

Concert formats influence how audiences experience live classical music

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Main Manuscript for**Concert formats influence how audiences experience live classical music**

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Abstract

Many people enjoy listening to live music. But what exactly does a live context contribute to people's experience, and do different types of concerts influence the musical experience in different ways? In this study, we focus on the Western classical concert, which has been claimed to be in an existential crisis. One way in which practitioners are seeking to counter this crisis is by adapting the concert format. Our study was inspired by such artistic endeavors and conducted live concert experiments in an ecologically valid setting to explore the effects of the concert format on the audience's aesthetic experience. Eleven chamber music concerts were organised, all of which presented the same three string quintets but differed regarding several format components. To represent the aesthetic experience of the audience ($N = 802$) in an exhaustive way, self-report data, physiological responses, as well as camera recordings of facial expressions were collected. The analyses revealed that each concert format variant had a unique effect on the audience. Variants that differed the most from the standard format had the strongest influence on the audience's experience, while also one concert that represented an ideal realization of the standard format, led to particularly positive experiences. Aesthetic emotions and heart rate were particularly susceptible to format changes, whereas appreciation of the music and the musical performance were not affected by the concert format. We found that 1) a high-quality concert venue can afford a more immersed experience and a higher appreciation of the concert as a whole; 2) explanations of the meaning of the pieces in a relatable, personal way during the concert help people connect emotionally with the pieces and increase tolerance towards contemporary pieces; 3) an intense musical experience and a satisfying social experience may compete with each other. Our results do not only

broaden our scientific understanding of how contexts contribute to aesthetic experiences, but can also be of use for concert practitioners.

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Main Text**Introduction**

Live performances likely go back all the way to the origins of music. If anyone wanted to listen to music, they either had to play it themselves or go to a place where others were performing. Based on the co-presence of performers and listeners, the music cultures across the globe have developed a large variety of participatory and presentational performance types (Turino 2008). In the West, presentational live performances of music whose main purpose is to allow for a focused and undisturbed musical experience are called concerts. Concerts started to emerge in Europe in the 18th century and developed along with a repertoire of musical works from Joseph Haydn to Gustav Mahler usually praised as the pinnacle of Western art music (Schwab 1971; Weber 1975; Johnson 1995; Schleuning 2000; Weber 2008; Thorau & Ziemer 2019). In the 20th century, further concert types emerged together with the novel forms of Afroamerican and other popular music genres. However, the necessity for co-presence and live performances had already ended with the invention of music recording, broadcasting and playback technologies around 1900 (Burgess 2014). More and more, people could listen to any music they wanted, anytime and anywhere which led some observers to predict the concert's imminent doom (Besseler 1926).

Today, the concert is still very much alive, although its future is the topic of an ongoing debate (Mazierska, Gillon & Rogg 2020). But while popular concerts are thriving, the classical concert has been the subject of a discourse of crisis and decline since the 1990s (Bugiel 2015)—a crisis of potentially great cultural, institutional and economic impact, since classical music is tied to a dense system of public institutions from music conservatories to orchestras and concert halls. Typical symptoms of this crisis are seen in the shrinking and ageing of audiences which is interpreted as the failure of the classical concert to attract younger and more diverse listeners and thus secure its own future (Kolb 2001; Kramer 2007; Pitts 2017). Several reasons have been discussed for this crisis in demand, one of them being the concert format and its etiquette which younger people and concert novices might neither understand nor feel comfortable with (North, Hargreaves & O'Neill 2000; Noltze 2010). While some institutions change their marketing strategies and music educators turn to potential future audiences to help them connect with classical music and its concert formats (Brown 2004; Wimmer 2010; Petri-Preiss & Voit 2023), concert managers and musicians have long since begun to address this problem by artistically experimenting with unusual concert venues, programs, visual augmentation, participatory and co-creational elements, or a loosening of behavioral regimes (Brüstle 2013; Uhde 2021; Smith, Peters & Molina 2024). This way, they seek to adapt the traditional concert format to the demands of contemporary listeners while preserving the particularly intense, rewarding, and meaningful musical and social experiences theoreticians ascribe to it (Heister 1983; Small 1998; Auslander 1999; Simon 2018) and audiences look for (Pitts 2005; Packer & Ballantyne 2011; Burland & Pitts 2014; Baym 2018).

From a scientific perspective, the idea that the concert format may positively or negatively influence how people experience music can be related to theories from the social sciences and (empirical) aesthetics. Specifically, sociologist Erving Goffman's concept of the "frame" that affects how people interpret a culturally and socially determined situation and how they behave in it (Goffman 1974) can be easily adapted to conceptualize the role of the concert for music listeners (Wald-Fuhrmann et al. 2021). And although (empirical) aesthetics has for a long time focussed almost exclusively on properties of an aesthetic stimulus and characteristics of the recipient to explain aesthetic judgments and experiences, more recently, philosophers of art (most notably, Danto 1964; Becker 1982 with their concept of "art worlds") as well as empirical researchers such as Helmut Leder et al. (2004; Leder & Nadal 2014), David Hargreaves (2012, "reciprocal feedback model") or Scherer and Zentner (2001) have included the context in which an aesthetic episode takes places into their theoretical models.

In addition to theoretical conceptualizations, researchers have also started to study music listening in (classical) concerts empirically and experimentally. Groundbreaking work was done using qualitative methods such as interviews and participant observation that identified why people go to (classical) concerts and what they usually experience there (Pitts 2005; Burland & Pitts 2014). Quantitative methods such as questionnaires and physiological measurements have been used to assess appreciation, expectation, emotion, feelings of connectedness, and physiological arousal (Thompson 2006; Egermann

et al. 2013; Merrill et al. 2021; O'Neill and Egermann 2022) and have found physiological synchronization of concert audiences (Tschacher et al. 2023a, Tschacher et al. 2023b), in particular in response to specific musical characteristics (Czepiel et al. 2021). Still rare, however, are studies that seek to compare the effects of different concert components and formats in a controlled experimental approach. The earliest strand of this still relied on audiovisual recordings and is composed of studies that explore the respective contributions of the visual and the audio component (Vines et al. 2006; Chapados & Levitin 2008; Vines et al. 2011 (all three articles were based on the same data); Behne & Wöllner 2011; Tsay 2012; Coutinho & Scherer 2017; Griffiths et al. 2018; Lange et al. 2022). Overall, being able to see and not only hear the musicians had significant positive effects, e.g., on audience's emotional responses (Vines et al. 2006; Vines et al. 2011; Coutinho & Scherer 2017), electrodermal activity as a measure of engagement (Chapados & Levitin 2008), perception of musical structure (Vines et al. 2006), ratings of performance quality (Tsay 2013; Griffiths et al. 2018), and perceived expressivity (Vines et al. 2011; Lange et al. 2022). In a meta-study, Platz & Kopiez (2012) calculated an average medium effect size of Cohen's $d = 0.051$ for the visual component in music listening. A second strand of research addresses the specifics of liveness by comparing live performances with recordings (Shoda et al. 2016, Coutinho & Scherer 2017; Swarbrick et al. 2019, Swarbrick et al. 2021; Swarbrick & Vuoskoski 2023; Trost et al. 2024). Findings indicate an influence of a live experience on physiological arousal (Shoda et al. 2016), brain activity (Trost et al. 2024), as well as on felt emotions (Coutinho & Scherer 2017), engagement (Swarbrick et al. 2019: faster head movements), and social connection (Swarbrick et al. 2021; Swarbrick & Vuoskoski 2023). A third strand of research is characterised by the experimental manipulation of individual format features of audiovisual recordings or streams of live performances such as presence or absence of an audience (Shoda & Adachi 2015), stereo vs. 3D sound (Shin et al. 2019), VR environments (Yakura & Goto 2020; Onderdijk et al. 2021), pre-concert talk (Egermann & Reuben 2020), or audience participation (Onderdijk et al. 2021; Wald-Fuhrmann et al. 2023). Overall, the existing body of experimental research provides neither comprehensive nor systematic understanding of which defining features of live concerts influence which experience dimensions, nor of the underlying mechanisms involved. The samples are typically very small (N s from 20 to 83, only four studies are based on samples of more than 100 participants: Shoda & Adachi 2015 ($N = 153$); Swarbrick et al. 2021 ($N = 317$), Wald-Fuhrmann et al. 2023 ($N = 525$), Swarbrick & Vuoskoski 2023 ($N = 107$)) and the vast majority of manipulations target recordings, not the live concert itself. To measure experience, mostly self-reports are collected, and only very rarely also physiological responses (e.g., Egermann & Reuben 2020, Trost et al. 2024), facial expressions (Kayser et al. 2022) or body movement (e.g., Swarbrick & Vuoskoski 2023).

