


Article

NeuroDante: Poetry Mentally Engages More Experts but Moves More Non-Experts, and for Both the Cerebral Approach Tendency Goes Hand in Hand with the Cerebral Effort

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Abstract: Neuroaesthetics, the science studying the biological underpinnings of aesthetic experience, recently extended its area of investigation to literary art; this was the humus where neurocognitive poetics blossomed. Divina Commedia represents one of the most important, famous and studied poems worldwide. Poetry stimuli are characterized by elements (meter and rhyme) promoting the processing fluency, a core aspect of neuroaesthetics theories. In addition, given the evidence of different neurophysiological reactions between experts and non-experts in response to artistic stimuli, the aim of the present study was to investigate, in poetry, a different neurophysiological cognitive and emotional reaction between Literature (L) and Non-Literature (NL) students. A further aim was to investigate whether neurophysiological underpinnings would support explanation of behavioral data. Investigation methods employed: self-report assessments (recognition, appreciation, content recall) and neurophysiological indexes (approach/withdrawal (AW), cerebral effort (CE) and galvanic skin response (GSR)). The main behavioral results, according to fluency theories in aesthetics, suggested in the NL but not in the L group that the appreciation/liking went hand in hand with the self-declared recognition and with the content recall. The main neurophysiological results were: (i) higher galvanic skin response in NL, whilst higher CE values in L; (ii) a positive correlation between AW and CE indexes in both groups. The present results extended previous evidence relative to figurative art also to auditory poetry stimuli, suggesting an emotional attenuation “expertise-specific” showed by experts, but increased cognitive processing in response to the stimuli.

Keywords: EEG; alpha; theta; frontal theta; frontal alpha asymmetry; skin conductance response; neuroaesthetics; neurocognitive poetics; time; Divina Commedia

1. Introduction

Neuroaesthetics is a growing field of research investigating the neurobiological correlations of the aesthetic experience [1,2]. Such an area of investigation is more classically focused on figurative arts, but it has been widening its areas of interest to text material, as witnessed by the *neurocognitive poetics*, which saw its dawn around 10 years ago and is defined as “the transdisciplinary empirical investigation of and theorizing about (poetic) literature reception by eye or ear including its neuronal underpinnings” [3]. The rationality and validity of such an area of investigation are clearly summarized into the sentence

expressed some years earlier by Turner and Pöppel [4]: “Poetry presents to the brain a system which is temporally and rhythmically hierarchical, as well as linguistically so, and therefore matched to the hierarchical organization of the brain itself”. A core element of the neurocognitive poetic model [3] is the *fiction feeling hypothesis*. Such hypothesis was born from the evidence that the medial and bilateral orbitofrontal cortex activation (OFC), known to be involved in social cognition, was engaged when processing stories with an emotional content, stories that would then elicit affective and cognitive empathy in the reader [5]. In addition, the medial part of the OFC has been found to be active during the exposure to both audio and visual beautiful stimuli [6]. However, higher-level cognitive processes, such as comprehension and reasoning, that are crucial for texts processing, are related to the prefrontal cortex activity (for a review [7]); therefore, in the present study, the entire prefrontal area was considered, not limiting the investigation to its most anterior part, that is the OFC. Moreover, in addition to studies focusing on subcortical regions’ (amygdala and insula) activation in correspondence with emotional engagement in response to words [8,9], in a study investigating the effect of the emotional valence on words processing, an activation of the bilateral inferior frontal gyrus in response to emotional words was found, and, in the superior frontal gyrus, is already known to support semantic retrieval, in response to positive words, therefore suggesting an association between familiarity and positive feelings for verbal material [10]. In fact, recently, researchers have started to measure cerebral and emotional activities, manipulating some factors that could alter or increase pleasure in the story perception [11,12]. In particular, an increase in liking and rhythmicity rating for metered and rhyming stanzas was found, which, from a neurophysiological point of observation, elicited smaller event-related potential (ERP) responses (N400/P600) in comparison to nonmetered, nonrhyming, or nonmetered and nonrhyming counterparts [12]. Such results are in accord with the *cognitive fluency theory* [13], predicting that higher perceptual fluency and, consequently, a higher aesthetic appreciation, would be produced by recurring patterns, such as meter.

In addition to ERP, an electroencephalographic EEG cerebral index of approach or withdrawal (AW) motivation toward a stimulus, suggesting an appreciation or avoidance toward it is based on the relative alpha asymmetry in the frontal area [14,15]. According to the AW model, a relative power suppression of the alpha rhythm across the left frontal cortex is associated with a propensity to approach a stimulus, while the relative power suppression of the alpha rhythm across the right frontal cortex is associated with a propensity to withdraw from a stimulus [16]. The AW index has been already applied to several kinds of audio–visual material, such as musicals [17,18], public service announcements [19–23], foreign products [24], commercials [25–30] and, importantly, neuroaesthetics, in response to the observation of: the real sculpture of Michelangelo’s Moses, XVII century Dutch painters and Titian masterpieces [31–33]. Concerning literature, it was applied to the study of the reaction to the reading of a novel [34]. Moreover, it was already employed in a preliminary investigation concerning the same poetic excerpts adopted in the present study, evidencing higher approach tendency in experts than in non-experts on Classical Literature [35]. The expertise on a certain topic has been identified as a key factor for the execution and the reaction to several kinds of stimuli, reflected not only by behavioral outcomes but also by neurophysiological parameter correlations. This was found in air traffic controllers for frontal and parietal theta synchronization and frontal alpha desynchronization [36,37], in wine sommeliers for frontal alpha asymmetry and brain activity estimated by fMRI [38,39], in pilots and Air Traffic Management for frontal theta and parietal alpha [40], in professional shooters for midline frontal theta [41], in dancers for alpha power desynchronization distributed over the scalp [42], in dancers for theta and gamma synchrony [43], in musicians for alpha and beta synchrony [43], and in art experts for approximate entropy [44]. Concerning the last application, that is the investigation of neural correlations elicited in experts and non-experts in response to artworks, only a few studies have been conducted till now (see below), despite several pieces of evidence being

reported that employ behavioral approaches such as ratings of liking and understanding of visual art [45–48] (Table 1).

On the contrary, scientific literature presents a plethora of studies investigating the brain activity in response to music listening in expert and non-expert musicians [49–53].

Table 1. The table summarizes mentioned cerebral processes and relative brain areas (see the main text for further details).

