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Assessment of musical listening in post-tonal contexts: The case of *temA* (1968) by Helmut Lachenmann

Avaliação da audição musical em contextos pós-tonais: o caso de *temA* (1968) de Helmut Lachenmann

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Abstract: Musical composition is a goal-oriented task in which sound materials are often organized to try to elicit the audience's emotional, intellectual, or any other kinds of responses. However, composers' intentions do not always align with the audience's expectations and actual responses. Scholarly speaking, these issues have been primarily addressed through tonal music; however, we currently know very little about them in the field of post-tonal music. Our contribution aims to broaden this knowledge through empirical research conducted with *TEMA* by Helmut Lachenmann. A cohort of 57 participants with different musical backgrounds was invited to compare pairs of sound excerpts derived from Lachenmann's piece, in terms of musical coherence and elicited pleasure. Results show that the continuity of the sound materials played a decisive role in the assessment, particularly for participants with a music background. Additionally, professional musicians and higher music

students exhibited stronger correlations between coherence and pleasure responses. Conversely, the presence of vocal sounds that may evoke pain or violence had only an evident influence on the pleasure response of naïve participants.

Keywords: post-tonal music, assessment of musical hearing, practice-based music research, Helmut Lachenmann

Resumo: A composição musical é uma tarefa orientada a um objetivo, na qual os materiais sonoros são frequentemente organizados para tentar provocar no público respostas emocionais, intelectuais ou de qualquer outro tipo. No entanto, as intenções das pessoas que compõem não correspondem necessariamente às expectativas e à resposta real do público. Academicamente, essas questões têm sido abordadas principalmente com a música tonal, mas atualmente sabemos muito pouco sobre elas no campo da música pós-tonal. Nossa contribuição busca ampliar esse conhecimento por meio de algumas pesquisas empíricas realizadas com *temA* de Helmut Lachenmann. Uma coorte de 57 participantes com diferentes níveis de experiência musical fora convidada a comparar pares de extratos sonoros derivados da peça de Lachenmann, em termos de coerência musical e de prazer provocado. Os resultados mostram como a continuidade dos materiais sonoros desempenhou um papel decisivo na avaliação, particularmente quando os participantes tinham experiência musical. Além disso, músicos profissionais e estudantes de música superior apresentaram correlações mais fortes entre coerência e respostas de prazer. Em contrapartida, a presença de sons vocais que podem evocar dor ou violência teve apenas uma influência clara na resposta de prazer dos participantes ingênuos.

Palavras-chave: música não tonal, avaliação da audição musical, pesquisa musical baseada na prática, Helmut Lachenmann.

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1. Introduction

The psychology of music has often underestimated contemporary music as a repertoire with research potential, mainly focusing on audience rejection (Smith & Witt, 1989). This situation started to change and, although scattered, research relating cognitive science and contemporary music currently ranges from theoretical perspectives (e.g., Besada & Pagán Cánovas, 2020; Wanke, 2024) to empirical research (e.g., Deliège, 1989; McAdams et al., 2004; Kozak, 2015; Egermann & Reuben, 2020).

Our article presents the outcomes of an experiment that took Helmut Lachenmann's *temA* (1968) as a source for sound stimuli. The goal was to understand how this music was perceived by audiences with diverse musical backgrounds, ranging from novice participants to professionals in the field of contemporary music. This introduction previously reviewed critical literature on expectations in tonal music and the trio, which serves as a case study. Both reviews led to the research questions that oriented our experiment.

1.1. Theoretical background

One of the first authors to examine the relationship between expectations and emotion in Western tonal music was Leonard B. Meyer (1956). He integrated principles from Gestalt theory with pragmatist postulates from Charles S. Peirce and John Dewey, aiming to explain the relationship between the structural organization of music and the listener's emotional responses. According to Meyer, musical structures have an inherent capacity to generate cognitive expectations, whose fulfillment or frustration constitutes the primary mechanism through which music evokes affective experiences.

A step further was taken by Fred Lerdahl and Ray Jackendoff (1983), transferring ideas from Noam Chomsky's transformational and generative linguistics into music. According to Chomsky (1965), human language is an innate capacity composed of a finite set of

cognitive rules that allow the generation of an infinite number of linguistic expressions. Universal principles would govern these human language capacities. Similarly, Lerdahl and Jackendoff argued that musical listening is based on a cognitive competence that enables listeners to internalize abstract rules with which they organize and understand Western tonal music. Their theory can be considered a structural formalization of Meyer's framework from a more emotional and phenomenological perspective.

Later, Eugene Narmour (1990; 1992) expanded and systematized Meyer's theory of musical expectations with his Implication-Realization model. Its basic principles are implication—expectation generated by the listener—and realization—how following sound events confirm or violate that expectation, generating a perceptual and emotional experience. Expectations in this model encompass both structural and perceptual aspects. E. Glenn Schellenberg (1997) reviewed it and introduced greater statistical and predictive rigor by using computation based on real corpora. This approach simplified Narmour's model and emphasized the need to validate the rules with empirical studies perceptually. Ultimately, according to Schellenberg, expectations are both structural and statistical.

Further scholars have continued to pave this path in the 21st century. Elisabeth H. Margulis made another step forward. Her significant contributions in this field are a systematization and computational formalization of Narmour's model (Margulis, 2005) and the study of expectation beyond the immediate prediction of melodic events (Margulis, 2014). On the one hand, she serves as a bridge between Narmour's abstract theory and Schellenberg's empirical validation; on the other, she has become a key figure in understanding expectation as a broader cognitive-affective phenomenon. Expectations, according to Margulis, are structural, statistical, and cognitive in nature. Finally, from an evolutionary and biological cognition approach, David Huron (2006) has explained how musical expectations generate emotional responses with his

ITPRA theory, corresponding to the initials of these responses: imagination, tension, prediction, reaction, and appraisal. These expectations encompass cognitive, physiological, and affective aspects.

