



Mechner's Reply to the Commentaries on His Article, "A Behavioral and Biological Analysis of Aesthetics"

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Abstract

The commentaries prompted my realization that it is more useful to view the core of the aesthetic reaction as composed of a set of Pavlovian respondents than as a quasi-emotional reaction. They also increased my confidence in the generality of my conclusion, based in part on my analysis of hundreds of instances, that aesthetic reactions (as well as many other types of affective reactions) are elicited by the conjunction of (a) synergetic (unusual and transformative) interactions among stimuli, (b) the behavioral history and current state of the reacting individual, and (c) circumstantial features of the prevailing situation, including social and cultural factors. Aesthetic reactions can never be predicted or explained based on stimulus properties only. An important mechanism by which originally neutral stimuli acquire the power to elicit aesthetic reactions is Pavlovian pairing, often early in life, with stimuli that already possessed eliciting functions. The commentaries support my contention that a full understanding of the behavioral and biological aspects of aesthetic reactions requires a phylogenetic analysis of their evolutionary origins. Such an analysis suggests that the development of aesthetic sensibility is an important milestone in human evolution. The reinforcing properties of aesthetic reactions are key to the maintenance of such cognitive competencies as language and the manipulation of concepts, learning and inquiry skills, mentalization skills like visualizing and other types of thinking, various social skills, and cultural cohesion. The domain of aesthetic reinforcers extends beyond the arts to the quality of artifacts like tools, implements, or vehicles, certain types of interpersonal activity, and displays of competency. All of these reinforcer categories have biological utilities that account for the selection, throughout evolution, of individuals who were susceptible to those reinforcers' effects. Also discussed are implications for therapy and education.

Keywords Behavioral and biological analysis of aesthetics · Aesthetic stimuli and responses · Evolutionary origins of aesthetics · Reinforcing effects of aesthetic stimuli · Pavlovian, classical, respondent reactions

I wish to express my gratitude to TPR's guest editor, Jack Marr, for his instigation of the project as well as for his outstanding editorial, managerial, and substantive contributions. His encompassing knowledge of the arts, literature, sciences, mathematics, and philosophy, not to mention behavior analysis, accounts for the unique perspectives he brought to the task.

I also thank the nine eminent scientists whose commentaries Marr invited—Phil Himeline, Peter Killeen, Maria Malott, Robert Mellon, David Palmer, Henry Schlinger, Charles Shimp, Travis Thompson, and Paul Verhaeghen—for their thoughtful analyses and their many (clearly premature) kind comments. Special thanks are due to Travis Thompson, whose vision that the arts and aesthetics warrant the attention of behavioral scientists, gave the project its original impetus.

When I started my work on aesthetics at Columbia University nearly 70 years ago, a naturalistic behavioral and biological approach to the topic of aesthetics was still widely regarded as unfeasible, even absurd. The commentators reveal the extent to which this perception has changed. The diversity and profundity of their ideas also showed me the extent to which my own

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understanding of the topic needed further development. I directed some of my replies at specific comments, often quoting them. In other cases, I replied by explaining how the commentaries as a whole led me to revise my own ideas and, as a consequence, perceive implications that transcend aesthetics.

Because the commentaries addressed a wide range of topics, I organized my replies accordingly:

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Summary and Conclusions

1.0 Where the Biological Perspective Leads

1.1 The Change from the Earlier Formulation

The commentaries led me to reverse the direction from which I am approaching the analysis of the behavioral/biological phenomenon of aesthetics. The new direction starts with the question, what are the various behavioral competencies the human animal needed in order to thrive in the environments it encountered during its evolution? The next question is, what is the role, if any, that the development of aesthetic sensibilities may have played in meeting these needs?¹

Mellon’s and **Killeen’s** comments (4.1 and 4.2 sections, below) endorsed and reinforced the phylogenetic approach I took in my 2017 article. This approach can be viewed as a heuristic for where to look for promising hypotheses. The present hypothesis relates to *the biological functions that aesthetic sensibilities may have evolved to perform*. For instance, we understand the biological functions of such behavioral characteristics as the salivary

¹ This approach may seem somewhat teleological, but teleological formulations can also be regarded as heuristics that can help make sense of complex evolutionary processes.

reflex (digestion) or curiosity (obtaining information), but we don't yet have a comparable understanding of the several biological functions of aesthetic sensibilities. I proposed some of these in the 2017 article—the subject of the commentaries—but now see that I overlooked some important ones that also flow from the phylogenetic analysis. One of these is discussed in the next few sections and others, prompted mainly by **Hineline** and **Killeen**, are discussed in 4.2 and 4.3 sections, below.

Readers who are familiar with the original 2017 article will note that I changed my characterization of the aesthetic reaction from “emotional” to one based on Pavlovian respondents. This change—prompted in part by **Hineline's**, **Palmer's**, and **Schlinger's** comments—proved to have far-reaching implications.

1.2 Refreshment and Maintenance of Skills and Competencies

In Section 4.4 of the 2017 article I suggested that one of the important primordial biological functions of stimuli that elicit aesthetic reactions, and one that is still operative, is to *reinforce and thereby maintain certain biologically important skills and competencies*. The term “competency” encompasses the concept of achieving desired results in the face of varying circumstances. For instance, speaking is a skill whereas communicating is a competency; walking is a skill whereas locomotion is a competency. Maintenance of other behavior is a function of aesthetic sensibilities.

The human body and its skills and competencies require maintenance, as does any complex system, like machines, airplanes, or buildings. Professional performers must keep refreshing their skills with daily practice. But these maintenance and refreshment requirements also apply to the more mundane competencies of daily living—perceiving features of the environment, responding to them appropriately, avoiding hazards, and seizing opportunities.

1.3 Self-Reinforcing Maintenance Activities

As I explained in Section 4.4 of the 2017 article, many of our mundane daily activities maintain and refresh many of our physical and behavioral competencies. Some of these activities provide benefits that are biologically important but also highly delayed. The activities whose benefits were too delayed to maintain them evolved to be *intrinsically*² reinforcing. Familiar intrinsically reinforcing activities are those inherent in eating when hungry, drinking when thirsty, and procreational behavior. If these

² I am using the term “intrinsic” in the sense of unlearned. The term does not apply to the types of activity-produced reinforcers that result entirely from learned associations, such as when activities like reading or being in someone's company have become reinforcing. It is understood that even intrinsic reinforcers are susceptible to modulation by situational circumstances and learning.

behaviors were not intrinsically reinforcing, they would quickly extinguish. Other basic mundane skills and competencies that evolved to be intrinsically reinforcing are the perceptual ones of noticing and discerning features and details of the environment and manipulating it.

Many refreshment and maintenance activities are self-reinforcing, either intrinsically or as a result of automatic positive consequences. Self-reinforcing activities will tend to be repeated, and repetition promotes refreshment and maintenance. To refresh and maintain one's concept of a melody or voice, one needs to hear it again, or of a painting's color scheme, to see it again. To refresh and maintain one's recollection of what comes next in a sequence, one needs exposure to the preceding material, as when we listen to a previously heard piece of music or reread a poem. Recognition, in and of itself, provides refreshment and maintenance, and is therefore reinforcing.

There are also many types of complex human behavior that are important biologically and became intrinsically reinforcing by virtue of long evolutionary histories going back, in some cases, to pre-mammalian times. Among these are parents caring for their young—at great immediate cost and no consideration of possible long-delayed benefits to the care giver. Other familiar instances (in both human and other species), are hoarding, nest building, migration, and altruistic behavior. All of these behaviors produce benefits that are too delayed to maintain them absent an intrinsic reinforcement bridge. Physical exercise can be reinforcing because the immediate release of beta endorphins provides prompt reinforcement. The satisfaction of curiosity (an ancient characteristic of many species) can act as near-term reinforcement, as its information-gathering benefits would usually be too delayed to maintain it.

1.4 More Complex Competencies that Need Maintenance

But, as the human animal's behavior repertoires became more elaborate, complex, and sophisticated, so did the skills and competencies that needed maintenance and refreshment. Many of these, having had relatively shorter evolutionary histories than older ones, were not yet sufficiently self-reinforcing to be self-maintaining. These skills and competencies included the use of language, problem solving, planning, organization, inquiry, communication, recognition of organizational or syntactic features of stimuli, interrelationships among concepts, social interaction, and analysis of prevailing behavioral contingencies.³ Many of these skills and competencies intersect orthogonally with those that involve mentalization, including visualizing, mental hearing, mental rehearsal, the various thinking skills, and the competencies of planning, problem solving, and practicing.

³ Behavioral contingencies are the if-then relations between instances of operant behavior, their agents, consequences, timing, probabilities, and the circumstances that occasion them (Mechner, 2008, 2010a, b, 2011).

The biological benefits of refreshing, and maintaining all of these newer, more complex skills and competencies are often highly delayed, and their near-term reinforcers are often insufficient to maintain them at useful levels. Unlike the behaviors discussed in Sections 1.2 and 1.3, most of them are not intrinsically reinforcing (in the nonlearned sense). And yet, given their biological importance, they must be maintained. In verbal societies, the reinforcement delay gap is often bridged by self-talk, and in organized groups and cultures by verbal reinforcement, custom, tradition, and peer pressure. But these methods can't do the entire maintenance job for all skills and competencies.

1.5 The Missing Reinforcement Bridges

Enter man-made aesthetic stimuli. One of their functions is to contribute to behavior maintenance—bridging the reinforcement delays for the newer and more complex skills and competencies described in Section 1.4, above. My theory is that aesthetic sensibilities evolved and became elaborated *in tandem* with these newer complex skills and competencies. Aesthetic reinforcers accordingly, became available as and when they became needed to perform the emerging function of maintaining those newer skills and competencies. When used in this way, aesthetic stimuli acted as reinforcers that were extrinsic to the behavior they maintained.

