Exegesis

The rationale for this portfolio of original compositions was to investigate ideas in relation to the use of dissonance, and in particular harmony, to represent the concept of darkness in an emotional and visual sense. Through the portfolio the ideas, formulas and techniques that are displayed will develop from piece to piece showing a fruition of complex and inventive systems for using harmony. In conjunction with these harmonic systems, aspects of musical structure that include texture, timbre, dynamics, and rhythm, will facilitate the composition's relationships with darkness. The portfolio consists of five works: two for large ensembles, *The Close Corridors* and *Symphony 2 'The Caves'*, endeavour to evoke a visual darkness, both being underground landscapes. The three smaller chamber works, *Limbus Infantium, Nocturne* and *Voices*, explore the dark side of child psychology with themes that include dreams, phobias and perceptions.

To understand the psychological effect that particular harmonic intervals have on the mind, extensive reading was undertaken and the findings were tested through the compositions in the portfolio. The research investigation for this portfolio looked at theories of dissonance in Western Music from the nineteenth through to the late twentieth century, including those of Helmholtz, Stumpf, D. D. Greenwood and Cooke. Although the emphasis on this portfolio was an emotional concept of darkness, it was felt necessary to explore scientific and acoustic approaches to consonance and dissonance. These investigations led to theories of a physiological nature, and then were linked back to those concepts of dissonance relative to the emotional and psychological sense.

The German acoustician and physicist Hermann Helmholtz devised a theory ranking harmonic intervals from most consonant to most dissonant. In his 1863 publication *On the Sensations of Tone: As a Psychological Basis for the Theory of Music*[1] he suggested that intervals having the property of consonance contain upper partials or harmonics which coincide to a high degree and therefore do not produce beats. The alignment of upper partials is greatest between two tones whose frequency ratios yield simple integers, such as 3:2 (perfect fifth) or 5:4 (major third).[2] Conversely, dissonant tones contain harmonics which do not coincide, but which occur sufficiently close together to produce 'beats'. As the dissonance increases the number of beats per second increase, up to a maximum of 33 beats per second. 'The most perfect chord is the unison, for which both compound tones have the same pitch. All partial tones coincide, and hence no dissonance can occur.'[3]

By the middle of the twentieth century more precise psychoacoustic experiments and computer modelling enabled researchers to take a much closer look at dissonance. D. D. Greenwood's seminal research (1961) did support Helmholtz's theory of beats but linked it to the critical band.[4] Greenwood used the term 'sensory dissonance'. Critical bands are frequency ranges in which one pitch will mask another pitch. R. Plomp and W. J. M. Levelt (1965) extended this concept further by generating pairs of sine waves and asking volunteers to rate those in terms of consonance hence creating dissonance ratings based on critical bands.[5] Plomp and Levelt estimated that

[1] Hermann Helmholtz. *On the Sensations of Tone: As a Physiological Basis for the Theory of Music*. (New York: Dover, 1954.) 179-197.
[2] Burdett Green and David Butler. 'From Acoustics to Tonpsychologie.' *The Cambridge History of Western Music Theory*. ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002) 260.
[3] Helmholtz. op. cit., 187.
[4] D. D. Greenwood. 'Critical bandwidth and consonance: In relation to cochlear frequency-position coordinates.' *Hearing Research*. 54 (1991)
[5] Keith Mashinter. *Calculating Sensory Dissonance: Some Discrepancies Arising from the Models of Kameoka & Kuriyagawa, and Hutchison & Knopoff.* February 2006.

pure tones produce maximum sensory dissonance when they are separated by about 25% of a critical bandwidth. However, their estimate was based on a critical bandwidth that is now considered to be excessively large, especially below about 500 Hz. D.D Greenwood (1991) "Critical bandwidth and consonance: In relation to cochlear frequency-position coordinates." from the journal *Hearing Research,* has estimated that maximum dissonance arises when pure tones are separated by about 40% of a critical bandwidth.[6]

A theory offering some significant objections to Helmholtz's views was put forward by German philosopher and psychologist Carl Stumpf in 1898[7]. His main point of objection was that consonant intervals could produce beats and dissonant intervals would not. He proposed the concept of tonal fusion. This physiological theory was based on the observation that in experiments where subjects had to identify whether one or two tones were sounding, the more incorrect responses were those tones that were consonant. Subjects would, for example, state that in an octave there was just one tone sounding, whereas a major second was identified as two tones. The results from the experiment allowed Stumpf to define degrees of consonance. This theory of consonance and dissonance rests not on the physical qualities of tone, but on the manner in which listeners experience tones.

The following table compares harmonic rankings from consonant to dissonant according to Helmholtz and Stumpf. These harmonies are within the compass of an octave, however, in Helmholtz's and Stumpf's rankings, the unison is not featured;

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http://emusicology.org/v1n2/temp-pdfs/EMR000007a-mashinter.pdf

[6] D. D. Greenwood. op. cit.,164 -208.

[7] Carl Stumpf. *Konsonanz und Dissonanz* (Beitrage zur Akustik und Musikwissenschaft, 1898) 91-107.

Table 1: *Comparison of Helmholtz's and Stumpf's consonance and dissonance rankings* [8]

Most Consonant		**Helmholtz**	**Stumpf**
	Octave	1	1
	Perfect 5th	2	2
	Perfect 4th	3	3
	Major 3rd	=4	5
	Diminished 5th	=4	=8
	Major 6th	=6	4
	Minor 6th	=6	7
	Minor 7th	=8	10
	Minor 3rd	=8	6
	Major 2nd	10	=8
	Major 7th	11	11
	Minor 2nd	12	12
Most Dissonant			

Schoenberg's views on dissonance represent the relationship between physiological and emotional concepts, 'The material of music is the tone, what it affects first, the ear. The sensory perception releases associations and connects tone, ear, and the world of feeling.'[9]

[8] Davies. op. cit., 158.
[9] Arnold Schoenberg. *Harmonielehre.* (London: Faber and Faber, 1978) 19.

For the purpose of this investigation it was important to understand these objective views of consonance and dissonance before embarking on psychological theories, so as to explain in more objective terms, the reasons behind the use of dissonance in the compositions. The following psychological concepts of harmonic intervals are the links between these early theories and the compositions and conjectures of an emotional nature that were a part of the rationale for this portfolio.

The British musicologist Deryck Cooke in his book *The Language of Music*[10] gives a subjective attempt to explain the phenomena of consonance and dissonance. His views refer to the emotional context of harmonic intervals in relation to the functional tendencies of those intervals. He isolated the basic expressive functions of all twelve notes of the equal tempered scale. His views are as follows:

Table 2: *The tonal functions of harmonic intervals of the equal tempered scale as defined by Cooke.*

1. **Tonic**: Emotionally neutral; context of finality.
2. **Minor Second**: Semitonal tension down to tonic, in a minor context: spiritless anguish, context of finality.
3. **Major Second**: As a passing note, emotionally neutral. As a whole-tone tension down to tonic, in a major context, pleasurable longing, context of finality.
4. **Minor Third**: Concord, but a 'depression' of natural third: stoic acceptance, tragedy.
5. **Major Third**: Concord. Natural third: joy.

[10] Deryck Cooke. *The Language of Music*. (Oxford: Oxford University Press, 1959)

6. **Perfect Fourth**: As a passing note, emotionally neutral. As a semitonal tension down to the major third, sorrow.
7. **Sharp Fourth**: As modulating note to the dominant key, active aspiration. As 'augmented fourth', pure and simple, devilish and hostile forces.
8. **Dominant**: Emotionally neutral; context of fluctuation, intermediacy.
9. **Minor Sixth**: Semitonal tension down to the dominant, in a minor context: active anguish in a context of fluctuation.
10. **Major Sixth**: As a passing note, emotionally neutral. As a whole-tone tension down to the dominant, in a major context, pleasurable longing in a context of fluctuation.
11. **Minor Seventh**: Semitonal tension down to major sixth, or whole-tone tension to minor sixth, both unsatisfactory, resolving again down to the dominant: 'lost' note, mournfulness.
12. **Major Seventh**: As a passing note, emotionally neutral. As a semitonal tension up to the tonic, violent longing, aspiration in a context of finality.[11]

One will observe, in Cooke's scrutiny of the above intervals, those intervals that in objective theories are rated as more dissonant. Here they are given adjectives that are related to the darker emotions of human character. These are, though, associated to vertical dissonance. Horizontal dissonances of these intervals, i.e. passing notes, do not have the same emotional character. Cooke describes that the ascending passing note, whether in a minor or major context, is one of an outgoing emotion. The descending passing note is of an incoming emotion. Cooke's views on the elements of musical expression through harmony, however, are partly flawed. He quotes musical examples that, for the most part, are from pre-twentieth century repertoire. Also he

[11] Cooke. op. cit., 89-90.

fails to appreciate the view that different intervals and chords could have different 'meanings' in the context of other works. For example a rising minor third, A - C, in an F major chord could have a different emotional feel than the same interval in a D major chord. Furthermore, this interval played in a low tessitura, with a certain timbre, could produce an emotional response different from other timbres and tessituras.

The expressive qualities of music have been a matter of disscussion by music psychologists. The most emprical research has focused on emotional expression in attempts to find out which factors in music contribute to the perceived emotional expression. These factors in the composed musical structure are represented in the musical notation, such as tempo, loudness, pitch, mode, melody, rhythm, harmony, and various formal properties.[12] Cooke refers to timbre and texture enhancing tonal tensions as 'vitalising agents'.

