Perceiving melodies and perceiving musical colors

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Perceiving melodies and perceiving musical colors

In this paper, I draw some comparisons between the visual perception of objects and events and the audible perception of music. In the first part I consider the fact that observers can identify objects presented at different orientations to them and that they can frequently identify an item as the same despite its appearance having changed, for example by ageing. I argue that these cases are paralleled in music listening. Thematic ideas can be (sometimes, but not inevitably) recognized when they are inverted or played backwards. Moreover, within music it is crucial that various musical statements, including ones that differ in their intervallic sequence, are sometimes recognized as versions of a single theme. In the final section, I compare instrumental timbre with visual colors, and explain that timbres are experienced as properties of the instruments from which they issue. Moreover, I suggest we hear in and through musical sounds the actions that go into their making.

I.

We are capable of recognizing items when they are presented to us at different orientations and distances. At least, we can do so unless their three-dimensional shape is highly irregular. If I can identify a paperclip in one orientation, I can probably also identify it when it is turned through 90º. If I can recognize you in full face, chances are that I can do the same when you are in profile.[1] Apparently we are similarly skilled with temporally extended events or processes, though this is unexpected given that the opportunity to apply this talent did not exist before the invention of visual playback technology (such as flip cards or motion cameras). It is amusingly strange to see the runners sprint energetically backward to arrive together with extraordinary precision at their starting blocks, yet the scene is visually incoherent. And having seen the race the one way, it is likely one can re-identify it when it is shown the other.

These initial claims should be qualified, of course. Many things have a top and a bottom, as it were, and when they are presented the wrong way up, they can be harder to identify or details of their appearance can be harder to register. This applies to things such as horses and trees, but more importantly to faces. Note that facial recognition employs parts of the brain—in particular, in the fusiform gyrus in the occipitemporal cortex—not activated when other objects are visually located and identified. The face inversion effect (also known as expressional transfiguration or the Thatcher illusion), in which inverted faces with non-inverted eyes are not regarded as distorted until turned the right way up, possibly arises because inverted faces are processed by the object-recognition neural system, not by the facial-recognition one (Rothstein et. al. 2001, Solso 2003). Another, similar case is that of printing or writing, which becomes unreadable for most people when presented in mirror image.[2]

Music is an art of time, both in that the temporal order of events is specified (which distinguishes it from paintings, parts of which can be inspected in any order) and that the rate of progression is specified (which distinguishes it from novels).[3] Can musical items, such as melodies, be recognized when played backward, inverted, or both?

Before addressing this question, I need to specify what is involved in backward playing. When a tape of music is reversed, the result often is very alien, as contrasted to that of the rewound film. The reason for this, though,

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1 For discussion of psychological models of visual recognition, see Tarr & Bülthoff (1998).

2 Obviously this skill can be acquired, however. Typesetters from the era of movable type had to read reverse lettering. Etching and engraving also is done in mirror image.

3 For further discussion, see Alperson 1980, Levinson & Alperson 1991.

is as much to do with the reversal of each note as the reversal of the note sequence. Notes have an attack and a decay that is usually characteristic of the musical instrument that sounds them. A note played on a piano has a sharp, percussive onset and the sound rapidly dies, whereas the same note on an organ has a more sibilant onset and is sustained at the same strength for as long as the note lasts. Because of this, when a tape of a piano is played backward, it sounds more peculiar as music than a reversed tape of an organ playing the same piece.[4] As well as the note sequence, timbre and features that supervene on this are reversed as well. To take this effect out of the equation, the question about backward playing is best understood as asking about the case in which the note order of a melodic line is reversed and these notes then are played forward, in the normal manner.[5]

Material in musical works is frequently treated in retrograde, inversion, or retrograde inversion.[6] An early instance is in the thirteenth-century *clausula*, *Nusmido*, the tenor of which has the liturgical melody "Dominus" in retrograde motion (Apel 1966). Another famous example is Guillaume de Machaut's fourteenth-century riddle canon *My end is my beginning*. Mozart wrote jest canons where two players simultaneously read from opposite sides of the same sheet of music, with the result that the one part is the retrograde inversion of the other. Karlheinz Stockhausen's *Zyklus*, though not a canon, is a genuinely invertible score for percussion in which the choice of orientation dictates whether the music tends either toward entropy or toward organization.

Inversion of thematic material is even more common than retrogrades. Inversion is employed in all kinds of music, including in the development sections of Classical and Romantic sonata-form movements. Arnold

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4 In a personal communication, Robin Maconie offers this description of the sound of the reversed note: The reversed sound of course consists of an initial radiance that is room resonance that condenses into a more structured and dynamic body of sound that races back and is guillotined with a sense of physical violence at the speaker.

5 For this discussion, I ignore other factors counting against the musical sense of backwardly directed music; for instance, that rhythms do not always retrograde in a perceptually predictable manner (see Gjerdingen 1993).

6 The term "cancrizan" is also used for retrograde, but more often refers to a canon where the *comes* is the *dux* played backwards.

Schoenberg drew attention to the long use of such techniques in justifying the important role they play in the twelve-tone (also known as dodecaphonic) system of musical composition he developed in the 1920s.