All this previous research has addressed chiefly tonal music, and its theoretical background implicitly assumed that several aspects, such as the perceived sensation of beat or the use of neatly pitched sounds, are somehow intrinsic to any musical repertoire. It is not the case, however, with some trends in contemporary music, particularly the case study that we have chosen as the starting point of our research.

1.2. A case study: *temA* by Helmut Lachenmann

In his writings, Lachenmann (1996) foregrounded *temA* as a crucial work in his oeuvre. It is one of the first compositions to treat breathing as a central issue. It constitutes a first step towards *musique concrète instrumentale* in which the mechanical conditions of the sound production are incorporated. Extreme or limit situations of unconventional interpretation are consciously accepted but organized strictly in a musical structure. In doing so, traditional techniques take on a new meaning, and the transgression of taboos does not arise from the presence of distorted or odd sounds, but rather from their compositional logic. Snore, pressed strings, or soundless blowing were tolerated as a humorous, dadaist, or expressionist source before Lachenmann's approach, but he took another path with them. For him, a critical issue was the emancipation of sound acoustics from its subordinate function in earlier music repertoires. This process, although innovative, has given rise to several misunderstandings.

Lachenmann proposed a sound classification in basic categories or families depending on the acoustic experience, which reflects different forms of sound production in contemporary music. He aimed to facilitate the comprehension of these sounds, covering both acoustic and gestural aspects, as well as structural

ones. In this classification of categories (*Klangtypen*), he remarked that a sound is not only characterized by its pitch, timbre, intensity, and duration but also by the distinction between sound-as-state and sound-as-process. Other authors have sometimes adopted a relatively divergent terminology (e.g., Hermann, 2002; Utz, 2023) when addressing Lachenmann's compositional practices; our research position aligns with theirs.

Regarding *temA*, the most thorough and detailed analysis has been provided by Karl Rainer Nonnenmann (1997). He has pointed out that the title itself—which means 'breath' in German but reads backwards—already indicates the central significance of human breath as the determining factor for the flute and cello layers. It may also guide, perhaps, the listeners' expectation toward the vocal part as the principal focus of the composition. According to him, vocal distortions in *temA,* such as snoring, pressed audible inhalations, or choking sounds, retain an expressive charge. However, the inherent semantic and expressive potential of these deeply embodied sound manifestations cannot be eliminated through their structural integration into a musical context. As the author states:

> "Although the vocal distortions – as Lachenmann prescribes in the performance instructions for the vocal part – are always to be understood instrumentally by the mezzo-soprano and the resulting sounds are to be perceived as equal to the instrumental sounds, expressions such as snoring, screaming, panting, moaning, etc., always remain more than neutral noises. The semantic and expressive potential inherent in them as physical vocal utterances can indeed be diminished through structural integration into a concise musical context. Still, it can by no means be eliminated. As a result, sound material produced

> primarily vocally resists being used as a 'neutral' means of instrumentation due to the connotations attached to it." (Nonnenmann, 1997, p. 108)[1]

This kind of reasoning helps to some extent explain the scope of our experiment, as discussed below.

1.3. Research questions

According to the theoretical background and the choice of our case study, we decided to conduct an experiment to gain a better understanding of how the audience assesses post-tonal music, particularly a repertoire in which pitches and repetitive rhythmic patterns are secondary features or even absent. We aimed to address the following questions:

- Does the categorization of sound families by Lachenmann induce a particular assessment of his music? We will address this question by selecting music materials in which the familiar affinity of sound was a deliberate compositional choice.
- Does the previous exposure to post-tonal music affect how it is appraised? We will address this question by examining the responses of individuals with different musical backgrounds.
- Does the presence of sounds that are highly unusual in tonal contexts but ordinary in daily life modulate the assessment of music? The choice of a piece like *temA* with its vocal particularities will facilitate addressing this question.

1 „Obwohl die stimmlichen Verfremdungen - wie Lachenmann in den Spielanweisungen zum Vokalpart vorschreibt- von der Mezzosopranistin immer instrumental aufzufassen und die entstehenden Klänge entsprechend gleichrangig neben den Instrumentalklängen zu hören sind, bleiben beispielsweise Schnarchen, Schreien, Hecheln, Stöhnen etcetera immer mehr als neutrale Geräusche. Das ihnen als körperliche Lautäußerungen inhärente semantische und expressive Potential kann zwar durch strukturelle Einbindung in einen konzisen musikalischen Zusammenhang zurückgedrängt, keinesfalls jedoch gänzlich eliminiert werden, so daß ein primär vokal erzeugtes Geräuschmaterial sich aufgrund der ihm anhaftenden Konnotationen gegen eine Verwendung als "neutrales" Instrumentationsmittel weitgehend sperrt".

2. Materials and methods

2.1. Participants

A cohort of 58 participants was recruited to participate in our study; one of them was excluded because she had already played *TemA* in the past. The 57 validated participants (47.37% female, 50.88% male, 1.75% other) were divided into three homogeneous groups, with 19 participants in each group; we provide their mean age (M) and standard deviation (SD). The following criteria were guided by one of the research questions mentioned above. Naïve participants—henceforth group Mus-N (age: M=48.4, SD=19.6)—were people without higher music education and a music professional career; most of them did not have prior musical training. They also declared that they were unfamiliar with post-tonal music and that their previous exposure to it had been limited. Tonal-experienced musicians—henceforth group Mus-T (age: M=36.89, SD=14.94)—were higher music-education students and professional musicians with a career oriented towards tonal music of the Common Practice Period. Although all of them were aware of what post-tonal music is, and some declared that they often listen to it, none of them stated that they play it regularly. Post-tonal-experienced musicians—henceforth group Mus-P (age: M=40.16, SD=14.47)—were higher music-education students and professional musicians with a career primarily oriented towards post-tonal music after 1945. The particular specificity of the third group factually conditioned the total size of the population.

