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Similarity relations between groups of notes: Music-theoretical and music-psychological perspectives

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• **Abstract**

The starting point of this article is Irène Deliège's essay on the similarity relationships that, it is claimed, lie at the heart of creating and cognising musical structure (2007): in particular (though not exclusively) relations that function *internally* within works, and which may be perceived *implicitly* or conceived *explicitly.* Initially, a music-theoretical tack is adopted, commencing from Arnold Schoenberg's concept of the musical "motive",[1] and his taxonomy of motivic transformations, which, he asserts, underpin musical coherence (1967). This and other classifications by the theorists Rudolph Réti (1951), Jan LaRue (1970) and Wilson Coker (1972) are interrogated using the author's "zygonic" theory of music-structural understanding (Ockelford, 2004, 2005a, 2005b, 2006a), and, with reference to the music-psychological work of Mary Louise Serafine (1983), David Temperley (1995) and Bruno Repp (1997), a new, composite taxonomy is proposed, which sets out the forms of connection that can logically exist between one group of notes and another. This is illustrated with musical examples, which suggest (a) that similarity cannot be judged in isolation from the musical context in which it occurs (something that is modelled through an expanded version of Leonard Meyer's (1973) "formula of perceived conformance"); and (b) that similarity is likely to be judged differently between and even within subjects, depending on the listening style that they adopt. This will vary in general terms according to listeners' musical beliefs and experiences, and specifically in relation to the attitudes and attention that they bring to bear on a given occasion. Hence it is concluded that there is not, and could never be, a universal metric of perceived musical similarity. How, then, does one explain the coherence of music as a communicative medium, which purportedly depends on a common understanding of relationships of similarity between composers, performers and listeners? It is surmised that composers intuitively or consciously endow their music with sufficient similarity for it to be recognisable and meaningful to listeners, even if some connections, particularly those functioning at a conceptual level, are missed or construed in unanticipated ways (Ockelford,

(1) Alternatively known as "motif".

2004). The highly repetitive nature of music means that analysts too are able to identify not only those similarity relationships that seek to illuminate the compositional process or reflect or influence the way that listeners approach pieces, but also those correspondences that are deemed to be intrinsically noteworthy, without necessarily having any direct bearing on the musical experience. Clearly, this stance is at odds with music-psychological methodologies that tend to examine aspects of similarity perception that are common across a population. That is to say, different music-related disciplines (and even different approaches *within* disciplines) are likely to afford similarity a different ontological status. Zygonic theory offers a way forward: a conceptual framework that different epistemological modi operandi can potentially share.

Keywords: repetition, imitation, relationship, zygonic, cognition.

Introduction

It is said that the perception of similarity (and, by implication, difference) lies at the heart of music-structural understanding (Toiviainen, 2007). Similarity relationships may be perceived *implicitly* or conceived *explicitly*; they may be *subjective* or *objective* in nature; and they may function *internally* within works or *externally* between them (Deliège, 2007). This article is concerned with the relationships of varying ontological status that exist between *groups* of notes as a whole, although it is important to acknowledge that these form only one of the many types of perceived logical connection between events that function in an integrated way in the creation and cognition of pieces of music (Ockelford, 2004; 2005a).

Just as groups of notes are perceptually "multidimensional", comprising concurrent series of qualia in the domains of pitch, perceived time, timbre and loudness, so, inevitably, are the relationships that potentially exist between them — a characteristic that is reflected in the wide range and diversity of the links that composers have used to connect musical motives, phrases and themes. During the 20th century, music theorists made a number of attempts to conceptualise this heterogeneous array: efforts that resulted in several different classifications. Arnold Schoenberg, for example, in his didactic text *The Fundamentals of Musical Composition* (1967), illustrates how 105 variants can be derived from a single motive based on a broken chord. However, no explanation is offered as to how the principles that are exemplified could be generalised to other musical material; and there are some omissions, including, for example, a change of mode (from major to minor). In contrast, the taxonomy presented by Wilson Coker (1972, pp. 83ff) is almost entirely concerned with the formulation of general principles, but is short on musical examples.[2] And despite the apparent rigour with which the classification is conceived (for example, "exclusion"

(2) A comparable "non-exhaustive" list is provided by Moles (1958/1966, p. 154).

is subdivided into six further categories such as "ellipsis" and "synopsis", while "inclusion" is split into seven, including "interpolation" and "corrective interjection"), again, there are omissions, such as simple transposition.

Another means of conceptualising motivic and thematic transformations in music is through a continuum of variation, beginning, at one extreme, with exact repetition, and from there extending over an ever greater degree of mutation. Writing from the perspective of cognitive psychology, Mary Louise Serafine (1983, p. 176), adopts such an approach, identifying three stages along the path of change: "relative repetition" (ranging from identity to transposition, and changes in mode, tempo, accompaniment or dynamics); "ornamentation" (implying the alteration of a musical event through the addition, overlay or superimposition of other events); and "substantive transformation" (involving, for instance, the preservation of contour alone). This may be compared with the music theorist Rudolph Réti's fourfold arrangement (1951, p. 240): "*imitation*, that is, literal repetition of shapes, either directly or by inversion, reversion, and so forth; *varying*, that is, changing of shapes in a slight, well traceable manner; *transformation*, that is, creating essentially new shapes, though preserving the original substance; *indirect affinity*, that is producing an affinity between independent shapes through contributory features." Other writers venture further along the continuum of change, acknowledging the possibility of contrast. This is true, for example, of Jan LaRue's music-theoretical account (1970, pp. 80-2), in which the spectrum between similarity and difference is divided into "recurrence", "development" (embracing all changes that derive clearly from the preceding material), "response" (including continuations that give the antecedent-consequent effect), and "contrast" (complete change).

Since these taxonomies differ so widely it is reasonable to question how they could possibly all be well-founded, although it could be argued that, since the transformation of musical material is such a complex affair, various models may be equally valid in different epistemological and functional contexts. A common problem, however, is the somewhat arbitrary nature of the proposed divisions. In Serafine's model, for example, would the addition of material combined with a change of mode be classed as "ornamentation" or "substantive transformation"? And with Réti's categorisation, would it be possible to determine consistently when "varying" becomes "transformation"? Then, with LaRue's version of affairs, is there a necessary difference between "development" and "response"? One way of addressing this issue is to explore the concept and nature of musical variation through Ockelford's "zygonic" theory (2004; 2005a; 2006a).[3]

(3) A "zygon" is a relationship between two things that are the same or similar — see comments below.

ZYGONIC THEORY

Zygonic theory seeks to answer the question: "How is musical structure modelled in cognition?" The theory is interdisciplinary in nature — an epistemological hybrid in which the idiographic intuitions that characterise music theory and analysis are informed by the nomothetic findings typical of cognitive psychology (Cross, 1998; Gjerdingen, 1999; Ockelford, 2008b). The zygonic approach takes music to be a system of perceived sonic variables. Some of these, such as loudness and timbre, gauge perceived *qualities* of sound, while others detail its perceived *location* in time or space; some, like pitch, pertain to *individual* notes, while others, including tonality, are characteristic of a *group*. Despite their diversity, these variables, which together comprise the "auditory scene" of music (Bregman, 1990), share a fundamental similarity in that each has a number of potential modes of existence, which may be termed "values" (Ockelford, 1991; 1993), and whose range in each case represents the freedom of choice open to those striving to create new pieces of music. Conversely, the appearance of a variable may be deemed to be constrained or "ordered" to the extent that its value is thought to be subject to restriction.

The belief that such order is essential for composers and performers to be able to communicate purposefully with listeners lies at the heart of zygonic theory. While some of the causes of perceived sonic control may lie beyond a composer's immediate jurisdiction (the selection of timbre may be determined by the availability of performers, for example, and a singer may be unable to reach a particular pitch), and while external influences (such as the cross-media effects of song-texts, for instance) may well have a bearing, zygonic theory contends that most — and certainly the most important — perceived sonic restrictions function *intra*musically, through the process of repetition. In short, a value may be considered to be ordered *if it is reckoned to exist in imitation of another*, since by imitating an existing value, a variable is necessarily restricted. It is as though the first value *generates* the second, or, conversely, the second *derives* from the first. Elsewhere, I describe this as a metaphor for the causation that we perceive in the wider world beyond music (Ockelford, 2005b, p. 87; 2008a, pp. 63ff). Since the vast majority of listeners are quite unaware of this type of cognitive activity, clearly it need not operate at a conscious level. Yet, if theory is correct, such activity must be a universal feature of purposeful attention to music, otherwise a random sequence of sounds would prove just as effective a means of communication as an orderly one, which is not the case.

The cognitive acknowledgement of derivation between aspects of musical events is predicated on the presence of what may be termed "interperspective relationships"[4]

(4) "Interperspective": a term coined by Ockelford (1991), to mean "between *perspects*" (that is, "*per*ceived a*spects*") of music; used in contradistinction to the term "parameter", which is reserved solely to refer to the physical attributes of sound. Hence the perspect "pitch", for example, most closely corresponds to the parameter "frequency", though the connection between the two is far from straightforward (*cf.* Meyer, 1967, p. 246).

— psychological constructs through which, it is hypothesised, incoming perceptual data are compared (*cf.* Krumhansl, 1990, p. 3). Interperspective relationships may be regarded as forms of "link schemata" (Lakoff, 1987, p. 283), which inhabit the mental space pertaining to music processing (*cf.* Fauconnier, 1985/94; Lakoff, *op. cit.* pp. 281 and 282). Such relationships potentially exist in any perceptual domain pertaining to music. We may surmise that in most circumstances they are formulated unthinkingly, passing listeners by as a series of qualitative experiences. However, employing the metacognitive processes typical of music theory and analysis enables interperspective relationships to be captured conceptually, and they may be symbolised as shown in Figure 1. Such relationships may be assigned values, some of which can be expressed as a difference or ratio, while others necessarily reflect the complex nature of the perspects to which they pertain.

In Figure 1, the relationships are shown using an arrow upon which the letter "I" is superimposed, which stands for "interperspective". Superscripts indicate in each case the perspect concerned, represented by its initial letter or letters — here "P(d)" for "pitch degree" and "O" for "onset". Relationships can exist at different *levels*, with "primary" relationships potentially linking perspective values, "secondary" relationships connecting primaries, and "tertiary" relationships offering a medium through which "secondaries" may be compared (Ockelford, 2002). The level of a relationship is indicated by the appropriate subscript (here, "1" in the case of the relationships of onset, and "1" and "2" in the example of the relationships of pitch degree). Observe that the values of the relationships (shown near the arrowhead as +1, +2, +♩. *etc.*) have two components: "polarity" (the quality of being positive or negative) and "magnitude".

Interperspective relationships through which derivation is cognised are deemed to be of a special type that I term "zygonic" (Ockelford, 1991, pp. 140ff), from the Greek term "zygon" for "yoke", implying a union of two similar things. Zygonic relationships, or "zygons", are represented through the use of the letter "Z". In Figure 1, it is suggested that primary zygons of pitch link the repeated notes in the viola,[5] the phenomenological implication being that each note is felt (albeit nonconsciously in the "typical" listening experience) to derive from the one that precedes.[6] A potential secondary zygonic relationship of onset is illustrated in the 'cello and bass part, reflecting the fact that the first three notes are equally spaced in

(5) Although they are not shown, it is assumed that primary zygonic connections would operate similarly in the second violin part.

(6) It is also possible that a note will be heard as deriving from others further back in the sequence. Hence, the third E♭ in the series may be thought to be generated in part from the first E♭ (as well as the second), for example. So it is conceivable that *networks* of relationships may link values that exist as part of a set of three or more. The webs of implicative relationships that potentially pertain to groups of identical (or similar) values are termed "constant systems" (see Ockelford, 2005a, p. 25).

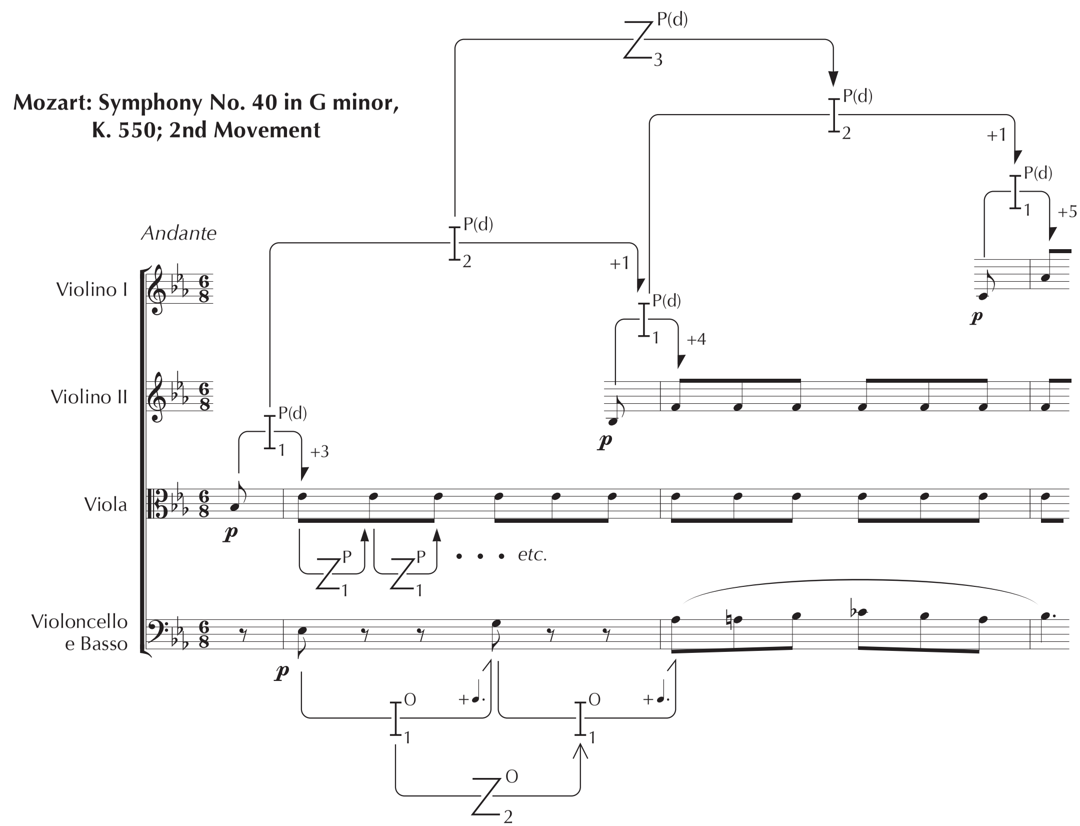


Figure 1.

Interperspective and zygonic relationships.

time, and that the second interonset interval between them can be considered to exist in imitation of the first. This is only one of many examples of the zygonic forces that can be considered to be at work in the realm of perceived time within a musical texture that, like that of most music, is replete with repetition and regularity in the domains of onset, duration and metre. Finally, it is proposed that a tertiary zygon of pitch degree connects the two secondary interperspective relationships that express the common difference between successive melodic intervals that announce the entry of the violas, second violins and then the firsts.

Observe that the zygonic relationships depicted in Figure 1 use *full* arrowheads, which signify relationships between values that are the same, as opposed to the *half* arrowheads of the interperspective relationships, which are indicative of difference. As we shall see, zygonic relationships too can make use of half arrowheads, when the values they link are similar rather than identical (see Figure 2). A further point to note is that *open* arrowheads (such as those pertaining to onset in Figure 1), indicate relationships between single values, as opposed to *filled* arrowheads, which link perspective values that persist in time (in Figure 1, those pertaining to pitch and pitch degree). This distinction is important because relationships linking values that endure are potentially *compound* in nature (see Ockelford, 2005a, p. 26). A number of other classes of zygonic relationship exist, which will be identified in the course of the sections that follow. More detailed accounts of zygonic theory are to be found in Ockelford (1993; 1999; 2005a)

Before proceeding, however, given the interdisciplinary nature of this article, it is particularly important to be clear about the ontological status of zygonic relationships (Ockelford, 2005a; 2008b). Despite their physical appearance on the page, it is important to appreciate that they are merely hypothetical constructs that are intended to represent aspects of the typically nonconscious cognitive processing that can be assumed to occur when we attend to, create or imagine music — a supposition suggested by the structural regularities of pieces, which, as the composer and conductor Leonard Bernstein asserts, offer “a striking model of the human brain in action and as such, a model of how we think” (1976, p. 169). The notion of a zygonic relationship can at best offer only a much-simplified version of certain cognitive events that may be stimulated by engagement in musical activity. However, while simplification is necessary to make headway in theoretical terms, it is important to bear in mind that the single concept of a zygon bequeaths a substantial perceptual legacy, with many possible manifestations, not only potentially linking individual pitches, timbres, dynamics, durations and interonset intervals, but also prospectively existing between tonal regions, textures, processes and forms the same; over different periods of perceived time; and within the same and between different pieces, performances and hearings. Whatever their context, zygons, it is hypothesised, may function in a number of ways: reactively, in assessing the relationship between extant values, for example, or proactively, in ideating a value as an orderly continuation from one previously presented.