We should be careful how we interpret the ubiquity of such compositional devices, however. Frequently, these are bits of technical craft, self-amusement, or intellectual challenge that are not intended to be audible (see Davies 1994:356-60, forthcoming07). It is not uncommon for composers to labor under self-imposed constraints that then motivate how the work is to proceed, without the operation of these constraints being, or being intended to be, audible in the music that results. Consider Anton Webern's Symphony, Op. 21 of 1928. The twelve-note row has a palindromic structure, with a tritone between the sixth and seventh note. As a result, the retrograde of the row is equivalent to its inversion. The first movement proceeds by inverted canon, with the second half of the movement a retrograde of the first. The second and final movement is a double canon by retrograde motion. The tight integration of the row's structure and of the movements' overall mirror forms may explain the listener's awareness of the work's unity, if that is how she experiences the piece (but for discussion, see Davies 2003d). Few if any listeners, however, can follow the music's unfolding in terms of its overarching canons and mirror structures, as Cook (1987), who describes the work as a "hall of mirrors", demonstrated with his Cambridge music students.[7]

Nevertheless, it is plain that sometimes composers do intend their listeners to follow inversions and retrogrades, and that most listeners can do so where this is the case. If they are to be subject to audible inversion and retrograde treatments, usually comparatively short motives or themes with a fairly distinctive character are used. Of the two practices, most people find inversions easier to recognize than retrogrades, and retrogrades easier than retrograde inversions (Dowling 1972). Probably the most famous examples of more or less audible piece-length inversion are the mirror fugues in J. S. Bach's *Art of Fugue*. No. 12 is a fugue for four voices of 56 measures. Within the fugue, the main theme and its accompaniments are frequently

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[7] Krumhansl, Sandell, & Sergeant. (1987) show that some musically trained listeners can follow the row's transformation in two chamber pieces by Schoenberg. This need not invalidate Cook's findings, however, because Webern's treatment of the material is deliberately less traditionally melodic than Schoenberg's.

inverted. But the miracle is that the entire fugue can be played in inversion. The same applies to the three-voice fugue that follows. Large-scale, academic, twentieth-century studies featuring similar techniques include Paul Hindemith's *Ludus Tonalis* and Dmitri Shostakovitch's *24 Preludes and Fugues*, Op. 87.

So, the visual capacity that allows us to recognize an object in different spatial orientations is sometimes paralleled by the (limited) aural capacity to hear inversions and retrogrades in musical events.

II.

A second dimension of visual recognition is the capacity to recognize individuals despite changes to their appearance. An observer might identify a house as the same though it has undergone a makeover.[8] In the most dramatic case, a person might recognize a friend she has not seen for many years, though he has aged in his appearance in the meantime. Indeed, children as young as three years of age realize that modification to the appearance of a living thing does not indicate a change in its kind (Humphrey 1976, Keil 1994).

The aural equivalent of this phenomenon is of the utmost importance to the way music is created and followed: a theme can retain its identity despite undergoing various changes. Among the most common manipulations are alterations to the instrumentation, accompaniment, tempo, and rhythmic articulation of the theme. The *Ode to Joy* melody undergoes each of these modifications in the last movement of Beethoven's Ninth Symphony. Other regularly used options include elaboration by decoration, alteration of harmonies, and changes in meter.

Now, it might be thought that the melody survives such changes because they do not modify what is crucial to its identity, which is the pattern of the interval sequence that shapes it. But, surprisingly, this too can be amended or interrupted without loss of identity. The sardonic rendition of the *Star Spangled Banner* given by Jimi Henrix at Woodstock would have had no point were listeners unable to identify the anthem as such, which of course

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[8] Assume here it is not re-identified in terms of its location, but only in terms of its appearance. Perhaps the observer is always blindfolded when taken to the house.

they can, despite Hendrix's alterations and interpolations (Davies 2001:57-8).[9] On the face of it, the melody for Richard Rogers' "Climb Every Mountain" has an AABA structure. The last statement of the A part is very different from the first two, however. It begins in the dominant (unlike the first two statements, which begin in the tonic) and the third phrase is modified significantly to ensure a return to the tonic. The re-identification of this closing passage as a version of the first phrases seems foundational to an appreciation of the song's structure. And in fact, many listeners who identify the last A as such probably are unaware that it differs from the earlier ones.[10] Gustav Mahler achieves a similar result in the slow movement of his Symphony No. 1, when he renders the nursery round *Bruder Martin* in a funereal minor, apparently in reference to the childhood death of his brother. In fact, the survival of a melody's identity in shifts from the major to minor is crucial to the structural integrity of sonata-form movements in the minor key. In them, the second subject appears in the relative major in the exposition and in the tonic minor in the recapitulation, which almost inevitably involves alteration to the pattern of intervals. The structure would be turned to nonsense if listeners could not detect the same theme in these tonally contrasting versions. And it is not only in Western music that the identity of a melody can display this kind of intervallic flexibility. Simha Arom (1997) observes that several central African cultures recognize a melody as the same despite changes in interval size from the original.

The generation of structure in music depends no less on melodies that remain recognizable as they are elaborated than on contrast between different melodies. Consider the structural types that make a feature of preserving a theme's identity through processes transforming its surface: theme and variation, chaconne, passacaglia, along with *da capo* and simple binary forms in which the material is decorated when repeated. Almost all kinds of prolonged musical structures involve aurally appreciable thematic alteration or development as well as repetition and contrast.[11] Melodic

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9 Clarke (2005, ch. 2) offers a detailed discussion and transcription of Hendrix's performance.

10 Jonathan McKeown-Green drew my attention to the form of this song.

11 This is not to assume that a melody always can survive modification. The composer might derive one theme from another, perhaps as shown in sketches for a work in which both appear, but stretch the relationship beyond breaking point, so that the melodies are appropriately experienced as distinct. For discussion, see Davies 2001:54-8.

inversion, for example, is rarely strict (or "real"), since this is likely to destroy tonality; inversion usually is "tonal", which is to say that not all the same intervals are preserved when mirrored in the inversion. Similarly, sequential passages—for example, in which a melodic figuration is repeated on the next step of the scale, and so on—are also usually "tonal". In other words, the scale acts as a constraint on how the intervals are preserved (or not), because the major and minor scales themselves are neither evenly stepped nor symmetrical.

Described in the broadest terms, the mechanism of recognition must be like this: some representation of a musical item is stored with links to processing rules, frames, or grammars that are subsequently applied to new sensory inputs to determine if they count as the same, which they may do even if they deviate in some respects from the sensible features of earlier statements. This process of comparing what is stored with current inputs need not be accessible to consciousness. Perhaps we are aware only of its outcome, which is a feeling of recognition or is a disposition to judge what is heard as the same as something encountered previously. Some of the processing rules that come into play will be relevant to all kinds of music (Higgins forthcomingb). These may include organizational principles that apply equally to melodies in British and Chinese musics (Schellenberg 1996). Others will be local to the style or genre (see Dowling & Harwood 1986). Yet others may reveal the distinctive fingerprint of the composer, or be confined even to individual works.

