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Contour, Motion and Gesture in Abstract Score Animation: a First Approach

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Introduction

Contour, motion and gesture have become key notions in addressing expressive and, more generally, semiotic musical features that escape a straightforward (score) analysis. The increasing categorical assimilation of music with non-music realms, both perceptual and non-perceptual, gains in empirical plausibility with regard to cross-modal (Chapados & Levitin 2008; Marin & Bhattacharya 2009), multi-sensory (Trainor & Unror 2009) and synaesthetic (Ione & Tyler 2004) hypotheses that guide a range of detailed neurobiological and psychological investigations into music perception. With the existence of multisensory percepts, such as in audiovisual synchrony (Lewis & Noppeney 2010), the traditional classification of sense organs becomes, in aesthetic terms, increasingly questionable. Additionally, theories of embodied cognition (Merleau-Ponty 1962; Gallese 2007; Freedberg & Gallese 2007) and ecological perception (Gibson 1966 and 1979) aim at disenfranchisement of the persistent philosophical subject-object dualism by blurring intuitive demarcation lines between action and perception, motion and emotion. Music theorists have followed this trend with 'corporeal' approaches to musical meaning that attempt to extend, if not revolutionize, the traditional stock of semiotic categories (Zbikowski 2002 and 2011; Hatten 2001 and 2004). Moreover, research in artificial intelligence has matured into a driving force in performance studies and reasoning about music expression, mediating between score information, acoustics and psychology in extracting and modeling aesthetic regularities from human music making that could be re-applied by a technological agent.

In providing new empirical insights into the sensory regularities and neural interdependencies of human perception, however, the scientific penetration of Aesthetics meets the odd hermeneutic circle of definition that captures any attempt of naturalizing human intentionality. Here, scientific definientia are critically bound to definienda rooted in intuitive and holistic human experience, whose epistemological potential sets an indispensable standard for scientific reconstruction. The qualitative, but nonetheless strikingly subtle differentiations an informed and careful music critic, for instance, is able to express in natural language, or an instrumental instructor through non-verbal communication, set a theme that cannot as easily be muted as, say, colour in modern physics. Thus, scientific definientia in the Humanities require 'definienda counterweighting'. Indeed, the accurate understanding of a neural mechanism or process, let alone the carving of a workable algorithm that roughly imitates an aesthetic capacity, at the current stage of research efforts often not only falls short of an overall explanation of the targeted aesthetic phenomenon as it is pre-theoretically understood. In addition, accuracy, (algorithmic) controllability and predictability tend to absorb definitional appropriateness, which, in terms of both Neurosaesthetics and Artificial Intelligence, might lead to an overly simplistic view on the functioning of art.[1]

In this article, we debate definitional appropriateness with regard to musical motion and timing. We raise objections against both kinematic (Todd 1995) and 'perceptual' (Honing 2005) quantitative models that limit their interpretation of expressive timing to data derived from temporal beat distance. In contrast to these approaches, we introduce methods of abstract score animation that accommodate multiple variables in their determination of musical movement. Notably, visual motion simulation imports spatial characteristics of melodic contours and integrates variation of loudness as a motional factor. While the visualization of musical motion is obviously no substitute for its rigid algorithmic modeling, we aim to demonstrate that the modus operandi of animated 'motion bracketing' provides a differentiating and appropriate interface for the communication of aesthetic intentions with regard to musical movement.

Further, our 'protosemiotic' method of score animation challenges the notion of musical gesture. Gestures in music are widely considered a continuous phenomenon (see for instance Hatten 2001) that transcends score structure. Bodily movements, particularly performance gestures, are supposed to deepen the 'meaning' of musical sound. Identification models based on embodied cognition, however, are reductive in typifying gestures, notably with regard to image schema theory (Johnson 1987; Lakoff 1987; Saslaw 1996; Brower 2000; Hampe & Grady 2005; Oakley 2007). In contrast, we advocate an epistemological model, targeting the particularity of musical motion, throughout this article.

Two hypotheses guide our approach: (i) a pulse related *ritardando* does not necessarily contradict an *accelerando* in overall motion, and (ii) musical motion profiles are best seen as the interplay between 'objective' gravitational forces and music's subjective agency.

That motion in music is essentially independent from pulse variation and does not automatically conform to kinematics obstructs a systematic account of sonic movement. However, one might think of contour theory (Morris 1987 and 1993; Polansky 1987; Polansky & Bassein 1992) as the most promising departure point for the quantitative modeling of motion in music. Contour theory establishes pre-harmonic musical *gestalts* through either ternary (in some theories, binary) symmetrical or, more seldom, asymmetrical contour descriptions (Polansky & Bassein 1992: 261) in terms of 'more', 'less' or 'equal' relationships between successive elements. Due to its high level of abstraction, reasoning with contours can also be applied to post-tonal music (Friedmann 1985) and is principally open to engage any orderable parameter. Since this article basically departs from discrete mappings of pitch, duration and dynamics onto three-dimensional space that are finally synthesized in spatial motion, metric models could well give valuable systematic insights into the 'motion potential' of contours. Indeed, it would be tempting to systematically inquire into possible (and impossible!) motional forms in music, or to algorithmically establish similarities among motion types. Yet alone the potential of one and the same contour to exhibit various motion profiles indicates a grave disparity between contour and motion analysis. Moreover, neither does there exist a common theory of sonic movement that provides adequate definienda for the evaluation of an algorithmic approach, nor can continuity and velocity distribution, as defining moments of motion, be obtained from a straightforward quantitative analysis of score information in terms of a 'logic of change'. The method of analog simulation serves us thus as the closest methodological refuge where the microstructure of musical motion can, if only in propaedeutic terms, be done justice.

The proposed simulation of musical motion is introduced and elaborated in the sections headed 'Simulation of Musical Motion' and 'Abstract Score Animation' respectively, after providing a brief discussion of expressive timing (section headed 'Expressive Timing and Motion'), musical gestures (section headed 'Motion and Gesture') and pictorial *gestalts* in scores (section headed 'Scores as Pictures'). The section headed 'A Final Example: Johannes Brahms' Symphony No. 3 … ' offers an abstract score animation of the entire third movement of Brahms' third symphony. A generalization of our methodology in semiotic terms concludes this article.

Expressive Timing and Motion

Todd's influential quantitative theory of expressiveness in music (see especially Todd 1995) is rooted in the variation of timing, while dynamics is given a supporting role only, without the consideration of further musical parameters. What underpin Todd's work are the principles of elementary mechanics that are suggestive as to a standard model of musical motion based on kinematics. The assimilation of motion, kinematics and expressive timing has been widely accepted and deepened in subsequent research. Repp (1995), for instance, follows Todd's assumptions and speaks, normatively (!), of a timing pattern's 'homogeneity' and 'correctness' in a study that evaluates the deviation from an expressive mean in comparing both expert and student performances of Schumann's *Träumerei* from his *Kinderszenen*, Op. 15.

Friberg and Sundberg (1999) studied the correlation between musical *ritardandi* and the deceleration of runners, which lead them to the following conclusion:

> A model of the final ritardando was derived from runners' mean-deceleration curve, assuming constant deceleration power. By introducing two main parameters, q for curvature and v_{end} for the end value, this model could well describe the average tempo curve in final ritardandi, the average velocity curve of runners' decelerations, as well as individual final ritardandi, and runners' individual decelerations. These findings substantiate the common assumption that locomotion and music are related (Friberg & Sundberg 1998: 1481–1482).

Honing (2005), in contrast, presents 'a perception based alternative to the kinematic approach' and emphasizes rhythmic structure, note density and a piece's overall tempo as expression variables that kinematic models usually ignore. Yet Honing's revision of predictive functions with regard to expressive timing still relies on tempo variation as the sole indicator of sound musical timing, a view that also characterizes recent developments in this field of investigation where algorithmic fine-tuning and predictive accuracy appear to be the main concern (see Flossman & Widmer 2011) for an advanced approach).

Tempo relations in music, it seems, have to be multiplied by a spatial variable whose value range is dissimilar in scope to, say, the step length of a runner. Indeed, the heuristic value of a direct comparison of expressive timing in music with locomotion seems questionable. While it might appear paradoxical that musical motion could change even if the successive temporal distance between, for instance, a first, second and third beat remains identical, we argue that when motion is visualized, the spatial distance between two beat markers can be manipulated, and has thus a direct impact on the distribution of velocity. This opens up a space for the inclusion of both pitch and dynamic contours, which is overlooked in both kinematic and perceptual models of expressive timing.

The direction of tempo change is a further problem area in relation to the aforementioned models. By only dealing with the question of how an *accelerando* or a *ritardando* is curved when it occurs, quantitative modeling of expressive timing is unable to originate such change. This importantly implies that melody, harmony and dynamics must play a decisive role in directing tempo, and letting one ask why these parameters should suddenly remain silent in outlining the exact shape that such tempo variation exhibits.

Hence, we posit that motion in music is irreducible to tempo; tempo variation cannot be isolated from motion characteristics that, subsequently, also derive from musical parameters other than tempo and rhythm, which is already indicated in Truslit's classical text about musical motion, yet has been neglected in recent research.

> … overt movements such as foot tapping are easily elicited by rhythmic motion. Rhythmic and melodic motion thus have very different meanings: one affects the limbs, the other the whole person. In its dynamo-agogic consequences, however, rhythmic motion must also follow the law of motion, which is regulated by the vestibulum (Repp 1992: 271).

Motion and Gesture

In his seminal work on analytic symbol theory, Goodman (1976) proposes a strict syntactical demarcation line between notational and pictorial symbol systems. Goodman stresses that syntactically 'dense' (i.e., in terms of Goodman's symbol theory, continuously valued) art works cannot be analyzed into discrete characters and are thus not replicable. Traditional score notation (and alphabetic text), by contrast, is articulated and open to reproduction, which leads Goodman to his adamant identity criterion of musical works in terms of 'scorability'.

Subsequently, an ontological problem translates into one that is aesthetic. If a musical work's identity rests on its score, its aesthetic substrate seems to be bound only to properties that standard music notation is able to capture, while specific performance parameters must be given the status of secondary qualities. Distantiation from notational syntax as the sole semiotic reference point, however, is indispensible for the recognition of musical gestures. Truslit writes:

> The acoustic elements that an artist manipulates in shaping a performance are pitch, timbre, intensity, and duration; while the first two are of great importance for the composer, the last two are most important for the performer (Repp 1992: 267).

Contour, motion and gesture form a conceptual triad that is rooted in, yet points away from, structural analysis and aesthetic formalism. Take, for instance, Hirata and Aoyagi's (2003) reasoning in terms of object-oriented database modeling of tonal music with regard to generative music theory.

> Time-span reduction represents the intuitive idea that if we remove ornamental notes from a long melody, we obtain a simple melody that sounds similar. An entire piece of Western tonal music can eventually be reduced to an important note or a tonic triad. The time-span reduction is performed based on the results of the grouping structure and metrical structure analyses in a bottom-up manner in the sense that parts come together to form a whole. … In applying time-span reduction, less important notes or chords are eliminated earlier. Next, neighboring heads similarly make a group. This process continues until a whole piece makes a group (Hirata and Aoyagi 2003: 74–75).

Here, the claim that the omission of ornamental notes could result in a simplified melody that sounds (sic!) similar to the original one is rather problematic.

According to Hirata and Aoyagi's interpretation of generative music theory, a turn like the one in the passage given in Example 1 has to be considered less important than its neighboring notes, yet this group is in terms of musical motion definitely one key element of the phrase's 'meaning'. Compressed to a single C#, the resulting interval C#-A, placed on the third and fourth beat respectively, would introduce the given phrase with a completely different motion, which an analysis of a pianist's hand gesture could demonstrate. While the turn can be realized in a light, yet rapid movement that provides sufficient velocity to ascend to the phrase's peak note A, a simple introductory C# as a result of the turn's omission would require more weight that, similar to a spring effect, establishes the connection to the A through elasticity. In an ordered gesture space the two versions would thus be far apart, and there is obviously a conflict between syntactical and gestural analysis if we consider both absolute.

In his later work, Goodman (1984, 84–85) acknowledges the continuous character of music performance, which, in his theoretical framework, assimilates sound with pictures, where even the smallest perceivable difference can count. Yet unlike pictorial expression, meaningful 'correct' performing is score based, and has thus been compared to text interpretation.

> Interpretation is essential to both music and language, but in different ways. To interpret language means: to understand language. To interpret music means: to make music. Musical interpretation is performance, which, as synthesis, retains the similarity to language, while obliterating every specific resemblance. This is why the idea of interpretation is not an accidental attribute of music, but an integral part of it. To play music correctly means first and foremost to speak its language properly. This calls for imitation of itself,

Example 1: W. A. Mozart, Piano Concerto No. 23 in A major, KV 488, 2nd movement, bars 20–21 (to be read with F sharp minor key signature).

not a deciphering process. Music only discloses itself in mimetic practice, which admittedly may take place silently in the imagination, on an analogy with silent reading; it never yields to a scrutiny which would interpret it independently of fulfillment. If we were to search for a comparable act in the languages of intention, it would have to be the act of transcribing a text, rather than decoding its meaning (Adorno 1963: Para. 8).

