

# Movement Perception in Music Performance – A Mixed Methods Investigation

Jan C. Schacher, Hanna Järveläinen, Christian Strinning

Institute for Computer Music and Sound Technology ICST

Zurich University of the Arts, Zürich, Switzerland

{jan.schacher,hanna.jarvelainen,christian.strinning}@zhdk.ch

Patrick Neff

Department of Psychology

Zurich University

patrick.neff@uzh.ch

## ABSTRACT

What are the effects of a musician's movement on the affective impact of experiencing a music performance? How can perceptual, sub-personal and cognitive aspects of music be investigated through experimental processes? This article describes the development of a mixed methods approach that tries to tackle such questions by blending quantitative and qualitative methods with observations and interpretations. Basing the core questions on terms and concepts obtained through a wide survey of literature on musical gesture and movement analysis, the iterative, cyclical advance and extension of a series of experiments is shown, and preliminary conclusions drawn from data and information collected in a pilot study. With the choice of particular canonical pieces from contemporary music, a multi-perspective field of questioning is opened up that provides ample materials and challenges for a process of converging, intertwining and cross-discipline methods development. The resulting interpretation points to significant affective impact of movement in music, yet these insights remain subjective and demand that further and deeper investigations are carried out.

## 1 Introduction

In this article we explore the potential that a mixed methods approach provides to investigating movement in music performance. The central question of this investigation is if and how those aspects of a musician's playing actions that carry affective potential can be observed, measured and classified. This research is done by blending empirical and systematic, quantitative with qualitative and interpretative analysis methods in a convergent concurrent design [1]. Within this triangulation, the disciplines of Music Analysis, Music Psychology – both in quantitative and qualitative modes – and Music Technology encircle the musician's practice.

The challenge of this methodology is to find ways to bridge between the different disciplinary methods, to make things commensurable and to achieve an equivalence of results necessary for interpretation. One of the aims of this article is to explore the intersections and particularities of the different perspectives, and to ascertain and get a clearer notion of the validity of such a multi-perspective approach.

As the literature on 'Musical Gesture' [2] from the past decade and a half has shown, music perception and music making is highly multimodal and therefore needs to be investigated in a cross-disciplinary way. When considering music as a broad category that represents an inherently cultural phenomenon, then the number of involved domains becomes even larger. This fact makes delimiting the field of enquiry essential. The choices in the enquiry discussed here are made from a perspective that focuses mainly on the act of music performance on a fundamental perceptual level rather than through stylistic and cultural categories or through dimensions of signification in musical terms. The choice is also informed by the necessity to have the topic be grounded in the our own practice, expertise and interests.

## 2 Background

Before detailing the investigation we are undertaking to elucidate aspects of movement perception in musical performance, it is important to situate our point of view and choice of methods. The standpoint we are taking is informed by complementary but also competing fields; complementary in the overlap of perspectives, competing with regard to validation of results between quantitative and qualitative approaches.

### 2.1 Mixed Methods Research

Mixed methods research began in the late 1950s in the social, behavioural and human sciences, when a third way was postulated to complement and unite the two dominant strands of quantitative and qualitative methodologies. The central idea is that through triangulation a higher validity of results can be achieved [3]. Through the four types of data-, investigator-, theory- and methodological triangulation, but importantly also through between-methods triangulation three effects arise: convergence, inconsistency, and contradiction [4]. All three effects can provide richer explanations of social phenomena, because creative ways of collecting data need to be developed, thicker and richer data collected, different theories synthesised or integrated, contradictions uncovered, and competing theories validated [5]. Even if a short definition of mixed methods research describes it as "the combination of methodologies in the study of the same phenomenon." [4, p.291], this does not explain how validity can be achieved, if this is indeed the goal. The purpose of mixing methods is understood as a critical step in designing a research project, which – apart from touching on a deeper level of knowledge generation – also has practical implications. Mixed

methods research can serve to: “validate and explicate findings from another approach and produce more comprehensive, internally consistent, and valid findings; provide more elaborated understanding and greater confidence in conclusions; handle threats to validity and gain a fuller and deeper understanding; and provide richer/more meaningful/more useful answers to research questions.” [6, p.122] The gain of using this framework is as much a strategic one as it is pragmatic in guiding research activities. These inner and outer effects have to do with the context of the research, thus in social sciences the justification has a different import than in music research. A comprehensive definition that is discipline-agnostic and positions triangulated mixed methods in a relevant way is given by Johnson et al.: “Mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration.” [6]