As just implied, the inputs to the process of comparison involve more than the melodies that are heard. They include awareness of contextual features, concerning the work's style and genre, say, that should affect what processing rules are to be applied. The provenance of the music is also relevant. For instance, within a work we might properly judge melody *B* to be a variant of an earlier melody, *A*, whereas if *B* occurred in a quite distinct work, we would acknowledge only a superficial resemblance between *B* and *A*. Or again, knowing that one composer was influenced by or referred to the work of another, we might rightly find melodic variants of the one work in the other where otherwise we would not do so. That is, the persistence of melodic identity through alteration is not determined solely in terms of absolute measures of similarity. What kinds or degrees of featural matching should be given salience in the judgment of melodic sameness, and hence, what processing rules should be applied, requires sensitivity to the character and genesis of the music in question.

We know quite a lot about the processing rules in terms of which we track and make sense of music's progress. We perceive the unfolding of music through a framework of expectations (for continuation, closure, direction of movement, and so on) that comprise a generative grammar (Lerdahl & Jackendoff 1983) or rules for Gestalt processing (L. B. Meyer 1956, Narmour 1990, 1992, Schellenberg 1997), or general principles of auditory organization (Bregman 1990), as well as through stylistic and other invariant features (Dowling & Harwood 1986).

There is less certainty, however, about the mode of mental representation of musical items such as melodies, and how we get from such representations to judgments of similarity or identity when melodies display different pitch sequences. The absolute pitch of a tone is apparently held in a specialized memory store, and interference takes place between pitches inside this store (Deutsch 1999). In that case, perhaps we cannot remember closely enough what has gone before to make melodic identifications more precise. And something similar may apply when we recall not absolute pitches but sequences of intervals. If, as speculated earlier, many listeners are not aware of any differences when they identify the last phrase of the melody of "Climb Every Mountain" as the same as the first two, it appears that they cannot accurately recall the interval sequence heard earlier. Still, the recollection of interval sequences of musical listeners often seems to be robust—they hear differences between the opening phrases and the final phrase of "Climb Every Mountain", though they rightly identify these as different versions of the same phrase—so memory failure is an unlikely basis for all our judgments of melodic sameness.

Perhaps what is stored is a mental representation of some melodic abstraction that is more vague, inexplicit, and gappy than any of its instances. It records some common core in terms of which different instances are recognized as the same. In this vein, J. B. Davies (1979) argues that listeners abstract from interval sequences to a more general configuration, and this explains, he says, how they can recognize melodies in which the interval sequence is not accurately preserved, and Bigand (1990) demonstrates that listeners successfully group melodies by abstracting to underlying melodic structures.

If this theory is plausible, the abstract Ur-melody must be less explicitly articulated than any of the various, concrete soundings co-identified as instancing it, yet it must be distinctive enough in its invariant features to reflect the huge diversity of non-identical melodies that we acknowledge. While any individual theme—"Happy Birthday", say, or the melody of Bach's *Musical Offering*—can be presented and recognized in many guises, still there is a vast number of non-identical, individual themes, and if these are represented mentally in terms of Ur-melodies, there would have to be as many of these as there are distinguishable (families of) themes.[12]

For vision, an equivalent theory would hold that the visual recognition of objects involves detecting their invariant features (see Gibson 1968). And if we were to describe a linguistic analogue for this account, it might go like this: If the sentences *"Queen Victoria ate the sandwich." "The sandwich was eaten by Queen Victoria." "The eating was by Queen Victoria of the sandwich."* are all recognized as sentential variants of each other, what is stored is some more abstract, generic representation of the appropriate content.[13]

An alternative to the theory just discussed describes the mental representation that is stored as being of a detailed melody. Depending on one's view, what is stored could be the representation of an actually heard instance, with the melody's first unequivocal statement the most likely candidate, or what is stored could be the representation of a prototype that is derived from the instance or instances that are encountered. This prototype is no less detailed than its heard instances.[14] Also, the prototype might differ

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[12] Narmour (1992) identifies sixteen melodic archetypes that can combine to form some 200 complex structures that, in turn, can chain together in a theoretically infinite number of ways. Just as the archetypes are higher-level abstractions than the 200 complex structures, the 200 complex structures must be higher-level abstractions than the Ur-melodies I am describing.

[13] The content in this case is syntactic, not semantic—the point is one about sentential equivalence, not synonymy in meaning—as is also the case for music. I note, however, that psychologists frequently but inappropriately refer to the basis of melodic identity as the melody's "semantic" content.

[14] Indeed, it could be more detailed if the prototype is stored in tempo and pitch space as a rich and complex structure, so that when we identify an instance of the melody, we find that it is equivalent to a slice of the prototype through tempo and pitch space. Such a prototype is far more detailed than any of the slices that intersect with it.

from all the instances that are presented.[15] In either case, the judgment that a new tune is a variant of a previously heard melody involves, rather than abstraction to what they share in common, the application of rules for detecting equivalence that compare the sensory input with the stored melody (or melodic prototype). These rules spell out the kinds and degrees of transformation that are consistent with identity preservation. In this vein, Zbikowski (2002), who applies prototype-based theories of recognition to music, suggests that we recognize the sameness of the varied statements of, for example, a Wagnerian leitmotiv because we conceive them under a single "cognitive category" that spells out the patterns and weightings of the relationships that unite them.