This theory immediately raises two questions. One is, how exactly do aesthetic stimuli perform this function of refreshing and maintaining these complex behaviors? And the second one is, how did humans come to create, control and use aesthetic stimuli for the performance of this function?

Let's start with the second question. It is related to the issue raised by both **Hineline** and **Palmer** concerning the essence of the aesthetic reaction. What is it? What distinguishes it from other reactions? How is it linked to reinforcement? How did it come to be? **Hineline** used the word “elusive” (Section 2.1) and **Palmer** called the analysis “incomplete” (Section 3.1). The answer begins to take shape when the aesthetic reaction is viewed as a respondent.

1.6 Repurposing, Synthesizing, and Elaborating Reinforcers

It is hardly surprising that humans learned to control and repurpose reinforcers that were originally intrinsically linked to eating, drinking, procreation, and other biologically vital activities. By severing those linkages, humans became able to control the schedules and contingencies for the occurrence of those stimuli, and thus repurpose them as extrinsic reinforcers for all kinds of behavior. One consequence was the emergence of the arts. By taking control of these reinforcers and then refining and elaborating them,

humans could not only enjoy them in new contexts, independently of their original biological functions, but also use them deliberately, to maintain other behavior whose self-reinforcement functionality may be inadequate.

One of the ways humans gained control of aesthetic reinforcers was by learning to generate and synthesize them. They learned that such stimuli are generated by synergetic interactions.⁴ Some synergetic interactions occur naturally (flowers, sunsets, plumages), and some are man-made (as in the arts and other disciplines, usually by the creation of effective synergetic brews). When interactions of elements within synergetic brews elicit aesthetic reactions, such interactions, acting as reinforcing stimuli, can perform various sorts of reinforcing functions (Part 4 of the 2017 article).

In Sections 1.10 and 7.4 of the 2017 article, I proposed 16 concept manipulation devices that creators of aesthetic effects have learned to use to create synergetic brews that have reinforcing properties.⁵ In general, these devices achieve their reinforcing effects via the manipulation of concepts. Poets, composers, and artists certainly use those devices and combinations of them to create aesthetic effects, as described in parts 8 and 9 of the 2017 article.

Here are a few familiar examples of complex activities that are maintained by aesthetic reinforcers.

- Speakers often try to maintain the attention of listeners by including anecdotes, humor, and little stories in their narratives (Hineline, 2018b), these being synergetic interactions that can act as reinforcers.
- Parsimony is a natural reinforcer of any activity whose purpose is to achieve the most with the least. This type of reinforcer maintains such activities as organization, planning, and communication (see also Sections 4.7–4.9 of the 2017 article).
- Many types of social bonds are maintained by the cohesive effects of shared music, decoration, stories, humor, and other artistic devices. Sections 6.5 and 6.6 of the 2017 article also explore the cultural and sociological functions of aesthetic effects that **Mellon** and **Thompson** discuss in their commentaries.

⁴ For a discussion of synergetic interactions and synergetic brews, and how elements of the brews produce transformative effects when they interact synergetically, see Sections 1.6–1.10 of the 2017 article. Briefly, synergetic interactions of elements have effects that are transformative and different *in kind* from the interacting elements (unlike *synergistic* interactions as when 2+2 = 5). Familiar examples of synergetic interactions are chemical reactions and biological phenomena like photosynthesis or fertilization. Synergetic brews are sets of simultaneously present synergetically interacting elements.

⁵ I must thank **Killeen** for restating the devices succinctly by recasting them, very creatively, in information theory terms and am awed by the meticulous way he related them to specific aesthetic effects. I also thank him for the final sentence of his entertaining commentary.

1.7 Types of Reactions Elicited by Synergetic Brews

Most cultures apply the term “aesthetic” to reactions elicited by stimuli they may describe as beautiful, delicious, awesome, impressive, elegant, and so forth, according to the art form or discipline involved. The core of the aesthetic reaction may be involuntary, almost reflexive, pleasurable, private, and therefore largely inaccessible to scientific observation, at least with present-day technology. If the core reaction is weak, it may not even be perceived. If strong it may induce verbal behavior that tacts the private sensation, or may even induce exclamations, chills, or gasps. The aesthetic reaction’s reality is supported by the universality and consistency with which the subjective perception of “beauty” is reported in virtually every known culture of recorded history, much like the sensations of pain, hunger, or love pangs.

In the course of their daily lives, humans react to synergetic interactions of stimuli in many diverse ways according to the particular situations, circumstances, prevailing behavioral contingencies (see footnote 3) in which the synergetic interactions occur, and the idiosyncratic learning history the individual brings to the situation. We identify these reactions by nouns, like pleasure, revulsion, hate, fear, discomfort, misery, awe, admiration, attraction, outrage, relief; or by adjectives like generous, loving, angry, anxious, sad, trusting, happy, envious, contemptuous, or aesthetic. Aesthetic reactions are but one type of reaction. All of these categories are fuzzy and not always distinct.

1.8 How Synergetic Brews Give Rise to the Above Reactions

But what *all* of these reactions have in common is that they are elicited by the interaction of elements within synergetic brews. Synergetic brews are combinations of elements some of which interact synergetically, that is, with transformative effect. Elements that interact synergetically normally don’t occur together. Part 3 of the 2017 article discusses the phylogenetic origins of “emotional” reactions to unusual combinations of stimuli. Phylogenetically, unusual combinations could signal danger or opportunity, either one evoking an adrenalized respondent reaction. As these primordial reactions evolved into their modern nonemergency descendants, like those listed in Section 1.6, above, it is not surprising that the respondent character of some of their components was preserved. Part 2 (below) provides further support for the respondent hypothesis.

A behavioral analysis of synergetic brews might partition the interacting elements into intrinsic and extrinsic ones. In the case of aesthetic reactions, the *intrinsic elements* would be those inherent in the stimulus itself—the music, the work of art, or the text; the *extrinsic* ones are those present in the prevailing physical and social environments, including the prevailing behavioral contingencies. Those extrinsic elements were among those also

referred to in the 2017 article as potentiating factors (see also Section 3.3, below).

The behavioral effects of all these synergetically interacting elements are a function of the idiosyncratic priming that occurred during the behavioral history of the reacting individual. In the case of aesthetic reactions, important priming factors are those involving prior exposure to the work itself, to parts or aspects of it, or to similar works. In the case of many of the other types of reactions (envy, fear, relief, etc.), additional priming factors are those that relate to the prevailing behavioral contingencies.

2.0 The Change from Emotions to Respondents

2.1 The Rationale for the Change

Each of the various reactions listed in Section 1.6, above, is specific to a situation-circumstance, including a set of behavioral contingencies. I will refer to all of those reactions as “respondent-laden”⁶ (i.e., laden with, or consisting of, clusters of respondents) rather than “emotional.” I was never comfortable with my description of the aesthetic reaction as a type of “emotional or quasi-emotional” reaction. Neither is **Schlinger**, evidently, when he states, “. . . emotional responses, however, do not ordinarily come to mind when one speaks of aesthetics” (Schlinger, 2018). I agree with him. But agreement is cheap—it presumes that we know what we mean by “emotional responses.” We don’t, really. But we do know what we mean when we say that a reaction consists of or includes Pavlovian respondents.

Semantic issues aside, however, what is the behavioral and biological basis of aesthetic reactions? That is the issue that both **Palmer** and **Schlinger** may have in mind when they suggest that it would be advantageous to increase the linkage of the theory of aesthetics to behavior analysis (see Section 6.4, below), and that **Hineline** may have in mind when he implies, in the final sentence of the excerpt from his commentary quoted below, in the kindest and gentlest possible way (and fairly), that my “characterization of the aesthetic response itself remains elusive”:

[Mechner’s, 2017 article] is a remarkably thoroughgoing treatment of his topic—transparently organized and meticulous in the exposition and interrelating of complex relationships. Anchoring a topic like aesthetics in natural science is a daunting challenge, and the author does a masterful job of delineating variables and likely processes that contribute to the *synergetic brew*. Great word! However, characterization of the expression “aesthetic response” itself *remains elusive* [emphasis added],

⁶ I am using the term “respondent-laden” to distinguish the classically conditioned respondent components of the reaction from the discriminative ones, which are usually also present.

and I think the limitation is as much in the ways our descriptive language works as in the covert aspects of the behavior of concern. (Hineline, 2018a)

I accept his criticism and hope that my revised analysis will answer it.

2.2 About the Concept of Emotion

Crying or laughter, frowns or smiles, fight or flight, are usually viewed as operant manifestations of underlying “emotional” reactions. Absent the operant component, all that remains—fear, joy, sorrow, anger, love—is a set of Pavlovian respondents such as pupil dilation, activity in the vascular and digestive systems, or in the skin. These respondents are involuntary, reflexive, and not modifiable by consequences, unlike the overt operant manifestations.

The reason why the concept of emotion is not useful in a scientific analysis is that associations between operant manifestations of emotional reactions and respondents are not consistent or universal. Unlike respondents, emotions are not physiologically or biologically defined (Skinner, 1953). Lisa F. Barrett (2017) explains that different individuals and different cultures categorize and name emotions differently. She explains that contrary to the classical and still widely held essentialist view, there are no neural, facial, or other types of “fingerprints” for commonly recognized emotions.⁷ Furthermore, the stimuli that evoke any particular emotion include behavioral contingencies that vary from situation to situation and culture to culture (Layng, 2017). Even instances of such universal emotions as fear or pleasure are associated with different brain patterns at different times, even in the same person and certainly in different people, notwithstanding the fact that the neural pathways for all emotional reactions appear to include the amygdala (Blood & Zatorre, 2001) and the autonomic nervous system.

