

The Effects of Expert Musical Training on the Perception of Emotions in Bach's Sonata for Unaccompanied Violin No. 1 in G Minor (BWV 1001)

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Abstract

The focus of this paper is the relationship between musical emotion, as expressed by the composer and perceived by the listener, and the structural features of a work of art-music. First, we analysed a work by J. S. Bach for solo violin (Sonata for Unaccompanied Violin, No.1 in G Minor, BWV 1001), from the standpoint of how its structural features were associated with the expression of different emotional categories from the perspective of the composer and through the eyes and ears of the music analyst. We then constructed two empirical experiments to test whether contemporary listeners could identify the same emotions identified by the analysis, targeted at two groups of subjects: relatively inexperienced popular music students; and musicians, composers and music academics (including some of the world's leading Bach scholars). Our results suggest that: emotional attributions by low-level experts are led by surface acoustic features; those by high-expert listeners are led by both acoustic and formal features; that this applied much more to the emotions of Sadness and Tenderness rather than to Anger or Fear; and that despite the common confusion between Anger and Fear in real life, listeners were capable of differentiating these emotions in the music supporting analytical findings in the score.

Keywords: music, emotion, feelings, training, analysis, acoustics

Introduction

The subject of music and emotion has been relatively neglected in current musicology and music theory, compared to the huge attention granted music's formal and topical aspects (Spitzer 2010). Leonard Meyer is the best known theorist to have studied musical emotion (Meyer, 1956; Spitzer, 2009). Nevertheless, his writings focused on undifferentiated core affect, as expressed by the tension and resolution of melodic processes, rather than on plural, discrete emotional categories. By contrast, such a plural approach to musical emotion is standard in the annals of music perception and the psychology of music. Conversely, psychological studies of music and emotion rarely adopt an historical perspective; or engage with complete works of art-music in analytical detail. Hence, in both respects, the present article comprises a fresh departure.

A conceptual starting-point for this study is the gap between emotions communicated (or intended to be expressed) by the composer, and the emotions perceived by the listener. Whereas, in the music psychology literature, many studies have focused on listeners' perception of emotion (e.g. Coutinho & Dibben, 2012, Fritz, Jentschke, Gosselin, Friederici & Koelsch, 2009), on induction of emotion (e.g. Bigand & Poulin-Charronnat, 2006; Coutinho & Cangelosi, 2011), and some on the interrelationship between the two (e.g. Evans & Schubert, 2008; Gabrielsson, 2002; Kallinen & Ravaja, 2006), much less has been written about the communicative level, partly because of the 'intentional fallacy' – the misconception that an artwork necessarily expresses the feelings or intentions of the artist (Wimsatt & Beardsley, 1946). (The classic refutation of the intentional fallacy in music is the ostensibly happy symphonies, Nos. 39 and 41, that Mozart composed in the summer of 1788, which was one of the most difficult and 'unhappy' periods of his career [Abert, 2007, p. 1115]). A relevant comparison is Juslin's Brunswikian lens model of communication, by which a performer 'encodes' and a listener 'decodes' emotions by means of a set of acoustic cues' (Juslin & Timmers, 2010, pp. 471-73), although this model is orientated towards the performer rather than the composer.

By 'emotional communication in music' we mean the composer's choices of musical materials that he or she knows have a particular affective character,

just as a painter selects colors or a sculptor a type of marble. Philosopher Peter Kivy's felicitous term, 'expressive of', is pertinent here: the music may be semiotically 'expressive of' an emotion, just as the apparently sad face of a St Bernard dog may be expressive of sadness (the dog is not necessarily sad itself), rather than transitively expressing the composer's personal emotion (Kivy, 1989). The composer manipulates the signs of sadness: slow tempo and drooping melodies are just as semiotic as the sad face pulled by a trained actor. A pertinent comparison, in the history of art, is Charles le Brun's late-seventeenth century treatise, *Caractères des Passions*, essentially a set of templates for budding artists to represent the basic emotions, or passions (Le Brun, 2010). Each plate portrays a face contorted by the expression of a different passion: Sorrow, Love, Sadness, Anger, and many others. Exactly analogous pedagogical exercises feature in baroque compositional treatises, such as Fridrich Erhard Niedt's *Musicalische Handleitung* of 1710; and Johann David Heinichen's *Der General-Bass in der Composition* of 1728 (Niedt, 1710; Heinichen, 1728; Lester, 1992). The student is presented with a melody or harmonic skeleton, and asked to clothe it in figurations appropriate to express texts of differing affect. The step, then, from a le Brun plate to a Rembrandt portrait, or from a Heinichen exercise to a Bach aria, is fairly direct.

This is where expert analytical knowledge can play a part: the analyst knows, through immersive study of historical musical style, the emotional character of compositional materials for contemporary listeners – a character which was often highly conventionalised. Lacking any access to the composer's private intentions – indeed, philosophically doubting that these intentions, were they knowable, are hermeneutically even relevant – analytical evidence will have to do. This evidence includes text setting, as when operatic or vocal liturgical music is accompanied by words which may mirror the music's emotional character. When the music is instrumental, thus wordless, then the analyst can detect stylistic comparisons between the piece and music which does feature a text.

The Bach violin sonata explored in this article is a good case in point. From one perspective, it might seem to be the perfect example of emotional expressionism because of its biographical background: it was published in 1720,

shortly after the death of Bach's first wife, so could be plausibly heard as the communication of the composer's personal anguish (Thoene, 1994). From an opposite standpoint, however, Bach started working on the set of violin sonatas and partitas in 1703 (Lester, 1999), so the sonata probably represents a lifetime's emotional experience, rather than reflecting an emotional reaction to a particular incident. Indeed, the analyst or music historian understands, through knowledge of Bach's many vocal compositions, including his passions and cantatas, that his expressive devices are fairly generic. Analogues for the sonata's four movements can be found in music with text, which thereby confirms the analyst's evaluation of the music's affect. See, for instance, the many cases of sad music setting words associated with the Crucifixion. Importantly, such historical-analytical knowledge can be reinforced by evidence from the modern psychological literature on music and emotion.

Perception of emotion in music: the role of expertise

It is common experimental practice in music psychology to compare experiences or perceptions of trained musicians with those of non-trained listeners (e.g., Bigand & Poulin-Charronnat, 2006; Law & Zentner, 2012). A key marker of musical expertise is the enhanced ability to extract and represent the music's structure beneath its surface parameters of pitch, attack, duration, and timbre. For instance, compared to non-musicians, musicians have been found better able to identify the thematic component in musical variations, an ability which improves through repeated exposure to the music (Pollard-Gott, 1983). Systematic music theory models the capacity of expert listeners to represent large-scale form in works lasting several minutes, such as a sonata (Lerdahl & Jackendoff, 1983; Schenker, 1935). Studies on emotional experience in music have suggested that increased training doesn't necessarily lead to increased musical pleasure; it is doubtful whether music induces greater emotion in experts than in non-experts (Bigand & Poulin-Charronnat, 2006). It is a different question, however, whether experts discriminate a greater variety of emotions, and are better at identifying them. The present study will investigate this possibility. It is arguable that experts perceive musical emotions more clearly to the extent that this perception is mediated through efficient processing of musical

structure. In short, the musical emotions expressed through form, rather than acoustic features, can only be accessed if and when listeners have the expertise to integrate them into a structure.

The relatively high level of confidence the analyst has in evaluating the emotional character of the music affords a standpoint from which to measure whether these emotions are actually perceived by listeners and how that relates to varying abilities and experience. Much recent work in musicology has explored fine-grained methods for understanding musical structures, especially in the latest generation of the Meyer (or ‘Penn’) School (Gjerdingen, 2007; Sanguinetti, 2012). In particular, research on eighteenth-century schemata and partimenti have revealed musical style to be a mosaic of little forms; equally, we understand that contemporary listeners processed this music as an interplay of such forms. The situation with baroque music is a little different from that in the galant and early classical era, principally because the more contrapuntal quality of its textures makes parsing the music into discrete schemata more challenging. Nevertheless, the case stands that the music of Bach and his contemporaries is just as formulaic as that of the Mozart era, even if the nature and nomenclature of these schemata may differ.

Given that Bach couches musical emotion in terms of the complex display rules of a sophisticated contrapuntal language, a listener’s ability to decode these rules will depend not merely on his or her musicality, but on his or her familiarity with Bach’s style; familiarity with the piece itself; and also on their ability to follow a complex musical argument unfolded over several minutes. With music as frankly ‘difficult’ and historically distanced as Bach’s, one would expect clear differences in response according to levels of expertise. Conversely, it would be equally interesting if there were *no* differences in response: our results will reveal that in some respects low-level and high-level experts respond to a surprisingly similar degree.

The main objectives of this study are to ascertain whether the acoustic features of musical emotion – which typically apply across a great range of styles and genres – converge with analytical findings, and how the level of expertise can explain possible differences. The two indicators of variance in expertise hypothesized in this paper are acoustic features and formal structure. By

‘acoustic features’, we mean those acoustic cues, similar to what Meyer called ‘secondary parameters’, which are also found in extra-musical stimuli and are strongly linked to vocal expression of emotions: chiefly speed, loudness, articulation, and contour (Coutinho & Dibben, 2012; Juslin & Laukka, 2003; Meyer, 1997). These acoustic features are similar to the ‘psychophysical’ dimensions of sound that Balkwill & Thompson (1999) found to be expressive of emotion independently both of musical experience and of listeners’ own culture: tempo, rhythmic complexity, melodic complexity, and pitch range. By ‘formal structure’, we refer to Meyer’s ‘primary parameters’ (those linked to musical syntax) and the ability to hear Bach’s sonata in terms of transformation of a formal model, similar to competence to perceive variation processes, as researched elsewhere (Bigand & Poulin-Charronnat, 2006; Pollard-Gott, 1983). Importantly, whereas the perception and cognition of ‘secondary parameters’ (whether in intra- or extra- musical contexts) is associated with general auditory predispositions and experiences, the processing of ‘primary parameters’ relies on exposure to music in general, and specific musical cultures in particular (Eitan & Granot, 2009), with or without explicit musical training (Bigand & Poulin-Charronnat, 2006).

The originality of the present study is to extend this approach further along the spectrum of musical competence. Rather than comparing musicians with non-musicians, our two experimental groups consist, respectively, of first-year university undergraduate music students (and many of them performing musicians), and professional musicologists and music analysts, the majority specialists in eighteenth-century music. Indeed, to our knowledge, no study of emotional perception has surveyed such a substantial group of music academics in this way before. Hence, given that ‘analysis’ figures at both ends of the process – the perception of professional music analysts of emotions predicted by a music analyst – this study is also of self-reflexive interest, throwing light on music analysis’s own methodology.

The article proceeds in the following stages. A first section presents the results of our acoustic and formal analysis of Bach’s sonata. We then describe two empirical experiments, targeted at listeners of, respectively, low and high

levels of expertise. After presenting and analysing the results of our experiments, we follow with a discussion and conclusion.

Music Analysis

The four movements of Bach's Sonata for Unaccompanied Violin in G Minor are highly contrasted in character, suggesting a succession of different emotions. Even though the music was composed three centuries ago, the emotional character of its structural features fits well within modern criteria identified in a wealth of psychological literature (Gabrielsson & Lindström, 2010; Juslin & Timmers, 2010). This is especially the case for the sonata's first and third movements – a fact which will become a particular topic for discussion later.

One important consideration for choosing the Bach sonata is that baroque music is much more consistent in its emotional character than later art-music, as is captured by the historical concept of 'unity of affection' (McCreless, 2002). That is, the baroque 'doctrine of affections' (*Affektenlehre*), from 1650 to 1750, put value on pieces which maintained the same emotion, whereas listener tastes in the Classical era of Haydn, Mozart and Beethoven preferred dramatic contrasts of emotion within movements (1750-1827). The reason for such unity is that the figurations which open baroque movements usually persist continuously throughout the music; in comparison, a typical Mozart sonata-form is a patchwork of contrasts (Ratner, 1980). In this respect, the emotional character captured by these opening figurations is fairly stable, notwithstanding gradations of intensity and occasional switches of valence. This is why it was realistic to base our experiments on entire, extensive, movements, rather than on snippets of music. Hence Bach's sonata is perfect for our purposes, affording four highly contrasting movements which would seem to be emotionally consistent within themselves.