2.2. Aural stimuli

The aural stimuli consisted of eight musical sound files derived from two passages of *TemA*: passage one spans from measure 153 to 158, and passage two from measure 159 (third beat) to 164. Passage 1 primarily features short-pitched and percussive sounds in

its three layers, often with sforzando articulation, and, in particular, the singer must also produce rough and choking-like vocal sounds. The polyphonic interaction of the three layers in passage 1 is quite discontinuous as voices rarely overlap (see Figure 1); this event distribution matches the notion of pointillism—controversial, though—in post-tonal music (Kostka and Santa, 2018, p. 233). Conversely, passage two primarily features unpitched breath and breathy-like sounds in its three layers, characterized by low dynamics. Events in passage 2 are on average longer than those in passage 1, and they often overlap, polyphonically speaking, which gives rise to a more continuous overall sonority (see Figure 2). In a nutshell, each excerpt was relatively homogeneous in its exploitation of sonic materials coming from affine families. Still, they were juxtaposed as significantly dissimilar blocks according to the same criterion. Lachenmann confirmed this compositional strategy during a work session we had with him in Winter 2024.

Figure 1. ***temA*** **measures 156–158. © 1971 by Musikverlage Hans Gerig, Köln. 1980 assigned to Breitkopf & Härtel, Wiesbaden.**

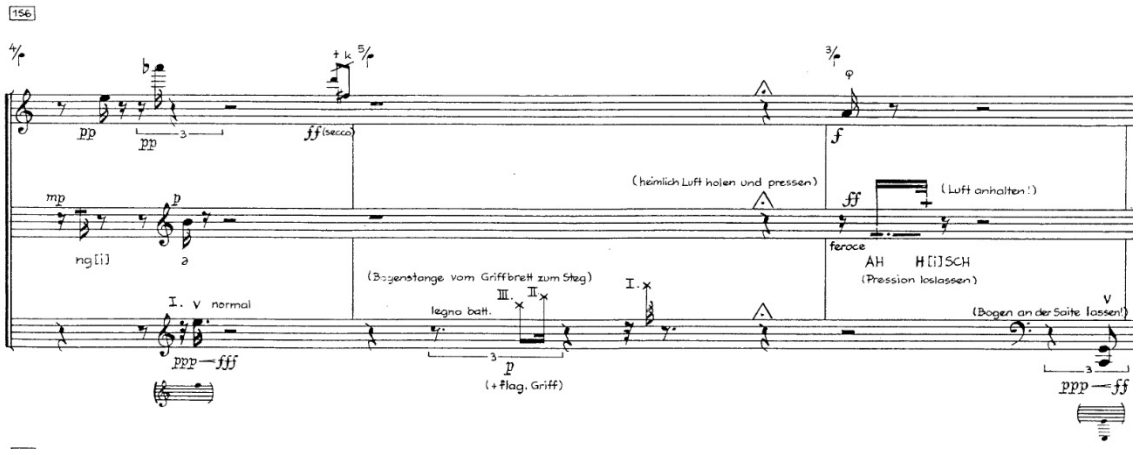

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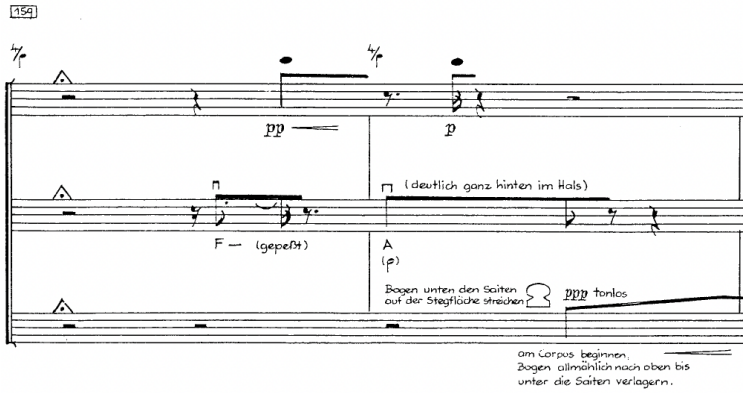
Figure 2. ***temA*** **measures 159–160. © 1971 by Musikverlage Hans Gerig, Köln. 1980 assigned to Breitkopf & Härtel, Wiesbaden.**



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Passage 1 and Passage 2 were played by the musicians of TRIO vis-à-vis (2025) during Autumn 2024 and professionally recorded. Each layer of both passages was individually performed to obtain the eight sound files mentioned above. For this purpose, musicians were requested to follow particular instructions: they had to play with a strict M.M.=60 tempo—helped by a click-track with headphones—and they were asked to ignore any fermata symbol; additionally, they were allowed to play expressively but were encouraged to avoid salient emphases which may diverge from average performance when playing jointly.

The studio mix followed the recording. Only two of the eight sound files consist of the reconstruction of passages one and two by mixing their respective recorded layers. Conversely, the other six files were created by combining layers from passages 1 and 2, resulting in hybridized musical outcomes. All possible combinations gave rise to the total amount of 8 sound files, which we henceforth identify with the notation F*x*V*y*C*z*, where F stands for the flute layer, V for the voice layer, and C for the cello layer, and *x*, *y*, and *z* take values 1 or 2 depending on the passage they came from. For instance, F1V1C2 represents the file in which the

flute and the voice parts from passage one are mixed with the cello part from passage 2. The strict tempo and removal of fermatas mentioned above were aimed at achieving a balanced mix, where all eight sound files had a total timing of 23 seconds.

2.3 Procedure

Participants were asked to compare the sound files in pairs, with each couple consisting of one file from the two files corresponding to the original score of *temA* and one from the six hybridized files. The total number of possible combinations is therefore 12. Their distribution was randomized at two levels: on the one hand, each pair could present the actual and the hybridized sound files in any order; on the other hand, the 12 couples were also randomly assigned to different sessions with participants. Additionally, these 12 sound duplets were interspersed with an extra set of 12 pairs of sound files. They had a similar duration, and their sonic materials equally came from actual but different passages of *temA*. Supplementary musical sound files were planned for further identical experiments, which we carried out simultaneously with the same participants. Although it is not our aim to discuss these experiments here, supplementary couples also served as distractors, impairing participants' ability to recognize our intentions in the experiment presented in this article.

