Aesthetics and the Explication of Surprise

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Abstract. Art is related to explanation, in fact according to Leyton [11] the aesthetic response is the mind's evaluation of explanation, and furthermore the level of aesthetic response to works of art is proportional to the level of complexity perceived. The perceived information complexity can be measured by the degree of surprise; the more surprising the information the higher its complexity.

Artworks engage our interest and challenge our ability of explication. Forming explanations of surprising information involves changing beliefs, expectations, and concepts. Therefore, if the aesthetic response to an artwork can be measured by the amount of surprise it engenders, then the degree of response is proportional to the degree of change a cognitive state undergoes in order to coherently accommodate and explain the surprise. Consequently, the measure of change is inextricably related to the measure of pleasure.

Introduction

Art is related to explanation; according to Leyton [11] the aesthetic response is the mind's evaluation of explanation, and the level of aesthetic response to works of art is proportional to the level of complexity perceived. It can be established that the more surprising the information gleaned from an artwork by the perceiver the higher its complexity.

Artworks command our attention and challenge our ability of explication. Forming explanations of surprising information involves changing our beliefs, our expectations, and our concepts. Therefore, if the aesthetic response can be measured by the amount of surprise engendered, then it is proportional to the degree of change a cognitive state undergoes in order to cogently accommodate and explain the surprise. Consequently, the measure of change is inextricably related to the measure of pleasure.

The main idea put forward in this paper is that the aesthetic response, or more loosely pleasure, is derived from the explicable surprise precipitated by a work of art. For example, an artwork may juxtapose objects and concepts in a way that is unexpected, it may distort the lines of perspective, or it may use optical inconsistencies to subvert our expectations of space [18]. The perceiver must modify their cognitive state in order to explain the unexpected nature of the work.

Normally, works of art that induce an aesthetic response are compelling and novel. This paper sets forth the proposition that the degree of surprise fomented by a work of art is a measure of the degree of pleasure it evokes. In particular, the degree of surprise the artwork causes is determined by how much the perceiver must change beliefs, expectations, and conceptual mappings in order to accommodate the information it contains, and to form a viable explanation. This explanation may occur at the perceptual level or at the higher representational and/or conceptual levels. One could argue that the more coherent, plausible, and specific the explanation of an artwork the more profoundly it is understood by a given perceiver.

Information and cognition

A work of art encapsulates information; it is usually an abstract representation of the physical world, or a representation of an artist's imagination. According to Goodman [10], representation involves the classification of objects rather than an imitation of them, and artists are able to recast entities and relationships a fresh, by reclassifying familiar objects and concepts in new and interesting ways, thus sharing their insight.

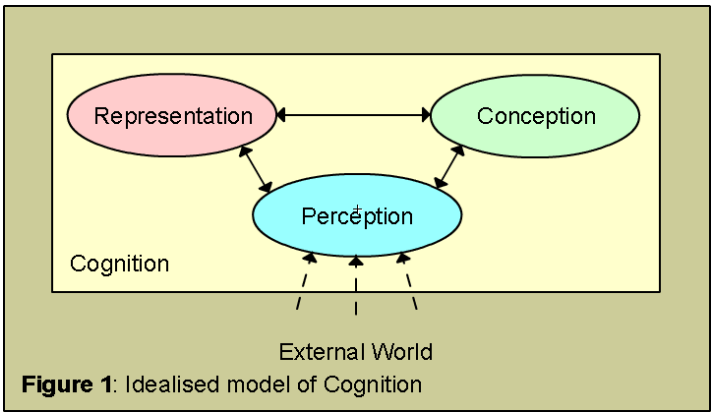

Figure 1: Idealised model of Cognition

An idealised model of cognition is illustrated in Figure 1; it depicts three interacting cognitive processes - perception, conception, and representation. The process of cognition is characterised as the formulation of sensory information procured from the real world to representations and concepts, this simple description of cognition will prove to be sufficient for our purposes.

When sensory information from the world impinges on us, cognitive processes at the perception level attempt to explicate and comprehend it. We will view the process of interpreting electrochemical signals by the brain as a black box phenomenon. Perceptual information is used as the foundation for the construction and formation of higher-level representations and concepts. The process of perception does not occur in isolation; features discerned from sensory information during perception are largely determined by the conceptual framework, the epistemic state, as well as the desires and intentions of the perceiver.