We could also consider the cultural aspects of perceiving dissonance. These can include epoch, 'It all simply depends on the rowing ability of the analysing ear to familiarise itself with the remote overtones, thereby expanding the conception of what is euphonious...what today is remote can tomorrow be close at hand'.[13] Schoenberg's view is a valid one. What one found dissonant in the early twentieth century might be considered less dissonant, or even consonant in the twenty-first century.

[12] Patrik N. Juslin, and John A. Sloboda, *Music and Emotion*. (New York: Oxford University Press, 2001.) 223
[13] Schoenberg. op. cit., 21.

An important aspect of the research in this portfolio was to study composers and compositions that follow a similar aesthetic direction to mine. Scottish composer James MacMillan specialises in dissonance - musically, culturally and spiritually.[14] His *Symphony: Vigil* deals with the progression from darkness to light, in emotional terms from despair to joy. The work is programmatically centred on the resurrection of Jesus Christ. MacMillan uses techniques such as timbre, tessitura, and harmonic dissonance to suggest the darkness in the opening bars of the first movement. The scoring of low, divided cellos and double basses is a similar technique used in my Symphony No.2 *The Caves*. The use of semitones and tones are prominent in the sustained notes. The cor anglaise melody, entering on the notes G#, A, and C#, is, programmatically speaking, reminiscent of Cooke's minor sixth definition: active anguish in a context of fluctuation. When light does arrive, MacMillan uses bright timbres such as the antique cymbals, high violins and rasping off-stage brass. The interjections that evoke the light are harmonically more consonant with a greater emphasis on thirds. The rhythm, although complex at times, is more prominent and accented in striving for the brightness of illumination.

Bartók, like MacMillan, uses similar techniques to communicate the idea of colour in his opera *Bluebeard's Castle*. Of the seven large doors in the castle, the two most extreme, in terms of the illumination beyond, are doors five and seven. Door five reveals a glittering cascade of light. Bartók uses block major chords, at a fortissimo dynamic, with wide-scoring orchestrations. The flutes and violins are heard in their upper register, and all strings are marked tremolando. The dynamic use is heightened by pianissimo passages between the grandiose, block chords. Contrast this with door

[14] Rev. Dr Robert Anderson *Education Should Not Indoctrinate* http://news.scotsman.com/opinion.cfm?id=166452005

seven, a darkened room, with a silvery moonbeam. Bartók this time scores a sustained C minor chord in the low, muted strings. The dynamic is pianissimo, there are no accents, but now tenuto markings. The melodic material in the horns and cor anglaise have chromatic inflictions around the tonic note C. The rhythm is of less importance than of door five, it is compound, and at times ambiguous.

To summarise, it could be said that to represent the concept of darkness in a visual sense, one must first be aroused in such a way as to experience an initial emotion. It is important to note that in all of the theories studied, acoustic, physiological and psychological, the characteristics that define consonance and dissonance are not too dissimilar. These can demonstrate a conflict of integer tonal ratios, complex frequencies within a critical bandwidth, or a psychological unsettledness provoking negative emotions. Regardless of which theoretical concept of dissonance I may regard as more correct, subjective or objective, the theories that were studied have directly affected the compositional aesthetic and technique on the works in the portfolio. Dissonance in musical structural elements such as timbre, rhythm, texture, and dynamic, has played a large part in all of these works. The vertical spacing of harmonic dissonances was given great consideration after studying acoustic and physiological theories. Cooke's theory of intervals and their emotional context was demonstrated particularly in *Limbus Infantium.* The five compositions are now analysed in this exegesis, with a view explaining how these techniques have been implemented to evoke darkness.

The Close Corridors

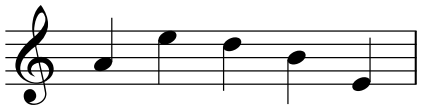
The first composition to be completed during the candidature was *The Close Corridors,* scored for a fourteen-piece chamber ensemble. The work is based on a history of the seventeenth-century close in Edinburgh's old town, Mary King's Close. It was one of the worst affected areas in Edinburgh during the outbreak of the plague in 1645. Today, Mary King's Close is a major tourist attraction in Edinburgh. A section of the close still exists under the City Chambers and guided tours are frequent. It is Edinburgh's most tragic and haunted place.

In a rather simple technique, in comparison with the later works in the portfolio, harmonic intervals were taken from the themes of each section within the piece, these intervals being both dissonant and consonant. This treatment of harmony was then implemented along with subtle textures in scoring to create the atmosphere that was sought. The work is structured in four sections with a bridge passage between the second and third sections (which is a short version of section A). The themes for each section are based upon the following pitch sets:

Mus. Ex. 1 *Pitch collections for the three sections of The Close Corridors*

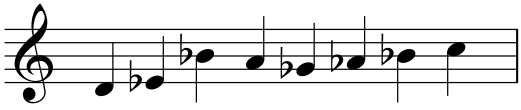
Section A

a)

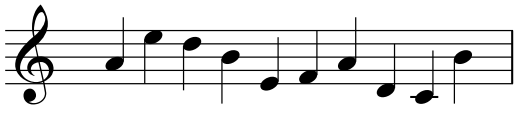


Section B

b)



Section C

c) 

The Close, and the rooms that adjoin, each have a distinct ambience, in both a psychological and atmospheric manner. The Close itself is cold and dry, the walls bare and the floor dusty. The story of the Close and the plague, as told by our guide, was both depressing and tragic.

The first theme develops slowly through the opening section; each note of the theme enters in order until all are present. This creates a static harmonic rhythm, evocative of the underground time capsule. The primary objective of the first section was to create a wafting blanket of sound. Entries were to be unobtrusive apart from the col legno strings. The dissonance was to be used subtly, and to help achieve this an open voicing of the minor second resulted in a major seventh or minor ninth. For example, the upper string writing in b.31 displays two major sevenths. This projects not only a thinner texture, but avoids the Helmholtz ‘beats’. It is a feature of this section that dissonances within instrumental families are scored at an expanded level to ensure there are very few semitonal clashes of similar timbres.

The first room adjacent to the Close was small, and extremely cold and dark. This room is not often opened to the public. It is the one room in the Close that has generated severe illness amongst members of the public. The stories we were told about this room, and its supernatural activities, dated back to 1645. It was envisaged that this second section would convey a feeling of intimidation, of being unwelcome. Therefore a substructure was organised where smaller sections, contrasting in style, created an unsettled and

moody atmosphere. The dissonances are perceived as harsher due to the scoring. The minor seconds, derived from the first four notes of the second theme, are scored close together. However, it is the character of the music that projects the roughness in a violent manner. The rhythms are at times complex, but come together in heavy chord clusters. There are contrasting moments of relatively uneasy calm at b.155. The chords here are augmented, but along with stylistic relief comes harmonic consonance. Cooke's 'vitalising agents' are present in this section. The timbre is varied by the brass mutes and string techniques such as pizzicato and sul ponticello. The texture is much thicker and changeable.

In the final small room there is a bricked-up window where the ghost of a little girl has been seen. It was a sad story that we were told by our guide, about an innocent, restless soul. The room was well lit, and at a fireplace were many gifts of dolls and toys left by visitors over the years. This section of the piece is intended to project a lighter, more transparent texture, with occasional passages of dissonance reminiscent of the tragedy. Again, as with the two previous sections, the first four notes of the theme play a large part in the ambience of the section. In this case there is a strong pentatonic feel to the lyrical music. In spite of cases like b.229 in the piano, the dissonance of the major second is not seen as harsh or dark. Although according to Stumpf and Helmholtz it is ranked toward the 'most dissonant', Cooke however refers to it as 'a pleasurable longing'. Perhaps the major second is one example of the contradiction of psychological effects of dissonance compared with those theories of an acoustic and physiological nature. Regarding this section's theme, the rising perfect fifth was used to keep a 'constant' running through the work which allowed a better chance to display the different effects of the dissonances as the similar themes are subject to differing dissonances, like the control in an experiment. The minor ninths reappear in the coda, a sign of the impurities in this place.

The next composition followed a similar use of harmony as the previous work. However on this occasion it was decided to use harmonies not directly related to the themes but use dyads and triads in an emotional context from Cooke's definitions of harmonic intervals. The subject matter revolved around a disturbing dream of a young child and was scored for flute, harp, piano and treble voice.

Limbus Infantium

Limbus Infantium (or *Children's Limbo*) is a place, according to Roman Catholic theology, between Earth and Heaven where the souls of young children and infants dwell when they have died before being christened or baptised, and have been too young to commit sin. Because the 'original sin' has not been washed away through baptism the soul can never reach the glory of the Kingdom of Heaven. Instead, they exist in a place of limbo, never to find eternal Paradise. No matter where one roams, the end will always be at the beginning. It is worth noting that the nature of Limbus Infantium is speculation: the Church has no clear revelation on this matter.

The music is structured in arch form A B C B_1 A_1, and the theme, first played on the harp, is subjected to different harmonic dissonance in each section. The theme centres around the note C#; a small drift away leads only to a hollow drop of a minor ninth before returning to the C# with a final small sigh.