The observation that there is no consistent physiological or neurological basis for naming and categorizing emotions also applies to the various “reactions” listed in Section 1.6, above—every one of these reactions is specific to a particular situation-circumstance, including a set of behavioral contingencies. Their definitions depend on cultural, social, situational, and idiosyncratic learning history factors—the same kinds of factors that make it unproductive to characterize aesthetic reactions as emotions.

⁷ Barrett explains that it was John Dewey who formulated (and named) the James–Lange theory of emotion. She explains that the theory is actually antithetical to William James’s view, which was constructivist rather than essentialist: James said that emotions have “instances,” not stable well-defined categories. The name “Lange” was that of the contemporary physiologist Carl Lange, whose essentialist view agreed with Dewey’s.

2.3 Aesthetic Reactions as Respondents

The observation that most of the reactions listed in Section 1.6, above, include sets of Pavlovian respondents has implications for the way forward in the study of all of these reactions, with implications for our understanding of the functions of aesthetic reactions and their future experimental analysis. Even though the specific respondents would be different in each instance, they are nonetheless measurable, at least in principle if not with current technology. This remains true in spite of each instance differing according to the synergetic brew’s extrinsic elements and the individual’s unique priming history and current physiological and mental state. For all of these reasons, *it is more useful and accurate to say that we respond to synergetic interactions with sets of respondents than with emotions*. The experimental analysis of such reactions can then follow the well-charted research paths of conditioned reflexes and classical conditioning in general.

Much of the conceptual confusion that commonly surrounds the topic of emotion may be due to the equating of emotions with their observable expression (first sentence of section 2.2, above). In view of the fact that “emotional control”—the management, expression, and suppression of emotions—is of concern in most human societies, it is understandable that the operant components would have become the focus of attention. Being sensitive to consequences like reinforcement and punishments, operant manifestations can serve as levers for control, whereas the covert respondent core cannot. Likewise, the imposition of operant contingencies affects only the operant *expression* of the emotions, not their private respondent core, as clinical psychologists well know.

2.4 Synergetic Interactions and Classical Conditioning

Further support for the suggestion that the covert, private cores of the reactions identified in Section 1.6 consist of respondents is provided by the remarkable parallels between traditioned unconditioned stimuli (USs) and synergetic brews. The earlier comment that the maintenance of skills and competencies may be intrinsically reinforcing points to one of the similarities between those processes and USs.

The assumption that every respondent is elicited by a stimulus puts the spotlight on the nature of the eliciting stimulus. As was explained in Section 1.6, above, including footnote 4, the stimulus is generated by the synergetic interaction of elements within the brew. The elements include temporal, spatial, logical, and relational parameters, as well as behavioral contingencies that reflect historical and present social and other circumstances.

These are the most obvious properties that synergetic interactions appear to share with traditional USs:

- (1) both elicit respondents;

- (2) the eliciting function of both is transferable to conditioned responses;
- (3) both are rooted in biological utility;
- (4) both have a reinforcing function (possessed by USs only in some cases);
- (5) to be effective, both need to be presented and potentiated;
- (6) both involve the autonomic nervous system.

2.5 Explanations of these Six Properties

Property (2) implies that interactions of elements within synergetic brews can function as the US in a classical conditioning paradigm, meaning that when the traditional US is replaced, in the paradigm, by a synergetic interaction (keeping in mind how “stimulus” is defined above), previously neutral stimuli may come to elicit responses that are related to the synergetic stimulus.

Property (3), that USs and synergetic brews are both rooted in biological utility, also requires comment. The responses (usually reflexive) to most traditional USs, have evident biological utility rooted in phylogeny. These utilities apply to digestion, reproduction, excretion, respiration, and physical protection.

The above conceptualizations of recognition/refreshment and other maintenance processes as being intrinsically reinforcing almost defines them as traditional primary reinforcers functioning as unconditioned stimuli (USs), because both have biological utility. A (delayed) biological utility of stimuli generated by synergetic brews that provide immediate reinforcement for refreshment and maintenance behavior often resides in enhancement of the individual’s future ability to predict and influence the environment—an ability that is biologically valuable, as are most USs (food, warmth, etc.).

Reactions to synergetic brews, too, have biological utility. These biological utilities are discussed in more detail in parts 3 and 4 of the 2017 article and in Section 1.2, above. An example of biologically useful reactions are ones that provide information and instruction for predicting and influencing the environment, or for maintaining or refreshing useful competencies.

A difference between synergetic brews and USs is that USs are, by definition, largely independent of experiential history, whereas the individual elements of synergetic brews, as well as the synergetic interactive effects that occur *within* synergetic brews, usually depend on ontological priming and other potentiating factors. However, the apparent commonalities between USs and synergetic brews may be sufficient to consider them analogous, if not equivalent.

As for Property (4), certain of the traditional USs—food-in-the-mouth, certain sexual stimuli, and some others—can reinforce the operant behavior that produced or potentiated

them (first box from the left in the chart below), in addition to performing their eliciting functions. Most synergetic brews, like some USs, perform the dual functions of eliciting and reinforcing. Reciprocally, most reinforcers, including USs, also elicit respondents.

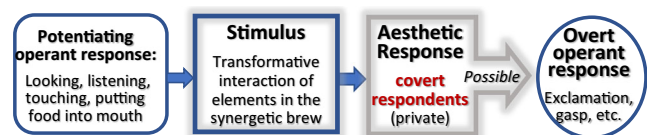
2.6 The Required Conceptual Leap

The reason a conceptual leap may still be required to view the aesthetic reaction as a set of respondents is that the core aesthetic reaction is often, or usually, covert (i.e., solely neural) and private, whereas traditional respondents, like salivation, galvanic skin changes, vascular changes, and so forth, tend to be associated with readily observable physiological reactions. Yet most of the aesthetic reactions we experience throughout a normal day are covert and private—often unnoticed even by the subject: one may have a subliminal and covert aesthetic reaction to musical stimuli while engaged in another activity, or to a beautiful flower garden while walking down the street while thinking about other matters. Because many respondents are composed of both overt and covert components, as Pavlov’s own writings suggest (Rescorla, 1988), it is plausible that the covert component survives when the overt component (activity of the engaged effectors) is eliminated. But the distinction between covert and overt respondents is not fundamental—it merely reflects the present-day status of our observational technology.

Thus, each instance of an aesthetic respondent has a unique profile of behavioral and physiological events, some overt and some covert, regardless of our current technological ability to observe them. Some elements of the *eliciting stimulus* also include private perceptions. The stimulus always includes, among its synergetically interacting elements, situational-circumstantial factors that include prevailing behavioral contingencies, conceptual associations, and other effects of idiosyncratic learning histories. All of these are elements of the synergetic brew.

2.7 Relation to Operant Behavior

Below is the diagram from Section 1.4 of the 2017 article, updated to reflect the new conceptualization.



The first and fourth boxes show the *operant* behaviors that are often associated with aesthetic reactions. Though the aesthetic reaction is normally *potentiated* by operant

behaviors that can present stimuli or expose someone to them (first box on the left), and although operant behavior is required for the *creation* of synergetic brews (second box from left), the core aesthetic reaction is a covert and private *respondent*. The covert respondent reaction may, in some cases, evoke verbal reactions (operants that tact the respondents, as **Mellon** points out) such as exclamations or gasps (right-most box).

Thus, operant behavior functions to potentiate, to elicit, and, in some cases, to communicate the core covert respondent of an aesthetic reaction. **Mellon** describes a third way operant behavior can be involved: an audience⁸ member may discriminate and tact his or her own covert aesthetic reaction, publicly or privately depending on prevailing contingencies. **Mellon** discusses the utility of such tacting beyond simple communication “as a prompt for subsequent productive action” for the individual him- or herself or for others. This type of operant reaction would be shown in Box 4.

2.8 Implications of the Respondent Hypothesis

This hypothesis makes several conundrums vanish and opens new avenues to experimental analysis. It provides an answer (Sections 3.2, 3.3) to **Palmer’s** observation that the tool kit for analyzing the impact of great poems and presumably also other great works is *incomplete* (Section 3.1, below). The answer developed in Part 3 includes **Schlinger’s** explanation, which anticipates the respondent hypothesis. With this hypothesis I am also able to respond to **Hineline’s** justified criticism that my characterization of the aesthetic response remains elusive (Section 2.1, above), and **Verhaeghen’s** comment that I may have relied too heavily on the surprise effect. It provides a multipronged explanation (developed in Section 3.3, below) for the ubiquity and power of narratives and stories in human affairs, as set forth by **Hineline (2018b)**, as well as hints and clues in the quest for dependent variables that may show promise in neurobiology research on aesthetics. Among these are variables associated with caudate nucleus activity related to classical conditioning, and neural correlates of respondents. Perhaps the farthest-reaching implication of the respondent hypothesis is in the light it sheds on the mechanisms by which synergetic brews generate the respondent-laden reactions listed in Section 1.6.

The respondent hypothesis also calls attention to questions that are not ordinarily considered. For instance, what are the conditions that elicit the reactions of laughter or crying? Sections 4.10 and 9.5 of the 2017 article explain that the humor (“funny”) reaction occurs when incongruous or contradictory concepts are juxtaposed. But what is the basis of this effect? Is the difference between laughter and mere smiling, or

crying and mere sadness, only a matter of degree, or of kind? Are they stronger or weaker forms of the same respondents, or different kinds of respondents? The respondent hypothesis may point to ways of addressing these types of question.

2.9 Beyond Terminology

Shifting the focus of the analysis to respondents should ultimately eliminate the scientific vocabulary’s need for concepts like emotion and aesthetics, just as the concepts of air, fire, and earth have disappeared from the scientific vocabulary of chemistry. We should expect to find that the synergetic brews of music, visual arts, literature, abstract concepts, as well as the various domains described in Section 5.3, elicit distinctive respondent clusters. Each such cluster may then correspond to a separate, yet to be named, reaction category, analogous to “emotions.” As I explained in Section 9.1 of the 2017 article, there are many disciplines, like humor, film, mathematics, chess, and various forms of interpersonal interaction, that may not ordinarily be considered art forms, for whose effects the “aesthetics” category does not quite fit—disciplines that nonetheless involve respondent reactions elicited by synergetic interactions.

