# Ups and downs in the relation between complexity and aesthetics: A historical perspective

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## INCEPTION

- Based on casual observation, *Wundt* [16] first postulated that an inverted-U curve related art 'complexity' and appraisal.

- Soon after, *Fechner* [5] founded experimental aesthetics (EA) with psychophysical methods and 'the aesthetic middle': Art is most attractive at the midpoint of arousal.

- The inception of EA accompanied by a surge of information theory research in 1950s-60s,[10] changed the norm in aesthetics from the speculative to the empirical approach.

- *Daniel Berlyne* [2,3] exceeded prior aesthetics theory with an idea: Ratings of art depend on *stimulus complexity*, quantified using *information theory*, such that an *inverted-U shape emerges*.



**Figure 1** *From top: W. Wundt, G. Fechner, D. Berlyne*
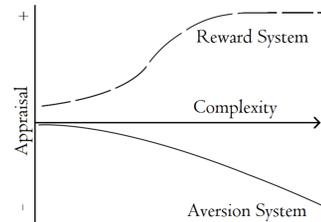


**Figure 2** *According to Berlyne, two functions cause the inverted-U. Information causes reward through conflict resolution, until aversion overrides (Adapted [3])*
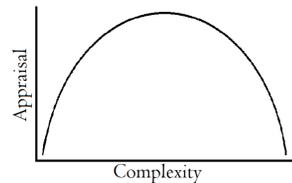
**Figure 3** *Inverted-U function ('Wundt Curve') [7]*

- Berlyne argued that tension increases through the mechanism of arousal. A supplementary aversion system is in place to maintain levels of arousal whereby logical analytic systems can continue.

- Though Berlyne has been a constant focus in aesthetics, a number of issues surround the inverted-U function between complexity and attractiveness:

**1. What mechanisms effect the two slopes?**
Aesthetics researchers generally agree that increasing stimulus information is reinforcing due to sensory curiosity (*the 'upward' slope*), but the 'Aversion system' has been less convincing. What mechanism enacts the '*downward slope*'?

**2. Why are findings sometimes conflicting?**
Although considerable evidence supports Berlyne, studies are not 100% unequivocal. Why? Is there no inverted-U function, or have there been flaws in the paradigms used in EA?

**3. Can Berlyne's theory be updated and revived?**
New methods are emerging that will surely herald the revival of Berlyne's theory, as well as moving EA towards a promising future.

## THE TWO SLOPES

In Berlyne's framework: as stimulus complexity increases, moderate discrepancies in expectations furnish the perceptual system with information which is rewarding [3].

Construction and appreciation of artwork is centered around a search for constancies about the world (*Plato*). Thus, information is appealing.

High stimulus complexity can lead to homogenization of the sensory stream, whereupon an observer cannot easily organize features into coherent forms.

*Less* information is *readily* available, leading to a lack of engagement.

The inability to organize a stimulus should change with familiarity, portending a shift in liking for complexity with experience.

## THE CONFLICT

Some critics of *Berlyne's* theory [5,6] have found that appraisal increases linearly with complexity.
**Where do these findings come from?**

### I

**The parameter space** used in experimental aesthetics must span a range from low to high complexity. Limited stimulus subsets will provide unreliable and inaccurate results.

- Complexity has not been convincingly quantified. Early EA used simple metrics to easily manipulate complexity, e.g. number of sides, vertices, degree of asymmetry, or subjective complexity [12].

- Subjective complexity often does not correspond to true stimulus complexity ([13, 14]) and should be avoided.

- Researchers mistakenly critique Berlyne's theory based on views such as: "Ten patterns ranging from one million to ten million elements would all be too complex to be pleasing" [8] -- the issue of the parameter space is underappreciated.

- Criticisms of Berlyne include the finding that no inverted-U function relates complexity to appeal in furniture, where practicalities would heavily influence selection [15].

### II

**What constitutes the Y-axis** of the inverted-U function?

- Ratings of beauty, attractiveness, appeal [1], pleasantness [3], and liking [9] are used interchangeably, with no reference to their concomitance.

- Experimenters [9] query how much polygons are liked/disliked – to be sure, disliking a polygon is quite unusual.

- The best paradigms approach the question of appeal indirectly:

  o Aesthetic appeal ('liking', 'beauty' etc.) has been determined using the preferential looking method (e.g. [11]) or forced choice selection (e.g. [15]) – more sound paradigms.



**Figure 4** *High complexity artwork: high levels of information, uncertainty, & surprise*

## EMERGENT METHODS

**What progression should be taken by the field?**

- Bayesian surprise[7] has been successfully used in attention research & is extendable to aesthetics;
  o 'Surprise' can be quantified in 'wows' by modifying Bayes' theorem:

$$S(D, M) = d[P(M), P(M|D)]$$

This idea is entirely commensurate with Berlyne's[1] theory: he refers to appeal as the resolution of curiosity. Individuals orient to unfulfilled expectations & subsequent reduction in conflict is reinforcing.

Accordingly, surprise theory provides a testable method of determining that attractive stimuli lie between the least predictable (white snow) and the most predictable (a blank screen)
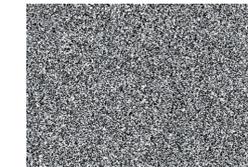


**Figure 5** *White snow: high information & entropy, low 'surprise'*

- Further work has increased focus on certain stimulus properties as metrics of complexity, e.g. Fourier spatial frequency decomposition of artworks [6].

- Nearest-neighbour techniques of 'uncertainty' estimation have proven effective in image processing. One approach [4] includes estimating redundancy in scenes using average minimum Euclidean distances between patches within an image.

## SUMMARY

*Berlyne's theory is highly relevant today.*

*Research conflicting with the inverted-U theory is frequently marked by issues of a limited stimulus subset, poor quantification of complexity, and similarly poor quantification of aesthetic appeal.*

*Emerging methods using advanced modeling techniques herald a renewal and extension of Berlynian theory.*

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