In line with the increasing interest in ecologically valid studies also in the field of music psychology (Tervaniemi 2023), our team developed a conceptual framework for concert studies that takes the concert as the stimulus of interest that needs to be systematically varied in order to establish how its various features interact with each other, with the music, and with characteristics of the audience members in creating musical experiences (Wald-Fuhrmann et al. 2021). Based on this framework, we started "Experimental Concert Research", an extensive research project that developed around several series of experimental live and streamed concerts and in which the same three string quintets by L. van Beethoven, B. Dean, and J. Brahms were played. The main concert series is the topic of this paper and comprised of eleven live concerts in Berlin, Germany, that were visited by an audience of $N = 802$ in the spring of 2022. The experimental manipulations related to the main defining elements of the concert frame as identified in the theoretical literature (Heister 1983; Wald-Fuhrmann et al. 2021) and were designed by Folkert Uhde, who has been active as a concert designer for many years: spatial-architectural environment, ensemble characteristics, musical programming, social relationship between performers and audiences, visual component, acoustic component and additional information on the musical pieces (more details are given below in the section "Stimuli"). For an overview of all concerts, see Table 1, for a schematic depiction of the study design, see Figure 1.

In this paper, we investigate the influence of these different concert components and formats on the audience's experience (see also Tröndle et al. 2025). To measure the experience of the audience in a comprehensive way, we have based our approach on the component process model of emotion (Scherer 2005) as was already done in an earlier study in music listening in concerts (Egermann & Reuben 2010). Here, affective experiences are characterized as (1) cognitive appraisals of stimuli that lead to changes in

(2) subjective experience, (3) physiological arousal, (4) expressive behaviour, and (5) action tendencies. In our study we measured the first four emotion components with questionnaires that audience members had to complete after the concert (component 1 and 2), physiological responses recorded during the performance (component 3), as well as camera recordings of facial expressions (component 4). The latter type of data had previously only been used capturing audience reactions on simple dichotomous stimuli and had not yet been applied to the realistic listening context of a classical concert (Kayser et al. 2022). We did not focus on action tendencies, as the etiquette in classical concerts does not allow typical approach and avoidance behaviors.

The rudimentary and inconsistent state of research on the influence of situational and contextual factors on the experience of (live) music to date hardly allows a hypothesis-based approach. The following analyses are therefore rather explorative and oriented on the artistic experience and intentions that have guided the design of the individual concert formats.

Materials and Methods

Stimuli

The concert was designed as a chamber music event and adhered to current programming conventions for such performances: three pieces in total consisting of two works from the classical and romantic periods and one contemporary piece, following a trajectory from shorter, introductory work to the main piece at the end. The contemporary piece was positioned between the two others. Specifically, the program comprised string quintets by Ludwig van Beethoven (op. 104 in C minor, first movement only), Brett Dean ("Epitaphs"), and Johannes Brahms (op. 111 in G major).

When creating the various concert formats that served as experimental stimuli, we drew upon the practical expertise of the project's artistic director (Uhde 2021), typical formatting variations found in contemporary classical concerts (Tröndle 2021), as well as established theories of concert performance and liveness (e.g., Heister 1983; Auslander 1999; Simon 2018; Sloboda & Ford 2019; Wald-Fuhrmann et al. 2021).

Several factors constrained artistic freedom due to practical, technical, and experimental requirements. Audiences had to be seated in fixed positions to accommodate the network installation, ensure consistent camera conditions, and minimize movement artifacts in physiological measurements. Each concert differed from previous ones in only one format component to isolate the effects of individual elements while maintaining ecological validity by approximating real concert experiences as closely as possible. These considerations led to the selection of the following format components for experimental manipulation:

Concert Hall: The construction of dedicated concert halls dates back to the late 18th century (Forsyth 1985; Beranek 2003). Their primary function is to provide a space large enough to enable the spatio-temporal co-presence of musicians and audience that defines live performance, while offering optimal acoustics for musical expression. Contemporary communities continue to invest substantially in concert hall construction, addressing issues of acoustics, attractiveness, and inclusivity. Being frames in a quite literal sense, from a psychological perspective, concert halls function as priming factors through their architectural aesthetics, semiotics, and the spatial relationship they establish between stage and auditorium (Wald-Fuhrmann et al. 2021). But they also co-constitute the musical realization of the programmed works via their acoustics.

Our concerts took place in two venues with markedly different architectural, acoustic, and aesthetic characteristics. The Pierre Boulez Saal (opened in 2017, architect: Frank Gehry) features an elliptical design characterized by light wood tones and bold, contrasting colors in the upholstered seating. It is designed to facilitate focused, undistracted listening and foster intimate musical encounters. The Radialsystem, by contrast, is a late 19th-century industrial building that served as a pumping station until 1999. Following renovation that integrated modern glass, steel, and concrete elements with the original brick architecture, it has hosted diverse cultural events and transdisciplinary performances since its opening in 2006. The former machinery hall where our concerts took place features black-painted walls and floors with flexible, unupholstered seating.

Pierre Boulez Saal embodies traditional concert hall aesthetics emphasizing comfort, acoustic excellence, and a focussed listening experience, while Radialsystem represents a modern "industrial chic" aesthetic not primarily associated with classical music and potentially more appealing to younger audiences. This manipulation addressed questions of how aesthetic, acoustic, and comfort aspects of concert venues influence musical experience.

Musicians: Musician prestige and skill play crucial roles in the classical concert business and, alongside repertoire selection, significantly determine ticket sales. Audiences value exceptional technical abilities, individual interpretation, as well as stage presence and appearance. In chamber music, distinguished as an intricate ensemble art form, an important distinction exists between musicians who form an established, well-rehearsed ensemble versus those who collaborate only occasionally—what might be termed their ensemble formation.

Our concerts featured two different professional ensembles addressing aspects of prestige and collaborative cohesion. Ensemble 1 (Yubal) consisted of young musicians not yet internationally recognized but who had performed together as a chamber music ensemble for several years (low prestige, established formation). Ensemble 2 (Epitaph) comprised senior musicians and internationally acclaimed soloists, only some of whom had previously collaborated in chamber music settings (high prestige, ad hoc formation). We investigated potential prestige effects against the possibly more polished interpretation achievable by a dedicated chamber music ensemble.

Moderation: In traditional classical concerts, all musician-audience communication typically occurs through musical performance itself. Other concert genres, particularly popular music, incorporate more direct communication forms such as artist speeches or vocal interaction—elements that effectively realize the co-presence aspect central to live performance. Within classical music, performers have increasingly experimented with verbal elements as more personal means of music delivery, helping audiences understand programming and interpretation choices (addressing the impersonal versus personal dimension identified by Sloboda & Ford 2019).

Building on this development, one concert featured a moderator who briefly introduced the topic of musical experience shared by audiences and musicians, then interviewed the musicians before the second and third works about their relationship to the pieces and their connection with the contemporary composer, who had previously performed his work with these musicians. This intervention targeted multiple experiential levels: (1) facilitating piece comprehension and programming understanding to increase emotional engagement, (2) making the contemporary work more accessible, (3) breaking the "fourth wall" between stage and auditorium characteristic of many performing arts, and (4) revealing musicians as personalities to foster personal audience-performer connections; effects that have been shown by previous research (Fischinger, Kaufmann, & Schlotz 2020; Wald-Fuhrmann et al. 2023). Overall, this approach emphasized concerts' inherent nature as social events, particularly the dimension of musician-audience co-presence.