Table 1. Likert scales of the experiment.

-3	Only the first one was coherent to me (alternatively pleasant).
-2	The first one was much more coherent to me (alternatively pleasant) than the second.
-1	The first one was more coherent to me (and also pleasant) than the second, although not by much.
0	I found both equally coherent (alternatively pleasant).
1	The second one was more coherent to me (alternatively pleasant) than the first, although not by much.
2	The second one was much more coherent to me (alternatively pleasant) than the first.
3	Only the second one was coherent to me (alternatively pleasant).

After hearing each pair of musical sound files, participants were invited to compare them in terms of perceived coherence and elicited pleasure. For this purpose, they were given 45 seconds between each pair's listening to provide their evaluation according to the Likert scales in Table 1. Once the assessment of the 24 couples of musical sound files was completed, participants were asked to engage in retrospection, describing the reasons that led them, in general terms, to consider some audio files as more coherent or pleasant than others. These two last questions were free-response oriented, and participants had 10 minutes to answer them.

2.4. Data analysis

Data from responses with the Likert scales were reordered, using opposite numbers when necessary, to homogenize data. After this treatment, negative values indicate a preference for the sound file matching the actual score of *temA,* while positive values indicate a preference for the hybridized file. Since Likert scales depend on ordinal rather than cardinal numbers, it is not a good strategy to assume normality of data. This hinders the application of ANOVA or similar methods to test significant differences among the three different groups. However, the estimation of means, medians, standard deviations, and correlation coefficients may help detect some tendencies and suggest plausible reasons for them. For this purpose, and according to our experimental design, we will consider, in absolute value, that a mean greater than 0.50 indicates a slight preference for one of the sound files, a mean greater than 1.00 indicates a clear choice, and a mean greater than 1.50 indicates a strong preference. Means with absolute values lower than 0.50 will be regarded as negligible. These assumptions are based on the previous calculation of Cronbach's a alpha on the data for estimating the reliability of our Likert scales (Cronbach, 1951). In our study, a=0.90 which indicates a high reliability of the survey. These assumptions also consider the limited number of extreme responses, i.e., taking values of -3 or 3 on the Likert scales, which are lower than 8.48% for the judgment of coherence and lower than 6.58% for the judgment of elicited pleasure.

The answers to the free-response questions were analyzed to identify potential keywords that could help cluster similar strategies under specific categories. We were able to discriminate 21 different categories, but, due to limited space, we will only discuss here those that are meaningful for a better interpretation of the quantitative data.

3. Results

3.1. Quantitative surveys

The means and the standard deviations per group of participants, detailed for each pair of sound files, help to understand the assessment of the coherence (see Table 2) and the elicited pleasure (see Table 3). First of all, the standard deviation, when pooling couples in two blocks which depend on each file actually coming from *temA*, was relatively stable across groups and for both questions. Indeed, it ranged from 1.11to 1.56.

Table 2. Means (M) and standard deviations (SD), per group of participants, of the appraisal of musical coherence when comparing each sound file actually coming from *temA* with the hybridized versions.

Pair code	Actual file	Hybrid file	Mus-N		Mus-T		Mus-P	
			M	SD	M	SD	M	SD
1	F1V1C1	F1V1C2	0.00	1.37	0.32	0.75	0.68	1.29
2		F1V2C1	0.26	1.48	0.47	1.61	-0.42	1.54
3		F2V1C1	0.37	1.01	-0.42	0.84	0.05	1.08
4		F1V2C2	0.47	1.87	0.37	1.68	0.42	1.68
5		F2V1C2	0.21	1.27	-0.53	1.02	0.47	1.65
6		F2V2C1	0.58	1.50	0.37	1.61	-0,32	1.86
1-6		**Pooled**	**0.32**	**1.42**	**0.10**	**1.34**	**0.15**	**1.56**
7	F2V2C2	F2V2C1	0.16	1.42	-0.53	1.65	-0.84	1.50
8		F2V1C2	-1.26	1.40	-0.47	1.35	-1.63	1.01
9		F1V2C2	-0.42	1.07	-0.74	1.10	-0.79	1.13
10		F2V1C1	-0.84	1.46	-0.95	1.18	-0.68	1.38
11		F1V2C1	-0.63	1.50	-0.21	1.36	-1.58	1.12
12		F1V1C2	-0.74	1.41	-1.16	1.01	-0.37	1.71
7-12		**Pooled**	**-0.62**	**1.42**	**-0.68**	**1.30**	**-0.98**	**1.38**

Table 3. Means (M) and standard deviations (SD), per group of participants, of the appraisal of elicited pleasure when comparing each sound file actually coming from *temA* with the hybridized versions.

Pair code	Actual source	Hybrid file	Mus-N		Mus-T		Mus-P	
			M	SD	M	SD	M	SD
1	F1V1C1	F1V1C2	0.11	0.94	-0.11	0.88	0.42	1.35
2		F1V2C1	0.58	1.57	-0.11	1.05	0.05	1.22
3		F2V1C1	-0.53	1.07	-0.16	0.90	0.16	1.38
4		F1V2C2	0.68	1.60	0.11	1.29	0.42	1.61
5		F2V1C2	-0.05	1.18	-0.26	0.93	0.11	1.15
6		F2V2C1	0.58	1.30	1.00	1.15	-0.32	1.57
1-6		**Pooled**	**0.23**	**1.34**	**0.08**	**1.11**	**0.14**	**1.38**
7	F2V2C2	F2V2C1	-0.26	1.33	-0.32	1.20	-0.84	1.21
8		F2V1C2	-1.05	1.54	-0.68	1.45	-1.26	0.99
9		F1V2C2	-0.37	0.96	-0.74	0.81	-0.58	1.02
10		F2V1C1	-1.47	1.34	-1.32	1.06	-0.32	1.49
11		F1V2C1	-0.58	1.34	-0.37	1.34	-0.95	1.18
12		F1V1C2	-1.32	1.00	-0.74	1.45	-0.26	1.73
7-12		**Pooled**	**-0.84**	**1.33**	**-0.69**	**1.26**	**-0.70**	**1.32**

Figure 3. Means of the Mus-N group per couple of sound files, represented with heat-colored graphs (up: for coherence; bottom: for elicited pleasure). Arrow directions emphasize preference.