Cerebral Process	Brain Area	Reference
Involvement in the processing of stories with an emotional content	Medial and bilateral Orbitofrontal Cortex	[5]
Involvement in the processing of audio and visual beautiful stimuli	Medial Orbitofrontal Cortex	[6]
Higher level cognitive processing (e.g. comprehension and reasoning)	Prefrontal Cortex	[7]
Involvement in emotional words processing	Inferior Frontal Gyrus	[10]
Semantic retrieval; involvement in positive words processing	Superior frontal gyrus	[10]
Relative EEG alpha asymmetry (approach-withdrawal tendency)	Prefrontal Cortex	[14–35]
EEG correlates of expertise in response to specific stimuli and task execution (theta synchronization and or alpha desynchronization)	Frontal area	[36,37,40,41,54]
EEG correlates of expertise in response to specific stimuli and task execution (alpha synchronization)	Parietal area	[40,54]
EEG correlates of expertise in response to specific stimuli and task execution (alpha desynchronization)	Distribution over the scalp	[42]
EEG correlates of expertise in response to specific stimuli and task execution (theta and gamma synchronization) in dancers	Distribution over the scalp	[43]
EEG correlates of expertise in response to specific stimuli and task execution (alpha and beta synchronization) in musicians	Distribution over the scalp	[43]

In addition to EEG indexes, the suitability of autonomic indexes for the study of emotional response is well-known [55]. Several studies and models support the notion that emotions play an important role in making aesthetic judgments [56,57]; therefore, since the involvement of arousal alteration is present in all kinds of emotional reaction [58], in the present study it has been focused on such dimension in relation to neurophysiological autonomic indexes. Several studies evidenced that, among them, the galvanic skin response (GSR) is strictly related to the rated arousal of emotional stimuli (e.g., [59–61]). Arousal represents one of the two dimensions of emotions, together with valence [62], and as GSR variations, it has already been employed in the study of emotion applied to different fields such as products and advertisement [20,22,24,27], music [63] and, obviously, art [31].

To the scope of the present study, it is possible to consider the poetry made up by the sum of musical properties (constituted by the meter and the rhythm) and of a narrative content, while the relative paraphrase is constituted by the sole content. Given that we subtracted the brain activity estimated in relation to the poetry being listened to by the

brain activity estimated in relation to paraphrase listening, and then divided by the sum of both the activities Equation (3), the result would provide positive values whether the higher relative activity occurred during poetry listening, and negative results whether the higher relative activity occurred during paraphrase listening. Employing such index, the investigation will be performed regarding different neurophysiological patterns in experts and non-experts in relation to the eventual modulation of the cognitive and emotional response to poetry or paraphrase stimuli.

The famous Italian XIV century poem the “Divina Commedia” by Dante Alighieri (1265–1321) is characterized by a repetitive and constant structure, as it is composed by three parts (cantiche: Inferno—Hell; Purgatorio—Purgatory; Paradiso—Paradise), each part is composed by thirty-three cantos, for an average length of 142 verses. The verse scheme used, “terza rima”, is hendecasyllabic (lines of eleven syllables), with the lines composing tercets relying on the rhyme scheme *xyx yzy z*. Each cantica takes place in a different environment, as suggested by their titles, so the reader follows Dante’s journey through Hell, Purgatory and Paradise, where the poet, respectively, meets damned souls, then souls expiating their sins and finally enjoys the vision of God. Studying the comparison among different cantica would enable one to assess the effect of a potentially differential previous knowledge of the peculiar cantica. Furthermore, the reaction to the exposure to stanzas belonging to each of the three cantiche would enable one to test the effect of the content of the excerpts, maintaining the meter and the rhyme scheme constant.

Experimental Objectives:

- Poetry stimuli are characterized by elements (meter and rhyme) promoting the processing fluency, a core aspect of neuroaesthetics theories. In addition, given the evidence of a different neurophysiological reaction between experts and non-experts in response to artistic stimuli, in light of the possible generalizability of neuroaesthetic concepts [64], the aim of the present study was to investigate in the literature art, and specifically in poetry, eventual differences in the neurophysiological cognitive and emotional reaction between the Literature (L) and Non-Literature (NL) students groups enrolled in the study.
- Since traditional approaches employ declarative behavioral data, such as appreciation or comprehension rating [45–48], and it has been proved that self-report data could be affected by many confounding factors [65–67], a further aim of the present study was to investigate whether neurophysiological underpinnings could support explanation of behavioral data.

2. Materials and Methods

In the present study, 47 healthy participants (23 Literature students; 12 females, 11 males; mean age 25.391 ± 4.408 , and 24 Non-Literature students; 12 females, 12 males; mean age 26.667 ± 2.316 years old) have been enrolled on a voluntary base; they have not received any compensation from taking part in the research. Participants were university students at Sapienza University of Rome, Literature (L) students attending humanistic courses and the second half scientific courses. All participants were given detailed information on the study and signed an informed consent. The experiment was performed in accord with the principles outlined in the Declaration of Helsinki of 1975, as revised in 2000, and it was approved by the university’s ethical committee.

The project identification code was RM11916B5ADDCB0B, as assigned by the University of Rome Sapienza on 21 April 2016.

Participants were sitting on a comfortable chair and instructed to listen to the auditory stimuli that were delivered through earphones at approximately 65 dB SPL [68–70], operating slight changes in order to fit each participant with a level of comfortable intensity. The stimuli were constituted by three excerpts from the reading of Dante Alighieri’s Divina Commedia (see Appendix A) and the corresponding paraphrase. The three selected emblematic pieces have been chosen by experts in Italian literature (academic professors and researchers) and each belonged to one of the three cantiche of the poem: canto V from

Inferno (Hell), canto XXX from Purgatorio (Purgatory) and canto XXXIII from Paradiso (Paradise), respectively. All the texts were read by an Italian professional actor to ensure the quality of the elocution. The mean duration of the read pieces was 189.833 ± 18.999 s and they were pseudo-randomly played, producing different trains of auditory stimuli in order to balance among participants the order of presentation of the three cantiche. The train was preceded and followed by sentences in Italian language that belong to a standardized set of sentences used normally for audiometric purposes in clinics [71]. Such sequence of short phrases lasted 1 minute of total length and has been used as the baseline in this experimental setup. The employed experimental protocol resembles one adopted in a previous pilot study [35] that employed almost the same neurometric indexes used in the present study: the Approach-Withdrawal index (AW) [19,20,25], the Cerebral Effort index (CE) [70,72,73] and the Emotional Index (EI) [19,20,26]. In the present study, we maintained AW and CE indexes, while, in contrast to the Emotional Index, that is a combination of the study of the heart rate and the galvanic skin response based on Russell's circumplex model of affects [62,74], we used the GSR, as index of emotional arousal [55].