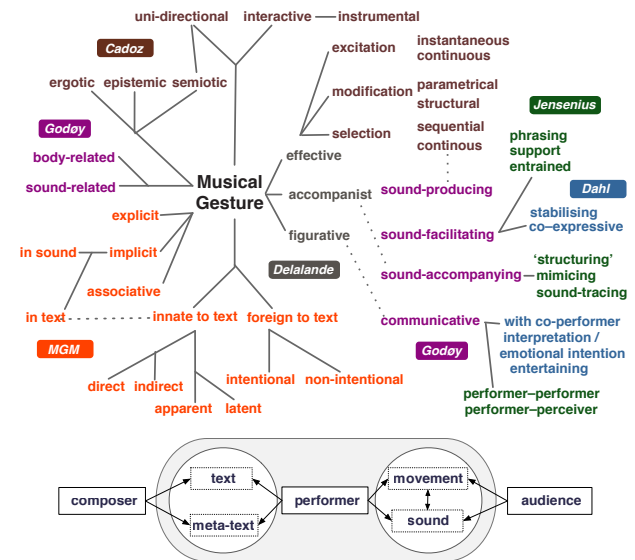
## 2.2 Research on Movement in Music

Our investigation spans a range of disciplines that overlap in some way with the domain of music and movement research. The following overview of topics and sources may serve as a map to delineate the field of references we operate in: Musicology approaches on gesture and semiotics of music [7–10], linguistics related to music and gesture [11–13], music psychology dealing with emotion and affective mechanisms [14–16], cognitive sciences delineating embodiment and ‘enaction’ [17, 18], psychological philosophy of body perception [19, 20], gestalt psychology and ecological embedded-ness [21, 22], human-computer interaction (HCI) for music [23], and systematic as well technical research on machine learning and mapping [24, 25]. The categorisations proposed by Cadoz [26] and Wanderley [27] were milestones in the domain of electroacoustic music related to gesture analysis, in particular the concept of a ‘gestural channel’ of transmission as well as the categorisation of instrumental gestures into excitation, modification and selection gestures. Within systematic musicology several projects deal with music-technological methods for investigating musical gesture in a multimodal way. The investigations on sound-tracing [28] and gestural music mimicking provide an important reference point [29], and the topical publication on musical gesture by Godøy [30] is particularly relevant. Similarly important is the research by Camurri on expressive gesture including the development of the Eyesweb platform [31, 32]. The tools developed by Gillian in Belfast [33] and Princeton [34] provide a useful basis for the software developments in our own project.

The field of dance research needs to be taken into account as well, where the shared fundamentals of Laban movement analysis [35] connect to music performance, even if specific projects in dance deal with other issues, such as notation, transmission and documentation [36, 37].

## 3 Terminological Explorations

Based on these background topics, we set out to make a map related to the term ‘musical gesture’. The main purpose of this analysis was to clarify the standpoint from which our own investigation is led. By taking definitions from the aforementioned literature [9, 26, 30] and adding specific references [38, 39], the purpose is to render visible the relationships of aspects of ‘gesture’ between composer, performer and listener, looking on the one hand at the presence of traces of embodied thinking in the score/text and on the other hand at the effect of the performer’s movement on the audience.



**Figure 1.** A map of terminologies on Musical Gesture and a relational schema of the music performance actors and mediating elements. Dashed lines show equivalence.

In the lower part of Figure 1 the relational schema of the actors in a music performance situation is sketched out. Not all musical styles manifests all the elements in the same way, but all elements are always present. Interesting for our analysis is on the one hand the tripartition between composer, performer and audience, and in a particular the equivalence of text (i.e., score), meta-text (i.e., common practices) with sound and movement as carriers of meaning. The schema should not be read as a directional flow going from left to right, but rather make visible the interdependence of all the elements.

