Bierstadt's paintings and Carleton Watkins' photographs) revealed the beauty of the American West to those in the urban East. Even now, stunning images of far-away galaxies produced by space missions serve a similar purpose.

Perhaps the deeper question is whether art influences how we perceive the world. Proponents of aesthetic cognitivism contend that art changes our understanding of ourselves and our place in the world. The emotional impact on the viewer is critical for such profound effects, with certain emotions, such as awe and wonder, likely important indicators of a new perspective on the world.

Awe is a multifaceted state characterized by an appraisal of vastness (e.g., viewing a towering building) and a need to integrate experience with knowledge (i.e., need for accommodation; Keltner & Haidt, 2003; Yaden et al., 2016). Other facets of awe include altered time perception and self-awareness (e.g., feeling small or insignificant; Yaden et al., 2017), feeling connected to other people and the environment beyond the self (e.g., connections to God; Woznicki, 2020), and physical sensations such as feeling moved (e.g., feeling like crying; Cotter et al., 2019; Pelowski, 2015) and experiencing chills (e.g., goosebumps and shivers; Silvia & Nusbaum, 2011). While awe can occur during positive (e.g., joy, beauty) or negative (e.g., sorrow, horror) experiences (Konečni, 2005), it typically has positive connotations (Yaden et al., 2019).

Keltner and Haidt (2003) described the need for accommodation provoked by awe as having an experience that requires updating knowledge—whether through challenging a previous experience or forming a new understanding because of the experience (Shiota et al., 2007). They suggested that artworks that evoke awe encourage novel ways of viewing objects and situations. Awe can reveal knowledge gaps and motivate a desire to close that gap (e.g., explaining and predicting events; McPhetres, 2019; Valdesolo et al., 2017). Therefore, awe can signal an opportunity to acquire knowledge, and outcomes such as pleasure and insight might result from the acquisition of that knowledge (Konečni, 2005; Muth & Carbon, 2013; Muth et al., 2015; Pelowski, 2015). Awe reflects one possible manifestation of the interactions between the emotion-valuation and meaning-knowledge systems, mutually reinforcing one another to support impactful aesthetic experiences.

Wonder is closely related to awe. Whereas awe is a rarer, more striking state, wonder denotes a more common state of being pleasantly perplexed (Fingerhut & Prinz, 2020). Wonder is conceptualized as broader than awe, encompassing both the vast (e.g., sweeping vistas) and the tiny (e.g., eyes of a fly; Fingerhut & Prinz, 2018, 2020). A key difference is that wonder is directed toward particular things that are not understood immediately.

In theological traditions, artworks can inspire wonder and encourage exploration. González-Andrieu (2012, p. 26) provided an example, stating, "While no human experience can disclose *what* the mystery of God is, experiences that brim with beauty . . . can suddenly make us aware of the enticing mystery enveloping us" (italics in original). Beauty in this context describes more than sensory stimulation; it describes engagement in deeper cognitive processing (Fingerhut & Prinz, 2018). In art, beauty can be revelatory, instilling a sense of wonder about the subject, intent, and meaning of the work.

People appreciate art that inspires wonder (Fingerhut & Prinz, 2018). The cognitive characteristics of wonder suggest that appreciation may be driven by a desire to know more, making wonder a motivation to understand an artist or artwork more deeply (Leder et al., 2004). Awe and wonder also foster curiosity and interest, stimulating new ways of thinking, prompting searches for meaning, and promoting knowledge acquisition (Anderson et al., 2020; McPhetres, 2019; Pelowski, Markey, et al., 2017; Schoeller, 2015). One study changed people's perspectives of paintings by making them larger and hanging them higher, producing more wonder (e.g., amazing, inspiring, interesting; Seidel & Prinz, 2018).

Intense motivational states, such as awe and wonder and feeling moved, are associated with the activation of DMN regions such as the striatum, orbitofrontal, and medial prefrontal cortices (Blood & Zatorre, 2001; Vessel et al., 2012). The medial prefrontal cortex specifically is associated with more complex states such as "pleasant fear" that might relate to awe (Pelowski et al., 2021; Wilson-Mendenhall et al., 2015). Curiously, some researchers report that the medial prefrontal cortex only responds to aesthetic experiences that are personally relevant with strong emotional content (e.g., feeling moved; Vessel et al., 2012; Williams et al., 2018). These findings suggest that activation of the medial prefrontal cortex may be a distinct neural indicator that corresponds to meaningful aesthetic experiences. The medial prefrontal cortex is situated between the emotion-valuation and meaning-knowledge systems, suggesting that its activation may signal their interaction, such as an intense emotional experience that leads to a search for meaning (Kirk et al., 2009; Seeley, 2013).

Wonder and awe can be regarded as an expression of a change in a person's view of the world and perhaps their own place in it. Wonder can initiate a further search and, like curiosity, can drive further knowledge-seeking behavior in an iterative fashion. These responses and states can be thought of as both consequences of and motivators to new knowledge. However, very little empirical work has been done on the actual knowledge gained when conditions are optimal.