The EEG activity was recorded using a 10-electrodes-based EEG frontal band (Fpz, Fp1, Fp2, AFz, AF3, AF4, AF5, AF6, AF7, AF8) by means of a portable 24-channel system (BEmicro, EBneuro, Italy). The signals were acquired at a sampling rate of 256 Hz and the impedances were kept below 10 k Ω . In order to reject the main current interference, a notch filter (50 Hz) was applied, and then the gathered signal was digitally band-pass filtered by a 5th order Butterworth filter ($2 \div 30$ Hz), in order to reject the continuous component, as well as high-frequency interferences, such as muscular artifacts. Successively, in order to identify and remove other artifact-related components, such as blinks and eye movements, an independent component analysis (ICA) was applied to EEG data [75]. Furthermore, in order to take into account any subjective differences in terms of brain rhythms, for each subject the individual alpha frequency (IAF) was computed on the 60-second-long closed eyes segment [76], recorded at the beginning of the experimental task, in order to define the EEG bands of interest as: theta (IAF $- 6 \div$ IAF $- 2$ Hz) and alpha (IAF $- 2 \div$ IAF $+ 2$ Hz) [72]. Moreover, the global field power (GFP) [77] was calculated, so as to summarize the activity of the cortical areas of interest in a specific frequency band. Specifically, in the present study, the GFP was computed from a specific set of electrodes for each index, by performing the sum of squared values of EEG potential at each electrode, averaged for the number of involved electrodes, resulting in a time-varying waveform related to the increase or decrease in the global power in the analyzed EEG. The GFP was defined according to Formula (1):

$$GFP_{\vartheta, Frontal}(t) = \frac{1}{N} \sum_{i=1}^N x_{i,\vartheta}(t)^2, \quad (1)$$

where ϑ is the considered EEG band, *Frontal* is the considered cortical area, N is the number of electrodes included in the area of interest, and i is the electrodes' index. In addition, the GFP function was averaged on 1-second-long signal windows, so to comply with the EEG signal stationarity hypothesis [78].

In particular, for the AW index calculation, Formula (2) was employed [73]:

$$AW = GFP_{\alpha_right} - GFP_{\alpha_left}, \quad (2)$$

where the GFP_{α_right} and GFP_{α_left} stand for the GFP calculated among right (Fp2, AF4, AF6, AF8) and left (Fp1, AF3, AF5, AF7) electrodes, respectively, in the alpha (α) band. Positive AW values stand for a participant's approach tendency, while negative AW values for a withdrawal tendency in relation to the stimulus.

Concerning the CE index, GFP in the theta band over all the frontal electrodes (Fpz, AFz, Fp2, AF4, AF6, AF8, AF7, AF3, Fp1, AF5) was considered for the index computation. Increased frontal theta (that is CE) values would imply an increase in the task difficulty [79].

Concerning the GSR, the electrodermal activity was recorded by means of a NeXus-10 (Mindmedia, The Netherlands) system with a sampling rate of 128 Hz and the skin conductance acquired by the constant voltage method (0.5 V). The electrodes were attached,

on the non-dominant hand, to the palmar side of the middle phalanges of the second and third fingers of the participant, following published procedures [80]. The tonic component of the skin conductance level was obtained using LEDA software [81].

In order to assess the influence exerted by the rhythm and the meter and the specific words composition of each excerpts, overcoming an eventual modulation of the participants' response exerted by the content, GFP and GSR (Index) data were standardized according to Formula (3) for each cantica excerpt:

$$\text{Index}_{\text{Rel Poet}} = (\text{Index}_{\text{Poetry}} - \text{Index}_{\text{Paraphrase}}) \div (\text{ABS}(\text{Index}_{\text{Poetry}}) + \text{ABS}(\text{Index}_{\text{Paraphrase}})), \quad (3)$$

where $\text{Index}_{\text{Rel Poet}}$ stands for GFP or GSR data corresponding to the listening to the poetry version of the cantica excerpts ($\text{Index}_{\text{Poetry}}$) relative to the GFP or GSR data corresponding to the listening to the paraphrase version of them ($\text{Index}_{\text{Paraphrase}}$). ABS stands for absolute values of the $\text{Index}_{\text{Poetry}}$ and $\text{Index}_{\text{Paraphrase}}$. Positive $\text{Index}_{\text{Rel Poet}}$ values stand for higher responses to poetry than to paraphrase, while negative $\text{Index}_{\text{Rel Poet}}$ values stand for higher responses to paraphrase than to poetry.

At the end of the listening session, participants were asked to fill in a short-written questionnaire, investigating whether they recognized and appreciated the audio pieces (yes/no) and to say what they have heard (free written description). The written descriptions of each participant for each of the cantiche were analyzed by authors with specific experience in literature in order to categorize participants in remembering and not remembering the pieces. These behavioral data were collected and analyzed.

Data from all indexes were converted in Z-scores employing mean and standard deviation of the baseline sentences. Statistical analysis was performed through Fisher's exact test on behavioral data, comparing the two groups (L and NL) for each of the variable: content recall, appreciation, self-declared recognition. ANOVA test was performed for each of the neurophysiological variables (AW, CE, GSR) recorded in relation to listening to poetry pieces and considering the factors: GROUP (2 levels: L, NL), CANTICA (3 levels: Inferno, Paradiso, Purgatorio), TIME POINT (3 levels: First 10 s, Central 10 s, Final 10 s) or HALF (2 levels: First half, Second half). Correlation analyses were performed between pairs of indexes (AW, CE, GSR) for data calculating the relative activity in response to poetry, obtained through Equation (3). Logistic regression analyses were performed on data from the three considered neurophysiological indexes (AW, CE, GSR) recorded in relation to listening to poetry pieces, and employing the variable GROUP as categorical factor.

3. Results

Given the evidences that time is a crucial point for highlighting a differential response between experts and non-experts, a multiple approach to the collected data has been conducted. In particular, Leder and colleagues reported that, considering a 10 s exposure to visual art, experts reported higher declared understanding in comparison to non-experts [46]; therefore, such time point has been considered in Section 3.1, but extending the analysis to the first, central and last 10 s of the exposure to the poetry stimuli. In addition, since Codispoti and colleagues [61] found differences when considering the first and second half of the reaction to emotional videos, in the present study, the same approach has been applied to poetry stimuli and is reported in Section 3.2. Furthermore, we also analyzed the neurophysiological reaction to the entire stimuli, in order to test whether the length of the poetry stimuli would influence the perception by experts and non-experts; such results are reported in Section 3.3. Finally, we investigated the eventual difference between experts and non-experts concerning the relative higher activity in response to poetry or paraphrase; the results have been reported in Section 3.4.

3.1. Analysis of the First, Central and Final 10 s of the Stimuli

Considering the listening to the Paradiso, a significantly higher GSR level for NL in comparison to L students during the first 10 s ($\text{Chi}^2 = 4.80, p = 0.03$) was shown. On the contrary, for the same time period, the NL group showed lower CE values than the L group

($\text{Chi}^2 = 4.24, p = 0.04$). Any difference was found by the logistic regression analysis between the groups for the other cantiche and temporal segments and for any other index.

Concerning the GSR index (Figure 1), ANOVA analysis showed a significant interaction among the variables $\text{CANTICA} \times \text{TIMEPOINT} \times \text{GROUP}$ ($F(4,104) = 2.80$, partial eta-squared = 0.10, $p = 0.03$). In particular, the post-hoc analysis evidenced significant differences within each group. In fact, despite Paradiso eliciting significantly higher (at least $p < 0.05$ for all the pairwise comparisons) GSR values for both groups, in comparison to the other cantiche at all the investigated time points (first, central and final 10 s), only for the NL group did the first 10 s elicit higher GSR values in comparison to the central and final 10 s temporal segments (Paradiso first 10 s vs. Paradiso central 10 s $p < 0.01$ and Paradiso first 10 s vs. Paradiso last 10 s $p < 0.001$).