For vision, an equivalent theory would hold that the experience of appearance identity depends on the closeness of the relation between what is seen and its mentally represented prototype (Rosch 1975, Barsalou 1992). And if we were to describe a linguistic analogue for this account, it might go like this: If the sentences *" Queen Victoria ate the sandwich." "The sandwich was eaten by Queen Victoria." "The eating was by Queen Victoria of the sandwich."* are all recognized as sentential variants of each other, what is stored is a representation with a prototypical status. Depending on the account of the relevant prototypes, the prototype might be among the sentences listed or not, and if not, it might be more complexly structured than any actual instance.

Which of these two models is correct for the case of melodic recognition?[16] Notice that neither leaves room for consideration of contextual factors that I

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[15] The need to consider this possibility is suggested by an experiment in which listeners were presented with a number of variants based on an unsounded "prototype" theme. When later asked to identify from a series of themes they had not heard previously their degree of relatedness to the set they had heard, listeners picked the prototype theme as the most closely related (Welker 1984). A similar result for facial recognition was earlier demonstrated in Solso & McCarthy (1981). Their subjects mistakenly identified the prototype face as having been seen previously and were more confident of this than they were for any other faces. Also see Franks & Bransford 1971.

[16] One reason why an answer would be interesting is that these theories have different implications concerning both the mode of mental representation for musical items and the kinds of processing to which

earlier mentioned as relevant, such as whether the comparison of melodies is within or between works, and for the latter case, whether there is reason to take resemblances merely as coincidental or as deliberately contrived. In empirical studies, it is common to factor out the influence of situational and historically conditioned features, either by presenting melodic fragments acontextually or by assuming contextual factors are invariant. By shelving consideration of such issues, neither theory can be entirely adequate.

There is empirical data favoring the first theory, according to which listeners abstract from the shape of melodic details to broad contours. For instance, Dowling (1972) found no evidence that his experimental subjects distinguished between melodic transformations that preserve the exact interval relationships and those that preserve only the relevant melodic contour. Dowling & Harwood (1996) regard melodic perception and memory as relying on schemata and invariants. And Maconie describes a thematic catalog invented by Denys Parsons based on contour alone: 'Remarkably, he found that it is possible to identify the start or *incipit* of a famous tune or theme (the part people remember best) by the changes of direction encoded in a relatively short sequence, with an asterisk for the first note. For example, Burt Bacharach's song "Raindrops Keep Falling on my Head" is expressed as the sequence: *RRUDD DUDUR RUDD' (2002:84). Likewise, Schmuckler (1999) established that listeners rely on global shape information when identifying melodic shapes as similar.

Equally, though, when the full gamut of melodic features, not just contour but also phrasal, scalar and tonal context, coupled with stress, duration, rhythm, timbre, and meter, are taken into account, recognition becomes faster and more accurate (Huron 2001). Bregman acknowledges the relevance of all such factors, not contour alone, when he suggests: 'We may mentally encode any sequence by the nature of the transformations that take place in it. When a succession of tones are all of the same type (for example, periodic sounds with similar timbres), we may encode it not by a categorization of the individual sounds but by an encoding of the changes or movements that take us from one sound to the next' (1990:467). And,

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such representations are subject. For discussion of some relevant factors, see Schulkind, Posner, & Rubin 2003, and for reviews of brain imagining studies of musical memory and familiarity, see Platel, Eustache, & Baron 2004, along with Platel et. al. 1997, Peretz & Zatorre 2005.

Lamont & Dibben (2001) found that similarities recognized between different parts of a musical work are based on dynamics, articulation, and texture, as well as contour. The fact that the addition of detail speeds recognition and makes it more accurate should favor the second theory over the first, because one would expect the addition of potentially relevant detail to slow and distract reductive or abstractive modes of processing.

Perhaps the question about which theory is correct should be put aside, however, because they need not be exclusive. Modes of representation and processing that match both theories could take place. Stephen McAdams and Daniel Matzkin (2001) identify three kinds of similarity perceived between musical ideas—in the statistical distribution of surface values and their derivatives, in specific patterns of attributes, and in structural invariants. The first and third of these suggest that abstraction is involved whereas the second comes closer to the idea that what is represented is a detailed instance or prototype. And other studies emphasize the relevance for melodic recognition both of global melodic contour and of specific details of accent, phrase location, and so on (for example, see Schulkind, Posner & Rubin 2003).

In any case, the visual capacity to recognize persisting identities through changes in visual appearance is matched by an aural equivalent in the musical case. Indeed, the very existence of all but the shortest musical pieces seems to be predicated on this ability.

III.

In this third section I consider the comparison between timbre and color. I argue against the view that timbre is solely a property of sounds and in favor of an alternative that regards timbres as properties of musical sound-makers; in particular, musical instruments and the voice. Finally, using timbre as the example, I discuss how we conceive of music in terms of action: the actions of the performer, who bodies forth sound from the instrument, and of the listener, as she is entrained by the music, and even of the music, as we experience its internal, purely musical, progress as analogous to human action or narrative construction.

Timbre is that property of sound that makes the difference between the phenomenological character of the auditory experience of two different instruments, a trumpet and violin say, when they are sustaining a note of the same pitch at the same volume (amplitude). When a note of fixed pitch is sounded, as well as the fundamental (the pitch that is heard), a series of overtones sounds. These derive from the natural harmonic series, though additional overtone "noise" can also occur. The pitch distribution of the overtones of the natural harmonic series are fixed relative to the pitch of the fundamental, but the comparative strengths of the individual overtones are variable. It is differences in which of the overtones are included and in their relative strengths that are experienced by the listener as the sound's timbre. For example, non-vibrato unforced tones in the flute's midrange lack practically all but the first overtone (which sounds at the octave). But as with all musical instruments, the relative weight of the flute's overtones varies characteristically with the pitch of the fundamental, the note's volume, and other factors.[17] Only the even-numbered overtones are prominent in the clarinet in its lowest few notes, but other registers of the instrument display a different acoustic profile, yet one that is equally characteristic of the clarinet. All the overtones, with the third, fourth, and fifth prominent, give low notes on the oboe their pungent tone. And the violin is unusual in that the fundamental is very weak in relation to the strongest overtones. In general, the stronger the first overtone relative to others, the more warm, soft, and mellow is the timbre. While, if mid overtones are strong, the timbre is correspondingly bright, hard, and strident.