Movements 1 and 3: *Adagio* and *Siciliana*

The sonata opens with an Adagio whose structural features suggest sadness (Huron, 2008; Gabrielsson & Lindström, 2010; Juslin, 1997; Moore,

2012): a slow tempo, minor-mode key, narrow intervals, legato articulation, variability of texture, preponderance of descending melodic contours, and high level of dissonance, especially involving semitone appoggiaturas (an ornament which ‘leans on’ the main note a step above). In musical semiotics, such appoggiaturas are historically associated with ‘*pianti*’, or crying, figures (Monelle, 2000), as if the musical contour were iconically representing the sound of a sobbing voice. *Pianti* figures were extremely prevalent signs of crying in both vocal and instrumental music from the sixteenth century. Far from being unique, the thematic profile of measures 1-2 in the Adagio corresponds to a stereotype, instantiated by many vocal works whose words express sad sentiments, as well as wordless instrumental music such as Albinoni’s apocryphal ‘Adagio’. Instantiations of this stereotype with text include Pamina’s aria, ‘Ach, ich fühl’s’, from Mozart’s *The Magic Flute*, and Bach’s aria, ‘Es is vollbracht’, from his *St John Passion*.

-- Insert Figure 1 here --

The structural features of the *Siciliana* evoke tenderness, or love: moderate tempo, major-mode key, triadic ‘sweet’ intervals, legato articulation, consistency of texture, and high level of consonance (Gabrielsson & Lindström, 1997; Juslin, 2010). More specifically, with its rocking motion, achieved in this case through the regular long-short rhythmic patterns of its compound ternary (12/8) meter, this *Siciliana* typifies the many instrumental lullabies written by Bach and his contemporaries. See, for instance, the aria ‘Vergnügte Ruh’ from Bach’s Cantata BWV 170, or ‘Schlafe, mein Liebster’, from his *Christmas Oratorio*. Although mediated through the sophisticated style of art-music, both the aria and the *Siciliana* share cross-cultural features of lullabies across the world, such as simplicity, smooth – and often descending – intonation contours, short phrasing, and slower rate of prosodic repetition (Trainor & Hannon, 2013; Unyk, Trehub, Trainor, and Schellenberg, 1992). Daniel Leech-Wilkinson has linked the preponderance of falling pitch contours in art-music lullabies to the descending motions of Infant-Directed (ID) speech, or ‘Motherese’ (Leech-

Wilkinson, 2006). The *Siciliana*, then, may be heard to express the emotional intimacy of lullabies, of Infant-Directed love.

-- Insert Figure 2 here --

Importantly, instrumental lullabies which begin in the major key often include episodes in the minor, reflecting the close relationship between tenderness and melancholy (and some of Bach's lullabies are based in a minor key, such as 'Ruht wohl' at the end of the *St John Passion*, hinging on the association between sleep and death). Such is the case in the *Siciliana*, whose middle section (measures 5-12) moves through G minor and C minor. It is interesting in this respect that the same appoggiatura figures which express 'crying' in a minor key (as '*pianti*') evoke loving 'stroking' gestures in the major. Another reason for this relationship is the aspect of tension implicit within yearning – a central feature of tender love. (Indeed, this is a case of musical tension having a positive emotional valence). In music, yearning is typically created by deferring or withholding the resolution of a harmony for as long as possible, the most famous example being Wagner's 'Tristan' chord from his music drama, *Tristan und Isolde* (Scruton, 2004), whose opening harmonies only properly resolve at the very end of the opera. The succession of appoggiaturas in Bach's *Siciliana*, as in the descending lines of measure 1, express yearning by repeatedly deferring the resolution of dissonances into consonances. Thus, the *Siciliana*'s blend of ID love, erotic love, and sadness exemplifies the complexity of emotion in Western art-music.

The interpretation of emotions in Bach's instrumental works is confirmed by a great many examples in Bach's vocal and choral works, where the meaning of the text corresponds with the emotional meaning of the music's structural features. In such cases, one doesn't need the words to 'read' the music's emotion; rather, the text confirms or clarifies this emotion. Nevertheless, the convergence between musical features and textual meaning, and between musicological and psychological orientations to emotion, seems to be *particularly* strong for the *Adagio* and *Siciliana*; i.e., we found that the emotions of sadness and tenderness are the most readily identifiable in Bach's sonata.

Movements 2 and 4: *Fuga* and *Presto*

Interpreting the emotion of movements 2 and 4 is harder, yet still viable. The difficulty seems to be because of ‘mixed signals’; i.e., they mix aspects of two emotions, fear and anger, emotions which are very closely related to each other, as we will explain more fully later. For instance, fear may be aroused by another person’s anger, so the difference is perspectival – whether we are considering the emotion of the object (anger) or the subject (fear). Similarly, acoustic features which express anger can sound frightening: high sound level, sharp timbre, spectral noise, fast mean tempo, staccato articulation, etc. (Juslin & Timmers, 2010, p. 463; Spitzer, 2009; 2010). Significantly, Fear and Anger occupy the same quadrant in Juslin’s & Timmers’ circumplex model of musical affect space, both characterised by high activity and negative valence. The other three basic emotions identified by Juslin & Timmers (Tenderness, Happiness, and Sadness) occupy distinct quadrants. That said, one of the differences in their model is that Anger is communicated by high sound level, whereas Fear is expressed via low dynamics.

Nevertheless, this dynamic determinant – high sound level for Anger, and low sound level for Fear – runs up against the problem that dynamic markings were rarely indicated in baroque music. Bach’s original score of the violin sonata lacks any markings for piano or forte. In this respect, our analysis is based on performance tradition, a tradition with which the recording we considered, by Gidon Kremer, is quite congruent. The same qualifier also applies to articulation, another parameter, like dynamics, which is under-determined in Bach’s notation.

The fugal subject of movement 2, the *Fuga*, as played by Kremer, suggests fear on account of its subdued dynamics, staccato articulation, minor mode, and harmonic dissonance. An important aspect of Kremer’s interpretation is that he chooses to play the repeated eighth-notes of the fugue subject sharply staccato. In this he is in line with Sergiu Luca’s historically informed performance practice in his 2005 recording; by contrast, Itzhak Perlman’s 1988 interpretation of the *Fuga* takes the repeated notes much more legato, arguably representing a less authentically historical, ‘romanticised’, reading (Fabian, 2005).

-- Insert Figure 3 here --

Indeed, as the subject climbs higher in pitch later in the movement (see measures 14-16), the reiterated staccato eighth-notes may remind us of the stabbing string figures in Bernard Herrmann's score for *Psycho*, which has become the prototype for fear in film-music studies (Brown, 1994, p. 24; Carroll, 1990, p. 38). On the other hand, some acoustic features of the *Fuga* also suggest Anger. See, for instance, the sheer density of triple-stopping (compared to that in the *Adagio*) in measure 3: each beat unfolds a spread chord across three strings, and the energy required to perform that in a compressed time-period heightens the sense of high emotional activation in the music suggestive more of anger than of fear.

Anger in the *Presto* finale is expressed via different material: an unrelenting stream of sixteenth-notes, projecting the extreme energy associated with this state.

-- Insert Figure 4 here --

Its idiom corresponds to the conventional 'rage aria', with numerous examples in Bach, Handel, and Vivaldi. Bach's cantatas include many rage arias, as is indicated not just by the character of the figurations but by their text setting. See, for instance, the aria 'By their fury, like a wild flood', from Cantata BWV 14, where rage is conveyed through the energy of a foaming torrent. Interestingly, rage arias can also be in the major, as in 'Schauet doch, dein Wetter', from BWV 46; or, most famously, 'Why do the nations so furiously rage', from Handel's *Messiah*. The apparent indifference of musical anger to mode explains why the *Presto* can still sound angry when the key changes from minor to major in the middle. However, as with the *Fuga*, the *Presto* couples Anger with Fear. One can hear its high activation as not energy *per se*, but the energy of fast motion associated with fearful behaviour, such as flight.

Given the interaction of both emotions in the *Fuga* and *Presto*, the role of musical form becomes decisive in selecting or foregrounding one or the other

emotion. Arguably, form affords a standpoint on the perspectival nature of the two emotions. The following analysis focuses on this formal dimension, in terms of contrapuntal schemata. Most, if not all, studies of musical emotion concentrate on acoustic parameters, and neglect pitch processes unfolded by musical form. Attending to musical form by definition takes longer, and is often more challenging, than perceiving acoustic parameters such as tempo and texture – dimensions which can be instantaneous. This is one reason why musical form is typically the province of the expert analyst. But whether or not musical form is necessarily more ‘abstract’ or ‘conceptual’ than acoustic parameters, and thus less emotional *per se*, is a matter of debate. For instance, there is a school of thought which denigrates ‘structural listening’ for being too abstract to have any psychological reality (Clarke, 2005; Dell’Antonio, 2004; Levinson, 1998; Tillman, Bharucha, & Bigand, 2000). We will dispute that. But first, in order to understand the structural level of the *Fuga* and *Presto*, let us consider the sonata as a whole.

Form

One way of thinking of the peculiarly relational aspect of formal perception, in contrast to the arguably more immediate quality of acoustic perception, is as ‘deformational’ – to borrow a central term from Hepokoski & Darcy’s seminal text on formal theory (Hepokoski & Darcy, 2006). Whilst Hepokoski & Darcy’s ‘deformations’ pertain to the large-scale temporal units of classical sonata-allegro form, we co-opt the concept to analyse much smaller phrase-length units or schemata. That is, we propose that Bach’s material in this sonata is based on differing transformations of a single formal schema. Hence it follows that a high-level expert listener’s identification of the music’s emotion depends on his or her stylistic familiarity with this formal schema.

A prototype of this schema is found in the slow movement of Vivaldi’s Violin Concert Op. 6 No. 3.

-- Insert Figure 5 here --

Bach would have been very familiar with Vivaldi's schema, as would many of his contemporary listeners (Bach made copies or transcriptions of Vivaldi's concertos, and this activity is credited with having 'Italianised' his style *circa* 1715; see Dreyfus, 1998, p. 43). The schema is organised according to the three-module *ritornello* form discovered by Wilhelm Fischer (Dreyfus, p. 61). A 'ritornello' describes the opening paragraph of a baroque concerto which encapsulates the main material of the movement, and which *returns* periodically in different keys. By Fischer's lights, a ritornello's initial phrase, called a *Vordersatz*, establishes the main key by alternating between tonic and dominant harmonies. This static phase is followed by the central, dynamic module based on a cycle of fifths: harmonic progressions in a sequence of perfect fifths, e.g. D-G-C-F. The fifth cycle was the main engine of harmonic motion in baroque music. There are many kinds of harmonic cycle, and they can be designated by scale-degrees. Thus the '3-6-2-5' pattern in Vivaldi's central module indicates that the fifth cycle begins on F, the third step of the D-minor scale, leaps up to Bb the sixth step, and so on. The interval between each successive step is defined as a fifth even when it seems to unfold a rising fourth, because fourths are inversionally equivalent to fifths. The fifth cycle is highly 'implicative', both because an intervallic progression can *imply* a continuation of the pattern (Meyer, 1956); and because each note of the cycle can imply both the resolution of a V-I cadential progression, and the onset of a new cadence (e.g. Vivaldi's F in measure 2 of the Adagio, Violin I, begins as part of the tonic D minor harmony, but then turns to become the dominant of the succeeding Bb). Finally, the third module restores tonal stability via a strong dominant-tonic cadential progression. Each of Bach's four movements begins with this three-part schema, decorated, bent, or twisted towards contrasting affective ends, not totally unlike the way dramatic themes, called 'leitmotifs', recur in differing guises throughout Wagner's operas. Let's pin-point the central module, the 5th cycle sequence, and track the four ways Bach expresses it. Figure 6 tables the four respective transformations of the cycle.

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The *Adagio* decorates the cycle almost beyond recognition. Compared to the clear presentation of the 5th cycle in the *Fuga* (as we shall see), here the pattern is highly deformed. Following the work of Alloy & Abrahamson (1979), David Huron has made the connection between sadness in music and the ‘detail-oriented thinking’ of ‘depressive realism’ (Huron, 2011, p. 48). Our analysis of the *Adagio* reveals it to be highly fragmentary in its texture and tonal structure, and this ‘atomistic’ quality could be related to the detail-oriented quality of its sad affect. Given that Juslin & Timmers’ parameters of sad music apply to its acoustic features, fragmentation may be a characteristic of sad music’s formal dimension: there is a need for extensive corpus analysis to establish this possible link between sadness and formal fragmentation.