Mus. Ex. 2 *Pitch collections for the main theme of Limbus Infantium*

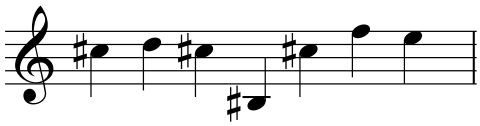


Table 3: *Sectional dissonances used in Limbus Infantium*

Section A – dyad - two notes a minor ninth apart

Section B – triad - a fundamental note and two notes a perfect fifth and a minor sixth above that note

Section C – dyad - two notes a tritone apart

Section B_1 – triad - a fundamental note and two notes a perfect fifth and a minor sixth above that note

Section A_1 – dyad - two notes a minor ninth apart

In an attempt to create a place of sadness, and of darkness, the above intervals were chosen in relation to Deryck Cooke's emotional characteristics of harmonic intervals. Each dissonance used is a semitone away from a perfect interval, just one small step from, programmatically speaking, Paradise. However this is never achieved, just like the infant's soul never reaching Heaven. Cooke's term of 'anguish' relates the dissonances of the minor second and the minor sixth. It is also appropriate, for this work, that he uses the term 'devilish forces' to describe the tritone which will be explained soon.

The harmonic rhythm in section A is static. The dissonance of the minor ninths and minor seconds remains with the pitches C# and D throughout. The use of the crescendos and diminuendos heighten the dissonance along with the melismatic vocal line. The anticipated emotional effect of these dynamics was that of a sigh, a childlike whimper.

The dissonance of section B works on the unfulfilled resolution of the minor sixth to the perfect fifth. Here we have the 'anguish' that Cooke describes in the semitone, however the emotionally neutral fifth, and its context of fluctuation, means that the resolution (that never occurs), will be to the dominant and a lesser psychological feeling of stability. The minor sixth, in the context of the tonic, is from an objective view relatively consonant (according to the Helmholtz and Stumpf table), and a second inversion of the triad would in fact give a major seventh chord (minus the fifth). The treatment of the melodic material is the aspect of this section that, beyond the harmony, evokes the negative emotions.

Section C, and the augmented fourth (the *diabolis in musica*) is, programmatically speaking, where the infant is furthest away from Paradise. The violent nature of the instrumental lines in this section is accompanied by the timbral effects in the piano and harp.

The ideas that were formulated for the previous two compositions developed further with study into child psychology and in particular children's phobias. This was to be the subject matter of the next piece, a chamber work for brass sextet, percussion and recorded text. The use of harmony was more complex, and the use of harmonic cells was developed to be employed in a justified context. The notion of harmonic cells is a

technique in tonality that has been used extensively in the twentieth century. A cell may operate as a kind of microcosmic set of fixed intervallic content, used either as a chord or as a melodic figure or as a combination of both.[15] The use of these cells in the following composition is of a fairly conservative nature, however this technique is extended much further with the subsequent works in the portfolio. The compound construction of cells develops from the practice of composers such as Varese and Takemitsu. Varese's *Octandre* and Takemitsu's *A Flock Descends into the Pentagonal Garden* were two works which were studied demonstrating these compound harmonic cells.

Nocturne

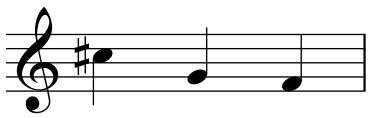
Nyctophobia is a fear of the darkness or night and is associated with the fear of uncertainty, helplessness and a sense of unfamiliarity because things look different in the dark. Children often develop a fear of the dark at about two years of age. Their first fears of darkness are associated with separation from their parents. Fear of the dark may be partly produced by the sense of being alone. Older children commonly say they hear noises or see images and may imagine ghosts or monsters. As children mature, most lose their fear of the dark, but if they do not outgrow their normal fear, it may develop into a phobia in which darkness has unconscious symbolic significance or is associated with danger or threat.[16]

[15] George Perle, *Serial Composition and Atonality: An Introduction to the Music of Schoenberg, Berg, and Webern*. (University of California Press, 1962)
[16] Ronald M. Doctor and Ada Kahn. *The Encyclopaedia of Phobias, Fears and Anxieties* (New York: Facts on File, 1989) 121.

The work sets out to convey the development of nyctophobia through the body and mind of a woman who, through the recorded text, relives her fears both in the present and in the past as a young nine-year-old girl.

The phobia motif is a simple three-note motif derived from the word phobia using the three syllables to determine pitch and intervals i.e. **F**o – **B**i – **A**. However due to difficulties in scoring, the motif was transposed and now begins on the pitch of C#.

Mus. Ex. 3 *Pitch collections for the 'phobia' motif of Nocturne*

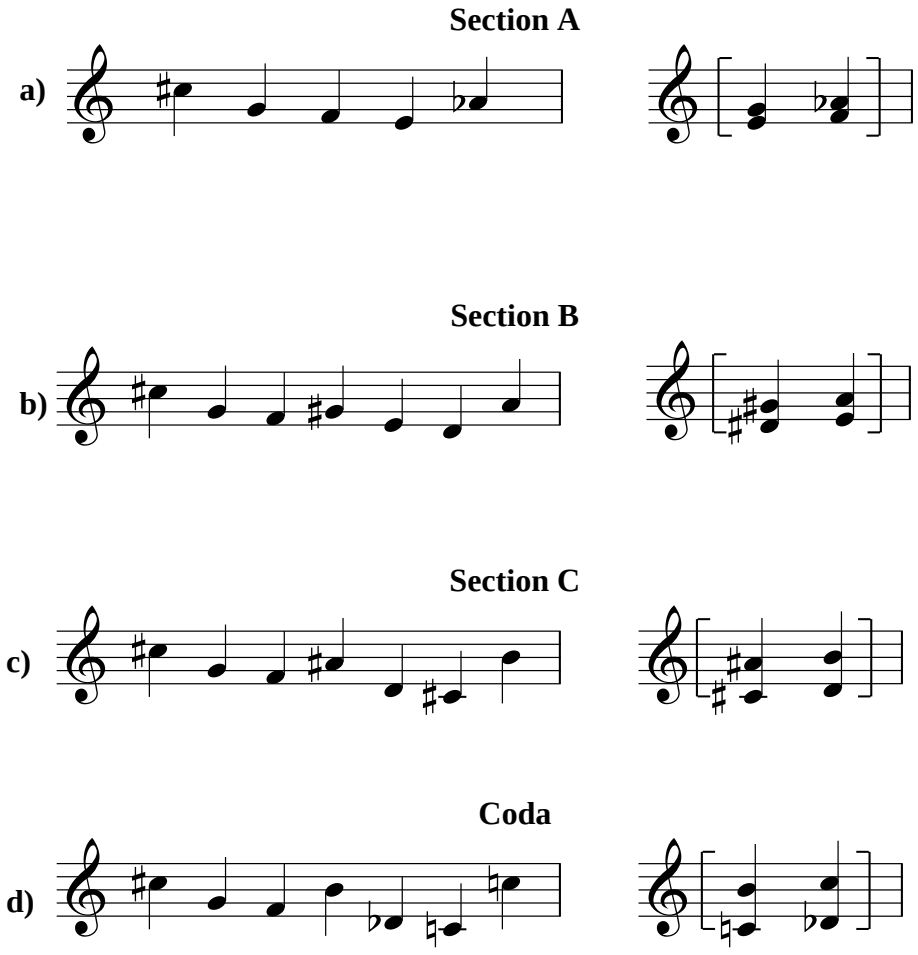


Themes and harmonic cells

The first three notes (phobia motif) remain constant, the remaining notes being divided into high and low expanding either up or down. Each of these, as you will observe, expands outwards firstly by a semitone, then a tone, and finally a semitone (a quasi intervallic swell). The extra two notes added for section B derive from the last four notes of section A, therefore the tone between the G and F has now become a major third between the G# and E expanding outwards a semitone. This is a similar harmonic technique to that used by Takemitsu in his work *A Flock Descends into the Pentagonal Garden*. In a pentatonic mode three notes of the scale are developed

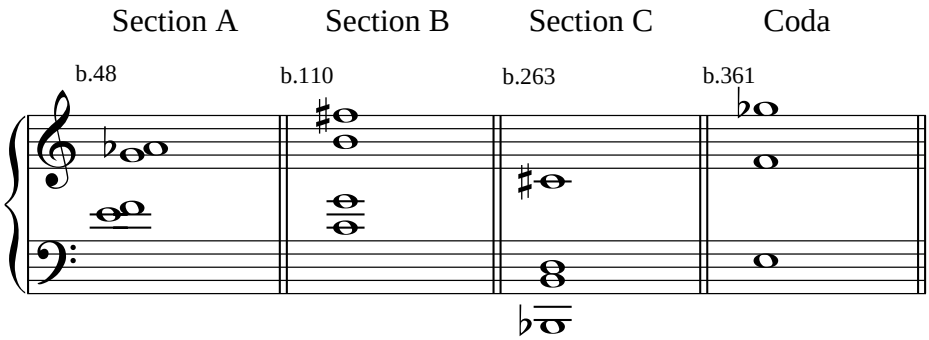
downwards (C#, Eb and F#), the other two notes being developed upwards (Ab and Bb).[17]

Mus. Ex. 4 *Pitch collections and harmonic cells for the four sections of Nocturne*



[17] Noriko Ohtake. *Creative Sources for the Music of Toru Takemitsu.* (Cambridge: Scholar Press, 1993) 30-31.