In studying reactions in these various disciplines, whether we call them surprise, expectation, revulsion, disgust, bliss, awe, envy, yearning, anger, rage, relief, and so forth, little is accomplished by playing with their category names. What these reactions have in common is that every occurrence has (a) a distinctive respondent core that can be entirely covert, and (b) a synergetic interaction of elements that evoke the reaction. The interacting elements always include situational-circumstantial factors, prevailing behavioral contingencies, and the results of idiosyncratic learning histories that include culture.

The path toward understanding these behavioral and biological phenomena involves the analysis of (a) and (b) above, including each reaction’s physiological and neurological correlates. As new and data-based categorizations emerge, the issue of category names will doubtless continue to be revisited.

3.0 Conditions Necessary for Aesthetic Reactions

3.1 The Missing Key Element

In the 2017 article, I proposed three conditions necessary for synergetic interactions to be effective in eliciting respondent-laden reactions:

- (1) The interacting elements rarely, if ever, occur together.
- (2) When they do, they elicit a respondent-laden reaction.
- (3) The effect of the interaction is reinforcing.

⁸ The term “audience” is used throughout to include listeners, viewers, readers, etc., as in the 2017 article.

The new insight, that the reaction referred to in (2) includes a set of respondents, provides a valuable hint as to the synergetic nature of the interaction of elements, as will be seen.

Palmer explains that “poetry, in all its forms, is a deliberate attempt to add an aesthetic element to semantic content.” Drawing on his vast knowledge of poetry, he brilliantly analyses several major works to provide examples of several of the 16 devices at play. He contrasts relatively nonsynergetic interactions (ones that would “fall flat”) with several interlocking and cross-referencing synergetic interactions with which Shakespeare created aesthetic stimuli in a couplet from *Cymbeline*. **Palmer** shows how Shakespeare weaves a wonderful web of conceptual relations that involve synergetic interactions. **Palmer** does it again with a second example—a passage from the King James translation of the Bible—and then with some additional ingenious analyses of the devices used in several other important literary works.

Having done this, here is how **Palmer** indicates his realization that a further condition is needed for an aesthetic reaction to occur:

I am also aware that [the foregoing analysis], even in the domain of literature, *is incomplete* [emphasis added], for the behavioral events identified here appear to be common to non-aesthetic effects as well. A telephone ringing at an unusual hour might. . .” (Palmer, 2018)

and he proceeds to describe various nonaesthetic and even aversive reactions one might have to such a telephone ring.

3.2 Carriers of Attached Respondents

I agree with **Palmer** that conditions 1–3, though necessary, are not sufficient as stated. For instance, finding a \$10 bill on the street could create a conjunction of elements that meets conditions 1–3 without creating an aesthetic event for the finder. What is missing for the event to be an aesthetic one? Answer: an additional element of the synergetic brew that would elicit aesthetic respondents when it interacts with the brew’s other elements. That element could be, for instance, the synergetic circumstance of the finder having been told earlier that he would find money on that day. Likewise, in the case of **Palmer**’s unexpected telephone ring, the additional element could be the synergetic circumstance that he was testing an invention that makes phones ring in response to solar flares, and had heard earlier in the day that such flares had been independently reported.

As **Palmer** implied with his phone ring example, the respondents elicited by the interaction are not necessarily positively reinforcing. The respondents elicited by the phone ring could also be those of fear, depending on the conditioning history related to the synergetically interacting elements.

In general, the additional element that is always required for a respondent-laden reaction to qualify as “aesthetic” is a stimulus (a synergetic interaction of elements, such as a beautiful melody) that can act as a carrier of respondents (such as those we might call sadness) that had become attached to the stimulus via classical conditioning (at an earlier time when sadness and the melody had been paired), with the result that they now interact synergetically with the elements of the instant situation. In the case of poetry, the missing elements to which **Palmer** alludes may include respondent-laden metaphors, rhymes, rhythms, alliterations, allusions, images, and references to shared experience. The *particular* respondents that attached to these features of poems in prior conditioning episodes (or to melodies, harmonies, timbres, or rhythms of musical works; to color schemes or subjects of paintings; to flavors or textures of foods; and so forth) *always differ from individual to individual, depending on the individual’s idiosyncratic conditioning history*.

3.3 How Respondent Conditioning can Occur

Here are some examples of types of conditioning episodes in which a stimulus becomes respondent-laden. (1) A child was often taken to a carousel that played a certain melody. As a result of those pairings, that melody became associated with various respondents elicited in outings with parents. (2) A reproduction of a Monet landscape hung in a child’s bedroom. The landscape’s color scheme became associated with respondents often elicited in the bedroom. (3) A parent used to read a certain story to the child and elicited respondents by commenting in certain ways on the actions of the story’s hero. (4) A young person listened to someone who elicited certain respondents when reciting a certain poem. (5) A seasoning that grandma used to employ acquired positive associations.

Several factors affect the effectiveness and robustness of stimuli that function as long-term carriers of respondents. One is their distinctiveness (discriminability), which would affect their susceptibility to being weakened over time by the blurring effects of generalization and consequent progressive extinction. This consideration supports the familiar observation that discipline-specific aesthetic reactions tend to develop in disciplines that lend themselves to ever finer and more sophisticated conceptualizations, like mathematics, music, language, the visual arts, and specialized fields of scholarship. Individuals who spend significant time in contact with the subject matters of such disciplines inevitably experience over time repeated pairings of the disciplines’ elements with respondent-laden reactions and with the intrinsic reinforcers of learning. The resulting conditioning episodes create increasing numbers of refined, sophisticated, and idiosyncratic aesthetic sensibilities tuned to those disciplines’ elements—sensibilities that those who lack comparable exposures and experiences would not share.

Other factors that affect the robustness of the respondent-carrier function is the biologically relevant circumstance in which the conditioning episode originally occurred, such as the age and impressionability of the individual, and all the other variables that have been shown to affect the susceptibility to, and robustness of, classical conditioning effects.

3.4 Origins of Aesthetic Elements

The above paragraph explains how sets of aesthetic respondents can become attached to their carriers, and why some carriers can be more robust than others. The phylogeny heuristic suggests possible reasons. Voices, tastes, and odors appear to be particularly “sticky” as vehicles for respondents, due perhaps to their reliable and consistent presence throughout every individual’s life, and to their primordial functions of signaling threats and opportunities, good and bad food, safety and danger. This may explain the ability of music (with its roots in the human voice and perhaps language) to carry and convey such respondent-based reactions as sadness, excitement, calm, agitation, or other “feelings” that may previously have been paired with those stimuli via classical conditioning.

As **Hineline** (2018b) pointed out, narratives and stories are another powerful medium for the conveyance of aesthetic stimuli. Their principal biological utility resides in their functions of conveying information regarding the management of life’s challenges and cultural transmission in general. These functions explain why narratives and stories frequently evoke reactions that are respondent-laden—a functionality that makes them powerful vehicles for the conveyance, transmission, and distribution of aesthetic tidbits. Words, phrases, metaphors, verbal concepts, and voices can easily come to function as conditioned stimuli for the elicitation of respondents—this being one of the answers to **Palmer**’s quest for the missing element, as will be seen. For some of the evidence that this is so, one need look no further than mankind’s treasure trove of literature and its pan-cultural power to reinforce.

Schlinger points to the long-term retention seen in human early language learning and songbird learning when he suggests that this effect may also apply to the long-term retention of aesthetic responses to music to which there had been early and frequent exposure. Some respondent reactions that never extinguish or habituate are genetically encoded, like cats’ reactions to snake-like objects or chicks’ reactions to overhead silhouettes of hawks. Others are learned quickly early in life, during impressionable periods, such as in imprinting. We know that children often carry into adulthood aversions and preferences for foods, melodies, or other stimuli, including people or groups, based on what a parent may have modeled or told them when they were very young.

Aesthetic reaction patterns (“tastes”) may thus be acquired early in life and retained in long-term memory (via the neural mechanisms described by **Eric Kandel**, 2006). Thus, the

conditioned responses that define aesthetic reactions can last a lifetime, as can memories of faces, odors, or motor routines.

A corollary of this analysis, which some may find disturbing, is that beauty is not only in the eye of the beholder, but is *exclusively* in the eye of the beholder, a principle that applies not only to aesthetic reactions but also to many of the other respondent-laden reactions listed in Section 1.6, above. However, the nature of effective respondent-carriers is not entirely arbitrary. Arbitrariness reigns only within the limited domain of a biological relevance. There is no conceivable conditioning history that could make white noise as aesthetically effective as a melody or darkness as effective as a sunset.

3.5 Clinical and Sociological Implications

The analyses in Sections 3.3 and 3.4 above support the clinical and sociological discussions in **Mellon**’s and **Thompson**’s commentaries. **Mellon**’s comments on the potential for improving the quality of lives when he writes that “the soul-stirring synergy of conceptual confluence could occur more often in more lives” when the power of synergetics is harnessed deliberately.

We know that the degree to which interactions with the environment elicit respondents is a strong function of age. Yelps of joy and tears of despair diminish dramatically with age. Childhood experiences are notoriously formative and determinative of the valence and quantity of the respondent content of the reactions listed in Section 1.6, above, including aesthetic reactions. Thus, a bad or happy childhood may involve the same conditioning mechanisms for determining the robustness of respondent-carriers as does a deep knowledge of music or mathematics. These conditioning mechanisms have evident implications for therapy, including techniques for the design of stimulus neutralization procedures, replacement, extinction, and adaptation (where stimuli are defined broadly, as in Sections 1.6 and 2.4, above).