In the present instance, fragmentation in the *Adagio* is seen in the way that the integrity of the fifth cycle is disguised by textural complexity and metrical placement. The Bb, the first note of the cycle, is buried as an inner voice beneath the top G on the third beat of measure 2 (in the course of arpeggiating the G minor chord on this beat, Kremer dwells fractionally longer on the top G, furthering the impression that it covers the inner Bb). Bb is formally dislocated from the next note of the cycle because it is projected as an ending of the first phrase (*Vordersatz*): the note is relatively long (an eighth note), resolves the preceding tonal tension (dominant 7th harmony) with a tonic; and is articulated by the following 32nd-note rest. If the Bb is an ending, then the lurch up to the Eb sounds like a new beginning, metrically stronger than the first beat of the next measure, especially as performed in Kremer’s interpretation. The A natural, the third beat of the cycle, is metrically weakened by being displaced by an eighth note in measure 3; and it is disconnected from the Eb because that note had fallen back down to a Bb. D, the fourth note of the cycle, is reached only two eighth-notes after A: each of the four steps of the cycle is differentiated by a distinct textural shape and metrical placement. This makes the ‘skeleton’ of the phrase, its grammatical deep structure, quite challenging to hear. Moreover, this sense of discontinuity is compounded by the abrupt tonal shifts across measures 2-3 from G minor to Bb major and back to G minor. Turns to the major in minor-mode music can suggest feelings as diverse as nostalgia (Huron, 2011; Spitzer, 2013)

and hope (Levinson, 1990); in which case, by rejecting these positive emotions, the slide back to G minor sounds all the more poignant.

Hence pin-pointing measures 2-3 shows how the *Adagio*'s fifth cycle is highly deformed effectively into a series of isolated structural notes, suggesting a 'detail-oriented' listening in line with the 'depressive realism' of sadness. We limit our discussion to the central module of the ritornello schema, but further analysis would indicate similar formal fragmentation across the rest of the movement. The *Adagio* contains by far the most contrast in Bach's sonata; its motivic shapes change virtually every measure. Its greatest moment of formal and affective discontinuity falls at the central climax, measures 11-13. After a build-up to a cadence in E flat major across measures 11-12, the cadence is dramatically interrupted by a diminished seventh chord at measure 13, which returns the music to a minor key. This tragic collapse of a positive emotion, associated with the modulation into a major key, back into the prevailing sadness arguably reworks the gesture of measure 3 (the lurch from Bb major back to G minor) at a higher structural level. This bespeaks great unity between the levels of local detail and Bach's architecture.

The fifth cycle is presented at measure 2 of the *Fuga* with utmost clarity. Its four notes are articulated plainly (undecorated), and with rhythmic and metrical regularity (equally spaced eighth notes). Kremer brings out these pitches by performing them staccato – not marked in Bach's score, but arguably implicit in the historical performance style (Luca's historical interpretation does the same). Compared to its treatment in the *Adagio*, then, the cycle is much more clearly defined. In this respect, the relationship between the *Adagio* and *Fuga* corresponds to the conventional pairing of prelude and fugue in Bach's works. Many of Bach's preludes outline ideas in an improvisatory fashion which are then crystallized in the subsequent fugue (see Lester, 1999).

The clear articulation of the cycle, especially when projected staccato, creates a sense equally of fear (as discussed above) and of aggression, expressive of anger. Given that these two emotions are mixed with each other, the thrust of our argument will be that anger comes to the fore, as we move away from acoustic to formal features. However, as we saw earlier, aggression is also strongly expressed by the *Fuga*'s sonic parameters, such as the dense triple-

stopping in measure 3. We argue that the standpoint of structural listening shifts the ‘perspectival’ relationship between anger and fear in this case towards anger.

It is at the formal level that a feeling of aggression is compounded through Bach’s deformation of the rules of counterpoint. Normally, an opening statement of a fugal ‘subject’ (here, measure 1) would be ‘answered’ by a version of the subject adjusted so as to cadence on the dominant. In the case of the present *Fuga*, a normative ‘tonal’ answer in measure 2 would have remained on the G, instead of descending to F, and would have resolved to F a little later as part of a D minor (dominant) harmony at measure 3. However, Bach writes an anomalous ‘subdominant’ answer instead, so as to cadence on C minor at measure 3 (in the baroque repertoire, the other great exception to this rule is the subdominant answer of the fugue in Bach’s famous Toccata and Fugue in D Minor). Why does Bach do this? The subdominant answer creates a powerful clash at measure 3 between the Eb and the D, creating an effect of the contrapuntal voices ‘fighting’ with each other aggressively. And at a higher level, the tilt towards the subdominant produces a formal dissonance in the piece, confirmed by the climactic ritornello in C minor at measure 55. It is interesting that the *Adagio* also climaxed with a subdominant ritornello, the reprise of the opening theme in C minor at measure 13 (interrupting the Eb cadence). This represents another instance of the *Fuga* reworking the material of the *Adagio*. Another similarity is the high level of contrast in the *Fuga*, but here the difference to the *Adagio* is instructive. In the *Adagio*, the ideas evolve fluidly from measure to measure; in the *Fuga*, contrast is polarised into dramatic collisions between blocks of fugal argument, and sixteenth-note episodes. Within the fugal sections, repetition of the fugal material is relentless. These abrupt, large-scale juxtapositions of fugal sections and episodic passage-work is expressive not of fragmentation, as in the *Adagio*, but of aggressive conflict associated with anger.

The cycle’s treatment in the *Siciliana* combines aspects both of the *Fuga* and the *Adagio*. Three of the cycle’s four notes are congruent with the lullaby’s metre, recalling the metrical regularity of the *Fuga*’s cycle: the D and G fall, respectively, on the strong and weak beats of the pattern, and the subsequent C comes in on the next strong beat. However, the unequal long-short metrical

pattern (the duration of the D is implicitly a quarter-note) characteristic of a lullaby's rocking lilt endows the rhythms with a rounded irregularity. The displacement of the cycle's fourth note, F, by one eighth note (it had been expected two eighth-notes after the C) stretches the length of the C, heightening the flexibility of the metre's lilt. This flexibility is very much in line with the smoothness and avoidance of sharp contrast noted of lullabies. But there are other lullaby aspects implicit in the voicing of the *Siciliana*'s 5th cycle. The pitches of the cycle are distributed between two contrapuntal voices, whereas in the *Adagio* and *Fuga* the cycle was confined within a single voice. The impression of there being two voices is heightened by the registral gap between the lower and upper notes, which is much greater than in the previous movements; for instance, the D and G are an octave and a half apart. This registral separation encourages the listener to 'stream' the pitches as distinct voices (Bregman, 1990), metaphorically suggesting a dialogue between two musical personas – perhaps a caregiver and a child. One could even interpret the voice-crossing of the two parts on the final F of the cycle (taken by the lower voice, rather than, as expected, by the upper) as symbolic of the personas' harmonious interaction. Contrapuntal dialogue had also featured in the *Fuga*. But there, the cycle at measure 2 'fights' against the fugal answer beneath it. In the *Siciliana*, the dialogue is not conflictual but harmonious, because the pitches of the cycle are shared between the two voices, and indeed cross-over.

The rhythmic and textural uniformity of the *Presto* – its continuous succession of sixteenth-notes – makes it initially difficult to pick out the fifth cycle from the background figuration. Interestingly, the cycle is slightly extended by a further 5th progression: A-D is followed by G-C at measure 11. This is the only movement where this happens. It is as if the forward-moving harmonic drive of the music is so great that the cycle's seemingly endless implicative potential to rotate around the circle of fifths (i.e. Bb-Eb-A-D-G-C-F-Bb etc.) can hardly be contained. With its great speed and harmonically implicative drive, the *Presto* evokes rapid physical motion, perhaps flight linked to fear. Indeed, there is an aria from Bach's *St John Passion* where very similar material, and in the same key of G minor, is set to words describing flight: 'Eilt, ihr angefocht'nen Seelen'.

-- Insert Figure 7 here--

Given the connection we earlier made between the *Presto* and the conventional aria of rage, we can infer that its emotions are as mixed as in the *Fuga*. That is, both *Fuga* and *Presto* mix anger and fear. However, as we argued with respect to the *Fuga*, a particular emotion emerges as we move our focus from acoustic to formal parameters, in this case fear.

If the *Presto*'s extreme speed iconically mirrors the flight behaviour linked to fear (Spitzer, 2010), then its formal process creates a cognitive symptom of this emotion: shock. The music unfolds a series of shocks by subverting its metrical pattern; indeed, this pattern is constantly shifting in unpredictable ways, cognitively 'wrong-footing' the listener (as it symbolically wrong-foots the fleeing subject, as it were). For instance, the very start of the cycle, the Bb at measure 6, subverts a pattern of two-measure phrases established at the opening. That is, the fast music suggest a slower metrical grouping, whereby measures 1-2 constitute one 'beat' of a 'hyper-measure'; measures 2-3 a second beat, and measure 5 the onset of a third beat. And it is this implicit three-beat hyper-measure which is interrupted by the Bb; it introduces a 'hypermetrical' disruption.

-- Insert Figure 8a here--

Moreover, a 'metrical reduction' of the cycle at measures 6-8 (i.e., leaving out the sixteenth-notes between the notes of the cycle) reveals that, by accenting the second beat of each group (the quarter notes Eb, D, and C), it encapsulates the preceding hypermetrical disruption in miniature. Hence the cycle not only arrives as a metrical shock to measure 1-5; it is itself a series of metrical shocks.

--Insert Figure 8b here--

There is another, broader, level at which the *Presto* expresses fear. The sheer speed of the music makes it difficult to follow, even by the expert listener. This

literally overwhelming quality evokes the classic formula of the sublime, which is fear at its most philosophically elevated level. The *Presto* evokes sublime fear both as cognitive overload, and as the behavioural reaction to fear, which is to flee. The category of the sublime, especially as explained by Kant, is useful also because it subsumes anger into fear. Or rather, it suggests a mixture of emotions: although Kant's celebrated notion of the sublime was only framed in the 1790s, the complex of emotions it describes fits well with Bach's *Presto* (Kant, 1989, 120-121):

The astonishment, amounting almost to terror, the awe and sacred thrill of devout feeling, that takes hold of one when gazing upon the prospect of mountains ascending to heaven, deep ravines and torrents raging there, deep-shadowed solitudes that invite to brooding melancholy, and the like – all this, when we are assured of our own safety, is not actual fear. Rather is it an attempt to gain access to it through imagination, for the purpose of feeling the might of this faculty in combining the movement of the mind thereby aroused with its serenity, and of thus being superior to internal and, therefore, to external, nature, so far as the latter can have any bearing upon our feeling of well-being.

We can pull out from Kant's definition emotions of anger ('raging torrents', as in rage arias), terror, awe (astonishment), even melancholy and serenity, suggestive of tenderness. A key question to be explored is whether the sublimity of the *Presto* is a product, or compound, of mixed emotions, or a distinct emotion in itself, unclassifiable by standard basic-level affective categories.

In conclusion, surveying all four movements of Bach's sonata, we have seen how the Vivaldian stereotype is transformed so as to project a dynamic process associated with an emotional behaviour, as defined by scholars such as Keith Oatley in terms of goal attainment (Oatley, 2004, pp. 79-81). The atomisation of the schema in the *Adagio* suggests the lack of goal – the lethargy – connected with sadness or depression. The contrapuntal conflict in the *Fuga* schema enacts the aggressive conflict which is often linked to anger, when goals are blocked. The fluid and flexible dialogue in the *Siciliana* suggests the tender dialogue between mother and child in a lullaby, mirroring social closeness. And

the animation of the *Presto* suggests a subject's physical flight, in extreme fear or panic.