Given this variety, there is, of course, no suggestion that the one concept represents only a single aspect of cognitive processing. Hence, empirical evidence in support of the theory is likely to be drawn from a diversity of sources. Currently, for example, one can point to experiments in auditory processing (such as the "continuity illusion", summarised in Bregman, 1990, pp. 344ff) and work on expectation in a musical context, particularly that involving the perceptual restoration of omitted or obscured notes (for instance, DeWitt & Samuel, 1990), to support the presence of proactive zygonic-type processes. There is general support for the theory too in the wide range of music-theoretical and analytical sources in which the fundamental importance of repetition in music is acknowledged. These are itemised in Ockelford (1999 pp. 9ff, 71ff and 763ff), and similar acknowledgements are made by Alistair Borthwick (1995), as a background to the exposition of his metatheoretical framework to which the notions of identity (and non-identity) are central. From across the twentieth century, relevant texts include those by such widely divergent writers as Basil de Selincourt (1920/56), Heinrich Schenker (1935/79), Igor Stravinsky (1942), Roger Sessions (1950), Rudolph Réti (1951), Victor Zuckerkandl (1956), Leonard Meyer (1956, 1967, 1973), Carlos Chávez (1961), Nicolas Ruwet (1966/87), Arnold Schoenberg (1967), Allen Forte (1973; 1985), John Rahn (1980), Fred Lerdahl and Ray Jackendoff (1983), David Lewin (1987), Eric Isaacson (1990), Jean-Jacques Nattiez (1990) and Robert Morris (1995). Perhaps most pertinent to zygonic theory, however, is the assertion of Edward Cone (1987, p. 237), made in relation to the derivation of musical material, that "y is derived from x (y ← x), or, to use the active voice, x generates y (x → y), if y resembles x and y follows x. By 'resembles', I mean 'sounds like'…".

Modelling inter-group relationships of similarity

Given the appearance of one perspective value, a range of possibilities for a second exists as follows (*cf.* Fiske, 1990, pp. 12ff) — see Figure 2.[7] As this shows, there are two broad categories of potential succession: a second value that is in some sense contingent on the first — in terms of the zygonic theory, that is *derived* from it; and a second value whose existence is perceived as owing nothing to the first. The group of potential values that are zygonically derived are themselves of two types: those that are felt to be a consequence of approximate or "imperfect" imitation, and that which

(7) Here, it is assumed that the values of perspect "A" exist on a unidimensional and monotonic continuum: that is, a range of values that vary in only one respect, and consistently increase or decrease as listeners metaphorically travel from one extreme of the perceptual domain to the other. This assumption was made to illustrate the principle that zygonic relationships can exhibit varying strengths of derivation; the concept is equally applicable in domains that are more complex (*cf.* Ockelford, 1999, pp. 40ff; Zbikowski, 2002, pp. 65ff).

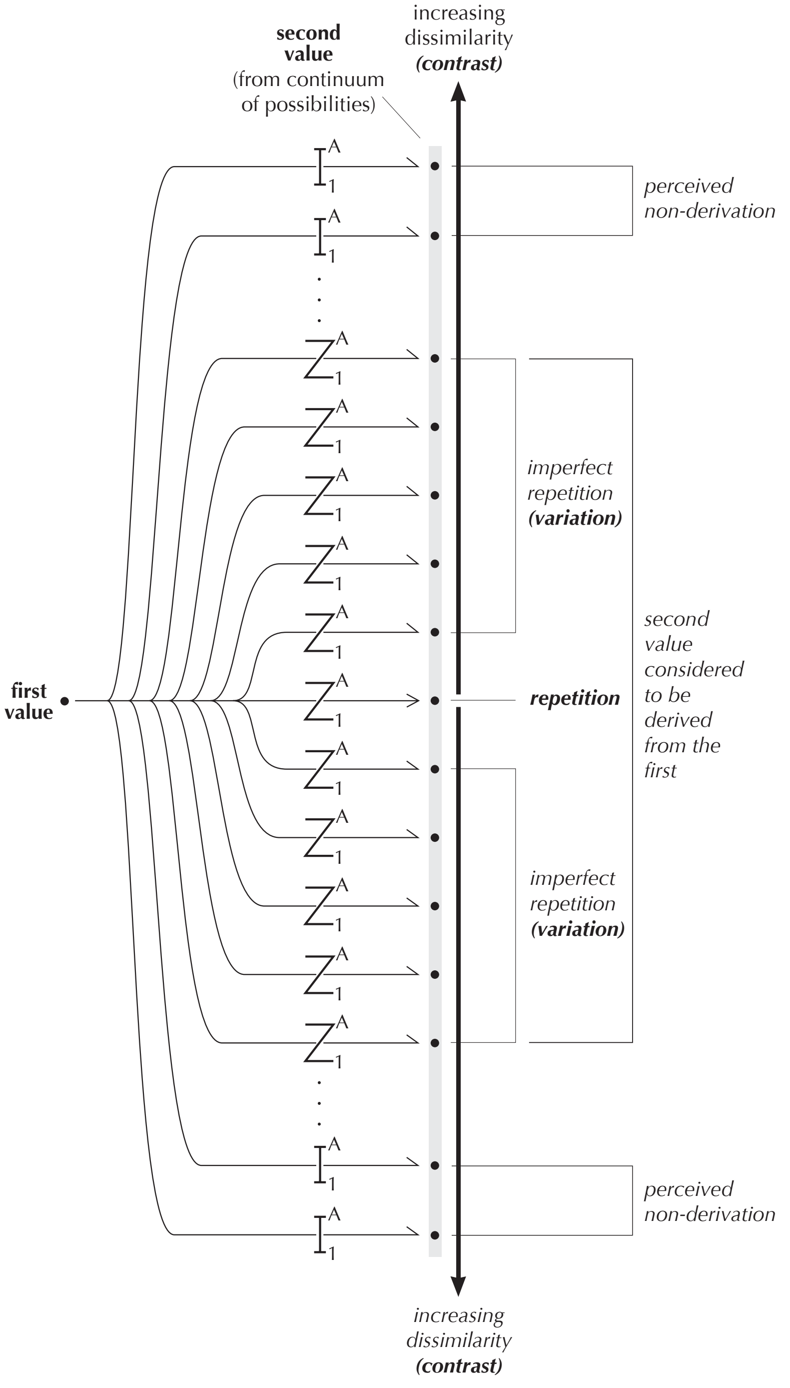


Figure 2.
Imitation, perfect and imperfect, and non-imitation.

repeats the preceding value exactly ("perfect" imitation). The boundaries between repetition and variation, and variation and non-variation are fuzzy, being dependent on their musical context and, ultimately, on the disposition of the listener. As a general rule, the freer the imitation, the more strongly must its presence be implied in the music if it is to be recognised. This may be achieved, for instance, through the gradual expansion of a pattern, through which the illusion of reasoned effect is conveyed by ever wider interperspective differences.

As far as interperspective values are concerned, which function as vectors (having both magnitude and polarity), variation can be achieved in terms of their polarity or magnitude or both — see Figure 3. Here, a range of possible continuations from an initial primary interperspective value are illustrated. The same principle applies to secondary values.

Given an initial *group* of perspective values, the possibilities for a second group are as follows. First, all perspective values may be repeated exactly (see Figure 4), implying the operation of three or more primary zygonic relationships operating in parallel. Such as series of relationships can be conceptualised as a "primary zygonic invariant system", and depicted as shown. The overall effect is of the second group *as a whole* deriving from the first *as a whole*, and this can be shown through a single zygonic relationship. Which form of symbolism is chosen will depend on which type of relationship it is that the analyst wishes to emphasise (as will become apparent in the sections that follow).

Within such a scenario, a further possibility is for one pair of values or more may be imperfectly zygonically related, or may differ to such an extent that the second is not perceived as deriving from the first (see Figure 5). In musical terms, this amounts to a type of "variation" of the first group, which, according to Schoenberg "is repetition in which some features are changed and the rest preserved" (1967, p. 9). Bernstein's account of variation is also of interest in the context of zygonic theory, suggesting that the ear anticipates exact imitation, and that any changes are heard as anomalies. That is, variation is the "Violation of Expectation. What is expected is, of course, repetition… and when those expectations are violated, you've got a variation. The violation is the variation" (1976, p. 162). There are resonances too with Fred Attneave's classic research in the visual domain: "The characteristics with respect to which objects are similar may be conceptualized either as more or less discrete and common elements or as dimensions on which the objects have some degree of proximity" (1950, p. 519).

Then, one pair of values or more may differ to such an extent that the second is not perceived as deriving from the first (see Figure 6). As the proportion of non-zygonic to zygonic relationships between groups is increased, there will come a point where one series of values as a whole is no longer considered to derive from the other (despite the existence of one zygonic link or more).

The *alteration* of perspective or interperspective values (as shown in Figures 5 and 6) constitutes only one of the main possibilities of variation between groups.

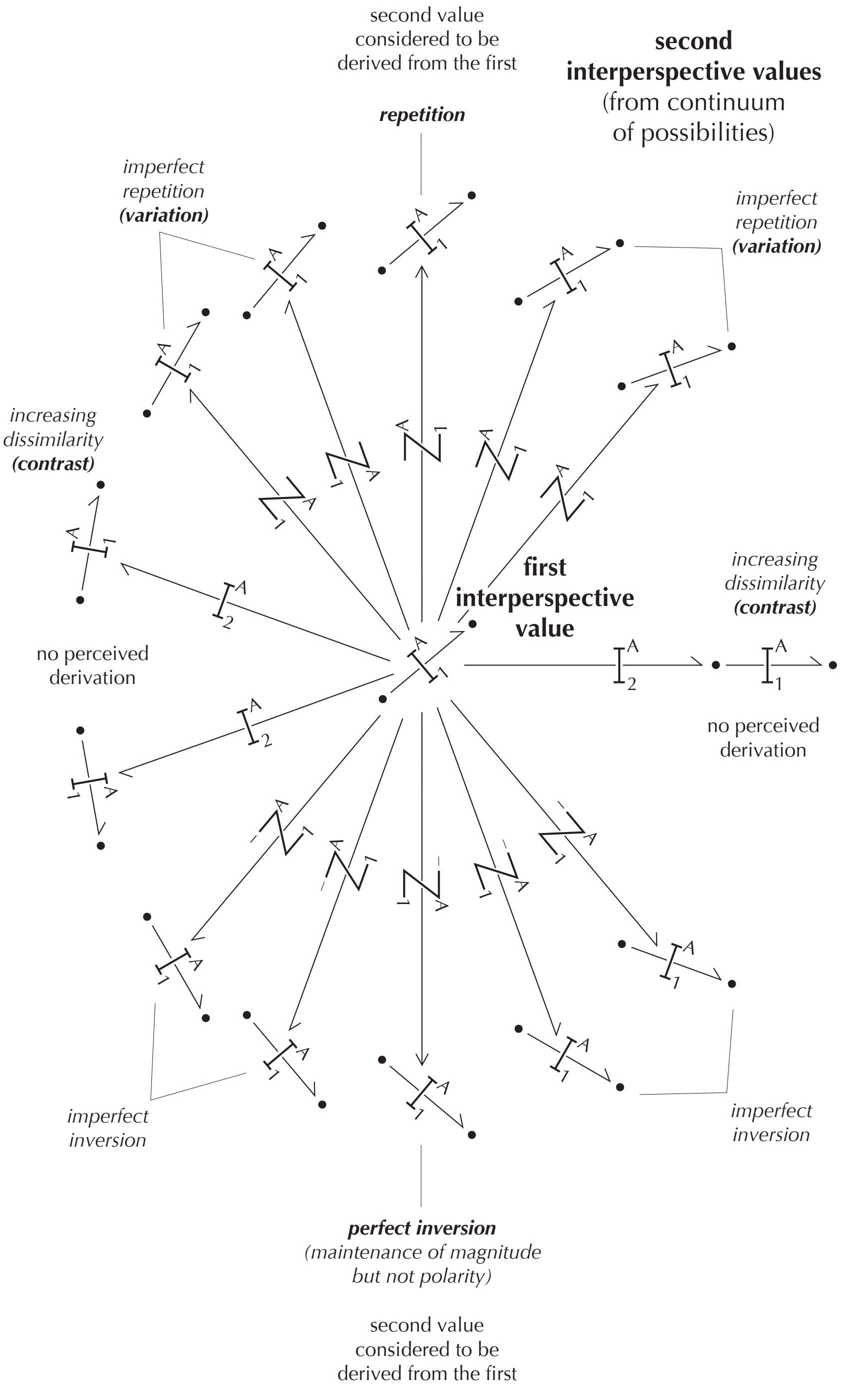
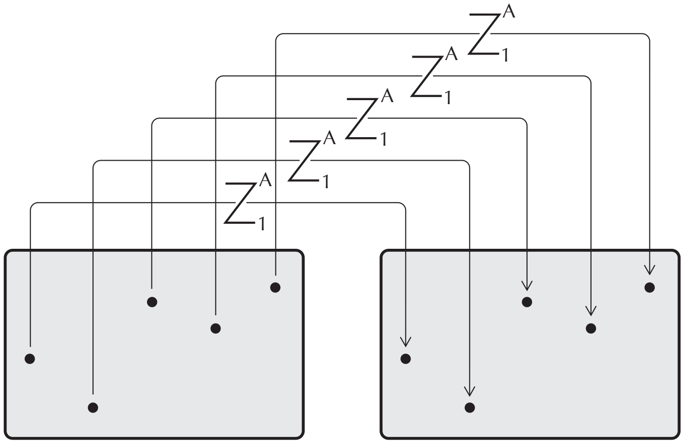
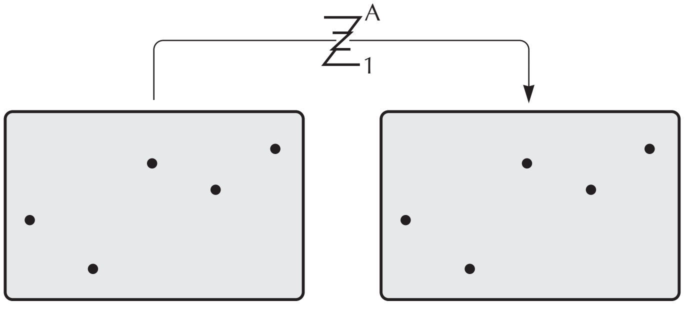


Figure 3.

Range of possible continuations from an interperspective value.



a series of parallel primary zygonic relationships such as this may be conceptualised as a 'primary zygonic invariant system', symbolised as follows, where the internal 'Z' symbolises the imitation of sequential location:



alternatively, a single relationship linking the groups as a whole may make the analytical point most effectively (which may but need not seek to model perception):

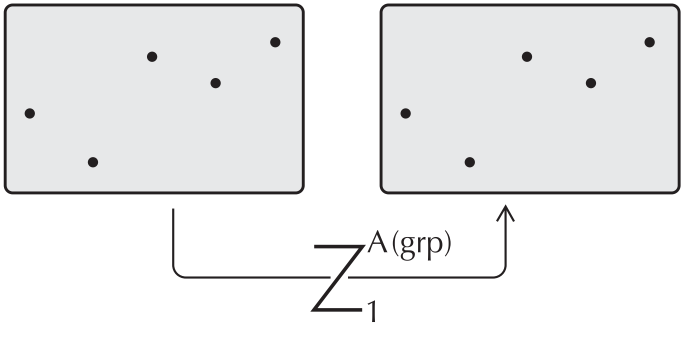


Figure 4.

Exact repetition of a group of values.

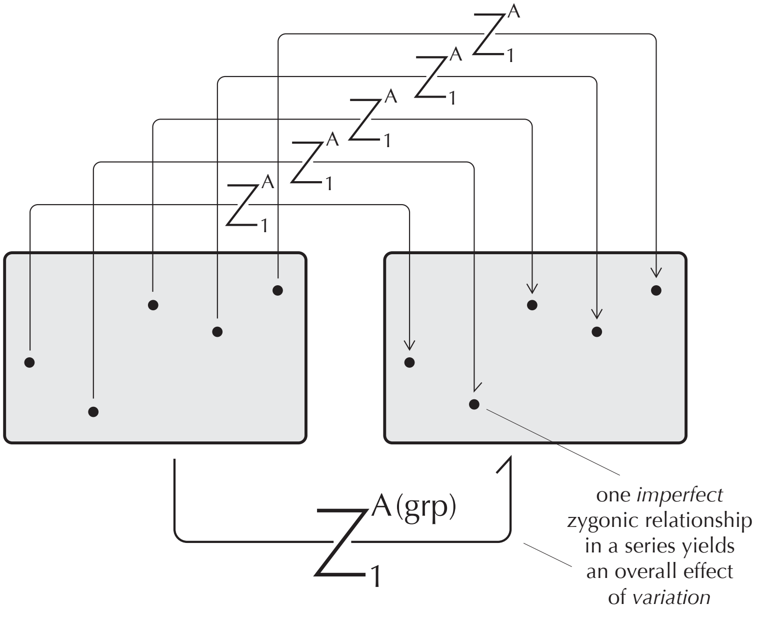


Figure 5.
Variation of a group through one value being imperfectly imitated.