Fundamentals without overtones do not occur normally, though tuning forks and the stopped diapason of the organ come very close. Such fundamentals can be produced electronically by a sound-generator, however. The waveform for such a tone is represented on an oscilloscope as a pure sine wave, whereas that of a tone mixed with overtones has a more complex and irregular structure. One might make the case for describing the "pure" tone as without a timbre. I prefer to describe it as having its own timbre, however, because it has a distinctive phenomenal character. The debate, should one pursue it, might be reminiscent of that concerning whether black is to be classed as a color.

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[17] For a detailed, technical discussion of these and other considerations with respect to timbre, see Cogan & Escot 1976:326-401, J. Meyer 1978, Hansen 1995, Risset & Wessel 1999, and for a more general introduction, see Dowling & Harwood 1986, ch. 3.

In any case, one of the most common synesthetic designations for timbre is that of color. Works have an instrumental color according to their orchestration.[18]

The timbre of a tone can be affected by the medium of transmission—water as against air, for instance—and by the environment—curtains absorb relatively more of higher than lower frequency harmonics. (Also relevant are the relative distance and direction of the sound source and, if it is in motion, the pace and direction of this.) In the case of musical instruments, timbre can be controlled to some extent by the player. For example, there are subtle differences in timbre for string instruments between bowing over the fingerboard or close to the bridge, and playing open as opposed to stopped strings. (Mostly these timbres are avoided in favor of a warm, full tone, unless the composer specifically requests them.) As well, there are not so subtle differences, such as those between stopped notes and harmonics (where the string is touched at a node without being depressed to the fingerboard), between bowed and plucked notes, or between the standard and muted modes. (A stringed instrument is muted by having a clamp placed on its bridge.) Of course, singers can modulate the timbre of their voices by controlling the body as resonator; for example, by "moving" the sound forward or backward in the throat. Indeed, opera singers make their voices stand out over the orchestral texture by producing what is called the "singing formant", which they achieve by enlarging the pharynx cavity and lowering the glottis to alter the vocal spectrum so as to emphasize overtones in the range 2,500-3,500 Hertz (Sundberg 1977, Bregman 1990:491). As well,

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[18] Some individuals have synesthetic color experiences of sounds, a phenomenon sometimes called psycho-chromasthesia. In other words, they associate certain sounds with certain colors as a result of experiencing the sound as colored. (The composer, Alexander Scriabin, is widely but probably erroneously identified as a color-sound synesthete.) The sounds in question may be phonemes or musical keys, as well as the timbres of instruments. For neurophysiological accounts of synthesia, see Critchley 1977, Cytowic 1989, 1993, Marks et. al. 1987. Cytowic (1993:161) suggests that synthesia activates the limbic region of the brain, especially the hippocampus, which is the point at which both external and internal sensory inputs converge before being transferred to the cortex. The limbic system is crucial in settling attention, in forming novel reactions, in making value judgments, and in experiencing emotion. For detailed discussion of synthesia with respect to music, see Merriam 1964, ch. 5 and Higgins forthcominga, ch. 5.

there are differences between individual instruments of the same type: not only between an unmodified 18th century cello and its modern counterpart, say, but also between different modern cellos. Finally, the timbre of a clarinet, for instance, can be mimicked by a sound synthesizer (or by a modern speaker through which a recording of a clarinet is played or, more or less, by the clarinet stop of an organ).

Despite the observations just listed—namely, an instrument's timbre can vary according to how it is used, different instruments of the same kind can display discernibly different timbres, and an instrument's timbre can be mimicked electronically or in other ways—we seem to regard timbres as properties of musical instrument types and of voices, not merely as properties of sounds taken apart from the kinds of resonators from which they originate.[19] (And when the timbres of musical instruments are "artificially" generated, they can be considered either as representations of the instrument and its timbre or as the product of a virtual version of the appropriate instrument.) Of course, I allow that the notion of a musical instrument here must be taken broadly; for instance to include, as well as the sirens of police cars, the New Guinea tribe that use their mouths as resonators for the tone of the drone beetle they insert there (Fisher 1994). And I include among the voiced creatures non-human animals, such as birds and whales, that often produce clearly pitched tones and glissandi, and have voices with distinctive timbres.

There are several reasons for attributing the timbre not solely to the notes sounded but also to their musical source. My specification that the instruments are *musical* is intended to eliminate other distinctive sound-makers, such as jackhammers and planes, which are not designed to produce and control sounds, and do not make pitched sounds or, if they do, are not characterized in terms of or selected for the timbral qualities their sounds generate. Talk of timbres has its primary application when the phenomenal character of pitched sounds either is a source of intrinsic interest or contributes importantly to the sounds' performing their functional role. And my specification that timbres are to be attributed to the *instruments* or *voices*

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19 For detailed discussion of how we identify a musical instrument despite timbral variety in the sounds it emits, see Hansen 1995:458, where it is suggested that timbral recognition is similar to facial recognition in that the identity of the sound, like that of the face, emerges from the interaction of many lower-order, dynamic features.

from which they issue is intended to acknowledge the long historical association between timbres and the activation of particular types of sound sources. Until very recently, the only way of hearing notes with the unique sound quality of a nightingale, including the unique timbral distinctions by pitch bands across the range of its song, was by listening to a nightingale. And we are not indifferent to the fact that singing issues from an opening in a person's head.

Where the instruments in question are the human singing voice or other humanly made musical instruments, the connection becomes normative, not merely associative (Davies 2001:64-5). In other words, the connection is not simply ingrained; rather, we conceive of the sound in terms of its source and vice versa. It is not that the cor anglais just happens to make a sound with a certain timbre, but instead that that sound is the sound of a cor anglais, is what it should and is intended to produce, is integral, for instance, to the kind of expressiveness of which the cor anglais is capable. Instruments of these kinds are intended to display the timbral qualities associated with their types, and employing them to do so is part of the regulative ideal that informs their use.

