CHAPTER 1

MARR AND STRAWSON: SPACE AND THE INEFFABILITY OF MUSIC

1.1 Music, Space, and Vision

The focus of this thesis is on the cognitive perception of music. Ordinarily, the listener with a keen interest in music will, in the activity of listening to music, organise, conceptualise and re-conceptualise themes, and dynamic, rhythmic, and harmonic groupings into new and slightly altered groupings. This may be interesting in and of itself, but it has not been fully fleshed out in what category of mental activity music listening lies. I contend that thinking spatially is prior to the activity of conceptualising music, and ought to be included in a philosophical account of music.

To construct a spatial account of perceiving music, my approach is the joining of an alternative conceptual structure of space and bodies drawn from P. F. Strawson's book *Individuals: An Essay in Descriptive Metaphysics* (his second chapter in particular, entitled 'Sounds') with a phenomenological approach derived from David Marr's computational theory of vision in his book *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. Marr's computational theory has been selected not only for its feasibility, but also for its emphasis on a *process* of perception in which an alternative spatial dimension is considered. I aim to show that a philosophical account of music is constructible by joining elements of Strawson's account of hearing and internalised spatial location with Marr's account of vision as process.

Music is an abstract, perceptual art. I have chosen to dislodge theories of music as abstract expression about *place* or substances, and will focus my discussion on *space*, infinite depth, and the intrinsic cognitive ability of the listener. The following brief statement from Strawson deftly incorporates the point about space I wish to reinforce:

> …the crucial idea for us is that of a spatial system of objects, through which oneself, another object, moves, but which extends beyond the limits of one's observation at any one moment, or, more generally, is never fully revealed to observation at any moment.[1]

The emphasis in my approach to music shifts from the popular notion of localised *place* to the concept and qualities of motion in *space*. I construct a theory of listening in which the spatial dimension of perception is prior to any verbal description a listener may offer publicly. In listening to music, the listener's perception is that the sound world is internal, yet not fully revealed to him, as the sound world sheds obscurity for clarity in motion.

1.2 Space, Separation, and Distance

In his book *Individuals: An Essay in Descriptive Metaphysics*, author P. F. Strawson, considers the implications of a world restricted to sound only. He seeks to define such a world, including human perception, within the limits of that projected world. His account of a sound-only world is to 'test and strengthen our own reflective understanding of our own conceptual structure' in a world without the structure that three dimensional space and spatial location provides.[2]

Strawson's overall interest is the nature of a conceptual scheme in which objective, and hence non-material, particulars are the foundation of that scheme. He writes: 'Is the status of material bodies as basic particulars a necessary condition of

1 Strawson, pp. 73-4.

2 Strawson, p. 86.

knowledge of objective particulars?'[3] Ordinarily we sense material bodies in three-dimensional space and a further single dimension of time. In Strawson's sound-only world, space is not contained by our notion of audible places in the experience of *topos*, for a sound world is *logically separate* from the listener in the ordinary practises of spatial location and ordinary language use.

That space is logically separate from the listener is one of Strawson's more publicly debated claims, despite his affirmation in the chapter 'Sounds' that he himself does not adopt any of his assumptions.[4] He introduces that separate nature of space by noting that, in such a supposed world, spatial location of objects does not arise in any ordinary, visual sense. Visual metaphors and ordinary language terms such as 'next to', 'at right angles to', or 'above' are ruled out in this projected frame. That is, space in a sound world is *logically* separate from the listener. To account for perception, Strawson posits that an individual's consciousness in a world of sound follows a pitch continuum. He offers the functioning, conscious listener a required *analogy of distance* in a continuum of pitch/consciousness in a sound-only world as a way of 'positioning' objective particulars.

My approach is related to Strawson's. My interest is in the spatial complexity that music has to offer, and not the dynamics of empirical and rational views on perception itself that Strawson considers. I contend with Strawson's position that a world that consists only of audible particulars is logically separate from, and internal to, any given listener. My approach is to test for cognition in hearing music that already imports distance and depth in the Pythagorean intervals; the argument for the depth of these basic intervals will be carried out in the following five chapters on metaphysical accounts of space in the history of Western philosophy.

3 Strawson, p. 62.

4 Strawson, p. 86.

1.3 Language about Space without Vision: The ‘Unfolding’ of No-Space

Strawson presents an extended argument about ordinary language use in an ordinary spatially located world. The language Strawson seeks to limit or condemn is language that incorporates spatial metaphors in three dimensions. Such language is closely tied to vision. Further, since sounds are immaterial, and as the perception of sound occurs internally to the *mind* of the listener, distance cannot be precisely calculated without losing the emphasis on a world of sound only. Number and indications of the location of sources in a sighted world indicate measurement and position that cannot be effected in a world in which perception is *only* of sounds.

It can be argued that absolute music is highly appropriate to this discussion. First, most musical works in the Western tradition are perceived to ‘unfold’ or are revealed in space and time in the experience of the listener. The quality of ‘being revealed’ or ‘unfolding’ satisfies Strawson’s account of space in a world of sound only (p. 1). Second, absolute music is non-referential in nature, and hence no particular discrete object in 3-dimensional space arises to the intuitive mind of the listener. This meets Strawson’s requirement that there be no material particulars in a world of sound only. And third, the listener uses his cognitive faculties to organise and reorganise the musical surface he hears without the benefit of a distinct material object (see §3.9, p. 65). The listener does not measure distance visually in a world of sound, and thus the language of location such as ‘three metres to the left’ or ‘behind the door’ does not apply. That is, the qualities of distance, that is, *nearer to* and *further from*, are a matter for sound perception.

1.4 Non-Solipsism

Strawson proposes a system gained by the limits of sense and perception that is not spatially contained by ordinary notions of location, is logically separate from the listener, and yet, is public.[5] He distinguishes the spatial perception of a listener who relates publicly by report of objective particulars in his account of non-solipsism. For Strawson, the *use* of an experience is secondary to the precise information the experience imports.

I incorporate Strawson's notion of No-Space and his non-solipsistic approach to hearing. That is, when we hear music without a thought of what *use* such experience will present to our emotions, we emphasise the intrinsic strength of 'hearing alone'. A solipsistic listener has an interest and a *use* for information derived from the music that concerns how he feels; the non-solipsist has an interest in music, but not a *use* for its representations, which suggests a different value to his experience (see quote on previous page). If we agree that emotions are useful habits or conditioned perceptions of comfort, joy, or pain, for example, and we are happy to reconfigure an emotional response to music, then we can agree not to put information processed from the music to *use*.

1.4 The Radio

Strawson centres his discussion on the pitch and pitch-range of a particular sound, employing an example from a radio. In Strawson's hypothetical account, pitch is internal space, until we experience music. In transferring this scheme to an

5 Strawson writes on hearing and the development of a conceptual scheme. Very briefly on music, perception, and a spatial dimension he writes as follows: 'Indeed, we customarily speak of differences of pitch on analogy with a spatial dimension – we speak of higher and lower notes – and moreover we customarily represent these differences by spatial intervals' (Strawson, p.73) This brief statement does not reflect Strawson's method in any concrete sense. The intervals he mentions are numerical and precise, and yet precise measurement is not an element in Strawson's conceptual scheme built on sound only.

understanding of hearing sounds, Strawson considers the cognitive awareness of the listener as a master-sound, as follows.

On an ordinary radio, which is a world of sound only, in which adjustments are made by turning knobs, the sound in between radio stations is a sound that is persistent. As one turns the knob, the sound changes pitch. This continuously changing pitch or 'master-sound' is an analogy of the conscious awareness of the listener. The master-sound is a constant volume of higher to lower pitches, and vice versa, that change as the knob is turned. Clearly the master-sound functions within a continuum of sound and hence employs an infinite range of pitches. [6] Once the knob 'tunes in' to a unified sequence of sounds, such as an identifiable radio station, the master-sound decreases and an objective particular, as in a piece of music of one, two, or more themes can be identified and re-identified. The listener can miss particulars if he is not in a relation to the master-sound. If the station has been passed by, the master-sound increases once again, and decreases as another station is approached. The change in the pitch of the master-sound gives Strawson the necessary analogy of distance as *nearer to* and *further from*.[7] He goes on to suggest that listeners are in a relation of *nearer to* and *further from* with respect to events of re-identifiable cognitive particulars. The experience of these particulars, such as the experience of a work of music, is seen as analogous to 'tuning in' to a radio station. Hence the perception of spatial relations in Strawson's sound-only world is by an analogy only, for the association of three-dimensional space and the location of objects is refuted in hearing.

Strawson's thought experiment aligns the consciousness of the listener with the changing pitch of the master-sound. I suggest that the consciousness/pitch

6 Strawson, *Individuals,* London, 1959, p. 75.

7 Strawson, *Individuals,* London, 1959, p. 75.

continuum relation may be substituted by the key signature of a particular work, such as b minor/D major in J. S. Bach's *Mass in b minor*, and that the analogy of distance is perceived by the listener in the modulation of the music. [8] Like a master sound, key signature and modulation provide the ground or tonic, and the related aural material that determines harmonic variety in consonance, dissonance, and the distance analogy of 'nearer to' and 'further from'. This distance analogy is produced not only by the varieties of loud and soft tones on the musical surface produced by the weight an instrumentalist applies to an instrument; an analogy of infinite depth is also produced in the intervallic relations of the perfect Pythagorean intervals.

What sort of perceptual scheme can be used to support Strawson's conceptual requirements? We require a scheme that affirms the persistent, cognitive listener who is capable of processing the information from hearing and of relating descriptions of heard events. And further, we require a scheme in which spatial location is not an immediate achievement but a process. I would like to review briefly Marr's computational theory in this regard, as I believe it may provide the alternative scheme we are looking for.