Visual dimension: Unlike recorded music, concerts constitute multisensory experiences with particular visual significance. Audiences observe musicians performing, experience specific lighting of stage and auditorium, and engage with the concert hall's visual appeal. Media exposure has conditioned audiences to perceive audio-visual correspondences that enhance their experience.

We addressed this component through two approaches. From the seventh concert onward, constant stage lighting was replaced with scenarios matched to respective movement characters in color, brightness, and intensity. The intensification of the visual component primarily aimed to create more immersive, movement-specific experiences based on cross-domain mapping theories. In one concert, a large portrait-format screen positioned next to the ensemble displayed either close-ups of individual musicians filmed in real-time or, during movements of the contemporary piece, photographs and biographical information of the deceased individuals to whom movements were dedicated. This intervention sought to strengthen felt audience-musician co-presence, enhance immersion, and make the contemporary piece more approachable.

Programming: Concerts differ from many other music listening forms by presenting multiple pieces in specific sequences that may create reciprocal effects between works (Weber 2001; Marín 2018). Within relatively strict conventions, concert organizers invest considerable thought in sensitive, meaningful programming, sometimes reflected in concert titles. Our concert series adhered to programming conventions, while also including a novel work and elements of surprise (dimensions established versus

new work and predictable versus unpredictable per Sloboda & Ford 2019). The pieces shared the common theme of life's end, death, and remembrance. However, this theme was made explicit only in selected concerts (through moderation, screen elements, and participation) to see whether affective priming might enhance emotional engagement and help tolerate the contemporary piece. A further format variation targeted the common program order by interlocking movements from the contemporary and romantic pieces in three concerts (see Table 2). This created an expanded musical context with continuous stylistic contrasts, intended to increase immersion, suggest alternative, less challenging ways of perceiving the contemporary piece, and adding a component of surprise and unpredictability.

Audience participation: While classical concerts have been considered epitomes of presentational performance in contrast to participatory formats (Turino 2008), recent analyses suggest they also incorporate co-creation and participation aspects (passive versus active dimension per Sloboda & Ford 2019; see also Clarke 2005; Pitts 2005). Accordingly, composers and programmers have experimented with explicitly participatory elements to enhance audiences' sense of agency, contribution, and community (Toelle & Sloboda 2021).

One concert in our series investigated participation effects on musical experience. Before the performance, audiences learned that the programmed compositions addressed farewell and death, with the contemporary piece specifically dedicated to deceased friends and colleagues. Audience members could write names of important deceased individuals on paper, which was then placed on stage-present boards. This inclusion of audience-chosen commemorated individuals in the musical remembrance aimed to increase personal and emotional engagement, improve contemporary piece accessibility, and strengthen intra-audience bonds.

Acoustic component: Finally, one concert also targeted the acoustic dimension. It was sought to enhance the sound's enveloping and immersive qualities by distributing live audio through a loudspeaker array surrounding the audience.

To summarize, the concert formats comprised both conventional and artistic-experimental elements whose forms can be subsumed under the four key dimensions of concerts proposed by Sloboda & Ford (2019). Our concert formats and their varied elements thus address central aspects of theoretical debates and empirical findings on concert experience, as synthesized by Wald-Fuhrmann et al. (2021). They target the most important constitutive components of concerts (venue and staging, program, musicians, musician-audience relationship). They engage the central characteristics emerging from these components (framing and priming through the dedicated environment, co-presence and social experience, multisensory nature, meaningful relationships between pieces, liveness components of immediacy, unpredictability, social interaction, and shared experience). Finally, they aim at various experiential dimensions that research has identified as crucial for musical experience in general and concert experience in particular: aesthetic appreciation, emotional involvement, attention and immersion, musical understanding and intellectual stimulation, as well as feelings of connection with musicians and/or other audience members (Wald-Fuhrmann et al. 2023).

Participants

The concert experiments were advertised via the concert listings of the two venues, but also via newsletters, media reports, and social media. People who were interested in visiting a concert had to book a ticket either as a concert visitor or as a research participant for a day that was convenient for them. They were informed about the starting time, the venue and which of the two ensembles would be performing, but did not receive any information regarding the concert format. In total, $N = 802$ people took part as research participants, that is, between 37 and 96 per concert. Their mean age was 43.9 years ($SD = 17.5$). Of these, 54.4% identified as female and 40.9% as male. For 77.9%, German was their first language. The sample had a very high education level, with almost 80% having a university degree (23.9% had a degree in natural sciences or engineering, 18.8% in music, arts, or cultural studies, and 36.2% in other humanities or social sciences). This was also reflected in their professional status and employment: 25.4% of the participants worked as medium or high-ranking employees or civil servants, 14.3% were university students, 13.5% pensioners, 11.7% workers or basic employees / civil servants, and 10.3% worked as freelancers or self-employed.

Participants had gone to 8.0 classical concerts on average in the previous year and reached an average score of 4.3 ($SD = 1.0$) on the GoldMSI (Müllensiefen et al. 2017) subscale of active engagement and 3.3 ($SD = 1.5$) on musical training. 146 participants came alone, while the others visited the concert with someone else.

In sum, the sample represents the typical classical concert audience in a German metropole relatively well, only the average age is somewhat lower than expected (Chen & Cabrera 2023), which might be related to both the research context and the somewhat “younger”, more alternative and urban character of one of the two venues (venue 2) where the majority of concerts took place.

Procedure and technical setup

Participants arrived one hour before the concert started, gave their informed consent and filled out an entry questionnaire that asked about sociodemographic information, musical background, motivations and prior concert experiences. Trained assistants then fitted the physiological measurement apparatus to the participants at their seat in the hall. For each concert, 88 seats were equipped with a customised glove that held a hub from Biosignals Plux with sensors to measure blood volume pulse – HR – from the index finger, skin conductance – SC – from the middle and ring finger of the non-dominant hand, and a belt to measure respiration – RESP – from the belly. The pluxes were connected to a Raspberry Pi single-board computer at the back of each seat that transmitted the data through a network to a central server controlled by a customised software. More details on the technical set-up that was custom developed for this research project are described in Tröndle et al. (in review). Table 1 presents the music pieces, their order, and mean familiarity. Also during the concert, four (Pierre Boulez Saal) or eight (Radialsystem) Geutebrück infrared cameras that were placed on the ceiling above the stage filmed individual sections of the audience at 25 or 29.97 frames per second to document their behavior and facial expressions. After the concert, participants completed an exit questionnaire on their appreciation and experiences. The questionnaires were administered via a LimeSurvey mask on iPads. Questionnaires and physiological measurement were pretested in three concerts in 2020 (Tschacher et al. 2023b).

Measures and pre-processing

To assess participants' appraisal and subjective experience, the exit questionnaire included items on the evaluation (15 items) and experience (18 items) of various aspects of the concert, as well as items from validated scales to measure piece-related aesthetic emotions (three individual items from the AESTHEMOS scale, see Schindler et al. 2017) and social experiences (SECS scale with five dimensions, see O'Neill and Eggermann 2022). Most of the ratings were based on 5-point Likert scales. In order to calculate response scores that summarize the items on evaluation and experience of concert aspects, participants' agreement ratings of those items where initially subjected to exploratory factor analyses with oblimin promax rotation. Here, we identified five underlying factors that were subsequently represented by choosing the highest loading two to three items. We then ran a well-fitting confirmatory factor analysis on the subset of these items ($\chi^2 = 240.259$, $df = 67$, $P < 0.001$, $cfi = 0.944$, $rmse = 0.057$), that was used to calculate scores for each factor which we named (1) immersion, (2) intellectual stimulation, (3) evaluation of the performance, (4) venue experience, (5) evaluation of the concert design (Table 4 lists the items that belong to each dimension). A linear regression model showed that ratings of the item “liking of the concert overall” were mainly associated with the experience factor “evaluation of the performance” ($\beta = 0.449^*$), and also weakly with “intellectual stimulation” ($\beta = 0.149$) and “venue experience” ($\beta = 0.105$), but not with “immersion” and “evaluation of the concert design”. Valid questionnaire data were collected from 764 (SECS) to 787 (Concert experience dimensions) audience members.