Throwing the spotlight on the schemas in movements 2 and 4, we see how their emotions expressed by the music's form do not tally with those expressed by the music's acoustic parameters. Thus what affords particular food for thought in this analysis is that these two levels of musical emotion – respectively, the acoustic parameters and the formal schemata – are congruent in movements 1 and 3, and divergent in movements 2 and 4. In other words, in both the *Adagio* and *Siciliana*, the emotional behaviour outlined by the formal schema confirms the emotion expressed by the tempo, texture, articulation, etc. But in the *Fuga* and *Presto*, the emotions of the schema do not fully correspond to those of the acoustic parameters. One can describe this process in slightly more complex terms, in the light of the 'perspectival' relationship between fear and anger in both movements. If acoustic parameters for fear and anger are both present in the *Fuga* and *Presto*, then the role of form becomes critical in foregrounding one or other of these emotions. Thus, the emphasis shifts, perhaps, from the frightening aspects of an angry object (*Fuga*), to the subject's frightened flight away from that object (*Presto*).

Empirical experiments

Our analytical findings, particularly the divergence between the emotional character of the acoustic and structural levels in two of Bach's movements, led us to make a set of hypotheses on the perception of emotion in the work, related to subjects' individual expertise and modes of listening.

Regarding the first, *low-level-expert*, group, there are two mediating factors against such a convergence between analysis and experiment. Firstly, the barrier of expertise: the analysis was undertaken by a *high-level expert* listener familiar with the music, whereas the listeners were entry-level university students largely orientated towards popular music. Secondly, the historical barrier: Bach published the piece in 1720, and one might expect that, even if eighteenth-century emotions were similar to emotions in the twenty-first century,

then *attributions* of emotion to certain musical materials would differ between historically situated listeners. That is, Bach expressed musical emotions in eighteenth-century stylistic materials, so the modern listener would need to penetrate the display rules, or stylistic coding, of the music in order to grasp the communicated emotion.

Regarding the second, *high-level expert*, group of listeners, many of whom are analysts themselves, two other mediating factors arise. In the first instance, it is questionable whether all scholars or analysts hear the same way, or proceed from similar methodological assumptions. Secondly, an analyst self-consciously contemplating a score (including the authors of the present study) may be conceptualising both the music and the task in hand differently to a listener of similar expertise who is responding more intuitively in real time. One task that the present writers are more experienced at, by definition, is the intellectual exercise of evaluating and categorising musical emotions according to theoretical criteria. Moreover, the present analytical evaluations are ‘final state’ in two key respects: they are based on many hearings of the music; they are based on readings, rather than hearings proper, and are thus, to a certain extent, abstracted from the acoustic impact of the music. Of course, scores always predicate the acoustic sound of the music; but we venture that an analysis based on a score isn’t tied to any particular performance of that work. Perhaps it summarises the many, often quite varying, interpretations the analysts have heard; or even presents an idealised or synoptic performance.

Another inescapable issue is that of performance practice itself. There is an entrenched school of thought which holds that emotional expression in music is mostly influenced by performance style, rather than the music’s acoustic features or formal structure (Leech-Wilkinson, 2013). Unfortunately, the extensive literature on performance of Bach’s violin sonatas and partitas has not touched upon the affective dimension (Fabian, 2005). We leave the question open whether choice of different performances would elicit different results in our experiments. It is interesting that the Amazon review of Kremer’s interpretation, the recording we played our listeners, focuses on the *Fuga*, and discusses it in affective terms: ‘The Fugue from the G minor Sonata is a powerful, terrifying thing, with Kremer accenting the repeated notes in the

fugue's subject harshly and fiercely. It explodes with a palpable fury from the instrument'. The words power, terror, harshness, fierceness and fury are arguably all correlatives of anger. The review thus confirms our analytical judgment of the affective character of the *Fuga*'s formal structure; although we stress that this evaluation was not based on Kremer's performance in particular. Not all artists play the *Fuga* as aggressively as Kremer; there is a temptation here to draw some prescriptive conclusions about how the piece ought to be played, but that will have to wait for a future study. In a follow-up study, Spitzer (in press) conducted a performance analysis of three recordings of the *Adagio*, comparing tempo and dynamic maps of versions by Kremer, Itzhac Perlman and Sergiu Luca. It would be illuminating to extend this approach to the other movements, including the *Fuga*.

For the present, our study assumes four hypotheses:

- 1) Firstly, we hypothesized that the emotions perceived would be highly consistent across listeners (independently of the expertise) for movements 1 and 3 (Sadness and Tenderness/love, respectively)
- 2) Secondly, due to the contradiction between acoustic and structural levels in music, we maintained that the emotions perceived would be more ambiguous for movements 2 and 4.
- 3) Thirdly, we hypothesized that our *low-level expert* listeners would identify the emotions of movements 2 and 4 according to the 'surface' acoustic parameters, that is, Fear and Anger, respectively.
- 4) Fourthly, we hypothesized that our *high-level expert* listeners would identify the emotions of movements 2 and 4 according to the 'deeper' character enshrined in the schemata, i.e., Anger and Fear respectively.

Method

The empirical experiments aimed at obtaining summative judgments of emotions perceived in each of the four movements of the sonata. We used two types of discrete measures to qualify emotions: emoticons (instrument 1) and a list of 36 emotion words and expressions (hereinafter "emotion-words"; instrument 2).

The emoticons were selected to represent the four basic emotions identified for each movement in the music-analysis stage described earlier: tenderness/love, anger, fear and sadness (see Table 1). The 36 emotion-words selected for instrument 2 allowed participants to describe in more detail the emotions perceived for each movements. The emotion-words selected consisted of a sample of terms pertinent to describe emotional experiences with music (Coutinho & Scherer, 2012), with a few additional terms selected by the authors. The full list of emotion-words used is shown in Table 2.

-- Insert Table 1 here --

-- Insert Table 2 here --

The task consisted of listening to each of the four movements of the sonata and describing the emotions perceived in each movement by using both of the instruments described. Participants were asked 1) to select one emoticon to summarize the emotional character of each movement, and 2) to select from the list of emotion-words shown in Table 2 a maximum of five terms that best describe the emotions perceived while listening to each movement.

Participants

Two groups of participants took part in a bipartite empirical study: *low-level experts* and *high-level experts*. The *low-level expert* group (Study 1) consisted of thirty-seven subjects (17 female), with average age of 19 years (SD = 2; range=18-27). They were all first-year undergraduate students at the School of Music from the University of Liverpool, the majority of whom were oriented towards popular music studies (choosing between four and eight modules in popular music studies from a possible total of eight modules). A questionnaire administered before the experiment revealed that most of the participants (33) were studying to become professional musicians; that more than half of them sing or play an instrument at a (semi-)professional level (22); and that all play at least one instrument (or sing) as a hobby. Furthermore, on average participants reported listening sometimes/often (3.6) to classical music and frequently (4.9) to

popular music (5-point Likert scale: 1-never, 2-rarely, 3-sometimes, 4-often, 5-frequently).

The *high-level expert* group study comprised thirty-one subjects (10 female), whose average age was 45 years (SD = 9; range = 31-70). Participants belonged to at least one of the following music-related activities/disciplines: performance, composition, music history, musicology and music analysis. A detailed background assessment revealed that 16 participants were performers (average career length: 18 years), 7 were composers (for an average period of seven years), and 22 were music historians, musicologists and/or music analysts (average career length of 23 years).

Procedure

Study 1. Participants attended a single session. The experiment took place in a classroom at the University of Liverpool, and the four movements of Bach's piece were played successively in the original order (*Adagio*, *Fuga*, *Siciliana*, *Presto*) through loudspeakers. In order to prevent affect carryover from movement to movement, listeners were presented with 30 s of distracting and emotionally neutralizing sounds (bird and cricket recordings) before each new movement was played, and after all the participants have made their ratings (approximately 2 min. separated the end of one movement and the beginning of the next). After the playback of each movement, participants reported on the two instruments presented in Tables 1 and 2, the emotions perceived in the music heard. Ratings were reported using a pencil and paper instrument.

Study 2. All participants took the experiment online. The four movements of Bach's piece were played successively in the original order (*Adagio*, *Fuga*, *Siciliana*, *Presto*), because we expected that participants would recognise the pieces and, due to their expertise, react negatively to a randomised order of presentation. After the playback of each movement, participants reported the emotions perceived in the music heard using the two instruments presented in Tables 1 and 2. Ratings were reported using a computer interface.

Results

All four movements were virtually unknown to the *low-level expert* listeners. Indeed, only 3% of the participants reported knowing the *Adagio*, the *Fuga* and the *Siciliana*, and 5% the *Presto*. In clear contrast to the *low-level expert* listeners, the majority of the *high-level experts* (68%) clearly recognised all four movements, and all these listeners had heard them before. This evidences the anticipated difference between the two groups in terms of knowledge about the pieces. It might be contended that our analysis confounds general expertise with the effect of familiarity. In answer, we would state, firstly, that knowledge of the classical repertoire is actually one of the determinants of musical expertise; secondly, that no tradition exists of associating the movements of Bach's sonata with particular emotions, nor is emotion discussed in any previous analytical writings on the work. Hence familiarity with either the music or the theoretical literature cannot prejudice the listeners' choices of emotions in the experiments.

Emoticons

Figure 9 shows the percentage of participants in each group that selected a particular emoticon to summarize the broad emotional character of each movement. The measures indicate the percentage of participants that selected a particular emoticon to represent the emotions perceived in each of the movements. We used the Test of Equal or Given Proportions (Newcomb, 1998; implemented in the *prop.test* function in R) to evaluate whether the choice of a particular emoticon was significantly above chance level (25%), that is, the possibility that a particular emoticon was chosen at random. This value is dependent on the number of subjects; hence there are different values for each group. The full line indicates the necessary proportion of *low-level expert* subjects to consider the selection of each emoticon significantly above chance level ($X^2(1, N = 15) = 3.882, p < .05$, two-sided confidence intervals for all tests). The dashed line indicates the same quantity for the *high-level expert* subjects ($X^2(1, N = 15) = 3.882, p < .05$). Henceforth, we will interpret to the emoticons chosen by a percentage of subjects higher than 41% (15 participants;

Study 1) and 42% (13 participants; Study 2) as consistent ratings of emotions perceived in each movement.

In order to determine if there were statistically significant differences between groups we used Fisher's Exact Test for Count Data (Fisher, 1922). The test was only performed for those categories (emoticons or emotions words) that were selected significantly above chance levels (as determined by the Test of Equal or Given Proportions). In order to counteract the problem of multiple comparisons, the p-values reported here were adjusted using the Bonferroni method (p-values were multiplied by the number of comparisons made in each test)".

-- Insert Figure 9 here --

In relation to the *Adagio*, 81% of the *low-level expert* participants identified the *Adagio* with the Sadness emoticon, a value significantly higher than the chance level (all the other emoticons were selected below chance levels). This emoticon was also dominant in *high-level expert* listeners' choices – it was selected by 74% of the subjects, a value also significantly higher than the chance level. There were no statistically significant differences between the two groups.

As for the *Fuga*, the Fear emoticon dominated the choices of *low-level expert* subjects (57%), but, in clear contrast, 58% of the *high-level expert* subjects selected the Anger emoticon. There was a statistically significant difference between the two groups in relation to Anger ($p=.001$, Bonferroni adjusted for two comparisons), and a tendency in relation to Fear ($p=.057$, Bonferroni adjusted for two comparisons). Taken together, these results clearly indicate that *high-level experts* perceive Anger-related emotions in the *Fuga*, and that *low-level experts* do not. Instead, *low-level experts* perceive Fear-related emotions, something that *high-level experts* tend to do as well.

Concerning the *Siciliana*, both groups were in agreement in relation to the main emotion expressed by this movement: 65% of the *low-level expert* subjects and 71% of the *high-level experts* selected the Tenderness emoticon. There were no statistically significant differences between the two groups.

Finally, for the *Presto*, *low-level expert* listeners did not exhibit a clear choice – three emoticons were selected slightly – but not significantly – above chance levels (Anger, Fear and Tenderness). The pattern of responses was clearer for *high-level expert* listeners: 52% selected the emoticon Anger significantly above chance. There were no statistically significant differences in the selection of the Anger emoticon between the two groups.

Emotion-words

Figures 10 to 13 show the percentage of participants in each group that selected a particular emotion-word to summarize the broad emotional character of each movement: *Adagio*, *Fuga*, *Siciliana* and *Presto*, respectively. Once again, we used the Test of Equal or Given Proportions described above to evaluate whether the choice of a particular emotion-word was significantly above chance level (14%). The full line indicates the necessary proportion of *low-level expert* subjects to consider the selection of each emoticon significantly above chance level (10 subjects, 27%; $X^2(1, N = 10) = 4.298, p < .05$). The dashed line indicates the same quantity for the *high-level expert* subjects (9 subjects, 29%; $X^2(1, N = 9) = 4.745, p < .05$). Fisher's Exact Test for Count Data was once more used to compare both groups in terms of the frequency of selection of those words selected by at least one of the groups above chance levels.