1.5 A Computational Theory of Vision

Marr's theory is that the conception of a different spatial dimension is intrinsic to human consciousness. It occurs naturally in the phenomenology of vision. I claim that it is also a necessary skill in hearing, and one that listeners can use in hearing cognitively. The benefit of Marr's approach is that it does not rely upon mapping to configure a congruence between a theory of vision and its practice. As Marr states in

8 Please see the Glossary at the end of this thesis for a definition of these terms.

the title to his book, *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*, his approach is computational, that is, aimed at a theory of knowledge grounded in the human function of information processing. At a basic level, computational theory is a theory of explanation. It explains *what* is processed, and, separately, *why* it is processed. [9] That is, the theory explains why the computational system of input/output and a transformational algorithm satisfies the appropriate constraints placed upon it. At a secondary level of explanation, computational theory also relates *how* a particular computational system functions.[10] Put simply, there is a representation at the level of input transformed into a representation at the level of output by an algorithmic process.[11]

At the highest level of computational theory, there is a goal we seek, that is, an answer to a question. A question pertinent to the topic of this thesis may read as follows: in addition to the perception of movement in music, what do the Pythagorean intervals, the octave 2:1, the perfect fifth 3:2, and the perfect fourth 4:3, import to a listener's experience of music? By this question, we might hope for some insight into the ineffability of music. Our inquiry reaches back to an age of musical speculation in citing the early Pythagoreans, their form of number mysticism, the metaphysical attribution of 'harmony' to the motion of the spheres, and hence a metaphysical relation between space and music.

At the second level of the computational approach, that is, representation and algorithm, we seek to set up how the computation runs. At the level of input information supplied by music, there are tones and associated overtones. Descartes

9 Marr, p. 23.

10 Marr, p. 23.

11 Marr presents the complex filter system used in vision. However the same algorithm is used in each of the four channels of vision, that is, ∇2G. See Chapter 2, pp. 54-75.

presented the tone as relations of its pitch and its harmonic series in *Compendium Musicae* (Ch.4, §1, p.96). The input representation arranged spatially consists of the tone as pitch, timbre, and loudness; the representation of the output depends upon the algorithm used to process that information.

1.6 The Limits of Marr's Approach

At this level it is necessary to sound a word of caution concerning Marr's theory of vision as applied to hearing. At the level of output by algorithm, we run a risk of asserting that there is a caused 'something-in' the music we are listening 'for', that is, that we can present as what the music is 'about'. Marr affirms that each level of explanation is '…logically and causally related' to the other, but that these relations are only loose, and some phenomena may be limited to one or two levels of explanation.[12] In Marr's assessment, the final purpose or *telos* of vision, or that which we are looking 'for', is increasing clarity of 'surface geometry' and discontinuities that communicate distance between the object and the viewer, and ultimately, information pertinent to our survival.

I would select from Marr the increasing clarity of the perception of distance, but exercise caution concerning the goal-directed emphasis on surface geometry. Marr asserts that the process of achieving the ends of vision begins as internal perception of intensities and is complete with the perception of a fully formed, distinct, external object and its approximate distance from the viewer. As the position I am adopting is of a non-solipsistic listener in an environment in which his relation to external events is not physically or spatially located in an ordinary sense, I assert that there is no further or ultimate causal principle, direction, or *use* for the representation of output.

12 Marr, p. 25.

That is, there is no goal in hearing music in Marr's model of computational theory.[13] I would affirm that an expanded experience of processing input is adequate reason for attending to the art of absolute music.

1.7 Using a Computational Approach

If we as non-solipsists apply a non-causal representation as the music goes on, we have an ordinary experience of music as the construction of themes, transitions, repetitions, cadences, and the appropriate panoply of musical conceits. If we keep in mind the question set at the beginning of the experiment, we ask, at a formal level of input, what import do the Pythagorean intervals, founded upon theoretical spatial relations in empty space, bring? If we take these relations seriously, then at the level of output, we have perceived those intervals internally as an *analogy of distance*, per Strawson, but this ought not to change the initial version of geometric space they are founded upon. As Marr points out, our grasp of the input/output relation ought to be implemented or enhanced, not changed in kind.

Kant affirmed that our intuitions of space were external, but I claim that music is one of the few, if not the only, forms of art that imports an internal, immaterial intuition of space. It is little wonder that artists have aspired to music. As the faculty of hearing alone does not serve to spatially locate objects, there is only 'space' to map the output representation onto. This presents the listener with a space in which the representation of the output may run as follows: there is/is not 'enough room' for the apparent motion of tones *and* the Pythagorean intervals (see §2.1, p. 13; §2.9, pp. 29-31). What we are running is an algorithm for the listener who observes and reserves space for 'that again' or re-identifiable particulars in the motion of the music, as

13 Marr, p. 25.

Strawson affirms, as well as the ‘infinite’ depth of harmonic agreement between the pitch and timbre of the Pythagorean intervals as presented in the chapters on Plato and Newton The listener experiences a corresponding or comparable analogy of distance, not only in the moving system of the musical unity, but also in the analogy of *nearer to* and *further from* imported by the musical surface and the sonorous, infinite depth of the Pythagorean intervals.

CHAPTER 2

PLATO

2.1 The 'About-ness' of Music

It is often noted that Plato sought to reinvigorate the Golden Age of Pericles in his philosophical inquiries into society, the individual, and the cosmos. But in looking back to the past, Plato also looks forward to an ideal Athens built on the strength of reason. He looks forward by employing geometry in his philosophical method. The practice of geometry, such as employing the Pythagorean law of the square of the hypotenuse of a right angle triangle in framing and solving a problem, prioritises the use of the memory of laws over experience. By alluding to laws that short-circuit thinking to truths of reason, the brute facts of experience and painstaking processes of abstraction that constitute learning are avoided.[14] For example, given two distances of thirty and forty metres (AB and AC) that are joined at a point (A), and with the distance of the line (BC) fifty metres, the angle at (A) will be a right angle. The craftsmanship of Athenian sculpture and the architecture of its cityscape are constructed with a grasp of this elegance of geometry and its proportional nature. Further, by the geometric method of exhaustion, an ideal shape such as a *perfect* circle that was otherwise unachievable to the ancient Greeks, can be described by successive right-angle triangles. Ships can plot their journeys by their relation to the stars using such basic geometry, and hence trade can be improved. It seems little wonder, then, that to the ancient Greeks art and nature should be seen to be subject to human

14 Jourdain, *The Nature of Mathematics*, Mineola, New York, 1956, p.7.

understanding with a view to an underlying metaphysical reasoning applied to the universe that is determined by mathematics.

The discipline of education in the Platonic Academy required study in arithmetic, geometry, music, and astronomy. Each of these separate disciplines is linked to the fundamental discipline of geometry, proportion, and the elements of number, body, space, and motion. Plato discounted worldly motion in his search for an immutable, unchanging order; only by a process of abstraction to the realm of the mind and the Ideal Forms was the perception of everyday change deemed to be acceptable. Plato's rationalist case for the Ideal Forms is two-tiered; firstly he affirms the unsuitability of a philosophical account of a world of change, and secondly, he affirms mimesis subject to Pythagorean geometry and mathematical reason. Geometry is conceived as the study and application of the laws of proportions of shapes in choric space. The purpose of geometry as the rationalisation of space is, in part, to harmonise relations of extremes towards a relation of like/like indicative of a harmonious universe. Plato uses the term *chora* or the idea of 'enough room' to address that space where all Forms exist harmoniously. Within the concept of choric space, relations of the planets, the cosmos, and music are a 'harmony of the spheres'.[15]

The practice of harmonising extremes in music is achieved by introducing a mean unit whereby two different string lengths may be measured.[16] In his book *Musical Thought in Ancient Greece*, author Edward Lippmann writes, "Music

---

15 Lippmann, *Musical Thought in Ancient Greece,* New York, London, 1964, p. 89. Lippmann asserts that the ancient Greeks would have used the term 'music of the spheres' for there is a sound or sonority to planetary motion. A 'harmony of the spheres' connotes a science of planetary relations that is a product of the dialectic. See also, Barker, 'Plato and Aristoxenus on the Nature of μελοζ', in *The Second Sense: Studies in Hearing and Sound from Antiquity to the Seventeenth Century,* London, 1991, p. 144.
16 Lippmann, *Musical Thought in Ancient Greece*, New York, London, 1964, p. 20.

accounts for the mathematical meanings of harmony."[17] Tone ratios were believed to set the unlimited and the limited, the high and the low, in a direct, yet mystical relationship that revealed the relations of cosmic order that was roughly mimicked in every-day life.

Plato's Ideal Forms are geometric in structure, and music is theoretically geometric; this is a connection that Plato clearly makes, that is, that a theory of space corresponds to a theory of music. As a system of producing explanation, geometry is an Ideal Form of Space itself in which orderly material representations occur and of whose qualities Ideal Forms consist. Further I claim that the aural perception of the Pythagorean intervals, that is, hearing an octave, a fourth, or a fifth, imports the dimension of infinite depth to this space. In exploring this theory I will employ the idea of three-dimensional, choric space espoused by Plato, that is, the concept of space as of 'enough room' or harmony in three-dimensional space for all objects and values defined by geometric relations, including music.

2.2 Perception: Process and Concept

Also in this chapter I will explore contemporary discussions on perception and sound that are closely linked to Plato's philosophy. I will look to P. F. Strawson for a discussion of hearing, and to David Marr for his discussion of the phenomenology of vision. I will also present introductory material by metaphysicians who had considerable influence on Plato's thought concerning the nature of a concept, Form, and mathematics. These metaphysicians include Parmenides, Socrates and Pythagoras.

---

17 Lippmann, *Musical Thought in Ancient Greece,* New York, London, 1964, p. 2.

2.3 Music and the Everyday

Music (*mousike*) in the ancient Greek tradition in the 4th century BC was song accompanied by the lyre, syrinx, or the aulos. The music consisted of a single formal unit called a tetrachord, that is, a group of four consecutive tones that descended from a higher to a lower register. For example, the Dorian mode incorporates the descending tetrachord in the form of two whole tones followed by a semitone, such as E –D – C – B. The outer tones are fixed at the interval of a fourth, and the inner two tones are flexible depending upon the mode. [18] The ancient Greek modes were seen to be musical instances of forms of behaviour. Hence there was a distinct mode and tuning for drunken-ness, for languor, for bravery, and for calm.[19]

Only certain kinds of music were acceptable to the Ideal *polis*. In a later work, *Laws*, Plato dismissed solely instrumental music, for it lacked imitation. Imitation for Plato is closely related to sight. Plato writes:

> For when there are no words, it is very difficult to recognise the meaning of the harmony and the rhythm, or to see that any worthy object is imitated by them. And we must acknowledge that all this sort of thing…is exceedingly coarse and tasteless.[20]

Sight and the importance of light is a crucial metaphor in Plato's thought. According to *Laws*, to find value in what is musically good and worthy, and to shun what is frivolous and shallow, is a sign of a worthy character. The sun is the mediating, harmonising element between the world of objects and the individual. To

---

18 Henderson, 'Greece', in *Harvard Dictionary of Music*, Willi Apel (ed.), Cambridge, Mass., 1970, p. 351.

19 Plato, "Republic", III, 398-405, *The Dialogues of Plato*, trans. B. Jowett, 3rd Edition, Oxford, 1882 in *Contemplating Music*, Katz & Dalhaus (eds.) 4 vols., Stuyvesant, 1987, i, pp. 25-27.