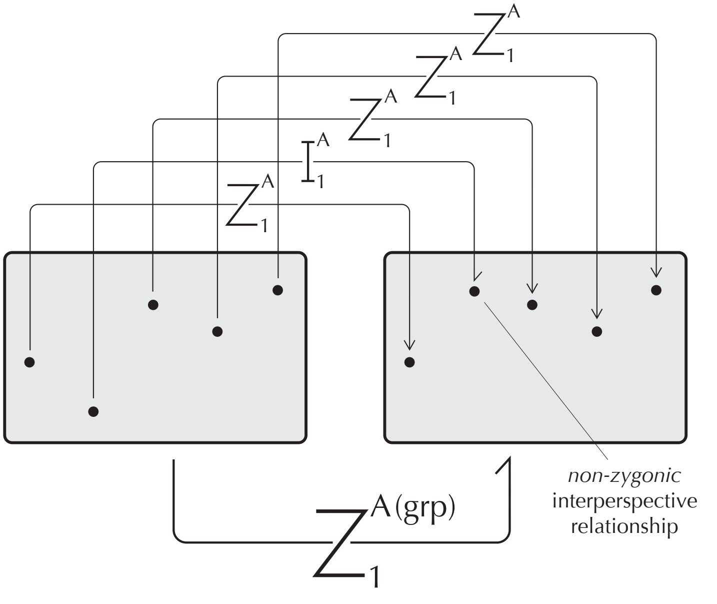


Figure 6.
Variation of a group through one value being non-zygonically related.

The others are the *omission* of material (Figure 7), and its *addition* (Figure 8). When material is added, coherence demands that it should have some form of zygonic link to the values determined through imitation of those in the first group. This is shown indicatively in Figure 7 with a primary zygon.

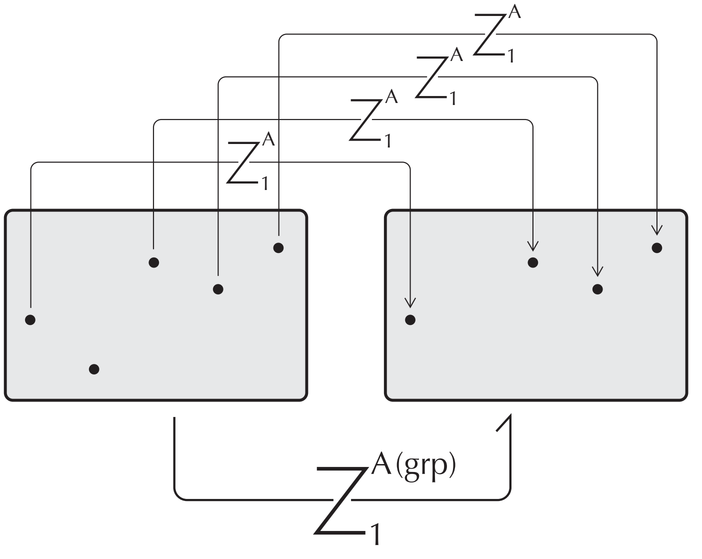


Figure 7.
Variation through the omission of material.

These three fundamental types of transformation — the alteration, omission and addition of material — are acknowledged by other writers in widely varying contexts. For example, they accord with the categories used in the pitch-error coding scheme used by Caroline Palmer and Carla van de Sande (1993) and subsequently by Bruno Repp (1997) in classifying pianists' errors as "substitutions", "omissions" or "intrusions"; and similar also to the matching algorithm developed by Edward Large (1993) and used by Tim Crawford, Costa Iliopoulos and Rajeev Raman (1998, pp. 86ff), who identify equivalent forms of transformation ("replacement", "deletion" and "insertion") in their classification of string-matching techniques for detecting musical similarity through computer-assisted analysis.[8]

As well as changes to the perspective values themselves, *the order in which they occur* may be transformed in many different ways (the number of permutations of a string of *n* values being *n!* — that is, the product of all positive integers less than or

(8) Logically, as Crawford, Iliopoulos and Raman point out, "replacement" = "deletion" + "insertion", or, in terms of the present work, "alteration" can be construed as "omission" + "addition".

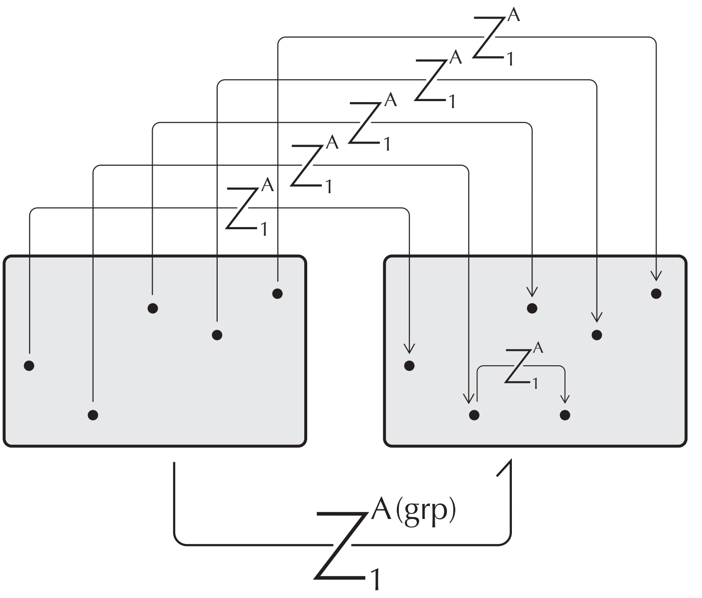
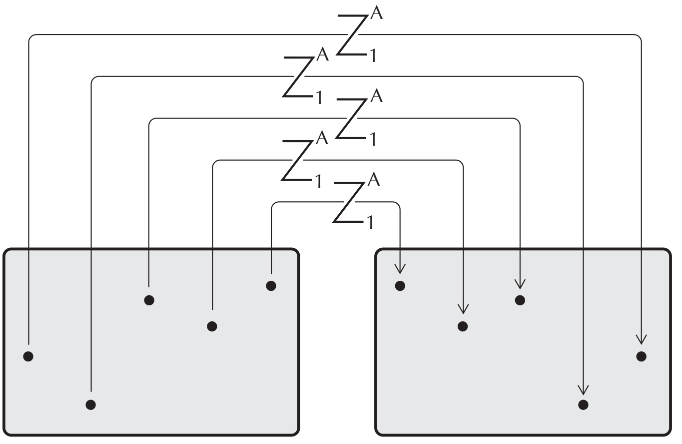


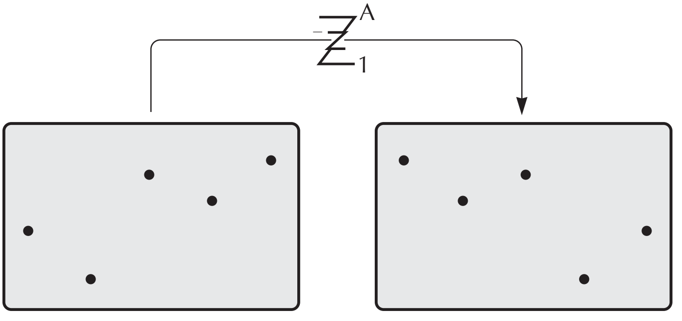
Figure 8.
Variation through the addition of material.

equal to *n*). For example, a set of six different values can appear in 6 × 5 × 4 × 3 × 2 × 1 = 720 different forms, while there are 12! — almost half a *billion* — permutations of the twelve pitch-classes of the chromatic scale. Despite the superabundance of possibilities that even a modestly-sized set of values offers, sequential change is rarely used in most musical contexts, as we shall see, probably on account of the perceptual difficulties that changing the order of events can incur. Predictability at some level in the musical structure is essential to the cognition of variation, and a necessary (though not a sufficient) requirement is, in terms of the present theory, *zygosequentiality*: just as a perspective value can be deemed to derive through imitation of another, so can its relative sequential location. The most straightforward form of zygosequentiality — and the most commonly encountered form of orderly sequential change — is "retrogression", through which the order of events is reversed. This is illustrated in Figure 9. Sequential transformation, of any type, may be combined with other types of group variation described above.

Groups of *interperspective* values may be coherently related in a number of ways. For example, a series of primary relationships may be repeated exactly (see Figure 10) or interperspective values may be altered, omitted or added (in ways comparable to those illustrated in Figures 5, 6, 7 and 8). With perspects whose values express both a magnitude and a polarity, change is possible in relation to either or both of these characteristics. A change of polarity, for example (referred to as "inversion" in the domain of pitch) may be conceptualised in zygonic terms as follows (see Figure 11).



a series of primary zygonic relationships such as this, through which values are linked in reverse order, may be conceptualised as a ‘retrograde primary zygonic invariant system’, symbolised as follows, where the internal ‘¯Z’ symbolises the reverse imitation of sequential location:



alternatively, a single relationship linking the groups as a whole may be conceptualised as follows:

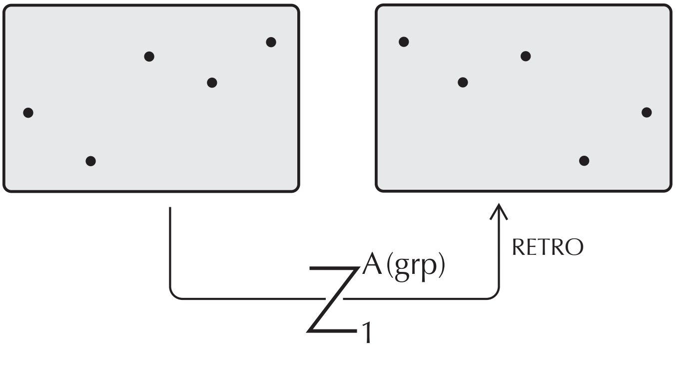


Figure 9.
Sequential change (retrogression).

Regular change in magnitude ("augmentation" or "diminution") is illustrated in Figure 12.

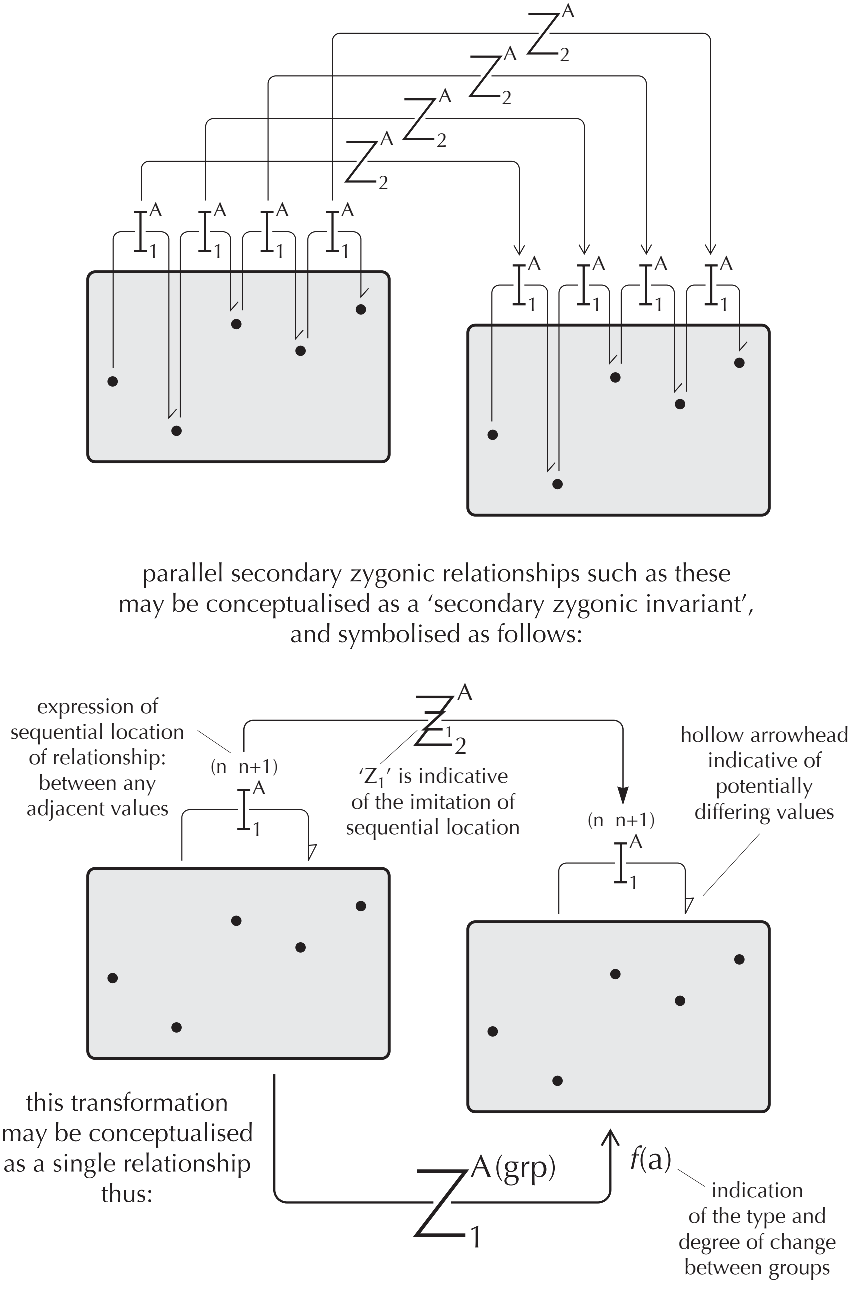
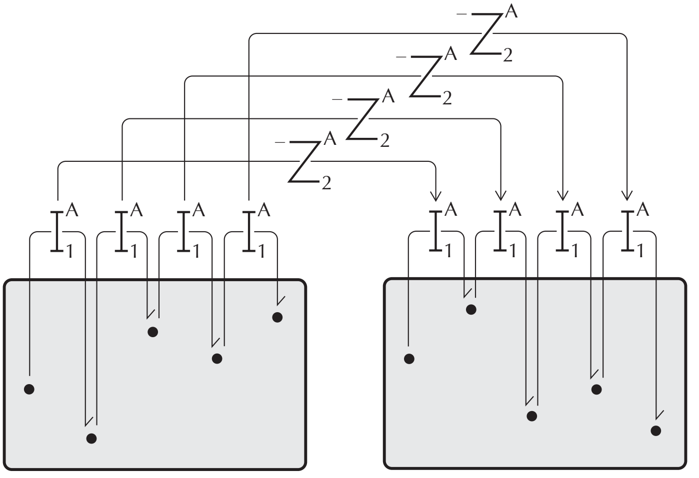


Figure 10.
Groups coherently related through the repetition of interperspective values.



parallel inverse secondary zygons such as these may be conceptualised as an 'inverse primary zygonic invariant', and symbolised as follows:

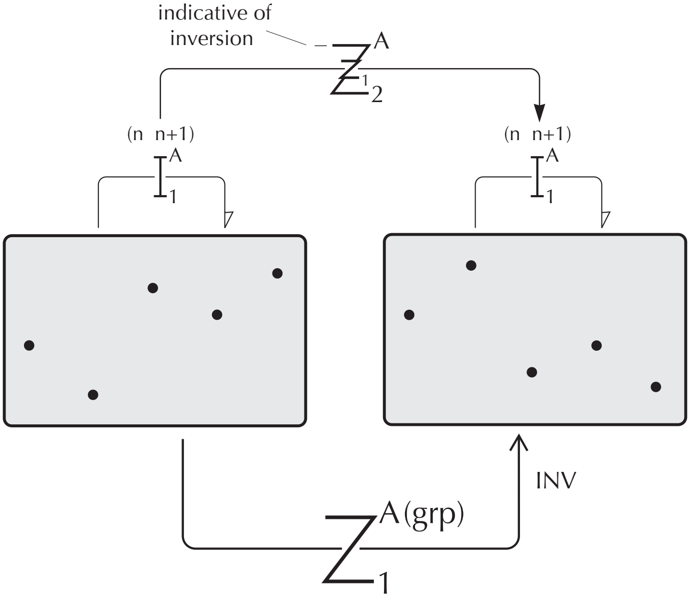


Figure 11.
Inversion.

