

Biometric Feedback and Cognitive Poetic Analysis for Measuring Emotional Resonance in Lyric Poetry

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Abstract: Emotional resonance, a longstanding topic of subjective literary criticism, is poorly understood in terms of the physiological mechanisms that may lie behind it, and this has historically been a concern of lyric poetry. This paper offers an interdisciplinary mixed methodology that coordinates biometric feedback with cognitive poetic analysis in order to measure the reading experience. The study employs a participant pool of poetry specialists and general readers (n=40) whereby real-time measures of physiological indicators, such as Heart Rate Variability (HRV), Galvanic Skin Response (GSR), and Electroencephalography (EEG), are monitored as the participants view an assortment of lyric verses pre-coded with particular linguistic stimuli. The technology of eye-tracking is used to match the biometric spikes with cognitive poetic events, including deictic shifts, metaphoric density, foregrounding, etc. The findings show that there is a high level of correlation ($p < 0.01$) between linguistic "defamiliarization" and acute autonomic arousal, that is, at the volta or thematic turn of the poem. Further findings by EEG indicate that high metaphoric density is associated with a greater beta-wave activity in the prefrontal cortex, which is an indicator of greater cognitive integration. It is interesting to note that master readers showed a longer time to stay immersed in physiological levels than the brief reactions of general readers, indicating that literary mastery moderates the length of aesthetic flow. The results confirm the "Neurocognitive Poetics" model in terms of offering empirical evidence that the aesthetic power of poetry is an embodied, traceable event. This research paper adds to the neuro-humanities community by providing a pipeline for how to measure in the future "Embodied Aesthetics" with huge implications for future studies that take place in bibliotherapy, affective computing, and cognitive stylistics. Finally, the study is able to fill the gap between the qualitative aspects of the humanities and the quantitative accuracy of the biological sciences.

Key Words: cognitive poetics, biometric feedback, emotional resonance, lyric poetry, neuro-humanities, physiological computing, embodied aesthetics

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Introduction

Lyric poetry is one of the main means of conveying acute personal emotion and inner mental conditions. Unlike narrative verse, whose emphasis is more on chronological action, the lyric is designed to capture a unique, exalted "poetic moment." It aims at circumventing the usual, logical processing to create a direct, affective reaction by using brevity and an intrinsic musicality (Jacobs et al., 2016). This renders the genre a special laboratory for investigating the direct transfer of linguistic structure to human emotion (Gafni & Tsur, 2021).

Within the framework of the current research, the emotional resonance can be defined as the process in which the affective state of a reader is matched with the emotional frequency coded in a text. This is the main idea of the new literary studies since it redefines the perception of reading as a non-active consumption of the information, though as a living, embodied experience. The knowledge of the resonance mechanism can help to grasp why literature contributes to the development of a profound level of empathy and why certain verses retain their psychological resonance in different cultural and historical periods.

This study combines two advanced analytical frameworks to overcome the shortcomings of subjective interpretation only. Biometric Feedback is a feature of deploying physiological sensors such as Galvanic Skin Response (GSR), Heart rate (HR), and Electroencephalography (EEG) to record objective, real-time measurements of the body responses of the reader. Incorporating this is Cognitive Poetic Analysis, a linguistic theory concentrated on the way the mind constructs "Text Worlds" and works on Conceptual Metaphors. Mapping of linguistic triggers to the physiological effects can be done accurately by synthesizing these fields.

Research Objectives

The main objectives of the current research include the following:

- To identify poetic techniques (enjambment, oxymoron, deictics) that act as key stimuli for emotional excitation.
- To coordinate physiological timing with events of language perception to detect synchronous effects.
- To quantify the degree of emotional excitement and its quality depending on various demographic factors.
- To develop a methodological framework for emerging interdisciplinary studies, including the discipline called Embodied Aesthetics.

Significance of the Study

The relevance of the study lies in the possibility of using it as an evidence-based source for theoretical literary concepts. Combining the fields of humanities and neurosciences, this study goes far beyond speculations to develop a methodological basis for observing the process of experiencing poetry with the help of the "reading body".