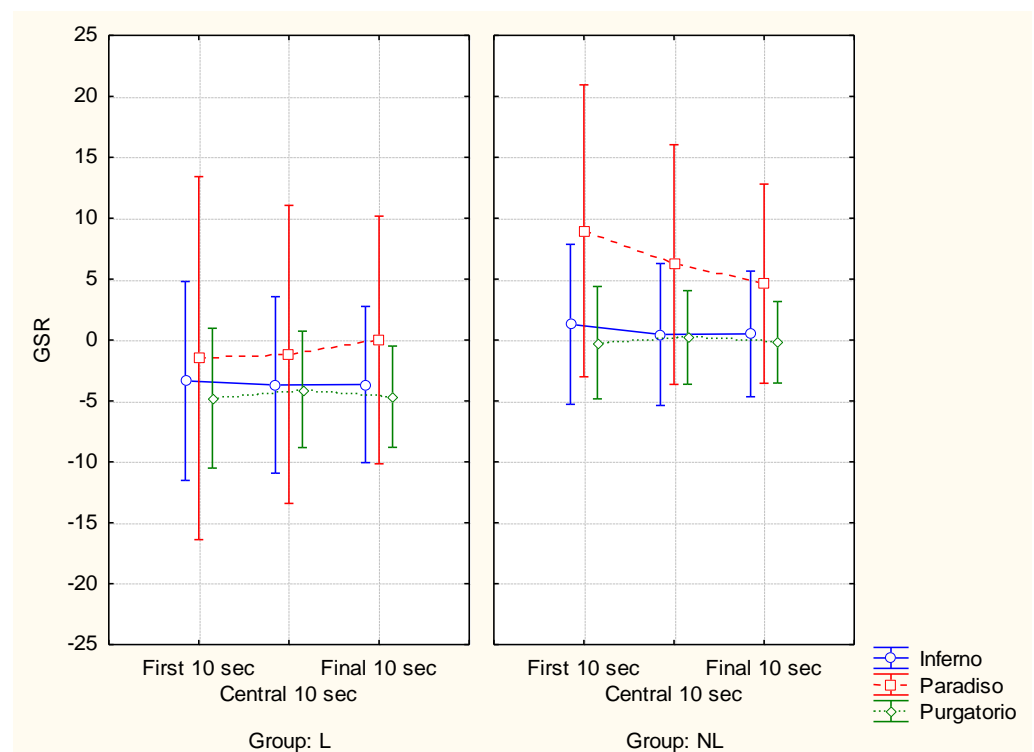


Figure 1. Graph representing the significant interaction between the factors: CANTICA (Inferno, Paradiso and Purgatorio), TIME POINT (first, central and final 10 s segments) and GROUP (L: Literature students; NL: Non-Literature students) resulting from the ANOVA analysis for the Galvanic Skin Response (GSR) index. Vertical bars denote 0.95 confidence interval.

3.2. Analysis of the First and Second Half of the Stimuli

Concerning the GSR analysis (Figure 2), the ANOVA test showed a significant interaction among the factors $\text{CANTICA} \times \text{HALF} \times \text{GROUP}$ ($F(2,84) = 4.80$, partial eta-squared = 0.10, $p = 0.01$). The post-hoc analysis showed that, for the NL group, Paradiso (both first and second half) reported significantly higher GSR values in comparison to all the other cantica segments ($p < 0.05$ for all), while for the L group, Inferno (both first and second half) showed significantly higher GSR values in comparison to all the other cantica segments ($p < 0.05$ for all), except for the second half of the Inferno in comparison to the second half of Paradiso ($p = 0.09$).

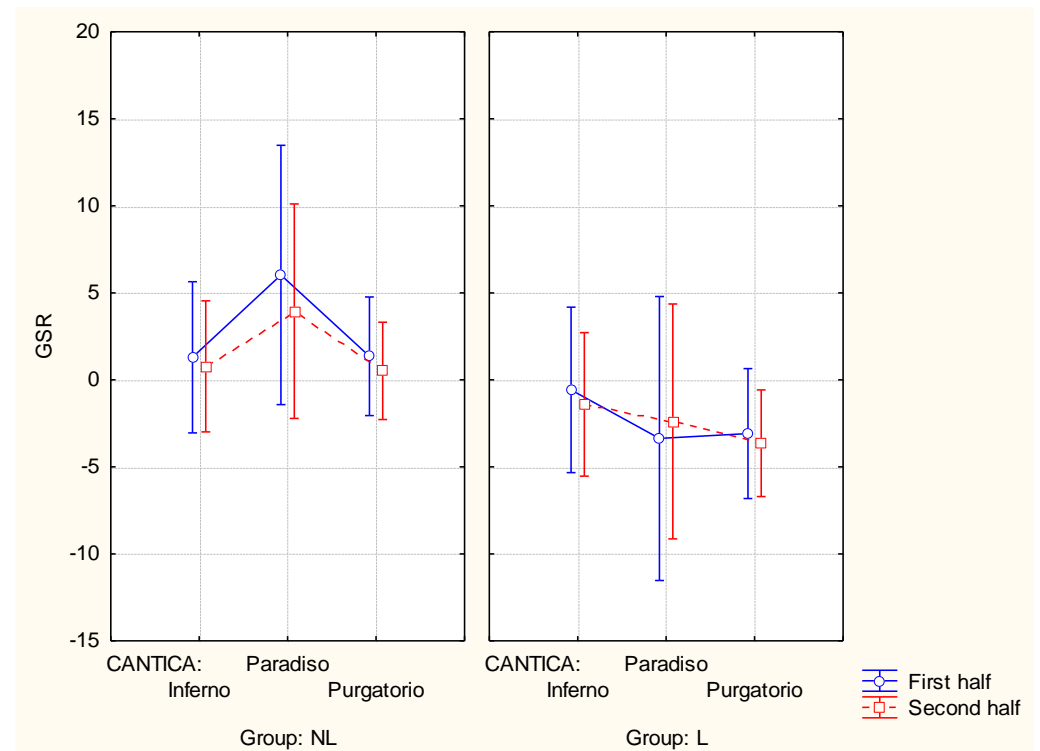


Figure 2. Graph representing the significant interaction between the factors: CANTICA (Inferno, Paradiso and Purgatorio), HALF (first and second half segments) and GROUP (L: Literature students; NL: Non-Literature students) resulting from the ANOVA analysis for the GSR index. Vertical bars denote 0.95 confidence interval.