The upper part of Figure 1 maps out aspects of movement and gesture, on the one hand as categorised by key authors in the field and on the other hand by putting them in relation with our particular standpoint (see left-lower section in orange marked MGM). Where in the left half of the tree the categories show fundamental relationships between the body (Godøy) [30], the instrument (Cadoz) [26], sound and text (MGM), the right part unfolds aspects of music performance relevant for musician and audience (Delalande [9], Godøy, Jensenius [38], Dahl [39]). What is interesting are the different weights generated by the score (text) and the music-playing act. In this regard the categories proposed by Cadoz of ‘ergotic, epistemic and semiotic’ gestures or the sound-facilitating aspects proposed by Jensenius apply only in a limited sense, in particular when considering that

a composer's own 'gesturality' is transported in the score – along or embedded within the instructions for the instrumentalist.

The map shows how key authors dealing with musical gesture take different perspectives, emphasising either the affordances (action spaces) or the perceptions of gestural actions. This reveals to us that the discourse on musical gesture has taken into account neither the role of the composer nor that of the text (score) in constituting or informing the bodily domain. An in-depth discussion of the terminological implications in relation to 'Pression' can be found in [40].<sup>1</sup>

#### 4 Designing the Study: What Music, Which Piece, Which Aspects?

The choice of musical style and specific piece for such an investigation determines the types of results or interpretations that can be gained. With a focus on the performance moment and with a standpoint that is oriented towards composer and performer, rather than the audience, our selection of a piece has to fulfil several criteria. Even though for the larger research project within which this work is done electro-acoustic and live-electronic music is central, looking at a more traditional piece has some advantages. The problem with perceiving movement in electronic music should be obvious, since some of the actions that produce sound are imperceptible in physical action since they are mediated through technical means. In a parallel task, live-electronic, interactive and technological music is indeed explored, but these will only be touched upon very briefly in the qualitative section.

For this study we chose the seminal piece for solo violoncello 'Pression' by Helmut Lachenmann from 1970 (in the 2010 version) performed for us repeatedly by cellist Ellen Fallowfield. This piece represents an important exemplar of what Lachenmann calls 'Musique Concrète Instrumentale'. The entire score carries action-notation mixed with standard notation; it describes the movements and extended playing-techniques on the instrument rather than the sounding result. The idiom of the piece is based on extended sounds of the instrument, which – together with the tightly choreographed movements – makes it useful for analysis both from a textual, music-analytical as well as point of view focusing on the performer's physicality [41]. As the title suggests, this piece explores the aspect of pressure, both of the bow and the hands on the instrument. This ties in well with the one playing aspect we are investigating in our mixed qualitative and quantitative method, namely that of *effort*.

When looking at the central question of this investigation about observing, measuring and classifying affective potential carrying aspects of music performance, the question is where to start. Since the focus lies on the movement and gestures of the performer rather than the sound and music, a look to a neighbouring field may provide the answer. In the movement analysis by Laban the term 'effort' provides the central pivot for describing corporeal

performance: "words and ... music are both apt to overshadow the truth of this effort display as it becomes apparent through the performer's bodily actions. ... Every human movement is indissolubly linked with an effort, which is, indeed, its origin and inner aspect. Effort and its resulting action ... are always present in any bodily movement; otherwise they could not be perceived by others." [35, p.9/21] Without adopting all the subtleties of the subcategories in the Laban effort concept, i.e., the aspects of Weight, Time, Space and Flow, the fundamental idea that all *affect* in a perceiver is generated by the resonance with the *effort* by the performer, in our opinion holds true for musicians as well.

The approach to designing this study is exploratory and done in a convergent concurrent manner [1]. Although the hypothesis and question is clear, when we began this enquiry we didn't have a definitive plan and methods all lined up. By proceeding with iterative steps that implement one part of the method after another, and by evaluating the results at each step, we are capable of adjusting and refining not just methods but also the scope and the domain investigated. This is an ongoing process which is not finished, even if we have reached a point where we have preliminary results and reflections to draw first conclusions from.

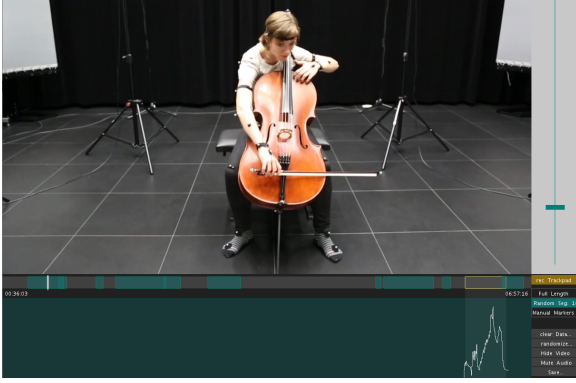
With the choice of musical material made, the two complementary investigations are carried out. They are done in parallel, since the shifting focus in one method leads to the adaptation of elements in the other. The iteration of several prototype *task-and-survey* modules establishes the certainty that the method is sound and we can proceed. The following two sections describe respectively the qualitative and the quantitative activities of what we merely consider a pilot study, which has by no means uncovered all we need to know.