20 Plato, *Laws*, trans. Benjamin Jowett, <http://www.classicallibrary.org/plato/dialogues/laws/book2.htm>, p. 20, accessed 14/3/2007.

deprive sight is to limit the opportunity to learn geometry, and, metaphorically, to limit the beneficial light of the Sun and the blazing rationality of the Forms. Yet in Plato's *Laws*, the Athenian Stranger prohibits the use of visual images such as 'good colour' when discussing music and its rhythms and melodies.[21] Thus we ought to look for the value in music (*mousike*) without recourse to the language of sight.

There is a contradiction in Plato's thought on these matters. We ought to hear music as an allegory of the Forms or Ideas if we impart meaning to music. Plato endorsed this notion, for this is the way in which musical gestures can be 'read' as instances of behaviour or body language. Reading or following the music in this way is like following the dialectic that achieves a Form of the Good; we learn the Form of the music or what it is 'about'. Due to the spatially located nature of mimesis, such as 'this' swan or 'that' table, which relies on communicating about the phenomena of sight, Plato's account does not address the faculty of hearing that relies on an alternative dimension of space. What can be seen leads to an ascent to the Forms with its appeal to geometry. Socrates states in *The Republic*:

> *Socrates*: Then do you think that there is any difference between the blind and those who are deprived of the true knowledge of the essences of things, and who have no vivid pattern in their souls, and who cannot, like painters, look away at the perfect truth as their model, and always with reference to and in the exactest possible contemplation of it establish in this world too the norms of the beautiful, the just, and the good, where they need to be established, and where they are established to guard them and keep them safe?
>
> *Glaucon*: No, in heaven's name there is not much difference.[22]

By this quote I draw attention to the strong dependence on sight possessed even by the ancient Greeks. From this early stage through to the study of Newton

21 Plato, *Laws*, trans. Benjamin Jowett, <http://www.classicallibrary.org/plato/dialogues/laws/book2.htm>, p. 3, accessed 14/3/2007.

22 Plato, 'Republic' 484D, in Flew, *An Introduction to Western Philosophy: Ideas and Argument from Plato to Sartre*, Indianapolis, New York, 1971, p. 59.

hearing is not considered to be an obvious faculty of perception or productive of knowledge.

2.4 Parmenides

The strength of Parmenides' approach and its influence on Plato concerns epistemology, that is, the nature of a philosophical concept. The sole written works by Parmenides held today are fragments of poetry. The fragment of most interest consists of two parts, 'The Way of Truth' and 'The Way of Appearance'.[23] It is in the former that we find Parmenides' understanding of appropriate concepts derived from a world of change. If we look to the world of flux and change that occupies our ordinary lives, Parmenides claims we look to the way of seeming and appearance. He asserts that whereas a world in motion is constantly changing in qualities, growth, and decay, the truth lies in a coherent, single, eternal, unchanging realm of unswerving being as 'what-is'. Parmenides conceives of change as a shift from 'what-is-not' to 'what-is'. To believe in change is not his way of truth, for '…what-is is in contact with what-is'.[24] Parmenides advocates an objective approach to thought in which only 'what-is' constitutes true reality. Stated positively, the Parmenidean principle has two parts: '…anything rationally conceivable must exist.' Further, '…we cannot refer to things that cannot be spoken or thought of.' [25]

Parmenides presented three modes of thought of objects; an unthinkable, a subjective, and an objective report.[26] To access the highest realm of philosophy, Parmenides argues that only one pathway of thought can access the truth of Being that

23 Waterfield, *The First Philosophers,* Oxford, 2000, p. 49.

24 Simplicius, 'Commentary on Aristotle's Physics', CAG IX, 145.1 – 146.25 and 38.30-39.9 Diels, in Waterfield, *The First Philosophers*, Oxford, 2000, 25, p. 60.

25 Randall, "Parmenides' Principle", http://www.elea.org/Parmenides/Parm-comment.html, pp. 1-2, accessed 5/3/2005.

26 Randall, "Parmenides' Principle", http://www.elea.org/Parmenides/Parm-comment.html, pp. 1-2, accessed 5/3/2005.

‘is’. This pathway is objective thinking, as opposed to subjective or incoherent thought.

2.5 Three Accounts of Parmenidean Thought

In the first of the two untenable accounts of thought, that is, the unthinkable account, necessarily, no possibilities exist of an account of a possible world.

> It was not once, nor will it be, since it is now, all together,
> single, and continuous. For what birth could you seek for it?
> How and from what did it grow? Neither will I allow you to say
> or to think that it grew from what-is-not, for that it is-not
> cannot be spoken or thought.[27]

Clearly such an approach is unworkable for although it would be continuously consistent, it would lack coherence.[28] That is, there is no way of re-identifying particular elements of such a world for there is no mode of cognition, and hence no public language concerning shared particulars. If a shared language cannot be constructed from particular objects of experience, it is difficult to fathom how such a world could persist coherently. Strawson is in accord with Parmenides concerning the public nature of cognition.

A subjective approach allows a blend of ‘what-is’ and ‘what-is-not’. Such an account of thinking occupies a grey area that lacks rigour. Parmenides writes of a subjective account of conceptualisation:

> …Therefore all those things which mortal men,
> trusting in true reality, have proposed, are no more than names-
> both birth and perishing, both being and not being,
> change of place, and alteration of bright colouring.[29]

27 Simplicius, ‘Commentary on Aristotle’s Physics’, CAG IX, 145.1-146.25 and 38.30-39.9 Diels, in Waterfield, *The First Philosophers*, Oxford, 2000, 5-9, p. 59.

28 Randall, “Parmenides’ Principle”, http://www.elea.org/Parmenides/Parm-comment.html, pp. 1-2, accessed 5/3/2005.

29 Simplicius, ‘Commentary on Aristotle’s Physics’, in Waterfield, *The First Philosophers*, Oxford, 2000, 38-40, p. 60.

While this is not unworkable, a subjective account lacks a persistent, critical method of coherence and consistency.[30] Per Parmenides, Plato notes that an everyday, subjective account of *mousike* is likely to lead to the listener being deceived, particularly as mere convention without reason underpinned the dominant interpretation of ancient Greek music and its modes as instances of behaviours such as courage, drunken-ness, and calm.[31]

The Parmenidean objective method of coherent conceptualisation is to view the world as a continuous single, unified scheme 'that-it-is'.[32] The mind and thought correspond directly in Parmenides' metaphysics, at the expense of perception. There are no parts to the abstracted conception of world. This scheme, 'that-it-is', is not to be identified with a sphere or any other shape, for there is no internal/external dimension to thought, and perceptions of edges, parts, objects, and motion are illusory, although he allowed that 'that-it-is' was sphere-like in order to align thought with a concept of uniformity throughout. That is, that the existing, unchanging All is everywhere equidistant from a centre.[33] Furthermore, the spatial and temporal dimensions of ordinary perception, three-dimensions and one-dimension respectively, are illusory. Ultimate reality, supported by reason but hidden from the senses, is singular and one-dimensional.

Most philosophers concur that the epistemological strength of the Parmenidean reality with the support of Zeno's method of mathematical reason and proof shows an influence in Plato's rationalist, geometric ontology. Plato's metaphysics departs from Parmenides' in Plato's own account of motion in *chora*, mimesis, and his theory of ascent to Ideal Forms.

30 Randall, "Parmenides' Principle", <http://www.elea.org/Parmenides/Parm-comment.html>, pp. 1-2, accessed 5/3/2005.

31 Plato, 'Republic'III, 399, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, i, 1987, pp. 25-6.

32 Waterfield, *The First Philosophers*, Oxford, 2000, p. 52.

33 Waterfield, *The First Philosophers*, Oxford, 2000, p. 54.

2.6 Pythagoras

The Pythagorean ascetic practice consisted of five years of silence and listening for the *akismatikoi*, and the study of the cosmic mathematical relationships for the *mathematikoi*.[34] The remarkable congruence of the geometry of musical instruments with early number theory seemed to provide an unshakeable foundation for the historical development of music. In the Western philosophical tradition the Pythagoreans laid the foundation for the transition of music from intuitions of space and myth to geometry, mathematics, and, later, the determination of the mean term as one of the methods of *logos*. The geometric precision and rigour of Pythagorean thought and its embrace of a rational cosmology shows a strong influence in Plato's overall metaphysics. The Pythagorean geometric principle of proportion is an important concept whereby a Platonic Ideal Form is identified in the mind.

The Pythagoreans situated their inquiry in a setting in which both number and proportion, modelled on the *gnomon*, are central. The *gnomon* serves as an analogy of the relations of the everyday world and the divine. By a system of arranging pebbles in lines, squares, and oblongs, and using number to identify the length of sides, geometric relations can be discerned that include the Pythagorean theory of the square of the hypotenuse. The *gnomons* also were used to model triangles. The triangular shape called the *tetraktys* was a powerful geometric figure in Pythagorean thought. It delineates an inside to otherwise infinite space. It consists of four points, three of which make a triangle shape. The fourth is positioned in the centre of the triangle. If each of the points is numbered sequentially, then the *tetraktys* contains the ratio of limited to the unlimited, 2:1. The sum of the points of the triangle equals 10, which

34 <http://www-groups.dcs.st-and.ac.uk/~history/Biographies/Pythagoras.html>, <http://www.smso.net/Pythagoreanism>, accessed 21/3/2007.

was the basis of decimal counting.[35] By joining the extremes to the centre of the triangle, a three-dimensional shape is constructed whose parts are equidistant. The *tetraktys* also contains basic intervals of the musical scale, that is, the double octave, twelfth, octave, fifth, and fourth (4:1, 3:1, 2:1, 3:2, 4:3).