Mus. Ex. 5 *The use of the four harmonic cells in Nocturne*

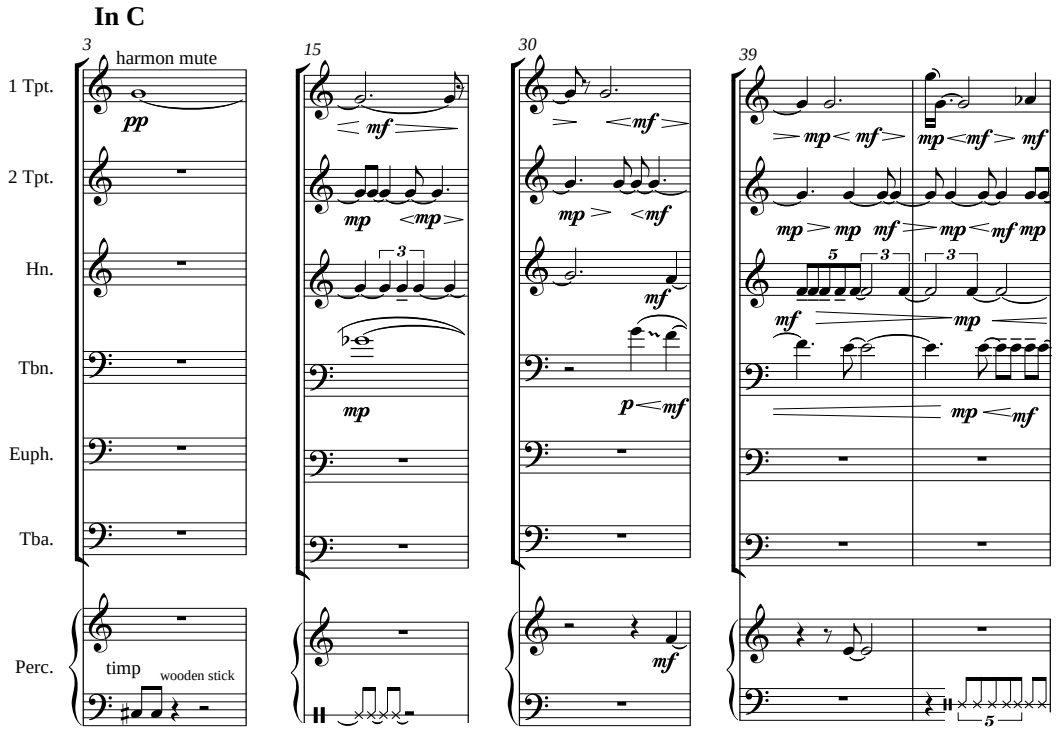


‘Swells’

The ‘swells’ or pulses that occur prominently throughout the composition relate to the onset and development of the phobia. The fear and panic that cause the physical symptoms of Nyctophobia do not necessarily remain constant. There can be periods of rest or rationality where the sufferer may realise the ‘immature’ nature of the situation. These swells are, at times, a combination of dynamics, texture, rhythmic complexity and dissonance.

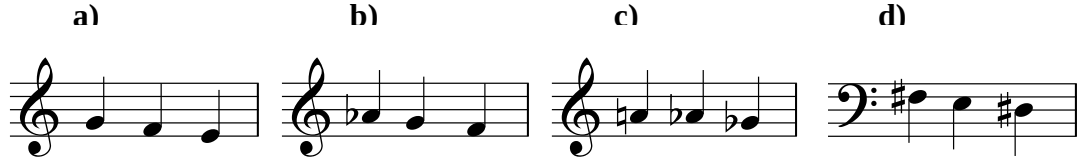
In section A, the first note G is seen as the starting point of the dissonance that spreads outwards and it is accompanied by the C# (the first two notes of the phobia motif). Gradually the third and final note of the motif, F, appears in b.24 via the Gb. The dissonance is spreading, as is the phobia, and we hear the E in the trombone and vibraphone at b.39, and finally the Ab in the first trumpet at b.40.

Mus. Ex. 6 *Gradual increasing of dissonance in the opening section of Nocturne*



Up to this point the pitch has been exclusively from the theme, starting out as a single tone and moving to a harmonic cluster range of a major third but as the section builds to a climax at b.66 these notes expand outwards, Ab becoming A natural in the trumpet, F to Gb in the horn, and in the low brass F#, E and D#. A correlation between the three notes of the theme and the harmonies b.61-65 in the low brass can be observed in Mus. Ex.7d.

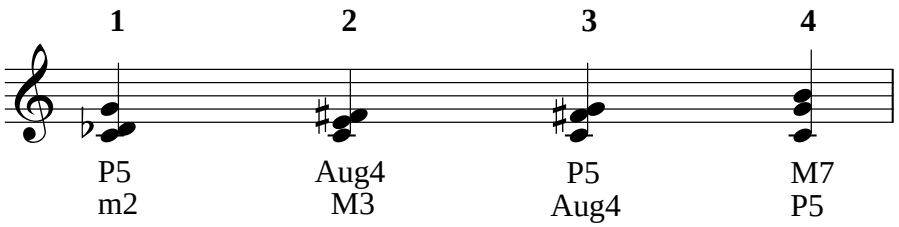
Mus. Ex. 7 *Correlations between the thematic motifs and harmonies b.1-65 of Nocturne*



The low brass chords at b.61 are used in conjunction with the major third-tritone chord (phobia motif) creating a pulsing harmonic rhythm effect. Over the next thirty bars pitches tend to come back to the focal point of the note G; by b.73 there are four notes, F, E, D# and D natural, by b.91 there are two, G and F. Upon reaching b.101 the harmony has arrived at a new point, briefly creating a pause, a break from the swelling pain and thicker texture.

The first part of section B, i.e. b107-175, can be observed as two distinct elements, the demisemiquaver figures in the trumpets and euphonium, and the chorale-like music in the horn, trombone and tuba. The music for the muted brass is mostly made up of notes from the theme for this section. The entries are spaced apart in the earlier part of the section but gradually come together with the bongos at b.161, a combining of energies. On the other hand, the chorale brass is much more subtle in their journey toward the union of these two elements. The swelling, as mentioned earlier, takes place in this chorale-like music, however it is not just the obvious use of dynamics that swell but harmonic movement as well. There are only four types of chords used, these being taken from the four-note harmonic cell and the phobia motif.

Mus. Ex. 8 *Four types of three-note chords in the chorale-style music at b.116 of Nocturne*



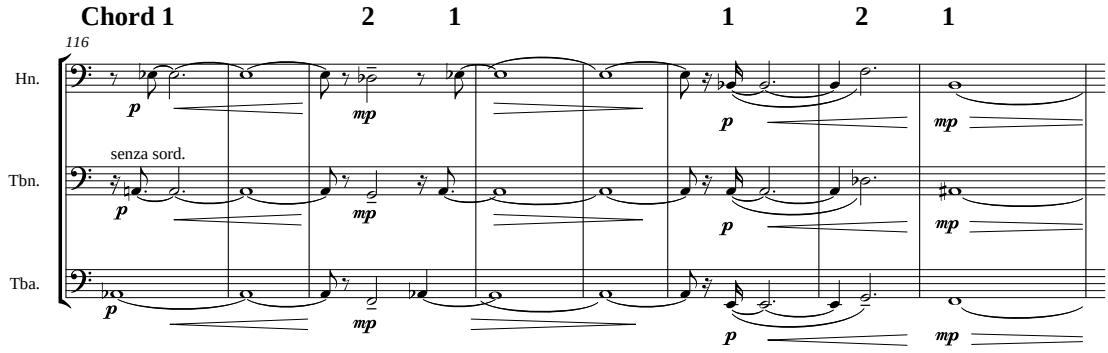
These chords start in b.116 with chord 1, followed by chord 2. The following chord number sequence for this section b.116-167 is as follows:

1 2 1 1 2 1 3 2 2 3 2 2 3 2 1 2 3 2 3 2 3 4 2 3 3 4 2 4 3 3 4 3 4 3 4 2 3 2 3 2 3 1 2 3 3 1 3 2 1 2

2 2 1 1 2 1 2 1 1

As one can observe, there is a swell in the numbers initially starting with 1's and 2's, and then gradually introducing 3's and 4's. The middle of the progression is mainly chords 3 and 4, with chords 2 and 1 eventually appearing at the end. The following musical example shows how these chords are used in the work.

Mus. Ex. 9 *Three-note chords from Mus. Ex. 8 in used in Section B of Nocturne*



The first part of section C, b.227-267, because of the new four-note cell, features more thirds and major seconds in the harmony than the previous two sections. b.282 displays a dynamic feature of this section, the rapid violent swell. All the harmonic

intervals are major thirds and the theme is present as one of the notes in the chord i.e. C#, G, F, A# (Bb), C#, D and B natural. These are then followed by the retrograde 'R' moving up a semitone starting on C natural at b.286, and 'R' moving up a further tone on D natural at b.291 reiterating the final note E over the crescendo. The three-note chords beginning at b.289 derive from the cell and follow a pulsing pattern. The two types of chord are the major-minor i.e. G, B and Bb, and the major third-minor ninth, i.e. C, E and Db.

The harmonic characteristics of the coda are the barrenness of the minor ninth with jabbing chords of semitone clusters. The theme does not present itself but was derived for the purpose of the harmonic cell. There are no bare thirds, fourths or fifths. The cluster at b.364 is chromatic Bb, A, G#, G natural, Gb, F and E. In a way, the cells which started in section A have swelled outwards to a point where we have now reached the first harmonic interval seen in this work, the compass of a tone.

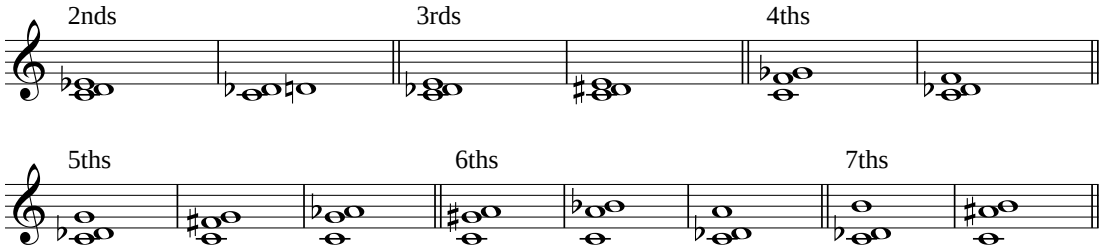
The next experimentation of the harmonic cells was in a symphonic work based on three underground limestone caves. In an endeavour to strive for a more original way of creating and implementing these cells, pre-composition ideas and methods were first developed.