The cognitive state can be described using plausibility to order beliefs and expectations [7, 8]. Firmly held beliefs have a higher order than beliefs that are less plausible. Plausibility orderings rank beliefs and expectations in terms of their cogency and defensibility. This representation has been used widely in Philosophy, Cognitive Science, and Artificial Intelligence; see [5] for example. We will use this plausibility reordering to describe a cognitive measure for surprise.

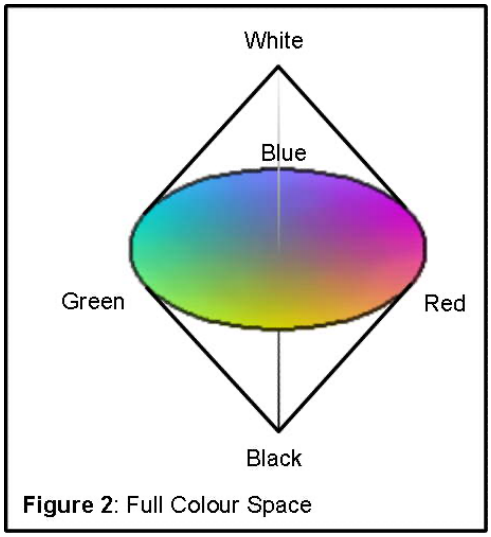

Figure 2: Full Colour Space

In some recent work, Gärdenfors [6] introduced cognitive entities called conceptual spaces. A conceptual space can be represented as a topological space and can be described using a number of so-called quality dimensions, such as colour, weight, spatial indicators, temperature, or time, depending on the concept. Gärdenfors asserts that these qualities can be pre-linguistic, that is, they do not require the presumption of a language of thought. He argues that the geometrical structure of conceptual spaces can be used to describe notions of naturalness, similarity, and prototypicality, which clearly have a significant role to play in the interpretation of art. To illustrate Gärdenfors' ideas, consider his example of the colour space [6, see Figure 2] a double-ended cone where achromatic colours (white, grey, black) characterise variations in brightness.

In Gärdenfors' formalisation, similarity and prototypicality can be characterised using distance measures. For naturalness, Gärdenfors uses the notion of convexity, in particular natural properties *carve out* convex subspaces within a conceptual space. For example, the red region in the colour space is a convex subspace; any object residing between two red objects in the colour space is also red.

In summary, cognition involves the transformation of sensory information into concepts and symbolic representations, as well as the manipulation and modification of these entities. Perception may be viewed as the process that our brain undergoes in order to explicate the sensory information it receives, in other words the process of elucidating information impinging on our senses. Activities at the representation level involve the construction and modification of symbolic representations of information such as preference orderings of beliefs, and conception can be viewed as the formation and manipulation of conceptual spaces.

Explanation and Aesthetics

In an effort to analyse and comprehend information conveyed in art, textbooks appeal to certain attributes, which may assist in the explication of the information works of art embody. Some pertinent attributes might be: physical properties, the subject, illusory properties, formal properties of composition, the perceiver's perspective, style, symmetry/asymmetry and structure.

Structural and symmetrical properties are often used to describe patterns and are important facets of information. The detection and explanation of structure and asymmetry pervades many areas of human endeavour, for instance astrophysicists seek explanations for observed structure in the universe, and for its apparent asymmetry with respect to matter and anti-matter. Similarly, cognitive scientists search for mechanisms that establish cognitive structure in an inherently asymmetrical neuronal plexus.

Leyton [11] argues that art is related to explanation. The analysis of the painting by Theo Van Doesburg, shown in Figures 3 through 7, can be found in many elementary textbooks on understanding art. It illustrates the stepwise transformation of the representation of a cow. Given the final product only (Figure 7) it is virtually impossible to know that the original intention of the artist was to capture certain properties of a cow. This artwork illustrates another point that artworks, due to their intentional ambiguities, inconsistencies, and deception, normally have a plethora of interesting interpretations. Even the artist may have more than one in mind. In order for an individual to experience pleasure from a work of art, they must be able to generate at least one sustaining interpretation. Consider the Dali in Figure 8, it is easy to see that there is a simple interpretation: the identification of the human face with the clock face, and the handlebar mustache with the hands of the clock. Perhaps there are other more subtle, albeit more esoteric interpretations. For instance, is Dali mocking the meaning of time, or is the time displayed significant.