3.6 Potentiating and Priming Factors

There is a whole other category of factors that determine the occurrence or nonoccurrence of an aesthetic reaction, independently of the stimulus inherent in the work. These extrinsic factors include the behavioral, mental, and physiological state of the audience (for instance, “being in the right mood”), and the potentiating and priming factors discussed in Part 6 of the 2017 article, including those that can give rise to recognition. For instance, the effects of the 16 devices discussed in Sections 1.10 and 7.4 of the 2017 article are modulated by these types of potentiating and priming factors.

Given that recognition requires prior exposure, one might ask how *first* exposures to artistic works can be reinforcing, as they often are. The answer is, via generalization. The prior

exposures need not be to the same work—they can be to elements of the work or to similar works.

Potential factors also include the audience’s receptivity and attentiveness to the stimulus, their stress level, and the sociocultural ambience. Thus, these types of factors are also relevant to **Palmer**’s missing element.

I would apply the term “catalytic element” to certain potentiating factors. It is the element that catalyzes the synergetic interaction with the brew’s other elements. The handkerchief that Iago showed to Othello functioned as the catalyst for the synergetic interaction of the elements that were already brewing in Othello’s mind, but Shakespeare’s target for the synergetic brew’s aesthetic impact was always the play’s audience.

These and other conditions are clearly potentiating factors that would modulate an aesthetic reaction’s occurrence. Further instances of effects of potentiators will be seen in Part 4.3, below, where the linkages between activity-generated reinforcers and their various potentiation requirements are discussed.

4.0 The Domain of Aesthetic Reactions

4.1 A Heuristic for Mapping the Domain

Some comments by **Hineline** and **Killeen** (cited in Section 4.2 below) prompted me to consider the wider domain of the synergetic brews that elicit aesthetic reactions. By domain, I mean all the places they can be found and all the forms they can take. The stimuli that elicit aesthetic reactions are not limited to music, art, narratives, and poetry. To map the entire domain, a helpful heuristic, once again, is to consider how aesthetic reactions may have come to be—their phylogeny (evolutionary history) as well as their ontogeny. Such a heuristic can suggest plausible hypotheses regarding their domain. For instance, the phylogenetic hypothesis that feathers evolved from reptilian scales may prompt the identification of other reptilian characteristics in birds.

Mellon agrees with the phylogenetic behavioral/biological approach to the analysis of aesthetic reactions. He observes that natural science analyses often require consideration of distal causes as well as proximal ones, a point that has significance beyond aesthetics:

Mechner’s splendid natural science interpretation addresses the inadequacy of appeal to [exclusively] proximal causes for aesthetic phenomena by investigating the role of distal ones, both in the individual’s personal history and ancestral past. All of the events that might affect the probability of putative aesthetic effects are physical, but their observation is challenged in that the

majority of relevant events occurred well before the aesthetic effects that they determine. (**Mellon**, 2018)

As **Mellon** points out, natural science accounts that are limited to proximal causes are rarely adequate and distal ones are often needed. **Killeen**, too, sees merit in the phylogenetic heuristic and consideration of distal events (see Section 4.2, below). To be fully satisfying from the biological standpoint, an account of the origins of a stimulus’s reinforcing effects must address both its ontological *and* its phylogenetic origins.

In the present case, the origins of reinforcing stimuli would include the evolutionary advantages that accrue to individuals susceptible to being reinforced by those stimuli, along with an account of the origins of such susceptibilities. If these individuals were susceptible to reinforcement by consequences that increase the probability of selection for survival or procreation, we would expect these individuals to exhibit behavior that produces such consequences.

This phylogenetic approach to explanation is epistemologically analogous to explaining traits like hairiness and skin pigmentation by reference to climatic factors; geologic formations to tectonic events; or planetary orbits to earlier cosmic events. The ever-pertinent issue is the degree of confidence to place in particular distal explanatory events, not whether to consider them.

4.2 The Qualitative Dimension of Reinforcers

To map the domain of synergetic brews that may elicit aesthetic reactions, we must look beyond the arts to a wide range of human activities that generate such synergetic brews, and their reinforcing effects.

Hineline observes that aesthetic reactions can be elicited by “the products of workmanship.” Indeed, few things are more beautiful to a craftsman than well-made tools, to a violinist than a Stradivarius, to a painter than a good brush, to a warrior than a well-made weapon, or to a chef than well-made cookware.

Hineline also relates this type of reinforcement to parsimony, whose reinforcing power is based on the amplification of small inputs into large outputs—accomplishing much with little. **Hineline** points out that the reinforcing effect of parsimony is seen in areas of design where the distinction between functional and misplaced precision is crucial (**Hineline**, 2005). Misplaced precision is unaesthetic because it is anti-parsimonious; functional precision, in contradistinction, translates into efficiency and effectiveness of function and is therefore parsimonious.

Killeen appears to agree with **Mellon** as he invokes distal events when he makes a point similar to **Hineline**’s:

The aesthetic response . . . is probably the crucial distinction between us and Neanderthals, whose

stone tools barely evolved during the 250,000 years they wielded them. Those of *Homo sapiens* steadily evolved over their 100 thousand years, in the last stages becoming beautiful artifacts such as the Clovis point. It is impossible not to imagine that the spire [Killeen's term for having an aesthetic experience] of discovering a better way of knapping flint, or of admiring a perfect arrow-head, did not mediate this evolution. (Killeen, 2018)

The full domain of reinforcing effects based on biological utility factors extends far beyond these quality-related subdomains. The heuristic I once again adopted for identifying these activity-based subdomains is that of examining how our aesthetic sensibilities evolved.

4.3 A Partial Map of the Domain

The domain of circumstances that function as synergetic brews that elicit aesthetic reactions is thus comprised of (a) actions and activities whose outcomes have biological utility, and (b) devices that creators of aesthetic effects use to create reinforcing synergetic brews, as explained in Sections 1.10 and 7.4 of the 2017 article.

In response to Hine's, Thompson's, Mellon's, and Killeen's prompts, I extended the heuristic described in the above sections to actions and activities whose reinforcing consequences promoted survival and procreation during our evolution. These include:

- **Making items** like tools, clothes, vehicles, abodes, or weapons. It is the *quality dimension* of such items that determines their functionality and reinforcing power—their biological utility in terms of protection, access, transportation, warmth, or control. An evolutionary selection advantage should thus have accrued to individuals susceptible to responding aesthetically according to the quality and effectiveness of exemplars. Significant potentiators of the aesthetic effects of these items include the identities of the audience members (craftsmen for tools, drivers for vehicles, warriors for weapons, etc.) and the circumstances in which they make contact with the items.
- **Acts of love** that protect members of the group, provide for them, or promote their procreation. A susceptibility to reinforcement by the effective performance of such acts has evident biological utility. The reinforcing effects of such acts on their witnesses would promote the acts' continued performance, with consequent enhancement of the group's survival and procreation. It is no accident that so much of art, music, poetry, drama, and literature uses love-related themes—mothers loving children, sexual love, selfless love, love of the family, the social group, or the nation. Significant potentiators for the aesthetic effects of acts of love are audience factors—individuals who are sufficiently mature to care about the significance and effects of such acts.
- **Social interaction**—communicating, sharing, collaborating, and maintaining memes related to language, customs, rituals, traditions, festivities, decoration, music, art, and dance. Among the biologically useful consequences of such activities are enhancement of the group's cohesion and long-term survival. An audience's susceptibility to reinforcement by the *quality and effectiveness* of such consequences would have evident biological utility for the group. Critical potentiators of the aesthetic effects of social interactions are the audience members' group membership, group identification, and the relationships among members of the group.
- **Creating narratives and stories**—Though this is an instance of social interaction, it deserves a special category, as Hine (2018b) has shown. As explained in Section 3.4, above, it is one of the most effective vehicles of cultural transmission, and of media for the creation of aesthetic effects, as evidenced by the rich trove of mankind's literature. Whether the medium is a parent telling a story to a child, an author writing a parable, a filmmaker creating a drama or documentary, or a historian relaying the history of an empire, the potential aesthetic and respondent-carrying impact and biological utility of narratives and stories, are unrivaled.
- **Collecting**—gathering and storing potentially useful items. Certain types of collections create buffers and redundancies that may be biologically useful in case of future scarcity (e.g., stored food) or need for rapid access (e.g., arrow quivers). Some translate into wealth or power. Among these are money, cattle, residences, cars, or political supporters. But even if the items have no *immediate* biological usefulness, like seashells or stamps, collections of them may still elicit aesthetic reactions and receive positive reinforcement within groups of appropriately primed members, according to the *quality* of the collection. The potentiators would usually include visual displays of the collection and social circumstances conducive to viewing it.
- **Striving to prevail**—fighting, competing for results or resources, or overcoming obstacles. Consequences that have biological utility include mastery or control of situations by winning, conquering, securing protection, succeeding, or attracting mates. Few activities enlist the passions of audiences like sports. Audiences routinely become enthralled by the quality and proficiency of the

performances of sports figures, athletes, and game winners. Significant potentiators of the aesthetic effects are visual displays of outcomes, the presence of other members of the activity's subculture, and the reinforcement contingencies related to prevailing. The great reinforcing power of this category of aesthetic reactions is seen in the quasi-addictive power of videogames, which are often about prevailing.

In all five of the above subdomains, the biological utility of the activities' consequences is seen to depend on a quality dimension and the presence of applicable potentiating factors. The consequences are aesthetic and reinforcing *to the degree that the actions that generate them are performed effectively, parsimoniously, and well*. **Malott's** commentary offers a richly detailed and scholarly analysis of the impact of the work's craftsmanship interacting with sociocultural norms functioning as the priming and potentiating factors, using the domain of portrait painting as her illustrative medium.