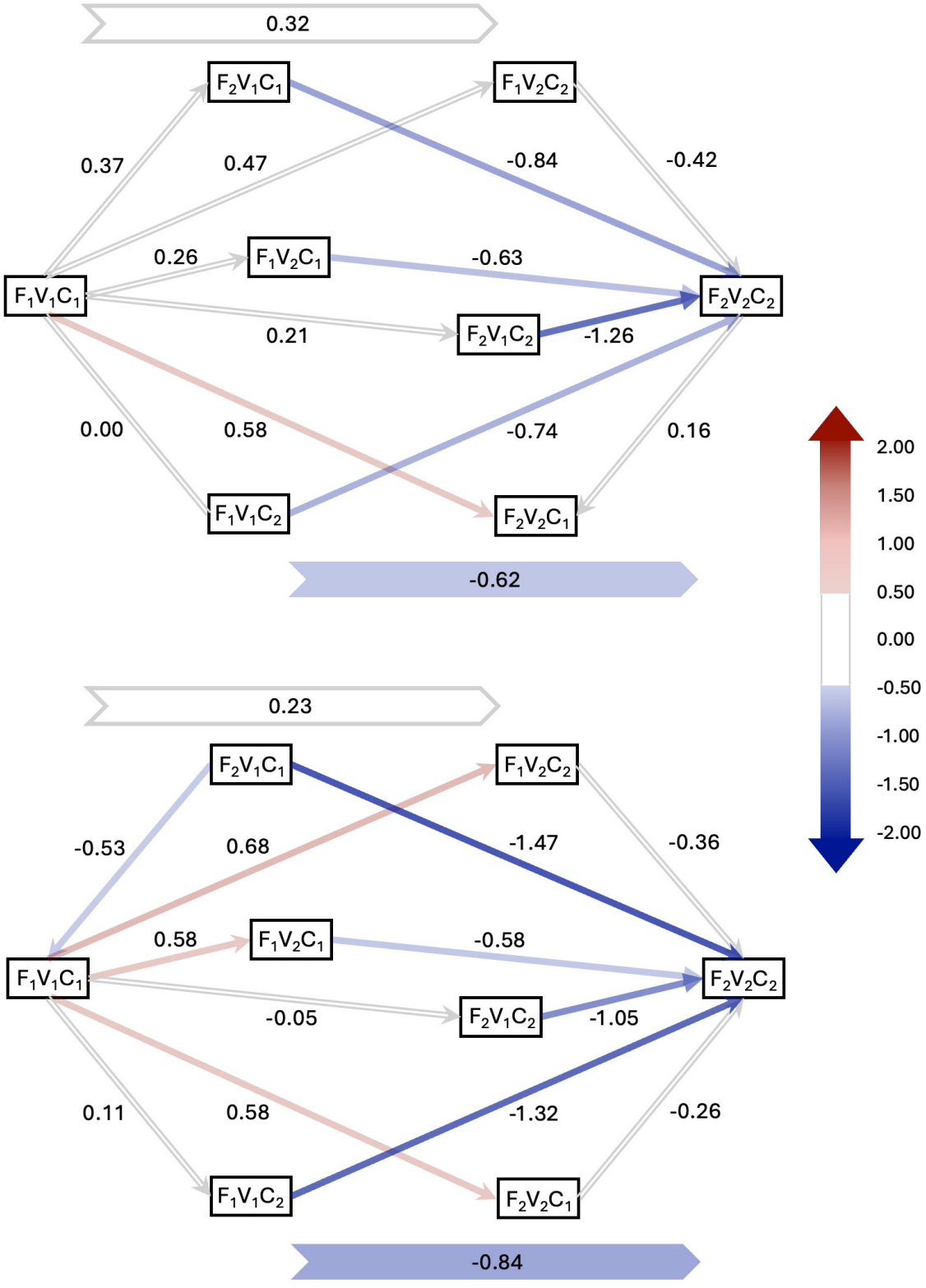


Figure 4. Means of the Mus-T group per couple of sound files, represented with heat-colored graphs (up: for coherence; bottom: for elicited pleasure). Arrow directions emphasize preference.