Leyton contends that the aesthetic response is the mind's evaluation of causal explanation. He maintains that the level of aesthetic response to artworks is proportional to the level of complexity that an individual observes. He goes further arguing that the desire for art works is part of a general desire that the human mind has for complexity.

Barratt [2] also claims that humans seek to explicate complexity, and furthermore that there must be a maximum degree of complexity that the mind is capable of explaining at any one time. If the degree of complexity is increased past this level, it exceeds the mind's capacity to explain it. Cognitive dissonance is reached, and consequently the perceiver deems the information incoherent. Barratt concludes that the limit is set - by the ability to give causal explanation. We refer to this limit as the *surprise explication threshold*.

Figure 3: Pencil Sketch by Theo Van Doesburg, 1917

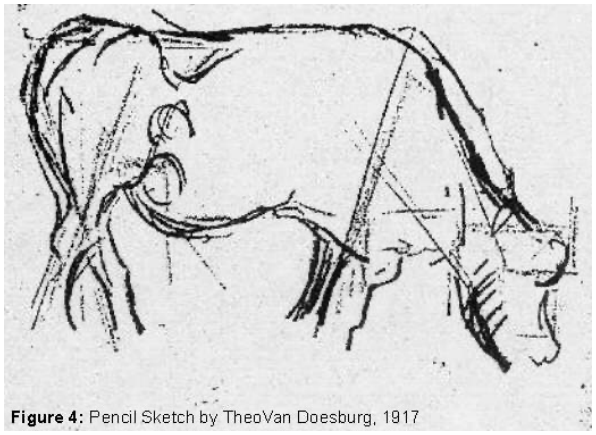

Figure 4: Pencil Sketch by TheoVan Doesburg, 1917

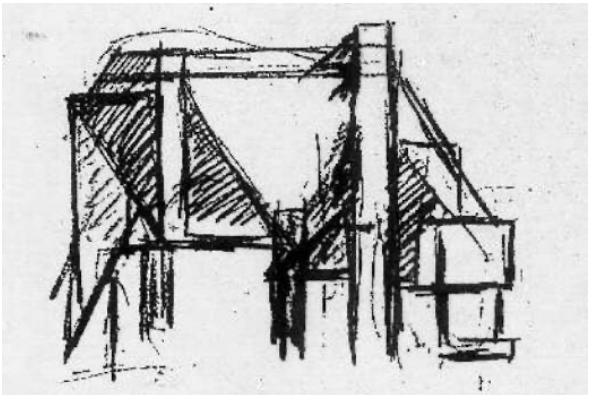

Figure 5: Pencil Sketch by Theo Van Doesburg, 1917

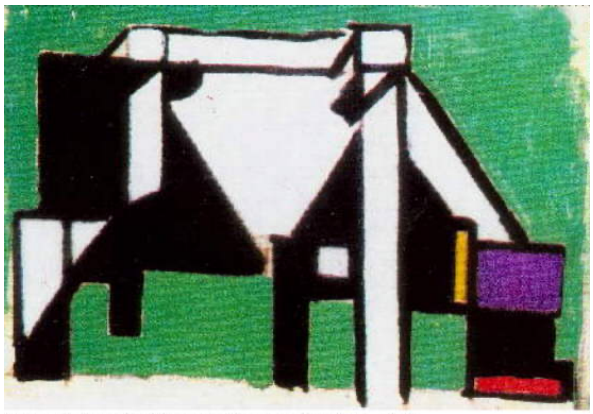

Figure 6: Gouache Sketch by Theo Van Doesburg, 1917

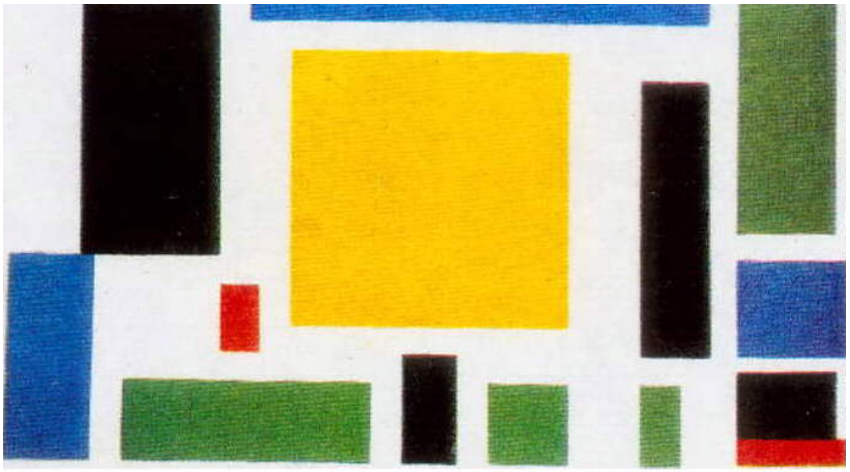

Figure 7: *The Cow* by Theo Van Doesburg, 1917

Figure 8: *Clock Face* by Salvador Dali

Aesthetic response

Most people would agree that the desire for pleasure is the ultimate motive of human behavior, and this gives rise to the aesthetic motive. Although not everyone is convinced of the value of aesthetics. For instance, Barnett Newman, a proponent of anti-art, made the provocative remark, Aesthetics is for me like ornithology must be for birds [3]. Consider the following aspects of aesthetic response perspicuity - ranging from cognitively penetrable to cognitively impenetrable, and intensity - ranging from cognitive resonance to cognitive dissonance.

Perspicuity characterises the spectrum of transparency that aesthetic apprehension can take. At the cognitively penetrable end of the spectrum, the reason for a pleasurable experience is very clear. If it occurs at the representational level, it is expressible. At the other end of the spectrum, the reason for an aesthetic response is mysterious and turbid. As a consequence, the ensuing pleasure is inscrutable, and hence ineffable.

Cerebral processes, which attempt to make sense of perceptual input, appear to be culturally based. Our minds are trained from childhood to make sense of the world. In the context of art appreciation, Western minds are accustomed to dealing with perspective in paintings, and similarly Western ears are trained for tonal music. For instance, they do not hear the finer nuances of atonal music. This sensitivity to features and cues, present in sensory information, is driven by concepts and representations at higher cognitive levels as well. Goodman says:

> "*... there is no innocent eye. Not only how but what it sees is regulated by need and prejudice. It selects, rejects, organises, discriminates, associates, classifies, analyzes, constructs.*"
>
> – Nelson Goodman, 1968 [10]

Artworks use numerous devices to capture the mind's attention, enticing it to form explanations at all cognitive levels. Some devices, for example, are visual rhyming, optical inconsistencies, subversion of the perceiver's expectations of space, juxtaposition of disparate objects and concepts, distortion of the lines of perspective. All of these devices are used by Picasso in Woman with Fish Hat, Figure 10.

Figure 10: *Woman with Fish Hat* by Pablo Picasso, 1942

Finally, what is negative aesthetic response, or more loosely displeasure. Does it result from an explanation that induces displeasure, or is it the result of cognitive dissonance due to the perceiver's inability or reluctance to form an explanation at all. From Leyton's work [11], the degree of pleasure is determined by the degree of complexity the mind can explain. Displeasure results when we try to explain some information but are unable to do so satisfactorily. That is, the information requiring an explanation is so surprising that it is beyond the mind's surprise explication threshold, resulting in cognitive dissonance.
Figure 9 shows the performing artist, Stelarc, suspended by stainless steel hooks pierced through the skin on his back. This event took place in New York City, and he remained suspended for 13 minutes. Upon first sight this tends to evoke displeasure in most people, perhaps even revulsion. Why is this so? It is because the viewer is incapable of providing an explanation, in other words the artwork foments cognitive dissonance; it is just too surprising! The background knowledge needed generate an acceptable explanation is that the artist' is exploring the idea of the human body in suspension; hung in space and time. The artist dramatically emphasises the dependence of the body on both.

Figure 9: *Street Suspension* by Stelarc, 1984

Solso [12] discusses what he calls visual dissonance, which he describes as occurring upon the receipt of information that is contrary to the mind's expectations of space:

> "[…] *much of art has been purposely designed to generate a form of creative tension that cries out for resolution. The viewer sees something inconsistent with their expectations, and is prompted to resolve the dissonance.*"
>
> – R. L. Solso, 1994 [12]

He suggests several ways in which our minds deal with visual dissonance:
by denying the importance of one or more of the elements, for example denying laws of physics or indeed inventing new ones,
by attaching meaning to the anomaly so that it may be corrected at the abstract level, or by using some form of mental contortion.

If visual dissonance cannot be resolved, a negative aesthetic response can be expected to be experienced by the viewer. Marguerite is a good example of an artist that exploits visual dissonance in much of his work.