By importing the means achieved by each of three functions, the arithmetic, geometric, or harmonic mean, the Pythagorean musical scale can be generated. This is best illustrated by employing the ratio 6:12 rather than 2:1. For example, the harmonic mean between the first two members of the first series, 6 and 12, is devised by adding to the smaller a proportion of itself and reducing the larger by the same proportion. The harmonic mean of 6 and 12 is 8, in which one-third has been added to the lesser and subtracted from the greater. The arithmetic mean, 9, is the middle term of a ratio, 6:12.[36] Putting these numerals into a sequence, 6:8:9:12 one gains both the arithmetic and harmonic means within a geometric ratio, as well as a model of ideal planetary relationships.[37]

---

35 Lippmann, *Musical Thought in Ancient Greece*, New York, London, 1964, p. 7.

36 The three means may be notated in the following ways using modern notation according to Guthrie:

Arithmetic Mean: $B = (A + C) /2$

Harmonic Mean: $B = 2AC/ A + C$

Geometric Mean: $B = \sqrt{}(A \times C)$

Guthrie, *The Pythagorean Sourcebook and Library*, Grand Rapids, Michigan, 1987, p. 333.

37 The nature of early Pythagorean mathematics can be summarised in the following points:

It is based on visible, countable points in a geometric shape, as a square, rectangle, or triangle.

Its approach is the relations of integers.

Expanding or reducing the form of the ratio is perfectly acceptable.

It cannot tolerate irrational numbers.

Ratios that sound simple are simple.

Richard Crocker suggests that the musical scale may have given the primary impetus for a mathematical function used by early Pythagoreans. According to Crocker, while it was not a problem for the ancient Greeks to square ratios, there was no method devised for compounding ratios. Having seen on the monochord that the interval of an octave has the ratio 2:1, and, in addition, that the perfect fifth can be located at the ratio of 3:2, and the perfect fourth at 4:3, the Pythagoreans discovered that the perfect fifth and the perfect fourth 'add up' to make an octave. Thus the ratios can be added together, 2:3:4, through the use of a common term of 3, whose outcome has the extreme terms 2:1, or the octave ratio. What was already self-evident could be understood arithmetically using a common term, i.e., that the intervals of the fourth and the fifth constituted the octave. The musical scale coincided smoothly with the visible nature of Pythagorean arithmetic, and, as shown, enhanced it. Relying on the expansion of

The Pythagorean intervals on the single-stringed monochord were shaped in a similar fashion to a line of points on the *gnomon*. To gain the octave ratio, the line is divided in half. The shorter length sounds the higher octave from the single length.

---

terms of ratios, the Pythagoreans could then explore the dimensions of the musical scale with some success using only integers. For example, with the knowledge that the perfect fourth and fifth constitute the octave, a pair of fifths can be seen to exceed the octave by a tone, and a pair of fourths to be less than an octave by a tone. The generation of these series also provides the whole tone, the distance between the fourth and the fifth, which divides the two tetrachords of the diatonic scale. The tone was arrived at by the generation of a geometric series, as follows:

2 4 8	The two fifths, expressed as the ratios 2:3 and 4:6, are followed by a 9
3 6 12	in the second column, and an 8 on the top of the third. This ratio shows
9 18	that the difference between two fifths and the octave, is a tone, or the
27	ratio 9:8.

Likewise one can find how many whole tones are in a perfect fourth as follows:

8 64 (64 x 3)192 (64 x4) 256
9 72 (72x 3) 216
81 (81 x 3) 243

In this series I have 'projected' the interval of the whole tone into the fourth. The two whole tones are present as 64:72 and 72:81. Then one projects 3 onto the first term of the series, and 4 onto the last. It is divisible into the fourth twice, with a 'lemma' of 243:256 as a remainder.

The use of a common term also applies in compounding unequal ratios such as 4:3 and 9:8. The mean term is 9, and the ratio is 12:9:8. Reducing the extreme terms gives the final ratio of 3:2, or the result that a tone 'added to' the perfect fourth is a perfect fifth. There may have been little difficulty in generating such series based on such whole number ratios, but there were problems. While the early Pythagoreans displayed little interest in developing their arithmetic beyond what was seemingly self-evident, the later Pythagoreans sought to establish a mean, or the exact halfway point of the octave (2:1). This produced an irrational number, the square root of 5, and so was inadmissible in an integer-based theory of number. Eudoxus, an ancient Greek geometer whose works were used by Euclid "…demonstrated that irrational numbers can be defined by means of approximations of rational numbers…" (van der Waerden, 'Eudoxus of Cnidus', *Encyclopaedia Britannica*, 15th edition, 30 vols., Chicago, vi, 1982, p.1021).

The harmonic mean is near the arithmetic mean, but is found in a way akin to the geometric mean; that is, finding the harmonic mean relies on taking one third of the extreme terms of a ratio, rather than simply adding up or taking away. The arithmetic mean is found by adding to the lesser term the same number as is subtracted from the greater. For example, the arithmetic mean term of 16:18 is 17. This method was useful in the larger ratios, that is, ratios whose terms differed by more than 1. The harmonic mean requires that one takes a part away from the greater term, and increase the lesser term by the same part; thus the harmonic mean of the octave 12:6 is 8. The result of finding these three means is a superbly Pythagorean ratio, 6:8:9:12, which contains in a unified, rational whole, the octave, 2:1, the arithmetic mean, 6:9:12, the harmonic mean, 6:8:12, and the geometric mean 8:9.

Crocker, 'Pythagorean Mathematics and Music', in *The Journal of Aesthetics and Art Criticism,* vol. 22, no.2, Winter 1963 <http:////links.jstor.org/sici=0021-8529%28196324%2922%3A2%3C189%3APMAM%3E2.0.CO%3B2-8>, accesssed 12/3/2002.

Similarly, to achieve the perfect fifth and fourth, the line is divided into three parts and two parts respectively, and the penultimate length is sounded.[38]

For the ancient Pythagoreans, and, by extension, the Platonists, the musical scale was cosmological, theoretical, and mimetic. Pythagorean cosmology is the notion that musical intervals can be seen as the perceived union of unrelated systems, that is, in which what is heard is spatially dependent upon a higher reality determined by fixed relationships in numbers such as 2:1. Theoretically, what was heard was *harmonia*, for the perfect musical ratios were an analogy of a hidden numerical order to the universe. These ratios were constituted in the material world by the Pythagorean scale. This scale was considered to imitate the ratios of the highest order of categories constitutive of the universe.

The theory of Pythagorean geometry was fatally undermined by the fact of incommensurability. A square with sides of one unit has a diagonal that is an irrational number ($\sqrt{2}$); this proved fatal for the geometric theory of the Pythagoreans. Later, Eudoxus put forward a method of solving this problem through corresponding ratios of lines.[39]

2.7 Socrates

One of the most important influences on Plato was that of his teacher, Socrates. Socrates took a very public approach to philosophical thought. He affirmed that he *knew* nothing, and served the populace in encouraging reflection and well-

---

38 Capleton, 'Circle of Pythagoras', <http://www.amarilli.co.uk/piano/theory/pythcrcl.asp>, accessed 17/3/2004. The Pythagorean method of tuning or 'just temperament' includes 11 perfect fifths that almost achieve a full 7 octaves before returning to the original perfect interval. The full 7 octaves cannot be achieved without some adjustment. To leave the intervals as they are results in the final interval or octave coming up short by a 'Pythagorean comma', a quarter of one semitone, or a 'wolf tone'.

39 Euclid, *The Thirteen Books of the Elements,* trans Sir Thomas L. Heath, 2 vols., New York, 1956, i, p. 137; Boyer, *The History of Calculus and its Conceptual Development,* New York, 1949, p. 31.

considered action, as well as revealing weaknesses in prominent Athenian citizens' ethical values.[40] His aim was to unify public interests with a philosophical approach to values. He sought to *limit* with reason and *define* by dialectic such public values as bravery and justice, in order that citizens might understand virtues and the degree to which they were made happy by them. The goal of happiness was seen as the moderation of values in an equitable balance.

In a Socratic method of dialogue, individual instances of justice, courage, or equality do not constitute the universals of Justice, Courage, or Equality as publicly shared values. By the dialectic method of collection and division, Socrates led his interlocutors towards a definition of such a value, such as the search for the Form of Piety in *Euthyphro*. The hidden principles of geometry in the built environment of Athens in which Socrates conversed are central to his overall philosophy. His preferred venue of philosophical discourse was the public arena, that is, the market, courtyards, and verandas of ancient Athens. His method of seeking a definition that encompasses all instances of a phenomenon is aimed at being as secure as the geometric laws that inform the public spaces he visits. The Form of Music (*harmonia*) was the highest kind of philosophy, according to Plato's Socrates. The following quote arises from Plato's *Phaedo*:

> The same dream came to me often in my past life, sometimes in one form and sometimes in another, but always saying the same thing: 'Socrates,' it said, 'make music and work at it.' And I formerly thought…the dream was encouraging me to do what I was doing, that is, to make music, because philosophy was the greatest kind of music…[41]

40 Cooper, 'Socrates', in *The Shorter Routledge Dictionary of Philosophy,* Edward Craig (ed.), Oxon, New York, 2005, p. 973.

41 Plato, 'Phaedo', in *A Loeb Classical Library Reader*, trans. Harold N. Fowler, Cambridge, Mass., London, 2006, pp. 73-9.

2.8 Plato: Form and Geometry

Plato extended the spatial limits of the Socratic dialogue to address a Parmenidean, separate, strictly conceptual realm of Forms, in which individual instances of courage, equality, as well as material objects such as tables, all 'participate' in individual, Ideal Forms. Plato's concept of infinite geometric space is *harmonia* or the 'fitting-together-ness' of the Ideal Forms, in which the ultimate Form of the Good contains the harmonising natures of the individual Forms.