The consequences of the "social, cultural, educational, and vocational" activities that **Thompson** analyzes (see Section 4.5, below, for an excerpt) were clearly conducive to survival and procreation during our evolution, and thus had biological utility. An evolutionary selection advantage would evidently have accrued to individuals *susceptible to reinforcement* by such consequences, as well as to their groups and cultures. This advantage would have manifested itself in the long-term evolutionary selection of such susceptibilities, with a resulting increase, over time, in the prevalence of such susceptibilities in the population.

4.4 Derived Relationships Via Covert Conditioning

The conceptualization of the aesthetic reaction as a set of respondents clearly opens paths for its experimental analysis. It may also open a new window on the study of traditional psychology topics like the etiology of emotional disorders, phobias, and social relationships.

Thompson's and **Mellon's** commentaries are consistent with the classical conditioning conceptualization of aesthetics. They provide a theoretical basis for the derived (second- and higher-order) relations that underlie the social and cultural dynamics they discuss. If synergetic brews can transfer their eliciting functions to previously neutral social and cultural stimuli via classical conditioning, then they can also transfer their *reinforcing* functions to such stimuli via classical as well as operant conditioning. For instance, previously neutral stimuli (concert halls, art galleries, libraries, etc.) can take on derived (conditioned) reinforcing properties of their own, as we know they often do, and so can any other inherently neutral ambience or concept. It does not take a great leap of imagination to see that second-order and higher-order conditioning effects can

generate the large webs and matrices of derived relations of aesthetic-sensibility–intertwined subcultures within such social groups as music, art, or literature lovers—groups that can include many individuals who need never actually experience the core aesthetic reactions. **Thompson** and **Mellon** analyze a broad range of derived relations and the myriad ways aesthetic reactions can permeate the daily lives of the individual, or the dynamics of the group or the larger society.

4.5 Broader Implications of the Conditioning Paradigm

Malott, Mellon, Thompson, and Verhaeghen indirectly make the point that the term "aesthetic" is used broadly in the sense of social behavior governed by contingencies of reinforcement, rules, and meta-contingencies. The term is often also used colloquially as an adjective, such as when we say, "aesthetic judgment" or "aesthetic taste." In line with **Malott's, Mellon's, Thompson's, and Verhaeghen's** commentaries, the term is often used in connection with social, cultural, religious, and community events, visits to museums, art galleries, or musical events. **Malott** explores the subtleties of the potentiation effects due to culture, with vivid and detailed examples drawn from the world of portraiture, including the commercial effects on the price of the paintings (**Malott, 2018**). Such operant activities may occur with or without associated core respondent reactions. **Thompson** explores and elaborates various derived relational functions relating to social dynamics. Here is an excerpt from his commentary:

Aesthetic preferences identify who we are and our group memberships, social, cultural, educational, and vocational. . . . If aesthetic materials had established derived symbolic relational contact with personal, family, community and other important cultural aesthetic nodes in derived relational trees, they will be embraced and incorporated into people's lives. . . . Elsewhere, these rules and relationships have been called "derived symbolic relationships" (de Rose and Bortoloti, 2009; Todorov, 2013; Glenn, 1988) or "relational frames" (Hayes, Barnes-Holmes, and Roche, 2001). (**Thompson, 2018**) One might expect the ramifications of aesthetic reactions involving the emergence of derived relations to be similar to the emergence of derived relations in the case of operant behavior, though this would be a topic for experimental research (**Fields and Amtzen, 2017**).

Mellon describes an additional socially important dynamic in the creation of the synergetic brews that elicit aesthetic reactions—one that has far-reaching implications. He points out that the potential reinforcing power of synergetic brews

may, in some cases, induce audience members to create their own synergetic brews, that is, stimuli to which they themselves will then react. He explains that when audience members create synergetic brews for themselves, they often balance the potential rewards against potential social punishment for creating those brews. Such social punishments may to a certain extent deter audience members from creating their own brews, via socially mediated as well as self-imposed *deterrents*. Here is how **Mellon** puts it:

Think, for example, of the self-imposed aesthetic impoverishment of so-called ‘picky’ eating, a synergy-free form of dining; or the conceptual development thwarted by the self-restriction of serious study to a single book or even a single genre of books (Mellon, 2018).

These observations have clear implications for education, therapy, personal development, the progress of disciplines, and the enjoyment of life.

5.0 Experimental Analysis of Aesthetic Reactions

5.1 Relevant Reported Research

In Section 10.4 of the 2017 article, I proposed a method for improving the validity of the independent variable of aesthetics experiments. It involves “asking participants to identify stimuli that had evoked genuine aesthetic responses *for themselves* in the past, and then using those stimuli in the experiments.”

The study by Salimpoor, Benovoy, Larcher, Dagher, and Zatorre (2011) cited and described by **Verhaeghen** uses a similar research method. The participants were asked to identify musical selections that contained “chill inducing” moments for them. Those selections were then played for them in the experimental situation in which PET scans and fMRI recordings were simultaneously being made. The participants were asked to press a button the moment they heard the “chill-inducing” passage.

Results: the nucleus accumbens and the right caudate nucleus (often involved in classical conditioning) became active during the 15-s period preceding the button press. When the button was then pressed, the caudate nucleus activity ended and the nucleus accumbens activity increased sharply, with release of dopamine. In other reported studies, these neural recordings were “combined with psychophysiological measures of autonomic nervous system activity,” suggesting that the button press is also correlated with traditional respondents. Here are the authors’ descriptions of their neurological observations:

The caudate was more involved during the anticipation, and the nucleus accumbens was more involved during the experience of peak emotional responses to music. . . . Notably, the anticipation of an abstract reward can result in dopamine release in an anatomical pathway distinct from that associated with the peak pleasure itself. (Salimpoor et al., 2011)

If the “chill-inducing” musical passage is regarded as the synergetic brew, corresponding to a traditional US, and the music leading up to it as the effective CS, then the conditioned response (analogous to Pavlovian salivation) should occur while the CS is playing. The reported observation of caudate nucleus activity while the CS was playing is consistent with the caudate’s known involvement in classical conditioning. Exciting stuff!

5.2 The Independent Variable in Neurobiology Research

Unfortunately, the Salimpoor et al. (2011) study has a design flaw that limits the conclusions that can be drawn from it: the observed neural events could just as well have been associated with the operant button press as with a possible aesthetic reaction. The observed dopamine release could also have been related to a reinforcing effect of correctly carrying out the experimenter’s instruction to identify the designated passage or of recognizing the identifying passage.

This design flaw can be corrected by having the experimenter, rather than the participant, press the button (without the participant’s knowledge) at the moment the previously identified passage plays. This would answer the question of whether the neurological reactions to the passage were due to something about the passage or to aspects of the procedure.

Another experimental design approach would be to ascertain whether new, certified “chills” passages could be identified on the basis of the neurological data only, and conversely, whether the new, certified chills passages can evoke neural responses similar to those evoked by the original one.

But even with these procedural refinements, the instruction given to the participants to identify passages that induce “chills” for them, in experiments like Salimpoor et al. (2011) or Grewe, Nagel, Kopiez, and Altenmüller (2005), is still unsatisfying as an independent variable, because the term “chills” means different things to different people, as **Verhaeghen** points out. Depending on the participant’s verbal history, the term need not have anything to do with aesthetic reactions at all. In any case, a verbal operant *report* of a private event (a tact of it) has a different status than the private event itself: it may be considered a type of correlate of a private event, but not a record of it.

One of the frontier research issues in neurobiology is that of defining and specifying the independent variable objectively. The common practice of using the

participant's response to verbal instructions as a presumed independent variable diminishes the generality of the conclusions that can be drawn—the data are then more like response–response correlations. The independent variable must not only be independent of the dependent variable; it must also be specified objectively and operationally.

6.0 Issues of Terminology

6.1 Expectancy and Expectations

When the synergetic brew has a temporal dimension, like music or literature, stimulus events that audience members recognize often set up expectations for what will follow. These expectations are then confirmed, disconfirmed, and usually something in between. It is in this in-between zone that refreshment of aesthetic reactions can occur. As per **Verhaeghen**, the confirmation–disconfirmation zone must be Goldilocked—not so obvious as to be trivial and not so unexpected as to be incomprehensible. In the case of synergetic brews that don't have a built-in temporal dimension, the audience may furnish one as the eye moves across the visual field or as contexts are perceived and brought to bear.

The expectation that the synergetic brew sets up, whether realized or unrealized, fulfilled or violated, often contributes elements to synergetic brews. Sections 6.2 and 6.3, below, discuss the epistemological status of such constructs as expectation or expectancy (almost synonyms).

The following excerpt from **Verhaeghen's** commentary illustrates how he uses the term:

Music—unsurprisingly—activates the reward/pleasure centers of the brain, notably the nucleus accumbens . . . expectation plays a large role in that pleasure. . . . A first observation is that music has expectancy violations woven into its very fabric. . . . expectancy violations are a precondition for one type of strong emotional aesthetic response. (Verhaeghen, 2018)

Zatorre and Salimpoor's (2013) article—a research review cited by **Verhaeghen**—provides an example of how neuroscientists are using the concept of expectancy:

Expectancies are generated based upon a listener's implicit knowledge about musical rules that have been acquired by previous exposure to music of that culture. Thus, hearing a particular set of tones leads one to expect certain specific continuations with greater probability than others. This phenomenon is significant because it points to our highly adaptive ability to predict future events based on past regularities. There is good evidence that the relevant sequential contingencies are encoded based on a process of statistical learning, which emerges

early in life for both speech and music and is also operative in adulthood. This dependency on environmental exposure also means that different individuals will have different sets of perceptual templates to the extent that they have been exposed to different musical systems or cultures. . . . (Zatorre & Salimpoor, 2013)

In Section 4.2 of the 2017 article, I explain my use of the term “surprise” for reactions when an expectation is unmet. In Section 6.2, below, I describe an operational and objective definition of expectation or surprise, based on known or experimentally arranged behavioral histories. To **Verhaeghen's** question regarding the pervasiveness of “surprise” reactions in aesthetics, I would reply that by my definition they correspond to unmet expectations.