Symphony 2 - 'The Caves'

There were two clear areas of focus involved in the preparation work for the composition of the Symphony 2, *The Caves.* The first involved a fieldtrip to the location of the caves close to the town of Margaret River in the south-west corner of Western Australia. Equipped with a light meter, digital thermometer, digital camcorder and camera, aspects of the three show-caves, Mammoth, Lake and Jewel Cave were recorded. The light intensity, measured in Lux (lx), was taken from the centre of each chamber. To give an indication of the measurements, a typical classroom with fluorescent light would give a reading of between 500-700 lx, however the measurements in the caves were usually under 5 lx. One must remember though, that apart from the entrance and exit to the caves, all light is artificial. A map of each cave was drawn and particular note was made of the number and size of the chambers which would eventually relate to structure within the movements of the composition.

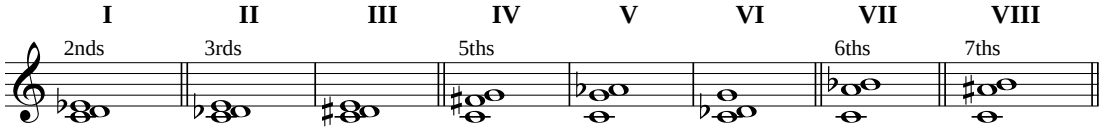
The second and musical aspect of the preparation of the symphony involved creating harmonic cells with the intention of relating them to differing shades of darkness found in the caves and implementing these harmonies through appropriate sections of the movements of the composition. The cells in this example are all based upon the note C. To form these cells the notes of the major scale were used to create a two note cell and to these were added a foreign chromatic note, a semitone above or below the first two to create a semitonal dissonance. For example there were only two possibilities for the cell containing the major second, C, D and Eb, and C, D and Db. These cells are illustrated in Mus. Ex. 10

Mus. Ex. 10 *Total possible number of cells before the elimination of inversions.*



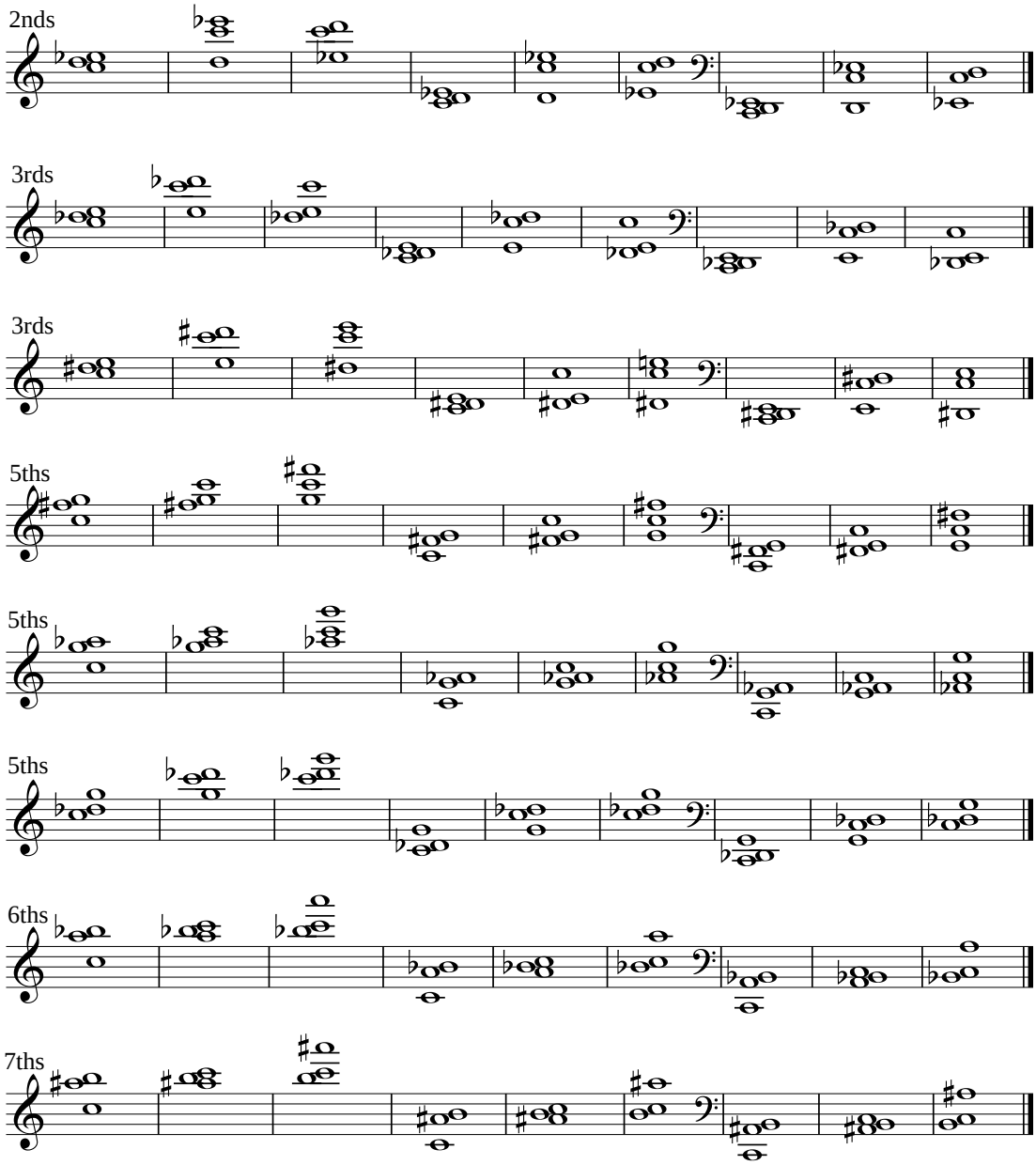
Although there were a total of fourteen cells various fourths and sixths, when inverted, were observed to be existing fifth and third cells. These were then eliminated and a total of eight cells were left. These were then assigned an order based upon the consonant interval. Roman numerals were used for the calculation of the test.

Mus. Ex. 11 *The three-note cells used in the Symphony No.2 'The Caves'*



The 'colour character test' was designed to include each of the eight cells notated in all inversions and different tessituras, giving the cells a variety of appearances.

Mus. Ex. 12 *The colour character test of Symphony No.2*



The colour character test was performed to find, in my own opinion, the darkest sounding chord of the eight in a psychological sense and then rank each chord through to the perceived lightest.

The initial part of the test was to play a recording of the cells as they appeared in the previous sheet ‘colour character test’. These were played twice, firstly at a mezzo-forte volume and secondly at a piano volume. A synthesiser was used for this test. This first part of the test featured the midi sound ‘bright piano’, and for the second part the ‘soft strings’ were used. These two timbres would create a variety in the initial attack on the chords as well as the decay. The duration for each cell was eight seconds with a four second gap between cells. The second part of the test was to hear the recording of the chords in each line in random order. The results of this part of the test were identical to the previous responses confirming a solid subjective perception of each cell’s shade of darkness.

The table on the following page shows the results from the test. The roman numerals relate to the three-note harmonic cells diagram on pag3 31, Mus. Ex.11.

Table 4: *Symphony No.2, colour character test results*

darkest							**lightest**
II	**III**	**VI**	**VIII**	**V**	**I**	**IV**	**VII**

These cells appear in their final order in Mus. Ex. 12. A new numbering system has been employed and will be used to identify these cells in the composition from now on.

The use of the colours in the ‘colour order’ diagram is only for ease of identification. The corresponding light measurements were designated so as to allocate different chambers to different cells. There are more chambers of under 1.1lx than above, therefore the range is 0.2lx per cell as opposed to the lighter chambers capturing a range of 0.5lx - 2.0lx.

Mus. Ex. 13 *Symphony No.2, three-note harmonic cells colour ordering*

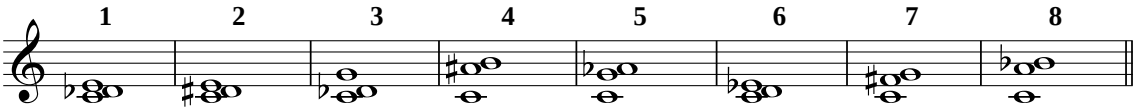


Table 5: *Symphony No.2, three-note harmonic cell colour association with light intensity*

1	2	3	4	5	6	7	8
Measurement in lux (lx)							
0-0.2	**0.3-0.5**	**0.6-0.8**	**0.9-1.1**	**1.2-1.7**	**1.8-2.3**	**2.4-2.9**	**3.0-5.0**

Overlapping cells

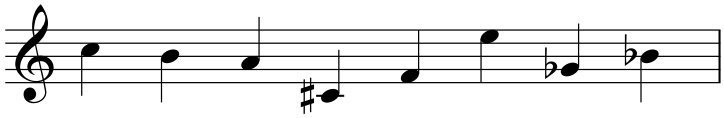
Overlapping cells are an important aspect of the symphony as they provide subtle changes in light intensity within individual chambers of the caves. When, for

example, a cave chamber is measured at 1.7lx (cell 5), and there is a section of the chamber that is less illuminated than that of the measurement, a cell overlap is used to simulate a reduction in the light. In this work a total of 4 overlapping cells will constitute a change to the light measurement one cell darker than the present one, (only occurs once in the Symphony at b.63 Mammoth Cave), a very subtle darkening to 1.5lx will see 2 overlapping cells, and a darkening to 1.3lx will see 3 overlapping cells. The range of light intensities is organised in such a way that in the darker cells, 1 - 4, a change of 0.1lx will affect the cell overlap, whereas in the lighter cells, 5 - 8, a change of 0.2lx is required. An overlap in this symphony is one which is a tone apart, no more, no less.