Physiological responses represented the physiological arousal component of emotion and experience (Scherer 2005). In a procedure similar to the one used in Eggermann & Reuben (2020), we calculated three types of physiological response scores per participant and musical movement. Skin conductance measurements were averaged per musical movement and participant. Subsequently, we z-standardized the resulting response variable across all observations. The HR signal was first low-pass filtered (with a cut-off frequency of 2 Hz). We subsequently calculated the mean inter-heartbeat interval of each participant for each musical movement. The resulting mean values were again z-standardized and subsequently inverted by multiplying them with -1 in order to achieve a more intuitive score that increases

with heart rate (as opposed to one that decreases with increasing heart rate). The RESP signal was also low-pass filtered (0.35 Hz) and respiration rate was calculated with a peak-to-peak detection algorithm. We then calculated each participant's mean respiration rate per musical movement and z-standardized the corresponding outcome values.

Before z-standardization of all SC, HR, and RESP response scores, we plotted all participants' raw data separated by musical movement across time in order to identify any visible measurement errors and artifacts (that might have been caused by participant movement or sensor misplacement). Subsequently, we removed all erroneous response scores per movement and participant. This resulted in the removal of 1,066 of SC response scores leaving 6,324, of 686 HR response scores leaving 6,704, and 606 RESP response scores leaving 6,784.

To capture the audience's expressive behavior, facial expressions were extracted from the camera recordings made in the venue 2 (concerts 3–11). We did not use data from the venue 1, because here, participants had to wear face masks as a protective measure against COVID-19. After synchronizing the film tracks from the various cameras (ensuring identical starting and ending points within each concert and across all concerts, using Adobe Premiere Pro CC 2023), we used a UnixTime timestamp displayed on a tablet held up in front of the audience just before the start of each concert to align the camera recordings with the physiological data. Then, we assessed the quality of each filmed face (up to 80 faces per concert). More than 50% of the given seats in the audience were captured by more than one of the eight cameras, which allowed us to select the video material offering the best perspective on each face. Certain factors hindered the analysis of facial expressions in all concertgoers (e.g., facemasks, individuals' gaze direction, broad-rimmed glasses, full beards, etc.). In total, 391 individual faces were captured, of which 303 were of sufficient quality to be included in the analysis. Following the cropping of individual videos for each face, Affectiva Media Analytics, an automated facial expression analysis software (reliability comparable to EMG findings, Kulke et al. 2018), was used. Based on the emotional facial action coding system (Ekman, Friesen & Hager 2002), the software captures muscle movements in 23 facial "action units", which correspond to various emotional expressions either individually or in specific combinations. In addition to identifying basic emotions (anger, sadness, disgust, fear, joy, surprise, contempt) and more complex facial expressions (sentimentality, confusion, neutrality, and attention), the software also provides aggregated indicators of emotional expression (emotional engagement and valence). In this analysis, we focus on the facial expression aggregates of emotional engagement (general measure of overall engagement or expressiveness) and valence (degree of how positive or negative the facial expression is) because we aimed to reduce the number of dependent variables and therefore chose those two signals that can be seen as a summary of all other facial expressions identified. Similarly to physiological response data, we calculated the mean for valence and engagement per participant and musical movement, leading to a dataset of 3.030 observations. We then z-standardised the resulting two variables.

In the end, dependent variables were z-scored and included:

from the questionnaires:

- (1) three relevant single item ratings (evaluation of the concert as a whole, experience of being moved, evaluation of the interaction between the musicians and the audience),
- (2) five dimensions of concert experience (musical immersion, intellectual stimulation, evaluation of performance, venue experience, evaluation of the concert design; see Table 4 for individual items belonging to these dimensions),
- (3) five dimensions of social experience (SECS, O'Neill & Egermann 2022),
- (4) piece-specific ratings of aesthetic emotions that were selected from the AESTHEMOS scale (Schindler et al. 2017), i.e., (this piece made me) happy, annoyed, melancholic;

from the physiological recordings:

- (5) skin conductance level,
- (6) heart rate,
- (7) respiration rate;

from automatic analyses of audience members' facial expressions:

- (8) emotional valence (from negative to positive),
- (9) overall emotional engagement.

Analyses

It was our main aim to establish the type and size of effects of concert formats on various measures of audience experience. Since our data were gathered in real-life contexts where many of the parameters were beyond our experimental control, we used a rigorous statistical approach for our analyses fitting models that included not only predictors of interest, but also potentially confounding factors. Depending on the data structure, we fitted either GLMs (for questionnaire data on concert experience and social experience) or HLMs (for piece-related questionnaire data on aesthetic emotions, as well as for continuous data, i.e., physiological responses and facial expression). Accordingly, we either used the GLM procedure (GLMs) or the MIXED procedure (HLM) in SPSS. Fixed effects were concert format dummy variables (see Table 2), as well as person-related variables, that included age, gender, number of classical concert visits in the previous year, time of listening to classical music, GoldMSI Active Engagement, GoldMSI Musical Training, BIG-5 personality traits, while piece was defined as a repeated effect (only HLMs). Person-related variables were included in the models in order to control for differences in audience composition between the concerts but will not be reported in the results section. We followed a forward model fitting approach. In a first run of model fitting, we included all person-related characteristics as predictor variables. In the second run we added the concert format variables and the person-related variables with a *F*-test (GLMs) or a *t*-test (HLMs) value larger than 1 in the initial run. This way, we only included relevant person characteristics while also keeping linear models as parsimonious as possible. For HLMs, we fitted an additional first run in which we choose the best fitting residual covariance (*R*) matrix (*diagonal, compound symmetry or compound symmetry heterogeneous*) based on the AIC value. After this, the same steps as in the GLMs followed. This was done to account for the repeated measurement structure of the data.

Results

Overall, we found that heart rate and aesthetic emotions (in particular, being annoyed) were most susceptible to format changes, while intellectual stimulation, evaluation of the performances, SECS satisfaction, SECS depth of processing, and emotional engagement did not respond to our concert variations. Further, those concerts that differed very clearly from the standard format led to more and

stronger responses than those with only relatively subtle modifications. For an overview of all effects see Table 3.

Effects of the concert hall

As expected, the two venues were evaluated very differently by the audiences: People enjoyed the classical venue (Pierre Boulez Saal) more than the modern Radialsystem (effect on "evaluation of venue", $\beta = 0.696$, $t = 6.247$, $P < 0.001$), which was also associated with higher ratings of the concert as a whole ($\beta = 0.270$, $t = 2.249$, $P = 0.025$), deeper degrees of "musical immersion" ($\beta = 0.233$, $t = 1.986$, $P = 0.047$) and a more positive "evaluation of concert design" ($\beta = 0.321$, $t = 2.667$, $P = 0.008$), despite the absence of any "experimental" formatting in Pierre Boulez Saal. We also found that skin conductance responses tended to be stronger in the Pierre Boulez Saal ($\beta = 0.247$, $t(595.218) = 1.94$, $P = 0.053$). Further, Radialsystem was indeed preferred by younger audience members ($m_{age} = 40.2$ years ($SD = 16.0$) compared to $m_{age} = 56.1$ years ($SD = 16.6$) in venue 2).