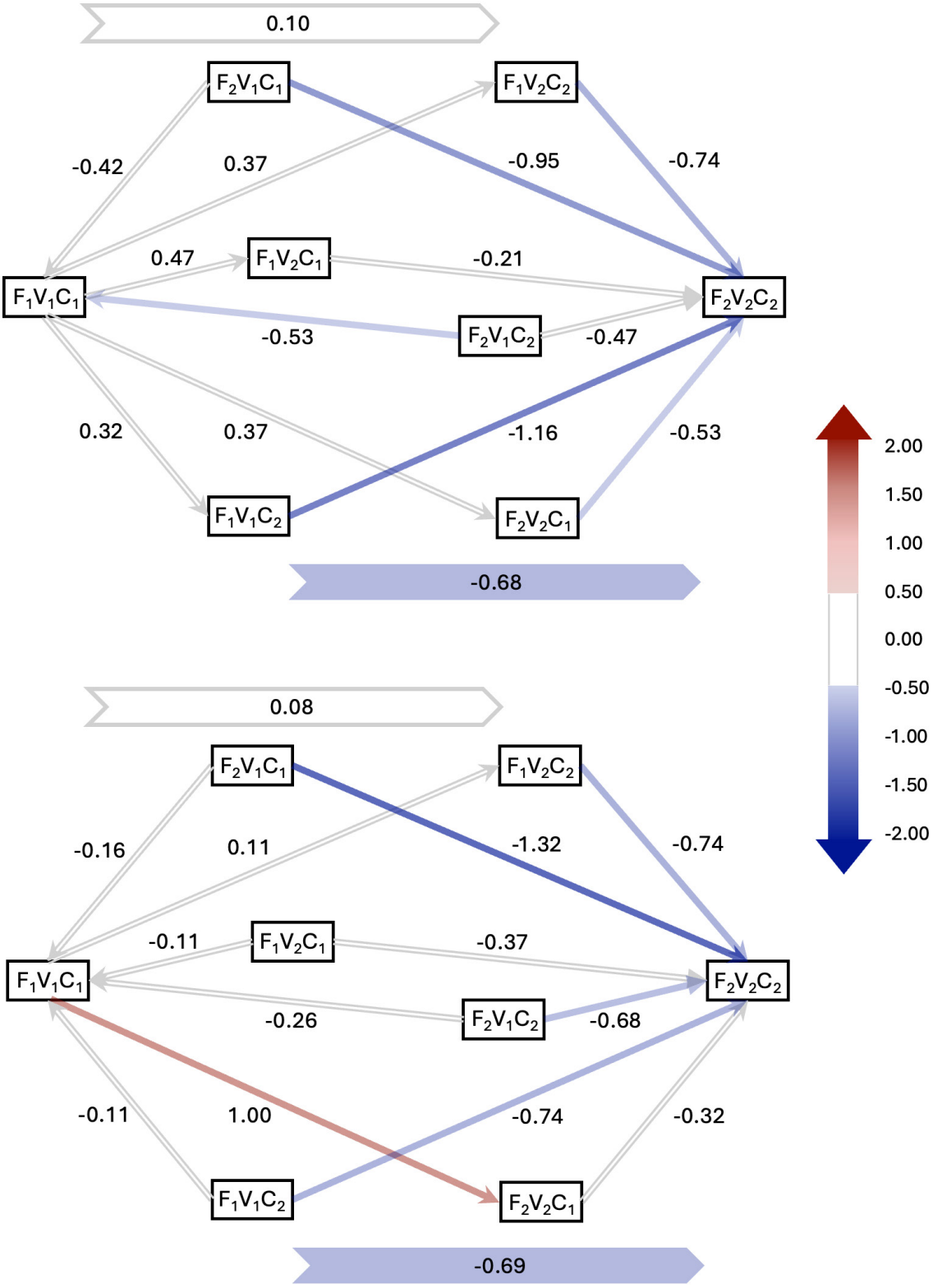
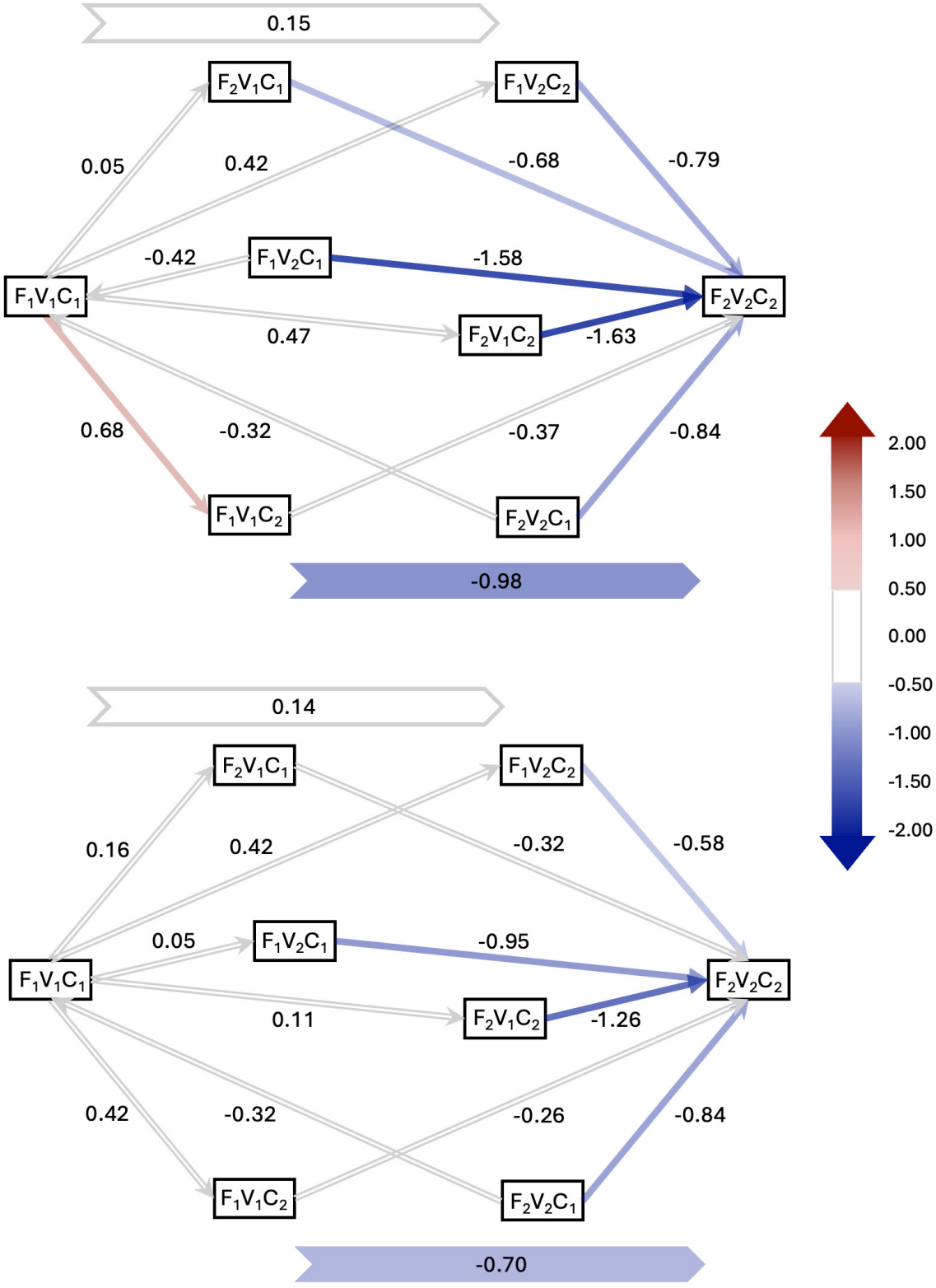