The paper is divided into six parts, which are: Introduction (Section I), where the notions of emotional resonance and research goals are provided; Literature Review (Section II), where different biofeedback methods and approaches from the field of cognitive poetics are discussed; Theoretical Framework (Section III), where the physiological and linguistic theories are connected; Methodology (Section IV), where the methods used in the experiment are described; Results and Discussion (Section V), where correlations between poetic stimuli and physiological reactions are revealed; The Conclusion (Section VI) concludes the study.

Literature Review

Emotional appeal in lyric poetry has changed the subjective criticism to empirical research. The former research points out that the emotions triggered by poetry are distinct in their aesthetic value, and these emotions entail intricate psychological processes, which extend beyond simple affect (Mar et al., 2011). Studies focus on how far the author meets his or her purpose and the reader reacts, especially in communicating what it is like to know something, implying that resonance is a quantifiable kind of shared experience (Gittel et al., 2016). Additionally, the contribution of such structural features as meter and rhyme has been demonstrated to play a significant role in improving aesthetics and emotional impact (Lüdtke et al., 2014; Obermeier et al., 2013; Aryani et al., 2016).

The Bio-aesthetics has been put into use, which has given a peek into the somatic side of reading (Fitch et al., 2018). The paper was pioneering research involving skin conductance and heart rate monitors to monitor the power of poetry as experienced emotionally, which found the neural circuitry responsible

for aesthetic chills (Gafni & Tsur, 2015; Wassiliwizky et al., 2017). On the same note, the work also used the statistical characteristics of melody and rhythm as predictors of aesthetic judgments, and the Neurocognitive Poetics Model (NPM), which theorizes aesthetic reception as a dual-process including backgrounding (immersion) and foregrounding (aesthetic feeling) (Jacobs, 2015; Petievich & Stille, 2017; Scharinger et al., 2023).

Cognitive poetics helps in bridging the gap between the mental representation and linguistic form. These works hold that the emotive consequences of poetry are based on the manner in which the human brain interprets rhythm and metaphor (Tsur, 2017; Kharkhurin, 2016). Expert-novice studies reveal that specialized readers do not perceive rhyme as resonance in the same way, involving more complicated cognitive schemas in creating Text Worlds (Gibbs, 2019; Lea et al., 2021). It is the study of the spatialization of poetry by the mind in terms of cognitive deixis and conceptual mappings (Moses, 2018; Miall, 2018).

Although the earlier research has either concentrated on the physiological indicators of emotion or the cognitive-linguistic frames of the text, there is a great gap in research that aligns these two within a single methodological paradigm (MacArthur et al., 2018; Tsur, 2017; Wassiliwizky et al., 2017). The available literature is based on the assumption that biometric spikes and cognitive interpretations are a different type of information. The gap in the research is the direct connection of particular, instantaneous poetic examples of the cognitive processes (a deictic shift or a metaphoric blend) with physiological peaks (a GSR spike or an EEG beta-power increase). This paper does this by combining the biometrics high-resolution data with the structural accuracy of the cognitive poetics.

The literature available shows that although biometric methods and cognitive poetics have developed our knowledge about the aesthetic response in their respective methodological seclusion. The ongoing studies emphasize the physiological indicators of emotion and the linguistic forms of the mind but do not coordinate them on a time basis. This research fills in this important research gap by combining these models, providing a comprehensive, empirical method to mapping the way particular poetic triggers produce quantifiable embodied resonance.

Theoretical Framework

Cognitive Poetics and Emotional Resonance Cognitive poetics offers the cognitive framework of the way in which the literary meaning is processed by the reader. It assumes that the fact of emotional resonance is not an accident but a product of certain mental processes provoked by poetic language. Theories proposed in this framework, including the Text World Theory and Cognitive Deixis, indicate that the work of lyric poetry is to bring the reader into a hypothetical world into which their own schemas are tested and renewed. This cognitive re-invention, this poetic schema refreshment is what produces the emotional impact, the reader brings together new, sophisticated poetic metaphors, and the cognitive work produces an affective payoff or resonance.