In persisting with the abstraction of moral values to a separate realm of Ideal Forms, Plato also insists upon the faculty of recollection that is consistent with greater cognitive function. The memory or recollection of the Forms is the function of the soul that contained the Forms prior to incarceration in a worldly body. This account of the remembering soul in the material world lends strength to the importance of learning geometry and its laws as noted in the introduction to this chapter. In seeking the Ideal, Plato's method is to gather likenesses into groups and parse the general likenesses into structural elements that serve to direct understanding towards an increasingly clear knowledge of Form.

Geometry and the axiomatic method of proof are a clear example of Plato's theory of Ideal Form. We may gather numerous seemingly right angle triangles and show the relationship of the sides to each other that makes them all much the same in a general category of like/like. The Forms they share are: a) three-sided plane figure, and b) perpendicular-ness of two sides. But the proof that a particular shape is a right angle triangle is not to be found in the visual image of the triangle, for sight can be misleading. Things as we see them are not 'real' forms; they are merely the stepping-off point for Ideal Forms. For a student of philosophy or geometry to put forth an identity of a shape, the memory of a mathematical law is required. The proof of the right angle triangle is found in its *structure*, proved by the Pythagorean theorem of the square of the hypotenuse.

The soul already knows an Ideal triangular structure by recollection, according to Plato. In our souls we also have hidden knowledge of a multitude of other Forms, such as table-ness, drunken-ness, or cloud-ness.[42] The realm of the soul is revealed in Plato's public dialogues. By means of these public dialogues, in which hidden thoughts and intuitions are revealed, and by education in the quadrivium of geometry, music, arithmetic, and astronomy, Plato constructs the means by which one may ascend to the Forms. To achieve the highest Ideal of Form, the Platonic Socrates affirms that a given hypothesis, that is, an inquiry into the rational nature of the Form, is discarded. By the notion of discarding the hypothesis, I suggest that Socrates affirms that the Forms, having been proved to be rational, have ascended to infinite space. The ascent begins again as the student then seeks to understand *harmonia*, or the principled way in which the Ideal Forms 'fit together'. In infinite space the concept of the distance relationships of the musical scale, the distance relations of the planets, and the geometry of the Ideal Forms are seen to harmonise or 'fit-together' in a philosophical Ideal Form of Music.

2.9 Plato's *Timaeus*

In *Timaeus*, Plato's concern is with the construction and relations of the material world of opinion and change, and the intelligible, unchanging realm of the Forms. Metaphorically, the lived world is a material world of pebbles, vowel sounds, and tones, but all are disordered and dishevelled.[43] On the other hand, there is an

42 Plato, *The Republic of Plato,* trans. Cornford, London, 1941, pp. 223-6.

43 Lippman, *Musical Thought in Ancient Greece*, New York, London, 1964, pp. 97, 100-1.

intelligible order to the soul captured in the body that remembers the Forms. The worldly element of the soul is the transformative element. The transformative soul forges the connection of the sensible and the intelligible realms by harmonising these two extremes. These realms are conceived as follows: the ‘indivisible existence’ is the realm of the Ideal Forms; ‘divisible existence’ is earthly material existence in another. To harmonise the two mutually exclusive sets, Plato introduces a mediating set that is identified with the soul, named ‘intermediate existence’.

In the first half of *Timaeus* Plato uses the model of the four numbers of the Pythagorean decad to outline the mathematical structure of the soul in this ‘likely story’. Because the soul is a part of this world and a part of a body, and hence is imperfect, its nature includes a material, worldly, three-dimensional element. Thus Plato includes in each four-numbered *tetraktys* a cubed number that represents the worldly element of the soul. The resulting order consists of a *tetraktys* series, also called the Platonic *lambda*, whose elements are 1, 2, 4, 8 and 1, 3, 9, 27.[44] Plato links the dual *tetraktys* of the soul with the relations of the Pythagorean musical scale. The corresponding ratios constituted by relations of the odd and even numbers of the dual *tetraktys* are filled in with the equivalent size of the arithmetic and harmonic means.[45] Hence the series in an ascending numerical order, omitting ratios that appear twice will appear as: 1, 4/3, 3/2, 2, 8/3, 3, 4, 9/2, 16/3, 6, 8, 9, 27/2, 18, 27.[46] By filling in the intervals of the remaining tetrachords with the interval of a tone, the Pythagorean scale is achieved in the following ascending form: 1 9/8 9/8 256/243.[47] This achieves the first tetrachord. The second tetrachord can then be built from the top down, so to

44 Theon of Smyrna, ‘How Many Tetraktys are There?’ in *The Pythagorean Sourcebook and Library*, Guthrie, Grand Rapids, Michigan, 1987, pp. 317-18.

45 Guthrie, *The Pythagorean Sourcebook and Library*: Appendix III, Grand Rapids, Michigan, 1987, p. 327.

46 Cornford, *Plato's Cosmology*, London, 1948, p. 71.

47 Cornford, *Plato's Cosmology*, London, 1948, p. 72.

speak, including the additional tone, 9/8, which will forge consecutive tones from the fourth to the fifth.

In the second half of *Timaeus*, Plato faces the problem of reintegrating the comprehensively rational generation and relations of the soul and the mathematical conception of planetary relations into the genesis of the world. The problem he faces is the nature of space: is space a unity; is it binary, or is it diffuse?

His response is to relate his metaphysics in a fictional form. The story is a 'likely' story of physics, matter, and change. Plato begins by introducing a medium in which change occurs, that is, *chora* (χωρα). *Chora* is a recipient of chaos and order, and has no power to discriminate. Prior to the advent of reason, there were swirling qualities in *chora* of earthiness, airiness, fieriness, and wateriness. According to Plato, there is no particularity to these fundamental qualities, for their essence is continually transforming, and hence they are qualities subject to change.[48] *Chora* is characterised temporarily by regions of these qualities.[49] Plato writes on *chora*:

> …but we shall not be wrong if we describe it as invisible and formless, all-embracing, possessed in a most puzzling way of intelligibility, yet very hard to grasp…the part of it which has become fiery appears as fire, the part which has become wet appears as water, and other parts appear as earth and air in so far as they respectively come to resemble them…[50]

At this chaotic juncture in the *Timaeus*, we cannot say that there is any kind of rational, law-like conception of space. The unnamed elements gather to form bodies determined by relations of like/like and disappear only to return again in other configurations or transformations. Accordingly, there are chance configurations of

48 Plato, 'Timaeus', II, 17, 49, in *Timaeus and Critias,* London, 1977, p. 68.

49 Plato, 'Timaeus' II, 18, 50, in *Timaeus and Critias,* London, 1977, p. 69

50 Plato, 'Timaeus' II, 18, 51, in *Timaeus and Critias*, London, 1977, p. 70.

harmony, but their temporal nature is fleeting, and the transforming qualities of space are beguiling.

> …(*chora*) provides a position for everything which comes to be, and which is apprehended without the senses by a sort of spurious reasoning and so is hard to believe in – we look at it indeed in a kind of dream and say that everything that exists must be somewhere and occupy some space, and that which is nowhere in heaven and earth is nothing at all…(A)n image…needs to come into existence in something else if it is to claim some degree of reality.[51]

Plato assigns a role to space in this story. *Chora*, also named the Receptacle, the mother, and the nurse of becoming, distinguishes regions by an analogy of separating grains from the husk, that is, the act of 'winnowing'. In this analogy, space has two functions: first, the activity of shaking, and second, the task of separating. By winnowing, *chora* separates discrete particles into regions per their *qualities* of heaviness and lightness rather than size or shape. That is, the function of weight has a role in ordering data at this early stage of creation, in which regions of space arise due to the qualitative weight of particles.[52]

In *Timaeus,* Plato the introduces the Demiurge, who, with the memory of ideal geometric relations in his soul, gives number and shape to the particles in regions, all of which are composed of the four elements of earth, air, fire, and water. Each of the elements is generated from one of two kinds of regular polygon shapes, the isosceles and the right angle triangle, and the square. To the earth is given the shape of the cube; to fire, the tetrahedron; to air, the octahedron; and to water, the icosahedron.[53] As such, Plato invests in a *topological* account of early choric space and the elements

51 Plato, 'Timaeus' II, 20, 52, in *Timaeus and Critias,* London, 1977, p. 71.

52 Plato, 'Timaeus' 52D-53C, in Cornford, *Plato's Cosmology,* London, 1948, p. 202.

53 Brown, 'Platonic Solids and Plato's Theory of Everything', <http://www.mathpages.com/home/kmath096.htm>, accessed 14/2/2003.

by their infinite divisibility and malleability, although he writes most thoroughly on the proportions and dimensions of bodies and geometric, and hence infinite, space.

2.10 Music and Gesture

If we use Plato's 'Divided Line' theory of knowledge and apply it to music, then in the lower realm of likenesses and *mimesis*, Plato searches only for what is 'melodically satisfactory', that is, complex musical relations of consonances and dissonances that come together as recognisable human gestures, indicative of socially acceptable values, and concordant relations.[54]

At a higher level of knowledge, we may judge the value of a theme or mode by the *logos* of its intervals. The listener in this construction of music is not expectant of solely pleasurable experience; hearing music is hearing the *static*, coherent attunement of a particular instrument, that is, the ways in which the instrument harmonises extremes.[55] Reminiscent of the Pythagorean *tetraktys* [56], in his article "Plato and Aristoxenus on the Nature of *Melos*" author Andrew Barker writes:

> From a musical point of view, the system's most notable feature is that every note in it can be reached, from any starting point, by movements through the concordant intervals of fourths, fifths, and octaves. Concretely, it is the diatonic system of attunement either identical with or closely related to the one that was indeed in practical use.[57]

In order to hear reason in music, hearing a ratio of 2:1 is not to hear two distinct tones; it is to recognise that the formula to gain the ratio is a law that allows

---

54 Barker, 'Plato and Aristoxenus on the Nature of Melos', in *The Second Sense: Studies in Hearing and Musical Judgements from Antiquity to the Seventeenth Century,* Charles Burnett, Michael Fend, & Penelope Gouk (eds.), London, 1991, p. 146.