The mimetic character of music seems to capture both performing and listening. Qualification of aesthetic experience as passive, in opposition to play that involves muscular activity (see for example Allen 1877), appears indeed unjustified. Wallaschek (1895) notes that 'in the most primitive concert an audience does not exist, all being performers'. More recently, Peterson (2006), in an interdisciplinary paper, reiterates the idea of the listener as music maker. Neurobiological evidence in relation to the mirror neuron system further suggests that perception is intrinsically active.[2]

On a semiotic plane, we thus might ask to which product genuine music listening, if understood as purposeful mimetic action (which, for example, performance definitely is), could possibly lead. Is there any mimetic alternative to the sonic product of performance? Wittgenstein (1967), for example, qualifies aesthetic evaluation as the determination of a suitable non-verbal interpretant[3], rather than a question of approval:

If I say of a piece of Schubert's that it is melancholy, that is like giving it a face (I don't express approval or disapproval). I could instead use gestures or … dancing. In fact, if we want to be exact, we do use a gesture or a facial expression (Wittgenstein 1967: 4).

Wittgenstein's discussion of aesthetic reasoning can be interpreted as a shift from a traditional 'the melody is beautiful because of X' to 'the melody sounds right if it is played like Y2, but not in resemblance of Y1 or Y3', where X is a description that exhibits certain truth-conditions, while Y stands for non-propositional interpretants that can be fine tuned in order to aesthetically 'fit' to a piece of music or a musical passage.[4] Interpretative 'exactness', however, is not as easily communicated as Wittgenstein suggests when he refers to gestures, dancing or facial expression.

In musicology, the notion of gesture has received increasing attention in the last decade. There is a vast amount of multidisciplinary literature (Gritten & King 2006, 2011; Godoy & Leman 2010) that, in one way or another, speaks of musical gestures, although without an apparent common ground. This is noted in a review of Gritten and King's *Music and Gesture* (2006), a collection of essays written by some of the most original musicologists in the field:

This volume starts by waving a flag and then throwing down a gauntlet. 'The study of music and gesture — of music as gesture, of Musical Gesture — has come of age', the editors tell us: 'the future is gestural' (p. xix). It is a risky move: not only do Gritten and King immediately pull the tail of the skeptical reader … but they also raise expectations of coherence and consensus within the volume and across the work of those advancing the cause. In fact, as they later acknowledge, such qualities remain elusive, partly because no single understanding of 'musical gesture' could encompass all of the meanings adumbrated in the twelve contributions. That may be inevitable, given the potentially disparate perspectives of composers, performers and listeners among others. Nevertheless, I wonder whether some authors have a clear sense of the term or, to put it differently, whether they are focusing on what the book purports to be about (Rink 2007: 224).

In order to find some orientation in the categorically rather loose discourse on musical gestures, it might be helpful to distinguish between movement gestures of a performer, gestures suggested by music itself, and gestures a listener creates, both mentally, in imagination, and physically. This distinction between production gestures, musical gestures, and reception gestures implies more than a simple division of an encoder, a coded entity and a decoder, as music performance and reception obviously not only lack a defined syntax and semantics, but involve a complex interplay of intentional behavior and causation. The following list highlights some problem areas that appear relevant:

1. A performer's bodily movement *causes* an instrument to produce sound that is based on musical intentions formed in score analysis.
2. A listener's perception could be gestural both due to a causal reaction and, ideally, an intentional musical response to the sound produced by a performer-cum-instrument (under particular acoustic constraints).
3. Seeing a performance can influence a listener's music perception by visually instantiating sensual cross modalities such as timing, phrasing, intensity etc.
    - 3.1. Production gestures can support, but also distract from the gestural character of music.
    - 3.2. The criterion of an appropriate gestural transfer from production to perception can only be derived from music itself.
    - 3.3. Analogies among production, musical and reception gestures can only be established through structural abstraction.
4. From particular score information (a concrete melody, for instance) basic contour shapes can be extracted.
    - 4.1. The correlation of contour shapes with image schemata builds upon structures that can be instantiated in production, musical and reception gestures.
5. In correct performances, sound qua music and discrete score structure is isomorphic in terms of discrete pitch relations and rhythm.
    - 5.1. Performance transforms discrete score information into continuously valued contours.
        - 5.1.1. Both musical motion and expressive timing result from the continuous gradation of tempo, note values and dynamics.
        - 5.1.2. Nuanced expressive and motional differentiation in music cannot be exactly mirrored by bodily motion.
6. Music can exhibit motion without inducing it, i.e. musical motion can be perceived and particularized without necessarily being mapped to a real or imagined self-motion of a performer or listener.
7. The notion of musical gesture is a derived one: either from the particular motion constituted by performance variables, or from basic images schemata.

The historical understanding of gesture as a type of bodily movement (see Bremmer & Roodenburg 1993) still leaves an impression on current research. However, it appears crucial to avoid a confusion of gestures intrinsic to music with both physical, and, more specifically, bodily motion, in analogy to the differentiation between emotion induced by and emotion expressed in music. Lidov (1999: 219), for instance, remarks that 'music confronts us as an acting subject, a persona with whom we identify'. Yet the question remains whether the 'persona music' must actually move like a human being or a familiar physical object. Not only have composers imitated the movement of animals, it could additionally be argued that music had performed movement stunts alien to humans long before cartoons and action movies could realize motion forms that defy physical constraints and common lifeworld experiences. Large parts of the virtuoso music literature from the 19th and early 20th century could qualify to prove this thesis. While humans usually perform this music, it would be a mistake to reduce its motion to performance gestures. Even in solo performances there is a crucial discrepancy between a piece's motion contours and the player's movements. In Chopin's *Étude* Op. 25/12 in C minor, for instance, a pianist has to reposition his hands in the shaping of an outgoing waveform, separating the extensive curves that, musically, are integrated, and whose global contour arms and shoulders can only indicate. The physiologically subtle balance between weight and pressure in the dynamic shaping of a performance that is only indirectly present in music, as well as timing and harmony, put further constraints on the analogy between production gestures and musical motion.

The notion of contour leads a kind of double life in current musicology. First and foremost, contour is a syntactic term that abstracts from the magnitude of change a musical parameter (pitch, dynamics etc.) exhibits. Taking into account the peaks and valleys in certain value series (melodies, for instance) only, reasoning with contour leads to fundamental musical structures and systematic interrelations that are sometimes undiscoverable on the musical surface. Contours, in terms of pitch, but also with regard to other parameters, allow yet for a further reaching semiotic interpretation with regard to possible similarities music yields to non-musical spheres and social practices.

Image schema theory (originated in Johnson 1987 and Lakoff 1987; for a systematic and historical account see Hampe & Grady 2005 and Oakley 2007) suggests certain dynamic structural universals, such as 'verticality' (see Zbikowski 2002: 68–69, Brower 2000 and Saslaw 1996), that can be instantiated in heterogeneous realms of reality, inclusive of music, and are supposed to occur also in a subject's proprioception. While elevating musicology to the spheres of cultural theory and sociology, cross-modal aesthetic universalism built on image schemata, however, is at risk of losing touch with the work in its individuality. Zbikowski exemplifies this tendency in his analysis of the socially embodied meaning of the Waltz in 19th century Vienna.

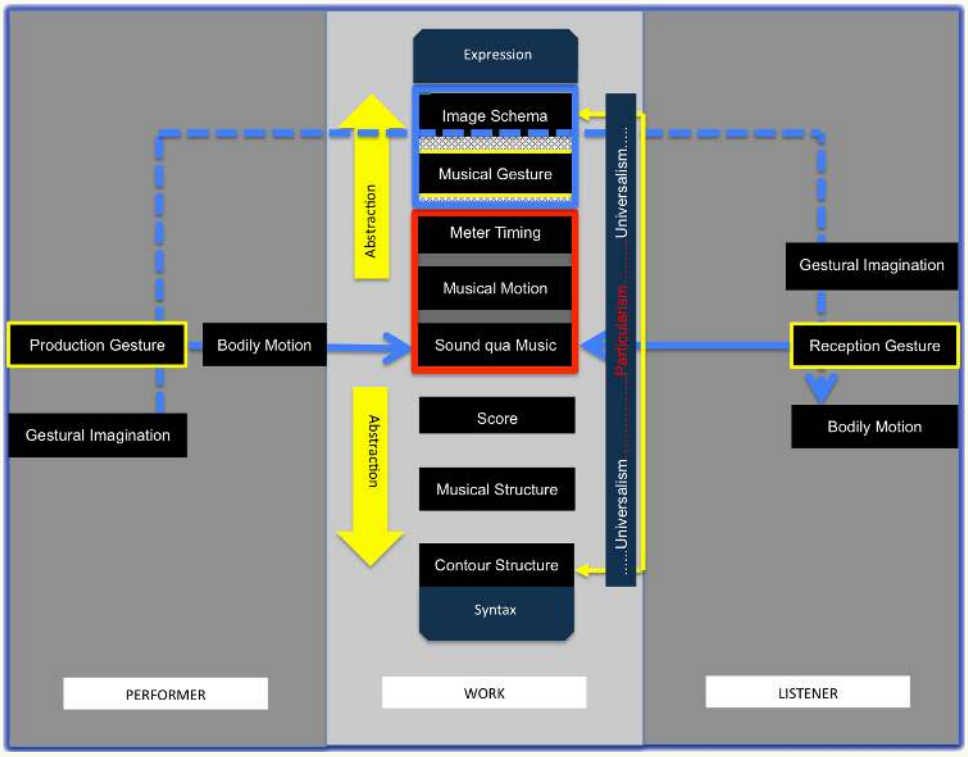
> I have argued that the kind of consciousness associated with attending to music is different from the kind of consciousness associated with attending to language. This difference reflects the different memory systems exploited by music, systems which are for the most part much more focused on the salient features of dynamic processes than on lexical knowledge or relationships between objects and events. That music should exploit such systems is a consequence of its function within human cultures, which is to provide sonic analogues for various dynamic processes that are common in human experience.
>
> An appropriate question … is why human cultures would have found a need to analogize such processes. Part of the answer can be found in the ballrooms and salons of nineteenth-century Vienna: dynamic processes such as those associated with the waltz are an integral part of complex forms of social interaction that are key to the construction of culture. That is, the rituals of the dance floor are organized around bodily movements … (Zbikowski 2011: 190–191).

Zbikowski's argument departs from a waltz by Mauro Giuliano, presented as a paradigmatic musical rendering of the flow and circular movement that characterizes this specific dance form. Waltz music, to Zbikowski, is not only a correlate to physical motion, but also an expression of habitual memory. Zbikowski's reference to Connerton (1989) underlines a claim that treats music as a pre-verbal, embodied, and conserving force, rooted in identity preserving social rituals that resist the ambiguities and revolutionary potential of verbal discourse. Similar thoughts can be found in Bourdieu's work (1984), where the familiarity to, for instance, opera is portrayed as an early developed habitus of intimate social engagement that, when lacking, cannot be compensated in formal education. Modern autonomous art, however, values idiosyncrasy over social function (see Bourdieu 1996 for a differentiated discussion) and, while Zbikowski's identification model of internalized gestures and motion might be applicable to entertainment music that is governed by strict stylistic constraints in a determined social field, it must remain doubtful whether habitual memory is the (sole) basis of the functioning of all Western art music.

In his string quartets Op. 59/3 (2nd movement, bars 44–53) and Op. 132 (3rd movement, bars 32–84), for instance, Beethoven seems to allude to the ambience of dance music, expressing, in the latter case, a vivid opulent motion and, in the former, melancholic gestures situated between noblesse and resignation. These passages are definitely rooted in the 19th century Viennese musical idiom, yet much more than the habitus of the ballroom is required in order to decipher Beethoven's music. This applies not only to the structural coherence of his central works, or the almost 'postmodern' formal and expressive musical landscapes in Beethoven's late compositions, but also to the motional and harmonic microstructure that, in the aforementioned passages, crucially deviate from any internalized style. Thus, while habitual memory might be the hook that familiarizes us with a certain musical practice (waltz, opera, but also rap or jazz), this process of identification is not yet the stage where art music really happens, but only the hallway that sounds its echo. An epistemological model of music perception seems necessary to complement identification, one where space is given for the detailed 'observation' of music's individual characteristics (for a similar criticism of 'corporeal and gestural meanings in music' see Tarasti 1997).

In order to provide some additional explanation, we would like to briefly read our categorization schema (see Figure 1) against some basic conceptualizations with regard to musical motion and gestures in selected relevant literature.

Figure 1: A categorical field built around the concepts of motion and gesture.



Andreatta and Mazzola (2007), for instance, innovatively use topology and directed graphs to model continuity with regard to the gestures of a pianist, leaving behind the usage of mathematics as a mere 'toolbox of formal models for music' (Andreatta & Mazzola 2007: 44). Their pre-theoretic understanding of gesture, however, seems to lack categorical differentiation:

> And already for Beethoven … ruling out gestural shaping misses the musical contents, as beautifully illustrated by Glenn Gould's notorious 'contrafactual' recording of Op. 57 'Appassionata', where, for example, the cascade in bars 14 and 15 of the opening movement is not played as a gestural cascade, but as a static structure of arpeggiated VII-chords, which destroys completely the inherent movement, as performed by Vladimir Horowitz, say (Andreatta & Mazzola 2007: 27).

Production gesture appears here confused with musical gesture. Gould's slightly provocative recording choses an extremely slow tempo and is played with great metric clarity, yet both dynamic plasticity as well as the final *ritardando* in its shaping of the cascade in Beethoven's masterpiece are, in our view, extremely gestural. While a pianist can definitely perform Gould's interpretation with a rather static posture, it shapes the concerned musical contour with more gestural clarity than more common interpretations that push the *Appasionata's* cascade to its final note in a single accelerating motion.