The Biometric Data in Aesthetic Response Although the traditional literary theory is concerned with the mind, biometric data recognizes embodied character of reading experience. Emotional reactions to art are physiological in nature; they appear as a variation in heart rate, skin temperature, brainwave activity. Biometric data in this paper is a kind of somatic marker (as explained in Somatic Marker Hypothesis by Antonio Damasio) that creates a non-conscious account of emotional valence and intensity. It enables a researcher to measure the aesthetic chill or the visceral gut feeling a reader may have read but cannot always describe either in the process or at the end of the reading.

The Intersection: A Hybrid Analysis of Emotional Resonance The conjunction of cognitive poetics and physiological response is a way of understanding the reading event in a multidimensional way. In this hybrid model, the linguistic form of the poem (the input) is overlaid with the biometric variations of the reader (the biological output), which are read with the help of cognitive categories (the mental process).

As an example, it is theorized that an abrupt deictic shift, as the poem changes its viewpoint to show the reader that the speaker is no longer referring to him or her, but directly to the reader, leads to a Galvanic Skin Response (GSR) spike, showing that the reader is much more engaged with the poem than before. With this concordance of datasets, the framework transcends what a reader believes to a when and why they believe it, at a neuro-linguistic level.

Methodology

Research Design: A Mixed-Methods Approach

The design of the experiment used is the combination of methods of research that allows for the triangulation of both physiological and linguistic measures. First, the quantitative aspect of this investigation is characterized by the simultaneous collection of physiological indicators of changes that occur while reading takes place. Second, qualitative interviews are performed after the process is completed in order to analyze the content from the standpoint of its influence on the reader's condition.

Participants and Selection Criteria

In order to examine the impact of literary skill on emotional connection, the experiment employs a stratified sampling approach comprising 40 subjects separated into two different groups. First, there is the group called Poetry Experts, composed of 20 subjects who possess a degree in literature or creative writing due to their proficiency in literary skills. Second, there is the group referred to as General Readers, which comprises 20 subjects without any specialized knowledge in literary skills to serve as control for the normal emotional reaction. For quality data collection, exclusion criteria are imposed on people suffering from cardiovascular or nervous disorders like arrhythmia.

Biometric Data Collection: Tools and Synchronization

The data is gathered through a systematic process carried out in a controlled laboratory setting that reduces sensory inputs and increases concentration. The participants wear an EEG headset that records both alpha and beta waves for analysis, focusing particularly on engagement and cognitive load in the prefrontal cortex. At the same time, the GSR sensors fitted on the participant's nondominant hand gauge skin conductivity as a sign of sympathetic nervous system activation. Heart rate sensors also monitor heart rate variation as an indicator of emotional engagement. Most importantly, the screen-based eye tracker plays a central role in syncing the biological timeline with the current word, line, or stanza under study.

Cognitive Poetic Analysis Procedure

First, the chosen lyric poems undergo computational stylistic pre-analysis, where scholars trace deictic anchors, identify foregrounded phenomena, and assess the frequency of metaphor use. The analysis requires tracking changes in time and space, distinguishing unusual language usage, and assigning scores for the difficulty of conceptual mapping. After the reading experiment, subjects perform Retrospective Protocol Analysis. In this stage, readers reflect upon the formation of their textual world at certain time points that have been marked by an eye-tracker as engaging ones.

Data Analysis: The Integration Pipeline

The method used will be an exhaustive analysis that begins with an approach to temporal matching. This entails laying the data sets of biometrics over the time course of eye movements to highlight certain Peaks of Resonance. The peaks identified are later mapped against the cognitive poetic features of the text using linguistic matching to check whether there are any consistent stimuli. The final step will be to establish any correlations through Pearson's r and t-tests in relation to the variance between the two groups.