-- Insert Figure 10 here --

-- Insert Figure 11 here --

-- Insert Figure 12 here --

-- Insert Figure 13 here --

In relation to the *Adagio*, the emotion-words consistently chosen by the *low-level expert* participants were Sadness (70%), Sorrow (70%), Melancholy (46%), and Tension (43%). The emotion-words favoured by *high-level expert* participants were Melancholy (74%), Sorrow (58%), Tension (42%), Sadness (35%), and also Tenderness and Being Moved (32% each). Unlike the *low-level expert* listeners, whose ratings are consistent with the emoticon results (Sadness), the emotion-word rated highest by *high-level expert* subjects was Melancholy.

Tenderness ratings significantly differed between groups, in such a way that this emotion-word was selected more often by *high-level experts* ($p=.041$, Bonferroni adjusted for 6 comparisons). There were no statistically significant differences in the frequency of choice of Being Moved, Tenderness, Melancholy, Tension and Sorrow.

With the *Fuga*, *low-level expert* subjects identified the movement with the emotion-words Tension (57%), Liveliness and Power (35% each). For *high-level expert* listeners, the top words selected were Vigour (68%), Power and Tension (58% each), and Nervousness (32%). It is interesting to observe that the emotion-words Fear (corresponding to the dominant emoticon chosen by *low-level experts*) and Anger (the dominant emoticon chosen by *high-level experts*) were not selected significantly frequently by any of the groups. Vigour was selected more frequently by *high-level experts* ($p=.001$, Bonferroni adjusted for 5 comparisons). There were no statistically significant differences in the frequency of choice of Power, Liveliness, Nervousness and Tension.

Looking now at the third movement, the *Siciliana*, the emotion words consistently selected by *low-level expert* participants were Affection (43%), Tenderness (41%), Beauty (38%); and then Love and Relaxation (30% each). *High-level expert* listeners significantly favoured the emotion-words Tenderness (77%), Affection (48%), Serenity and Thoughtfulness (45% each). Both groups' selections conform to the chosen emoticon (Tenderness/Love), although the *high-level expert* listeners conformed much more clearly. Tenderness was selected more frequently by *high-level experts* ($p<.022$, Bonferroni adjusted for 7 comparisons). There were no statistically significant differences in the frequency of choice of Affection, Love, Relaxation, Serenity, Thoughtfulness and Beauty.

Finally, with the *Presto*, the emotion words chosen by a significant number of *low-level expert* subjects were: Liveliness (65%), Vigour (57%), Power (43%), and Tension (35%). The emotion-words rated by the *high-level expert* listeners were very similar, although with different relative importance: Vigour was clearly the preferred emotion-word (90%), followed by Liveliness (71%), and then Tension (48%) and Power (39%). Vigour was selected more frequently by *high-level experts* ($p=.011$, Bonferroni adjusted for 4 comparisons).

There were no statistically significant differences in the frequency of choice of Power, Liveliness and Tension.

Table 3 shows a summary of the results for both studies.

-- Insert Table 3 here --

Analysis

Adagio

In the *Adagio*, both *low-level expert* and *high-level expert* subjects consistently identified the hypothesised emoticon, Sadness. For *low-level experts*, this was paralleled by a high level of convergence between the emoticon and emotion-words selected: Sadness and Sorrow were the top words selected by 70% of the participants (followed by Melancholy and Tension). For the *high-level experts*, 74% selected the Sadness emoticon, but they preferred the emotion-words Melancholy (74%) and Sorrow (58%) (followed by Tension, Sadness, Melancholy and Being Moved), rather more nuanced categories of Sadness (especially Melancholy).

Generally, the most significant difference between both groups seems to be indeed the preference for Sadness (*low-level experts*) or Melancholy (*high-level experts*) to describe the emotional character of the *Adagio*. One possible explanation is that *high-level expert* listeners are more aware of the emotional variety and complexity in a movement which contains a lot of contrast. Hence their expertise consists in a higher ability to synthesise emotional variety into a single, more nuanced, emotional category. Another explanation is that *high-level experts* use a more sophisticated language to express emotions (as pointed out by one of the reviewers of this article); it is a matter not so much of the emotions themselves as of the means of reporting them and preferences for specific words.

The general consistency between both groups mirrors the convergence, in the analytical study, between the music's acoustic features and its formal process, both of which express the same emotions. Taken together, these results confirm part of our first hypothesis for this study, in which we predicted that the

emotions perceived in the *Adagio* would be highly consistent across listeners independent of expertise.

Fuga

With the *Fuga*, *low-level expert* subjects identified the movement with the emoticon representing Fear, whereas *high-level experts* identified the same movement with the emoticon representing Anger. These results conform to hypotheses 3 and 4 for this study: that *low-level experts* would perceive the emotions conveyed in terms of acoustic features (Fear), and *high-level experts* the ones communicated through the music's formal processes (Anger). Additionally, the level of agreement between subjects in each group is lower in the *Fuga* than in the *Adagio*, suggesting a higher degree of ambiguity (confirming our second hypothesis).

Such ambiguity is also evidenced in the relationship between the emoticons and the emotion words. Emotion words permit the subjects much more freedom to choose terms they feel best describe the emotions the music communicates. Looking at *low-level experts* first, what is immediately evident is a very poor match between (the emotion intended to be represented by) the emoticon chosen and the emotions-words selected: the emotion-words Fear, Panic, Scary, and Apprehension (all related to the dominant emoticon chosen) were all selected below chance levels. Instead, the preferred emotion-word was Tension (selected by 57% of *low-level experts*), followed by Liveliness and Power (each selected by 35% of the subjects in this group). This is an interesting outcome: Tension describes levels of intensity or activation associated with danger detection (either real or imaginary; Thayer, 2012), rather than a clear emotional category. Such indeterminacy is mirrored by the open role tension plays in musical style. The dimension of tension is only associated with Fear when allied to certain kinds of textures (e.g. quiet staccatos) and minor-mode keys; in legato, major-mode contexts, by contrast, tension can communicate the romantic yearning of tender emotions. The fact that Tension is characteristic of both Fear (predicted by the acoustic analysis) and Anger (predicted on the basis of formal features), may reflect the contradiction identified in the analytical study between features and formal processes.

Staying with the *low-level expert* group, it is also important to reiterate that Anger and Fear are closely related to each other, hence identifying one or the other emotion can depend on the listener's perspective. For instance, the staccato stabbing gestures of the *Fuga* can sound frightening for the very reason that they communicate the rage of an aggressor. This paradox is epitomised by Bernard Herrmann's score for *Psycho* (the celebrated shower scene), where the high strings gestures blend together a multitude of domains or perspectives, including knife stabbings (the aggressive object), screams (the terrified subject), and terror (that of the viewer/listener). In this context it is also interesting to observe that the choice of the emotion-word Power (35%) to describe the *Fuga* suggests undertones of Anger, since Fear is generally linked to weakness – i.e., absence of power.

Turning now to the *high-level experts*', the choice of emoticon decisively flipped from Fear to Anger, strikingly confirming our initial hypothesis that musical training would lead to a focus on the formal structure of the music rather than on its acoustic level. This flip is partially echoed in the choice of emotion-words -- *high-level experts* consistently chose Vigour and Power as descriptors of the emotions perceived in the *Fuga* (by contrast, the top-rated emotion-word for *low-level experts* was Tension). Although Vigour and Power are aspects of Anger (Berkowitz & Harmon-Jones, 2004), it is puzzling that none of the emotion-words Anger, Rage (a stronger form of Anger) and Irritation (a milder form) was identified above chance levels. Perhaps the emoticon Anger, with all its negative connotations, functioned as a placeholder for an aesthetic emotion marked by more positive qualities of Vigour and Power.

Taken together, these results confirm our second hypothesis, and partially the third and fourth hypotheses, for the *Fuga*. Indeed, there was a general ambiguity in the recognition of the main emotion conveyed by this movement, and the *low-level expert* listeners identified the emotional character of the *Fuga* according to the 'surface' acoustic parameters, rather than the 'deeper' character enshrined in the schemata (as *high-level expert* listeners did). Nonetheless, despite having demonstrated that listeners identified the emoticons hypothesized for each group, the analysis of the emotion-words selected by each group failed to confirm the recognition of the hypothesized main emotions

(Anger/Rage/Irritation in the case of *high-level experts*, and Fear/Panic/Scary in the case of *low-level experts*). However, the more general emotion-words chosen by each group describe emotional states consistent with the main emotions hypothesized: Tension in the case of Fear (*low-level experts*); Vigour, Power and Tension in the case of Anger (*high-level experts*).

Siciliana

In the *Siciliana*, both sets of subjects identified the emoticon representing Tenderness/Love, an emotion on which both the acoustic and formal analysis concurred. As with the *Adagio*, choice of emoticons and emotion-words largely converged – Affection and Tenderness were the top words selected by both groups. It is nevertheless noticeable that Tenderness was more frequently selected by the *high-level expert* listeners (there are no significant difference in relation to the frequency of selection of the emotion-word Affection).

These results confirm our first hypothesis: as with the *Adagio*, the emotions expressed by the *Siciliana* were perceived by both *high-level experts* and *low-level experts* in a highly consistent fashion. The general agreement between both groups seems to mirror the convergence between the music's acoustic features and its formal process.

Presto

Compared with the first three movements, the *Presto* yielded much more complex results. First, no single emoticon was selected above chance level by *low-level expert* listeners to represent the emotional character of the movement. Second, *high-level expert* subjects, contrary to our hypothesis based on the analysis of the music's formal structure, chose the emoticon Anger to summarise the emotional character of the *Presto* (although above chance level, the frequency of choice of the Anger emoticon is not statistically different than that of *low-level expert* listeners).

Some light was shed on this problem by the choice of emotion-words in both groups. The emotion-words consistently selected by *low-level experts* were Liveliness, Vigour, Power and Tension, which are either positively or neutrally valenced (except Tension which can also be negative) with high level of

activation, characteristics which are not captured by any of the emoticons: Anger, Fear and Sadness are all negatively valenced, and Tenderness/Love is characterised by low activation. The *high-level experts'* choice was broadly similar, the top four for both groups being Vigour, Liveliness, Tension, and Power. The only statistically significant difference between the frequencies of choice of emotion-words in both groups pertains to Vigour, which was significantly greater for the *high-level experts* group. As with the *Fuga*, this is possibly due to a linguistic preference.

Taken together these results confirm our second hypothesis, which stated a greater ambiguity in the emotions expressed in the *Presto*, but disprove our third and fourth hypotheses: *low-level expert* listeners did not perceive Anger in this movement, and *high-level experts* did not perceived Fear. For the *low-level expert* listener, deciding whether the stream of sixteenth-notes suggests the powerful rage of an aggressor, or the action tendency of a fearful subject in flight, may simply be a matter of point of view, as we argued with respect to *Psycho*. More problematic, however, is that the results suggest not confusion between two categories (Fear and Anger), but confusion *per se*: i.e., the emoticons may have been selected as placeholders, either because the listener is simply guessing (there being no symbol here to represent different or more finely grained emotions), or because the *Presto* expresses a sheer multiplicity of affect, defeating the selection task. The latter explanation would fit our analytical findings of the *Presto* as 'sublime' and expressive of mixed emotions.

Discussion and Conclusions

We draw five key conclusions from our empirical exercise: (i) That everyday-life emotional categories can be perceived in Bach's music, suggesting a commonality between worldly and aesthetic emotions, albeit most strongly for Sadness and Tenderness over Anger and Fear (in line, for instance, with Mohn, Argstatter & Wilker, 2010); (ii) That at least some of these categories cut across the vast historical gulf separating Baroque from contemporary culture; (iii) That these emotional ratings can be predicted through an analysis of the music's structural features at two levels: acoustic and formal; (iv) That *low-level expert*

listeners were led more by ‘surface’ acoustic features than by ‘deep’ formal features of the *Fuga*; and (v) That *high-level expert* listeners were led by both ‘surface’ acoustic features and ‘deep’ formal features of the *Fuga*.