Cox approaches gestures in music from the viewpoint of perception:

> To see this — to feel this — compare the following conceptualizations of the opening two-note event of the finale of Beethoven's Violin Concerto: (1) a figure, (2) a motive, (3) a leap and (4) a gesture. 'Figure' suggests something that is external to us and fixed. 'Motive' highlights the dynamic of change, conceived as motion, but still leaves the event(s) as external. 'Leap' suggests a more embodied sense of motion but it is too big for us to feel directly in terms of our own experience of leaping: to leap requires a much greater exertion than the exertion reflected in this opening event; it has an analogous dynamic, or exertion 'contour', but it is out of proportion. However, 'gesture' suggests not only an analogous exertion dynamic, but one of the same proportion, and this isomorphism affords a closer comparison with our own embodied experience (Cox 2006: 57).

Example 2: L. v. Beethoven, Violin Concerto Op. 61, 3rd movement, bars 1–4.

Music appears here again deprived of its motional autonomy, and aesthetic experience prematurely embedded in an identification model. The proportion of human embodied motion is normatively imposed on the musical phenomenon, without giving much room for music to play on its own. One only needs to imitate the concerned passage (Example 2) with hand gestures in order to feel the definite leaping characteristic in bar four, that is hard to realize with gestures, and, it must be noted, bears a syntagmatic relationship to the piece's beginning. Cox's differentiation between leap and gesture appears thus rather artificial, and in contrary to her suggestion we would rather argue in favour of an epistemological model of motion that, in the example discussed, considers the music's leaping primary.

A more fruitful application of the gesture notion in music analysis can be found in Hatten's detailed remarks concerning Beethoven and Schubert (Hatten 2001, especially Lecture 6). The fourth movement of Beethoven's Piano Sonata in A major, Op. 101, for instance, develops a gestural panorama with an initial motif of utmost structural simplicity. Consisting of one interval only, the motive's diverse dramatic roles could not be individuated without reference to genuine performance parameters (or any other non-structural meaning inexpressible in traditional music notation). Hatten speaks here of 'gestural' tropes that are introduced to allow a semantic step beyond the surface structure of music scores, constituting motive-based relationships whose semantic connotations must remain undiscovered in atomistic score analysis. Hatten's main concern, however, appears to be the functional juxtaposition of two semantically divergent tropes, which relates to his syntagmatic theory of markedness (Hatten 2004), and he leaves the actual characterization of specific gestures to verbal description.

Hatten's approach could be interpreted as mediation between gesture and motion: while he does not (aim to) provide a clear motional profile of the gestures he analyzes (which needed either algorithmic modeling or a method like the one introduced in this article), his theory allows differentiation of gestural tropes that not only have a common base in their image schema, but even in their specific contour (different tropes instantiated by a descending minor third interval as in the case of Beethoven's Piano Sonata Op. 101, for instance).

As our final example in this section, closer to the method introduced in this article, but still crucially different from it, we select Nettheim (2007), in which armchair conducting based on Becking curves is discussed. Becking's work is well known for its differentiation of pulse in relation to composers like Mozart and Beethoven. Nettheim departs from four basic Becking curves, and uses computerized animations to either match or mismatch them with certain composers. Nettheim's method of displaying pulse in continuous motion of conducting curves exemplifies the potential of 'analog interpretants' to make music visible, rather than only a subject of mathematical modeling (as in Repp 1989).

Motion typologies, however, are coarse, and face methodological objections similar to those that we have raised concerning musical gestures. Lippman (1994), for instance, makes the following ambivalent remark with regard to Becking and another early 20th century German scholar, Herman Nohl:

> The types of motion distinguished by Nohl and Becking were thought of concretely as a bodily participation of the musical listener that could be described in graphic form. Typology … can help account for the individuality of a musical work, yet, if is used incorrectly, it contains the danger of neglecting this basic task of hermeneutics in favor of the mere identification of type (Lippman 1994: 358).

Repp (1993) emphasizes the following limitations in the introduction to his partial translation of Truslit's work:

> … Truslit curves often extend over a number of measures, with the more detailed rhythmic structure being marked by small local loops, if at all. Not surprisingly, Truslit seems to be most interested in music that exhibits a pronounced gestural character; many of his musical examples come from Wagner, while there are no Mozart and Bach examples in his book (Repp 1993: 131).

With the development of score based abstract animation, we aim to escape from the aforementioned restrictions. Our approach should not only grasp a particular visual image of an individual musical sequence, but also create space for interpretative possibilities in terms of musical movement without being, in principal, limited to a particular musical idiom.

Scores as Pictures

A single note does not make music: melody, rhythm and harmony emerge only in the pairing of notes. Music's *gestalt* character is probably the natural source of any speculation with regard to continuous qualities of sonic gestures or motion. Visual *gestalts* can be generated from a transformation of discrete marks (e. g. notes in a score) into a continuous contour. Such 'Inductive translation' (Goodman 1976: 164ff.) is a straightforward way of structure modification and enhancement of visual score information.

In *gestalt* visualizations, the limitation of inductive transformation to legato passages can serve transparency since non-legato and staccato passages appear clearly separated from legato sequences. Figure 2, for instance, shows transcriptions of three occurrences of the main theme in the second movement of Beethoven's Third Symphony (*Eroica*). This theme famously dissolves at the movement's closure, and it is remarkable that Beethoven employs here 'gestural' rather than 'logical' relationships among the theme's occurrences. Through the grouping of legato passages, the *gestalt* transcriptions allow for an immediate grasp of the melodies' similarities in a display of musical texture that is unmatched by traditional score notation.

To give a second, and slightly more interpretative example, we refer to J. S. Bach's Prelude BWV 862 from his Well-Tempered Clavier (Figure 3).

Example 3/Figure 2: L. v. Beethoven, Symphony No. 3 in E flat major, Op. 55 (*Eroica*): Three occurrences of the second movement's main theme in score notation and *gestalts*.

Example 4/Figure 3: J. S. Bach: Prelude BWV 862 from Well-Tempered Clavier, Part I: Score excerpt and *gestalt* (right hand part).

The drafted transcription is highly interpretative in terms of articulation and phrasing, creating enriched musical information through continuous *gestalts*. Visual reasoning allows here again an immediate grasp of musical texture and structural information. The numbered legato motives, for instance, appear type identical, with the fifth legato *gestalt* being expansive. Moreover, our transcription highlights the legato motive's conclusion or continuation. In contrast to the original score, the conclusion of the first motive appears the most 'static' part of the passage, which is additionally supported by visual dynamic emphasis; the continuation of the second and third legato motive mirrors the first motive's curving, while the fourth connects with a sequence that returns to a more static character. This happens through token-based overlapping, since the last part of the fourth motive is identical with the start of the succeeding sequence. Moreover, the indicated bar lines show a shift of musical meter that regroups exactly with the fourth motive's closure.

Visual legato *gestalts* allow for a straightforward transposition of analog[5] musical information that escapes score notation, yet obviously leads also to a loss of definitional clarity in terms of pitch and note duration, and thus cannot be considered notational in the strict sense. *Gestalt* transcriptions like those presented in Figures 2 and 3 are related to contour theory, not in terms of abstracted discrete structure, but rather as continuously formed shapes. Thus, pictorial score interpretation could be morphologically analyzed with topological modeling (see for instance Buteau & Mazzola 2000), and bears similarities to the task of alphabetic character recognition (see Cheriet et al. 2007).

In the visualization of gestures or motion, music's structural characteristics do not suffice. The method of score based 'motion bracketing', introduced and presented in the subsequent sections, not only builds on music's *gestalt* character, but tries to tackle the problems of continuity and velocity distribution. However, the potential to simultaneously represent both discrete (melodic and harmonic) structures and *gestalt*-based gestural motion in aesthetic integration must remain a distinguishing feature of the sonic 'information system' music.

Simulation of Musical Motion

It is often claimed that music alludes to spatial motion, yet the movement music is supposed to reveal is rarely shown. In a philosophical debate between Roger Scruton and Malcom Budd in the British Journal of Aesthetics (Budd 2003, Scruton 2004), which received additional scrutiny by Rafael De Clercq (2007) and Zangwil (2010), one can find divergent answers as to whether for a melody to be perceived 'an unasserted thought containing spatial concepts is (i) a constitutive condition, (ii) an enabling condition, or (iii) not a condition at all' (De Clercq 2007: 164). A common theme, however, accompanies this dispute: music can, if at all, only metaphorically be grasped through reference to movement. Taking into account recent neuroaesthetic research this assumption is debatable. For instance, if brain areas that are responsible for motor perception are stimulated by music, and physiological events of this kind are supposed to be causally related to what is actually musically experienced, it appears also justified to say that music literally expresses movement.

Both philosophers and neuroscientists commit to a possibly misleading speech if they depart from a too strict separation of the visual and the audible, and presuppose that reference to motion is intrinsically linked to spatial movement — the philosopher by referring to what are seemingly two categorically distinct faculties, seeing and listening, and the neuroscientist by forming aesthetic distinctions based on the human brain's functional topography. However, in phenomenological terms, aesthetic experience is cohesive rather than breaking up into units that relate to a signal's separate neural stages. It appears counterintuitive that during the process of perception an acoustic stimulus could be separated from its possible transformation into motor perception or its conversion into an emotional state; a melody, for instance, is rather perceived instantaneously through certain qualities it possesses.

Since the individuation of music's basic qualities appears to be dependent on linguistic expressions, the dispute about music's spatial characterization happens to be linked to a traditional ontological problem:

> Metaphors can be more or less appropriate. And what the appropriateness of emotion, motion or spatial metaphors consists in is given by the nature of musical experience. Thus what appropriateness consists in depends on the aesthetic realism issue. An aesthetic realist will say that emotion, motion or spatial descriptions of music are metaphorical description of aesthetic properties of music. So they are more or less appropriate in virtue of being more or less faithful to the aesthetic properties of the music. On such a view,

> there is bound to be a loose relation of fit between metaphor and property. By contrast, on a non-realist view of Scruton's kind, metaphors are appropriate in virtue of the concepts employed in the imaginative act by which we apprehend the music. We hear the music imaginatively as sad, as in motion, as high, and that is why the literal words for the properties of emotion, motion and height are suitable metaphors for describing the sounds that we hear in those ways. Other non-realist writers may have different accounts of metaphorical appropriateness (Zangwill 2010: 94).

Whether an ontological framework that differentiates between subjective imaginative and objective properties of music contributes much to a better understanding of its aesthetic experience is doubtful. If, for instance, imaginatively heard properties can be more or less appropriate to the apprehension of music, to what else than music's 'actual' properties could the justification of such appropriateness refer? Furthermore, what could actually be meant with the notion of a 'metaphorical (objective) property'? These questions are especially urgent once we accept that music cannot be reduced to acoustic or notational information and thus does not even exist without a subject of perception.

Instead of searching for its ontological roots, the determination of what so-called metaphorical speech can contribute to the differentiation of the musical phenomenon appears to us the real challenge. There are more or less suitable ways of reference to music, certainly, yet one might argue that the question whether we grasp music metaphorically or literally, in imaginative or real terms, bears less significance than the investigation into musical distinctions that can be actually drawn from a certain categorical field (e. g. movement with regard to music). *If there is motion in music, it should be possible to point out a particular movement it takes*.

The interrelation between different art forms provides further evidence against the rooting of basic aesthetic categories in a single reception faculty. This, for instance, can be demonstrated with a comparison between music and dancing. Adam Smith was one of the first theorists who drew upon this connection:

> Rhythm and time, or measure, he (Adam Smith) thought, connect the two arts, music being a succession of sounds and dancing a succession of steps, gestures and motions. Dancing was superior to music, he thought, in the clear expression of meaning. On the other hand, music and poetry are independent arts, whereas dancing is not. This Smith explained by the fact, as he saw it, that measure and rhythm are more easily apprehended through the ear than through the eye and that therefore dancing demands music as an accompaniment to it (Schueller 1953: 342).

According to Smith, dance movement can gain rhythmic clarity through musical accompaniment only (see Repp 2004 and Repp and Penel 2004 for contemporary studies that support the reception priority of audible rhythm). Yet if rhythmic interdependence between music and dance exists, and musical rhythm can elicit embodied rhythm, then the notion of rhythm must go beyond, or lie within both modes of expression. When a dance movement interacts with musical rhythm, we perceive actually two rhythmic streams in an interplay that can range from perfect correspondence through divergent parallel rhythmic complexities to actual mismatching. Rhythm must thus be considered an autonomous phenomenon that is realizable in both the sonic and the visual realm.

The same token of reasoning can heuristically be applied to the concept of motion. In this view, movement is present in sound as much as it is a phenomenon of space. This only appears counterintuitive if motion is prematurely connected to kinematics. Once motion is defined in minimal terms as change in direction and velocity, however, the very idea that motion is an intrinsic feature of music is not implausible. After all, tempo is constitutive for music; direction too is implicit to the musical happening, not only with regard to tonality characteristics but also with regard to melodic shaping and phrasing.

If identical motion principles can indeed be realized in both the acoustic and the visual realm, both spheres should have a semiotic linkage. We subsequently ask whether music scores can serve as a straightforward symbolic dock for motion visualization. More precisely, in our short experiment we inquire into the possibility of utilizing *gestalts*, as discussed in the preceding section, in music's visual simulation.

Our investigation follows Trenholm's (1994) distinction between analog and symbolic simulation:

> Analog simulation … is defined by a single mapping from causal relations among elements of the simulation to causal relations among elements of the simulated phenomenon (Trenholm 1994: 119).