The Caves Theme

The Caves theme was constructed along with a matrix of eleven transposed versions which would be used in retrograde, inversion, retrograde inversion and segmentation.

Mus. Ex. 14 *Pitch collections for the main theme from the Symphony No.2*



Mammoth Cave

Light: 0.3 lx in first and fourth chambers, 1.6 lx in the small second chamber, 0.7 lx in the main chamber, 2.6 lx at the exit. 0.0 lx in the small passage between the second and third chambers. The map of Mammoth Cave and its chambers is represented by the following diagrams. The spectrum shows the overlaps that are used throughout the movement. These correspond to the map diagram in terms of structure and the shade of each section's harmonic cell. In the main chamber, for example, the three overlaps are indicated by the darker strips, which give an indication as to their location within the section.

Illustration 1: *Map of the chamber structure for Mammoth Cave*

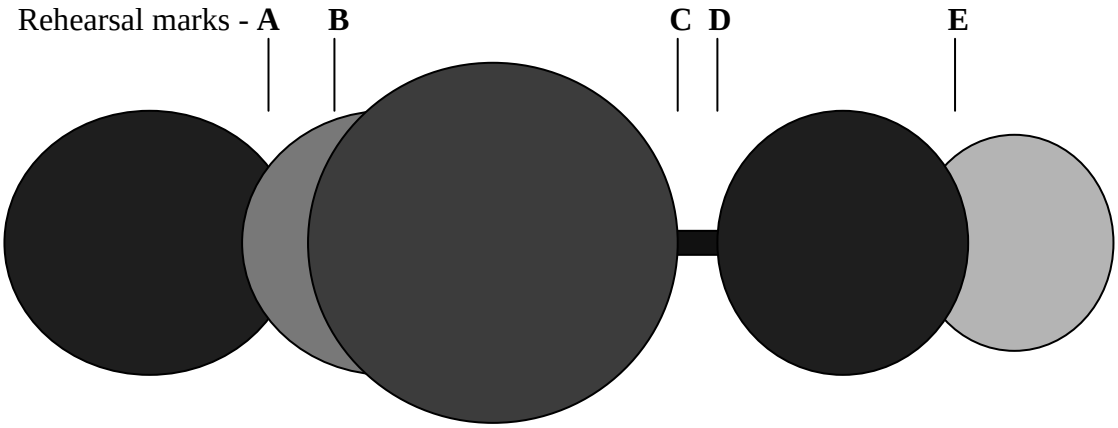
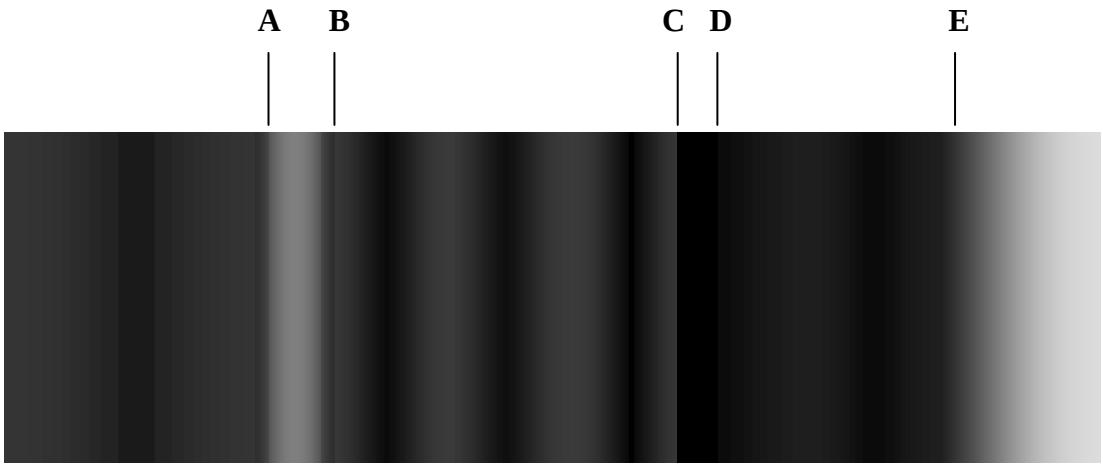


Illustration 2: *Mammoth Cave spectrum map*



Mammoth Cave

Composition Overview

Mammoth Cave could be described as the ‘Granddaddy’ of the three caves. It is the oldest and its features are not as attractive as those in Lake or Jewel Caves. There is, though, more of a feeling of stepping back in time. The opening of the movement represents the dark entry to the cave. This cave’s entrance is on street level, the low strings dissolve and we are left with a quiet and simple motif of C - A over the A pedal. Over the remainder of this section, cell 2 is overlapped gradually to b.63 to match the darker area of the chamber and then returns to just the one cell by b.73.

The second section is intended to evoke the set of steep, ascending stairs. Brightly lit walls, ethereal in atmosphere, lead upwards to the summit of the main chamber.

The main chamber is large, grey and cool. The objective of this section was to create a sense of space, distance and of patience. It is not until one sits in this large chamber that one realises how small one is. To create the sense of space I have chosen to use small musical ingredients with much space surrounding them, rather than creating wide-scoring music. There are three cell overlaps at b.145, b.152 and b.168, each of these beginning on the bare fifth before glissing to the overlaps. The following short, dark passageway links the main chamber to the fourth chamber (fourth section) of music. It is static, hence the pedal C# throughout and an increased feeling of motion with motifs from the bassoons and bass clarinet.

The fourth section sets out to convey a chamber that is very dark, while still having tinges of light coming through from the adjacent exit chamber. It is visually a very

effective device in creating a mix of ambiences, the essence of light dominated by darkness. Musically this section is episodic in the quest for light and dark, which eventually come together in a violent battle at b.332. It is a gradual evolving of textures, displaying the wooden sounds of the strings and percussion versus the metallic sounds of the muted brass, harp, piano, bells, and antique cymbals played by the woodwind section. The string writing is very complex, but atmospheric, and flows along, rising and falling in waves. From a harmonic point of view the three string episodes see a gradual diluting of three rows, and eventually, over the last episode, stripping away the last row to reveal the essence of this section, the harmonic cell no.4 and its pitches of A, C and Db. Visually speaking it is the viewer seeing in detail the cracks and contours of the chamber walls, then gradually relaxing their focus, drawing back and viewing the chamber as an entirety where those details once clear are now blended into the chamber and its ambience.

The exit chamber is small, half in darkness and half in sunbeams. The large exit of the cave faces upward and a steep ascent via stairs allows natural light to enter the cave. Once again, as with section two, there is an ethereal atmosphere to this section linked to the ascent of stairs and the brighter illumination. The brighter cell 7 is used here and the only overlap occurs at b.359, with a gradual brightening from the previous chamber.

Lake Cave

Light: 0.7 lx in the first chamber, 1.0 lx in the small walkway between the chambers, 0.0 lx in the second chamber. The map of Lake Cave and its chambers is represented by the following diagrams.

Illustration 3: *Map of the chamber structure for Lake Cave*

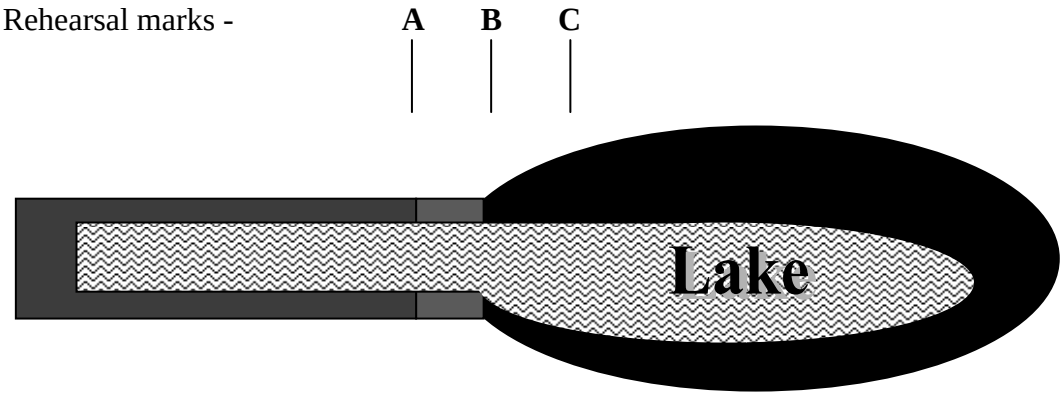
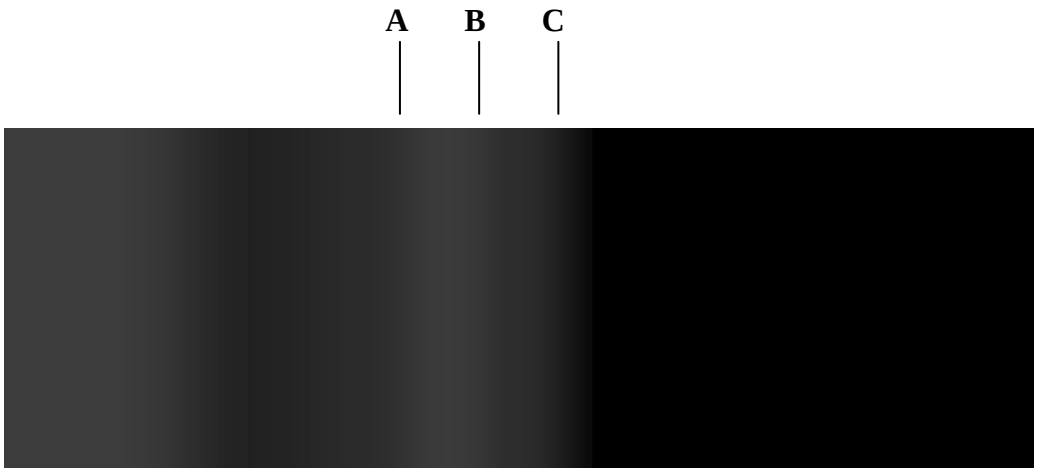