The test, therefore, generally confirms the predictions with which we started. This was particularly the case in Study 2, where the majority of the *high-level expert* listeners selected the Anger emoticon for the *Fuga* – a bold confirmation of our hypothesis that *high-level experts* would rely on formal features over acoustic ones to determine the emotions perceived in the various pieces, whilst *low-level experts* would prefer the reverse. Even though the *high-level experts* avoided Anger emotion words (preferring the more positive attributions Vigour and Power), their selection of the Anger emoticon is still striking, despite the common findings in the literature that Anger and Fear were (a) often confused with each other in real life; and (b) rare in music. But let us explore in more detail these conclusions and their implications.

That Fear and Anger were less easily identified by the listeners is not a surprise, because these emotions are often confused with each other and are not easily distinguishable in music (e.g., Eerola & Vuoskoski, 2010; Green, Whitney, & Gustafson, 2010; Kreutz, Ott, Teichmann, Osawa, & Vaitl, 2008; Terwogt & Van Grinsven, 1988). This is also corroborated by the fact that the acoustic profiles associated with the expression of these two emotions in music (and speech) are quite similar: both are associated with fast tempi, high sound levels¹, much voice intensity/sound level variability, high pitch level, rising contours, and microstructural irregularity (Juslin & Laukka, 2003).

There is also a pair of broader questions regarding these less ‘clear’ emotions, respectively in the *Fuga* and *Presto*. The question for the *Fuga* is why *low-level expert* listeners seem to be guided more by acoustic than by formal features. Or rather, by certain acoustic features, since parameters both of anger and fear were represented in each movements. With the *Fuga*, it is possible that the primacy effect of hearing the quiet, ‘threatening’, music first overrules the later angry triple-stopping; without structural hearing, the former predominates. Conversely, to hear the *Presto*’s sixteenth-notes as ‘fleeing’ through a musical landscape requires an ability to conceptualise music as metaphorical motion

¹ Some types of fear, such as panic fear, are associated with high sound level, although milder types of fear can be associated with low sound levels.

through tonal ‘space’ (see C. Nussbaum, 2007), an ability inherent to structural, even analytical, listening. Perhaps one needs to grasp the form of the *Presto* as a totality in order to hear metaphorical ‘flight’ through it.

In some ways, this is hardly a surprise: form is typically characterised as more abstract, or harder to hear. Nearly all the *low-level expert* listeners in the first experiment had not heard this sonata before; hence were hearing it for the first time. It is possible that, with greater familiarity and knowledge about the composer and music style, they would learn to hear the music’s formal processes; and that, in due course, the emotional character of the form would eclipse that of the surface features. The music’s emotional character would ‘flip’. This possibility endows the sonata’s ‘emotional rhythm’ with yet another aspect: the emotions of the *Fuga* are not only more obscure, they are also more *dynamic*, ‘flipping’ with greater familiarity. A long term prediction would be that, with familiarity, the emotional reading of the *Adagio* and *Siciliana* would stay the same, whilst that for the *Fuga* would change. This dynamism parallels the greater vitality of *Fuga*, compared to movements 1 and 3: not only the music moves; the emotion perceived changes. Yet, the *Presto* results challenge this interpretation, as we will see below.

Let us now consider the relationship between the emoticons and the emotion-words, the two main strands of the experiments. It is possible that the forced-choice element of the emoticons committed listeners to identifying a basic emotion not because they necessarily heard it in the music, but because it was the least-worst representation of that emotion, compared to the other three choices on offer. Thus the list of emotion words then provided listeners with a freer and finer-grained outlet for their judgment. In this respect, we found a clear match between emoticons and emotion words for the *Adagio* (emoticon: Sadness; top two emotion-words: Sadness and Sorrow [low-level experts]; Melancholy and Sadness [high-level experts]) and *Siciliana* (emoticon: Tenderness/Love; top two emotion-words: Affection and Tenderness [low-level experts]; Tenderness and Affection [high-level experts]).

With two of the movements – *Fuga*, and *Presto* – the highest-rated emotion words differed from the chosen emoticons. For the *high-level expert* listeners, in both the *Fuga* and *Presto*, this deviation was dramatic: the emotion-

word Anger scored zero – the majority of listeners selecting Vigour, Power and Tension for both movements, Nervousness for the *Fuga*, and Liveliness for the *Presto*. As for *low-level expert* listeners, the emotion-words selected for the *Fuga* didn't include either Fear or Panic, with listeners preferring the more positively contoured emotions of Vigour and Power, and the ambiguously valenced Tension.

Most of the emotion words selected for the *Fuga* and *Presto* are positively valenced, in stark contrast to the negativity of their respective emoticons. This suggests that an ineliminable aspect of musical experience is aesthetic pleasure, which is hard to reconcile with negative real-world emotions such as Anger and Fear (but if so, why should Sadness – also a negative emotion – be any different?). One possible explanation for this, identified in another study (Kallinen & Ravaja, 2006, p. 206), is that, for negative emotions, positive felt emotions exceeded negative perceived emotions. Hence it may be that listeners who select positively-valenced emotion words for the *Fuga* and *Presto* are confounding perception with experience of emotion. In short, it may be hard for even *high-level expert* listeners to disentangle perception and induction of emotions.

It is also remarkable that most of the emotion words identified, by *high-level experts* and *low-level experts* alike, in the *Fuga* and *Presto*, are not clearly defined emotion categories *per se*, but instead *dimensions* of emotions, such as Power, Vigour, and Liveliness. Are listeners identifying the dynamic profile of emotions, rather than emotions themselves? But why should this be, since they select 'proper' emotions for the *Adagio* (Sadness) and *Siciliana* (Tenderness); hence the responses to the *Fuga* and *Presto* point to the particular emotions involved, rather than to a *general* problem with musical emotions. That is, why should the emotions in the *Fuga* and *Presto* be in principle any more ineffable than in the other two movements? Another possibility is that, in the context of music, Power and Tension do indeed constitute real aesthetic emotion types, rather than dimensions of emotion, which seems to be supported by the findings of Zentner, Grandjean and Scherer (2008) that these two classes of emotions are clearly important in the context of music; and, furthermore, that Tension appears to be an important "classificatory unit of musically induced affects" (p. 514).

Another approach to interpreting the results of the *Presto* is to consider that both are co-present as an affective alloy at both acoustic and structural levels. It may be the co-presence of the two emotions which makes the music's character distinctive and hard to judge. The music's aesthetic emotion is also distinctive because Tension – a dimension which is normally (i.e., in everyday life) linked to weakness and negativity – is brought into close relation with the positive qualities of Liveliness, Vigour, and Power. Interestingly, the Tension factor of the Geneva Emotional Music Scale is positively correlated with the Transcendence, Power and Joy factors, all positive clusters of emotions (see Table 4 in Zentner, Grandjean & Scherer, 2008). Perhaps such positive representations of Tension are only possible in aesthetic contexts. However, since the *high-level experts* discovered this cocktail of Tension, Liveliness, Vigour, and Power in both *Fuga* and *Presto*, how are these movements distinguishable from each other? The answer may be simply the case of these emotions being more intensely activated in the *Presto*; and, secondly, of the shifting proportions of Tension and Power (more Power in the *Fuga*; more Tension in the *Presto*). This answer would tally with the observation that acoustic features of both Fear and Anger are co-present in the *Fuga* and *Presto*, and are alternately foregrounded/selected by the musical form. The complexity of the possible *perspectival* interrelationships between Fear and Anger (e.g. the music can express fear aroused by an object's anger; or the anger itself; or physical flight in response to a threat, etc.) creates a network of possibilities. Perhaps even *high-level expert* listeners negotiate that network of perspectives in manifold ways.

That said, the wonder is not that listeners disagree with each other, but that they agree so clearly in at least two of the movements, the *Adagio* and *Siciliana*, and indeed, the *Siciliana more* so than in the *Adagio*. This result may invite us to reflect on why, in music, Sadness, and Tenderness, affiliated to Love, are perhaps more transparent emotions than Anger or Fear (see, for instance, Juslin & Laukka, 2003 and Vieillard, Peretz, Gosselin, Khalfa, Gagnon, & Bouchard, 2008).

The interesting conclusion to which we are drawn is that abstract musical emotions – emotions which are visible in the score, but inaudible in performance

– have a psychological, analytical reality. The notion of abstract emotion may perhaps seem absurd to us in the twenty-first century, especially in the realm of music. It is here, however, that the history of emotions becomes helpful (Dixon, 2003; Reddy, 2001; Spitzer, 2010); in particular, the history of how emotion was conceptualised in Bach’s era by philosophers such as Spinoza (Spinoza, 1996). The contemporary relevance of Spinoza has been demonstrated by writers as far apart as Antonio Damasio (Damasio, 2004) in neuroscience and Brian Massumi in philosophy (Massumi, 2002). Damasio’s familiar distinction between feeling and emotion draws on an ancient opposition between ‘passion’ and ‘affection’, turning on whether a subject’s emotional experience is ‘passive’ or ‘active’. For example, we can be passively in the grip of depression; by contrast, many emotions, such as hope and desire, are active expressions of a subject’s will. Historians of emotion tell us that such distinctions are not captured by modern, psychologically-orientated, accounts of emotion (Dixon, 2003). A theory of musical emotion which deals adequately with historical music, such as Bach’s, will need to re-negotiate this methodological gap. Damasio and Massumi’s notions of ‘feeling’ and ‘affect’ as preconceptual matches the baroque idea of ‘passion’. By contrast, their theory of ‘emotion’ *per se* as a more defined category doesn’t quite fit Spinoza’s concept of ‘affection’. The contrast between ‘feeling’/‘affect’ (Damasio/Massumi) and ‘affection’ (Spinoza) can be confusing. Essentially, by ‘affection’ Spinoza and his contemporaries mean the kind of emotion which may be experienced through reflection; this actually goes back to the Stoic philosophers, St. Augustine and the Church Fathers – indeed, to the venerable tradition of finding emotion through prayer and contemplation (Dixon, 2003; M. Nussbaum, 2003). We suggest that this is not too far away from the ‘deep’ emotion listeners discover by contemplating Bach’s forms analytically. This may shed light on why one of the Bach authorities in our survey – indeed, one of the most famous Bach scholar-performers in the world – selected the Tenderness emoticon for the *Presto*. Kant’s talk of the sublime arousing ‘serenity’ in the mind, as we have seen earlier, suggests how Bach’s *Presto* may induce a feeling of Tenderness in a listener at several orders of abstraction.

In short, we see that Bach’s acoustic features project the ‘passions’ of the music, whilst the formal schemata unfold its ‘affections’. Learning to hear his

profound emotional journey entails learning to hear ‘beneath’ the passions into the underlying affections. This is a hearing the analyst takes for granted. Analysis can be a beacon guiding a listener unfamiliar with this music.

Perhaps the central message of this paper is that the perception of emotions in music is linked to listeners’ level of formal training and expertise. *High-level expert* listeners may not experience music more deeply (Bigand & Poulin-Charronnat, 2006); but they can perceive different emotional categories than low-level expert listeners for the same piece of music. This is an interesting conclusion, given the wide-spread assumption that a particular musical work expresses a particular emotion, irrespective of performance style and mode of listening (Kivy, 1989). On the other hand, our results also question an opposite thesis (Leech-Wilkinson, 2013), that a work’s expressive character is overwhelmingly in the hands of the performer, commuting the score into an emotional *tabula rasa* or neutral plasma, to be shaped or inflected indefinitely. On the contrary, our experiments show an impressive degree of consistency within each respective subject group: whilst choice of emotional category was relative to expertise, it was not entirely open. At the same time, we should also stress that differences between *high-level expert* and *low-level expert* emotional identifications is not a matter of right and wrong. Hence *high-level expert* hearing of Anger in the *Fuga* does not invalidate the *low-level expert*’s identification of *Fear*. The music probably expresses both emotions (and many more); perhaps listeners’ perspectives on these emotions change as they journey along life’s pathway. This journey – encompassing a musician’s own pedagogical pathway – does not necessarily move in the direction of a *better* identification of emotions. For instance, it could even be the case that *low-level experts* perceive musical emotions more clearly and with greater immediacy than high-level experts; i.e., that analytical knowledge blocks or interferes with a more naturally intuitive relationship with the music. Such an assumption lurks behind a plethora of writings in New Musicology, with their attack on music theory (Kramer, 1995), in favour of a supposedly more ‘natural’, less ‘structural’, mode of listening associated with the nineteenth century. We leave this question open, as a subject for future research. It would also be interesting to investigate the degree that changes of emotional identification depends on the complexity of

the musical style. The prototypical example might be a work of the Second Viennese School, such as Schoenberg's Third String Quartet. We might hypothesise that the great majority of low-level expert audiences would hear predominantly negative emotions in this music, because of its great dissonance. Conversely, it is arguable that it takes much familiarity with this style of music in order to hear past these dissonances to the positively-valenced emotions it expresses – its tenderness and joy, for instance – which are certainly there. In this respect, expertise means an ability to decode a work's stylistic display rules. Exploring this process in musical Modernism would help frame our Bach experiment in a wider perspective. For example, it may be equally difficult to discern tenderness in Schoenberg as it is technically challenging to hear anger in music of the common-practice tonal period, such as Bach's. The expertise required to identify anger in the *Fuga* jibes with the results of Zentner *et al* (Zentner, Grandjean & Scherer, 2008), that anger is the rarest emotion that lay audiences feel in response to most music. Perhaps it is similarly unusual to *perceive* Anger in tonal music as is it to feel it.