In opposition to symbolic (syntactical or mathematical) modeling, analog simulations create events that instantiate certain causal structures. Operating at the concrete level of token and value instead of type and variables that are abstracted from the phenomenal world, analog simulation realizes particular natural processes by establishing sequential coherence between simulating and simulated media:

> In abstraction, analog simulators are physical systems whose processes are characterized by what might be termed variable properties — physical magnitudes whose values vary over time. The variable properties of a causal structure are higher-level (emergent) properties and hence provide only a partial characterization of the simulation process — that is why there may be so little outward resemblance between the simulating process and the phenomena simulated. Naturalistic simulation requires that variable properties of the simulating process correlate with those of the simulated process so that (in principle) they could provide information on the values of the correlated properties of the simulated process. The simulating process must have sufficient complexity to mimic over time (at some level of abstraction) the causal structure of the simulated process (Trenholm 1994: 123).

Analog simulation needs some adaptation for our purposes. First of all, animations are quasi-simulations at best. They do not actually realize a natural process, but rather imitate such realization. Three additional constraints must be stressed: (a) we apply a kind of *lex parsimoniae* in an attempt to generate the highest possible degree of differentiation among analog interpretants of musical motion with basic visual animation tools, (b) we depart from a straightforward visual mirroring of musical *gestalts* and (c) we acknowledge, in informal terms, Newton's laws of motion and the general theory of forces.

The first constraint is rather self-evident. If motion is inherent to music, its essence should be expressible through basic motion blueprints that subsequently can underpin an enriched metaphorical grasp of movement (such as a bouncing ball as the interpretation of a rhythmic sequence). For instance, in Schubert's famous songs *The Trout* and *The Erlking*, basic motion types illustrate a fish's swift motion and a restless horse. The motion types can be clearly individuated, yet reference to a trout or a horse can only be established contextually (through the songs' lyrics, for instance).

The two remaining guiding principles are more problematic: is it indeed possible to derive an outline for visual analog simulation of music directly from scores? And can the obtained trajectories be interpreted in terms of motion laws?

Example 5 is a straightforward demonstration of such a possibility. The indicated passages in Beethoven's piece suggest a downward slide (literally performed by the first violin!), which appears especially significant after the *ritardando* in the first four bars of the score excerpt.

The final passage of the third piece from Schumann's *Davidsbündlertänze* Op. 6 is another obvious example. The motion of this rollercoaster like passage is directly linked to the *gestalt* of the respective note sequences, which forms a trail that determines motion types in terms of a straightforward simulation of gravity (see the Section headed 'Abstract Score Animation' for a further discussion of this sequence).

Now gravity is not only the central notion in modern Newtonian Physics, it also stands in opposition to the central concept, in both 18th century aesthetic and ethics, of freedom. According to the German writer Friedrich Schiller (1793) the rising above gravity is actually freedom's aesthetic expression:

> If mass has influenced the form, we call it plump; if the mass has influenced movement, we call it awkward. … Mass is at all times beholden to gravity which has an alien potential with respect to the organic body's own nature. We perceive everything to be beautiful, however, in which mass is completely dominated by form (in the animal and plant kingdom) and by living forces (in the autonomy of the organic). … It is not unimportant to note that the ability to overcome heaviness is often used as the symbol of freedom (Schiller 1793: 164).

Example 5: L. v. Beethoven: String Quartet Op. 130, 2nd movement.

Example 6: R. Schumann: *Davidsbündlertänze* Op. 6, 3rd piece, final passage.

Schiller's thought allows us to refer back to the second movement of Mozart's Piano Concerto KV488 (see the extended passage in Example 7). In this sequence, the opening gesture is repeated twice, with each of the phrases developing a particular motion type. The phrase's three stages could be interpreted as a gain of freedom against the force of gravity. The first segment obeys gravity rather directly in a motion that appears being dragged down gradually before running out with two repetitions of a C#; the second expresses some resistance to nature by holding back the motion with two slurs that, while leading to an accelerated 'deliberated' motion, is still feeling downforce; finally, a triumph over gravity in the third attempt, with a subjective force countering nature, and freeing itself to a hopeful gesture that Mozart ingeniously supports with both harmony and orchestration.

Language has certainly the ability to metaphorically paraphrase music's content; our animation of the concerned passage, however (see Animation 1), aims to show music's inherent motion through a visual lens, thus, in abstraction from the complete musical phenomenon.

Visual 'motion-bracketing' suggests a possible link between written score and sound in the form of an autonomous motion image that creates, as in musical performances, the enriched mirror image of score information. Yet not only is such an image in its visual abstraction selective and ontologically different from the musical phenomenon as a whole, it is not even necessarily isomorphic to music's acoustic structure, a characteristic which can bring it paradoxically closer to musical signification. This possibility is paradigmatically instantiated by the piano tone, whose loudness is determined by a single hammer stroke that cannot be readjusted after the sounding of the affected strings, causing decrease of loudness even where a preservation of energy appears necessary in semiotic terms. Indeed, in the daily practice of instrumental instruction, singing as well gestures are used as didactical tools whose power of differentiation often reaches beyond the possibilities of the concerned instrument, but helps creating an intentional semiotic image that transgresses instrument-dependent acoustic peculiarities.

Building on this observation, we examine the possibilities of a visual representation modus that allows for a visual analog grasp of motion in music, whose autonomous semiotic status should be systematically established through a straightforward, one could say 'naïve', procedure. Departing from 'Pitch-Loudness-Duration' (PLD) transcriptions that are directly derived from scores, '*gestalt*-images' of tonal sequences are carved and subsequently used as a blueprint for the discussion of musical motion by means of visual animation. The transfer from PLD-transcription to animation involves three constitutive layers:

1. **Motion trajectories** follow *gestalts* as legato interpretations. It has been pointed out that legato passages can be represented in curved lines that connect discrete notes. The resulting visual *gestalt* shapes can subsequently be interpreted as motion paths, and since in such inductive translation the exact shaping is undetermined, an interpretative space, especially with regard to long notes, opens up (see Figure 4). In terms of non-legato passages, a rhythm based direct PD (pitch-duration) isomorphism appears the most straightforward visual translation. Yet it is questionable whether a simple correlation that interprets pitch as visual height and duration as visual length with regard to both notes and pauses does justice to the *gestalt* character of many non-legato passages. A visual non-legato interpretation in terms of bounces, for instance, appears often more appropriate (see the section headed 'Abstract Score Animation' for further discussion).
2. **Velocity** involves tempo gradation and individuates motion in terms of acceleration and deceleration. If a subject (e. g. a shape) travels along a certain motion path, its speed can obviously vary, or its movement can stop momentarily. Velocity distribution relates to the specific shape of a motion path, which can further be interpreted in terms of physical forces.

Example 7: W. A. Mozart, Piano Concerto No 23 in A major, KV 488, 2nd movement, bars 20–26 (F# key signature).

3. **Voice** development deals with intrinsic modifications of the motion subject through resizing, shading etc., which in isomorphic animation is used for an emphasis of dynamic (=closeness of the subject).

Figure 5 provides a synopsis of the investigated animation types. The method will be exemplified in the next section.

Abstract Score Animation

In this section, the method of score animation is exemplified, first with reference to the opening phrase of Beethoven's Piano Sonata Op. 2/1 (Example 9). We begin with two simple dynamic-based animations, presented in both script and animation that are rooted in the structured *gestalt* transcription shown in Figure 6.

Dynamic based animation disregards pitch distance, and thus gives an impression of music visualization that is not directly associated with the notion of melodic height as spatial indicator. Limited to rhythm and dynamic, correspondence with non-legato passages is established in terms of temporal order, duration and the interpretation of loudness through shape size. Legato passages, however, are visualized in continuous *gestalts* that guide a particular motion.

Score animation leads to either internal enrichment or additional extension of notational structure. In animation scripts (see Figure 7) score enrichment is indicated with arrows between shapes that correlate to notes.

In our first example (Animation 2), legato passages are simply presented in continuous transition between dynamic values (shape sizes); in the second (Animation 3), however, an initial dynamic value is added to section A6 and B6 in order to emphasize the respective peak notes with shape augmentation before the 'backward' movement commences. Being acoustically unachievable with the piano, such change in dynamic on a single note could still be considered a more accurate rendering of the concerned phrase in terms of constitutive aesthetic intentions relevant to both performing and listening.

A second major difference between these introductory animations concerns the *acciaccatura* in segment C6 and D6, which is interpreted as a continuous development in the first, and with a special effect in the second, where an interrupted transition between dissimilar shapes is supposed to visually recreate the respective musical effect.

Example 8/Figure 4: Three different *gestalts* based on F. Schubert, Piano Sonata in A minor. Op. 42 (D784), 1st movement, bars 1–2.

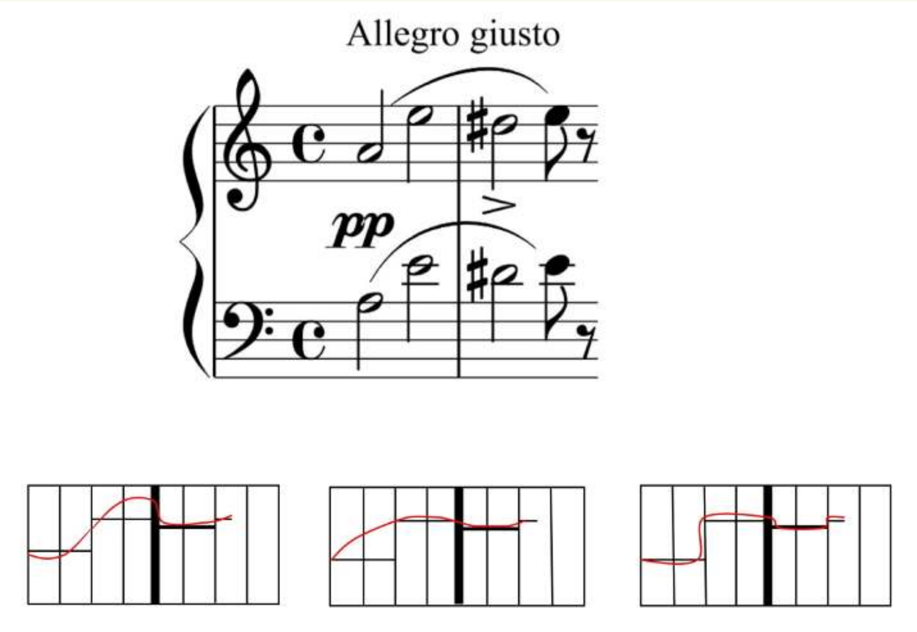
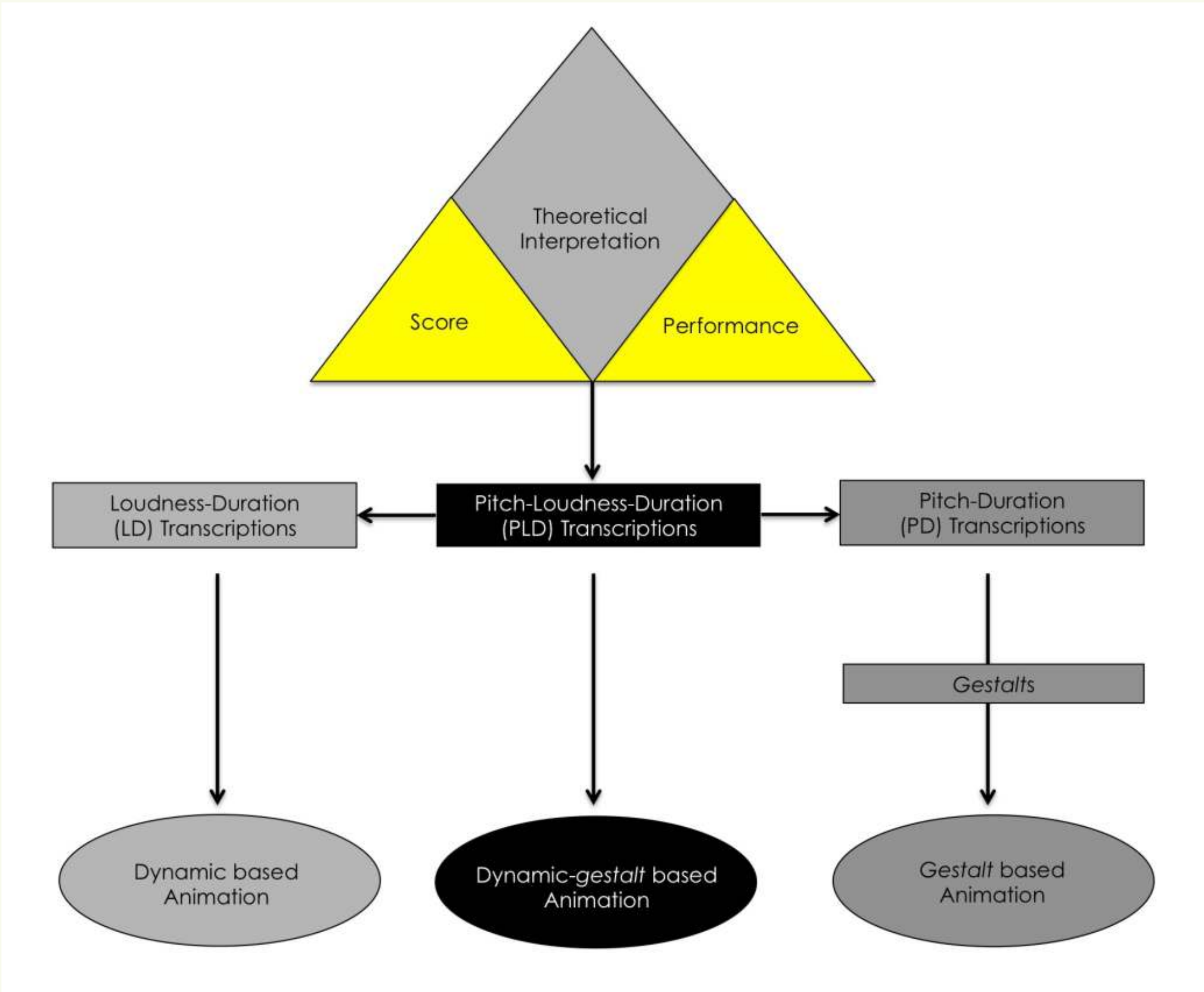


Figure 5: Overview of animation types based on score transcription.