Effects of the ensembles' prestige and formation

The concerts performed by the Yubal Ensemble attracted fewer listeners (mean $n = 56.3$) than those by the Ensemble Epitaph (mean $n = 79.5$) which might reflect the higher prestige of the musicians playing in the latter. Further anticipated effects on appreciation and experience were not found. A significant effect of ensemble was only found for one social experience dimension: Concerts played by the Ensemble Epitaph were related to higher self-definition of the participants with the audience (i.e., individual's recognition of similarities among group members or between themselves and the group; $\beta = 0.285$, $t = 2.304$, $P = 0.021$).

Effects of moderation and interviews with musicians

The presence of a moderator who interviewed the musicians during the concert successfully facilitated piece comprehension and programming understanding, as evidenced by enhanced emotional engagement: AESTHEMOS ratings showed that expressed and felt emotions became more congruent, with "made me happy" ratings decreasing for pieces by the classical ($\beta = -0.336$, $t(1081.695) = -2.296$, $P = 0.022$) and contemporary composers ($\beta = -0.552$, $t(1135.970) = -3.492$, $P < 0.001$), while "made me melancholic" ratings increased for these same pieces (classical piece: $\beta = 0.339$, $t(1090.718) = 2.273$, $P = 0.023$; contemporary piece: $\beta = 0.674$, $t(1160.914) = 4.280$, $P < 0.001$). This emotional alignment was also reflected in facial expressions, which showed more negative emotional valence during these two pieces (classical piece: $\beta = -0.385$, $t(439.155) = -2.281$, $P = 0.023$; contemporary piece: $\beta = -0.199$, $t(2014.783) = -2.347$, $P = 0.019$). The moderation also succeeded in making the contemporary work more accessible, as AESTHEMOS ratings of "annoyed me" for the contemporary piece were significantly lower in this condition ($\beta = -0.337$, $t(1006.758) = -2.027$, $P = 0.043$). Furthermore, the intervention effectively broke the "fourth wall" and fostered personal audience-performer connections, as evidenced by significantly higher ratings on the single item "interaction between the musicians and the audience" ($\beta = 0.716$, $t = 4.451$, $P < 0.001$). Finally, we found a non-significant trend for respiration to be faster in this concert ($\beta = 0.321$, $t(685.371) = 1.928$, $P = 0.054$).

Effects of a movement-specific lighting

Although we did not find the expected effects on immersion, lighting influenced some other dimensions: It reduced the ratings of the "interaction between the musicians and the audience" ($\beta = -0.381$, $t = 2.530$, $P = 0.012$), as well as the experience of the venue ($\beta = -0.272$, $t = -1.971$, $P = 0.049$), and was also associated with a slower heart rate ($\beta = -0.326$, $t(647.269) = -1.984$, $P = 0.048$).

Effects of visual augmentation (video screen)

The additional visual information presented on a large screen on the stage had only some of the anticipated effects, in particular, it led to an alignment of expressed and felt emotions (lower ratings of "made me happy" ($\beta = -0.331$, $t(762.023) = -3.133$, $P = 0.002$)) and made the contemporary piece more accessible (lower ratings of "annoyed me" ($\beta = -0.389$, $t(791.802) = -3.669$, $P < 0.001$)). But we found no significant effect on audience-musicians relationship. Instead, it led to a decrease of the social experience dimension attention towards other audience members ($\beta = -0.404$, $t = -2.491$, $P = 0.013$), while the change in solidarity just missed significance ($\beta = -0.319$, $t = -1.958$, $P = 0.051$). Further, we found positive effects on skin

conductance ($\beta = 0.427$, $t(594.708) = 2.720$, $P = 0.007$) and heart rate ($\beta = 0.478$, $t(646.702) = 2.938$, $P = 0.003$).

Effects of a modified programme structure

The interlocking of the movements by the contemporary and the romantic piece in three of the concerts led to mixed effects: While it was able to increase the audience's musical immersion ($\beta = 0.312$, $t = 2.049$, $P = 0.041$), it was also associated with increased feelings of being annoyed ($\beta = 0.341$, $t(793.684) = 3.218$, $P = 0.001$).

Effects of audience participation

The audience participation concert showed mixed results regarding its intended effects. Contrary to expectations for increased personal and emotional engagement, this concert led to lower ratings in two social experience dimensions: attention to other audience members ($\beta = -0.450$, $t = -2.751$, $P = 0.006$) and self-definition as part of the audience ($\beta = -0.333$, $t = -2.052$, $P = 0.041$), suggesting weakened rather than strengthened intra-audience bonds. However, the intervention did improve contemporary piece accessibility, as evidenced by decreased ratings of being annoyed ($\beta = -0.226$, $t(792.580) = -2.121$, $P = 0.034$). Additionally, we found that heart rate was on average faster in this concert ($\beta = 0.398$, $t(647.146) = 2.536$, $P = 0.011$), which may indicate increased physiological engagement despite the contrary social bonding effects.

Effects of immersive sound

Using a loudspeaker array to envelop the audience in the sound was not related to self-reports of higher immersion, but only associated with an increased heart rate ($\beta = 0.574$, $t(647.156) = 3.578$, $P < 0.001$).

Relative contribution of concert formats on aesthetic experience

In the context of our underlying framework, it would be important to quantify the strength of the relative influence of the concert frame on the aesthetic experience in comparison to the two other main factors, i.e., the music and the person. There is, however, no straightforward way to do this. But we may at least propose the following approximation: Our models allow to directly compare the effects of person-related and concert format variables, in the case of the Hierarchical Linear Models (HLMs) also effects of musical pieces, with the help of parameter estimates (β values). The strength of the influence of the music can only very indirectly be estimated from the delta between $R^2 = 1.00$ and the R^2 values of our models.

However, while the list of frame components relevant in our experimental concerts is complete, the same cannot be said of the person-related variables. Although we captured a large variety of such variables in accordance with the existing literature, it is still likely that other influential factors exist that were not accounted for in our study.

In the case of the five dimensions of concert experience and appreciation, the following picture can be seen: The General Linear Models (GLMs) including frame and person-related variables explain between 10 and 23% of the total variance per dimension (adjusted R^2 values). Parameter estimates for person-related variables range from 0.071 to 0.209 and for frame components from 0.233 to 0.696.

A similar pattern emerges for the five dimensions of social experience, although the explained variance is much smaller (adj. R^2 values range from 0.016–0.067). Parameter estimates for person-related variables range from 0.084 to 0.198 and for frame components from 0.285 to 0.450.

Physiological responses were more often associated with frame and music (pieces) predictors than with person-related variables. Parameter estimates for person-related variables range from 0.081 to 0.436, for frame components from 0.326 to 0.574 and for musical pieces from 0.031 to 0.242.

Overall emotional engagement as measured from facial expressions was only associated with two person-related factors (β values of 0.099 and 0.109) and one frame component ($\beta = .050$), while emotional valence was associated with two interaction effects of frame component and musical piece (β values of 0.199 and 0.385).

Discussion

Our results show that in a live context, people's aesthetic experience is not exclusively dependent on the music and how it is performed by the musicians, but co-constituted by frame components such as the space, the visual and acoustic design of the performance, as well as verbal primings and modifications of the typical roles associated with classical musicians and audiences. Thus, we could experimentally corroborate the theoretical framework we presented in an earlier article (Wald-Fuhrmann et al. 2021) and add quantitative findings from an ecologically valid setup to the existing literature on the relevance of the context for aesthetic experiences (Hargreaves 2012; Leder & Nadal 2014).