3.3. Analysis of the Activity Elicited during the Listening to the Entire Cantica

Concerning the emotional reaction to the entire cantica, as suggested by the arousal level indexed by the GSR, we found a higher reaction by NL in comparison to L students for the Inferno ($\text{Chi}^2 = 5.47, p = 0.02$) and values just missing the significance for the Purgatorio ($\text{Chi}^2 = 3.34, p = 0.07$). On the contrary, the CE in response to the listening to the just mentioned cantica elicited lower CE levels in NL in comparison to L students: Inferno ($\text{Chi}^2 = 3.38, p = 0.07$) and Purgatorio ($\text{Chi}^2 = 6.71, p = 0.01$).

3.4. Analysis of the Relative Activity Elicited by Poetry and by the Paraphrase

Concerning the relative indexes activity in response to poetry or paraphrase versions of the cantiche Equation (3), it has been evidenced that, in comparison to the L group, the NL group showed higher relative activity in response to the poetry version of the Inferno for the GSR index ($\text{Chi}^2 = 8.92, p < 0.01$) and of the Paradiso for the CE index ($\text{Chi}^2 = 6.33, p = 0.01$).

The correlation analysis between the indexes for each cantica reported for the L group a significant positive correlation between AW and GSR for the Inferno ($r = 0.48, p = 0.03$). Furthermore, for both L and NL group, we found a significant positive correlation between AW and WL values for all the cantiche (Inferno—L: $r = 0.67, p = 0.001$, NL: $r = 0.65, p = 0.001$; Paradiso—L: $r = 0.63, p < 0.01$, NL: $r = 0.83, p > 0.0001$; Purgatorio—L: $r = 0.73, p < 0.0001$, NL: $r = 0.70, p < 0.0001$).

3.5. Behavioral Outcomes

Statistical analysis showed a different frequency distribution of the content recall between the two groups, higher for L group in comparison to the NL group for Inferno and Paradiso (Fisher's exact test $p = 0.049$ and $p < 0.001$, respectively) (Figure 3 top). Moreover, concerning the appreciation of the cantica, the L group showed higher rates of participants who appreciated the cantica in comparison to NL group for Paradiso and

Purgatorio (Fisher's exact test $p = 0.02$ and $p = 0.03$, respectively) (Figure 3 center). Finally, concerning the self-declared recognition of the cantica, L students in comparison to NL students reported a larger number of participants who recognized Paradiso (Fisher's exact test $p = 0.02$) (Figure 3 bottom).

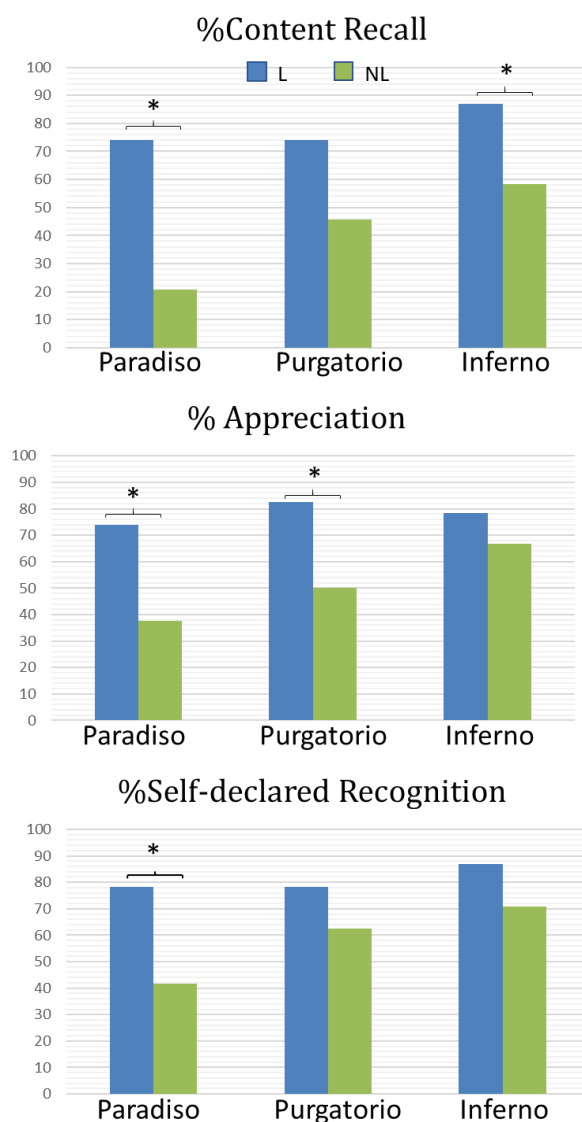


Figure 3. Graph representing the significant differences between the GROUPS (L: Literature students; NL: Non-Literature students) resulting from the Fisher's exact test performed on behavioral data. Asterisks denote a statistical significance equal or lower than $* p = 0.05$.

4. Discussion

By looking at behavioral data, there is a very immediate suggestion that in NL students, therefore non-experts, knowledge makes them happier. In other words, in the NL but not in the L group, the appreciation/liking went hand by hand with the self-declared recognition and with the content recall, which can be considered a form of understanding and knowledge. This is in accordance with fluency theories in aesthetics, predicting higher liking linked to higher successful recognition of the stimulus and to the owning of the knowledge needed for the interpretation of the stimulus; in other words, when less effortful heuristic strategies are employed then positive affective states are elicited [82]. In fact, in the present study, the highest appreciation, self-declared recognition and content recall percentages were obtained in non-experts by Inferno stanzas, that represent the most well-known and studied verses of Divina Commedia by Italian high school students. However,

for the L group, other aspects possibly explaining a less clear behavioral pattern could intervene, further investigated by the neurophysiological approach.

Main neurophysiological results of the present study were: (i) an inverse pattern for GSR and CE indexes, with an opposite trend in the two groups; (ii) a positive correlation between AW and CE.