Our conclusions are suggestive for future directions in music analysis. For instance, more work is needed to see whether the 'rhythm' we found in Bach's cycle of four movements, by which clear and unclear emotions alternated, was paralleled in other multi-movement cycles in the repertoire. The relative emotional confusion of movements 2 and 4 bestows Bach's sonata with a satisfying architecture, where movements of emotional clarity (*Adagio* and *Siciliana*) alternate with movements of emotional obscurity (*Fuga* and *Presto*). This 'emotional rhythm' (clear/confused) supervenes upon and consolidates the 'tempo rhythm' of slow/fast/slow/fast. This 'rhythm' suggests a new tool for emotional analysis. What can be pertinent to an analysis is not just the identification of an emotion, but the degree to which an identification is even possible. In this respect, 'clear' emotions – such as Sadness and Tenderness – can function as prototypical nodes around which less clear emotions can cluster. It would be exciting to research how variability in an emotion's clarity helps composers plan the architecture of their music.

Finally, it is important to underline the limitations of our approach and of this study in particular, as well as potential ways of dealing with these limitations.

A future study would seek to consider populations with no musical training at all. Although we do not expect differences between no expertise and low-level expertise, such confirmation may be necessary to fully support our findings. It would equally be informative to conduct the same study with a group of experts in a different music style, such as ethnomusicologists or medievalists. This might clarify the role of stylistic competence in the perception of musical emotion, as well as evaluating the role of familiarity with particular pieces in the perception of musical emotions. Also, given the age difference of the two groups investigated in this work (low-level experts' average age was 19 y.o., and high-level experts' mean age was 45 y.o.), it would be necessary to conduct the same experiment with groups of similar age in order to eliminate possible confounds associated with age. Finally, given the acknowledged confounds between the perception of fear and anger as well as the low frequency of detection of these two emotions in music, it would be ideal to conduct a new set of studies in which the hypothesized contradictions between the emotions communicated by acoustic and formal features pertain to other emotion classes.

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Table 1

Emoticons ... Note: only images were shown to participants.



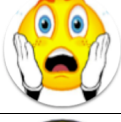
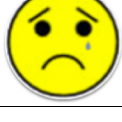
Emoticon	Emotion represented
	Tenderness/Love
	Anger
	Fear
	Sadness

Table 2

List of emotion words chosen for instrument 2.

Wonder	Sorrow
Being moved	Sadness
Inspiration	Harmony
Spirituality	Beauty
Affection	Interest
Tenderness	Sense of discovery
Melancholy	Fascination
Love	Indifference
Nostalgia	Weariness
Relaxation	Apprehension
Serenity	Scary
Power	Astonishment
Vigour	Surprise
Liveliness	Anger
Nervousness	Irritation
Tension	Fear
Thoughtfulness	Panic
Predictability	Rage

Table 3

Summary of the results of the empirical studies.

		Hypothesized emoticon	Emoticon chosen	Emotion-words chosen
Adagio	<i>low-level experts</i>	Sadness	Sadness (81%)	Sadness (70%), Sorrow (70%) Melancholy (46%), Tension (43%).
	<i>high-level experts</i>	Sadness	Sadness (74%)	Melancholy (74%), Sorrow (58%) Tension (42%), Sadness (35%) Tenderness (32%), Being Moved (32%)
Fuga	<i>low-level experts</i>	Fear	Fear (57%)	Tension (57%), Liveliness (35%), Power (35%)
	<i>high-level experts</i>	Anger	Anger (58%)	Vigour (68%), Power (58%) Tension (58%), Nervousness (32%).
Sicilina	<i>low-level experts</i>	Tenderness/ /Love	Tenderness/ /Love (65%)	Affection (43%), Tenderness (41%) Beauty (38%), Love (30%) Relaxation (30%)
	<i>high-level experts</i>	Tenderness/ /Love	Tenderness/ /Love (71%)	Tenderness (77%), Affection (48%) Serenity (45%), Thoughtfulness (45%).
Presto	<i>low-level experts</i>	Anger	-	Liveliness (65%), Vigour (57%) Power (43%), Tension (35%)
	<i>high-level experts</i>	Fear	Anger (52%)	Vigour (90%), Liveliness (71%), Tension (48%), Power (39%)

Figure 1.
Adagio, measures 1-4



Figure 2.
Siciliana, measures 1-6



Figure 3.
Fuga, measures 1-7



Figure 4.
Presto, measures 1-12



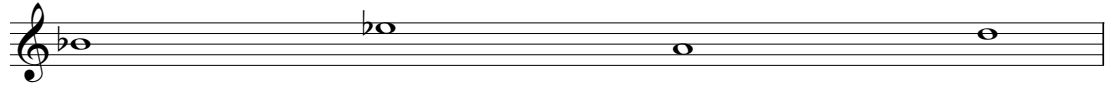
Figure 5.
Vivaldi, *Violin Concerto Op. 3 No. 6, Largo*, measures 1-6

The image displays a musical score for the first six measures of the Largo movement from Vivaldi's Violin Concerto Op. 3 No. 6. The score is written for a violin (VI.1) and a basso continuo. The tempo is marked "Largo" and the dynamics are "pp sempre". The key signature is one flat (B-flat major/D minor) and the time signature is 3/4. The violin part features a melodic line with sixteenth-note patterns and rests, with fingerings 3, 6, and 2 indicated above measures 1, 2, and 3. The basso part provides a harmonic accompaniment with a steady bass line, with fingerings 4 and 5 indicated above measures 4 and 5.

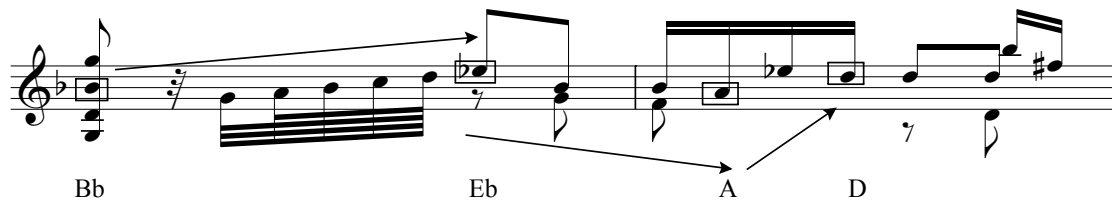
Figure 6.

Bach's inflections of the 5th cycle in the Fortspinnung module of his schema

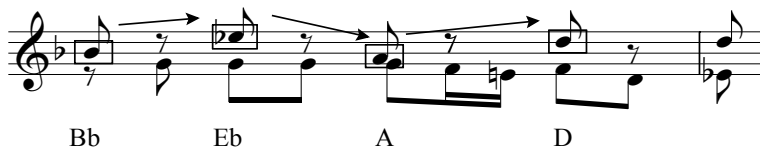
Fifth Cycle



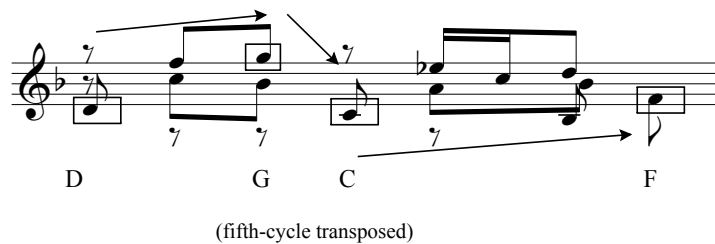
Adagio



Fuga



Siciliana



Presto

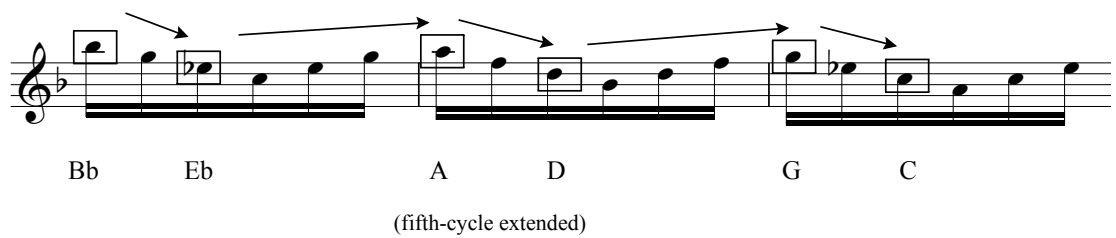


Figure 7.

J. S. Bach 'Eilt, ihr angefocht'nen Seelen', *St John Passion*, measures 17-23

Musical score for measures 17-23 of 'Eilt, ihr angefocht'nen Seelen' by J.S. Bach. The score is in 3/8 time and B-flat major. It features five staves: Violin 1 (VI. 1), Violin 2 (VI. 2), Viola (Vla.), Bass (Basso), and Continuo (Cont.). The lyrics are: Eilt, - - - eilt, eilt, eilt, ihr an - ge - focht' - nen

Musical score for measures 23-24 of 'See - len, ihr' by J.S. Bach. The score is in 3/8 time and B-flat major. It features five staves: Violin 1 (VI. 1), Violin 2 (VI. 2), Viola (Vla.), Bass (Basso), and Continuo (Cont.). The lyrics are: See - len, ihr

Figure 8.

a) *Hypermetrical reduction of Presto, bars 1-6*

Hypermetrical disruption
↓

b) *Metrical reduction of bars 6-8 of Presto, revealing syncopation*

Figure 9.

Number of subjects choosing each of the emoticons to describe the emotions perceived in all four movements. The full line indicates the necessary proportion of low-level expert subjects to consider the selection of each emoticon significantly above chance level (41%; $p < .05$, two-sided confidence intervals for all tests). The dashed line indicates the same quantity for the high-level expert subjects (42%; $p < .05$). Significant differences between the frequencies of chosen emoticons by each group (obtained with Fisher's Exact Test for Count Data) are also indicated.