Effects on the four levels of measurement

Overall, we found effects on all four levels of measurement (appraisal, subjective experience, physiological response, expressive behavior), but in contrast to controlled laboratory experiments on emotions (e.g., Bradley et al. 2001; Grewe et al. 2009; Fuentes-Sánchez et al. 2021) the effects did almost never appear on all levels at the same time. This confirms the benefit of our multilevel approach, but also poses some questions. At this stage of research, we cannot fully interpret this observation. But it seems likely that the naturalistic context and the data collection design we had chosen were at least in part responsible for this. While controlled studies on emotion focus on short, individual episodes and their direct measurement, our concerts unfolded over a much longer timespan of c. 70 minutes. Appraisal and experience ratings were collected *post hoc* from memory and our continuous *ad hoc* data (physiological responses, facial expressions) was averaged across musical movements. However, in the light of the disadvantages of the design – which we had knowingly accepted in order to allow as much ecological validity as possible – we believe that the effects we did find are robust. Further studies could try to find ways to improve multimodal measurement setups and refine analyses, e.g., by zooming in on individual sections and events. Some other studies, e.g., have collected self-reports after each musical unit such as a piece or movement of a piece, which resulted in a stronger correlation between subjective experiences and physiology (Egermann et al. 2013; Egermann & Reuben 2020; Merrill et al. 2021).

Despite the *post hoc* design, the majority of effects were found on the levels of subjective appraisal and experience. Of these, three of the concert-specific appreciation and experience dimensions, i.e., music immersion, evaluation of the venue, evaluation of concert design, as well as two of our three relevant AESTHEMOS ratings were particularly susceptible to the concert frame, but not the overall appreciation of the concert or music-immanent dimensions such as intellectual stimulation and evaluation of the musicians. As in earlier studies by Swarbrick et al. (2021) as well as Swarbrick and Vuoskoski (2023), concert format did not influence how moved the audience felt. Also, the five dimensions of social audience experience did only rarely respond to the format changes, and if so, felt connection with the other audience members decreased. We see this as an indication for a specific and selective rather than global effect of the concert frame on the aesthetic experience of a live audience. In particular, the appreciation of the music itself and its performance, as well as of the concert as a whole seem to be difficult to affect by the concert frame. This is in line with results from our study on concert streams (Wald-Fuhrmann et al. 2023) and an analysis of social experience dimensions in live classical concerts that were found to be related to overall enjoyment, but not to emotional responses to the music (O'Neill & Egermann 2022). A dissociation between aesthetic judgment on the one hand and enjoyment of and affective responses to a live music performance on the other had already been found by Thompson (2006). It also confirms our approach to understand musical experiences in live concerts as multidimensional and to measure them in a nuanced and differentiated manner. We would not want to generalize our findings on the social experience dimensions, however. That almost none of our format variations succeeded in increasing social experience might rather be the obvious result of the fact that all concerts kept the typical setup of an audience seated in tiers and facing towards the stage without any encouragement to interact. While this was mainly done for technical and practical reasons, it can be expected that other audience constellations might positively influence the social experience of an audience as was already shown in studies that compared various types of concert streams or used an VR environment (Shin et al. 2019; Onderdijk et al. 2021; Swarbrick et al. 2021; Wald-Fuhrmann et al. 2023; Swarbrick & Vuoskoski 2023).

Of the physiological responses we collected, heart rate responded most often to format changes and was affected by both visual (lighting, screen) and acoustic stimuli (immersive sound), but also by an externally triggered change of listening mode (participation). When compared to the related questionnaire results,

increases in heart rate seem to be associated with a more positive or engaged listening experience, while a decrease seems to signal a less positive experience. This interpretation is also supported by earlier studies that have shown that heart rate is not just an index of arousal, but also of positive aesthetic experiences (of music) (Blood & Zatorre 2001; Salimpoor et al. 2009). In particular, Czepiel et al. (2021) reported heart rate in live concerts with the same musical programm as ours to be predicted by self-reported positive emotions, while Tschacher et al. (2023b) found increased heart-rate synchrony of a concert audience to be related to being moved, immersed and feeling inspired by a piece.

An effect of concert formats on expressive facial behaviour was found in only one case which, however, was congruent with the questionnaire data. In principle, expressive behaviour of the audience is not part of the classical concert etiquette. Due to the typical seating arrangement of tiers it cannot easily fulfill a communicative function as it does in many real-live social situations or concerts of other music genres. It is therefore plausible to expect only limited and unsystematic facial expressions in classical concert audiences. In addition, the captured facial expressions seem to occur more as a direct response to the music and its expressiveness (as in Kayser et al. 2022) and are not strongly influenced by concert formats. Last but not least, automated facial expression analysis in ecologically valid concert situations with many visitors still faces limitations due to poor lighting conditions and the resolution at which individual faces can be captured, which might also explain the small observed effects.

Concert format effects

When creating the various concert formats that served as experimental stimuli, we drew upon four key sources: the practical expertise and theoretical reflection of the project's artistic director, systematic observation of current experimental practices in the concert field, established theories of concert performance and liveness, and empirical research on audience experience. These format variations were designed to target specific experiential dimensions, and our results reveal distinct patterns of which interventions successfully influenced particular aspects of concert experience.

Emotional alignment and congruence: Three format components successfully enhanced the congruence between expressed and felt emotions, suggesting that certain interventions can facilitate more authentic emotional engagement with musical content. Moderation and musicians' interviews produced the strongest effects in this domain, with audiences showing decreased "made me happy" ratings and increased "made me melancholic" ratings for both classical and contemporary pieces, accompanied by corresponding changes in facial expressions. Visual augmentation and information via a screen display achieved similar but more limited emotional alignment, reducing "made me happy" ratings without the complementary increase in melancholic responses. This emotional alignment reflects successful facilitation of piece comprehension and programming understanding, as these interventions helped audiences connect with the inherently melancholic themes of farewell and death that characterized our program.

The differences that emerged between the verbal and the visual priming route can be explained by drawing from general research on priming. Both modalities likely activated semantic and affective priming mechanisms, but with different strengths and processing pathways (Klauer & Musch, 2003; Storbeck & Robinson, 2004). The verbal moderation condition combined semantic priming—through explicit activation of death-related conceptual networks via musicians' personal accounts—with direct affective priming through the emotional valence of the spoken testimonials. This dual-mechanism approach created stronger spreading activation across both semantic and emotional memory networks (Storbeck & Robinson, 2004). In contrast, the visual presentation primarily relied on semantic priming, as the photographs with names and dates activated death-related associations but provided less direct affective content.

The concert involving personal memorial contributions from audience members (audience participation), in contrast, failed to produce emotional deepening effects. This null finding can be explained by several priming mechanisms: the temporal distance between writing personal names before the concert and the musical experience likely exceeded effective priming durations, the lack of specific contingency between personal names and particular musical pieces weakened the prime-target relationship, and the highly personal nature of the stimulus may have triggered emotional regulation mechanisms that reduced rather than enhanced engagement (Klauer & Musch, 2003). This finding underscores that effective contextual

priming requires appropriate temporal contiguity and optimal emotional intensity, not merely thematic relevance.

Contemporary music accessibility: Reducing negative responses to contemporary music emerged as one of the most consistent effects across our format variations. Moderation and musicians' interviews significantly reduced annoyance ratings for the contemporary piece, likely through the personal contextualization provided by the composer's presence and the musicians' relationship narratives. Visual augmentation achieved even stronger effects in this domain, with the largest reduction in annoyance ratings observed across all interventions. The biographical information and photographs of deceased individuals provided concrete, relatable context for the abstract contemporary composition. Audience participation also contributed to contemporary music accessibility through reduced annoyance, as the personal connection to themes of remembrance created emotional investment in the musical content. Notably, these three successful interventions all involved personalizing or contextualizing the contemporary work through additional verbal or visual information or emotional connection, suggesting that accessibility barriers to contemporary music may be overcome through enhanced understanding and personal relevance rather than purely musical strategies, in line with a study on the different effects of emotional vs. music-analytical program notes (Fischinger et al. 2020).

Overall, our interventions effectively addressed typical barriers towards contemporary classical music by providing contextual scaffolding that reduced cognitive load and uncertainty while creating personal relevance (Schäfer & Sedlmeier, 2009). This supports theories of music accessibility emphasizing that engagement with contemporary works may depend more on enhanced understanding and emotional connection than purely musical factors (Fischinger et al., 2020), transforming the listening experience from effortful processing of unfamiliar stimuli to meaningful engagement with personally relevant content.