Example 9: L. v. Beethoven: Piano Sonata in F minor Op. 2/1, 1st movement, bars 1–8.

Figure 6: L. v. Beethoven: Piano Sonata in F minor Op. 2/1, 1st movement, bars 1–8, structured *gestalt* transcription.

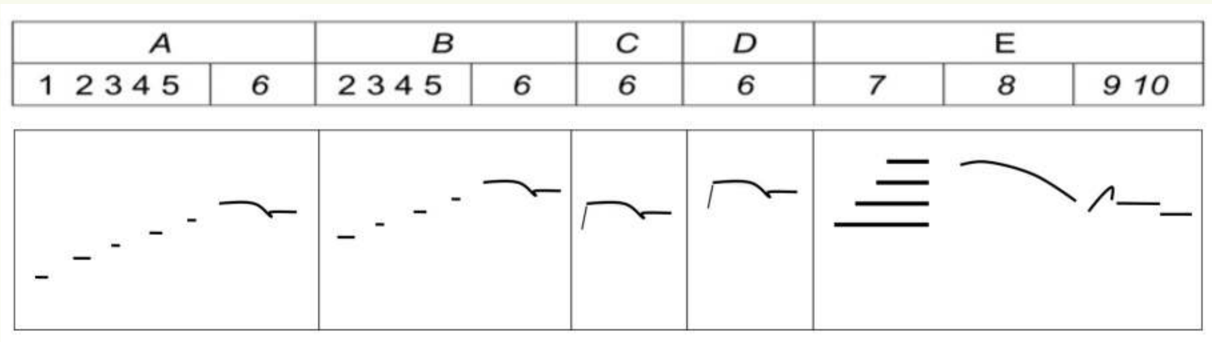


Figure 7: Scripts for Animations 2 and 3.

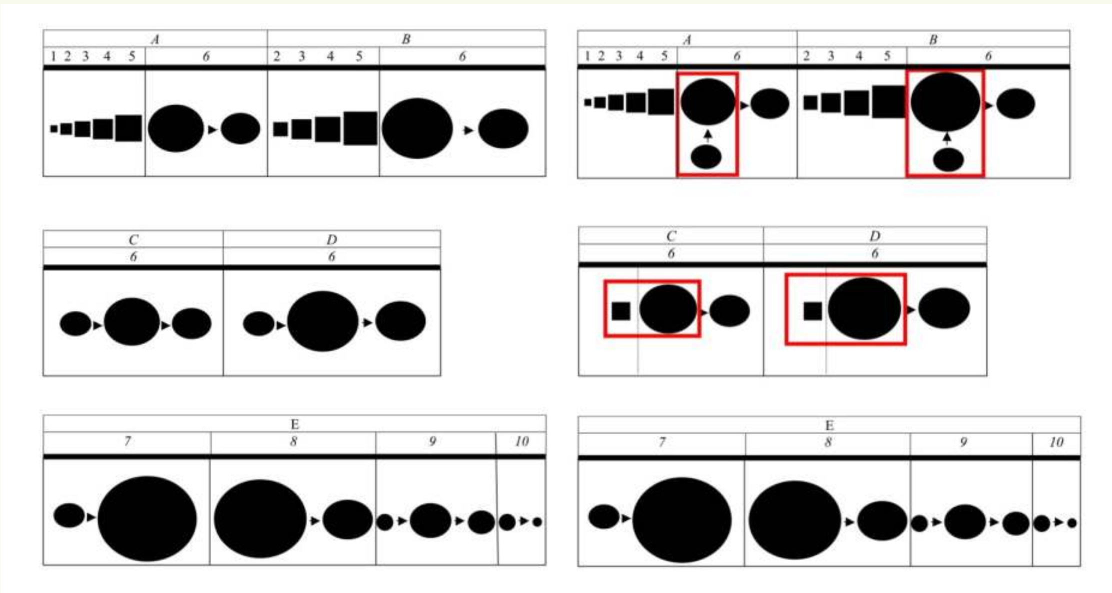
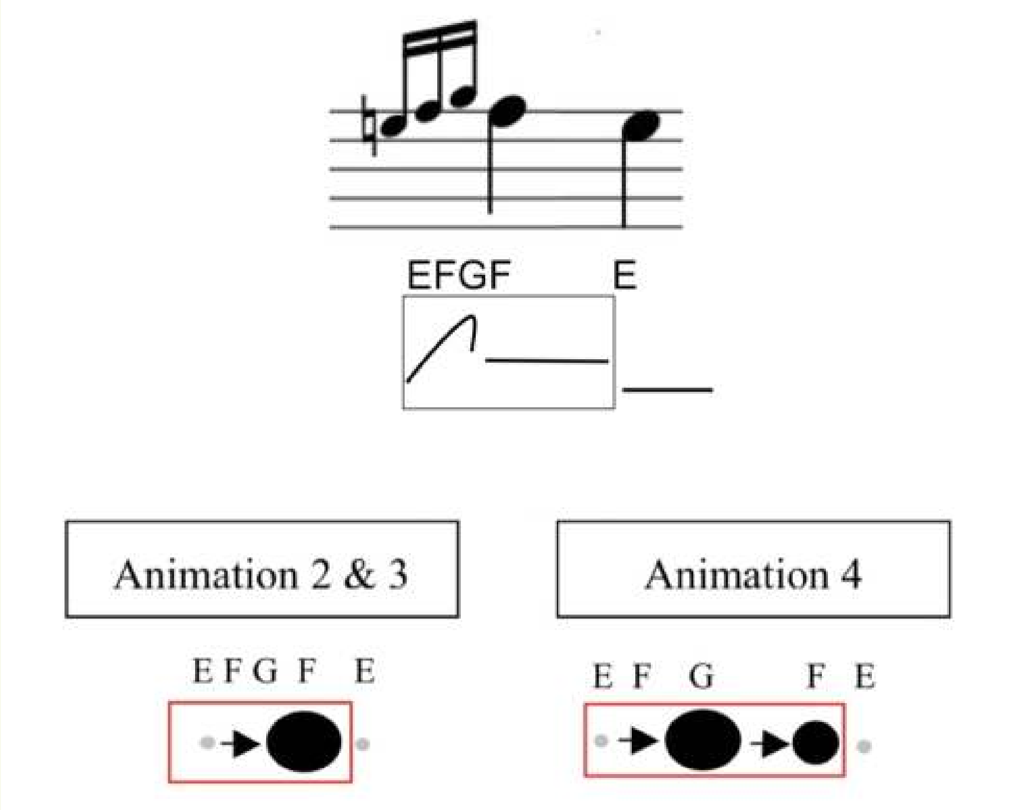


Figure 8: L. v. Beethoven: Piano Sonata in F minor, Op. 2/1, 1st movement, turn in bar 8, scripts for Animations 2, 3 and 4.



Animation 4, by contrast, differs in three respects from the previous two:

First, the peak notes in A6 and B6 are overemphasizted, creating a rather acute visual interpretant of the concerned passage.

Second, the accompanying chord rhythm is imitated with an extra visual layer in an attempt to capture the specific rhythmic interplay between the right and left hand parts.

Third, the turn in segment E10 appears more accurately articulated. The turn's scripts (Figure 8) clarify that Animation 4 employs a pitch related change in circle size that imitates the turn's melodic backward movement (from a G to an F), which violates the basic mapping principle of dynamic based animation in its exclusion of pitch relations. Musical motion, however, appears to be constituted by relevant changes with regard to possibly all musical parameters. Thus, dynamic-based animation is successful only where dynamic changes capture a motion's essence.

For a brief orientation, the following three basic approaches towards music animation should be differentiated:

- **Non-isomorphic music animation** does not depart from one-to-one relationships between notes and visual primitives. Most of music animation exemplifies or expresses solely higher order qualities instead of integrating detailed musical structure, and thus falls under this category. For example, it is unclear how instances of timbre and harmony could be 'visually' quantified and ordered, which makes a direct analog mapping of these parameters onto the visual realm impossible. Non-systematic animation of music is thus the most common, exemplified by large parts of famous semi-abstract animation work such as the well-known Walt Disney production Fantasia.

- **Isomorphic non-serial score animation** overwrites serial or directed (melodic) development with an emphasis on rhythmic and textural qualities. Animation 5, for instance, provides a simple example with its idiosyncratic interpretation of segment E7 (see Figure 6).

- **Isomorphic serial score animation,** by contrast, is rooted in the straightforward mapping of musical parameters onto the visual field (see Figure 9 for an example) and the subject of investigation in this paper. It is questionable, however, whether structurally truthful score animation can do more than rhythmically instantiate prevalent structural changes. The sudden shift from dynamic to pitch representation in Animation 4 does not appear counterintuitive, and inverted dynamic based animations (see Animation 6 for an example) can be considered equally appropriate although they do not follow the apparently natural correlation of a crescendo with shape enlargement. Yet while extended mapping of the three parameters duration, loudness and pitch onto three-dimensional space does not directly import extra-structural value, the following stimulates further speculation about the modeling of musical motion.

In enriched dynamic-*gestalt* based animation, genuine categorical unification between the visual and audible is suggested by pitch-based motion trajectories that serve as markers for direction and velocity of movement whose determination and interpretation in terms of physical forces is a crucial aesthetic challenge, particularly with regard to gravity-based 'objective' motion in contrast to 'subjective' free motion that overcomes gravitational forces (see the section headed 'Simulation of Musical Motion').

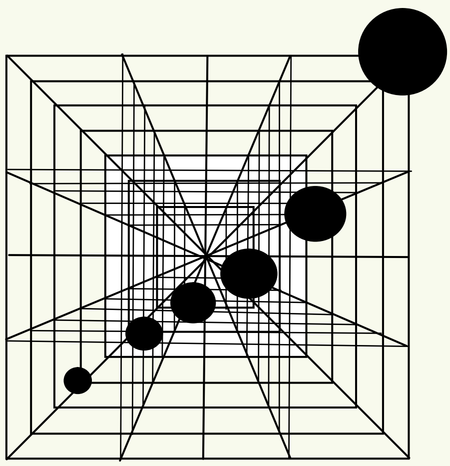
Animation 7 is an example of dynamic-*gestalt* based animation, highlighting aesthetic questions concerning motion that are unrecognizable in the preceding simple dynamic-based animations. Particularly, *gestalt*-based animation appears more suitable in its response to the triplets in the discussed phrase by Beethoven (segments A6, B6, C6 and D6 in Figure 6), whose continuation after the dotted crotchet Animation 7 interprets as an accelerated descending. However, this particular movement is presented without a clearly articulated ending, which relates to two aesthetically relevant features of the phrase concerned.

First, the sequence's left-hand part appears to overlap and finally dominate the respective passages (A6–D6) with a pressing chord repetition that prevents the right-hand part from being distinctively marked and brought to closure.

Second, the shift in direction and velocity introduced by the triplets could be interpreted as the effect of a more objective gravitational force at the end of each musical segment, and leads thus to an 'escaping' motion. Animation 8, which differs in screen structuring from Animation 7, puts emphasis on the downward movement and demonstrates the possibility of motional fine-tuning.

The phrase under discussion could thus be seen as a series of unsuccessful trials to ascend before being forced to 'slide' downwards, first with some preparation (segments A and B), followed by impatience (C and D), before resignation takes place after a final powerful attempt (E). Such motional 'drama' counters the idea that this paradigmatic example could aesthetically be reduced to rhythmic or formal analysis, and thus be properly imitated with attentiveness to structural interdependencies alone (see Thoressen 2007 for a recent structural approach to this phrase in terms of aural analysis).

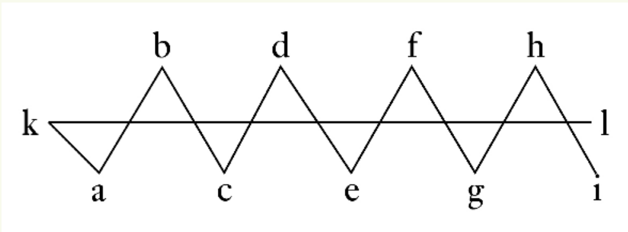
Figure 9: L. v. Beethoven: Piano Sonata in F minor, Op. 2/1, 1st movement, bar 1, categorically unified mapping onto space.



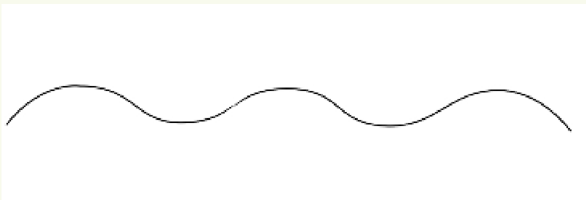
[Animation 9](#) 'motionalizes' the turn (E9) that has not received proper attention in [Animations 7](#) and [8](#). The chosen trajectory follows a motion type suggested by Truslit that is actually not in accordance with temporal 'left-to-right' ordering of note succession. Truslit's 'open' movement (see [Repp 1992: 268](#)) appears suitable as it visually 'energizes' the (reversed) turn with a swift spin that closes on a crotchet as the phrase's longest and most static part.