Retrospective reports when people have experienced awe and wonder can further elucidate the psychological and environmental conditions that preceded and followed the experience and whether any revelations occurred. When people have had a sublime experience with an artwork, an emotional impact closely related to awe, they retrospectively reported that they tended to be in a museum and the feeling typically occurred immediately (Pelowski et al., 2021). Experience-sampling methods could tap into when people are having intense emotional impacts like awe and would avoid memory fallacies that can occur with retrospective reports. People could also be asked whether they gained new knowledge or understanding after their experience and to describe what they have learned.

Summary

In our review of empirical and neuroscience aesthetics, we discussed how the environmental features, visual properties, and challenge of artworks can set expectations and present opportunities to gain knowledge from art. These contextual factors can affect the interactions between sensory-motor, emotion-valuation, and meaning-knowledge systems before and during processing of artworks. Different motivational states can be used as empirical indicators of engagement, signaling the potential to acquire knowledge (e.g., awe, wonder, curiosity, interest) as well as whether knowledge was gained (e.g., insight; McPhetres, 2019; Schoeller & Perlovsky, 2016). Together, these contextual and motivational factors interact with people's dispositions over time, leading to variation in processing and subsequently experience. Empirical investigations into aesthetic cognitivism can illuminate how these processes operate in concert to promote the acquisition of new knowledge.

Future Directions for Empirical Aesthetic Cognitivism

Experimental investigations testing whether art promotes new knowledge and understanding directly have been limited. Here, we identify three ways that research could advance to test the hypothesis that art promotes knowledge and understanding: assessing the kind of knowledge gained directly, operationalizing claims, and targeting specific points in the unfolding of aesthetic experiences.

What knowledge is gained from art? This question is at the heart of philosophical debates over aesthetic cognitivism (Baumberger, 2013; Diffey, 1995; Gaut, 2005; Stolnitz, 1992). Philosophers opposed to aesthetic cognitivism argue that knowledge should only be construed as propositional—a claim that can be verified in the real world (e.g., Paris is the capitol of France). Cognitivists argue that knowledge is broadly defined, encompassing facts about the world as well as gaining new understanding about oneself or others and an artist or artwork. Understanding, viewed as a change in one's sensibilities, can be feeling the turmoil and torture behind Picasso's *Guernica* or experiential such as learning how it might feel to have schizophrenia from an artist's portrayal of their symptoms.

Our view aligns with the broad definition of knowledge. Constraining the impact of art to propositional knowledge only limits the potential for art to provide meaningful experiences that could be transformational for the viewer. Meaningful experiences may also take time to process before transformative effects are evident, suggesting that knowledge acquisition may not be obvious immediately during or after an aesthetic experience. Research on aesthetic cognitivism might benefit from identifying different types of knowledge, including affective conditions from which understanding might emerge. Different types of artworks (e.g., narrative, performance, visual) might be better suited to impart different kinds of knowledge on this continuum.

Experimental approaches to aesthetic cognitivism would benefit from operationalizing the claims. Specifically, mapping the tenets of aesthetic cognitivism to psychological and biological states and processes would be helpful. As a starting point, researchers need to develop a common vocabulary for describing the properties or cognitive-emotional impacts of artworks. Pelowski and colleagues (2021), for example, constructed a map of aesthetic emotions that were associated with self-reported sublime experiences using network science methods to better understand its conceptual space (Hayn-Leichsenring et al., 2020). Similar methods could be applied to aesthetic cognitivism that involve crowdsourcing different properties and impacts of artworks that are relevant to aesthetic cognitivism.

Once the properties and impacts of artworks are operationalized in a common vocabulary, artworks could be identified that exhibit high and low characteristics on these properties and impacts. Identifying a set of artworks that vary on these properties and impacts provides a systematic platform from which to investigate whether specific contexts and impacts lead to new knowledge across people. Such a stimulus set could incorporate different styles and cultural origins of artworks so that opportunities for engagement are maximized for different people (e.g., Hayn-Leichsenring et al., 2020).

Once equipped with a clear set of constructs and well-characterized stimuli, researchers would then be able to systematically study aesthetic cognitivism in lab, virtual, and real-world spaces (e.g., Rodriguez-Boerwinkle, Boerwinkle, & Silvia, 2021). Time spent viewing certain artworks will be an important factor (Smith & Smith, 2001; Smith et al., 2017). Reflective processes are unlikely to unfold in the first few seconds when artworks are processed automatically (Graf & Landwehr, 2015). Spending more time with artworks grants people the opportunity to engage with them in a contemplative manner, allowing affective impacts and cognitive elaboration processes to unfold (Leder et al., 2004; Pelowski, Markey, et al., 2017; Smith et al., 2017). Providing information about the artwork such as historical and cultural context is also critical to comprehend an artist's and artwork's intent (Cupchik et al., 1994) and easily incorporated when working with a standardized set of diverse artworks.