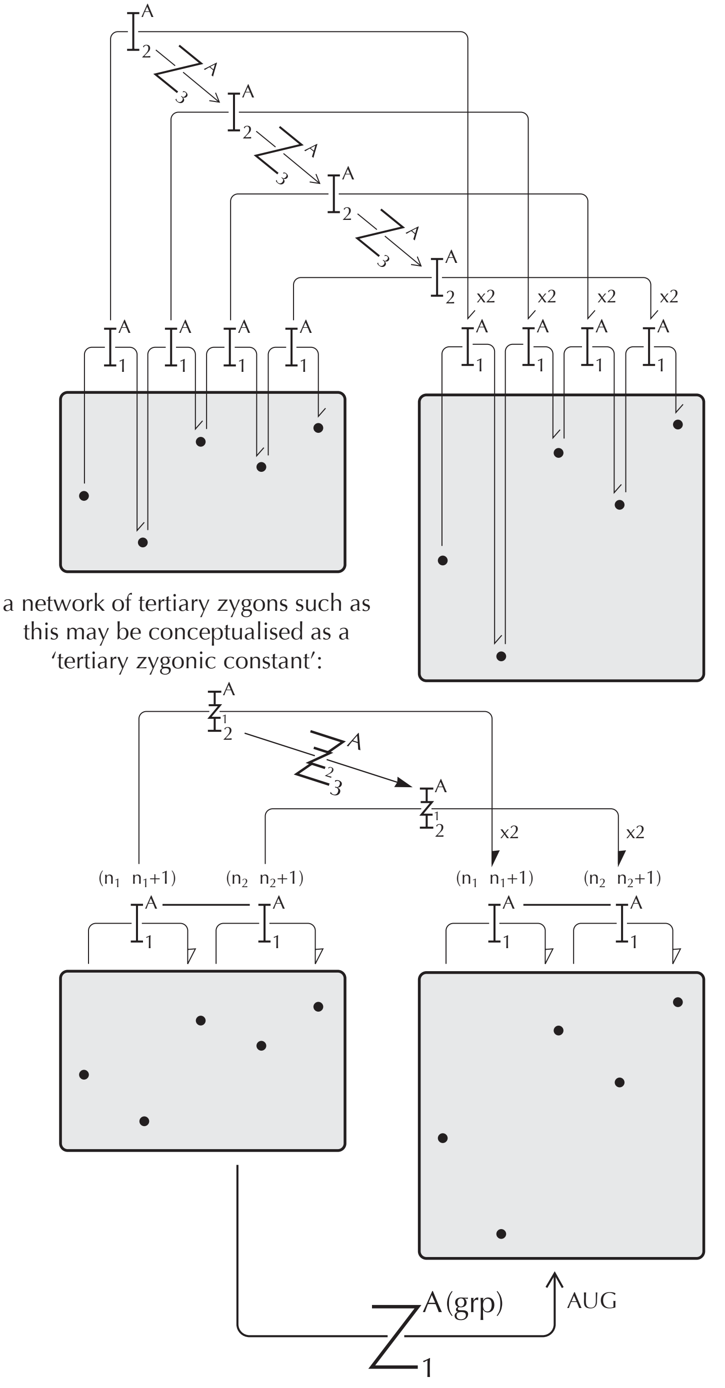


Figure 12.
Augmentation.

An extreme case: identity

The options for repetition, variation and non-variation considered above in an abstract way (in relation to groups of individual perspects) will now be extended to series of complete perceived sounds. First, we consider the extreme case in which *all* the relationships linking two groups of musical events are perfect zygons. Here the implication is of two identical sequences of perceived sounds, forming one perceptual unit, whose intrinsic duality can only be implied. Figure 13 illustrates how Benjamin Britten uses this form of musical construction to depict Narcissus falling in love with his reflection, which he happens to see in a pool, in the fifth of his *Six Metamorphoses after Ovid*, Op. 49, for oboe solo (see Hiramoto, 1999, p. 25; Djiovanis, 2005, 44-6). At the climax of the piece (the second beat of bar 23) man and image merge musically into a single trill, whose conceptual duality can only be discerned from the converging pitch structure that precedes.

Music with characteristics such as these is unusual, however,[9] and an orderly link between two musical events typically comprises a mixture of zygonic and non-zygonic relationships.[10] Although there are exceptions, the maintenance of only the pattern of relative pitches of a passage (which I term its "profile" — see, for example, Ockelford, 2005a, p. 45) and its rhythm have traditionally been regarded as "repetition" (as opposed to "variation"), even though other perspects, including timbre and dynamics, may be varied.[11] Hence the identity of a melody is not generally considered by musicians to be compromised by its instrumentation (an extreme example is provided by Anton Webern's orchestration of Bach's *Ricercata a 6 voci*,

(9) There are, though, many examples of single notes functioning in a dual capacity in contrapuntal keyboard music when lines coincide in a unison (see, for instance, the conclusion of J.S. Bach's Fugue No. 11 from the Well-Tempered Clavier, Book 2, BWV 880).

(10) *Cf.* George Kubler, 1962, p. 67: "It is in the nature of being that no event ever repeats, but it is in the nature of thought that we understand events only by the identities we imagine among them."

(11) See Nicholas Cook's (1994) critique of Rita Wolpert's (1990) research, in which musicians and "nonmusicians" (so-called) were asked, among other things, to compare a tune and accompaniment played (a) on a different instrument and (b) on the same instrument as the original, but with the accompaniment transposed down a fifth. The musicians consistently chose option (a) — for them, playing the accompaniment in the wrong key made a bigger difference than playing the music on a different instrument — whereas the "nonmusicians" almost exclusively opted for (b): for them, the identity of the instrument outweighed any changes they noticed in the accompaniment. According to Wolpert, these findings show that musicians do not listen in the same way as "nonmusicians": their choice of instrumentation over correct harmonic accompaniment "suggests a profound overestimation of what most listeners hear". As Cook points out, though, this is a far-fetched conclusion: what Wolpert's experiment actually reveals is that listeners with different backgrounds respond in different ways to questions as to whether one musical extract is more or less like another (*op. cit.*, p. 68).

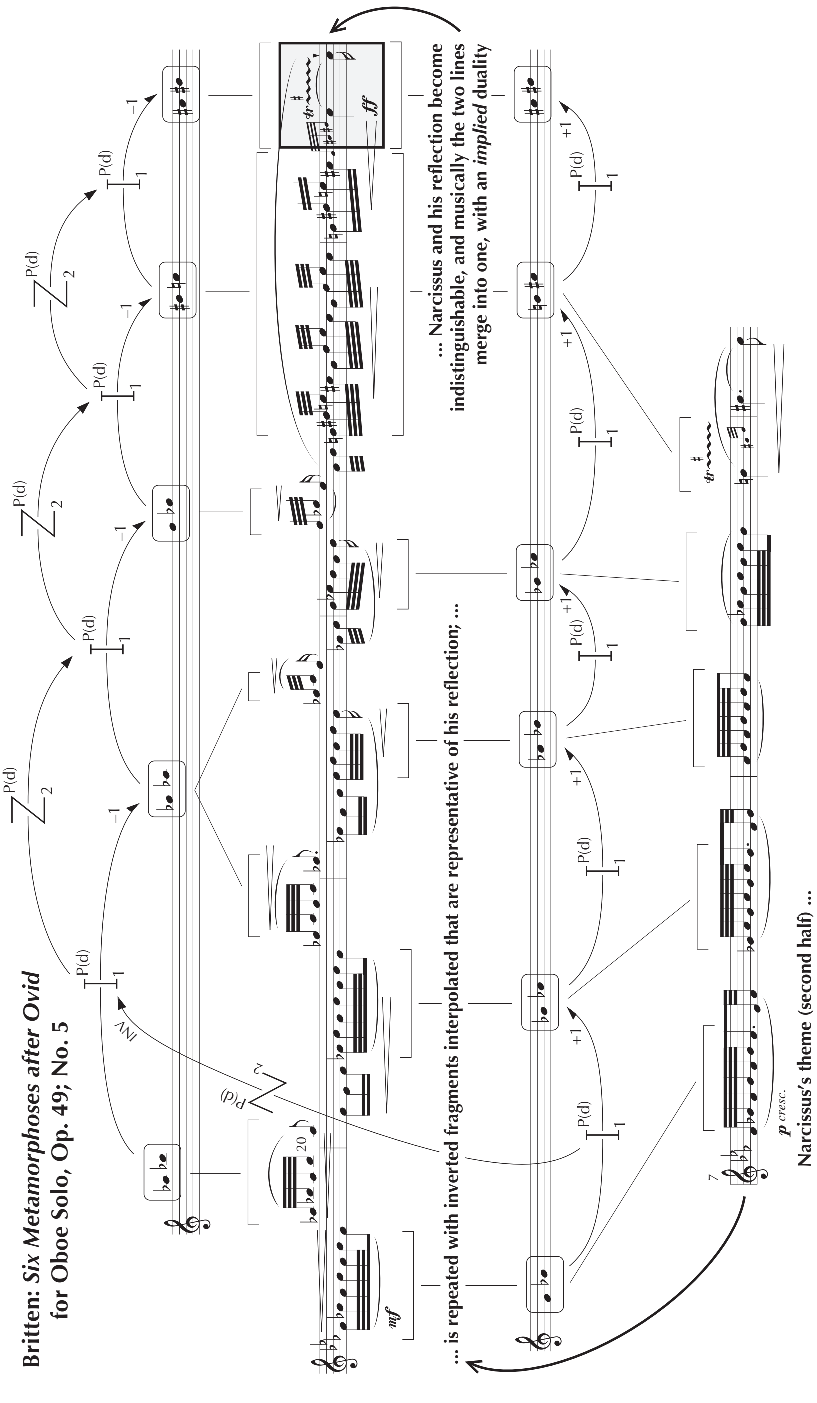


Figure 13.
Conceptual duality in perceptual identity.

1934-35). For instance, Donald Tovey, in analysing the second movement of Beethoven's 6th Symphony, Op. 68, writes of the thematic fragment that opens bar 33 on the first bassoon as subsequently "repeating itself again and again as one instrument crowds in upon another" (1935, p. 50).

Using the principles of zygonic organisation outlined above, it is possible to construct taxomonies of the repetition and variation of profile and rhythm, alone and in combination, and these are set out below. These frameworks will inform the discussion of similarity that follows.

A taxonomy of inter-group relationships of similarity in the domains of pitch and perceived time

Modelling transformations of profile

Zygonic theory suggests there are eight operations that can comprise or contribute to the transformation of profile: repetition, transformation, inversion, augmentation/diminution, sequential change (for instance, retrogression), and the omission, addition or alteration of material. In addition, the fact that pitch in a musical context may be perceived bi-dimensionally, possessing both a certain "chroma" (defined in music-theoretical terms as "pitch-class") and a metaphorical "height" (see, for example, Shepard, 1982; Warren, Uppenkamp, Patterson & Griffiths, 2003), means that "pitch-class equivalence" — a particular combination of repetition and transposition, whereby notes with the same letter name in any octave are perceived as different manifestations of essentially the same thing — also needs to be taken into account. There are therefore nine possibilities as follows.

In considering transformations of profile, it should be remembered that, in many styles and genres of music, melodic coherence demands a harmonic context, actual or implied,[12] and that melodic lines may be linked *indirectly* (sharing *indirect* similarities) as a whole or in part through a common harmonic framework. For example, a given melodic line may initially appear with the support of a series of harmonies. Subsequently, a variant of the melody may be constructed over the same harmonic pattern. In abstract terms, the following zygonic connections are implied.

Hence, in many styles of music, direct motivic connections between the melodies will inevitably be tempered by harmonic considerations. Consider, for example, the relationship between the theme and first variation (RH) of Mozart's *Es war einmal ein alter Mann.* As the analysis in Figure 16 shows, the melodic line of Variation 1 is, on one level, entirely "self-sufficient" in organisational terms: the logic of each pitch degree can be accounted for without recourse to the underlying harmonic structure. However, the design of the variant can only be appreciated fully by

(12) Indeed, melody was characterised by Richard Wagner as the "surface of harmony" (see, for example, Solie, 1982, p. 203).

number	musical effect	pitches	intervals	example
P1	repetition	repeated	repeated	Figures 17, 26, 27
P2	transposition	+ i	repeated	Figure 23
P3	inversion	subject to irregular change	x –i	Figures 21, 25
P4	augmentation or diminution	subject to irregular change	x r	Figure 27
P5	pitch-class equivalence	pitch-class equivalent	repeated or complementary	Figure 30
P6	sequential change (eg, retrogression)	order changed (reversed)	subject to irregular change (reversed)	Figure 29
P7	omission of material	one or more omitted	one or more omitted, with the possibility of change as a consequence	Figure 24
P8	addition of material	one or more added	one or more added, with the possibility of change as a consequence	Figure 16
P9	alteration of material	one or more changed	one or more changed	Figure 21

Figure 14.
Potential transformations of profile.

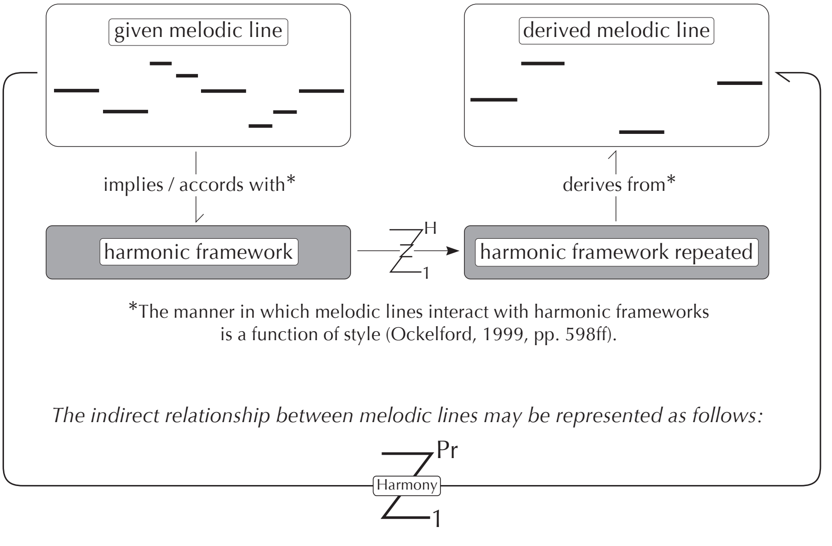


Figure 15.
Indirect relationship between melodic lines through sharing a common harmonic framework.

considering its harmonic context too. For example, the C♯5 (circled) that marks the first deviation from the theme, as well as initiating a pattern of rising 3rds, is derived directly from the opening A major harmony.

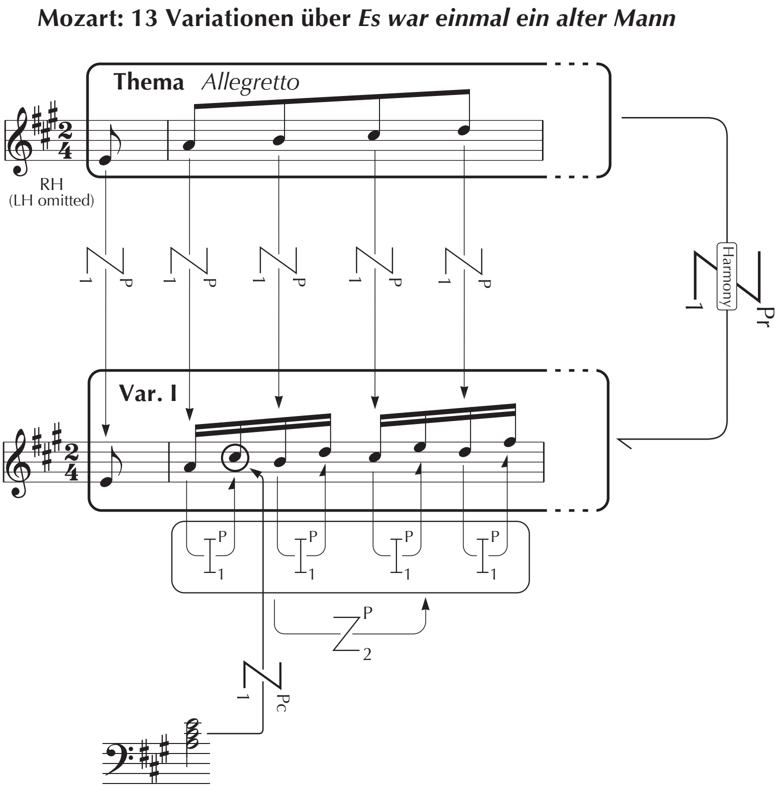


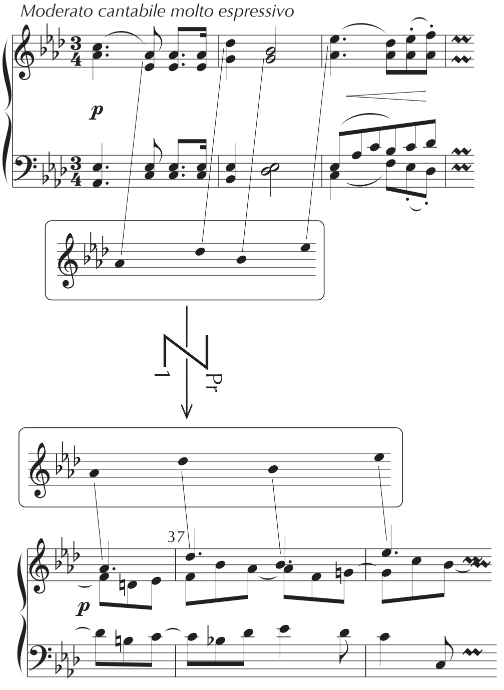
Figure 16.
Example of thematic connection influenced by underlying harmonic framework.