Truslit's approach to the visualization of musical motion appears to have its roots in 18th century aesthetics, which can be demonstrated with the following passage by Friedrich Schiller:

> A follower of Baumgarten will say that the curving line is the most beautiful because it is the most perfect to the senses. It is a line which always changes direction (manifold) and always returns to the same direction (unity). But if it were beautiful for no other reason the following line would also have to be beautiful:



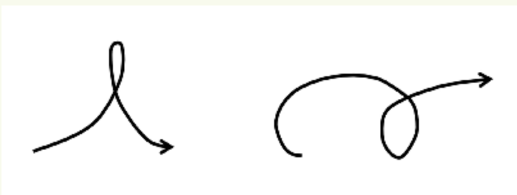
> which is certainly not beautiful. Here too there is a change in direction; a manifold, namely a, b, c, d, e, f, g, h, i; there is also a unity of direction which reason adds to it and which is represented by the line k l. This line is not beautiful even though it is perfect to the senses. The following line, however, is beautiful, or could be such if my pen were better.



> Now, the whole difference between the second and the first line is that the former changes its direction ex abrupto while the latter does it unnoticed; the difference of their effects on the aesthetic feeling must be based on this single noticeable difference in quality. But what is a sudden change of direction if not a violent change? Nature does not love jumps. If we see it making one, it appears that it has suffered violence. A movement seems free, however, if one cannot name the particular point at which it changes its direction. This is the case with the curving line which is different from the line above only in its freedom. ([Schiller 1793: 173](#))

Loops are the essence of Truslit's movement forms (see [Figure 10](#)) and realize Schiller's aesthetic denial of 'sudden changes of direction'. However, the annulations of discrete turning points do not neglect melodic correspondence; in contrary, the dynamic of a swift circular motion accentuates melodic peaks and valleys (see [Parncutt 2003](#)), and thus constitutes a basic, yet possibly non-proportional, motional mirror image of melodies.

Figure 10: Two basic motion forms, closed and open, introduced by Truslit (see [Repp 1992: 268](#)).

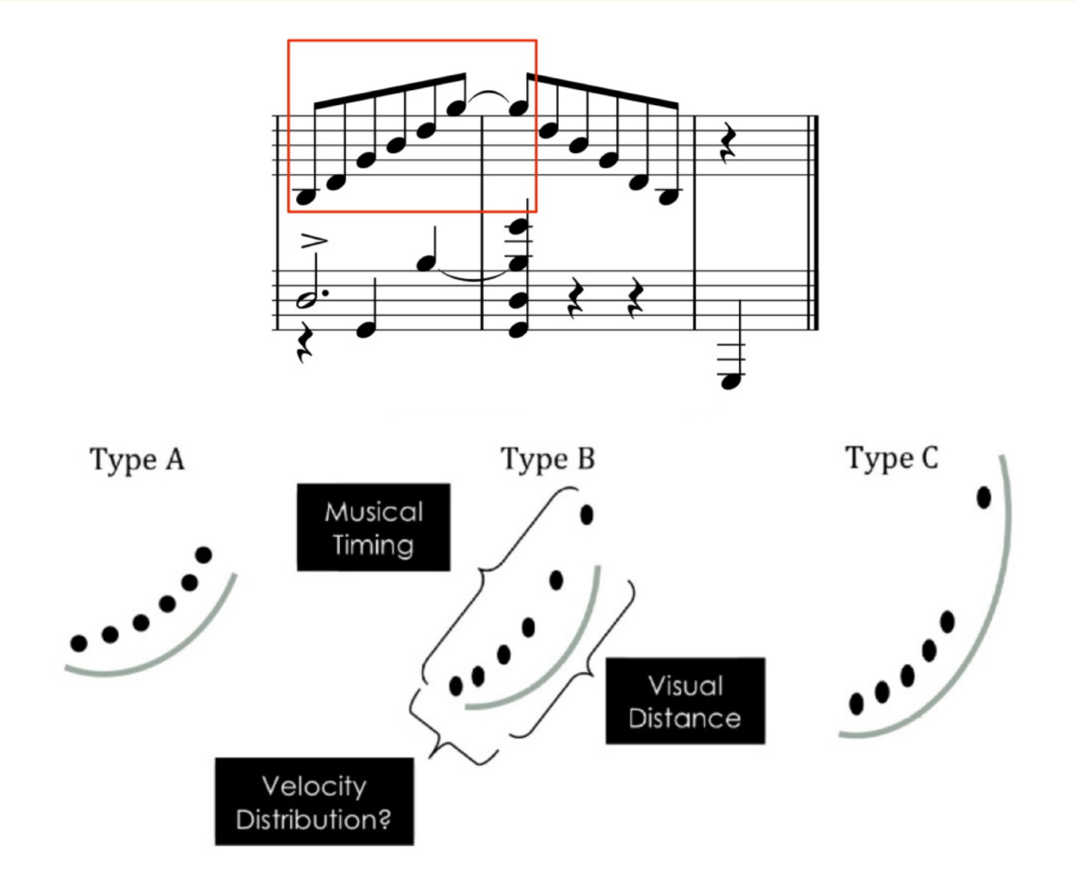


Truslit's intuitive differentiation of motion curves, however, lacks a reasonable criterion. Animation 10 for instance, instantiates a wave like movement that relates to the last passage of the third piece of Schumann's *Davidsbündlertänze* Op. 6 (see Example 6 in the section headed 'SImulation of Musical Motion'). The three versions of this movement instantiate a simple smooth curving as well as Truslit's open and closed motion form, yet all of the theoretically distinguished motion types appear to have the same potential to exemplify velocity and moments of direction change.

In conclusion, visual bracketing, through parameter isomorphism, allows for a straightforward grasp of semiotic problems in relation to musical motion, not merely solving or simplifying the problems raised by Truslit's speculations, but rather allowing for their better formulation. The following theoretical components appear crucial:

1. Visual *gestalts* (motion trajectories) depict a melody essentially in terms of its peaks and valleys.
2. Turn visualization presents musical motion in a curved, rather than abrupt development and thus does not capture pitch change in the form of discrete steps.
3. Continuous connectors between *gestalt* turns do not signify pitch transgression as pitch is a 'digital' phenomenon.
4. In the 'naïve' mapping of music onto space, the visual distance of two diachronic note events is determined by pitch (translated into a shape's vertical position), dynamic (closeness), and timing (horizontal position).
    - 4.1. Note (=shape) distance determines velocity in relation to musical meter and tempo.
        - 4.1.1. Pitch and dynamic are independent from musical tempo and meter, and have thus the potential of modifying motion velocity autonomously.
        - 4.1.2. Tempo gradation creates a representational paradox with regard to motion. A delayed note, for instance, augments temporal distance that, if directly translated into the visual, does not necessarily lead to slower motion since an object that travels a longer distance is sufficient for the indication of a musical *rallentando*. If note values, however, are arithmetically idealized and represented in terms of fixed visual units, it is velocity that has to capture agogics.

Figure 11: R. Schumann, *Davidsbündlertänze* Op. 6, 3rd piece, final bars.



Musical motion is thus an autonomous parameter that cannot be directly and exhaustively derived from musical meter. This diagnosis differs essentially from the assumption made by Das et al. (1999) who, in a rare study with regard to Truslit's work, try to link his motion curves to tempo changes. To view Truslit's curves as simple archetypes of acceleration or deceleration, however, appears a mistake, as does the principal exclusion of pitch and dynamic distance in motion analysis (also see the section headed 'Expressive Timing and Motion').

In order to illustrate the categorical difference between motion and meter, we return to the aforementioned passage in Schumann's *Davidsbündlertänze*, particularly to its final peak (Figure 11).

There are obviously many interpretative options available to the pianist in order to shape this piece's ending. Since Schumann prescribes a decrescendo, however, interpretative choices will have to rely merely on timing. Figure 11 displays three basic tempo types with regard to the last upward movement in this closing section, the first without tempo change, the second with a gradual rallentando, and the third with a delayed peak note. Motion analysis, contrary to both static analog visualization and listening, enforces an immediate decision whether the supposed tempo reductions in type B and C should translate into an increase of visual distance or a decrease of velocity. In Figure 11, we suggest an identical trajectory for type A and B — the latter thus exhibiting a slowing motion — while type C is presented without change in velocity, yet with an augmented distance between the last two note events. Type B can subsequently be interpreted as lacking subjective energy in order to overcome gravity in moving upward, which particularly appears meaningful when one performs the preceding curves without tempo loss. Type C, by contrast, keeps the tempo during the movement's first five notes and the sudden delay of the peak note is probably more naturally interpreted as a final extensive gesture, rather than a sudden slowing between the passage's fifth and sixth notes.

Animation 11 instantiates type C in the modus of a simple *gestalt*-based animation. Here, the stretching of the final upward movement does obviously not indicate pitch distance, but is a mere motional exaggeration of the peak note's late appearance. Here we face a concrete example that questions reductive, pulse oriented, views on musical motion, as discussed in the introductory sections of this paper. It is shown that in terms of gesture, the final peak note in Animation 11 ends an accelerated upward movement, while the passage's tempo is, at the same moment, indeed slowing.

Motion trajectories, we have seen, are mainly images of melodic peaks and valleys, and once their visual connection is understood as the interpretation of overall motion rather than the truthful mapping of separate parameters like in static score visualization, pitch, dynamic and temporal distance become determining factors with regard to motion trajectories. The following components can thus supplement the enumeration from above:

5. Correlation of visual peak-valley distance (or else velocity!) with pitch, dynamic and tempo is non-linear. Obviously, the doubling of a melodic interval, say the transformation of a major second into a major third, does not necessarily increase its 'motional' effect proportionally. This seems to apply equally to dynamic and agogics.
6. Visualization of motion has its own 'psycho-logic'. A gesture's visual augmentation, for instance, can exemplify the motion type of a subtle musical event more effectively. Visual 'peak shifts' (see Ramanchandran & Hirstein 1999) deviate from a proportional grasp of score parameters and are a crucial challenge for every algorithm based computerized visualization of musical motion.

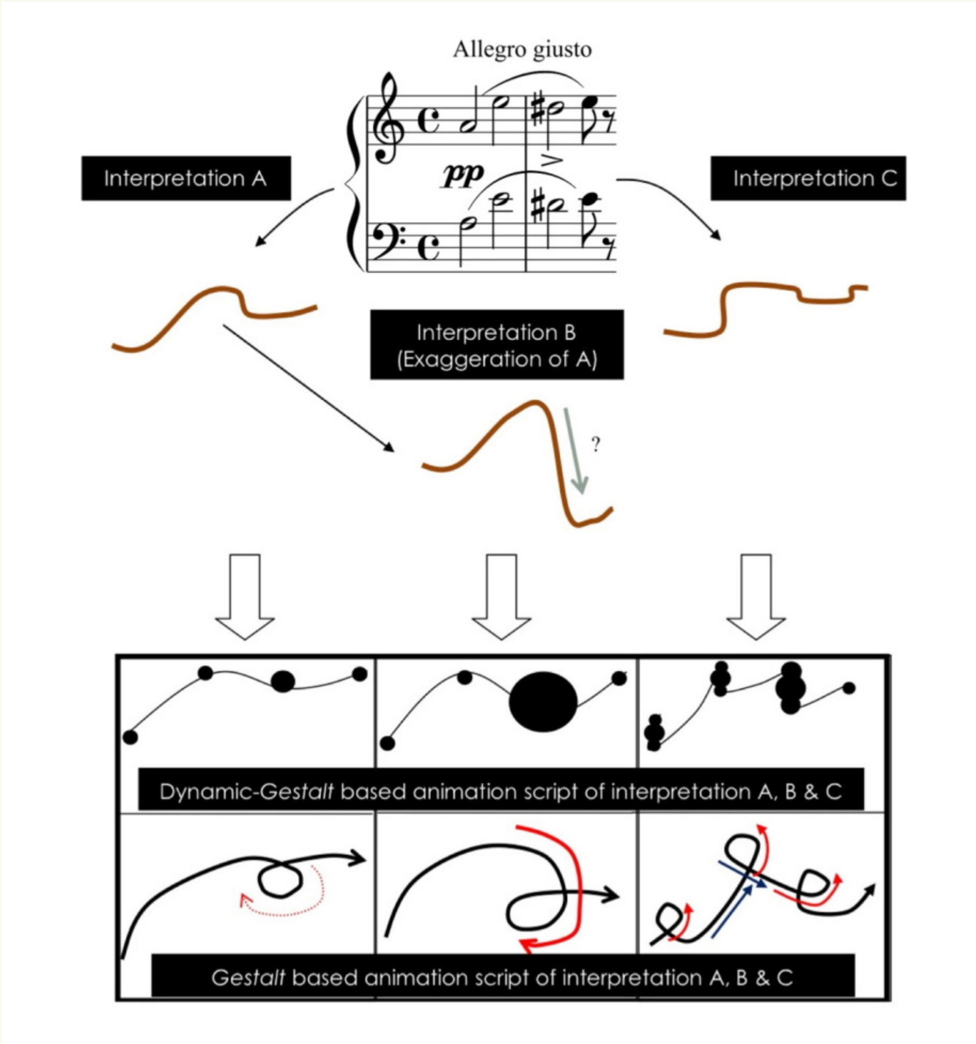
Our considerations have been based on the assumption that a musical legato exhibits permanent motion that, in visual animation, derives from, yet is not entirely determined by pitch, tempo and dynamic variation. With regard to the latter, one more crucial component should be stipulated:

7. Dynamic changes are motional changes and can thus be incorporated into visual trajectories.

Subsequently, the principles of *gestalt*-based score animation prove effective in the discussion of musical motion, which is demonstrated in Figure 12.