Illustration 4: *Lake Cave spectrum map*



Lake Cave

Composition Overview

Lake Cave is a smallish, humid cave, but as it is very beautiful in its stalactite and lake features, it could be described as the most feminine of all the caves. It contains two sections, the entrance section with its low ceiling and colourful rock features, and a final chamber which is very dark and cool with a high ceiling in a dome-like shape, similar in fact to a planetarium.

Musically the two sections are diversified texturally to try to convey the difference in humidity and the abundance and fineness of the stalactite features. The opening section of the movement features the flugel horn, unusual for the symphony orchestra. The idea was to create a beautiful, rich-toned melody accompanied by low brass (rich texture) and surround this with a sort of mist or humidity. These ‘mist’ instruments remain very quiet and in the background whilst the brass are featured in the foreground. The harmonic analysis chart for this mist section is on the following page.

The idea behind the final chamber was to create something a little filmic in the background musical texture. This dark chamber reminded me of a cinema, dark and quiet, although the images I saw were not manufactured or synchronised by man but were natural living features and images, in a sense a cinema of life. Therefore while this filmic music is being performed in the background by strings we are alerted to the ‘real-world’ features of this living, breathing cave by interludes from our harmonic cell 1. Even the transformed melody that enters at b.147 is allowed to roam free at its own pace, not conforming to the ‘director’ filming in the strings.

Table 6: *Lake Cave, mist analysis chart b.5-84*

Note	Cells	Instruments	Overlaps	Bars	Link bars
G	**G D Ab**	Vn 2, vla, vc	0	14	1
F#	**F# C# G**	Vn 2, vla, vc	0	5	2
E	**E B F**	Vla, fl	2	6	4
	F# C# G	Vn 2			
Ab	**Ab Eb A**	Vn 1, fl	2	5	4
	Bb F Cb	Vla, cls			
C	**C G Db**	Vc	3	5	1
	D A Eb	Vn 1			
	Bb F Cb	Vn2, bsn, bcl			
B	**B F# C**	Tbn, euph, vla	3	5	2
	C# G# D	Hns			
	A E Bb	Vc			
Db	**Db Ab D**	Vn 2	3	7	4
	Eb Bb E	Vc, cls			
	B F# F#	Fl, vla			
F	**F C Gb**	Fl,bsn, hns,vn2, vc	2	8	
	G D Ab	Vn 1, vla, cls			

- **Note -** The fundamental note of the theme that underscores this section
- **Cells -** The cells (no. 3) used in the mist-like music. The original plus one tone higher and lower go to create overlapping cells. The bold text refers to the cells used. In the case of one overlap (2 cells) the second cell to overlap the original is determined by the next fundamental note; if the shortest interval to the next note is upward then the overlapping cell will be the cell a tone above, and vice versa.
- **Overlaps -** The total number of overlapping cells.
- **Bars -** The number of bars that feature the fundamental tone (related to the number of human paces between various light features in this cave)
- **Link bars -** The number of bars in the 'sliding' link passages between the fundamental tones. These relate to the pitch difference between adjacent tones. i.e. One semitone difference (B - C) equals one bar. A major third (E - Ab) would then equal four bars. The term 'sliding' is used as it relates to the chromatic progression through these bars. Each bar features cell 3.

The sequencing of the above notes from the fundamental pitch F# through to Db in their cell is a canon. That is to say each group of instruments e.g. second violins or cellos, features the same sequence of notes as each other but in different rhythms hence creating a wash of sound. The dynamic markings in this 'mist' section increase from an initial *ppp* to *f*; also the scoring range gradually increases from one octave in the first phrase to four octaves at the climax. The climax of this section at b.84 sees notes from the featured two overlapped cell 3, F, C and Gb, and G, D and Ab. These notes eventually fade away to be left with a bare fifth F and C at b.91 where the divided double basses enter with the previous two overlapped cells. The final note in

the transformed theme (in the fundamental notes) is heard in the harp at b.98 and pre-empts the same note in the first violin.

Jewel Cave

Light: 1.0 lx in the first chamber, 2.7 lx in the second, 2.6 lx in the third, 0.5 lx in the fourth, 4.0 in the fifth, 0.0 lx in the short passages between chambers. The map of Mammoth Cave and its chambers is represented by the following diagrams.

Illustration 5: *Map of the chamber structure for Jewel Cave*

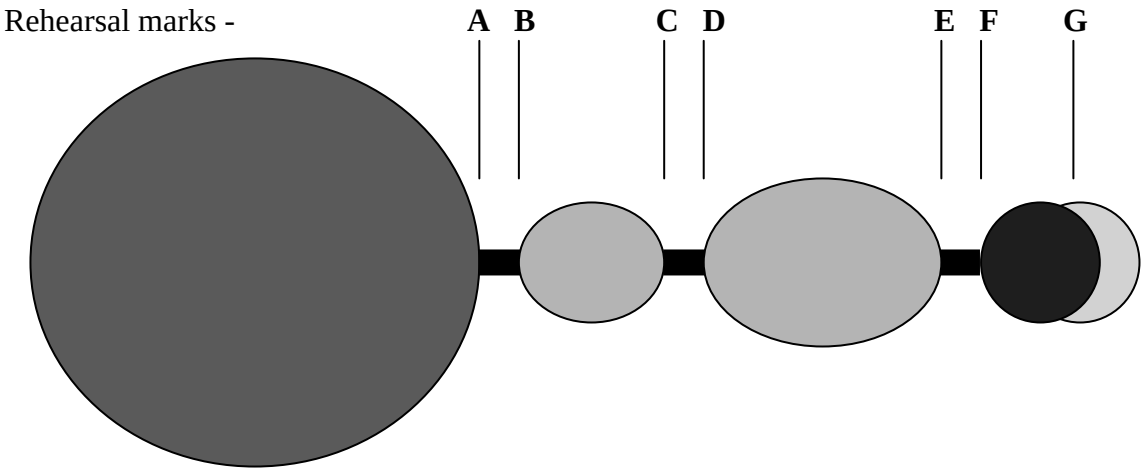
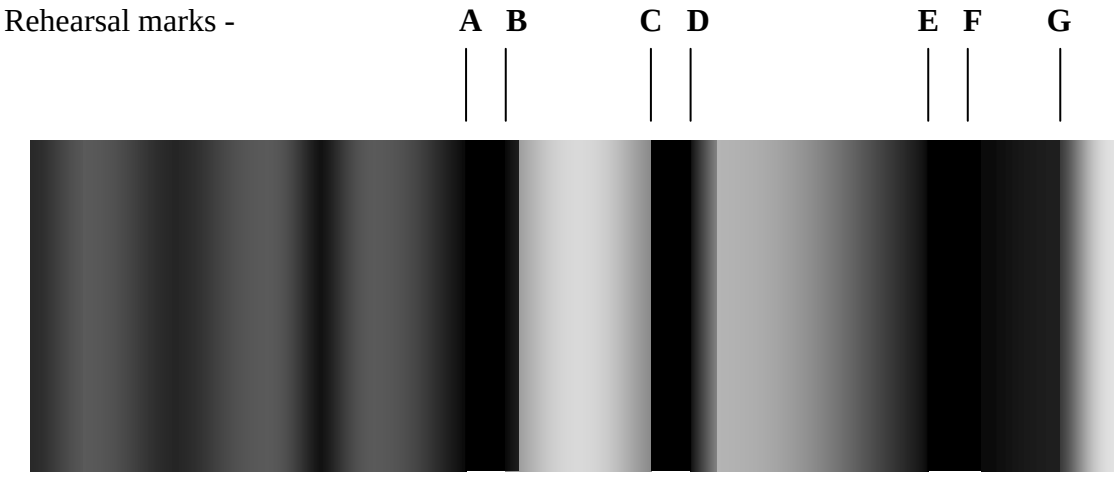


Illustration 6: *Jewel Cave spectrum map*



Jewel Cave

Composition Overview

Jewel Cave is the largest, deepest and most brilliant of the three caves. The opening walkway is perched high above the passageway leading to the other chambers and, as the golden formations are well below us, the entrance appears lifeless, still and cool.

There are eight sections of music in a comparatively short movement of eleven minutes. This leads to a very episodic work, however, given the many contrasting chambers in this cave, the music is allowed to present its theme in differing styles and textures. The entrance chamber starts with the barren-sounding cell 2 with great emphasis placed on the minor ninth interval. The music then becomes focused, determined, unlike the previous two movements of the symphony. There are cell overlaps at b.55, b.60 and again at b.77. There are three dark, narrow passageways in Jewel Cave. Each of these features a pedal note F, effectively trapping and confining any adventurous harmonic movement.