Physiological arousal and engagement: Heart rate increases emerged as a consistent physiological response across multiple format interventions, suggesting that departure from traditional concert conventions inherently activates audiences at a biological level. Immersive sound produced the strongest heart rate elevation, followed by visual augmentation, audience participation, and moderation (trend level). This pattern suggests that multisensory enhancement and active engagement components most effectively increase physiological activation.

Social experience and connection: Format effects on social dimensions revealed complex, often competitive relationships between different types of connection and attention. Musicians-audience interaction was most strongly enhanced by moderation and interviews, confirming the intervention's success in breaking the "fourth wall" and fostering personal connections. However, this came with subtle costs elsewhere, as both visual augmentation and audience participation reduced attention to other audience members, while participation also decreased self-definition as part of the audience. This pattern suggests an "attention economy" within concert experience, where enhanced focus on specific relational aspects (musician personalities, visual content, personal memories) competes with broader social awareness and collective identity formation.

Venue effects and environmental priming: Concert venue emerged as a foundational environmental priming factor influencing multiple experiential dimensions simultaneously. In particular, perceived venue quality was directly related to core measures of concert experience including overall concert liking, musical immersion, and concert design appreciation. The traditional venue (Pierre Boulez Saal) produced consistently higher ratings across these dimensions while also trending toward stronger skin conductance responses. These effects demonstrate the venue's dual role as environmental prime and facilitator of optimal listening conditions, aligning with research on contextual priming where physical environments automatically activate associated cognitive schemas and behavioural expectations (Smith & Vela, 2001). The traditional concert hall likely primed classical music listening schemas, enhancing receptivity to the musical content through environmental congruence.

Although younger audiences seemed to be attracted by the more modern and unconventional industrial environment, this attraction did not transform into a more positive concert experience. This counter-intuitive finding suggests that venue effects may be mediated by cultural associations and aesthetic expectations that operate below conscious preference levels, with traditional concert hall features resonating more strongly with audiences already committed to classical music conventions. This supports theories of schema-congruent priming, where environmental cues activate culturally learned expectations that facilitate or hinder processing of subsequent stimuli (Herring et al., 2013). The industrial venue may

have created incongruent priming for traditional classical music, requiring additional cognitive resources to reconcile the environmental-musical mismatch, potentially explaining the reduced immersion and evaluation scores despite initial aesthetic appeal.

Musical immersion and deep engagement: Only two format components successfully increased musical immersion: the traditional venue and modified programming through interlocking movements. The venue effect aligns with our theoretical predictions about environmental optimization for musical focus, while the programming effect suggests that stylistic contrasts and an unexpected series of events may increase immersion by sustaining attention, in line with general research on attention focus and working memory (Lavie, 2010).

Implications for concert design

Re-inventing the classical concert has been a high priority for concert managers and musicians in light of the often discussed crisis of the classical concert. The concert venue and the concert format have been in the center of these artistic deliberations and experiments. Our results confirm from an experimental-psychological perspective that these efforts are worthwhile (but see Tröndle et al. 2025). They also suggest that concert format effects may operate through distinct mechanisms rather than uniformly enhancing all aspects of experience, though these findings should be interpreted with appropriate caution given that each format variant represents only one of countless possible implementations.

The most consistent effects emerged from interventions that provided additional context, meaning, or personal connection to a highly demanding musical content—moderation, visual content on a screen, and audience participation—suggesting that format innovations may be most effective when they address cognitive and emotional barriers to engagement rather than simply intensifying sensory experience.

However, it is important to note that alternative approaches to these interventions (different types of visual content, varied moderation styles, or other forms of participation) might yield substantially different results. The venue effects revealed a fundamentally different mechanism of influence, operating through purely musical and concert-inherent components—architectural acoustics, environmental comfort, and aesthetic appropriateness—rather than through added content or interaction elements. This venue influence on musical immersion and overall appreciation represents a more direct path to enhanced musical experience, suggesting that optimizing fundamental concert conditions may provide a foundation upon which other format innovations can build. The robustness of these venue effects across multiple experiential dimensions indicates that environmental factors may indeed set boundary conditions within which other format innovations operate.

The consistent pattern of attention trade-offs across multiple interventions—where enhancing one type of connection or engagement came at the cost of others—suggests an important principle for format design, though the specific manifestation of these trade-offs would likely vary considerably with different implementation approaches. This indicates that format designers should carefully consider their primary experiential goals and accept that comprehensive enhancement across all dimensions may not be achievable simultaneously.

Finally, the dissociation between behavioral effects (attendance) and experiential effects (appreciation, engagement) observed for ensemble prestige highlights the importance of distinguishing between factors that attract audiences and those that enhance their actual concert experience. However, the specific balance between prestige and collaborative excellence observed in our study represents just one possible configuration of these factors.

Given the preliminary nature of systematic experimental research on concert formats, these implications should be viewed as initial insights rather than definitive principles, requiring further investigation across varied implementations and contexts to establish their generalizability and their usefulness for concert practitioners.

Limitations and future perspectives

Most limitations of our study need to be considered in light of the unavoidable trade-off between an ecologically valid study design (with high external validity) and precise control over manipulations and measurements (with high internal validity) (see also Danielsen et al. 2023). For instance, some concert variants attracted fewer participants than others, leading to potentially smaller statistical test power for some concert format effects tests.

This trade-off also applied to the recording of audience faces for facial expression analysis. A more technically optimized setup—with brighter lighting, a greater number of cameras positioned closer to the audience, and instructions asking participants to keep their faces uncovered and oriented toward the stage—would likely have increased the number of analyzable faces and allowed for the detection of more subtle facial expressions. However, such adjustments would have compromised the naturalness of the concert experience. Future studies could improve data quality while preserving ecological validity by using higher-resolution infrared cameras and strategically positioned devices with optimized placement.

Musical experiences in a concert are dynamic and may intensify, weaken, or change their character in response to musical developments and the varying character of individual pieces and movements. These dynamics were not fully captured by our post-concert questionnaires, which may have resulted in less differentiated findings regarding the subjective experience. To partially account for this, we used continuous measurement of physiological responses and facial expressions. However, future studies should increasingly substitute retrospective questionnaires with continuous measurement methods that follow audience experiences and listening behavior with higher temporal resolution.

This approach would require researchers to identify valid objective indices of various relevant subjective experience dimensions—a goal that has only been partially accomplished and may not be possible in all cases. Promising new avenues include recordings of audience bodily actions and movements, analyzed for their synchronization (e.g., Seibert et al. 2019; Tschacher et al. 2024) or for moments of collective and music-related "stilling" (Upham et al. 2024; Martin & Nielsen 2024). From a completely different angle, also qualitative data can meaningfully complement quantitative data types. Böndel et al. (2025) present results of post-concert interviews conducted within our research project, providing additional nuanced insights on how the different concerts were experienced.

The non-representative nature of our individual concert format variants raises questions about generalizability to other potential artistic interventions. However, we believe the study's main contribution is not to prove that specific interventions tested will always produce the reported effects, but rather to demonstrate that changes to the concert frame can systematically alter audience musical experiences, even when the musical content remains constant. This establishes the principle of format-dependent experience modulation and provides a theoretical framework for understanding how different priming mechanisms operate in concert settings.

Furthermore, our findings should be understood within their specific cultural context. It remains to be explored how different audiences within non-European or non-Western-art-music contexts would respond to similar concert format manipulations, and whether the priming mechanisms we identified operate on a more general or a culturally specific level.