The above animation scripts indicate the transformation of dynamic accents into motion. Categorical unification of dynamics with spatial depth is thus abandoned in basic *gestalt*-based animation. Interpretation A shows Schubert's motive in a relatively slow steady motion (the black trajectory is supposed to signify a stable tempo) that receives a slight accent on the third note through light acceleration (the

Figure 12: *Gestalt* Analysis of F. Schubert, Piano Sonata in A minor, Op. 42 (D784), 1st movement, bars 1–2

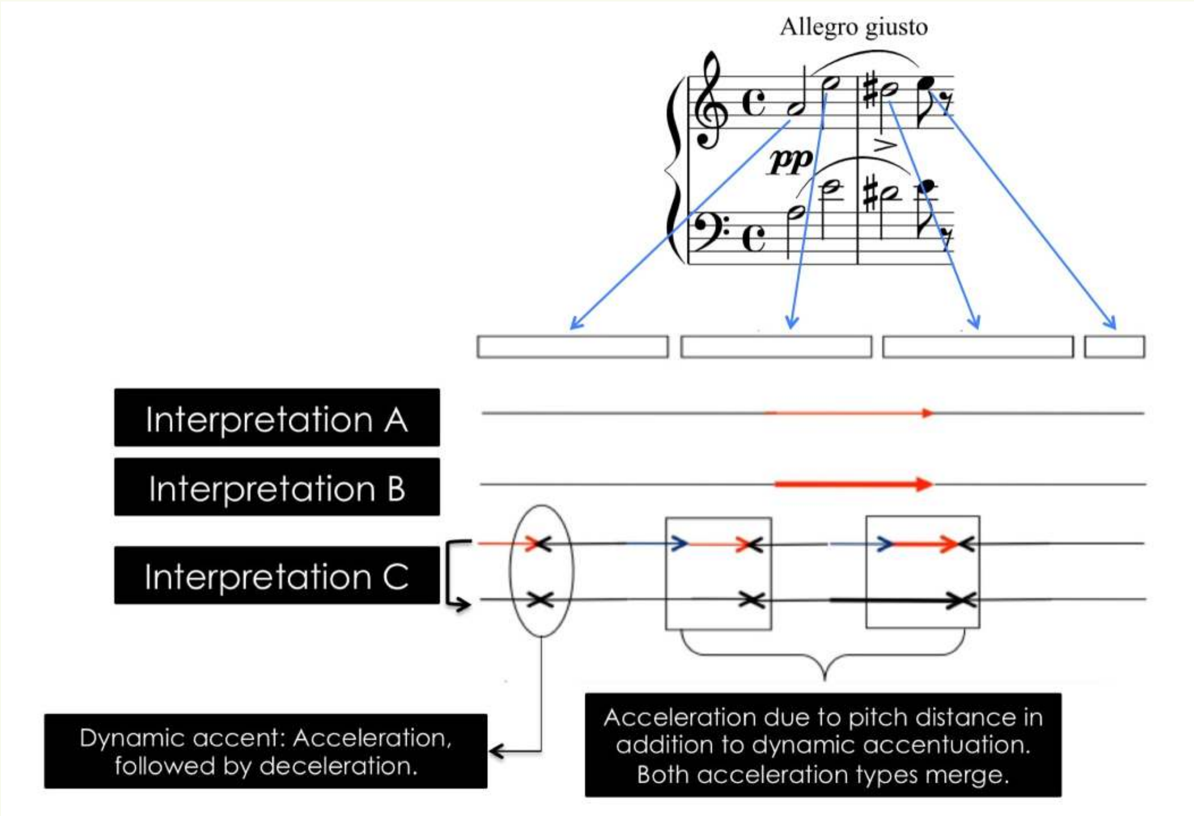


red arrow). Interpretation B exaggerates this movement, while Interpretation C, quite in contrast to Schubert's instructions, puts motional emphasis, rooted in dynamic accents, on the first three notes (indicated in dynamic-*gestalt* animation through shape size modifications on each note). Interpretation C would result in a rather uneven velocity distribution if we assume that a dynamic accent accelerates movement before bringing it back to medium speed (a motional contrast which makes an accent understandable), followed by a renewed acceleration that appears necessary to reach the subsequent note in time (the blue arrows).

Yet if musical motion is primarily concerned with velocity distribution, trajectories could entirely be abandoned and musical movement could thus be essentially signified in motion that is linear (see Figure 13).

Linear movement appears to lack crucial aesthetic information. When it is synchronized with music (or read against musical meter), however, the two main interpretative factors we have explored, namely velocity distribution and visual distance between note events, can still be exhaustively represented in such a modus. Obviously, linear motion might be perceived as unnatural when it involves too many tempo changes within a short period of time. However, linear motion is just one possibility of how both variables, tempo and distance, can be realized. Pitch-based trajectories form a particular subset among all such possibilities through the determination of peaks and valleys. Changes in direction seemingly add an aesthetic component to motion that is presented in linear terms. However, since melodic peaks

Figure 13: Reductive *gestalt* analysis of F. Schubert, Piano Sonata in A minor, Op. 42 (D784), 1st movement, bars 1–2 based on Figure 12.



and valleys are usually accentuated, they can be transformed into motional changes as it is indicated in the transition of Figure 12 to Figure 13. Subsequently, only in correlation to physical forces, notably gravity, pitch-based trajectories import a distinctive aesthetic feature.

We thus can derive a framework for the visualization of musical motion that, while being rooted in velocity distribution in its interplay with visual note distantiation, can be enriched through direction change based on melodic valleys and peaks, and employ gravity as an interpretative factor. This might seem trivial, yet addresses problems with regard to musical motion that are overlooked in current debates about this topic, as the following passage demonstrates:

> … if melodies are structures, then the following answer to the question 'What is necessary for hearing a sequence of sounds as a melody?' suggests itself: to hear a sequence of sounds as a melody (that is, to hear a melody in them) one has to hear that they exemplify a certain structure — in particular, one must hear that they exemplify a structure the defining relations of which concern only relative pitch, relative duration and order. In a similar vein, one might suggest that hearing a sound as a tone (that is, in Scruton's words, as having certain 'musical implications') requires hearing that it occupies a place in such a structure. (Compare: seeing a visual speck as a cursor requires seeing that it occupies a place in a certain causal structure.) Of course, Scruton would not disagree with such minimal conditions. He would merely add another one to it, namely that one hear movement in the sound — not literal movement, of course, but metaphorical movement. However, metaphorical movement may be exactly what one hears when one hears that a certain melodic structure is exemplified (De Clercq 2007: 167).

Quite in contrast to this passage, music's analog simulation suggests that while every melody instantiates a discrete structure, it also does exhibit a motional *gestalt*. In reducing motion to the identification of an element in a structure, De Clercq hardly addresses the problem

Example 10: W. A. Mozart: Piano Sonata in C minor, KV 457**.**

of musical movement, neither in literal nor metaphorical respect, since motion, in whichever modus it might be present, is an analog phenomenon that adds crucial semiotic aspects to musical structure. Hearing 'movement in the sound' is hearing real motion, i.e. the perceiving of a change in velocity and direction to which all musical parameters can contribute. The additional interpretation of musical motion in terms of physical forces or the imaging of a particular life-world object's movement is subsequently rather a specific modeling of a universal motion type than music's metaphorical transformation. The question of whether there are non-kinematic models of musical motion (see Honing 2005) appears to us misleading if it is presented as an ultimate one. Either a piece of music (i) suggests certain kinematic interpretations, (ii) presents movement patterns that are alien to our visual life-word experiences or (iii) does not allude to motion and its metaphorical transposition at all. Once motion is defined in terms of velocity distribution and direction change, however, it should principally be possible to transfer any musical movement into the visual realm by means of abstract animation. Abstract score animation appears here a straightforward modeling tool from which aesthetic speculation in terms of kinematics can depart.

The problem of motion in music is seldom approached from the perspective of non-legato passages. With analog simulation, however, it can be demonstrated that a musical non-legato is not necessarily exclusive with regard to continuity. Animation 12, for instance, interprets the non-legato segments A 1–5 and B 2–5 (Figure 6) with a continuous bouncing motion. Whether such light motion, or rather a discrete abrupt procession as in Animation 2 is appropriate, is an aesthetic question that can certainly be better communicated with abstract visual animation. Considering the character of the phrase concerned, and especially taking into account the articulation of the chords in the left-hand part, an interpretation as a disconnected motion would probably appear more suitable.

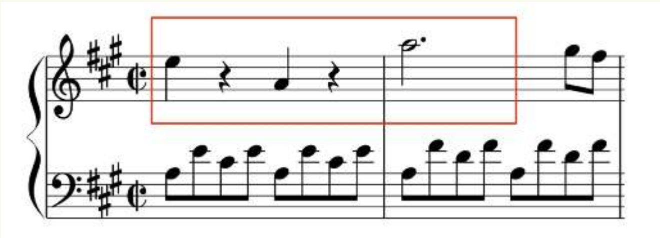
With regard to Mozart's opening of his Piano Sonata in C minor, KV 457 (Example 10), however, a jumping motion seems to be a serious aesthetic interpretative candidate as the contrast presented in Animation 13 aims to show. In a further example — the opening of Mozart's third movement in his Piano Concerto in A major, KV 488 — analog modeling demonstrates how motion fills rests that separate notes, first with a steady movement, second with shape contraction on the first note followed by acceleration, and lastly with a holding shape contraction on the first and second note (see Animation 14 for a comparison). Interestingly, these visualizations directly manipulate our perception of the passage concerned, which provides evidence for the motional plasticity in the perception of one and the same acoustic source.

Curiously, especially non-legato passages provide good examples of motion corresponding to subtle differentiation in articulation and dynamic. And so, analog modeling can make motion behind the notes visible, thus not only comprehensible to the non-musician, but a matter of discourse from an aesthetically new perspective.

A Final Example: Johannes Brahms' Symphony No 3, Op. 90, 3rd Movement (*Poco Allegretto*)

With the complete visual rendering of the third movement of Johannes Brahms' Third Symphony (Animation 15), we provide the reader with a more extensive example of abstract score animation. Here, we apply the method of dynamic-*gestalt*-based visualization, using

Example 11: Piano Concerto No 23 in A major, KV 488, 3rd movement, bars 1–2.



loops for both rhythmic accentuation and dynamic-based tempo variation. The following excerpts seem especially significant in relation to what we have discussed in this article:

First, Animation 16 compares the bars 4–12 and 142–150 in slow motion. The motional disparities between these melodically identical passages provide evidence that motional microstructure is the result of an interplay of all musical parameters, questioning once more the plausibility of straightforward kinematic models of expressive timing based exclusively on pulse evaluation.

Second, Animation 17 emphasizes motional acceleration in bar 28. Dynamic continuity here supports phrasing, energizing the connection from C to G, rather than separating these two notes (see Example 12).

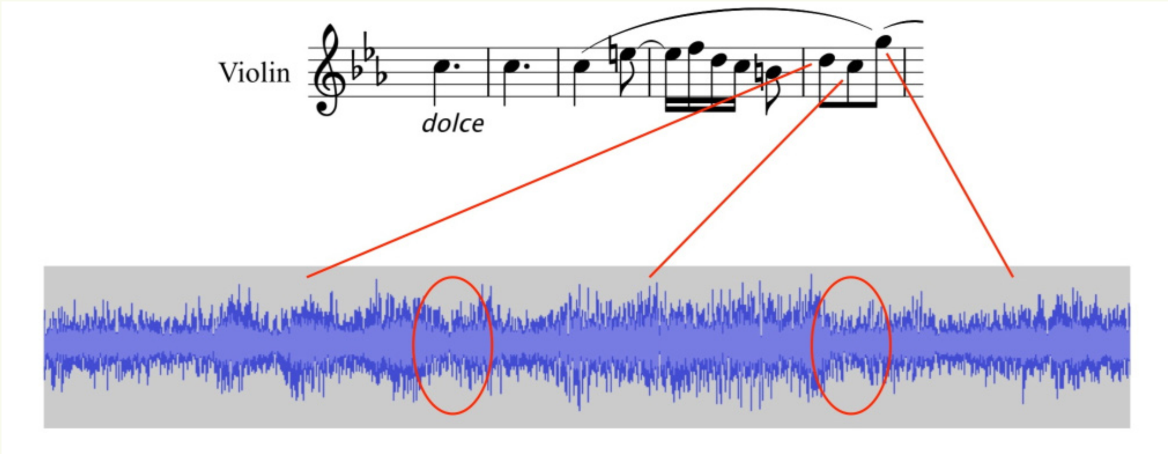
Third, Animation 18 exemplifies again the effect dynamics have on motion, even with regard to a single note.

Finally, we would like to briefly address our animation of the middle part in Brahms' piece. One of the biggest obstacles in the visual transformation of music is harmony. Motion bracketing, as it is introduced in this article, does obviously not suggest that music could be visualized in all its respects. Harmony definitely influences and supports motion development, and in its broad characteristics of departure and return, tension and resolution, abstract score animation is able to incorporate this parameter. The specific qualities of harmony, however, escape naturally any isomorphic visual correlate. It might however be possible to establish, in certain circumstances, a higher order relationship between a specific harmony and a visual event. Nelson Goodman's notion of exemplification (Goodman 1976: 52ff.) could be applied to such cases. There is more to symbolization than pictorial representation and verbal description, Goodman claims. Non-denotative arts like music exemplify qualities and express emotions, i.e. they symbolically refer back to certain 'labels' that apply to them (see Jensen 1973 for a further discussion of exemplification).[6] Example 14, for instance, highlights the first chord of a new motion that characterizes the middle part of Brahms' piece. Here, we try to visually grasp musical tension and fluctuation, caused by both harmony and timbre, with a motional twist. This presupposes that the specific quality of twisting is exemplified both visually and acoustically, and is thus a non-isomorphic form of animation.