Investigating processes that underlie the interest-confusion motivational states might be key to understanding how people gain new knowledge and understanding from art. The VIMAP offers a time-dependent model on the processing stages that result in confusion or interest, which can be tested using continuous, dynamic measures of these states (e.g., Fayn et al., 2022). A critical stage in the model is whether people can comprehend and relate to the artwork. For some people, additional support might be needed to keep them from disengaging (being confused) and gain interest in an artwork (e.g., providing more contextual information; Belke et al., 2010; Cupchik et al., 1994; Muth & Carbon, 2019). Novel approaches such as using joysticks to simultaneously capture confusion and interest during an aesthetic experience (e.g., Fayn et al., 2022) could be used to understand the time course of these feelings and evaluate predictions from the predictive coding model (Van de Cruys & Wagemans, 2011).

Using time series analyses, neuroimaging techniques can clarify when initial perceptual processing gives way to more elaborative cognitive processes, allowing more explicit time course explanations of processes underlying aesthetic experiences (e.g., Pelowski, Markey, et al., 2017). EEG and MEG are particularly suited to evaluate the temporal processes, whereas fMRI techniques can reveal how sensory-motor, emotion-valuation, and meaning-knowledge systems spatially interact over time, corroborating insights into their dynamics.

Neuroimaging studies (e.g., EEG, fMRI, MEG) can identify specific regions and temporal processes of the brain associated with impacts relevant to aesthetic cognitivism—awe (van Elk et al., 2019; Wassiliwizky et al., 2017), curiosity (Cervera et al., 2020; Kidd & Hayden, 2015), pleasure (Berridge et al., 2009; Vessel et al., 2019), and insight (Kounios & Beeman, 2014). Regions of interest are part of the default mode (e.g., anterior frontal cortices), reward (e.g., orbitofrontal cortex and ventral striatum), semantic memory (e.g., anterior and medial temporal regions), sensory-motor (e.g., thalamus, precentral and postcentral gyri), and cognitive control systems (e.g., dorsolateral prefrontal cortex; Barrett & Simmons, 2015; Chatterjee & Vartanian, 2014). Understanding how these systems work in concert and with other neural systems like salience and visuospatial networks can help identify biomarkers of aesthetic experiences that elicit new knowledge and understanding (Chatterjee & Vartanian, 2016).

Approaches to understanding the interactions between these networks could be used to identify brain connectivity associated with gaining new understanding, which may otherwise be difficult when people are unable to verbally communicate what they have learned. Parametric analyses that focus on different brain regions, for example, can be used to clarify properties or impacts of artworks that are associated with different neural signatures (e.g., Coburn et al., 2020). Exploratory whole-brain connectomes—

network connectivity between brain regions—can also investigate how these systems contribute to aesthetic experiences and predict who is more likely to seek out new knowledge and understanding (Li & Zhang, 2020; Shen et al., 2017).

In general, modeling aesthetic cognitivism is not straightforward. Although some properties of artworks may have common effects on people (e.g., brightness and positivity; Specker & Leder, 2018; Specker et al., 2018), artworks themselves are unlikely to be processed in the same way by everyone—people differ in their preferences for artworks (Chatterjee & Vartanian, 2016; Chen et al., 2022; Fayn et al., 2019). Researchers therefore need to explore a diverse set of artworks to encourage engaging experiences for different people.

Multilevel models can be used to understand the between-person effects of each artwork as well as their effects on individual people. A novel approach in this direction could be to model the impacts on each person as a network, where impacts are represented as nodes (circles) and edges (lines) represent associations between impacts for a given artwork (Specker et al., 2021). Specker and colleagues (2021) used a network science approach to understand the interactions between the artwork and person as an active experience where the properties of an artwork interacted with each person's cognitive-affective impacts (e.g., awe, confusion, insight, pleasure; Mischel & Shoda, 1995). Because each artwork can affect people differently, the organization of these impacts will differ for each person. An artwork that activates pleasure in two people, for example, may activate different experiential pathways (e.g., curiosity in the first person and warmth in another). Impacts such as feeling awe, curiosity, and insight and being transformed may suggest that a person has obtained new knowledge or understanding, whereas pleasure and warmth may merely suggest aesthetic appreciation.

Programmatic empirical research to test the aesthetic cognitivism hypothesis will be challenging. Ultimately, we need to assess what a person has learned and how they have changed by engaging with art. These changes may be short lived or enduring. For many, the notion that art can promote knowledge is intuitively appealing. We have described conditions under which advancing knowledge seems most likely; however, the challenge of operationalizing and capturing when and what knowledge is acquired remains. Empirical aesthetics and neuroscience can offer a scientific foundation to move toward this goal. By grounding aesthetic cognitivism in science, researchers can generate testable hypotheses about art's transformational power. What we want to know is how art can change our view of ourselves and of the world.

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