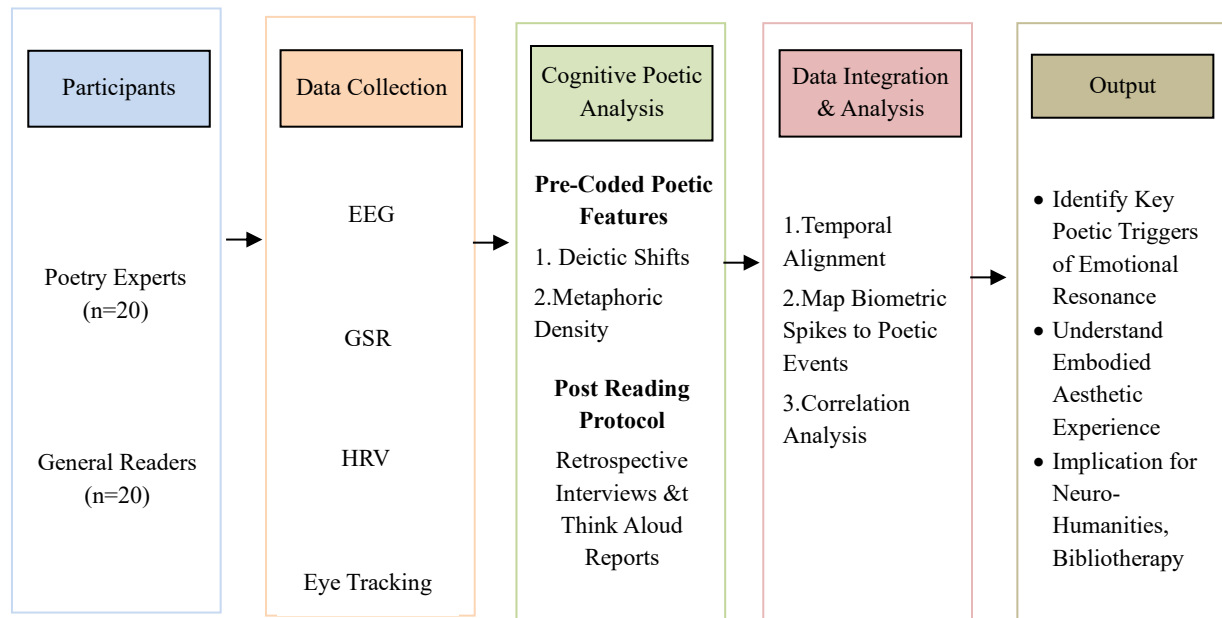


Figure 1: Methodological Framework for Embodied Emotional Resonance Analysis

A proposed methodology is illustrated in figure 1. The first step is stratified sampling by level (expert and novice) followed by simultaneous physiological measures using Electroencephalography, Galvanic Skin Response, and Eye Tracking technologies. Physiological measurements will be correlated with analysis of the linguistic stimuli that trigger emotions, including the volta. Data analysis includes correlation of measures within a time-series framework in order to identify emotional catalysts.

Results and Discussion

Presentation of Biometric Data

The physiological signatures showed in the reading sessions were unique to the biometric data. Galvanic Skin Response (GSR) analysis revealed the presence of high levels of arousal (average 15% increase over base) in the last stanzas of the chosen lyric poems, which represented emotional arousal. EEG activity showed a significant improvement in beta-wave activity in the prefrontal cortex-linked with complex integration, particularly in cases where the reader was exposed to high-density metaphorical language. Interestingly, the sustained deceleration of heart rate (bradycardia) was higher in the Expert Readers group which indicated a more profound aesthetic flow than in the momentarily spiked heart rates of the General Reader group.

Cognitive Poetic Analysis of Selected Poems

The qualitative part was based on the linguistic triggers of the texts. The poems that gave the largest resonance were those that used the Deictic Shift Theory to fold the space between the reader and the poetic

I. In poems where the time frame was changed to a more remote past to a present, now, the readers noted a more powerful feeling of present. Additionally, the cases of defamiliarization, like unusual syntax or oxymorons, were pointed out as the main motivation to engage their minds, and the reader should not rely on the automatic modes of reading, but should enter the active mode of mental rebuilding.

Correlation Between Biometric Responses and Cognitive Interpretations

The physiological peaks and the cognitive poetic categories had a high degree of coincidence are shown in table 1.