Conclusion

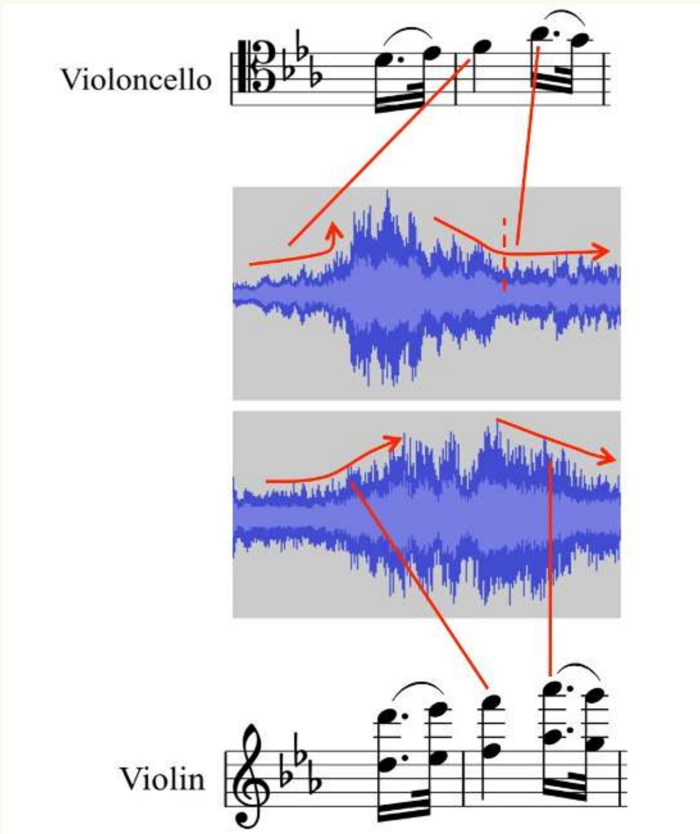
In this paper, we have presented a method of abstract score animation that aims to bridge the gap between the algorithmic reconstruction of musical motion and its pre-theoretic qualities in music experience. Our simulations constitute analog interpretants of music that, we believe, could (i) set aesthetically relevant targets for a mathematical grasp of music's expressiveness, (ii) enhance the understanding of individual and socio-cultural variation in the reception of an acoustically identical source, (iii) help finding deeper insights into neurobiological constraints with regard to the perception of musical motion[7], and (iv) contribute essentially to music semiotics, i.e. to the question of whether music is related to non-musical phenomena and if so how.

Example 12: Johannes Brahms: Symphony No. 3, Op. 90, 3rd movement (*Poco Allegretto*), bars 24–28 (Melody played by Violins & Violoncelli). The Waveform demonstrates dynamic continuity.



Algorithmic modeling is predominant in current research about musical motion and expressive timing. Especially in aesthetics, however, rigid definientia can become restrictive, or even manipulative in the treatment of its subject. Our investigation shifted attention towards pre-theoretic definienda, i.e. the aesthetic intentions with regard to musical motion. We tried to show that abstract animation is useful as it explains and facilitates the expression of musical motion in terms of a simple visual language whose syntax is constrained by 'objective' score information without being restricted in its 'mimetic' transfer of musical movement into the visual realm. Subsequently, abstract score animation can play the role of an informative mediator between natural language, scientific modeling and music performance.

Example 13: Johannes Brahms: Symphony No 3, Op. 90, 3rd movement (*Poco Allegretto*). A comparison of bars 4 and 5 (faster) with bars 142 and 143 (slower). The waveforms indicate a crucial difference in dynamic development.



Finally, we believe that our approach to musical motion rests on semiotic principles whose relevance transcends this work's topic. In argumentative form, these are:

1. The meaning of symbols (and thus its theory, semiotics) can be approached through an investigation into their proper understanding.
2. The proper understanding of an individual symbol can be reconstructed as the selection of the most suitable interpretant among relevant alternatives.
3. Relevant interpretants can be systematically compared, organized or even ordered given that they stem from common constituting principles.
4. A particular typology of relevant interpretants can contribute to the better understanding of a certain aesthetic area (e.g. classical music) by provoking open questions as to which particular aesthetic entities it is properly applicable.

Subsequently, an investigation into frameworks of interpretants forms a systematic contribution to semiotic problems by (i) offering possible relevant alternatives for the interpretation of symbols (music) and (ii) by provoking the specific question as to which symbolic areas the framework is applicable.

This article discussed the addition of the following premises in assuming the soundness of the aforementioned argument:

5. Relevant interpretants for the systematic understanding of music can be analog in nature.
6. Motion based abstract animations constitute relevant analog interpretants for at least a subset of (classical) music.

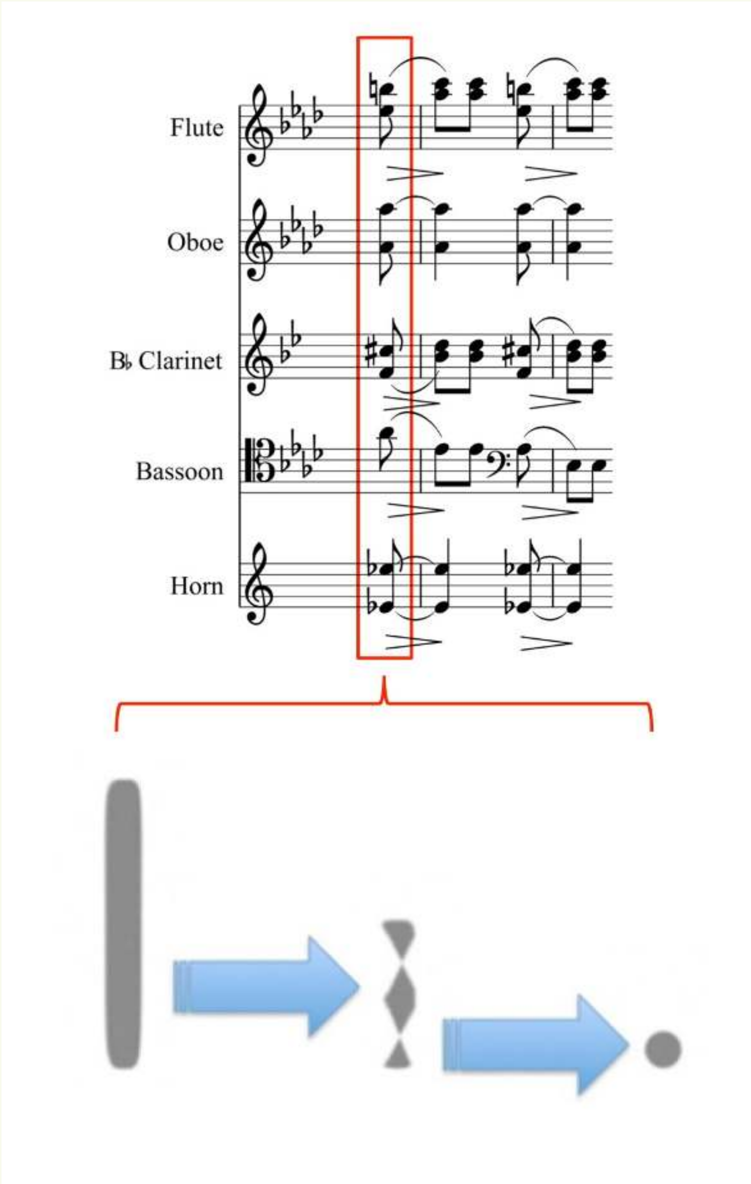
If we have been successful in arguing for the acceptance of the aforementioned premises, this work should be considered a systematic contribution to the semiotics of music in the form of an investigation into the possibility of systematic frameworks of analog interpretants in terms of motion based abstract animation that appear applicable to at least a subset of (classical) music.

ENDNOTES

1. Anagnostopoulou and Buteau (2010), for instance, explicitly acknowledge this problem by asking 'Can computational music analysis be both musical and computational?' in an introduction to a recent issue of *The Journal of Mathematics and Music.*

2. Neuroaesthetic research provides striking evidence that brain areas that are responsible for conceptually different tasks of perception are interlinked, a phenomenon that finds its purest expression in synaesthesia (see Ramanchandran and Hubbard 2003). Freedberg and Gallese (2007) differentiate types of embodied simulation caused by the mirror neuron system. Formulated with regard to visual art, their framework also bears relevance to performance studies and music pedagogy. Apart from bodily engagement with the gestures, movements and intentions of others, which sheds light on the distinctive characteristic of seeing a performance instead of listening to music alone, Freeberg and Gallese highlight the formal qualities of abstract visual art pieces in connection with the observation of the artist's gestural traces. That not only the qualities of what we perceive, but furthermore the process of how it has been produced can be neurally simulated, could explain why, for instance, a pianist and a violinist tend to listen to pieces written for 'their' instrument with different involvement. To my knowledge, no neuroaesthetic study has ever looked into this issue, yet especially with regard to technically demanding works like etudes a difference in terms of embodied simulation could be detected, depending on whether a listener actually is able to master the respective instrument. Mirror neurons have received extensive attention in research dedicated to music perception. Molnar-Szakacs and Overy (2006), for instance, present a review of literature that links music perception with the mirror neuron system, connecting music to motor-related brain areas and, subsequently, emotion. Hadjidimitriou et al. (2009), in a case study with the opening theme of Mussorgsky's 'Pictures at an exhibition' ('*Promenade*'), highlight the effectiveness of combined visual and auditory stimulation (video and music) of the mirror neuron system that leads to motor related low level modulation.

Example 14: Johannes Brahms: Symphony No 3, Op. 90, 3rd movement (*Poco Allegretto*), bar 53. The quality of a chord visualized in a twist (see Animation 15's middle part).



3. In Charles Sanders Peirce's *Semiotics*, an interpretant is supposed to interact with a so-called representamen (the sign itself) and the object(s) of references in a process of 'semiosis' (Peirce 1931–1958: 5.484). According to Peirce, an interpretant is a sign itself, one that is evoked by the first sign (Peirce 1931–1958: 2.228).

4. The opposition between the truth of (scientific) statements and the 'rightness' of non-verbal symbols also plays a crucial role in Nelson Goodman's aesthetics and epistemology (see Goodman 1976, Chapter 6).

5. The following passage is a good summary of why *gestalts* are analog:

   An analog medium is usually primed into a smooth tabula rasa as preparation for it to receive an imprint of creative activity. The artistic gesture maculates a smooth continuum. The resulting echo is an analogue of the reality echoed: it tends to have curves where its source has curves and is straight where the original is. The reason for this similarity is that information is essentially transcribed from one physical material to another. A direct physical impression moves information from a subject to its analog representation. … Digital representations, on the other hand, take measurements rather than impressions of what they represent:

their goal is mensuration rather than maculation. To achieve their transaesthetic epiphany, they convert information from material into numerical entities rather than transcribing it from one physical substance into another. ... But digital media transform physical form into conceptual structure. A shape or color is converted into a number whose symbol is then inscribed on a ledger so that it can subsequently be ascertained by a machine or a person. The material out of which this ledger is constructed is incidental to the information stored, unlike the constitutive material defining an analog medium (Binkley 1997: 109).

6. For instance, many pieces of music are short but the exemplification of formal shortness in music seldom occurs and it is an important mode of reference when it occurs (the fourth movement of Chopin's piano sonata op. 35 in B flat minor is an example).

7. For instance, score-based simulation of musical motion could play a crucial role in experiments with regard to audiovisual synchrony (see Lewis & Noppeney 2010).

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SOUND AND IMAGE SAMPLE CREDITS

The sound samples for Animations 1–14 were recorded by the author.

Sound for Animations 15, 17 and 18: Johannes Brahms Symphony No. 3 in F major, Op. 90, 3rd Movement *Poco Allegretto*. Artists: Dimitri Mitropoulos cond., New York Philharmonic Orchestra. Live recording from the *Salzburger Festspielhaus*, 26 July 1955. Downloaded from http://www.liberliber.it/musica/b/brahms/index.htm on 25 October 2011 (Creative Commons license).

Ms. Jariya Ruangjun created Animations 1, 13 and 14, Mr. Kullapat Srikrisanapol created Animations 2–12, and Mr. Aaron Schmidt created Animation 15. Animations 16-18 are based on Animation 15 and were edited by the author.

ABSTRACT

This study examines the creation of animated music scores through the 'bracketing' of musical motion. The aesthetic claim that music could be perceived in terms of (spatial) motion is tested by means of abstract animations in the form of straightforward, one might say 'naïve', mappings of musical parameters onto space.

The proposed method establishes detailed blueprints of movement that (i) differ essentially from coarse motion types like those suggested by the German pioneers Becking and Truslit, (ii) are the result of interpretative 'hands-on' modeling rather than products of reductive algorithms (iii) depart from systematic methodological considerations with regard to contour, motion and gesture that sets our method apart from idiosyncratic (abstract) animation artwork.

A comparison between simple 'duration-loudness' animations with the visualization of pitch-based trajectories concretizes the aesthetic speculation about spatial metaphors being involved in the perception of music. Score animation suggests that motion types could be instantiated in both the visual and the audible realms and thus complement rhythmic and accentuated structure as a transferable autonomous 'synaesthetic' phenomenon. However, our approach provides evidence that with the 'spatial' variability between two diachronic notes, kinematic or tempo-based models of expressive timing ignore a crucial factor. We demonstrate that only with reference to this hidden musical parameter can one understand what could be seen a paradox: that when music's pulse slows, its motion can still accelerate.

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Keywords: Musical Gesture, Musical Motion, Music Semiotics, Expressive Timing, Music Visualization

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