The second chamber features the ‘Organ pipes’ straw stalactite formation, the longest straw stalactite found in any showcave in the world. There is a gradual rhythmic and harmonic climax to these bold, mass chords that include notes from cell 7 and cell 2. The reason for using two different cells at either end of the spectrum was to convey the contrast of the bright stalactites with the darkness between each individual straw, i.e. light-dark-light etc.

The third chamber, although displaying the same light intensity as the previous chamber, contains more delicate stalactite formations and was, as a result, scored much more

lightly with a quasi-duet between the piano and glockenspiel, accompanied by the chimes, cymbals and crotales, with sustained string and wind chords in the background presenting cell 7 with a number of overlaps.

The penultimate chamber, of a darker illumination, sees a contrast between two distinct elements, the moist dream-like strings, harp and piano, and the dry muted brass and woodwind. Cell overlaps at b.211 are explained as follows:

Table 7: *Overlapping cells in Jewel Cave at b.211*

Overlaps -	2	1	2	1	2	1
Cells based upon root note of -	**D**	**E**	**E**	**F#**	**F#**	**G#**
	C	**F#**	**D**	**G#**	**E**	**A#**
	E		**F#**		**G#**	
Total notes -	9	6	9	6	9	6

An ascending set of stairs brings a return of the soaring string theme, and its short lofty journey eventually leads us to the final chamber, bright and brilliant. b.268 is based on the note A, an overlap of cell 7; A, E and D#, and B, F# and E#. The glissandi in trombones hark back to Mammoth Cave, a subtle reminder of where this all started.

After the symphony, the final work relating to the underground locations, the next work of the portfolio returned to child psychology. The harmonic cell technique was once again employed, however this time it developed on from the visual darkness to a use related to psychological perception.

Voices

The work for string quartet is based on the psychological test by Swiss psychologist Herrmann Rorschach. The Rorschach test is a diagnostic test based on perception, consisting of ten inkblots about which the subject reports his or her observations. The concept of the work was therefore to relate the depth of perceptions to harmonic cells and complexities in rhythm, timbre and texture. This composition looks at three different children's visual interpretations of the inkblots, taking into account their test scores and analysis. This includes data on their average reaction time to each inkblot, and the depth of detail in which they identify images, shapes or emotions in their perception of each inkblot. The children are aged three, seven and eleven, and feature in the book *Rorschach with Children* by Jesse Francis-Williams.[18]

Rorschach Symbols

Table 8: *Rorschach abbreviated symbols*

W - The whole blot, perceived as a whole
D - Large divided sections of the blot
d - Smaller divided sections
dd - Very small divided sections
F - Form, the shape of the blot
FM - Animal-like action or movement
M - Human-like action or movement
C - Colour i.e. blue - sky or water, red - blood or fire
H - Human figures
A - Animal figures
N - Nature i.e. landscapes, rivers, mountains
R - Total number of responses for test
K - Effect of shading creates a sense of depth
FK - Shading sense of perception
Obj - Man-made objects
m - Abstract or inanimate objects
Fm - Definite form of inanimate object
P - Popular responses

[18] Jesse Francis-Williams, *Rorschach with Children.* (London: Pergamon Press, 1968.)

The Rorschach Theme - Music

There are ten notes in the theme corresponding with the total number of inkblot plates.

The symbols were used in the order in which they appear in the three categories of Location, Determinants, and Content.

Table 9: *Rorschach symbols, Location, Determinants and Content.*

Location			Determinants			Content			
W	**D**	**F**	**M**	**FM**	**C**	**H**	**A**	**N**	**P**

By assigning a number based upon the sequential order in which they appear in the alphabet, this number was then divided by the total number of letters in the alphabet divided by semitones in an octave i.e. 26/12 = 2.167. The total was recorded and rounded to the nearest whole number and this number was the pitch in a chromatic scale, with the first note being notated as 0 and the last as 11.

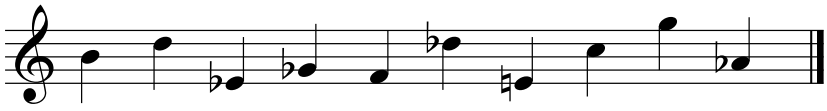
Table 10: *Rorschach symbols' numerical sequence based on the alphabet*

	W	**D**	**F**	**M**	**FM**	**C**	**H**	**A**	**N**	**P**
	23	**4**	**6**	**13**	**9.5**	**3**	**8**	**1**	**14**	**16**
/2.167										
	10.6	**1.8**	**2.8**	**6**	**4.4**	**1.4**	**3.7**	**0.5**	**6.5**	**7.4**
Rounded	**11**	**2**	**3**	**6**	**(5)**	**1**	**4**	**0**	**7**	**(8)**

Taking the note C as the number 0 the theme is represented by the following notes:

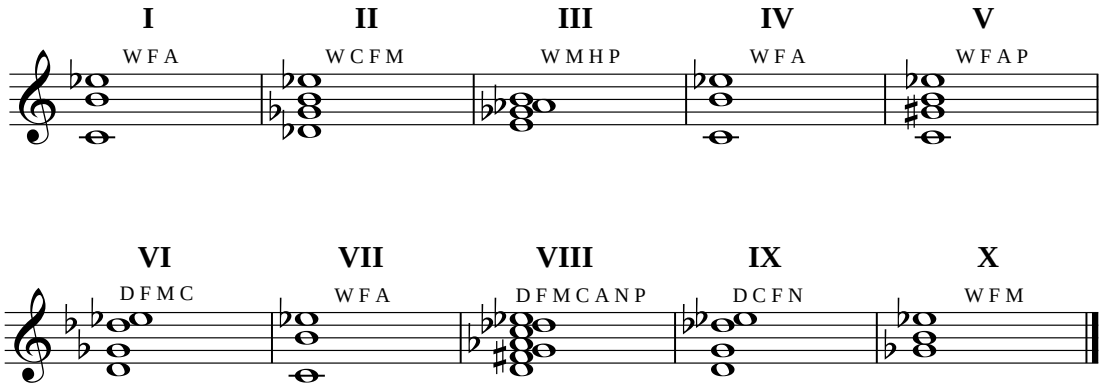
Mus. Ex. 15 *Pitch collections for the Rorschach theme based upon the numerical values in Table 10*

B D Eb Gb F Db E C G Ab



The harmonic cells have been constructed from the test analysis, with each note being assigned to a symbol. For example, the first child's Rorschach test result from Plate I is W F A. W = the note B, F = the note Eb, and A = the note C.

Mus. Ex. 16 *Harmonic cells used in Voices*



Each movement relates to a child's perception of the inkblots, and is conveyed not only through the harmonic cells, but also through texture, timbre and rhythm. In the first movement the seven-year-old boy has data from inkblots II, V and VIII. He has a

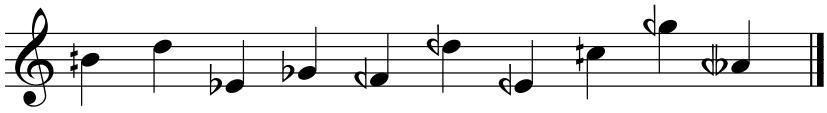
perception that identifies many small details of the inkblot, whilst still providing descriptions of the inkblot as a whole. These are conveyed in a two-layered perception, with the opening section being an exploitation of the multi-response details, very episodic, where the quartet position themselves around the audience. They sequentially return to their seats on stage once the chorale-like section brings forth the fullness of the whole inkblot perception. Harmonically we observe a transition from the cells of II, V and VIII with the final plate VIII being the most deeply perceived and therefore having the most dissonance. However, there is consideration to be made in reference to his test. His reaction time was very quick for a child of his age. It is then observed that he has a perception starting in detail and then focusing back to the inkblot as a whole. As a result, when structuring this movement, the more dissonant cell will be featured first and diluted to reveal cells V and then II. This happens in the pizzicato chords.

In the second movement data is collected from the three-year-old boy's perceptions of inkblots I, IV and VII. Because of his young age he has a very limited perception of the inkblots. His answers were very general, his responses low, never reaching beneath the surface of the whole inkblot. The musical material is slowly progressive, developing gradually in intensity without any undercurrent or background layers. If we look at this young boy's three inkblots we observe that the perception is identical - W F A. As a result the music reflects his lack of depth in perception, with the harmonic cell unchanged through the movement and the texture remaining fairly constant.

The final movement features the perceptions from inkblots III, VI and IX of the eleven-year-old girl. As one might expect she is the most perceptive of all the children. The music becomes much more episodic and dissonant, displaying three contrasting materials which eventually overlap and give way to a sudden final coda, the combined responses of the three children to the final inkblot X. Despite being the most perceptive, her reaction time is at the long end of the scale at 59 seconds, displaying a gradual perception through W to dd. Although the dd is not featured in her three inkblots of III, VI and IX, it is her perception of d that takes her deeper into the inkblot than the other children. For the purpose of the movement and a gradual focus into d, the cells will be arranged as III, IX and VI.

The coda to the third movement is plate X. Only the perceptions W, F and M are used here, being a combination of all the children's results. In this final section of the composition the true pitch of the Rorschach theme is heard, displaying quarter tones.

Mus. Ex. 17 *Pitch collections for the Rorschach theme containing quarter tones*



𝅘𝅥 - 1/4 flat ♯ - 1/4 sharp 𝅘𝅥 - 3/4 flat