55 Barker, "Plato and Aristoxenus on the Nature of Melos", in *The Second Sense: Studies of Hearing and Judgement from Antiquity to the Seventeenth Century*, Charles Burnett, Michael Fend, & Penelope Gouk (eds.), London, 1991, p. 147.

56 See p.18 of this chapter.

57 Barker, "Plato and Aristoxenus on the Nature of Melos", in *The Second Sense: Studies of Hearing and Judgement from Antiquity to the Seventeenth Century*, Charles Burnett, Michael Fend, & Penelope Gouk (eds.), London, 1991, p. 147.

us to form a given interval from any pitch. Yet the proportionate nature of that law does not correspond directly to its product, and in this way music may have remained irretrievably *abstract*.

Barker constructs a separate conclusion. He asserts that there is a hidden, unheard element to music that is '…objectively present in the physical events underlying the experience.'[58] In his point of view, one may surmise that the ordering of a perceptible melody is superimposed on an imperceptible harmonic pattern. It cannot be said that Barker's approach to space relates to music's abstract nature. His view concerns the underlying harmonic pattern that composers may choose to construct their work. There is little doubt that the recognition of pattern is an important element of the comprehension of a musical unity, but the hidden mathematical element remains hidden from the *listener*, and is in the domain of the composer, the instrument-builder, and the instrumentalist. In Barker's approach, a chosen pattern is hidden only from the listener; this does not qualify music as *abstract* if its construction is hidden from only one section of the public.

2.11 Hearing: Space and Process

Neither Plato nor Strawson address the lived world in any substantial way. That is, there is no eternal substance to the lived world; it is in a constant state of change, either by the nature of motion or by vibration. They both seek to situate the cognitive individual or listener in a world void of material objects or land 'marks'. Plato populated this conceptual space with Ideal Forms. While Plato's conceptual

58 Barker, "Plato and Aristoxenus on the Nature of Melos", in *The Second Sense: Studies of Hearing and Judgement from Antiquity to the Seventeenth Century,* Charles Burnett, Michael Fend, & Penelope Gouk (eds.), London, 1991, p. 148. Further, Barker notes that Archytas, a later Pythagorean, was the first to isolate the variables necessary to formulate a law of a single pitched sound without the dependence on ratio, that is, pitch is a relation between the speed of transmission and the density of the medium of transmission.

scheme affirms that there is a metaphysical and a physical relation between the events in the world in geometry and the way in which we think of them conceptually, Strawson suggests that within the limits of a world of sound only, the cognitive listener establishes distance relations within the continuum of pitch fluctuation and variation.

Distances: Strawson and Plato

I invite the reader to view the Platonic *chora* in a way similar to Strawson's theory of No-Space. Neither theorist considers space to be a void. Plato invests in geometry as the mode of assigning distance relations.[59] A Platonist approach looks to rational conceptualisation and the function of abstraction as the method of gaining value in music. This has been of inestimable value in the development of the early versions of the Pythagorean musical scale throughout the history of Western music. Also, Plato's appeal to cognition and the memory is an integral element of the enjoyment of listening to music. Strawson's rigorous approach to concept formation is based on perception of sound. He explores the limits of a complete conceptual scheme in which sensory data are derived from hearing only. Whereas the ascent to a grasp of proportion and the Ideal Form of an object constitutes a concept for Plato, Strawson looks to change, and change in pitch in particular, as a correlative indicator of spatial awareness.

Yet Plato does not distinguish vision from audition, and hence his account does not include the information derived from hearing alone. In contrast to Plato's

59 Unfortunately this was not as coherent a system as Plato or the Pythagoreans would have liked. The hypotenuse of an isosceles triangle whose sides are a single unit produces the irrational number, $\sqrt{2}$. Irrational numbers were abhorrent to the Pythagoreans as they indicated a less than rational universe.

approach that proposes geometric relations as the preferred conceptual scheme, in Strawson's conception, space is conceived as constantly unfolding. This is a far cry from Plato's theory of geometric, choric space, in which *harmonia* is achieved by clear conceptions of Ideal Forms in rational, law-abiding space.

Strawson considers space conceived by the limits of hearing alone. The crucial difference between the ancient Platonic account of space and music, and Strawson's approach, is in the act of spatial location. Strawson affirms that in hearing, objects do not have the same quality of spatial location that they possess by virtue of the faculty of sight. In this way, Strawsonian space is *separate* from the listener, and, unlike Plato's rationalist account that subjects space to the rationalisations of geometry, Strawsonian space is a product of our limits of hearing. This is not to assume that space is therefore chaotic or anarchic in Strawson's estimation; it is constantly in motion in the act of 'unfolding'.

Marr

It is at Marr's theoretical level of 2-1/2 dimensional space employed in visual focus during pursuit-tracking, that, I argue, we ought to listen to music. That is, that between two and three-dimensional space, space is 'unfolding' in 2 1/2 dimensions. Marr's account of vision is built on points of intense shade or 'zero-crossings'. In his computational model, at the incipient moment of visually tracking a desired object, only intensities are perceived; these become clearer over time in a process that achieves the perception of surface, edges, terminations, and distance. Prior to complete visual perception of an object in three-dimensions, that is, prior to the spatial location of an object, Marr suggests that perception occurs in a lesser 2-1/2 dimensions in which vision is a consistent, computational process.

In a computational approach, input is subject to a function or algorithm that produces the output. The persistent application of a function or algorithm applied to a collection of zero-crossings either does or does not produce a distinct visual perception. With success, the final experience is of a clear, distinct object and the viewer's distance relation to it in three dimensions. [60] I argue that the idea of the 2-1/2 dimensional 'sketch' from Marr's theory of vision can also be applied to music. In this section I will present the method of understanding the relation of music and space. My approach to listening is a phenomenological account derived from Marr's account of vision. In this discussion I will present the similarity between a Platonic account of Form and Marr's phenomenological theory of vision. I suggest that the formation of a concept in Plato's theory of 'ascent to Form' and the process of vision are correlative, and further, they are correlative with the process of hearing. There has not been sufficient research performed on hearing processes, and hence this theory can only be put forth as such at present.

Although Marr asserts that focussing begins as viewer-centred with the aim of becoming three-dimensional and external, I claim that the experience of space in music perception is a dynamic of internal perception in 2-1/2 dimensions and perceptions of infinite depth imported by the perfect, Pythagorean intervals. Marr's theory of vision and the raw primal sketch is aimed towards the vision of a singular individual shape. Vision is supported by algorithms that serve to distinguish 'what-is' from 'what-is not'. In its initial stage, vision of a targeted object is of intensities of colour. These intensities increase in clarity in a 2-1/2 dimensional space *internal* to the viewer. The eye makes constant adjustments within these dimensions as the brain interprets the algorithms from one point to the next. Very quickly the surface of an

60 Marr, *Vision: A Computational Investigation into the Human Representation and Process of Visual Information*, New York, 1982, p. 37.

object and its angles become clearer; information is gained concerning the terminations or boundaries of the object and its distance from the viewer. The process is finally complete when perception is of an object completely external to the viewer.

Marr's theory of the spatialisation of a visual image and the Platonic ascent to the Ideal Form both share the method of the dialectic in which 'form' is achieved by collection, division, and abstraction. A Platonic Ideal Form, such as the Form of a Table, has a surface geometry of boundaries and terminations, is recognisable, and available to the memory. I argue that a correlative cognitive approach to processing information is found in Plato's theory of Form and Marr's theory of vision. In his chapter 'Representing the Image' Marr writes:

> Roughly speaking, the goals (of the spatial organization of images) are to make tokens and to find boundaries. Both tasks require selection processes whose function it is to forbid the combination of very dissimilar types of token, and both tasks require grouping and discrimination processes whose function is *to combine roughly similar types of tokens into larger tokens* or to construct boundaries between sets of tokens that differ in certain ways…One initially selects roughly similar elements from it (the raw primal sketch) and groups and clusters them together, *forming lines, curves, larger blobs, groups, and small patches to the extent allowed by the inherent structure of the image*…At each step the primitives (tokens) used are qualitatively similar symbols – edges, bars, blobs, and terminations or discontinuities – but they *refer to increasingly abstract properties of the image*.[61] (My italics)

This brief quote suggests the similarity of the process of vision in a 2-1/2 dimensional sketch with the method of grasping a Platonic Form or concept. By the process of a persistent demand for clarity of distance relations in concept formation, in sight, and in music, the form in each process becomes clearer. In each of these processes, the student/viewer/listener distinguishes that which applies to the limits of the Form or image from that which does not. Increasingly abstracted qualities serve to

61 Marr, *Vision,* New York, 1982, p. 91.

delineate and clarify the Form/image/theme from other images. The experience of hearing musical sounds is a process of internal perception and arrangement that occurs in and includes depth relations in 2 1/2 and 3-dimensional space.

CHAPTER 3

ARISTOTLE

3.1 Making Music

There are many elements to Aristotle's empirical philosophy. Its overall emphasis is a systematic account of experience founded upon the causes of motion and change. I will consider a causal account in music, the judgement of music, and the associated notions of Aristotelian substance and final cause. In general I will argue against a causal account of listening to music, despite the popularity of such an approach. I claim that the listener does not hear the totality of the music; he hears only what he listens 'for' and uses this experience to claim that music addresses his emotions. I will consider two accounts in support of an Aristotelian approach: first, Aristotle's theory of the soul and sense perception, and second, a functional theory of the perception of music as related to generative grammar. I will then discuss in what ways they are seriously limited in respect to a spatial account of music.

3.2 Method

Aristotle emphasised causes of spatio-temporal phenomena, rather than a realm of abstraction. His method involves the observation of motion or change that is explained by one of four species of cause. Aristotle's commitment is to *place* and surface as topological relations between bodies and the medium of motion. The role of the philosopher is to present a concise account of the 'being' of a substance by the four species of cause, that is, material, formal, efficient, and final. Further, causal relations of bodies provide the explanation of motion in *relative* space.