Concerning the first point, in comparison to the L group, the NL group showed higher emotional reaction in terms of arousal, as indexed by the GSR activity, in response to the first 10 s of Paradiso and the entire length of Inferno and Purgatorio. Such results are in accord with previous electromyography data, concerning the emotional reaction indexed by the decreased contraction of the *corrugator supercilii* in art experts in comparison to non-experts when exposed to artworks but also to the International Affective Picture System (IAPS) pictures, suggesting that art experts would in general process visual stimuli differently from non-experts [83]. The present results extend such evidence also to auditory poetry stimuli, suggesting that the emotional attenuation showed by experts could be specific to the area of expertise. This observation appears aligned to the concept of the need for the testing of effects found for the visual domain with other sensory domains, in order to proceed toward a unifying model of neuroaesthetics [64]. An alternative interpretation for higher GSR values reported in NL in comparison to the L group could be found if considering the GSR as an index of listening effort [84,85], therefore suggesting that the NL group would experience higher cognitive effort in comparison to the expert group when listening to the investigated stimuli. However, further studies are needed in order to elucidate a clear role for GSR as index of listening effort, disentangling it from its possible involvement in attentional mechanisms and as influenced by emotional aspects [84,86–88]. It is interesting to note that the same temporal segments reported an opposite result when analyzing the CE index, therefore, showing lower CE values in NL in comparison to L students. Vice versa, the L group reported lower GSR levels and higher CE values in comparison to the same temporal segments. Such results support the occurrence of the separation between liking/appreciation and emotional arousal, already described in the theory of emotions, describing those as composed by valence and arousal [62]. Present results are also in accord with the distinction between aesthetic emotion and aesthetic judgments, outlined as outputs of the information-processing stage model of aesthetic processing proposed by Leder and colleagues [89]. Specifically, L students appear to be less moved by poetry, but more appreciative of it, as witnessed by the higher declared appreciation of the cantica by L students in comparison to NL students, except for the Inferno, which is a very famous episode of Divina Commedia, well-known and appreciated also by non-experts, since describing the love story between two lovers (Paolo and Francesca), that as well as Lancelot and Guinevere, were experiencing a forbidden love. However, it is interesting to note that, for that episode, only in the L group, a positive correlation between GSR and AW values that considered the relative activity in response to poetry was found, suggesting an unconscious cerebral appreciation as well as arousal elicitation identifiable in experts but not in non-experts, according to the notion that appreciation of art by experts involves “cognitive mastery” [89]. Furthermore, concerning the temporal segments in which an opposite tendency between experts and non-experts was evidenced, that is the first 10 s for Paradiso and the entire length of the stimuli for Inferno and Purgatorio, it could be related to the content of the different cantica. In particular, the episode taken from Paradiso was very descriptive of the environment, while Dante was proceeding toward God’s vision, while the ones taken from Inferno and Purgatorio were focused on more narrative episodes, that were the Paolo and Francesca love story and the reprimand of Dante by Beatrice, respectively. This peculiar characteristic could account for the discrepancy in time points needed for highlighting differences between experts and non-experts, in fact according to the Vienna Integrated Model of Art Perception (VIMAP), that insists on the necessity of integrating bottom-up artwork-induced processes, with top-down mechanisms occurring within the processing experience, leading to changes in persons (e.g., to be moved or disturbed) [90]. Therefore, the interpretation given to the stimuli would take more time

to be fulfilled for the narrative episodes, whilst for the Paradiso already the first 10 s was enough. It is also interesting to note that only for Paradiso was a statistically significant difference obtained between the L and NL groups in all the behavioral items investigated (recall, appreciation and self-declared recognition). This would suggest that the conscious verbal evaluation of the cantica would rely on the very first time of exposure. Such time point, 10 s, has been proved to be necessary in order to observe differences between experts and non-experts in front of abstract paintings, therefore, allowing observers to assign a meaning beyond the mere description [46]. This observation could be applied in the present study making a comparison between Paradiso and abstract artworks that share rarefied features. In addition, in the period of the first 10 s a correlation between traditional and contemporary artworks' verbal appreciation and the neuroelectric indexes estimated during their observation was already shown [91]. Concerning the evidence that, in response to Paradiso, higher GSR responses were reported at all 10 s length time points considered in the study in both groups, it could be due to the just mentioned rarefied, sublime atmospheres of the cantica. Specifically, the fact that only in the NL group, the first 10 s showed higher GSR values in comparison to the central 10 s and the last 10 s, could be due to the fact that non-experts react more tightly basing their artworks evaluation on their gut response, consistently with the feelings-as-information theory [13]. This could also explain the fact that in the NL group, both the first and second half of the Paradiso obtained higher GSR values in comparison to all the other cantica halves. Furthermore, it could be suggested that for Paradiso stanzas, predominantly a "faster" perceptual fluency (i.e., the ease of identifying the physical features of a stimulus) would occur, while for the more narrative Purgatorio and Inferno stanzas, a "slower" conceptual fluency (i.e., the ease of mental operations concerned with stimulus meaning and its relation to semantic knowledge structures) [92] would prevail—fluency components that resemble the bottom-up and top-down processes mentioned above. However, such fluency components could be summarized with the concept of processing fluency [13], which could instead explain commonalities between L and NL groups when analyzing the entire cantiche's excerpts, without taking account for the time points of the exposure. The correlation between AW and CE found in both groups could be discussed in line with the cognitive fluency theory [13] mentioned above. In fact, rhyme and meter, focused in the present study through the calculation of the relative neurophysiological activity in response to poetry Equation (3), can increase beauty while decreasing the ease of semantic processing (given the words choice and order constraints); however, the balance between these two components, which could be synthesized in perception versus semantics, was still positive [93].

The correlation found between AW and GSR only in L students in response to Inferno stanzas, when considering the relative activity in response to poetry than to paraphrase, could be explained by the peak shift effect [94]. Such effect states that when a rat is rewarded when, for instance, performing the discrimination between a rectangle (target) and a square, it will be even more responsive when facing a rectangle presenting more pronounced length differences between base and high in comparison to the prototype. Similarly, comparing the paraphrase version with the prototype and the poetry version with the more characterized geometric shape, it would be possible to explain the reason of the neurophysiological appreciation and arousal by L students but not by NL students, because of the higher capacity of attributing meaning to the poetry stimulus and semantic meaning knowledge in the formers (conceptual meaning). The reason of such reaction only to Inferno stanzas would be related to the highly emotional nature of the content, describing the passionate verses of the Paolo and Francesca love story. This could also explain, in the L group, the higher GSR (for both the first and second half of the stimuli) in comparison to almost all the other cantica halves. However, the analysis of the cantica halves did not evidence a usefulness of focusing in such a time window for the investigation of differences between groups. In fact, results did not show differences between groups due to the half portion of the cantica's excerpts, but rather evidenced within group differences in the emotional reaction to the different Cantiche. This result appears in accord with Codispoti

and colleagues [61] who did not find, between groups (men and women), differences in GSR levels in the analysis of the reaction to the first and second half of emotional movies. It is interesting to note, instead, that the same authors found an effect of the interval, not retrieved in the present study, suggesting a sensitivity of the employed time window for movie stimuli, not extendible to literary stimuli. Anyway, further research is needed in order to verify or not such suggestion.

5. Conclusions

We summarize, in relation to the experimental objectives stated at the end of the introduction section:

- The present study evidenced that also in literary art, and in particular poetry, emotionally activating processes appeared more pronounced in non-experts (NL students in the present study) than in experts (L students). On the contrary, experts resulted to be more cognitively engaged on the same stimuli segments, further supporting the suggestion that time of exposure to an artistic stimulus constitutes a matter of importance [34,46];
- It was suggested that for the formation of declarative judgements (appreciation, recognition) non-experts would more strictly rely on the ease of processing, based on previous knowledge of the artistic stimuli, while experts would rely more to the cerebral processing in response to the stimuli, therefore more to top-down processes. This would be supported by the evidence that cognitive and emotional aspects are more intertwined in non-experts [83].