Figure 5. Means of the Mus-P group represented, per couple of sound files with heat-colored graphs (up: for coherence; bottom: for elicited pleasure). Arrow directions emphasize preference.



Means in Tables 2 and 3 are visually represented in Figures 3-5 with heat-colored graphs to facilitate the understanding of the following argumentation. The lower graph in Figure 3 is significant. Consider the three red-shaded arrows and the three blue-shaded arrows with a darker hue. They all connect pairs of sound files with a shared feature, which is not fulfilled in the other arrow connections: they link pairs in which one of the vocal parts comes from excerpt one and the other one comes from excerpt 2. Indeed, in the case of group Mus-N when assessing pleasure, this connection is always oriented towards a preference for the vocal part of the latter.

This fact led us to rearrange the pairs: instead of comparing an original *temA* file and a hybridized one, we can compare files with dissimilar vocal parts, considering the voice from excerpt two as the primary reference and that from excerpt one as the alternative—respectively notated F*V2C* vs. F*V1C*, where asterisks may take any value. This choice retains all pairs with an even code but requires reversing the sign of the participants' responses for pairs with codes 2, 4, and 6 to facilitate proper data analysis. Partial results of this rearrangement would be redundant with those presented in Tables 2 and 3; however, the pooled outcomes (see Table 4) shed new light. In the case of group Mus-N, the means were very close, even slightly greater in absolute value, to those from the block of duplets including sound file F2V2C2. Mus-T participants had a similar tendency, but in this case, the means were slightly lower in absolute value. Conversely, Mus-P participants reached scores between the two former blocks of couples, and, more importantly, the new means were consistently below the 0.50 threshold in absolute value.

Table 4. Means per group of participants for the appraisal of both coherence and elicited pleasure. The two upper rows summarize the pooled values in Tables 2 and 3; the lower one displays the new values resulting from the rearrangement.

Ref. file	Alt. file	Mus-N		Mus-T		Mus-P	
		coherence	pleasure	coherence	pleasure	coherence	pleasure
F1V1C1	hybrid	0.32	0.23	0.10	0.08	0.15	0.14
F2V2C2	hybrid	-0.62	-0.84	-0.68	-0.69	-0.98	-0.70
F*V2C*	F*V1C*	-0.69	-0.95	-0.63	-0.62	-0.39	-0.33

Finally, the Pearson coefficient for testing the correlation between coherence and elicited pleasure revealed different tendencies. The median correlations for Mus-N participants were moderate, reaching a value of 0.53; three subjects even scored a negative correlation. Conversely, the other medians of correlation were higher, reaching values of 0.72 for group Mus-T and 0.77 for group Mus-P.

3.2 Qualitative retrospection

Despite the varied explanations provided by the experiment participants, we were able to identify 21 labels for categorizing how participants appraised the perceived coherence and elicited pleasure of the pairs of musical stimuli they heard. These labels can be grouped into five main fields: sound intrinsic properties, sound relational properties, specific features of vocal sounds, exogenous influences, and interdependency coherence-pleasure.

Sound relational properties were, for all groups, the most flagged argument for assessing coherence, particularly the evocation of sound continuity and/or silence (8 Mus-N participants, 8 Mus-T participants, 6 Mus-P participants) and similarities among sounds (3 Mus-N participants, 6 Mus-T participants, 5 Mus-P participants). Interestingly, the reference to highly technical terms like harmony or counterpoint was evoked mainly by the naif people (6 Mus-N participants, one non-Mus-N participant), in terms of absence, though. Concerning the assessment of elicited pleasure,

the broader number of descriptions fell into the field of specific features of vocal sounds, particularly the presence of choking and pain-related sounds (9 Mus-N participants, 1 Mus-T participant, 1 Mus-P participant), which were always negatively evaluated, and more ordinary sounds like deep breathing or snoring (8 Mus-N participants, 4 Mus-T participants, 3 Mus-P participants), which raised more ambivalent opinions.

Finally, the interdependency coherence-pleasure, although flagged by a minority, was not uniformly distributed by groups. Mostly Mus-N participants acknowledged that they compared coherence in function of the pleasure they felt (4 Mus-N participants, 1 Mus-N participant). Conversely, only non-Mus-N participants highlighted coherence as a factor that influenced the joy they felt (2 Mus-T participants, 3 Mus-P participants).