#### 5 Quantitative Experiment

Continuous self-report methods are widely used in evaluation of emotional response to music [42]. A pilot experiment was conducted, in which subjects rated *perceived effort* in a video recording of a performance of 'Pression'. The performance was assessed separately, based on either the audio or the video. The goal was to find out how similar or different the ratings would be based on audio or video, and which modality dominates the perception and what the contributing factors are. In addition to the conceptual and terminological considerations laid out earlier, the choice of the measured attribute evolved through preliminary iterations. Attributes included musical intensity, perceived tension, musical tension, amount of emotion, aesthetic response, emotion expressed, arousal, and valence. In a preliminary iteration of the present experiment, subjects assessed intensity, but this proved to be problematic, since it was too easily associated with loudness. We decided that the chosen attribute needed to be perceivable both in the auditory and the visual modality. Moreover, the attribute had to be associated with the gestures and movements of the performer and be as little as possible associated with valence (pleasantness) as possible. Based on these insights, the choice of the attribute of *perceived ef-*

<sup>1</sup> See also <http://mgm.zhdk.ch/mindmap/mindmap.html> for an interactive version of the map.

fort seemed the best fit.



**Figure 2.** View of the survey software: segments on the timeline, virtual slider and time-series data for segment 10.

The subjective ratings about this were given by pressing on a force sensor while watching or listening to the recorded performance in a custom software (see Fig. 2 and refer to [43] for more details on the technical elements of this investigation). Subjects were instructed to press harder with increasing perceived effort. The pressing force was recorded at 10 ms intervals and mapped logarithmically to a numeric scale between 0 and 100.

Eleven segments of 4–40 seconds duration were selected from the complete performance, representing the various sound materials and playing techniques present in the piece. The presentation mode was treated as a within-subjects design; all subjects rated all 11 segments for both the video and audio conditions. The presentation order of the segments was randomised, and the order of the audio and video trials was balanced across subjects. Half of the subjects started with the audio and the other half with the video condition.  $N = 6$  subjects took part in the pilot experiment, including the present authors. All except one are trained musicians.

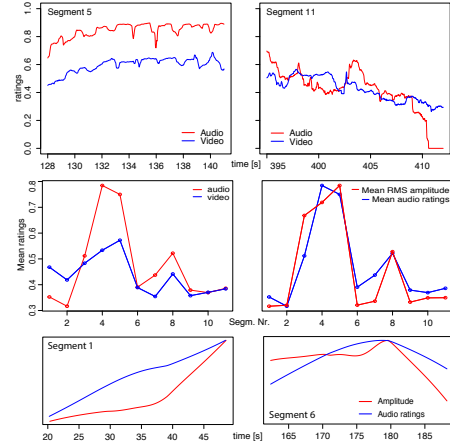
The result of the measurement was a non-stationary, dependent time series for each subject. Median time series were computed across the subjects for each segment and presentation mode, as seen for selected segments in Fig. 3.

Results of the audio and video conditions were surprisingly closely related. The general profiles of the median time series for audio and video were similar in all segments but one. Furthermore, the audio and video medians were very close to each other in five segments. In the remaining segments the audio ratings were either higher than the video (segments 4, 5, and 6) or vice versa (segments 1 and 2).

The mean audio and video ratings across segments were positively correlated ( $\rho = 0.81$ ). The range of the video ratings was narrower compared to the audio ratings (see Fig. 3). The results suggest that the perception through the two modalities is contradictory, when soft audio is combined with movement in the video, as in segments 1 and 2, or if loud and/or unpleasant audio is combined with calm bowing movements of the left hand, as is the case in segments 4 and 5 (see middle of Fig. 3). A future goal is to find out what the total percept would be in these mismatched situations.