In his metaphysics, a fundamental cause that explains the way in which a substance is self-consistent is an account of the 'being *qua* being' of a substance. The *dynamic* of matter and form is the essence of substance; the system by which it acts independently is how it functions. Dynamics is an important approach to motion, for it informs later inquiry by Newton and Leibniz into planetary relations, as well as the physics of instrument building, the acoustics of the venue, and the wave theory of sound. I argue that Aristotle's account of an independent, self-producing substance is mistakenly applied to absolute music in the following way. In a substance-based approach to music, listeners listen 'for' the repetition of surface and its terminations. This approach emphasises the musical surface, but makes no inroads into the nature or perception of the so-called perfect intervals. Aristotle does not support the *a priori* role of geometry in an empirical study of motion. Without a grasp of the theory of the musical scale and the dimensions it imports, music is limited to a study of its surface relations, and hence is incomplete.

Finally, I claim that an aspect of music's ineffable quality is space, which is indicated by the theoretical relations of geometry and musical intervals, as well as by the perception of sounds. I argue that an attempt to describe 'absolute' music's ineffability as a causal relation directly between the music and the listener cannot be upheld.

This chapter will begin with the elements of Aristotelian method that have been useful in the study of music, and, in particular, musicology.

3.3 Musicology

In music, Aristotelian systems of explanation inform some areas of the study of musicology. Aristotle questioned the purpose of music and in what ways it served the general happiness of the public. He noted the importance of music to ritual in which music sets off and characterises the limits of a particular place (*topos*). Clearly music served a purpose in the education of youth, for it was a skill that enhanced pleasure.

He asked what is innate to the musician, and what skills must be learned. The skills gained in the growth and development of musicians contains valuable empirical data. A burgeoning field of spatial relations in both harmony and melody, the practical realities of increasingly complex composition – and of playing and performing such compositions, the history and development of musical style, ear training, and music analysis constitute study in the field of musicology and informs the study and training of musicians. In this Aristotelian style of analysis, by observing musicians, a causal analysis can be made of the origin, nature, and purpose of their skills. Further, by association with this causal account of the practice of music, it is a popular conception that music listeners share with or identify something in the music that has an effect on their emotions. There is a wealth of information to be gained from a causal inquiry into music and its phenomena that is a central focus in music education at present. But a causal analysis of the role of music beyond a community was of no interest to Aristotle, and he left music largely unaccounted for in his physics and metaphysics.

3.4 Music and Judgement

Apart from his study of a format for logical thinking, Aristotle expounded a method of exercising judgement. Aristotle used his own version of a dialectic method, in which, in its constructive guise, we may proceed without the benefit of a thorough scientific approach.[62] This approach is in three steps and will be followed in the following section. First, ordinary conventions, beliefs, and their problems are reviewed in order to acknowledge the work already completed in the area under inquiry. Second, the student explores what is acceptable and valid, and what is unacceptable, yet valid. [63] And third, a causal account is offered. I will follow this method in the following discussion.

In many ways, Aristotle's approach to music seems pertinent to Western ears, and perhaps quite pointed. In what ways might the general populace judge a performance of 'absolute', wordless music? What skills, if any, are required to make a good judgement of wordless, orchestral music? He suggests that a good critic of music might be an ordinary listener in the following quotation: 'Why cannot we attain true pleasure and form a correct judgement from hearing others, like the Lacedaemonians? - for they, without learning music, nevertheless can correctly judge, as they say, of good and bad melodies.'[64] Noticing that educated musicians are often critics, he asks a crucial question: 'What is it that makes music pleasurable and how can we judge it without becoming musicians ourselves?'[65] While this is certainly a warranted appeal to pleasure in the experience of music, ultimately it will be shown that in Aristotle's estimation, we should become musicians, that is, critics and performers, in order to hear music *correctly*.[66] This has also been shown to be the case in recent studies into understanding music. Well-trained musicians undergo experiments to reveal what happens in a musician's brain when playing or hearing

62 Shields, *Aristotle*, London, New York, 2007, p. 126.
63 Shields, *Aristotle*, London, New York, 2007, p. 127.
64 Aristotle, 'Politics', Book VIII, 5, 1338b, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, 1987, i, p. 253.
65 Aristotle, 'Politics', Book VIII, 5, 1338b, in *Contemplating Music,* Katz & Dalhaus (eds.), 4 vols., Stuyvesant, 1987, i, p. 253.
66 Aristotle, 'Politics' Book VIII, 5,1340b, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, New York, 1987, i, p. 257.

music. Regrettably, little study is made of the mind or perceptions of the ordinary listener. Yet there are numerous theories and notes to musical programs that will inform such an ordinary listener of how to listen to music. In his book *Music, Imagination, & Culture*, author Nicholas Cook writes:

> People who go to concerts must sometimes be upset by the lack of correspondence between the manner in which they experience a piece of music and the manner in which it is described in the programme-note; for programme-notes often dwell on large-scale tonal structures or motivic relationships that are in practice inaudible to listeners. To be told that the beauty or significance of a piece of music lies in relationships that one cannot hear is to have the aesthetic validity of one's experience of the music thrown into doubt; and the manner in which music is described by professionals can only create in the untrained listener a sense of inadequacy, a feeling that though he may enjoy the music he cannot really claim to understand it.[67]

By way of conceiving and analysing the ways in which listeners might conceive of space, I aim to address this problem called 'the music appreciation racket' that Cook discusses above.

Spatial Relations

While the topic of this thesis concerns music and its historical connection to space, there are several ways of conceiving of their relation. Musical space as a general term can be discussed in the following way. In the ordinary understanding of the term, musical space is accidental. It is the arena of communication located between the performers and the listeners that is dependent upon the energy and skill of the performers, and the attention of the listeners. It appears to be a one-way sort of communication in which the performers 'give' and the listeners 'receive'. This version of musical space also includes the visual spectacle of a performance. The

67 Cook, *Music, Imagination, & Culture*, Oxford, 1990, p. 1.

audience is encouraged to view the technical skill of the performers, the interaction of the conductor with the orchestra and its individual sections, and the interactions of the performers themselves, in addition to hearing the music. The experience of hearing music is layered with the visual experience to the extent that ordinary listeners are often left in a state of confusion as to how to locate or integrate what they heard and what they saw. To complete the experience, the aim of music is often construed as affecting the emotions. The listener sublimates the musical content presented and forms an account of the music that is linked to his emotions.

The listener is ordinarily conceived of as an emotive recipient of music's sound and structure. The intensity and duration of the emotions are unique to the individual listener, and hence, while valuable to the listener himself and reflective of his interests, musical emotions are an important element in a *subjective* account of music. As Carroll Pratt affirms: 'Music sounds the way moods feel.' [68]

Some theorists hold that music is meaningful of the emotions, either as expressed by the composer, or as aroused in the listener. An emotion-based account of music implies that the emotions and the music are similar in some way. In what way exactly are music and listeners alike? If a cause is identified to be 'in' the music, then the music is said to be expressive. If a cause is identified in the listener, then it is said that the music 'arouses' the listener's emotions. This kind of approach to music begs the question of 'meaning' or a final cause in music. Contrarily, other theorists hold that music is not meaningful, although it may have a high degree of cognitive value, that is, that music's form best explains what music 'is'. Two such theorists are Eduard Hanslick and Peter Kivy.

68 Pratt, 'The Meaning of Music', 1931, New York, in Ridley, *The Philosophy of Music,* Edinburgh, 2004, p. 74.

Hanslick asserts that music neither expresses nor represents emotions, for feelings or emotions are more complex than the scope of music can contain.[69] The beauty of music lies in the production and combination of tones.[70] In his book *The Philosophy of Music* author Aaron Ridley criticises Hanslick:

> The formalist view that the value of music is rooted exclusively in 'tones and their artistic combination' encourages the claim that the relation between music and emotion, though real, is merely *causal*, and hence of little philosophical or aesthetic interest.[71]

Ridley follows this claim with two ways in which music may be explained causally. Expectations and their gratification in the experience of musical tension and release as suggested by Leonard Meyer is one causal explanation of hearing music. The other lies in a theory of music and associations with previous events in the listener's life. Neither of these accounts seems to make a suitable account of cognition, as the listener is constructed as having little control over either of these particular functions. This is not to deny absolutely that the emotions play a part when hearing music. I suggest that if the music is experienced cognitively, without undue expectation or association, then the listener hears the music as situating and enhancing the limits of spatial relations in a 2-1/2 and 3-dimensional sketch.

Kivy affirms that musical emotions are particular to an overall formalist approach to music. Musical emotions are in the music as a part of its structure, and are

---

69 Hanslick, *On The Musically Beautiful*, trans. Geoffrey Payzant, Indianapolis, 1986, pp. 54-55. Hanslick writes:'If we trace the pathway which a melody must follow in order to act upon our state of feeling, we find that it goes from vibrating instrument to auditory nerve…Is the solar plexus, which is traditionally regarded as one of the main loci of sensation, especially responsive to music?…So far as we know, physiology can answer none of these questions.'

70 Hanslick, *On The Musically Beautiful*, trans. Geoffrey Payzant, Indianapolis, 1986, p. 83. Hanslick writes: '…from indefinite feelings, to which such a content is attributable, no spiritual content derives: rather, in each composition, the content derives from its particular tonal structure as the spontaneous creation of mind out of material comparable with mind [i.e., the tones].'

71 Ridley, *The Philosophy of Music*, Edinburgh, 2004, p. 71.

'possessed' or 'embodied' as contours in the music as part of its syntactical form.[72] As such, Kivy is similar to Kant in finding music to be patterned, decorative, 'sonic wallpaper'. His position has been subject to attack by music analysts. They assert that those very contours that Kivy identifies as syntactical form are vertical pitch relations, which are the source or core of those contoured properties.[73] The music analysts argue for more than a temporal account of a musical surface.

While it may be difficult to support Kivy's argument to the emotions, the impasse between the Kivy's formalist, contour point of view and the analysts' structuralist points of view is resolved by noting that the spatial perception of musical forms or contours and the elements of music share a common link. In an account of music and space, pitch relations describe Kivy's contours or shapes. These shapes have two attributes: they are in a phenomenological process of 'becoming' in an internal sketch in 2-1/2 dimensions for the listener, and they are descriptions of pitch relations in motion in space. The impasse is resolved by considering the analysis of the musical scale, the process of perception, and the concept of space that unifies them both.