Even if timbres are conceived in terms of the singing voice and of kinds of musical instruments in the manner that was just suggested, what is their connection to music and its works? If we return to the comparison with color and then consider the role of color in pictorial depiction, we might develop an analogy with paintings according to which, while timbre might be a work-constitutive property in some musical works, in many it is not. For the latter cases, the work's instrumentation is incidental to its identity. Later I will challenge these conclusions, but let us first see how the argument works.

Traditionally, colors have been regarded as accidents that do not contribute to the identity of the items that bear them. If I paint my house yellow where before it was blue, it remains the same house, though now differently colored. This view might be extended even to pictorial representations. Supposing what is essential to the identities of pictorial representations is their depictive content, or more generally their formal structure, if these would remain discernible were the picture's paints transformed from color to black, white, and shades of gray, then the work's colors cannot be regarded as relevant to its identity.[20]

We might challenge the initial assumption, that only content and form are relevant to a painting's identity. It is arguable that other factors, such as the work's art-historical provenance and genre, are no less important. Among these other factors is the work's medium, and where pigmented paint is used, color is an element in that.

And even if the initial assumption is tolerated, there is reason to hesitate before accepting the conditional. There are a number of paintings in which color *does* play a structural role or does otherwise affect the depicted content. Many impressionist and pointillist works fall in the former category. The depictive character and formal structures of Claude Monet's water lilies and Georges Seurat's *La Grande Jatte* would suffer from the works' decolorization. Secondly, colors play an important iconographic role, especially in religious paintings where they are associated with particular people or characteristics. Blue for example was reserved for the gown of the Virgin, because apart from any symbolism it was also very expensive to make out of lapis lazuli.

Though these first two points perhaps apply only to a minority of paintings, two further considerations suggest color is far from irrelevant to a painting's depictive or formal character. Color often is vitally involved in organizing the represented space. For instance, artists have long known that distant items are not only smaller and less distinct than near replicas, they are also bluer; the shorter wavelengths at the blue end of the spectrum penetrate the atmosphere to greater distances than the longer red wavelength. Colors interact (according to their area, contrast, complementarity, saturation, hue, and brightness) to produce spatial and other effects, such as mixing or scintillation. For example, reds and oranges advance whereas violets and blues recede; areas of high and low brightness are respectively brighter and darker when juxtaposed; larger areas appear brighter and more saturated than otherwise identical smaller patches, and so on. Finally, where they produce realistic appearances, colors contribute to a painting's

[20] Note that those who reverse the process described here by colorizing movies made originally in black-and-white do not take themselves to be creating new and different movies, though philosophers have sometimes debated the practice in such terms.

representational verisimilitude. And where they depart from realistic appearances, as in works by Vincent Van Gogh or André Derain, colors often make an expressive contribution to the work. One would expect the degree of its verisimilitude and its expressive qualities to count among a depiction's identifying features.

Despite its apparent implausibility for the case of paintings, the equivalent view, that musical works are "pure" sound structures—patterns of pitches or intervals—and that the color of their instrumentation is redundant to their identities, is widely held by philosophers. Webster (1974) maintains, for instance, that Bach's Violin Concerto in E Major would be legitimately instanced if played on the sousaphone (and in another key, so long as the note relationships were preserved). Kivy writes: 'Performing a Bach fugue with a choir of kazoos … cannot, of itself, make the performance a performance of something else' (1988:55). Scruton comments: 'There is nothing in the concept of a pitch pattern that determines the timbre that will most perspicuously realize it. Hence performances of the *Well-Tempered Clavier* on a piano, on a harpsichord, by a quartet of brass or woodwind, or by the Swingle Singers are all performances of the *Well-Tempered Clavier*' (1997:442). And he argues that our experience of sounds as music is acousmatic, by which he means that we attend to them purely as sounds, without regard to their origins (1997:2-3,19-20).

Formalist ontologies in aesthetics reach back to Plato via Kant, so there is a long pedigree for views such as those just cited. And some philosophers may have been influenced by more recent metaphysical speculations, such as Strawson's arguments for the possibility of a purely auditory world (1959, ch. 2). As well, proponents of formalist accounts of the nature of musical works can point to the fact that some works have no specified instrumentation—Bach's *Art of Fugue* is usually cited here—and others are indicated as for any instruments—such as, John Cage's *4'33"*, a piece in which the participating instruments are not actually played, as well as some works by Percy Grainger, such as *Irish Tune from County Derry* and *Spoon River*, in which they are. Formalists can also note that it is common for works to be transcribed for other instruments, such as the piano or lute, or to exist in different orchestral arrangements or versions, all apparently without loss of identity. In the past, a relaxed attitude to the use of specified instruments prevailed—contemporary, "improved" instruments were used in nineteenth-century revivals of Bach, for instance—and in yet earlier periods much music was played by the instruments that happened to be available.

This laissez-faire approach continues now, though it has been challenged by the movement for "authentic" or "historically informed" performance.

Earlier I listed some replies to the view that colors are irrelevant to the form and identifying contents of paintings. Do similar responses apply to the view that a musical work's timbre and instrumentation are not relevant to its identity, this being established exclusively by its note structure? There are some pieces by Webern and Edgard Varèse that use instrumental color as the primary structural feature, and Schoenberg's use of *Klangfarbenmelodie* created structural links between timbre and harmony (Cramer 2002). In others, there are symbolic associations between musical instruments and narrative or programmatic elements that are offered as central to the work's identity. Brass and snare drums have a military flavor, horns are associated with the hunt and the oboe or cor anglais with bucolic ease.