This example illustrates too the importance of a shared *rhythmic* context in leading the ear to hear the variation, exemplifying a synergy between the domains of pitch and perceived time that appears to be typical of music-developmental techniques across styles and genres. Profile is rarely imitated alone, and when it is, the effect may be more *con*ceptual — a product of compositional artifice — than immediately *per*ceptual: an issue that is discussed at some length below. See, for example, Figure 17.

Modelling transformations of rhythm

With regard to transformations of rhythm themselves, the position is somewhat more complex than is the case with profile, since there are more potential variables.

Beethoven: Piano Sonata Op. 111
1st Movement



3rd Movement

Figure 17.
Repetition of profile without rhythm.

Each note has a certain length or "duration", and, where notes succeed each other, they are separated by an "interonset interval" ("IOI") that gauges the typically short span of time between the beginning of one note and the start of the next. Where notes follow one another contiguously (without a break in sound), duration and IOI are the same (indeed, the term "duration" is often used loosely in referring to both) — although the two can, and often do, function distinctly, as in music that is played *staccato*, for example. With passages that are conceived within a metrical framework (a hierarchy of underlying pulses of different speeds, with periodicities that are congruent at the level of the bar) each note has a position within the prevailing metre, which may be termed its "relative metrical location" ("RML"); see Ockelford (1993, p. 589). Together, these variables yield 21 logical categories of transformation.

Moreover, as with profile, one rhythm may derive *indirectly* from another (sharing *indirect* similarities), in this case through both being constructed within a common *metrical* framework (see Figure 19). Such structures may run concurrently. See, for example, Figure 20 (where a shared *harmonic* framework is also influential).

number	musical effect	RMLs	IOIs	durations	example
R1	repetition	repeated	repeated	repeated	Figures 21, 23, 25
R2	proportional change in articulation	repeated	repeated	x ratio (r)	Beethoven, Op. 14, No. 2; 2nd movement, bars 3 and 11
R3	uniform change in articulation	repeated	repeated	+ difference (d)	Ockelford, 1993, p. 610*
R4	change in tempo; durations maintained	repeated	x ratio (r)	repeated	Bizet, *Carmen*; Act II, No. 12, 'Gypsy Song'; Tamb. part bars 34 and 74
R5	change in tempo; uniform change in durations	repeated	x ratio (r)	+ difference (d)	Ockelford, 1993, p. 611*
R6	change in tempo	repeated	x ratio (r)	x ratio (r)	Chopin, Prelude in A♭ Major (1834); bars 33–41
R7	syncopation	+ difference (d)	repeated	repeated	Figure 26
R8	syncopation: proportional change in durations	+ difference (d)	repeated	x ratio (r)	Beethoven, Op. 31, No. 1; 1st movement, bar 4 (RH & LH)
R9	syncopation: uniform change in durations	+ difference (d_1)	repeated	+ difference (d_2)	Ockelford, 1993, p. 616*
R10	augmentation or diminution	irregular change	x ratio (r)	x ratio (r)	Figure 29
R11	augmentation or diminution; durations maintained	irregular change	x ratio (r)	repeated	Figure 27
R12	augmentation or diminution; uniform change to durations	repeated	repeated	+ difference (d)	Ockelford, 1993, p. 619*
R13	uniform change in interonset intervals and durations	repeated	+ difference (d_1)	+ difference (d_2)	Messiaen, Livre d'Orgue (1951); I – *Reprises par Interversion*
R14	uniform change in interonset intervals and proportional change in durations	irregular change	+ difference (d)	x ratio (r)	Ockelford, 1993, p. 621*
R15	uniform change in interonset intervals	irregular change	+ difference (d)	repeated	Ockelford, 1993, p. 622*
R16	rhythmic inversion	irregular change	x – value	x – value	Figure 30
R17	change in metre	irregular change	repeated	repeated	Ockelford, 1993, p. 643*
R18	sequential change (retrogression)	irregular change	(x – 1)	repeated	Figure 29
R19	omission of material	one or more omitted	one or more omitted, with the possibility of change as a consequence	one or more omitted	Figure 24
R20	addition of material	one or more added	one or more added, with the possibility of change as a consequence	one or more added	Figure 16
R21	alteration of material	one or more changed	one or more changed	one or more changed	Figure 23

* synthetic examples

Figure 18.

Potential transformations of rhythm.

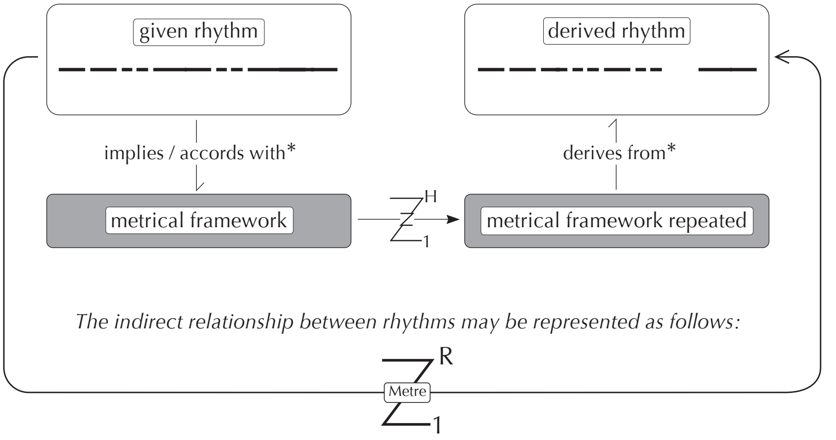


Figure 19.
Indirect relationship between rhythmic lines brought about through sharing a common metrical framework.

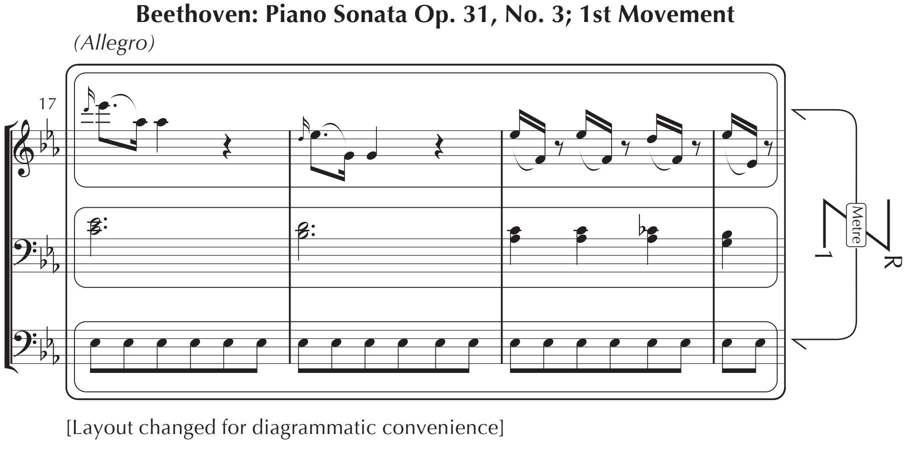


Figure 20.
Example of rhythmic connections influenced by a single underlying metrical framework.

Modelling integrated transformations of rhythm and profile

Through the process of "auditory binding" (see Roskies, 1999; Huron, 2006, p. 124), the discrete perspects that we have conceptualised as profile and rhythm, which resulted from the same physical stimulus, are reunited in cognition, and listeners hear streams and clusters of *whole sounds* (Ockelford, 2006a, p. 90). Reflecting on the listening process suggests that the relationships between the perceived qualities of different notes are bound together too, functioning as parallel strands in cognition.

Any zygonic effect that operates with respect to one perceived quality of sound may be transferred to other, simultaneous relationships (zygonic and non-zygonic) — the strength of the transfer varying according to the perceptual domains in question.

For example, we have already observed that the tone colour of a melody does not determine its identity, and, correspondingly, zygonic relationships of timbre typically make an important contribution to background coherence but do not define musical structure (Ockelford, 2004, p. 40). That is to say, only in exceptional circumstances would zygons of timbre have the derivational power to draw relationships pertaining to different perspects into their ambit of influence (see, however, Schoenberg, 1911/1978, p. 421; Slawson, 1985). Rhythm, on the other hand, tends to exert a potent force within the surface structure of music: the perceived temporal characteristics of a motive often define it most clearly, and zygonic relationships of rhythm alone are often sufficient to ensure musical coherence, potentially drawing patterns of pitch into the derivational equation that would otherwise be only weakly imitative or even lacking a zygonic component at all. See for example, Figure 21, in which the significance of transformations of profile involving high levels of change (whereby only contour in inverted or repeated form is retained) are strengthened through the repetition of rhythm.

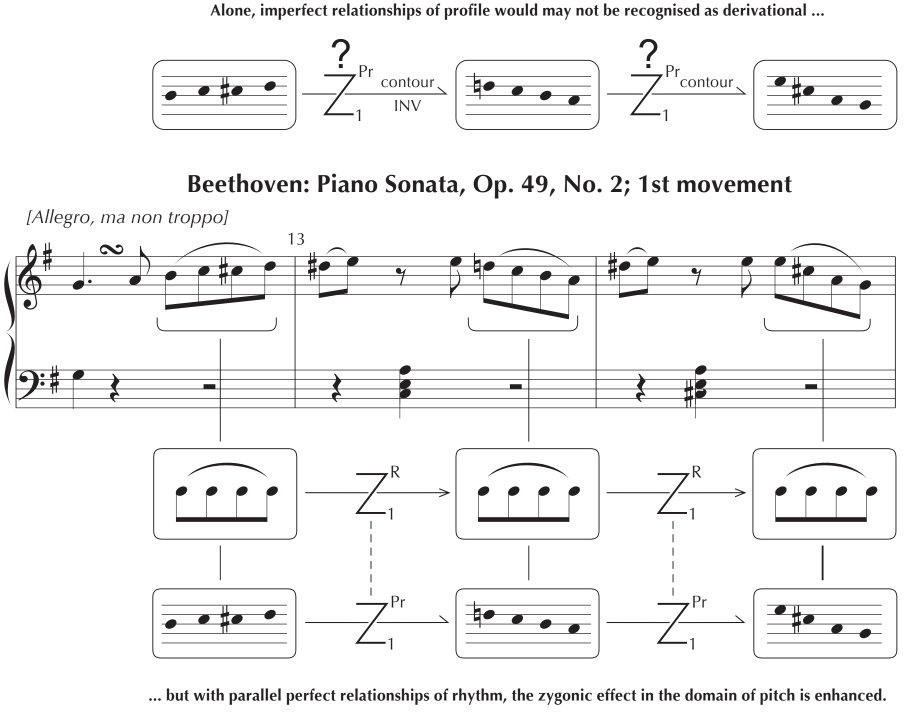


Figure 21.
Rhythmic repetition strengthens the perception of transformations of profile.

Most often, though, zygonic relationships of rhythm and profile operate in partnership: musically, each reinforcing the other, producing (as we shall see) transformations that are potentially highly salient and, therefore, of music-structural significance (Ockelford, 2004). Possible combinations of transformations exist as follows (see Figure 22).

This taxonomy provides a relatively straightforward theoretical framework for conceptualising an almost endless variety of musical outcomes, as the wide range of examples in Figures 23-30 illustrate.

The diversity of these examples reinforces the fact that the framework merely indicates what is *logically possible*. It does not take into account the following factors that its reification would demand.

1. The *nature* of the material in question, including its length and complexity. For instance, the repetition of rhythm and profile can pertain to motives, phrases, sections or even entire movements.
2. The *context* in which the transformation occurs, including:
   a. its temporal disposition (within a single line, related motives may occur contiguously or be separated in time, for example; within textures of two parts or more, they may also occur simultaneously, or overlap — *cf.* Ockelford, 1999, p. 159);
   b. its textural location (whether within a single line — melody, bass, *etc.* — or functioning between two parts or more); and
   c. its position in relation to other transformations (yielding different music-structural functions such as fugal exposition, the recapitulation in sonata form, the chorus of a song, *etc.*).
3. The *frequency* with which a given transformation occurs within a particular repertoire. This is critical in gauging its stylistic import: see, for example, Huron's (1999/2001) critique of Forte's (1983) analysis of Brahms's String Quartet in C minor, Op. 51, No. 1.
4. The *status* of the transformation in the minds of those engaging in different ways with the music concerned, including the composer, performers and a range of potential listeners (from the film-goers who are not consciously aware of the music they are hearing, for example, to music-analysts, who typically supplement auditory input with data gleaned visually from the score). The cognitive standing of transformations varies from ready perceptibility, through conceptually-enhanced perception, to their apprehension only as concepts. As Temperley (1995, pp. 141 and 167) observes, "There is an important distinction to be drawn in the way different kinds of motivic relationships are perceived… Metrically parallel transpositions… are perceived in a fast automatic way… [they] are also phenomenologically direct: there is a strong sense of hearing *that* they are there… Other relationships — non-parallel transpositions, retrogrades, and other set-theoretic relationships — may be detected, but only in a slow, deliberate phenomenologically indirect way."

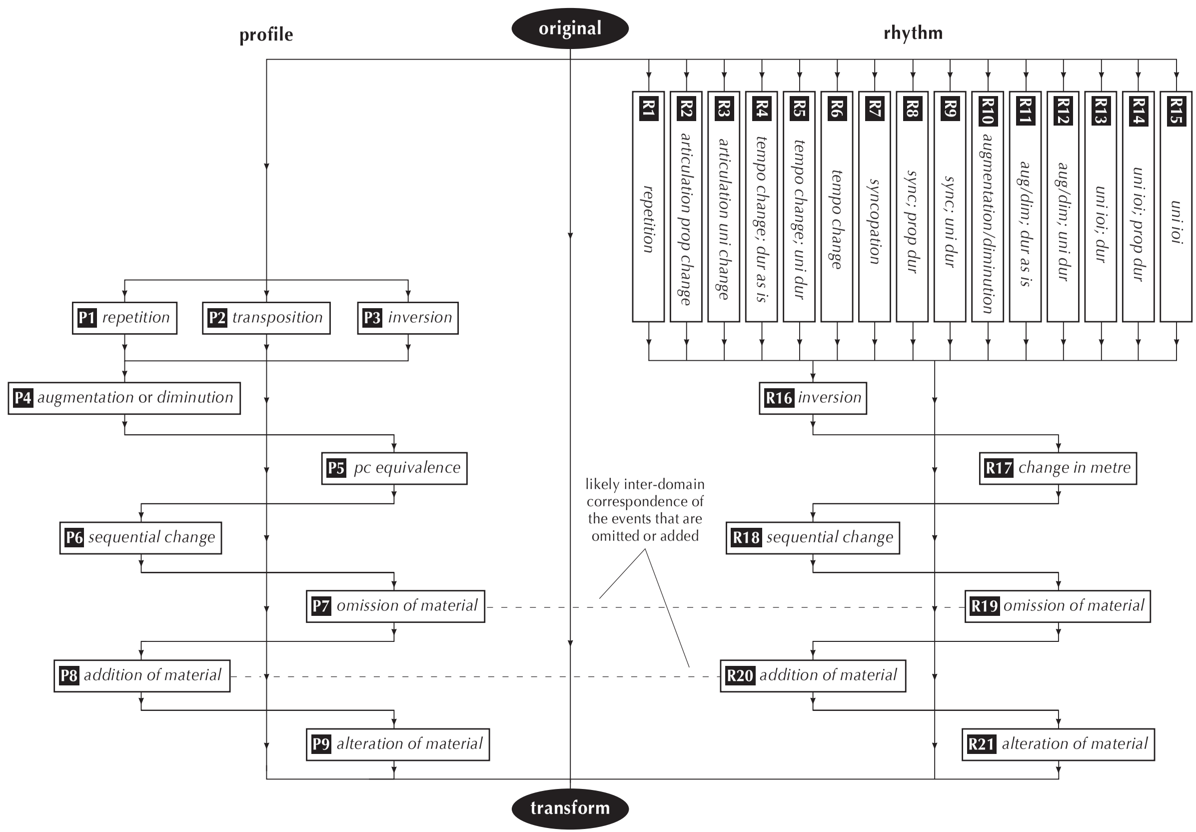


Figure 22.