Future research may benefit from the combination between a systematic emotional assessment as formulated into the Aesthetic Emotions Scale (AESTHEMOS) [95] and the neurophysiological assessment, in experts and non-experts. This approach would provide further insight into the eventual relation between elements of the aesthetic experience evaluated through the AESTHEMOS scales (prototypical aesthetic emotions, epistemic emotions, and emotions indicative of amusement) and subscales.

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Appendix A

Inferno V

94 Di quel che udire e che parlar vi piace, 95 noi udiremo e parleremo a voi, 96 mentre che 'l vento, come fa, ci tace.

97 Siede la terra dove nata fui 98 su la marina dove 'l Po discende 99 per aver pace co' seguaci sui.

100 Amor, ch'al cor gentil ratto s'apprende, 101 prese costui de la bella persona 102 che mi fu tolta; e 'l modo ancor m'offende.

103 Amor, ch'a nullo amato amar perdona, 104 mi prese del costui piacer sì forte, 105 che, come vedi, ancor non m'abbandona.

106 Amor condusse noi ad una morte. 107 Caina attende chi a vita ci spense». 108 Queste parole da lor ci fuor porte.

109 Quand' io intesi quell' anime offense, 110 china' il viso, e tanto il tenni basso, 111 fin che 'l poeta mi disse: «Che pense?».

112 Quando rispuosi, cominciai: «Oh lasso, 113 quanti dolci pensier, quanto disio 114 menò costoro al doloroso passo!».

115 Poi mi rivolsi a loro e parla' io, 116 e cominciai: «Francesca, i tuoi martiri 117 a lagrimar mi fanno tristo e pio.

118 Ma dimmi: al tempo d'i dolci sospiri, 119 a che e come concedette amore 120 che conosceste i dubbiosi disiri?».

121 E quella a me: «Nessun maggior dolore 122 che ricordarsi del tempo felice 123 ne la miseria; e ciò sa 'l tuo dottore.

124 Ma s'a conoscer la prima radice 125 del nostro amor tu hai cotanto affetto, 126 dirò come colui che piange e dice.

127 Noi leggiavamo un giorno per diletto 128 di Lancialotto come amor lo strinse; 129 soli eravamo e senza alcun sospetto.

130 Per più fiate li occhi ci sospinse 131 quella lettura, e scolorocci il viso; 132 ma solo un punto fu quel che ci vinse.

133 Quando leggemmo il disiato riso 134 esser baciato da cotanto amante, 135 questi, che mai da me non fia diviso,

136 la bocca mi baciò tutto tremante. 137 Galeotto fu 'l libro e chi lo scrisse: 138 quel giorno più non vi leggemmo avante».

Mentre che l'uno spirto questo disse, 140 l'altro piangëa; sì che di pietade 141 io venni men così com' io morisse.

142 E caddi come corpo morto cade.

Translation *Inferno V* excerpt:

Whatever pleases you to hear and speak will please us, too, to hear and speak with you, now while the wind is silent, in this place.

The land where I was born lies on that shore to which the Po together with the waters that follow it descends to final rest.

Love, that can quickly seize the gentle heart, took hold of him because of the fair body taken from me—how that was done still wounds me.

Love, that releases no beloved from loving, took hold of me so strongly through his beauty that, as you see, it has not left me yet.

Love led the two of us unto one death. Caina waits for him who took our life." These words were borne across from them to us.

When I had listened to those injured souls, I bent my head and held it low until the poet asked of me: "What are you thinking?"

When I replied, my words began: "Alas, how many gentle thoughts, how deep a longing, had led them to the agonizing pass!"

Then I addressed my speech again to them, and I began: "Francesca, your afflictions move me to tears of sorrow and of pity.

But tell me, in the time of gentle sighs, with what and in what way did Love allow you to recognize your still uncertain longings?"

And she to me: "There is no greater sorrow than thinking back upon a happy time in misery—and this your teacher knows.

Yet if you long so much to understand the first root of our love, then I shall tell my tale to you as one who weeps and speaks.

One day, to pass the time away, we read of Lancelot—how love had overcome him. We were alone, and we suspected nothing.

And time and time again that reading led our eyes to meet, and made our faces pale, and yet one point alone defeated us.

When we had read how the desired smile was kissed by one who was so true a lover, this one, who never shall be parted from me,

while all his body trembled, kissed my mouth. A Gallehault indeed, that book and he who wrote it, too; that day we read no more."

And while one spirit said these words to me, the other wept, so that—because of pity—I fainted, as if I had met my death.

And then I fell as a dead body falls.

Paradiso XXXIII

94 Un punto solo m'è maggior letargo 95 che venticinque secoli a la 'mpresa 96 che fé Nettuno ammirar l'ombra d'Argo.

97 Così la mente mia, tutta sospesa, 98 mirava fissa, immobile e attenta, 99 e sempre di mirar faceasi accesa.

100 A quella luce cotal si diventa, 101 che volgersi da lei per altro aspetto 102 è impossibil che mai si consenta;

103 però che 'l ben, ch'è del volere obietto, 104 tutto s'accoglie in lei, e fuor di quella 105 è defettivo ciò ch'è lì perfetto.

106 Omai sarà più corta mia favella, 107 pur a quel ch'io ricordo, che d'un fante 108 che bagni ancor la lingua a la mammella.

109 Non perché più ch'un semplice sembante 110 fosse nel vivo lume ch'io mirava, 111 che tal è sempre qual s'era davante;

112 ma per la vista che s'avvalorava 113 in me guardando, una sola parvenza, 114 mutandom' io, a me si travagliava.

115 Ne la profonda e chiara sussistenza 116 de l'alto lume parvermi tre giri 117 di tre colori e d'una contenenza;

118 e l'un da l'altro come iri da iri 119 pareva riflesso, e 'l terzo pareva foco 120 che quinci e quindi igualmente si spiri.

121 Oh quanto è corto il dire e come fioco 122 al mio concetto! e questo, a quel ch'i' vidi, 123 è tanto, che non basta a dicer 'poco'.

124 O luce eterna che sola in te sidi, 125 sola t'intendi, e da te intelletta 126 e intendente te ami e arridi!

127 Quella circolazion che s'è concetta 128 pareva in te come lume riflesso, 129 da li occhi miei alquanto circunspetta,

130 dentro da sé, del suo colore stesso, 131 mi parve pinta de la nostra effige: 132 per che 'l mio viso in lei tutto era messo.

133 Qual è 'l geomètra che tutto s'affige 134 per misurar lo cerchio, e non ritrova, 135 pensando, quel principio ond' elli indige,

136 tal era io a quella vista nova: 137 veder voleva come si convenne 138 l' imago al cerchio e come vi s'indova;

139 ma non eran da ciò le proprie penne: 140 se non che la mia mente fu percossa 141 da un fulgore in che sua voglia venne.

142 A l'alta fantasia qui mancò possa; 143 ma già volgeva il mio disio e 'l velle, 144 sì come rota ch'igualmente è mossa,

145 l'amor che move il sole e l'altre stelle.