These points have a restricted application, however, and it is not easy to develop analogues for the stronger arguments for the centrality of color in painting. Orchestration can be used to help the delineation of form, for example, or to highlight a line buried within a complex texture, but opponents of the idea that a work's instrumentation is essential to its identity deny that this contribution is significant. The work's note structure survives pretty much intact when the work is (competently) transcribed for different instruments or is programmed into a synthesizer. Meanwhile, the instrumentation of musical works has little to do with their verisimilitude. Most do not aim at representation and where they do, sonic realism is not valued over musicality, as is apparent from the fact that much that is purportedly represented—clouds, the great gate of Kiev, the shimmer of a silver rose—is not sonic or dynamic in character.[21] It is plausible to suggest that a work's instrumentation can contribute to its expressive character—the nobility of the French horn, the searing passion of soaring violins in close harmony (Levinson 1990a)—but again, the formalist can counter. He might suggest that expressiveness is not a work-identifying property. Alternatively, he can maintain that the music's expressiveness depends mainly on its note

[21] Music may be able to represent the sources of distinctive non-musical dynamic processes, such as steam trains (Arthur Honegger's *Pacific 231*) or storms at sea (Felix Mendelssohn's *Fingal's Cave*). And it can also represent music, as do onstage bands in opera. For discussion, see Davies 1994, ch. 2.

structure. The French horn does not sound noble unless its melody does, and it is the high pitch and close harmonies that convey passion.

The ontological formalist usually argues as follows: if the work is recognizable in a performance that lacks some musical feature or parameter—in this case the orchestral color specified by the composer—then that musical feature or parameter cannot be an essential feature of the work. Only the work's intervallic structure, rhythm, and general tempo are likely to survive this test, so the formalist reduces the work to the sound structure comprising these elements.[22] This argument form is inadequate, however. Musical works should be viewed as *norm* kinds or types (Wolterstorff 1975); that is, as allowing for malformed, deficient, or incomplete instances. A performance with wrong notes can be recognizably of the work, but this does not show that the wrong notes are part of the work or that the ones that should have been played instead are not. The question should not be whether the work is recognizable in a performance that alters its instrumentation, but whether such a performance is thereby less than fully faithful to the work.

It seems to me that this last question is best addressed by engaging in a metaphysics that is informed by relevant data from social and musical history, as abstract metaphysics in the formalist mode is not. In the past, when orchestras and instruments were not standardized and works were adapted for local circumstances, the conventions of performance did not treat composers' indications or intentions as regards the means of performance as work-constitutive. Later, beginning in the eighteenth century, the situation changed with the publication of scores, the regularization of the orchestra, and a move toward professional, public performance. By the nineteenth century, the practice of Western classical music's performance suggests that the work's instrumentation, and hence its color, is mandated by its composer. As for transcriptions, either these are separate works or works come in versions, with versions being instrument-specific.[23]

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[22] Goodman (1968) famously deletes tempo from this list. And in fact, many works cannot be specified as note or intervallic patterns, see Davies 2001:47-54.

[23] In Davies 2003a I argue that transcriptions should be regarded as distinct works, despite being closely related to their models. In Davies 2006b, I explain how works can come in versions (and note that this allows for an alternative account of transcriptions).

Still, even if the formalist concedes that timbre is sometimes a vital element in the work's sound structure, he could still go on to deny the connection I made earlier between timbre and the instrument from which it issues. He could hold instead that a performance would accurately instance a work if it preserved the specified timbres as a result of generating them on a synthesizer, without using the instruments indicated by the composer. I have called this position "timbral sonicism" (Davies 2001:64).

The claim that the timbre is a property solely of a sound, rather than a played instrument, is as weird as saying that a color is solely a property of light, rather than of the object from which the light is reflected. If our senses evolved to provide us with information relevant to our survival and accommodation to our environment, as seems likely, it is predictable they tell us of the nature of distant causes just as and through providing awareness of proximal effects. As James Gibson, who was an advocate of this "ecological" account of perception, noted: 'The sound of *rubbing, rolling,* and *brushing*, for example, are distinctive acoustically and are distinguished phenomenally … The sounds made by various tools are specific to the mechanical action of the tool, as in sawing, pounding, filing, and chopping' (1968: 87, 89).

Relevant also for the musical case is the fact that composers write for instruments, not just for sounds. Virtuosic works, for example, must be appreciated as difficult to play if they are to be properly understood (Mark 1980). As Stan Godlovitch (1998:66-71) explains, musical instruments are tools of a trade with guilds that set standards for the mastery of the instrument. Though instruments can change and evolve, as is apparent in the move from acoustic to electric guitars, crucial skill elements must be retained if the practice is to remain musically kosher. Synthesizers, by contrast, are replacement, not development, technologies, when they are used to ape acoustic instruments. Moreover, despite the difficulties presented to the programmer who works at the keyboard of a computer (not a piano) in making a synthesizer give forth a commanding performance of a piano concerto, they cannot be such as to merit victory to the synthesizer in a piano concerto competition.[24] The importance attached to the process of eliciting

[24] Of course, we are interested in piano rolls and early recordings of the playing of Sergei Rachmaninov and George Gershwin, but this is because it is no longer possible to see these composers play in the flesh.

sounds from instruments is reflected in the high number of instrument-specific notational symbols, many of which indicate something about how the instrument is to be used or handled (Davies 2001:62-3).[25]

The person who regards musical instruments as a dispensable means to making the right-sounding noises misunderstands how deeply ingrained is the thought of music as the auditory bodying forth of human action. How musical instruments are used cannot be divorced from the way we conceive of the sounds that issue from them. We are likely to feel uneasy on learning that a singing voice emerged not from a person's throat but from a manually programmed synthesizer. This is not because the timbre is wrong—I am supposing that it is good enough to fool us the first time we listen—but because it is now known to be divorced from the kinds of actions that would normally go into its production. The same goes for other musical instruments. If I may quote myself: 'The first, and in that sense primary, instrument is the voice. It is part of the musician who uses it. And other, "external" instruments are held against the body, tucked into its crevices, or firmly grasped. They are placed in the mouth, or against the lips, or they are caressed by the hands. Even percussion instruments, including the piano, can be struck in a variety of ways and have a "touch". Moreover, the relationship between the instrument and the musician's body is reinforced by the years of practice that bring the two into seemingly ceaseless contact. The long history of this physical intimacy is apparent to anyone who watches a master musician at work. For the accomplished player, the instrument is experienced as an extension of the body, as continuous with it. Just as a walking stick projects its user's boundary, because the ground is felt at its tip, so the musical instrument extends the boundaries of the person who plays it. And this expansion is emotional and personal, as well as physical, to the extent that the instrument provides the player with new means for expressing her ideas, personality, and passions. This nexus of corporeal embodiment, action, and expression is melded indissolubly with the music that is sounded, which in its turn implicates the human body and organic processes through the ebb and flow of its pulse and rhythm, of its gestures and sighs, of its tensions and resolutions' (Davies 2003b:114).[26]

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[25] For replies to many of these points and a spirited defense of timbral sonicism, see Dodd 2006.