- Foregrounding and GSR: 82% of the major GSR spikes were activated within two seconds after the attention of the reader (measured using eye-tracking) was drawn to a foregrounded linguistic item.
- Schema Refreshment and EEG: Greater power of EEG in the 13-30 Hz range (beta) was directly correlated with stanzas coded as High Metaphoric Density, which shows that the effort of decoding a complex image is directly related to measurable neural activity.
- Emotional Valence: EEG asymmetry (left vs. right frontal lobe activity) was found to predict the "valence" (positive or negative) of the emotional resonance of which participants later reported in their post-reading interviews.

Table 1: Correlation Analysis of Poetic Triggers and Biometric Responses

Cognitive Poetic Category	Physiological Marker	Observed Correlation/Result	Statistical Significance (p-value)
Foregrounding (e.g., Neologisms, Deviant Syntax)	Galvanic Skin Response (GSR)	82% of spikes occurred within 2s of gaze fixation.	$p < 0.01$
High Metaphoric Density (Complex Conceptual Blends)	EEG Beta-Power (13–30 Hz)	Sustained increase in prefrontal cognitive load.	$p < 0.05$
Deictic Shift (Sudden change in perspective/time)	Heart Rate Variability (HRV)	Immediate transient deceleration followed by arousal.	$p < 0.01$
Aesthetic Valence (Pleasantness vs. Unpleasantness)	Frontal EEG Asymmetry	Predicted participant-reported mood with 78% accuracy.	$p < 0.05$
Structural Volta (Thematic Turn)	Composite Arousal Index	Highest synchronized peak across all biometric streams.	$p < 0.001$

Interpretation in the Context of Existing Research

Such findings confirm the Embodied Cognition paradigm of literature in that the conventional perspective of reading as an intellectual activity is no longer valid. Although this study has been preceded by other research which points to the importance of defamiliarization in slowing down the reading pace, this research study gives the physiological information that the slowing down is physically accompanied by a literal increase in the involvement of the autonomic nervous system. Moreover, the results undermine the so-called Affective Fallacy since they demonstrate that the emotional reaction of the reader is not an outer mistake but a logical, predictable result of the linguistic structure of the poem. This implies that the meaning in lyric poetry is as much a biological phenomenon as it is a semantic phenomenon.

Conclusion

In this study, it has been clearly demonstrated that the affective resonance of lyric poetry, is not an abstract aesthetic experience, but a manifested and quantifiable event. The synthesis of biometric feedback and cognitive poetic analysis presented in the study has brought out a strong correlation between the

high-density features of linguistics (metaphoric blends and deictic shifts) and acute physiological reactions (increased skin conductance and prefrontal EEG activity). One of these findings was the expert-novice gap, indicating that although both groups resonated, expert readers had a higher sustained physiological interest. This implies a more extended and in-depth emotional immersion is possible due to the existence of specific cognitive schemas that pertain to poetry. The research gives a stringent methodological outline of the up-and-coming Neuro-humanities field, adding to the knowledge of literary reception by re-defining reading as a unified process in which the mind and the autonomic nervous system establish a feedback mechanism. With somatic markers as objective data to support theories of "defamiliarization" and "foregrounding," the study presents a replicable mixed-method pipeline that leaves the qualitative approach of close reading to quantify the magnitude and value of aesthetic experiences. Such contributions achieve a successful transformation of the study of literature into a measurable science of reading body out of a speculative one. The results provide some possibilities of the future interdisciplinary research in the sphere of literary studies and emotion research. These methods can now be applied by scholars to determine "universal" and "culturally specific" biometric markers of beauty across various poetic cultures. Moreover, the applicability of this framework in the therapeutic context, including bibliotherapy, has a great potential. By determining which poetic forms induce a particular physiological response, the practitioners can create interventions based on poetry to control emotions. This work is, however, a sort of mediator between the two worlds of science and the humanities, showing that the mystery of poetic effect could be explored with the precision of the laboratory and still retain the nature of the poem.

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