6.2 The Epistemological Status of “Expectation”

Some of the commentators seem uncomfortable with the expectation construct. **Schlinger**, for instance, asks, “But what behaviors are ‘expectations?’” In my view, they are not behaviors, but rather constructs whose epistemological status is similar to that of such widely used behavioral constructs as discrimination, generalization, reinforcement, extinction, and conditioning.

All of these constructs conform to the same general paradigm: *an organism is in an initial state defined by temporary (transient) properties.*⁹ The state's properties include the effects that various operations may have. “Expectancy,” “expectation,” or “anticipation” all refer to a state of the organism created by events that occurred in its prior history, where certain events followed each other in a certain order or were arranged in a certain configuration.

By way of example, in Section 1.17 of the original 2017 article, I proposed a simple, nonverbal way to define “expectation” operationally in an experimental design:

. . . a rudimentary model of expectation and surprise can be created by installing a learning history in which Concept A was always followed by either Concepts B or C, whose relative historic frequencies could then serve as an independent variable.

For instance, if, in the participant's experience, A had always been followed by B, we could call this procedure the installation of an “expectation” of B given A. If A were then, at a subsequent time, followed by C instead of B, we could call this a “nonrealization of an expectation,” an unexpected event, or a

⁹ The term “state” is generally used in a variety of senses and contexts. Nonpermanence or transience is a common one. When a system is said to be in, for example, a state of oscillation, equilibrium, anxiety, decomposition, or euphoria, the implication is that this property is transient. If the term “state” were left out, the implication would be that the property is a permanent and inherent one.

“surprise,” but whatever we choose to call it, the operational specification permits the systematic variation of such parameters as frequencies, probabilities, and time intervals. One could, for instance, program different frequencies for B-given-A and C-given-A. In short, the paradigm always identifies an initial state, an operation/event, and a resulting altered state. The “property” is the effect that the operation/event will have. This type of experimental design makes the independent variables amenable to parametric variation. Experienced experimenters know that varying a parameter over a range of values is a powerful technique for identifying and analyzing the controlling variables.

6.3 The Usefulness and Survival of Constructs

A common qualm regarding the use of constructs in behavioral science is that they are not “directly observable.” But direct observability is rarely a good criterion of usefulness, even if we tried to define what we mean by “direct.” For instances, genes, atoms, atomic bonds, photons, or gravitational waves are not directly observable, but their usefulness is due to their ability to explain, predict, or control events that are of interest. Their epistemological status is, in that sense, equivalent to that of such behavioral constructs as expectancies.

Here is MacCorquodale and Meehl’s (1948) comment regarding the issue:

It is naive to object to such formulations [constructs] simply on the grounds that they refer to unobservables, or are “hypothetical,” or are not “statistical.” None of these objections is a crucial one for any scientific construct, and if such criteria were applied, a large and useful amount of modern science would have to be abandoned.

6.4 Preservation Versus Importation of Terms

Palmer, too, expressed a qualm regarding my terminology:

[My] speculations can be subsumed within Mechner’s account, but they confine themselves to a more limited vocabulary, namely the narrow vocabulary of behavioral principles and concepts. Mechner does not hesitate to dip into a wider pool for his terms, and given the scope of his paper, that policy may have been necessary. But ultimately, terms such as *priming*, *transformation*, *surprise*, *synergetic brew*, etc., must find a translation in basic behavioral processes, and my goal is to offer a closer approximation to such a translation. But I have found it to be a difficult exercise. Every generalization that occurs to me appears to be subject to exception. (Palmer, 2018)

I resonate with **Palmer**’s frustration. The analysis of aesthetics and the arts does not have a well-developed vocabulary for the kinds of relations that need to be conceptualized, including different types of stimulus interactions. In poetry and literature, for instance, relations are categorized as metaphors, allusions, rhyme, meter, or similes, and in music and other arts by various other labels. The discomfort that **Palmer** expresses regarding terminology is widely shared by scientists when new territory is being explored. **Schlinger**, for instance, says,

Mechner introduces many new terms and concepts that I found difficult to operationalize. . . . In my opinion, throughout his article Mechner has gone beyond the basic principles of operant and Pavlovian learning and introduced new and, at least to me, difficult to understand concepts (e.g., concept repertoire, power amplification)¹⁰ to explain the phenomenon of interest (Schlinger, 2018).

Perhaps the shift to identifying the core reactions as respondents rather than emotions will satisfy some of these qualms. **Hineline** proposes the terminological innovation *complex invariance*, which he developed in Hineline (2005, 2018b). But even if these suggestions fail to satisfy **Schlinger** and **Palmer**, one must keep in mind that in the history of science, the scientific exploration of new territory has often required the importation or invention of new concepts, constructs, and terms (Mechner, 2008a, pp. 236–237).

The present endeavor—analyzing aesthetics from a behavioral and biological perspective—is clearly new territory, for the study of which traditional concepts are likely to require supplementation. The “narrow vocabulary of behavioral principles and concepts” to which **Palmer** refers has proved useful in the study of operant behavior, but if the core aesthetic reaction is a set of respondents (it doesn’t operate on the environment and is not shaped by its consequences), one should not be surprised to find the operant terminology inapplicable.

6.5 Comments Regarding Terminology

I will address two of **Schlinger**’s “quibbles,” as he characterized them. The first of these concerns his view of the nature of “auditory imagining”: “As I argued in my (2009) article, auditory imagining is parsimoniously interpreted as sub-vocal talking when imagining hearing speech, and sub-vocal singing or humming when imagining hearing music” (Schlinger, 2018).

I concur that music mentalization sometimes involves “subvocal singing” in some individuals, and that some types

¹⁰ For discussions of “concept repertoire,” see Mechner (2017), Part 2, and Mechner (2008a), pp. 237–238. For a discussion of power amplification, see Mechner (2017), Sections 4.7–4.9.

of thinking involve “silent speech” in the sense of speech with subliminal muscle involvement. However, I believe that the neural processes underlying such phenomena as mental hearing, mental seeing (“visualization”), and other types of thinking normally occur without any engagement of effectors (muscles) at all, at a purely neural level (unless one also chose to apply the terms “silent speaking” or “singing” to purely neural activity).¹¹ I find it implausible that in such activities as silent reading or mental arithmetic, the musculatures involved could engage and disengage from their neural networks at the typical highly accelerated (10x to 20x) mentalized speeds over their observed overt speeds. Even if such subliminal muscle involvement provided a benefit (there is no evidence that it would), it would greatly slow down such mental activities, expend energy unnecessarily, and forego the benefits of the higher speeds of mentalization.

Schlinger also had a question regarding my concept of functionality thresholds:

But when Mechner then states that “It is during such exposure that the necessary concepts and relations can attain the functionality thresholds required for the intended synergetic interactions and aesthetic impact” (p. 30), I must admit that he loses me. (Schlinger, 2018)

By “functionality thresholds,” I meant what Skinner referred to in the quotation that **Palmer** cites, “We are especially reinforced by speakers and writers who say what we are *almost* ready to say ourselves—who take the words ‘off the tip of our tongue’” (Skinner, 1957, pp. 271–272), and what **Palmer** referred to when he said, “It is the text that brings strands of incipient behavior to strength that delights us” and. . . “the abrupt strengthening of inchoate behavior.”

I believe that this threshold-crossing phenomenon applies not only to poetry and literature, but also to visual, auditory, or abstract disciplines that involve aesthetic reactions. When a concept in our repertoire is primed to a level of strength somewhere between zero and overtness, the right event can then boost the concept’s strength over the overtness threshold, to functionality.

6.6 The Roles of “Familiarity” and “Exposure”

Verhaeghen states that “familiarity is a particularly strong determinant” and “a very strong driver” of the aesthetic response. This is true to the extent that “familiarity” is considered equivalent to “the effects of a priming history” (See

¹¹ fMRI studies have shown that visualization involves some of the same neural pathways as seeing, and mentalized hearing as listening, but only some. Visualization also involves other pathways that exteroceptive seeing or hearing do not. Likewise, visualization is a type of mentalization that does not necessarily involve images or “internal seeing.” For a more detailed analysis of these issues, see Mechner (2010a, b).

Section 1.11 and Part 6, *Priming and Potentiating Factors*, of the 2017 article). Like priming, familiarity would then be a necessary though not a sufficient condition for a synergetic brew to elicit an aesthetic reaction.

One of the priming (familiarity-producing) mechanisms **Verhaeghen** cites is the “mere-exposure” effect (Kunst-Wilson & Zajonc, 1980):

. . . the mere-exposure effect (Kunst-Wilson & Zajonc, 1980) is well-known—mere exposure to random stimuli (such as polygons, nonsense words, scribbles, or photographs of faces) increases people’s affective response to them, even in the complete absence of recognition memory for the stimulus. (Verhaeghen, 2018)

Prior exposure to certain stimuli can certainly be a factor in priming future aesthetic or affective responses to them. One plausible mechanism for this effect is “perceptual practice”: just as the repeated performance of a motor routine makes its performance more efficient and effortless (Mechner & Jones, 2015), so does the repeated perception of a stimulus make its perception faster, more probable, and more automatic. This effect could be viewed as priming of the *perceptual* capabilities required for the aesthetic reaction. As for the *affective* response that **Verhaeghen** cites, a possible explanation of it may be that repeated exposures provide occasions for extinction of the common initial aversiveness of unfamiliar stimuli.