From the biological perspective, Changeux [4] suggests that percept, memory image and concept constitute different forms of the basic material infrastructure of mental representation, which he calls a mental object. He claims that the cerebral machinery is capable of performing computations with mental objects, that is to say it can evoke and combine them, thus creating new concepts and hypotheses that can be compared among themselves.

According to Changeux resonance between mental objects on the cognitive plane is communicated to the neighboring emotional part of the frontal cortex, releasing bursts of impulses that travel to the limbic system and the hypothalamus with a consequent pleasurable effect. If there is dissonance, then a depressive effect.

Information and surprise

Leyton [11] argues that the degree of aesthetic response is determined by the degree of complexity the mind can explain. If the degree of information complexity is equated with the degree of informational content, then the aesthetic response is determined by the degree of informational content. Since information complexity causes an inherent craving, the human mind seeks high informational content.

It is well known in information theory that there is an inverse relationship between probability and informational content: the less probable an event the more information its occurrence provides. The less probable an event the more surprising it is, therefore the more surprising the information the higher its informational content.

One can link complexity of information and surprise directly by noting that the more complex information perceived by a cognitive state, the more the cognitive state must change to comprehend it. Understanding information by a cognitive entity involves assimilating information. The more the cognitive state must change during this assimilation, then the more complex the information must have been. Furthermore, the more change a cognitive state undergoes to assimilate new information then the more surprising the information.

Using the connection between the complexity and the surprise value of information, together with Leyton's argument, we conclude that the human mind seeks surprise, and the aesthetic response is proportional to the degree of explicable surprise.

Surprise and change

By modelling the intrusion of new information, change in beliefs, expectations and concepts can be related to the construction of explanations for surprising information. When a cognitive entity receives new information then its state may change, the more surprising the information the more drastically it will change. For instance, a cognitive state is expected to change far more if the new information is inconsistent with the current state than if the new information is consistent. Central to an explanatory capability is the need for the revision of beliefs, expectations, and concepts [5].

Cognitively impenetrable pleasure is determined by the degree of change a cognitive state undergoes in order to make sense of the sensory information. An artificial neural network [13] may be used to model the impingement of new sensory information at the perception level. Presenting surprising information to a neural network entails changing its weights, and the more surprising the information the more the weights must be changed. A neural network exhibits cognitive dissonance when no matter how much the weights are changed, the network cannot respond appropriately.

For cognitively penetrable pleasure at the representational level, techniques in belief revision [1, 5, 7] may be used to model the process of accepting new information. If new information can be integrated in such a way that the cognitive state remains coherent then a resonant pleasure will ensue, on the other hand if it cannot then cognitive dissonance will follow, instead. The process of belief revision, and the notion of explanation have been studied extensively in Philosophy, Artificial intelligence, and Cognitive Science. Characteristics of explanations are often a reflection of the richness of an individual's background knowledge, and their ability to discern the surrounding world. Gardner [9] asserts that without background information we have an incomplete grasp of material we see, that is, context enhances meaning; or as Goodman states:

> "*the naked eye sees nothing naked!*"
>
> – Nelson Goodman, 1968 [10]

A cognitive state can be represented as a plausibility ordering. Beliefs about the world are not all held with the same degree of plausibility; an ordering can capture this relative degree of plausibility. Belief revision models the process involved in accepting new information in such a way that the cognitive state remains coherent. This process is based on the principle of minimal change; the cognitive state incorporating the new information is changed in a minimal way based on some measure of change. More precisely, when new information is accepted this, normally, entails modifications to the underlying plausibility ordering of information. In other words, when a perceiver accepts new information some beliefs gain plausibility, whilst others lose it.

For example, if I strongly believe that champagne is made from white grapes, then when my wine expert friend Rupert informs me that it is in fact made from red deskinned grapes I will continue to believe my friend's name is Rupert with the same degree of plausibility, however I will reduce the degree of plausibility that I attribute to the fact that champagne is made from white grapes. According to the principle of minimal change only those things that must change their plausibility do so, and the plausibility of other beliefs remain the same.

The process of changing the underlying plausibility ordering of beliefs and expectations is called transmutation [17]. The degree of surprise is embodied in the degree of change the plausibility ordering undergoes during a transmutation. For example, the new information that my parents believe in Father Christmas is more surprising than Father Christmas lives in Sweden. Incorporating the former involves more change to my plausibility ordering of beliefs and expectations than does the latter.