4. Discussion

Concerning the first research question mentioned above, the results confirmed that the compositional distribution of affine sound materials may have an impact on music assessment, but only under certain conditions—the dissimilar responses to stimuli involving actual excerpts 1 and 2 point to this fact. Although the identification of sound similarities was an essential criterion for the listening assessment, the continuity and use of silence seemed to play a more substantial role, as confirmed by the qualitative survey. When comparing a pointillist texture or a breath-like, continuous one with in-between hybridized textures, a preference for the source was only noticeable in the second case, regardless of the listeners' musical background. In addition, the comments on harmony and counterpoint by some Mus-N participants reveal their struggle, in some cases, to detect relational features among sonic materials for this evaluation. This fact reveals a comparison between the excerpts they heard and their contextual musical competence as listeners of mostly tonal music. Interestingly, the most apparent preference in this experiment was for the least

pitched musical excerpt, which suggests that the absence of referential pitches did not cause some Mus-N participants' inability to identify structurally layered relationships. To explain this, our best hypothesis is that, in the context of pointillist layers, participants struggled to assess coherence or pleasure, paradoxically, when there were more pitched sounds, as their briefness, sparsity, and non-tonal logics impaired their capacity to recognize familiar affinities. We believe that this difficulty was probably related to the psychological grouping mechanisms for extracting relational features within complex musical stimuli (Deutsch, 2013). This issue, along with musical segmentation, has also been addressed in post-tonal music repertoires, primarily considering the first half of the 20th century (e.g., Wright & Bergman, 1987; Bennett, 1992). In particular, research on the reception of György Ligeti's textures has detected that grouping capacities for this repertoire are not substantially affected by musical expertise (Phillips et al., 2020), but we have not found similar empirical approaches to post-tonal music in which pitched and unpitched sonic materials cohabit and silence plays a pivotal role. Nevertheless, criticism of serial music based on the psychology of musical grouping (Ball, 2011) and on the cognitive constraints of its pitch organization (Lerdahl, 1992) may perhaps apply to the pitched sound materials of the experiment we performed.

Concerning the second research question, the results have not shown, quantitatively speaking, significant differences among groups when comparing actual excerpts 1 and 2. However, it does not mean that this relative homogeneity is necessarily an outcome of similar causes. In the case of musically trained participants, particularly those in the Mus-P group, the correlation and retrospection data seem to point toward a more coherence-driven assessment of the pleasure they felt. This hypothesis is consistent with previous research about the influence of expertise on perceived emotion while listening to music (Battcock & Schutz, 2022). In the case of Mus-N participants, we believe that the proximity of their scores masks another issue related to the third research question.

Listeners' general background may influence their appraisal of post-tonal music, as cross-cultural studies have primarily shown. For instance, Anton Webern's music has been narratively described with horror content by US naïve listeners but with playful content by Chinese ones, according to their previous exposure to a tonal frame (Margulis et al., 2019). In our experiment, "horror" likely originates from another source, which may help answer the third research question. Suffocation and further pain-evoking sounds of the vocal layer in excerpt 1 reached the worst emotional comparative scores in the case of Mus-N participants. Research on tonal music has proven that happy or sad music elicits mixed feelings in terms of pleasure (Hunter et al., 2008; 2010; Schellenberg et al., 2008). One could say that happiness and sadness in music are deeply culturally encoded. Still, choking sounds are often associated with suffering and stressful situations, eliciting empathic responses from anyone hearing them (Lang et al., 2011). These—and even less pain-evoking breath sounds—may also cause misophonia (Ferrer-Torres & Giménez-Llort, 2022), which is strongly related to the evocation of musical emotions (Babalola et al., 2024). We hypothesize that the vocal sounds Lachenmann borrowed from suffocation and further breathing actions may have had the most significant influence on the emotional aspect of the musical excerpts heard by Mus-N participants.

Even more critical, these vocal sounds did not have this influence in the case of Mus-P participants, whereas for the Mus-T group, the data are inconclusive. This feature leads us back to the second research question, in which we suggested a coherence-driven assessment of the pleasure that Mus-P participants felt. Unlike Group Mus-N, they did not have a remarkably emotionally driven evaluation in response to the choking sounds. The most plausible explanation for this comes from exposure: many Mus-P participants may have played and/or heard post-tonal pieces including these sorts of vocal elements, which, in return, are highly

unusual in tonal contexts. Consequently, they have probably interpreted them as sounds that integrate musical textures in the same way as instrumental ones. In contrast, Mus-N participants have failed to incorporate them in a similar musical manner.

There is, however, an essential limitation on our approach. As stated in the introduction, the distinction between sound-as-state and sound-as-process was important in Lachenmann's conception of sound categories. Our approach was able to consider further aspects of the involved sound typologies, but was not particularly aimed at observing this feature. For this purpose, a strategy that considers more extended excerpts and repeated listening would be perhaps more suitable.

5. Conclusion

We were finally able to provide answers to the three research questions posed in the article. First, the categorization of sound families had a limited impact in the assessment, according to the capacity of listeners to grasp similarities, which depended on the very nature of the sound materials. Second, exposure affected musical appraisal, mostly leading to more emotionally driven or more coherence-driven responses, depending on the previous musical background. Finally, vocal sounds, such as suffocation, which are extremely rare in a tonal context, clearly modulated the assessment of naïve listeners but did not have a salient impact on experts in post-tonal music. Of course, these results are limited to the case study presented in this article and should not be generalized from it. It gives cues, however, to more controlled research in a quest for more generalizable outcomes. We believe that some tools and concepts from Relevance Theory (Sperber & Wilson, 1995; Carston, 2002), borrowed from pragmatics in linguistics, will shed more light on this experiment and those we performed in parallel but have not yet analyzed.

Finally, it is essential to highlight that the first author of this paper is also a member of TRIO vis-à-vis. This demonstrates how the field of contemporary music performance can be particularly fruitful from the perspective of practice-based research (Candy & Edmonds, 2018), offering an empirical orientation to music studies. In particular, some of the consequences of our work may be helpful in considering the implementation of contemporary music in educational curricula (Pérez Eizaguirre et al., 2024).

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Ethics Statement

All participants were adults and provided informed consent prior to participation. The protocol for collecting and managing data was approved by the Research Ethics Committee of the Complutense University of Madrid (ref. CE_20250313_03_HUM).

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Authors' contribution

Both authors jointly designed the experimental protocol, performed the experiment for gathering raw data, interpreted statistical data, and wrote the article. Natasha López coordinated the elaboration of sound stimuli and recruited participants. José L. Besada managed the ethical authorization of the experiment and statistically analyzed raw data.

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