Potential combinations of transformations of profile and rhythm.

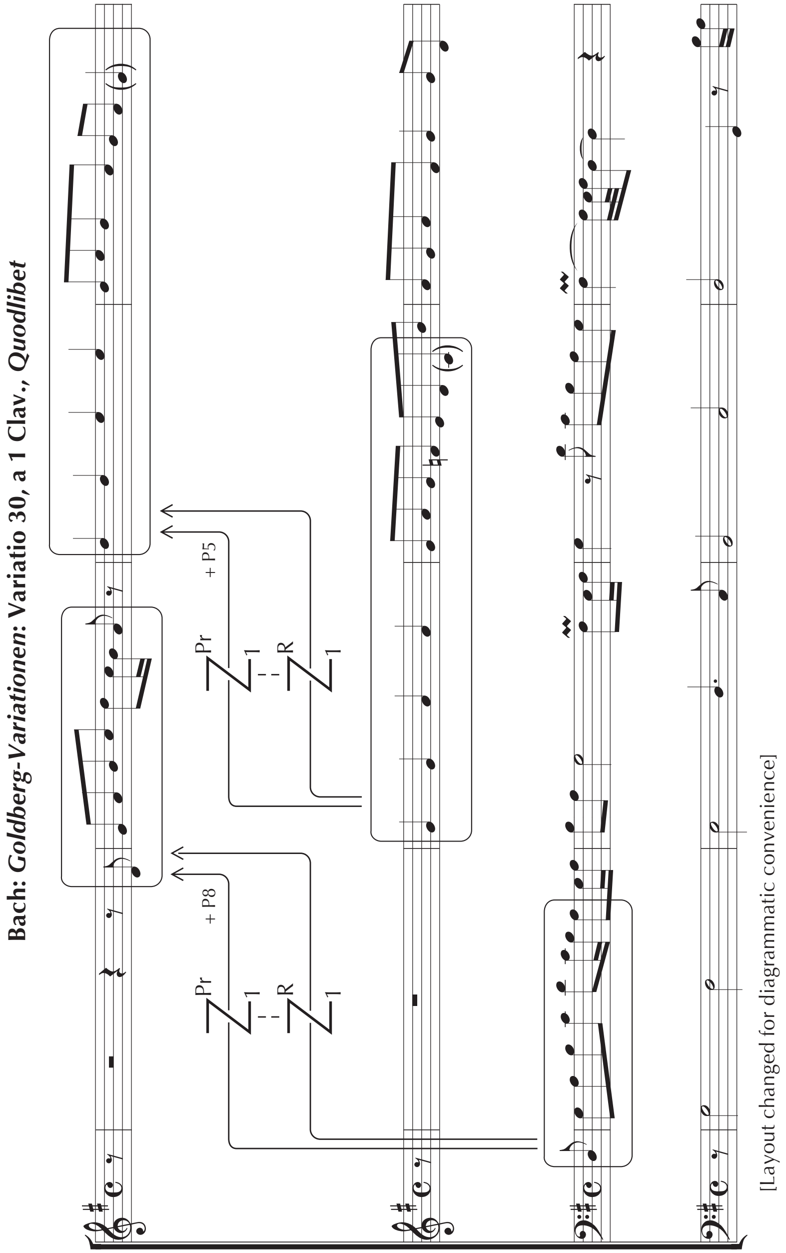


Figure 23.
Transposition of profile with rhythmic repetition.

Beethoven: Piano Sonata, Op. 2, No.1; 1st Movement

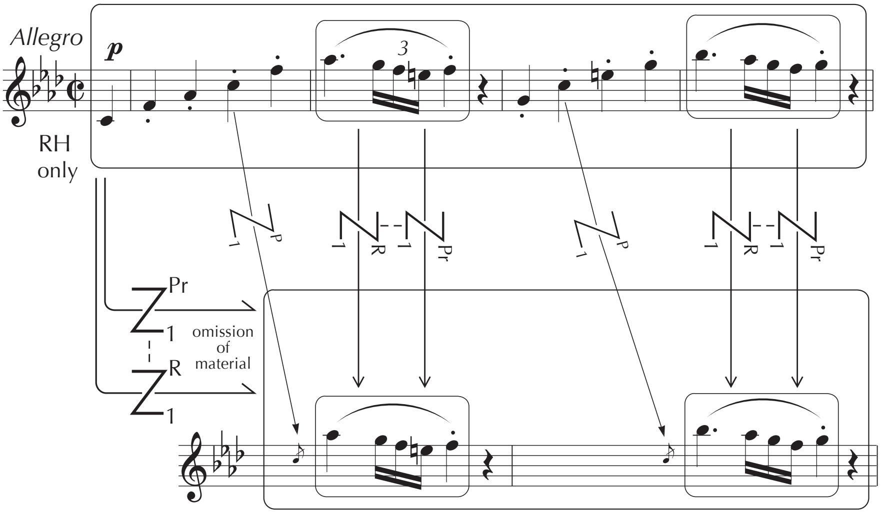


Figure 24.
Omission of material.

Brahms: Symphony No. 4, Op. 98; 2nd Movement

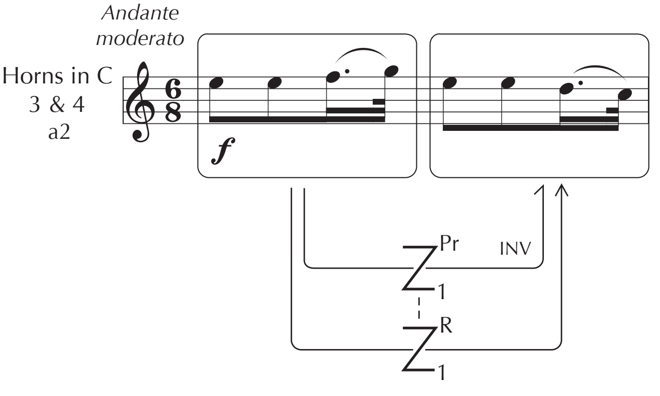


Figure 25.
Inversion of profile with rhythmic repetition.

Tchaikovsky: Symphony No. 2, Op. 17; 4th Movement

(Allegro vivo)

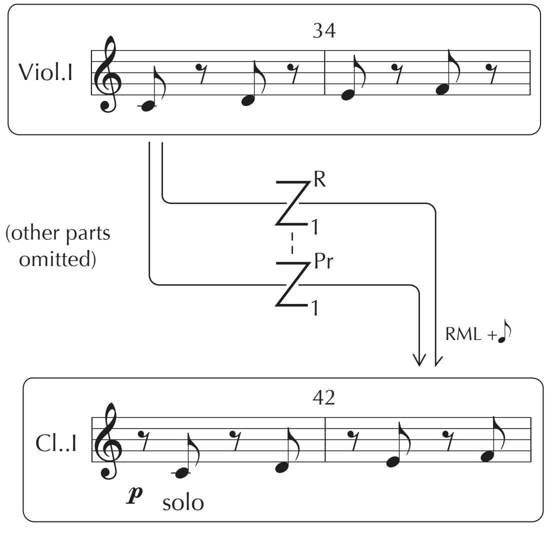


Figure 26.
Syncopation with repetition of profile.

Rózsa: ’Cello Concerto, Op. 32; 1st Movement

(Allegro e inquieto
(♩ = ca.138))

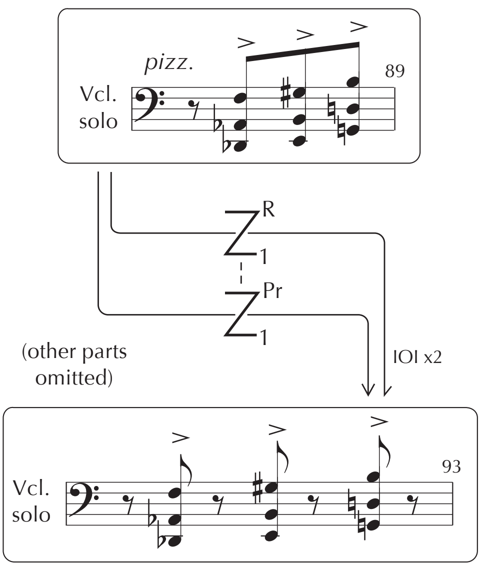


Figure 27.
Augmentation of IOIs with repetition of durations and profile.

Glinka: *Russlan and Ludmilla* (1837–1842); Overture

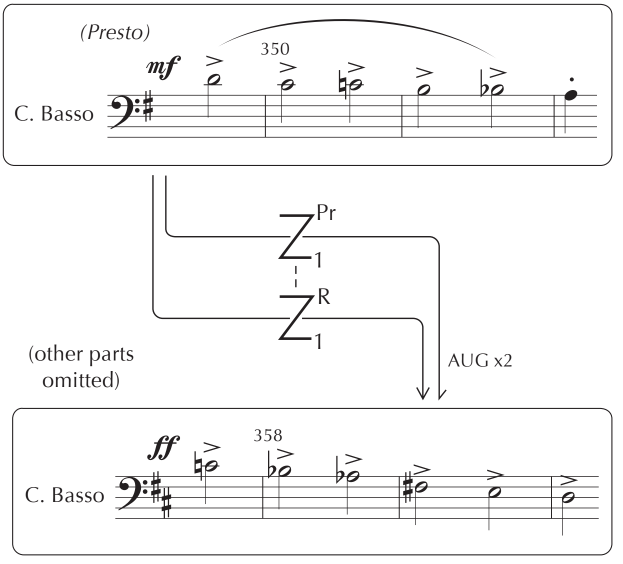


Figure 28.
Augmentation of profile with repetition of rhythm.

Dufay: *Missa L'Homme Armé* (c.1450); V. *Agnus Dei*

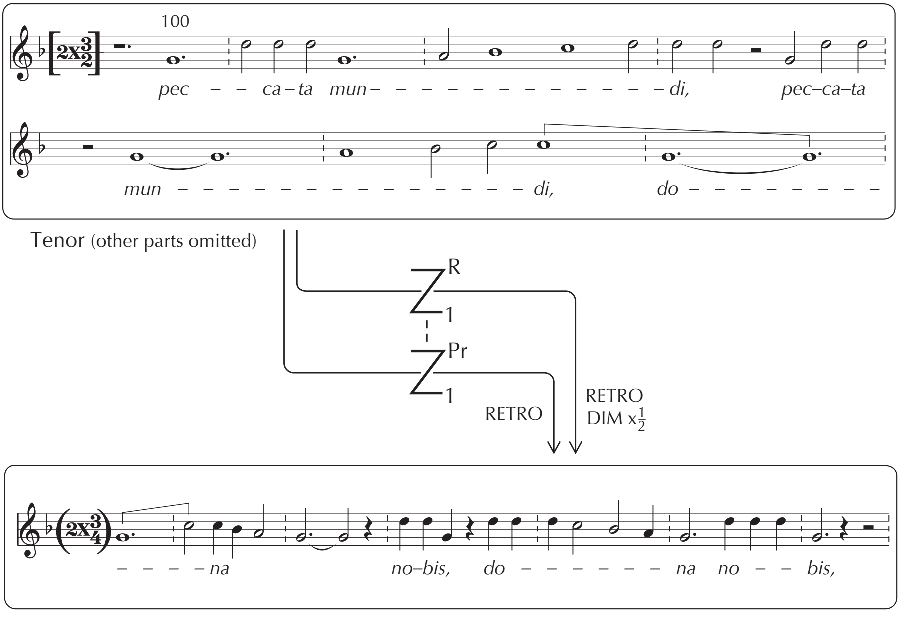


Figure 29.
Retrograde diminution of rhythm with retrogression of profile.

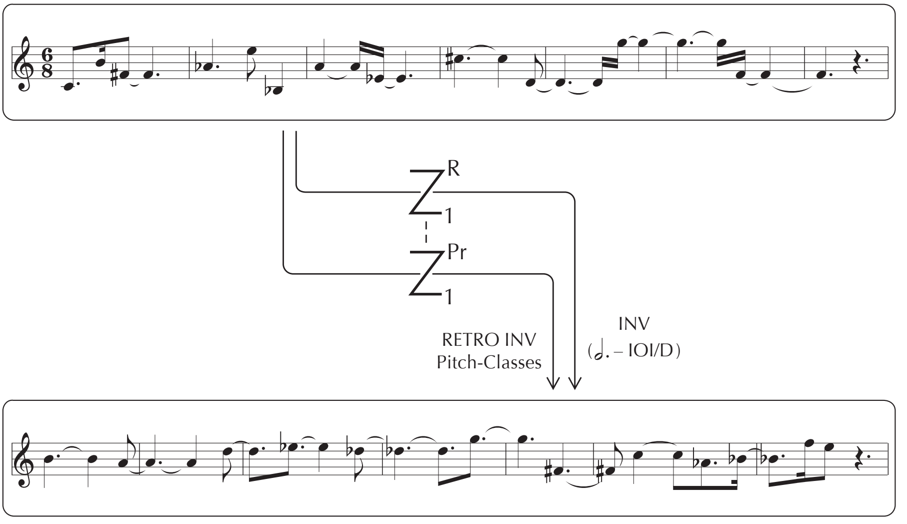


Figure 30.

Retrograde inversion of profile with inversion of rhythm (synthetic example, after Milton Babbitt, 1962, pp. 65ff).

Further empirical-musicological research could enhance our knowledge and inform our understanding of these factors, shedding light on the way that they are interrelated. For example, it may be that there is a broad correlation between the frequency of use of transformations (ranging from ubiquitous to non-existent) and their perceptual/conceptual status (see Figure 31). Exceptions to this general principle (for example, where a transformation is readily perceptible but has rarely been used) raise potentially interesting musicological questions and may even point to areas that may profitably be explored by composers in the future.[13]

Similarity in context

The perceptual/conceptual dimension has resonances with other theoretical constructs, such as the idea of implicit and explicit learning in the field of cognitive psychology (see, for example, Reber, 1989; Proctor & Dutta, 1995; Sun, 2002), the compositional and listening grammars posited by Lerdahl (1992), and, of course, the notions of similarity and difference explored in this paper (see Figure 22). But how does the duality inherent in each of these dimensions work? With regard to similarity and

(13) As an anonymous reviewer of an earlier version of this article pointed out, it could be, for example, that the greater the "absolute" dissimilarity between two musical fragments becomes, the higher the probability that listeners will differ in their *perception* of how similar the fragments are.

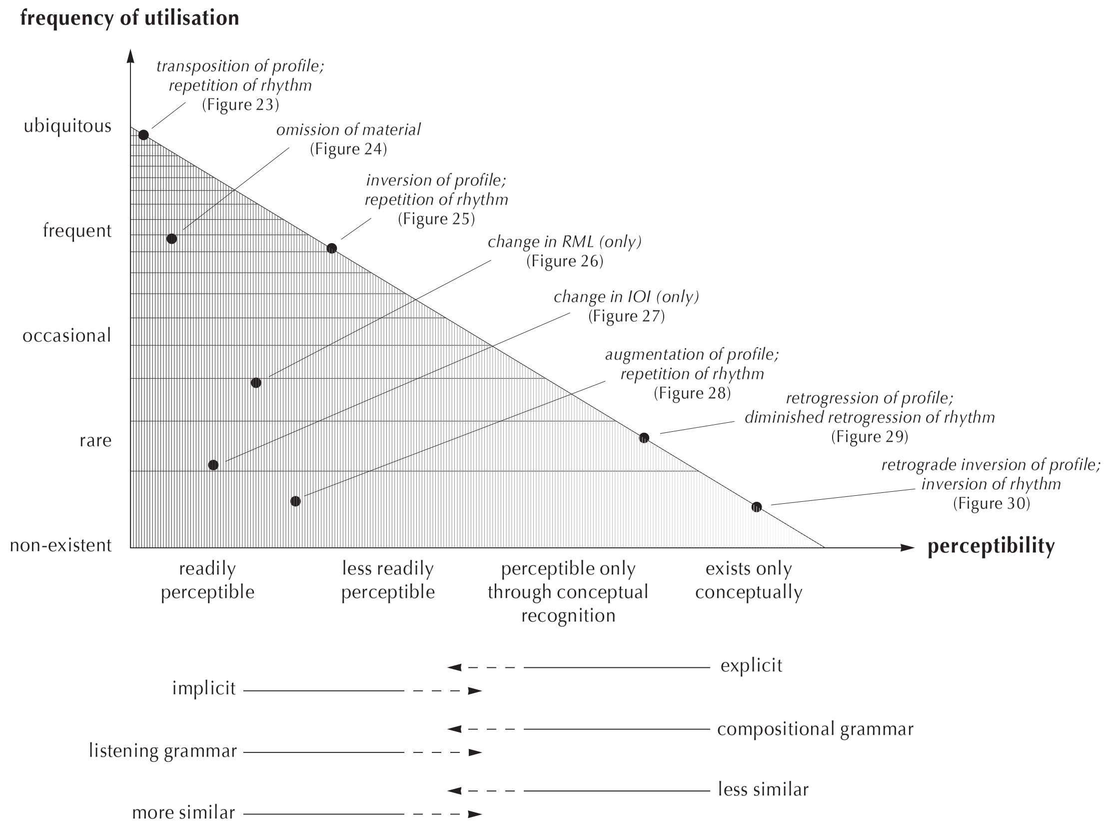


Figure 31.