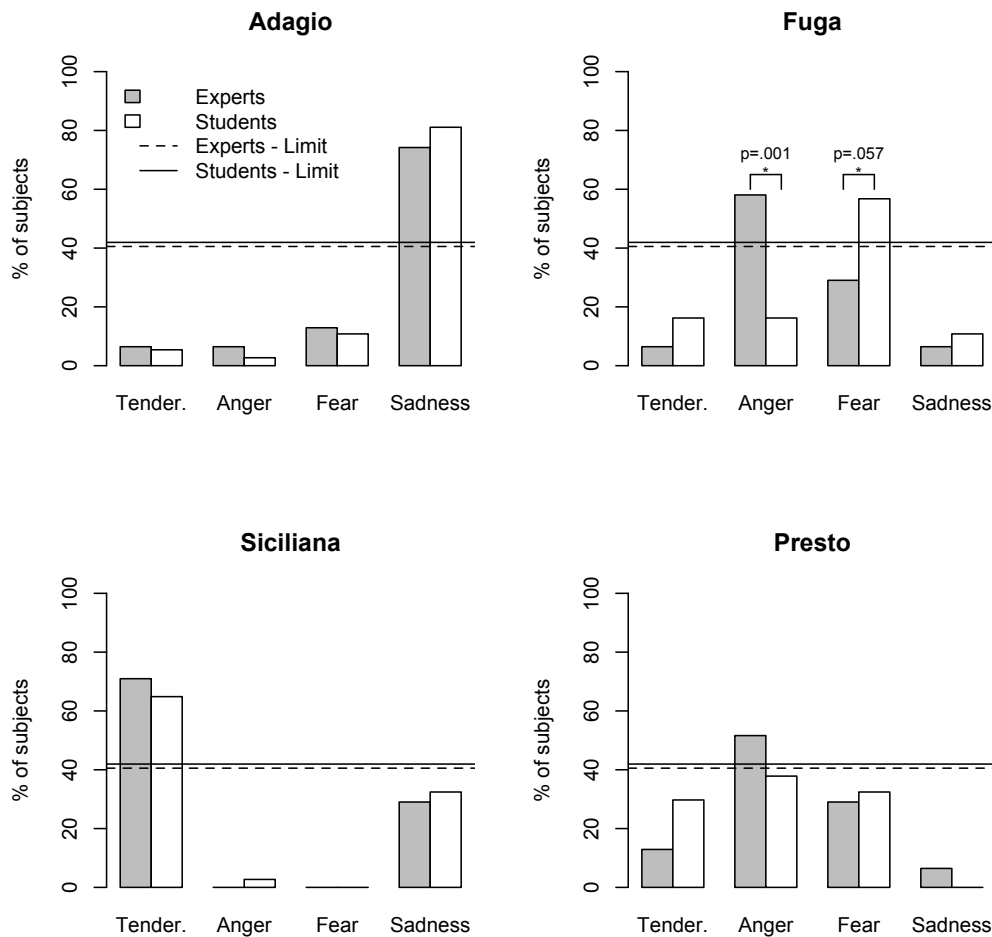


Figure 10.

Number of subjects choosing each of the emotion-words to describe the emotions perceived in the Adagio. The full line indicates the necessary proportion of low-level expert subjects to consider the selection of each emoticon significantly above chance level (27%; $p < .05$). The dashed line indicates the same quantity for the high-level expert subjects (29%; $p < .05$). Significant differences between the frequencies of chosen words in each group (obtained with Fisher's Exact Test for Count Data) are also indicated.

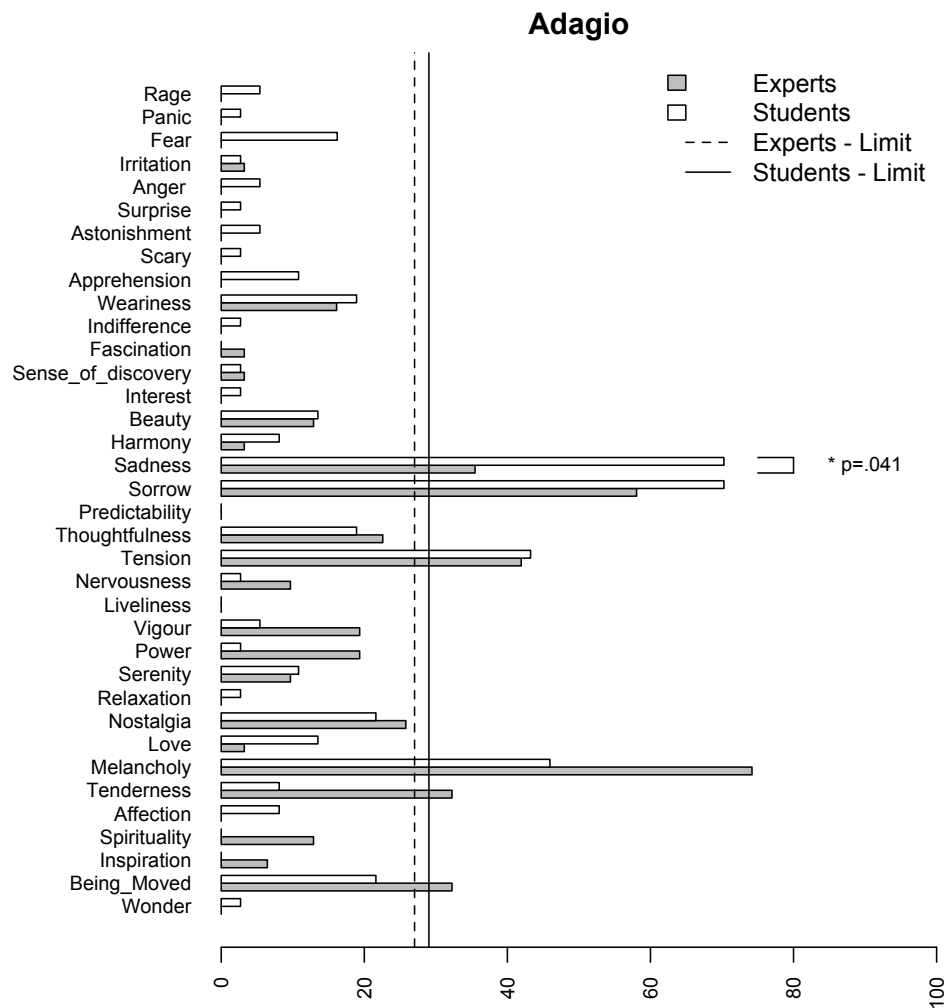


Figure 11.

Number of subjects choosing each of the emotion-words to describe the emotions perceived in the Fuga. The full line indicates the necessary proportion of low-level expert subjects to consider the selection of each emoticon significantly above chance level (27%; $p < .05$). The dashed line indicates the same quantity for the high-level expert subjects (29%; $p < .05$). Significant differences between the frequencies of chosen words in each group (obtained with Fisher's Exact Test for Count Data) are also indicated.

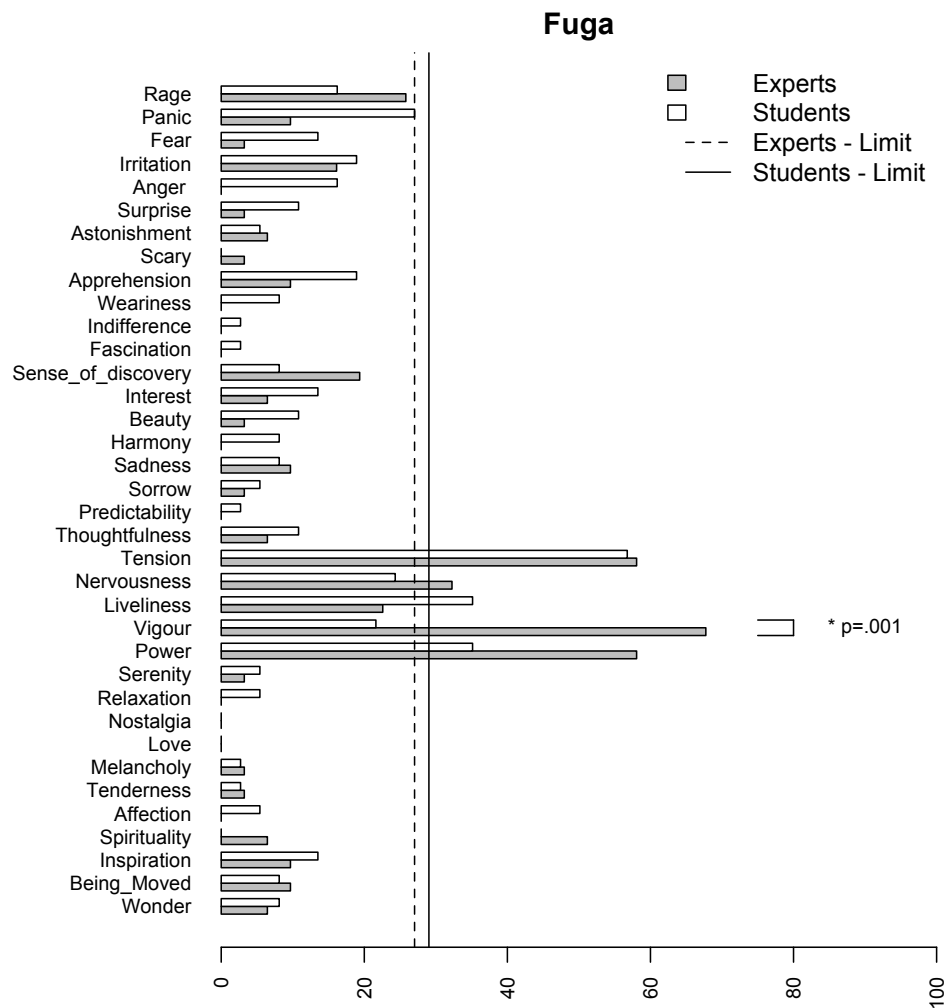


Figure 12.

Number of subjects choosing each of the emotion-words to describe the emotions perceived in the Siciliana. The full line indicates the necessary proportion of low-level expert subjects to consider the selection of each emoticon significantly above chance level (27%; $p < .05$). The dashed line indicates the same quantity for the high-level expert subjects (29%; $p < .05$). Significant differences between the frequencies of chosen words in each group (obtained with Fisher's Exact Test for Count Data) are also indicated.

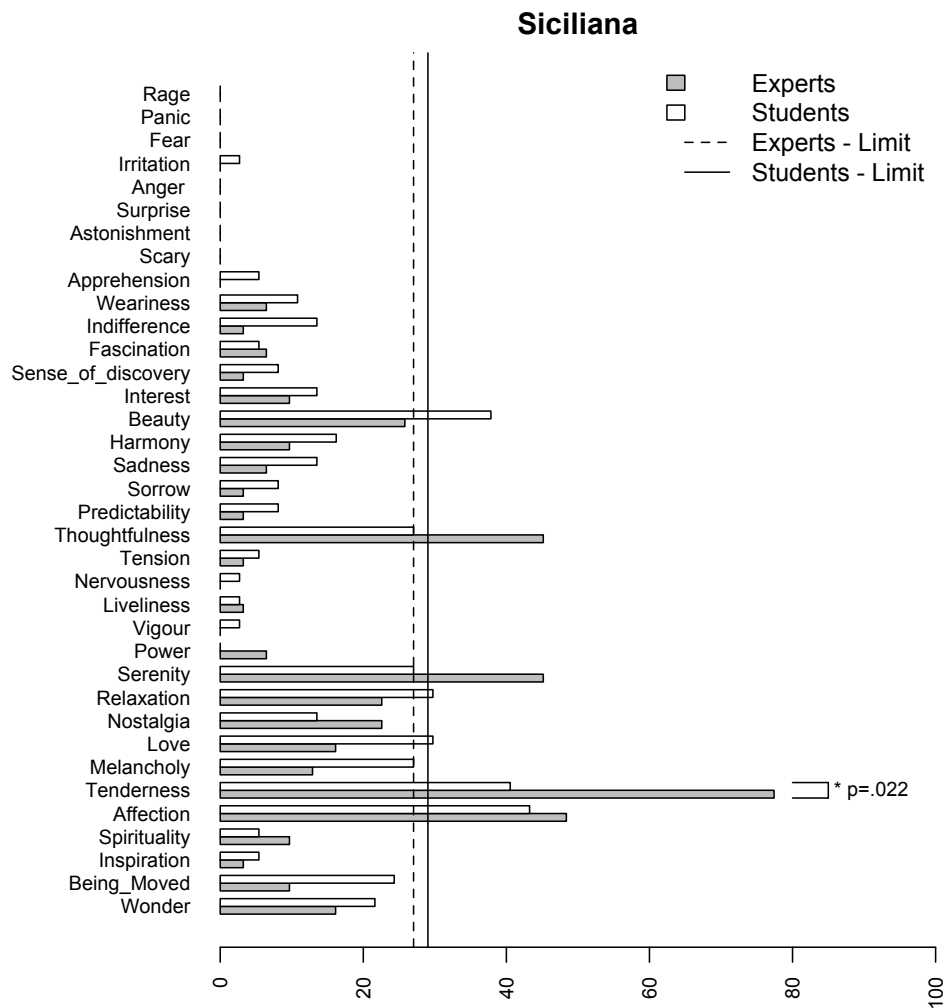


Figure 13.

Number of subjects choosing each of the emotion-words to describe the emotions perceived in the Presto. The full line indicates the necessary proportion of low-level expert subjects to consider the selection of each emoticon significantly above chance level (27%; $p < .05$). The dashed line indicates the same quantity for the high-level expert subjects (29%; $p < .05$). Significant differences between the frequencies of chosen words in each group (obtained with Fisher's Exact Test for Count Data) are also indicated.