Translation Paradiso XXXIII excerpt:

That one moment

brings more forgetfulness to me than twenty— five centuries have brought to the endeavor that startled Neptune with the Argo's shadow!

So was my mind—completely rapt, intent, steadfast, and motionless—gazing; and it grew ever more enkindled as it watched.

Whoever sees that Light is soon made such that it would be impossible for him to set that Light aside for other sight;

because the good, the object of the will, is fully gathered in that Light; outside that Light, what there is perfect is defective.

What little I recall is to be told, from this point on, in words more weak than those of one whose infant tongue still bathes at the breast.

And not because more than one simple semblance was in the Living Light at which I gazed— for It is always what It was before—

but through my sight, which as I gazed grew stronger, that sole appearance, even as I altered, seemed to be changing. In the deep and bright

essence of that exalted Light, three circles appeared to me; they had three different colors, but all of them were of the same dimension;

one circle seemed reflected by the second, as rainbow is by rainbow, and the third seemed fire breathed equally by those two circles.

How incomplete is speech, how weak, when set against my thought! And this, to what I saw. is such—to call it little is too much.

Eternal Light, You only dwell within Yourself, and only You know You; Self-knowing, Self-known, You love and smile upon Yourself!

That circle—which, begotten so, appeared in You as light reflected—when my eyes had watched it with attention for some time,

within itself and colored like itself, to me seemed painted with our effigy, so that my sight was set on it completely.

As the geometer intently seeks to square the circle, but he cannot reach, through thought on thought, the principle he needs,

so I searched that strange sight: I wished to see the way in which our human effigy suited the circle and found place in it—

and my own wings were far too weak for that. But then my mind was struck by light that flashed and, with this light, received what it had asked.

Here force failed my high fantasy; but my desire and will were moved already—like a wheel revolving uniformly—by

the Love that moves the sun and the other stars.

Purgatorio XXX excerpt:

22 Io vidi già nel cominciar del giorno 23 la parte oriental tutta rosata, 24 e l'altro ciel di bel sereno addorno;

25 e la faccia del sol nascere ombrata, 26 sì che per temperanza di vapori 27 l'occhio la sostenea lunga fiata:

28 così dentro una nuvola di fiori 29 che da le mani angeliche saliva 30 e ricadeva in giù dentro e di fori,

31 sovra candido vel cinta d'uliva 32 donna m'apparve, sotto verde manto 33 vestita di color di fiamma viva.

34 E lo spirito mio, che già cotanto 35 tempo era stato ch'a la sua presenza 36 non era di stupor, tremando, affranto,

37 senza de li occhi aver più conoscenza, 38 per occulta virtù che da lei mosse, 39 d'antico amor sentì la gran potenza.

40 Tosto che ne la vista mi percosse 41 l'alta virtù che già m'avea trafitto 42 prima ch'io fuor di puerizia fosse,

43 volsimi a la sinistra col respitto 44 col quale il fantolin corre a la mamma 45 quando ha paura o quando elli è afflitto,

46 per dicere a Virgilio: 'Men che dramma 47 di sangue m'è rimasto che non tremi: 48 conosco i segni de l'antica fiamma'.

49 Ma Virgilio n'avea lasciati scemi 50 di sé, Virgilio dolcissimo patre, 51 Virgilio a cui per mia salute die'mi;

52 né quantunque perdeo l'antica matre, 53 valse a le guance nette di rugiada, 54 che, lagrimando, non tornasser atre.

55 «Dante, perché Virgilio se ne vada, 56 non pianger anco, non piangere ancora; 57 ché pianger ti conven per altra spada».

58 Quasi ammiraglio che in poppa e in prora 59 viene a veder la gente che ministra 60 per li altri legni, e a ben far l'incora;

61 in su la sponda del carro sinistra, 62 quando mi volsi al suon del nome mio, 63 che di necessità qui si registra,

64 vidi la donna che pria m'apparso 65 velata sotto l'angelica festa, 66 drizzar li occhi ver' me di qua dal rio.

67 Tutto che 'l vel che le scendea di testa, 68 cerchiato de le fronde di Minerva, 69 non la lasciasse parer manifesta,

70 regalmente ne l'atto ancor proterva 71 continuò come colui che dice 72 e 'l più caldo parlar dietro riserva:

73 «Guardaci ben! Ben son, ben son Beatrice. 74 Come degnasti d'accedere al monte? 75 non sapei tu che qui è l'uom felice?».

76 Li occhi mi cadder giù nel chiaro fonte; 77 ma veggendomi in esso, i trassi a l'erba, 78 tanta vergogna mi gravò la fronte.

79 Così la madre al figlio par superba, 80 com' ella parve a me; perché d'amaro 81 sente il sapor de la pietade acerba.

Translation Purgatorio XXX excerpt:

I have at times seen all the eastern sky becoming rose as day began and seen, adorned in lovely blue, the rest of heaven;

and seen the sun's face rise so veiled that it was tempered by the mist and could permit the eye to look at length upon it; so,

within a cloud of flowers that were cast by the angelic hands and then rose up and then fell back, outside and in the chariot,

a woman showed herself to me; above a white veil, she was crowned with olive boughs; her cape was green; her dress beneath, flame—red.

Within her presence, I had once been used to feeling—trembling—wonder, dissolution; but that was long ago. Still, though my soul,

now she was veiled, could not see her directly, by way of hidden force that she could move, I felt the mighty power of old love.

As soon as that deep force had struck my vision (the power that, when I had not yet left my boyhood, had already transfixed me),

I turned around and to my left—just as a little child, afraid or in distress, will hurry to his mother—anxiously,

to say to Virgil: “I am left with less than one drop of my blood that does not tremble: I recognize the signs of the old flame.”

But Virgil had deprived us of himself, Virgil, the gentlest father, Virgil, he to whom I gave my self for my salvation;

and even all our ancient mother lost was not enough to keep my cheeks, though washed with dew, from darkening again with tears.

“Dante, though Virgil's leaving you, do not yet weep, do not weep yet; you'll need your tears for what another sword must yet inflict.”

Just like an admiral who goes to stern and prow to see the officers who guide the other ships, encouraging their tasks;

so, on the left side of the chariot (I'd turned around when I had heard my name— which, of necessity, I transcribe here),

I saw the lady who had first appeared to me beneath the veils of the angelic flowers look at me across the stream.

Although the veil she wore—down from her head, which was encircled by Minerva's leaves— did not allow her to be seen distinctly,

her stance still regal and disdainful, she continued, just as one who speaks but keeps until the end the fiercest parts of speech:

“Look here! For I am Beatrice, I am! How were you able to ascend the mountain? Did you not know that man is happy here?”

My lowered eyes caught sight of the clear stream, but when I saw myself reflected there, such shame weighed on my brow, my eyes drew back

and toward the grass; just as a mother seems harsh to her child, so did she seem to me— how bitter is the savor of stern pity!

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