Several avenues for future investigation emerge from our findings:

- Systematic variation of format elements: Testing different implementations of verbal, visual, and environmental priming as well as sensory intensification to establish optimal parameters for various musical genres and audiences
- Cross-cultural validation: Examining whether semantic, affective, and environmental priming mechanisms operate similarly across different cultural contexts and musical traditions
- Long-term effects: Investigating whether format-enhanced concert experiences influence subsequent music listening behavior, concert attendance patterns, or musical preferences
- Individual differences: Exploring how personality traits, musical training, and demographic factors moderate responses to different priming interventions

- Real-time measurement integration: Developing more sophisticated continuous monitoring techniques that can capture moment-to-moment changes in attention, engagement, and emotional response

Overall, this study provides important methodological and topical contributions to current research on the constituents and experiential dimensions of liveness, the influence of contextual factors on aesthetic experiences, and large-scale quantitative research in naturalistic environments. By identifying specific psychological mechanisms underlying format effects—particularly various forms of priming—our results offer practitioners in live music concrete theoretical frameworks for developing promising new approaches to the classical concert to further realize its specific potential for affording intense, rewarding, and social experiences with music while adapting to contemporary audience needs and expectations.

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Figure 1. Schematic depiction of the study design. Data that were collected during the three phases of each of the eleven concert experiments (before the concert: questionnaire, during the concert: physiological responses and facial actions, after the concert: questionnaire). This figure is covered by the Creative Commons Attribution 4.0 International License. Copyright © Max Planck Institute for Empirical Aesthetics, all rights reserved.

Table 1. Overview of music pieces performed in concerts

Piece No.	Composer	Familiarity ¹ M(SD)	Movements	Presentation order 1	Presentation order 2
1	Ludwig van Beethoven: string quintet op. 104, c minor (1817) (approx. 10 min.)	2.7 (1.5)	1. Allegro con brio	1.	1.
2	Brett Dean: Epitaphs (2010) (approx. 20 min.)	1.4 (1)	I. Only I will know (... in memory of Dorothy Porter) II. Walk a little way with me (... in memory of Lyndal Holt) III. Der Philosoph (... in memory of Jan Diesselhorst) IV. György meets the "Girl Photographer" (... in memory of Betty Freeman, hommage à György Ligeti) V. Between the spaces in the sky (... in memory of Richard Hickox)	2. 3. 4. 5. 6.	2. 3. 6. 7. 9.
3	Johannes Brahms: string quintet op. 111, G major (1890) (approx. 30 min.)	2.7 (1.5)	1. Allegro non troppo, ma con brio 2. Adagio 3. Un poco allegretto 4. Vivace ma non troppo presto. Allegro assai	7. 8. 9. 10.	4. 5. 8. 10.

¹Familiarity was rated as agreement to the statement "This piece ... was known to me", on a scale from 1 "totally disagree" to 5 = "totally agree", Beethoven: n=765, Dean: n=778, Brahms: n=751.

Table 2. Overview of concert formats

	Concert format variants
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Concert (participants)	Spatial- architectural environment (1 = Boulez Saal, 0 = Radialsystem)	Ensemble characteristics (0 = newcomers, 1 = seniors)	Moderation and interviews with musicians (0 = not present, 1 = present)	Audience participation (0 = not present, 1 = present)	Visual enhancement: movement- specific lighting (0 = not present, 1 = present)	Visual component: screen (0 = not present, 1 = present)	P int of (p p
1 (89)	1	0	0	0	0	0	
2 (97)	1	1	0	0	0	0	
3 (38)	0	0	0	0	0	0	
4 (42)	0	0	0	0	0	0	
5 (73)	0	1	0	0	0	0	
6 (58)	0	1	1	0	0	0	
7 (73)	0	1	0	0	1	0	
8 (79)	0	1	0	0	1	0	
9 (74)	0	1	0	1	1	0	
10 (83)	0	1	0	0	1	1	
11 (99)	0	1	0	0	1	0	

Table 3. Effects of concert format manipulations on audience experience

Dependent variables	Concert format variants						
	Spatial-architectural environment (Boulez Saal)	Ensemble characteristics (seniors)	Moderation and interviews with musicians	Visual enhancement: movement-specific lighting	Program: interlocking of pieces 2 and 3	Audience participation	Visual component: Screen
Single items from questionnaires							
Concert overall	0.270						
Being moved							
Interaction musicians – audience			0.716*	-0.381*			
Appreciation and experience dimensions							
Immersion	0.233*				0.321*		
Intellectual stimulation							
Eval. musicians							
Eval. venue	0.696*			-0.272*			
Eval. concert design	0.321						
Social experience factors (SECS)							
Satisfaction							
Attention						-0.450	-0.404*
Self-definition		0.285*				-0.333*	
Solidarity							-0.319
Depth of processing							
Aesthetic emotions (AESTHEMOS)							
Made me happy			cl: -0.336* cont: -0.552*				-0.331
Annoyed me			cont: -0.337*		0.341	-0.226*	-0.389*
Made me melancholic			cl: 0.339* cont: 0.674*				
Physiological responses							
Skin conductance	0.247						0.427
Heart rate				-0.326*		0.398*	0.478
Respiration rate			0.321				
Facial expressions							
Emotional valence			cl: -0.385* cont: -0.199*				
Emot. engagement							

Note. Values in the cells are standardised parameter estimates (β values). Asterisks indicate the level of significance ($P < 0.001^*$, $P < .01$, $P < 0.050^*$).

Italics mark results that minimally missed statistical significance ($P < 0.055$). cont = contemporary piece, cl = classical piece.

Table 4. CFA factor loadings for dimensions of concert experience

Factor	Item	Factor loading Estimate	Std.Er r	z- value	p(> z)
	<i>I was able to immerse myself in the music with all my senses.¹</i>	1.000			
Musical immersion	<i>I was able to establish a deep connection to music.¹</i>	1.008	0.047	21.34 4	<.001
	<i>I was able to concentrate entirely on the music.¹</i>	0.924	0.050	18.49 4	<.001
	<i>I was able to expand my understanding of music through the concert.¹</i>	1.000			
Intellectual stimulation	<i>I was surprised by new impressions.¹</i>	0.938	0.072	13.06 9	<.001
	<i>I was able to get to know new works.¹</i>	0.691	0.057	12.02 6	<.001
	<i>I found the musicians...²</i>	1.000			
Evaluation of the performanc e	<i>I found the interpretation of the pieces...²</i>	1.202	0.066	18.08 6	<.001
	<i>I found experiencing the musicians live...²</i>	0.910	0.050	18.24 3	<.001
	<i>I found the ambience of the concert venue...²</i>	1.000			
Venue experience	<i>I was disturbed by background noises or something else.¹</i>	-0.886	0.118	-7.528	<.001
	<i>The seating comfort during the concert was...²</i>	1.260	0.127	9.915	<.001
	<i>I could recognize the theme.¹</i>	1.000			
Evaluation of the concert design	<i>I found the staging of the performance...²</i>	0.771	0.092	8.413	<.001

Note. ¹Rated on a scale from 1 = *I do not agree at all* to 5 = *I completely agree*; ²Rated on a scale from 1 = *very bad* to 5 = *very good*.

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Contributions

Melanie Wald-Fuhrmann was involved in the study design, questionnaire development, data collection and self-report data analysis, and drafted and finalised the paper. Ann-Kristin Herget was involved in data collection, conducted the facial expression analysis and contributed to the paper. Martin Kreutzer was involved in data collection, interpretation of statistical analyses and contributed to the paper. Hauke Egermann was involved in the study design, questionnaire development, data collection, physiological response processing and data analysis and contributed to the paper. All authors read and approved the final version of the paper.

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Ethical declarations

Competing interests

The authors declare no competing interests.

Ethical approval

All procedures performed in this study were approved by the ethics council of the Max Planck Society as of 20 December 2017, application ID 2017_12. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed Consent

All participants gave their informed written consent on the day of their concert directly before the study started (concert dates were April 12, 13 and 30 2022 and May 1–6 2022). The consent included collection of self-report, audio, video, and physiological data, its pseudonymised storage, processing, and publication of results in scientific outlets and for public outreach purposes.

Data Availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

■ Boulez Saal
■ Radialsystem