Transmutations not only play a fundamental role in the process of belief revision when new information is acquired, but they can also determine when a belief is an explanation for another belief [5, 15]. Spohn [14] argued that if increasing the plausibility of a belief entails the subsequent increase in plausibility of another belief then the first belief is an explanation for the second. For example, if raising the plausibility of my belief in it is raining means that I must increase the plausibility of my belief in the lawn is wet, then the fact that it is raining must be an explanation for the lawn being wet. On the other hand, if

the lawn is under cover, then increasing the plausibility of the fact that it is raining will not increase the plausibility of the lawn is wet, hence if the lawn is covered then the fact that it is raining is not a viable explanation. In summary, transmutations can be used to modify beliefs, expectations, and to determine explanations.

At the conceptualisation level, if Gärdenfors' model [6] of conceptual spaces is adopted, change operations can be defined that modify conceptual spaces geometrically, and some measure of change can be used to determine the amount of change to a conceptual space. Since conceptual spaces do not refer to a symbolic representation, they can be used at both the cognitively impenetrable and cognitively penetrable levels.

For example, the colour space shown in Figure 2 could be viewed as the result of the reconceptualisation of the electromagnetic spectrum in a manner more closely corresponding to the human visual system. This reconceptualisation preserves some features (orange remains *between* red and yellow), loses others (red is *closer* to yellow than it is to blue) and introduces new ones (violet moves *between* blue and red).

Figure 11 contains 35 hats depicted using different artistic styles, each one forces us to change our concept of hat. In fact, many of them would stretch the bounds of the conceptual hat space quite substantially, for example when does a hat become a seal? Picasso's Woman with Fish Hat, Figure 10, also forces us to disturb our concept of hat, it seems the only thing that makes us view the fish on a plate, with accompanying knife and fork, as a hat is its location on a woman's head.

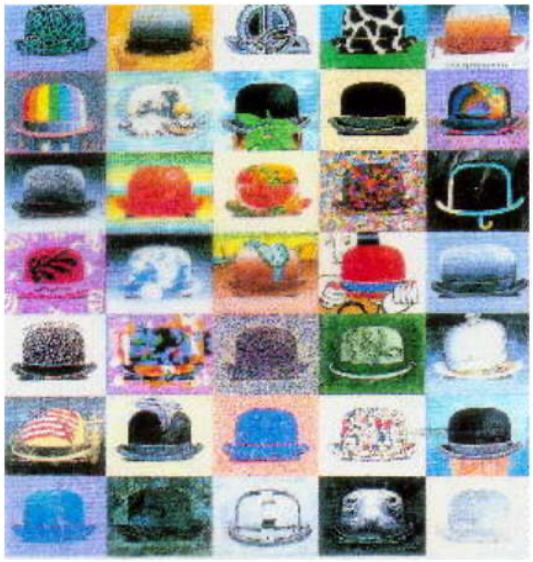

Figure 11: *Derby Hat* by Paul Giovanopoulos, 1988

If pleasure can be measured by the amount of explicable surprise an artwork holds for the perceiver, then the degree of pleasure is proportional to the degree of change necessary to reconcile the surprise.

Whenever the information is too surprising for the cognitive state to coherently explicate, that is, it is beyond the perceiver's surprise explication threshold, then the result is

cognitive dissonance which according to Changeux [4] gives rise to displeasure. Pleasure and the surprise value of the information perceived increase hand-in-hand until the perceiver is incapable of explaining what it perceives, that is he has reached his surprise explication threshold.

Conclusions

Clearly, the degree of complexity can be equated with the amount of surprise, and using Leyton's arguments it is surprise that the human mind seeks.

Understanding art involves elucidating an information puzzle. Artworks challenge our ability to explicate surprising information. Forming explanations of surprising information involves changing beliefs, expectations, and concepts. The more change that a cognitive state undergoes in order to construct a viable explanation the more surprising the accepted information; a good metaphor, for instance, is one that satisfies while it startles [10]. The amount of change required can be determined by an underlying measure of change. If the information is so surprising that it is inexplicable that is the cognitive entity is incapable of explaining it, then cognitive dissonance ensues.

The aesthetic response can be measured by the amount of surprise encapsulated in the explanation, and it is proportional to the degree of change a cognitive state undergoes in order to coherently accommodate and explain the surprise. Therefore, the measure of change is inextricably related to the measure of pleasure.

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