Indicative relationship between the perceptibility of transformations and their frequency of utilisation.

difference, Lerdahl and Jackendoff reflect that "When two passages are identical they certainly count as parallel, but how different can they be before they are judged as no longer parallel?… It appears that a set of preference rules for parallelism must be developed, the most highly reinforced case of which is identity. But we are not prepared to go beyond this, and we feel that our failure to flesh out the notion of parallelism is a serious gap in our attempt to formulate a fully explicit theory of musical understanding" (1983, pp. 52 and 53).

This is a task, however, for which even the zygonic taxonomy of transformations formulated above (through which an "index of similarity" could theoretically be calculated, expressing in each case the proportion of similarity to change that was present: see, for example, Ockelford & Pring, 2005; Ockelford, 2006b, 2007, 2008) must necessarily be insufficient, since, in perceptual terms, the dimension of *context* identified above exerts such an overwhelming influence. To take the extreme case: even where a musical event is repeated exactly, there is no guarantee that this repetition will be apprehended, since, within the confines of the tonal and rhythmic frameworks which musical material typically defines, and by which it is constrained, a great deal of repetition is inevitable (Ockelford, 2005), and the majority of potential relationships between similar events considered in isolation are not directly of perceptual significance. Clearly, in general terms, the longer and more individual the excerpts in the context of surrounding material, the greater their salience (Ockelford, 2004) and the more likely is their similarity to be recognised (albeit nonconsciously) as being of particular structural consequence. Leonard Meyer (1973, p. 49) summed up this notion some time ago in his formula for the "strength of perceived conformance" between groups of notes:

$$\text{strength of perceived conformance} = \frac{❶\ \text{regularity of pattern} \cdot ❷\ \text{individuality of profile} \cdot ❸\ \text{similarity of patterning}}{❹\ \text{variety of intervening events} \cdot ❺\ \text{temporal distance between events}}$$

Figure 32.
Leonard Meyer's "formula of perceived conformance" (1973, p. 49).

His formula may be interpreted in zygonic terms thus:

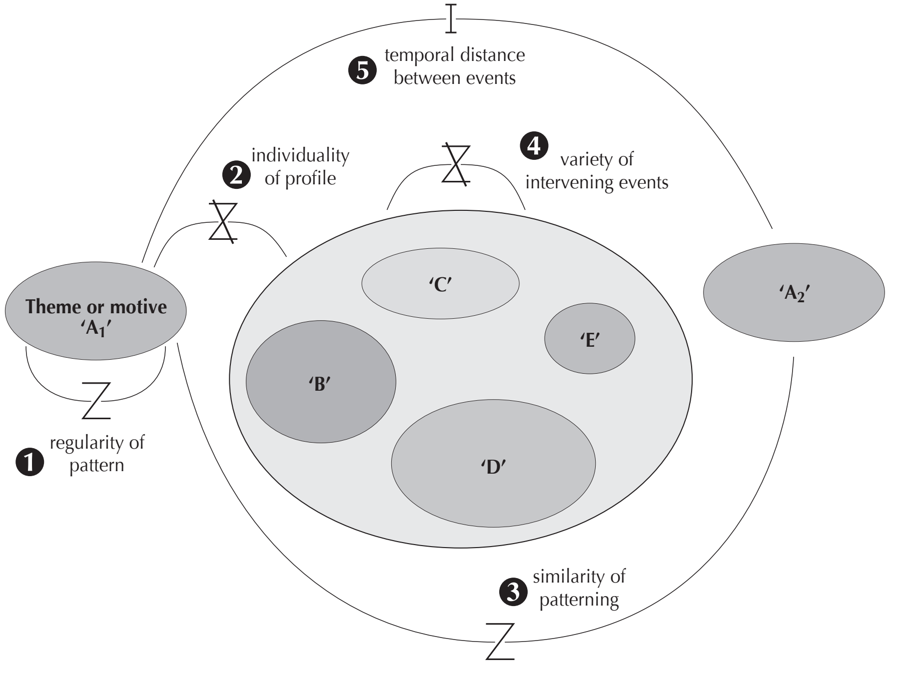


Figure 33.
Zygonic interpretation of Meyer's formula.

This interpretation suggests other factors that should be taken into account in gauging the probable strength of perceived conformance, including the same transformation of preceding material (**6**), similarity of context (**7**) (such as a particular form of accompaniment, for example), previous occurrences of the same transformation (**8**), and further appearances of the same transformed configuration (**9**).

Even with additions such as these, however, the model would still be unable to predict accurately the degree of conformance (that is, similarity) perceived by a given listener, since personal experiences, knowledge, attitudes and expectations vary so much (*cf.* Medin, Goldstone & Gentner, 1993, p. 257). Consider, for example, material transformed through retrogression (P6/R18 in Figures 14, 18 and 22), and compare Réti's and Serafine's definitions cited above. Réti describes the process as a literal repetition of shape, and therefore holds reversion to be a close form of imitation, whereas for Serafine, playing material backwards amounts to substantive transformation. From the composer's standpoint, Réti's position makes good sense, since retrogression demands, in logical terms, a minimal degree of change. However, as far as most listeners are concerned, reversing material of any length or complexity may well take it to the boundaries of what is perceptible and beyond. This is where Serafine's thesis — derived from a music-psychological perspective — comes in (*cf.* Lerdahl, *op. cit.*).

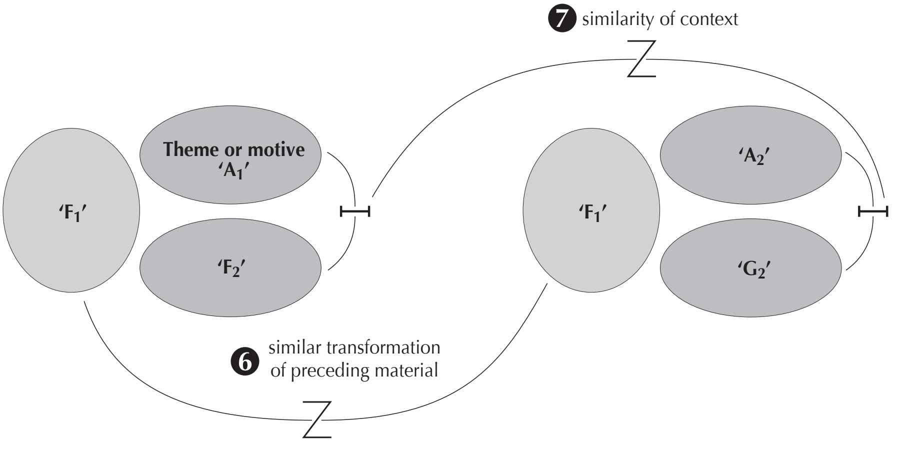


Figure 34.
Additional factors that may influence the perception of conformance.

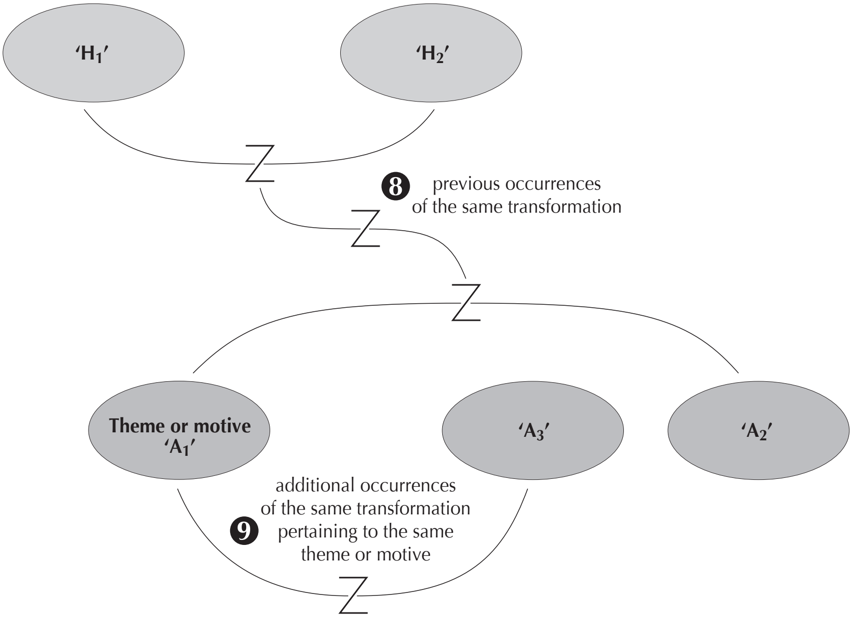


Figure 35.
Further factors that may influence the perception of conformance.

Hence there is not, and there could never be, a metric of perceived musical similarity that was universally applicable. Yet, to return to Toiviainen's assertion, if the perception of similarity does indeed lie at the heart of music-structural understanding, how can this be? How can one explain the coherence of music as a communicative medium, which purportedly depends on a common understanding of relationships of similarity between composers, performers and listeners?

It is my assertion that most composers imbue their music — intuitively or consciously — with sufficient similarity for it to be meaningful to listeners, even if some connections, particularly those functioning at a conceptual level, are missed or are construed in unanticipated ways (Ockelford, 2004). Take, for example, the countersubject in Bach's Fugue XVI in G minor from Book 1 of *Das Wohltemperierte Klavier*, BWV 861 (see Figure 36). The countersubject extends seamlessly from the subject through a number of motivic threads. Of particular significance among these for the ensuing fugal texture is the link through inversion of the second half of the subject to the opening of the countersubject. That is, essentially the same material performs two functions, affording the musical fabric a taut logic that is so characteristic of Bach. *But*, even if a listener were to fail to pick up on this connection, either consciously or unwittingly, the music would still make sense, since the countersubject meets the minimum requirement of harmonising the "answer", of fulfilling the harmonic expectations set up by the subject.

This belt and braces approach to composition — of ensuring that compositional grammars are supported by the safety net of listening grammars — was characteristic of all Western composers, from Dufay, Palestrina and Bach, for example, to Mozart,[14] Schumann and Brahms; that is, from the Middle Ages right up until the end of the 19th century. It was only with the advent of techniques such as serialism in the early 20th century, through which, in terms of the present theory, composers chose to structure music primarily through zygonic relationships that were conceptual in nature, and (in Schoenberg's case) consciously abandoned many of the perceptual similarities that listeners had hitherto relied on, that the well-documented rift between contemporary composers and mainstream audiences first opened up. To put it simply, this was all because there was insufficient similarity, within and between pieces of new music, for non-initiate listeners to hold on to.

In contrast, that special breed of listener — the music analyst — has not always felt the need to be constrained by issues of perceptibility, and, due to the generally highly repetitive nature of music, has potentially been able to identify many similarities,

(14) In a letter to his father of December 28, 1782, Mozart wrote that he still had two more piano concertos to complete of the three that he was working on for his 1783 subscription concerts (K. 413-15): "These concertos are a happy medium between what's too difficult and too easy — they are brilliant — pleasing to the ear — natural without becoming vacuous; — there are passages here and there that only connoisseurs can fully appreciate — yet the common listener will find them satisfying as well, although without knowing why" (Spaethling, 2000, p. 336).

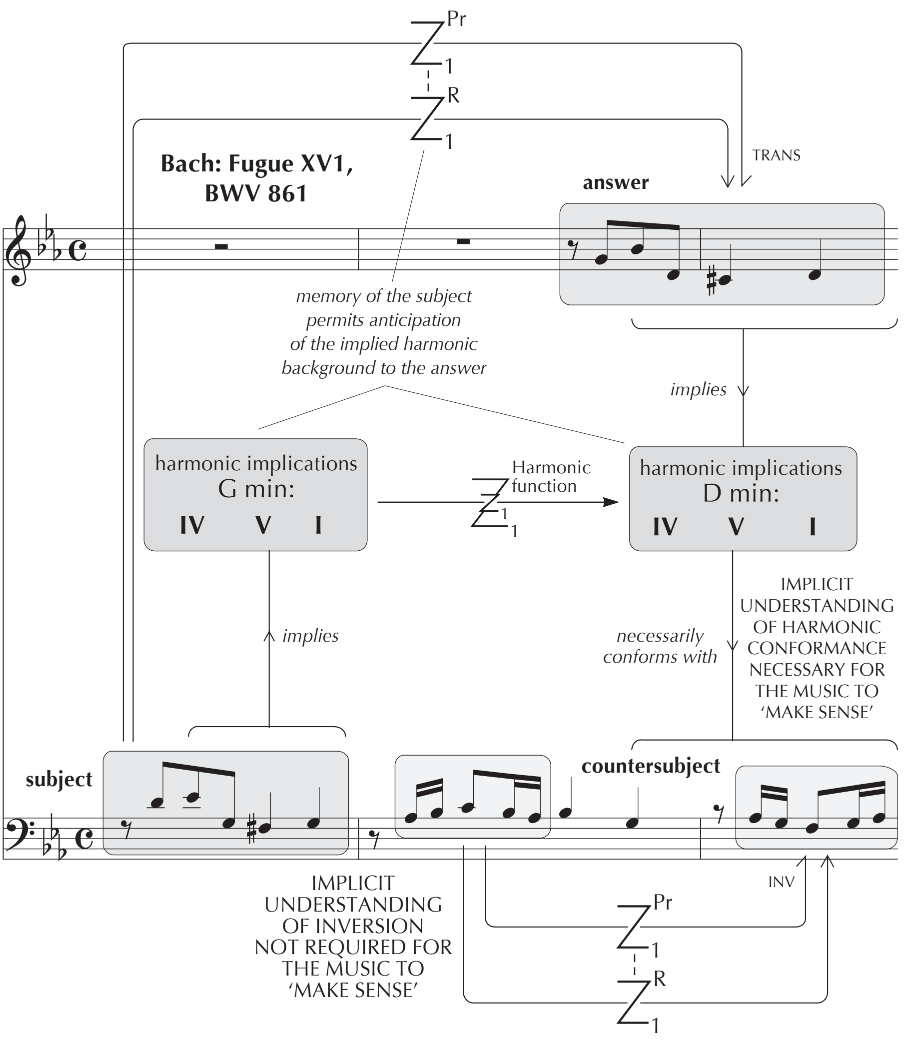


Figure 36.
Composition and listening grammars imagined to function in a Bach fugue.

which may exist anywhere along the whole length of the horizontal axis shown in Figure 31, including those to which composers themselves may have been oblivious (Ockelford, 2005, p. 121). For sure, such an approach is anathema to certain analysts. Tovey, for instance, in the introduction to his six volumes of *Essays in Musical Analysis* (1935) concludes: "I once more beg to reassert my first article of musical faith: that, while the listener must not expect to hear the whole contents of a piece of music at once, nothing concerns him that will not ultimately reach his ear… these essays… do not contain speculative and fanciful thematic derivations which exist only to the eye…". In contrast, other analysts may seek out conceptual structures with a view to informing perception, whose works are ultimately of value as "ear-openers" (Dubiel, 1999, p. 274).

There are some, though, who consciously seek to ferret out structures with no more justification than the fact that they find them intrinsically interesting. Take, for example, Forte's reading of the first of Schoenberg's *Drei Klavierstücke*, Op. 11, which uses "set theory". This holds that one group of pitches can be regarded as *equivalent* to another, irrespective of transposition or inversion, the octave in which pitches occur, whether or not they are repeated and, additionally, the order in which they occur (*cf.* Figure 14). Yet there is nothing to suggest, either in the manuscript or in verbal commentaries, that Schoenberg conceived the opening of Op. 11, No. 1 in terms of the 28 pitch-class sets ("pcsets") Forte identifies, or, indeed, that sets of any description were used as a tool to facilitate its composition (in contrast to the way that tone rows were subsequently described and used). Could it be, then, that pcsets nevertheless offer a valid model of how listeners intuitively make sense of the work's structure? Again, there is no empirical evidence of this — quite the contrary, in fact. While the process of formulating even a single pcset from material presented in abstraction demands a high level of aural and intellectual skill, to identify sets in the context of a living piece of music is an almost inconceivably complex task. It is not clear how one is to know which of the 208 potential sets to listen out for: presumably, different possibilities have to be tried, with many being rejected *en route* to the final "reading". Hence, to Lerdahl's twofold taxonomy of "listening" grammars and "compositional" grammars one may be justified in adding a third — "analytical" grammars — that acknowledge manifestations of similarity that lie beyond practical levels of engagement with music.