Another way mere-exposure can promote aesthetic reactions is by priming the identification and recognition of the individual elements that comprise the ingredients of synergetic brews. A first exposure to a work is rarely sufficient for such identification and recognition. When we react to a work aesthetically on first exposure, it is always because at least some of its elements were already familiar due to prior priming.

But the mere-exposure effect, whatever its mode of action, does not explain why some “familiar” stimuli produce aesthetic reactions whereas others don’t. Familiarity is always the result of a priming history, but obviously, not all that is familiar elicits aesthetic reactions. The several familiarity-promoting studies **Verhaeghen** cites illustrate some of the ways aesthetic reactions can be primed, but without identifying the attributes that distinguish aesthetic reactions from other reactions.

7.0 Persistence of Aesthetic Effects despite Repetition

7.1 Long-Term Persistence of Aesthetic Effects

Most musical performers will attest that when they practice a piece of music and therefore hear it hundreds of times, certain passages remain beautiful—perhaps not “heart-wrenchingly”—

but still evocative of some level of covert aesthetic reaction. Most of us would say the same for works of art that have hung on our walls for years or poems we have read innumerable times. And the Eiffel Tower remains beautiful even to Parisians. This long-term perseveration of aesthetic reactions is clearly *independent of the number* of prior exposures. We need to explain why these aesthetic reactions do not succumb to extinction or habituation.

This is another aesthetics-related phenomenon whose explanation is aided by the respondent formulation. There exists a substantial literature on long-term retention of Pavlovian conditioning effects (e.g., Coulter, Collier, & Campbell, 1976). Sensory modality has been studied as one of the variables, with the auditory and olfactory modalities being associated with longer-term retentions than other modalities.

The explanation for the long-term retention of aesthetic effects I find most plausible is **Schlinger's**—that the original aesthetic reaction to the stimulus was learned during an impressionable period and was retained in long-term memory (via the neural mechanisms described by Eric Kandel, 2006). If memories of faces, odors, Pavlovian conditioned responses, or motor routines can last a lifetime, as we know they often do, why wouldn't memories of respondents, including aesthetic reactions?

7.2 The Refreshment Explanation

I agree with **Verhaeghen** and **Schlinger** that the refreshment explanation I offered for the sustained reinforcing effect of repeated exposures (see Sections 4.4–4.6 in the 2017 article) is probably not the whole story. But although **Schlinger's** explanation of the persistence of aesthetic effects despite repetitive exposures (Section 7.1, above) may be the primary one, I believe that the refreshment mechanism is also always at work, unable though it may be to carry the entire explanatory burden. The essence of the refreshment explanation is that each successive hearing of a piece of music, viewing of a painting, or reading of a poem, intervening experiences, elapsed time between successive exposures, and changed contexts, alter the concept repertoire and hence the response to the next exposure, at least to some degree. Each successive exposure thus refreshes the details of its recollection, with an effect that is generally reinforcing, as are most refreshment experiences.

Schlinger commented that this explanation might be circular on the grounds that “the only evidence for the altered concept repertoire is that we continue to contact works of art.” But continuing to contact works of art is not the only evidence, and even if it were, continuing contact is not the same as continuing to respond aesthetically. There is ample evidence (for instance, the extensive literature regarding “spontaneous recovery” in operant and respondent conditioning effects) that repetition, the passage of time, and altered

contexts have behavior-modifying effects, as do the reinforcing effects of concept refreshment.

8.0 Regarding Creativity

8.1 The Audience's Behavior Versus the Creators'

Killeen's, **Schlinger's**, **Shimp's**, **Thompson's**, and **Verhaeghen's** commentaries convinced me that I need to emphasize more strongly the fact that my analysis applies only to the *behavior of the audience* that reacts to aesthetic stimuli, and not to the behavior of the aesthetic stimuli's creators. In the original 2017 article, I restricted myself largely to the audience's aesthetic reactions, and avoided the very different topic of creativity and the creative process. Because several of the commentaries nonetheless addressed the issue of creativity, I will touch on it briefly.

In Section 7.4 of the 2017 article, I described the aforementioned “devices” that the creators of synergetic brews use to elicit aesthetic reactions in their audiences, in most cases via the manipulation of concepts (and, as **Killeen** points out, this can be described quantitatively as the manipulation of information or entropy). Although the use of such devices is related to the creative act, there is clearly far more to creativity than the use of these devices, or than can be covered here. **Shimp's** commentary, for instance, focuses on the shaping of the behavior involved in musical performance and the creation of music: “To the extent to which performing science and performing music are under the control of their consequences, they are operant behaviors and we can immediately ask how shaping contributes to establishing and maintaining scientific, religious, and aesthetic musical behaviors.” But because the vast topic of shaping and its relation to creative behavior falls well outside the limited scope of this reply article, I must reluctantly defer a substantive response to **Shimp's** provocative ideas.

8.2 The Dual Role of the Creator

Composers, performers, visual artists, and writers must often switch back and forth between the roles of creator and audience. When they do, they momentarily take the audience's point of view to gauge the possible impact of their creative efforts.

This much can be said with confidence: the degree to which creators of stimuli achieve success in eliciting aesthetic reactions from their targeted audience depends on *their familiarity with the audience's aesthetic reaction patterns and relevant priming history*. When the creator of a synergetic brew projects his or her own priming history onto that of the audience, the aesthetic effect will depend on the validity of that projection. **Malott**, herself

a talented portraitist, draws on her great knowledge of portraiture and American art generally to provide several vivid and persuasive examples of the impact of the artist's understanding of his audience's priming history and culture.¹²

Thompson comments in passing on artists' common claim that they "express their emotions" through their work. Whatever meaning one may wish to assign to "expressing emotions," a dispassionate examination of creative activity suggests that personal expressions of emotion may interfere with the craftsmanship and discipline required for the creation of stimuli that will elicit intended emotional reactions from others. Beethoven explained that when he composes he does not, at the same time, experience the emotional reactions that he intends his music to evoke from an audience.

8.3 Creativity: An Illusory Phenomenon?

Although it may not be intuitive, my view is that creativity, like beauty, resides mainly "in the eye of the beholder." According to this view, creativity would generally be an *observer's* reaction to the behavior or behavioral output of another person—almost an illusion, as when witnessing a magic trick. We may describe someone's behavior as "creative" when we don't understand how it achieved a remarkable result. Just as there is no color until light of a certain frequency hits a retina's color receptors, so there is no creativity until an audience is impressed by a work product.

Thompson's analysis supports the view that our perception of creativity, like our perception of "beauty," is a joint product of our priming history, our culture, and prevailing potentiating circumstances. Robinson Crusoe might have considered the technique he used for lighting a fire creative, based on his own cultural background, but his "man Friday," coming from a vastly different background, might have considered Crusoe's technique clumsy and primitive.

Summary and Conclusions

The exercise of studying the nine commentaries by **Hineline, Killeen, Malott, Mellon, Palmer, Schlinger, Shimp, Thompson, and Verhaeghen**, and of replying to them, increased my understanding of aesthetic reactions in the ways I discussed above. If I had to encapsulate in one paragraph how the commentaries changed my views, it would be that my characterization of aesthetic reactions shifted from "emotional" to "a set of Pavlovian

respondents," thereby bringing the large body of classical conditioning research to bear. An exciting ramification of this shift is the revelation of many parallels and analogies between the functions of synergetic brews and Pavlovian unconditioned stimuli. One implication of this reformulation is that reinforcers that are separated from their original biological functions, or are synthesized from scratch (as in the case of the arts), can be repurposed for new functions: for instance, they can then be used to refresh and maintain relatively complex human skills and competencies that are not sufficiently self-reinforcing to be self-maintaining and whose benefits are too delayed to perform that refreshment and maintenance function.

I also became aware that the domain of aesthetic reactions is far larger than I had realized, as it includes the consequences of various kinds of activities that have biological utility—specifically, their qualitative dimensions and potentiators—and I became more aware of the many types of respondent-laden reactions that synergetic brews elicit in addition to the aesthetic ones.

Viewing respondent-laden reactions as matrices of interrelated conditioned responses also opens new vistas for research on issues related to affect. For instance, one can then formulate experiments for the investigation of how melodies or odors can become long-term carriers of emotions, and we may discover that there exist respondent counterparts of sensory synesthesia phenomena, as when aesthetic reactions might be found to leap across sensory modalities via classical conditioning. The respondent hypothesis may also suggest ways to study the nature of such phenomena as laughing or weeping.

All nine of the commentaries and what I learned from them illustrate, once again, the validity of Eric Kandel's and Ernst Mach's advice (Mechner, 2008a, p. 236), that a discipline's frontiers are most often found at its boundaries with neighboring disciplines. The neighboring disciplines in the present case are biology, physiology, neuroscience, psychology, sociology, anthropology, philosophy, education, and, of course, the arts.

Some of the commentaries also explain how the impact of synergetic brews can reach into clinical and sociological realms, with the potential to affect the quality of daily life. It is daunting that the sets of respondents that comprise aesthetic reactions are able to bind group memberships together while simultaneously providing the spices and sweeteners that make their lives enjoyable.

For thousands of years, the philosophers of the world's major cultures have consistently assigned an exalted place to aesthetic sensibilities—a place that defines their cultures' members as civilized and human. It would be ironic if the roots of these sensibilities now proved to reside in our prehuman origins. Yet, the more deeply we delve, the clearer those biological origins become, supporting once again Theodosius Dobzhansky's oft-quoted statement that nothing in biology

¹² A related tour de force is Eric Kandel's (2012) analysis of the Viennese figure painting scene of the early 1900s, with particular focus on Klimt and Schiele.

makes sense except in the light of evolution. If it proves correct that our aesthetic sensibilities evolved via the selection of susceptibility to biological-utility–based reinforcers, then we might come to perceive in the resulting spectacular efflorescence of our nuanced affective reactions a grandeur similar to the one that Charles Darwin saw in the evolution of species via the natural selection of advantageous traits.

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