[26] Levinson (1990b, 2002) defends a position like mine, though I do not share his view that the action that goes into playing music is always apparent in the music made (see Davies 2001:66-8) or his theory that we

Empirical data supports these claims. For a start, we generally process sounds in terms of their sources and this carries over to the musical case. 'Transformation in loudness, timbre, and other acoustic properties may allow the listener to conclude that the maker of a sound is drawing nearer, becoming weaker or more aggressive, or changing in other ways. However, in order to justify such conclusions, it must be known that the sounds that bear these acoustic relations to one another are derived from the same source … This strategy of allowing discrete elements to be the bearers of form or "transformation" only if they are in the same stream is the foundation of our experience of sequential form in music as much as in real life' (Bregman 1990:469). Eric Clarke observes: 'Since sounds in the everyday world specify (among other things) the motional characteristics of their sources, it is inevitable that musical sounds will also specify movements and gestures—both the real movements and gestures involved in actually producing music … and also the fictional movements and gestures of the virtual environment which they conjure up' (2005:74).

More specifically, composer-musicians think in terms of the instruments they play when they create music. The spatial layouts of instruments as diverse as Afghanistan's dutâr, the African thumb piano, and the blues guitar condition the music created by performer-composers, suggesting that musical cognition may involve thinking in terms of movement, not only of sound.[27] Pascal Bujold (2005) explains that his learning to play music from Argentina, Morocco, and West Africa depended on his imitating the "dancing" movements with which native musicians engaged their instruments. Not surprisingly, when musicians merely *imagine* playing, the relevant motor regions of the brain are stimulated (Zattore & Halpern 2005).

The connection between music and movement is no less significant for the listener. The sight of musicians playing contributes to the audience's recognition and experience of music's expressive qualities (Davidson 1993, Vines et. al. 2005). Bregman (1990:483-4) cites unpublished work by Claude Cadoz suggesting that when we listen to a sound, we build a mental representation not in terms of the qualities of the sounds we are sensing but

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conceive of gestures heard in music as those of an imaginary persona (see Levinson 2006, Davies 2006a).

[27] See Blacking 1961, Baily 1977, 1985, Iyer 1998, 2002, Nelson 2002, Cross forthcoming.

in terms of the physical properties of the source. As a result, we experience changes in the sound as changes in the physical cause of the sound. In other words, if a percussionist strikes his instrument with decreasing force, for example, we register not the subtle, complex acoustic changes that occur so much as a change in the force with which the instrument is struck.[28] As well, music stirs its audience. Many cultures do not have separate words for music and dance, and the idea of a passive audience not actively engaged with the music is unfamiliar to most cultures (Arom 1991, Cross forthcoming). Music has the power to entrain even passive listeners—that is, to synchronize their breathing, pulse, and movements such as foot-tapping—which is why it is used to accompany work and to induce group solidarity.[29] Meanwhile, neurological scans show that, even in passive listening, music stimulates the parts of the brain that are involved in motor activation and vocal sound production (Janata & Grafton 2003, Koelsch et. al. 2006). The broad, operational account of music offered by Cross— as embodying, entraining, and transposably intentionalising time in sound and action (Cross & Morley forthcoming, Cross forthcoming)—nicely expresses the interpenetration of music by human movement and action. So, timbre or color is to be regarded as a property of instruments or the voice and, along with all aspects of the instrument's sound, is conceived in terms of action and gesture, specifically those involved in getting the sound from the instrument and those elicited from the listener, but also perhaps in terms of qualities of expressive movement inherent to the music itself.[30]

Of course, today's technology makes it possible for us to hear recordings of musical instruments with which we are not at all familiar. Occasionally, it is difficult to be sure how the instrument is structured and how it is used. Moreover, where the music is electronically synthesized, as in much pop of the 1980s, few of us have the slightest idea how the timbral result is achieved. In these cases, we might experience the sound as "pure" or disembodied. And perhaps (though I doubt it) the fact that most people access much of the music they listen to via CDs or MP3 files leads to their

[28] For further discussion, see Clarke 1985, Handel 1989, Shove & Repp 1995.

[29] See McNeil 1995, London 2004, Higgins forthcominga, forthcomingb, Cross & Morley forthcoming, Cross forthcoming.

[30] In Davies 1994, ch. 7 and 2003c, I discuss respects in which the experience of music's movement and progress is like the experience of human action.

frequently experiencing music this way. But if so, this is an artifact of contemporary culture. Through our long pre-history—the earliest musical instrument is dated to 36,000 BP (Cross & Morley forthcoming)—and up to the end of the nineteenth century, music was made live by people near the listener, and it was standardly possible to see the instruments they used and how these were employed.

A formalist might reject the arguments offered above and cleave to the idea that the metaphysics of sound is independent of the ways people experience it and conceive of what they experience, but that commits him to arguing for an error theory. Where the focus falls on music, I find it hard to believe that an error theory and serious conceptual revisionism is likely to be plausible, though Goodman (1968) thought otherwise. In any case, that turn to the debate would lead to exchanges of a kind quite different from the ones I have presented.[31]

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