This stance is at odds with the approach usually taken by music psychologists, which, as we observed earlier, tends to focus on aspects of similarity perception that are common across a population. That is to say, different music-related disciplines (and, as we saw in relation to music analysis, even different approaches *within* disciplines) are likely to afford similarity a different ontological status. Therefore, the theoretical stance one adopts in considering similarity itself needs contextualising, and this is where the zygonically-conceived framework shown in Figure 22 offers a way forward, since it can potentially be shared by different epistemological *modi operandi*, and can be used metatheoretically to compare and contrast different approaches (Ockelford, 2005a).

Conclusion

This article set out from Irène Deliège's contention that similarity relationships lie at the heart of our understanding of musical structure. Indeed, it was noted that a number of theorists have formulated classifications of similarity relationships of musical material, including Arnold Schoenberg, Rudolf Réti, Jan LaRue and Wilson Coker and the music-psychologist Mary Louise Serafine. All have their limitations, however, and a new taxonomy was proposed of the forms of connection that can logically exist between one group of notes and another.

However, with reference to a number of musical examples, it became clear that similarity cannot be judged in isolation from the musical context in which it occurs. Moreover, it is likely to be judged differently by different listeners, depending upon their preferred listening styles. These will vary in general terms according to their beliefs and experiences, and specifically in relation to the attitudes and attention that they bring to bear on a given occasion. It was therefore concluded that one could never isolate a measure of perceived musical similarity that would be universally applicable.

This left the problem of how one could explain the coherence of music as a medium of communication, with its purported dependence on a shared understanding of relationships of similarity between composers and listeners. It was surmised that composers (whether intentionally or not) typically endow their music with sufficient similarity for enough of it to be picked up by listeners to enable the music to make sense, even if some connections, particularly those functioning at a conceptual level, fail to be heard or are misconstrued. As far as musicologists are concerned, the fact that music is highly repetitive (and therefore replete with similarity) means that they too are able to identify not only relationships of similarity that are intended to shed light on the compositional process, or reflect or influence the way that listeners may approach pieces, but also those correspondences that are deemed to be intrinsically worthy of note, without necessarily having any direct bearing on the musical experience. It was observed that this stance is at odds with music-psychological methodologies that tend to examine aspects of similarity perception that are common across a population. Hence, similarity is likely to be afforded a different ontological status in different fields of musical and musicological study. It is asserted that zygonic theory potentially offers a way forward — a conceptual framework that different epistemologies can potentially share.

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• Relaciones de similitud entre grupos de notas: perspectivas en teoría de la música y en psicología de la música

El punto de partida de este artículo es el ensayo de Irène Deliège sobre las relaciones de similitud que, como ella ha dicho, reposan en el centro de creación y de la toma de conciencia de la estructura musical (2007): en particular (aunque no exclusivamente) las relaciones que funcionan *internamente* dentro de las obras, y que pueden ser percibidas *implícitamente* o concebidas *explícitamente*. Al principio, se adopta una línea teórico-musical partiendo del concepto de Arnold Schoenberg del "motivo" musical, y su taxonomía de las transformaciones motívicas, que, según él afirma, sostienen la coherencia musical (1967). Esta clasificación, junto a las elaboradas por los teóricos Rudolph Réti (1951), Jan LaRue (1970) y Wilson Coker (1972) son confrontadas por el autor usando su teoría "zygónica" de la comprensión de la estructura musical (Ockelford, 2004, 2005a, 2005b, 2006a), y, en relación a los trabajos de psicología musical de María Louise Serafine (1983), David Temperley (1995) y Bruno Repp (1997), se propone una nueva taxonomía, compuesta, que presenta todas las formas de relación que pueden existir lógicamente entre un grupo de notas y otro. Se presentan varios ejemplos musicales, que sugieren (a) que la similitud no puede ser valorada aisladamente del contexto musical en la cual tiene lugar (concepto elaborado a partir de una versión ampliada de la "fórmula de la conformidad percibida" de Leonard Meyer (1973)); y (b) que es probable que la similitud sea juzgada de forma diferente en un mismo sujeto y entre sujetos diversos, según el estilo de escucha adoptado. La similitud variará, en términos generales, según las creencias y experiencias musicales de los oyentes, y en particular, en relación con las actitudes y la atención que los oyentes presten en una circunstancia determinada. Se puede concluir que no hay, y que no habrá jamás, una medida universal de la similitud musical percibida. ¿Cómo, entonces, es posible explicar la coherencia de la música como medio de comunicación, dependiendo en su intención de una comprensión común de las relaciones de similitud entre compositores, intérpretes y oyentes? Se puede conjeturar que los compositores, intuitiva o conscientemente, dotan a su música de una similitud suficiente para que sea reconocible y significativa para los oyentes, incluso si faltan ciertas conexiones, o se construyen de forma imprevista, particularmente las que funcionan a nivel conceptual (Ockelford, 2004). La naturaleza altamente repetitiva de la música permite también a los analistas identificar no sólo las relaciones de similitud que permiten aclarar el proceso compositivo o reflejar o influir en la forma en la que el oyente afronta la escucha de los pasajes, sino igualmente esas correspondencias consideradas relevantes intrínsicamente, sin tener necesariamente una relación directa con la experiencia musical. Claramente, esta posición está en conflicto con las metodologías de la psicología musical que tienden a estudiar los aspectos de percepción de similitud comunes en un pueblo. En otras palabras, disciplinas diversas relacionadas con la música (y también aproximaciones diferentes dentro de una misma disciplina) pueden probablemente atribuir a la similitud un estatus ontológico diferente. La teoría zygónica ofrece una solución: una estructura conceptual potencialmente capaz de ser compartida por diferentes *modi operando* epistemológicos.

• Relazioni di similarità tra gruppi di note: Prospettive teoretiche e psicologiche in musica

Il punto di partenza di questo articolo è il saggio di Irène Deliège sui rapporti di similarità che si sostiene siano al centro della creazione e della presa di coscienza della struttura musicale (2007): in particolare (anche se non esclusivamente), i rapporti che funzionano *internamente* in un brano e che possono essere percepiti *implicitamente* o concepiti *esplicitamente*. Innanzitutto, si adotta una linea teorico-musicale partendo dal concetto sviluppato da Arnold Schoenberg di "motivo" musicale e dalla sua tassonomia delle trasformazioni motiviche che, egli sostiene, sottendono la coerenza musicale (1967). Questa classificazione e altre classificazioni elaborate dai teorici Rudolph Réti (1951), Jan LaRue (1970) e Wilson Coker (1972) sono analizzate dall'autore attraverso la teoria "zigonica" della comprensione della struttura musicale (Ockelford, 2004, 2005a, 2005b, 2006a) e, in rapporto al lavoro di psicologia musicale di Mary Louise Serafine (1983), David Temperley (1995) e Bruno Repp (1997), è proposta una nuova tassonomia composita che mette in evidenza le forme di connessione che logicamente possono esistere tra due gruppi di note. Ciò è presentato attraverso esempi musicali che mostrerebbero (a) che la similarità non può essere valutata separatamente dal contesto in cui essa si verifica (concetto elaborato da una versione ampliata della "formula della conformità percepita" di Leonard Meyer (1973)); e (b) che la similarità è percepita in modo diverso da uno stesso soggetto e da soggetti diversi, a seconda dello stile di ascolto adottato. La similarità varierà, in termini generali, a seconda delle credenze e delle esperienze musicali dell'ascoltatore, e in particolare, in rapporto alle attitudini e all'attenzione che egli presta in relazione a una determinata circostanza. Se ne desume che non c'è e non potrà mai esserci una misura universale della similarità musicale percepita. Com è possibile spiegare, dunque, la coerenza della musica come strumento di comunicazione, presumibilmente derivante da una comprensione comune dei rapporti di similarità condivisa da compositori, esecutori e ascoltatori? Si suppone che i compositori intuitivamente o coscientemente forniscano alla loro musica un livello di similarità sufficiente ad essere riconoscibile e comprensibile all'ascoltatore, anche se alcuni passaggi sono omessi o costruiti in modo imprevisto (Ockelford, 2004), in particolare quelli che agiscono a livello concettuale.

La natura altamente ripetitiva della musica permette anche agli analisti di identificare non solo i rapporti di similarità che permettono di chiarire il processo compositivo o di riflettere o influenzare il modo in cui l'ascoltatore affronta l'ascolto di un brano, ma anche quelle corrispondenze giudicate intrinsecamente rilevanti, senza avere necessariamente un rapporto diretto con l'esperienza musicale. Chiaramente, questa istanza è in contrasto con le metodologie psicologico-musicali che tendono invece a esaminare aspetti della percezione della similarità comuni in un popolo. In altre parole, discipline diverse in rapporto con la musica (ma anche approcci diversi all'interno di una stessa disciplina) attribuiscono alla similarità uno status ontologico diverso. La teoria zigonica offre una nuova prospettiva: un contesto concettuale che i diversi modi operandi epistemologici possono potenzialmente condividere.

• Relations de similarité entre groupes de notes : perspectives en théorie de la musique et en psychologie de la musique

Le point de départ de cet article est l'essai d'Irène Deliège sur les relations de similarité qui, comme elle l'avance, reposent au coeur de la création et de la prise de conscience de la structure musicale (2007) : en particulier (mais non exclusivement) les relations qui opèrent *de façon interne* au sein des oeuvres, et qui pourraient être perçues *implicitement* ou conçues *explicitement*. Au départ, on adopte un point d'ancrage de théorie musicale avec le concept de « motif » musical d'Arnold Schoenberg, et sa taxonomie des transformations motiviques, lesquelles, affirme-t-il, sous-tendent la cohérence musicale (1967). Cette classification, ainsi que d'autres proposées par les théoriciens Rudolph Réti (1951), Jan LaRue (1970) et Wilson Coker (1972), sont confrontées à notre théorie « zygonique » de compréhension de la structure musicale (Ockelford, 2004, 2005a, 2005b, 2006a), et, en référence aux travaux de psychologie de la musique de Mary Louise Serafine (1983), David Temperley (1995) et Bruno Repp (1997), une taxonomie nouvelle, composite, est proposée, qui présente toutes les formes de relations qui peuvent logiquement exister entre un groupe de notes et un autre. Des exemples musicaux viennent illustrer tout ceci, qui suggèrent (a) que la similarité ne peut pas être jugée isolément du contexte musical dans lequel elle survient (quelque chose qui est modelé au travers d'une version élargie de la « formule de conformité perçue » de Leonard Meyer (1973)) ; et (b) qu'il est probable que la similarité soit jugée différemment entre, et même au sein des sujets, suivant le style d'écoute adopté. Ceci variera généralement selon les croyances et expériences musicales des auditeurs, et plus particulièrement en relation avec les attitudes et l'attention qu'ils apportent en une occasion donnée. On peut donc conclure qu'il n'y a pas, et qu'il n'y aura jamais, de mesure universelle de la similarité musicale perçue. Comment, alors, expliquer la cohérence de la musique en tant que moyen de communication, dépendant dans son intention d'une compréhension commune des relations de similarité entre compositeurs, exécutants, et auditeurs ? On peut conjecturer que les compositeurs, intuitivement ou consciemment, dotent leur musique d'une similarité suffisante pour qu'elle soit reconnaissable et significative aux auditeurs, même si certaines connections manquent, ou sont construites de façon imprévue, et particulièrement celles qui fonctionnent à un niveau conceptuel (Ockelford, 2004). La nature hautement répétitive de la musique signifie que les analystes aussi sont capables d'identifier non seulement ces relations de similarité qui cherchent à illuminer le processus de composition, ou reflètent ou influencent la façon dont l'auditeur approche les morceaux, mais également ces correspondances considérées comme intrinsèquement remarquables, sans qu'il y ait nécessairement une incidence sur l'expérience musicale. Manifestement, cette position est en conflit avec les méthodologies de psychologie de la musique qui tendent à étudier les aspects de perception de similarité, communs au sein d'une population. Cela revient à dire que différentes disciplines liées à la musique (et même des approches différentes au sein de mêmes disciplines) peuvent probablement fournir à la similarité un statut ontologique différent. La théorie zygonique offre une solution : une structure conceptuelle potentiellement capable d'être partagée par différents *modi operandi* épistémologiques.

• Ähnlichkeitsbeziehungen zwischen Notengruppen: Musiktheoretische und musikpsychologische Perspektiven

Ausgangspunkt für diesen Artikel ist Irène Delièges (2007) Aufsatz über Ähnlichkeitsbeziehungen, die, wie behauptet wird, zentrale Bedeutung für die Gestaltung und Verarbeitung musikalischer Strukturen haben. Insbesondere (jedoch nicht ausschließlich) werden *intern* wirkende Beziehungen innerhalb von Werken untersucht, die wiederum *implizit* wahrgenommen oder *explizit* vorgestellt werden können. Anfangs wird eine musiktheoretische Richtung eingeschlagen, beginnend mit Arnold Schönbergs Konzept des musikalischen „Motivs" und seiner Taxonomie motivischer Transformationen, die ihm zufolge musikalischer Kohärenz unterliegen (1967). Dies und andere Klassifikationen von den Theoretikern Rudolph Réti (1951), Jan LaRue (1970) und Wilson Coker (1972) werden untersucht unter Verwendung der „zygonischen" Theorie des Autors zum musikstrukturellen Verstehen (Ockelford, 2004, 2005a, 2005b, 2006a). Außerdem wird unter Bezugnahme auf musikpsychologische Arbeiten von Mary Louise Serafine (1983), David Temperley (1995) und Bruno Repp (1997) eine neue, umfassende Taxonomie vorgeschlagen. Darin werden Verbindungsformen beschrieben, die logischerweise zwischen einer Gruppe von Noten und einer anderen Gruppe existieren können. Dies wird anhand von Musikbeispielen illustriert. Es kann vermutet werden, dass (a) Ähnlichkeit nicht isoliert vom jeweiligen musikalischen Kontext beurteilt werden kann (wie durch eine ausgearbeitete Version von Leonard Meyers [1973] „Formel der wahrgenommenen Konformität" modelliert wird), und (b), dass Ähnlichkeit in Abhängigkeit vom Hörstil wahrscheinlich unterschiedlich zwischen und sogar innerhalb von Versuchsteilnehmern beurteilt wird. Unterschiede treten generell in Abhängigkeit von den musikalischen Erfahrungen und Ansichten der Zuhörer auf, besonders im Zusammenhang mit Einstellungen und der Aufmerksamkeitsfokussierung in einer bestimmten Situation. Daher wird geschlussfolgert, dass es keine universellen Maße der wahrgenommenen musikalischen Ähnlichkeit gibt und niemals geben wird. Wie kann dann dennoch die Kohärenz von Musik als kommunikativem Medium erklärt werden, das vermutlich auf einem gemeinsam von Komponisten, Musikern und Hörern geteilten Verständnis von Ähnlichkeitsbeziehungen aufbaut?

Es wird vermutet, dass Komponisten intuitiv oder bewusst ihre Musik mit ausreichend Ähnlichkeit ausstatten, damit sie für Zuhörer erkennbar und bedeutsam wird, sogar wenn einige Verbindungen (besonders auf konzeptioneller Ebene) fehlen oder auf unvorhersehbare Weise konstruiert werden (Ockelford, 2004). Diese stark repetitive Form der Musik versetzt Analytiker auch in die Lage, nicht nur die Ähnlichkeitsbeziehungen zu identifizieren, die den kompositorischen Prozess beleuchten oder die Art des Zuhörens widerspiegeln oder beeinflussen. Vielmehr können Analytiker außerdem solche Zusammenhänge identifizieren, die intrinsisch bemerkenswert erscheinen, ohne notwendigerweise das musikalische Hörerlebnis direkt zu beeinflussen. Diese Herangehensweise unterscheidet sich eindeutig von musikpsychologischen Vorgehensweisen, die tendenziell Aspekte der gemeinsamen Ähnlichkeitswahrnehmung in einer Population untersuchen. Damit soll gesagt werden, dass verschiedene musikbezogene Disziplinen (und selbst verschiedene Herangehensweisen *innerhalb* einer Disziplin) der Ähnlichkeit einen anderen ontologischen Status einräumen. Die zygonische Theorie bietet einen vorwärts weisenden Ausweg: einen potenziell gemeinsamen konzeptuellen Rahmen für verschiedene epistemologische *modi operandi*.