A further observation is that in the audio ratings, at the

end of the piece, effort is perceived only as long as there is sound. In the video condition, similar or even increased effort was perceived until the player put the bow down, released the attention or tension and thus finished her performance. In this performance, as is often the case, the physical release occurred several seconds after the sound had already died down.



**Figure 3.** Top Row: Median time series for segments 5 and 11 in the effort measurement experiment. Middle Row: Mean audio and video ratings over all segments. Mean audio amplitude and mean audio ratings over all segments, linearly scaled to equal range. Bottom Row: Trends in audio amplitude and audio ratings

Audio RMS envelopes were computed for each segment using the MIR Toolbox for Matlab [44], and Quantity of Motion (QoM) was computed for the video segments. Significant positive correlations were found between the objective characteristics and ratings:  $\rho = 0.93$  between mean audio amplitude and mean audio ratings and  $\rho = 0.68$  between QoM and mean video ratings. Moreover, audio amplitude correlated highly with video ratings ( $\rho = 0.87$ ) and QoM with audio ratings ( $\rho = 0.84$ ), which is further evidence that cases of extreme mismatch between the modalities were rare.

Trends were extracted from both the audio ratings and audio amplitudes, as shown in Fig. 3, bottom row. In 7 of the 11 segments they are similar, indicating that increased loudness is followed by an increase in perceived effort in the performance.

This pilot study suggests a hypothesis that effort is perceived similarly based on the auditory and visual aspects of a music performance. Future plans include extension and revision of the experiment from a pilot to a larger scale study with ‘fresh’ test subjects. At present, the subjects who took part in the experiment are already familiar with the previous stages of development and therefore know the performance too well. The experiment will also include the combined audio-and-video condition in addition to audio or video conditions alone. Preliminary experiments were already made for this third condition, but since measurements were done using a slider instead of a touch sensor, the results cannot be compared at present. The analysis will be extended from the descriptive level to an inferential model, and more auditory features will be considered



in addition to amplitude envelope, such as spectrum, onset detection, tempo, attack time, brightness, roughness, and pitch. Motion capture data is now available as well from the same recording, including acceleration data of the different points; this will be taken into consideration instead of the simpler QoM measure. A goal of the extended study will be to explore through analysis of individual segments, what causes the observed differences between audio and video ratings.

## 6 Qualitative Methods

After the measurement-based part of the study, let us now explore the complementary part that deals with subjective assessment of the *identical* musical performance materials. The question of how to retrieve individual qualitative data concerning perception and performance of music performance, possibly even abstract electroacoustic gestural music, poses a challenge since neither the form nor the language of the subject matter are directly accessible or established by convention. As laid out earlier, in order to reach a validated selection of terms in a similar iterative fashion as with the *perceived effort* in the quantitative track, we base the concepts and aspects for the subjective and qualitative enquiry on the literature accumulated. In addition to the more traditional approaches that make use of a general gesture terminology coming from linguistics [13], or describe the gestural morphology in the actual context [30], be it on a phenomenological/epistemic level [2, 45], or by focusing on functional aspects [38], we add terms from the relational schema of music performance actors (see Fig. 1) and the score–action dichotomy that is present in the piece by Lachenmann. In addition to the musical categories we introduce additional general impression and preference ratings with a compilation of items from [16]. The aim of this qualitative approach is to blend and apply the terminologies and concepts with a questionnaire related to the ‘Pression’ study.

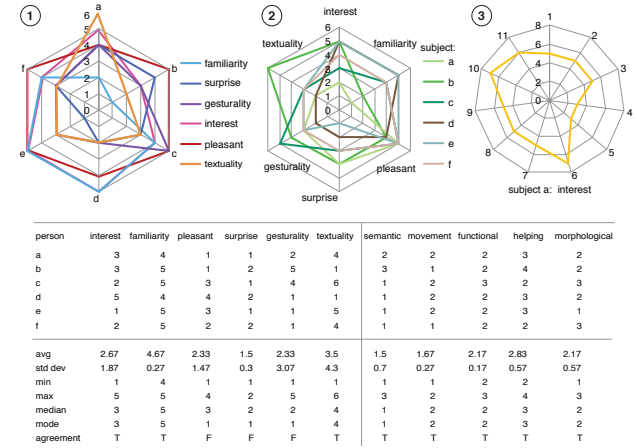
### 6.1 Survey

As outlined above, several cycles of *task-and-survey* tandem modules were carried out. The terminologies derived from literature and our conceptual analysis were complemented with generic terms like ‘gesturality’ or ‘expressivity’ and compiled into a questionnaire and set up alongside the continuous self-report tasks of the quantitative track. Each subject, after completing the entire *perceived effort* task, filled out a questionnaire for each segment they had previously rated. Participants were asked to categorise the same ‘Pression’ segments according to the given terminologies via multiple choice and by adding comments about their choice for each segment. The terms are organised in the following categories:

- General: interest, familiarity, pleasantness, surprise, ‘gesturality’, ‘textuality’.
- Phenomenological : ‘ergotic’, epistemic, semiotic [2].
- Movement type: trajectory-, pattern-, force-based.
- Functional: communicative, sound-producing, sound-facilitating, sound-accompanying [30].
- Musically supporting: melody, harmony/musical struc-

ture, timbre, sound level, rhythm, tempo.

- Morphological: impulsive, sustained, iterative [46, 47].



**Figure 4.** Ratings of a segment’s categories by all subjects (1), all subjects by category (2), or a single participant judging a single quality across all segments (3). The table shows all ratings from segment five, familiarity is the overall mode agreed on: it is the only section in the piece with a ‘normal’ bowing tone.

This first iterations, dealing with ‘Récitation 1’ by Georges Aperghis, as performed for us by the renowned singer Donatienne Michel-Dansac, served as a feasibility test for understanding and checking acceptance of the terminologies as well as for validating the actual questionnaire form.

The feedback and experience from the previous round was integrated into a digital form; the survey was condensed to a single- or forced-choice format for every categorical subsystem with an added description of the concepts as quoted from the sources. Taken together, these iterations demonstrated a certain *interrater-reliability* as most of the segments were categorised similarly by all participants. In some of the points of the questionnaire divergent individual interpretations and ratings remained, which need to be conserved for further analysis, unless they can be attributed to methodological issues. In order to rule out remaining confounding influences by the selection of categories as well as the focus set by the rater, in a third iteration of the questionnaire, we asked the participants to provide specific information about those elements within each segment that had led to the actual categorisation. At this stage, the analysis of the data is done on the visual interpretation of basic descriptive statistics and plots (see Fig. 4). This is due to the limited number of participants, and the fact that the same subjects have done several iterations and are already too attuned to the process. The result of this analysis is two-fold: on the one hand each segment obtains a rating for all given categories and the most commonly named mode wins, on the other hand the deviations from this norm prove to be what raises most questions, showing the inter-individual difference in appreciation and interpretation of the different playing techniques observed.

For the next iteration of the study we will synthesise the insights into an online questionnaire that integrates

closed/forced choice items as well as open formats and directly embeds audio-visual materials. The participant will be able to propose their own categories, and to comment on categorisations and the entire survey. The specific language of the category systems stemming both from literature and performance practice needs to be translated into more accessible, everyday language to be suitable for non-expert, non-musician participants.

## 6.2 Observation and Evaluation in the Field

In parallel to the tandem method described here, we are extending the mixed methods with further purely qualitative approaches. The main goal is to evaluate the given concepts and insights through observation of concrete artistic processes of creation, rehearsal and performance with audience. This extended method provides a blend of a Grounded Theory approach [48] with more general, ethnographical and social-science approaches of qualitative research [49]. By accompanying artistic work through musical rehearsals and performance in a first phase, and by collecting interview data from the performers and composers in a second phase, the overarching research-questions of the project are approached from an angle that is a step more removed from empirical data analysis. After the observation, the collection of materials is done with the artist in semi-structured interview with narrative aspects [49]. The notes, interviews and other traces will be textually analysed and condensed into reports as well as thematic layouts which are then discussed and re-synchronised with the other research tracks.

## 7 Discussion

The final step remaining in a mixed methods investigation is the blending of the results obtained in the two tracks in a triangulated interpretation that is appropriate for the research question. Although this might seem to be a final step in the process, in fact, the cross-contamination of the two perspectives already occurred throughout the iterative development cycles. A central anchor for the research was given by the fact that even though both methods collect data in their separate ways, the data-gathering occur back-to-back, and both rely on subjective, i.e., personal opinions and derive the categories from a common model. This is particularly important because the objects of investigation are perceptual qualities, rather than physical or physiological invariants [50].

When comparing the test-segments for significant deviations from a consensual base-line given by the subjects, several aspects come to the attention. Since ‘Pression’ is a piece for violoncello, almost all of the body-parts are constrained in their placement and kept under tight control in relationship to the instrument and bow, and particularly by the unusual, extended playing techniques that constitute this piece. The only exception is the head, which has relative freedom of movement, except where damping the strings with the chin is demanded by the composer. In segment 6 (legno saltando, bow below the bridge, top of p.3 in 2010 score) the divergence between the effort ratings in audio and video (see bottom right of Fig. 3) and the agree-

ment in four out of five categorisations (phenomenological, functional, musically supporting, morphological), as well as a comment saying that this is “a very gestural segment”, indicate a positive affective impact, which is stronger than in other segments. Even when looking at the point-light display of motion-capture data of the same performance the salient feature, apart from the bouncing bow, is the way the player emphasises the light and springy movements of the bow and the bouncing sounds with similar movements of the head. In contrast, when observing the data obtained from the fifth segment (the second half of *Largo Feroce, am Saitenhalter gepresst*, bottom of p.2 in 2010 score), it is already visible from the data that this section contains a high effort level (perceived more in the auditive than the visual domain, see the top left of Fig. 3) and subjectively generates low levels of pleasantness, surprise, and interest, and a remote text/score relationships. The data from both the qualitative and the quantitative tracks confirm a uniform opinion by all the test-subjects. When listening to this forceful scratching section, which is the hallmark of ‘Pression’, the negative affective impact of this section becomes evident.

After attempting an interpretation of the preliminary data and information gathered in this process, a higher level analysis of the research process is needed. The study described here is not the only part of the investigation: the developments of the method and the embedding of the different layers into a larger fabric form integral part of the process. By looking beyond the iterative cycle of *task-and-survey* modules, it is evident that they need to be framed by the terminological definitions and classifications, and observations and interviews about artistic processes. We believe that it is within this wider context that the interpretations based on our mixed perspectives will ultimately bring their best results. However, much needs still to be done. The quantitative track will proceed through a new full cycle of a *task-and-survey* experiment with fresh subjects, basing its analysis on more reference-data. The qualitative strand needs to solidify the observational, ethnographical process and bring together the insights from both the structured, systematic studies and the grounded theory approach that accompanies artistic creation and development processes. Finally, the synthesising, interpretation part of the method needs to find more ways of validation with richer data-sets and complementary analysis methods both in the qualitative, subjective and quantitative, empirical domains.

## 8 Conclusion

In this article we describe the methods development process of an investigation into cross-modal perception of key musical performance aspects. Starting from a perspective that is based on an embodied, ecological perspective of music perception, a blend of methods is sketched out and iteratively tested that mixes qualitative and quantitative methods. The selection of musical material that serves as testing ground is crucial. The choice of European contemporary music is motivated by the need to work with music that is less bound to traditional harmony and melody and

symbolic music analysis, and more conducive to perception where the musician's performance action and the resulting phenomenal sound-world come to the foreground. The choice of aspects to investigate is equally important, on the one hand the *perceived effort* in continuous self-report, and on the other hand the subjective opinions about *six dominant categories* stemming from literature on musical gesture.

The quantitative experiment suggests that effort is indeed a meaningful attribute to measure the perception of music performance. At this point the study is still inconclusive and serves mainly to form hypothesis and collect first experiences in a non-tonal context. A larger study will further test the hypothesis that effort is perceived in both auditory and visual modalities and how they relate. Exploring and validating mixed methods research for music perception investigations is the central goal of this article. The interpretation that is carried out by blending the results from the two domains clearly shows significant effects of movement on affective impact of music performance, and demonstrates some of the ways this occurs. Thus far the project raises questions that can only be approached using a mixed methodology: Can effort be a structure-defining attribute that could serve both as an analytic and compositional device, i.e., effort-based music analysis and effort-based composition? How is the notion of effort already part of an artistic process, be it in composition, performance and music listening?

The hybrid approach presented evidently generates results that remain subjective and tied to the specifically selected study-object. At the same time it shows a path forward that is truly multi-perspective and has the potential to unlock those elements of perception with affective power that are situated in the highly multi-modal and complex enfolded 'thing' we call Music.

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