3.5 Music and the Four Causes

An Aristotelian account of this every-day, lived-in world demands consistency by an explanation of change in phenomena per laws of cause and effect. In a response to Plato's theory of Forms, Aristotle is concerned with motion, processes of change, an account of an underlying substance, and its essential function. Marr's interest in process is implicated in Aristotle's study of change. Were we to discard the emphasis

72 Douglas Dempster, 'Review of Peter Kivy's The Fine Art of Repetition', Cambridge, 1993, in *Music Theory Online*, v. 2.3, <www.societymusictheory.org/mto.issues/mto.96.2.3/mto96.2.3.dempster.html>, accessed 21/3/2008.

73 Dempster, 'Review of Peter Kivy's The Fine Art of Repetition', Cambridge, 1993, in *Music Theory Online*, v. 2.3, <www.societymusictheory.org/mto.issues/mto.96.2.3/mto96.2.3.dempster.html>, accessed 21/3/2008.

on substance in Aristotle's philosophy, we would encounter the parameters of Marr's phenomenological approach to perception, that is, the perception of objects in motion, the processes of change in vision, and the function that relates the input representation with the output.

Working within the limits of Aristotle's account of cause, I aim to show that a causal account of music is not a sufficient account of perceiving music by showing that Aristotle did not consider a rational structure to space prior to a world infused with motion and change. Almost imperceptibly, a music listener in this model would hear the directed motion of groups of tones as dense, invisible substances in the music that arise to the listener as forms or images. These forms represent a composer's ideas in a medium, that is, representations and imitations of substance, coloured by relations of loudness, pitch, and timbre in air. In general, were we to view this approach in a musical context, we would be in a position to say that there is something, some form *in* the music that causes certain effects, such as a descending form causes the image of a falling tear (lachrymose). Listening then becomes a selective process of listening 'for' certain effects, subject to programme notes written by music professionals.

Aristotle's Dynamics

Matter, or the stuff of things, and form, or the momentary shape of things constitute the everyday world. The grounds of Aristotle's hylomorphism, that is, the dynamics of matter and form, can be gleaned from Aristotle's response to Parmenides. The grounds for Parmenides' claim that change is impossible arise from his account of being and non-being. Asserting that what can be thought is co-extensive with what exists, the contrary claim arises that what cannot be thought cannot exist, and further, that thoughts of change from 'not-being' to 'being' imply what cannot exist. Furthermore, Parmenides claims, changing objects cannot arise *ex nihilo*; hence, change is impossible. Aristotle refutes this claim. It is clear that objects exist and that they experience qualitative change. The space in which change occurs is infinitely divisible, for change may be minute, but does not arise out of nothing. Change, including change of place, occurs in a seamless continuum of infinitely divisible space in which the causal relations of bodies define motion.[74]

Aristotle viewed change and the alteration of shape as a dynamic of matter and form. Aristotelian dynamics are the observation of change explained by the four species of cause: the material, formal, efficient, and final causes. His dynamics are also distinguished in terms of potentiality and actuality. Change is the process of the actualisation of what is potentially *P* insofar as it is potentially *P*.[75] Aristotle's account of change is the *process* of actualisation from the potentiality of matter, but not the result.[76]

In music, the Aristotelian efficient cause accounts for the source and the making of the sound. This explains where a sound 'comes from', or a spatial as well as a formal account of the sound. An efficient cause in a musical context allows the listener to spatially locate a source of a sound. This requires an act of sight, for ordinarily, hearing alone does not directly locate a source. For example, in my small office, the motor in my refrigerator is whirring at the moment. If I were to think of a way to *integrate* that timbre of the refrigerator with the sounds of the birds and the heater already making audible sounds, the sounds of the bird, heater, and refrigerator would only be describable by timbre and loudness, not place discovered by spatial

74 Shields, *Aristotle*, London, New York, 2007, pp. 51-5.

75 Aristotle, 'Physics', Book II, ch.1, 201a10-201b in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, pp. 73-75.
76 Shields, *Aristotle*, London, New York, 2007, p. 203.

location. Hence an efficient cause, that is, a source of musical sound, does not serve to elucidate an account of hearing.

Matter is potentially creative stuff. The material cause is a substrate consisting of the stuff from which an object is formed.[77] Citing Aristotle's famous example, the matter of the bronze sphere is the bronze before it is formed into a sphere. In music, the material element of music is timbre. Music's substrate of timbre is air with a particular texture, such as a wind whistling down a tunnel, a refrigerator motor, or the panting of a dog. Sounds occur by the motion of pushing airwaves or particles in particular patterns of timbre. Musical timbre is 'enformed' air. Schoenberg affirms this understanding of timbre: 'I cannot accept the distinction between tone colour (timbre) and pitch as it is generally stated. I find that tone makes itself noticed through colour, one dimension of which is pitch. Tone colour is therefore the large area, of which pitch is one division.'[78] A musician uses an instrument to put form, that is, a principle of arrangement, into the timbral matter that is eventually produced as a tone.[79] Timbre in this sense is material by virtue of the existence of musical instruments. Musical instruments are similarly 'enformed' by the existence of musicians to play them.[80]

A formal cause is matter with shape that exists in actuality to the sense of the perceiver.[81] Visual perceptions of what exists and images of objects in the mind are forms. Once form is lost, matter reappears. In this dynamic approach, the perception of music is a listener's awareness of the dynamics of form as tone and matter as

77 Aristotle, 'Physics', Book II, chs. 8-9, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, pp. 49-51.

78 Quote from Arnold Schoenberg, 'Harmonielehre', in Fritz Wenckel, *Music, Sound, and Sensation*, New York, 1967, p. 118.

79 Aristotle, Metaphysics Book VIII, 8,1034a, in *Contemplating Music,* Katz & Dahlhaus (eds.), 4 vols., Stuyvesant, 1987, i, p. 237.

80 This excludes instruments that move to shifts in air such as wind chimes. Sound is not an accidental property. The music of wind chimes is atomistic, not formal/material.

81 Aristotle, 'Physics' Book II, Ch.2, 193b20-194a10, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 52.

timbre in the shaping of a tone. We may discuss particulars in music by a formal cause that brings the particular shape or theme to the cognitive mind. That is, a listener may identify and re-identify a sound. In a formalist account of music, the cognitive listener attends to the forms that arise to his mind. These forms are argued to be the way in which the music functions, or its essence. To theorists such as Lerdahl and Jackendoff, music is perceived functionally in this way that is similar to understanding language. This approach will be explored in more depth later in this chapter.

Another important example of a formal cause in the relation of music and substance is found in the spatio-temporal process of succeeding tones that have *direction* either upwards towards a higher register or downwards towards a lower one. A single tone also has a formal cause by virtue of its relations to other tones in the musical scale. As a principle of arrangement of tones, form is also realised in a variety of ways, such as structural and polyphonic forms including monophonic, arch, fugal, dance, and theme/variation.

A formal cause such as the *direction* of tones is often linked to the Aristotelian final cause as that which appears to the mind effortlessly, or the 'end' or purpose of direction. With respect to Aristotelian final causes, we might look to cadences in music. The listener hears a melodic line and its harmony that lead to a final closing chord or cadence. This cadence is the realisation of the melodic line from its potential to its actual state. In an account of a final cause, the *actual* state of the music is inherent in the unfolding of the music as a *potential* to realise form, and its final cause or '*telos'* is complete in its final or ending.[82]

82 Aristotle, 'Physics' Book II, Ch. 3, 195a20, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 54.

In most cases of classical orchestral music in the Western diatonic tradition, a final cadence consists of perfect intervals. Can this pattern also be explained causally? One may ask: what is the consonant nature of the perfect intervals 'for'? Is there a greater purpose for the concordance of these perfect intervals or consonances? Clearly the answer was in the affirmative for Plato. To Aristotle, the final cause and the ultimate source of motion is answered in terms of time, change, and the source of motion, the Unmoved Mover. I find that, the Unmoved Mover relates to questions concerning change in time, not space. In a later section of this chapter (§3.11), how this may be done is considered with a view to Strawson's account of 'No-Space' and the musical scale.

3.6 Substance and Place/*Topos*

To Aristotle, the purpose of music was intellectual enjoyment and to characterise place, such as the role of music in ritual.[83] Its melodic, rhythmic, and harmonic elements serve to characterise the limits of a place. As such, the aural phenomenon of infinite depth in music is precluded by Aristotle's commitment to spatio-temporal accounts of motion.

As Aristotle favoured an empirical approach that looked to substance and primary causes, I will briefly follow such a pathway concerning music. Adapting his approach to Western classical music, music is a representation of a substance in a process of change. This section will look at the ways in which music might represent substance. I will discuss a substantival approach to music in two ways: first, with a view to Aristotle's *Physics* and his conception of place, and second, with a view to the soul as substance. I remind the reader that substances, as Aristotle describes them, are

83 Aristotle, 'Politics' Book VIII, 1340a-b, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, 1987, i, pp. 255-6.

constituted by a dynamic of matter and form. The tone and a succession of tones are substances in this argument.

In *Categories*, Aristotle lists the categories of properties that are essential for an entity to 'be' substantially, that is, as a hylomorphic compound. The categories of substance are: an individual substance, a quantity, quality, a relation, place, time, situation, a condition, an action, or a passion.[84] Music may imitate or represent each of these or a combination therein. In contrast to Plato's theory of space and *chora* that is prior to the motion of substances, Aristotle finds change of place (*topos*) to hold primary significance in the attribute of substance. Having a place is an attribute of 'being' for Aristotle, for if a thing has 'place' then Aristotle states that it has a claim to 'be' substantially.[85] Thus we may link the representation of a substance in a place as an explanation of music and motion. Reflecting Aristotle's causal account of motion in his *Physics*, music *represents* a category of acting substance as that in which weight adheres. Substances with weight and motion 'arrive' somewhere, however briefly.

Motion and Weight

Aristotle's theory of motion in *Physics* is built on the relations of cause and effect and the nature of substance. A substance has the immediate power to act. An intrinsic element of the substance's power to act is the attribute of weight. Yet weight is not a *cause* of motion.[86] I have considered this claim in looking at the loudness and the sense of *nearer to* and *further from* in music. The perception of loudness is related

84 Katz & Dalhaus, 'Aristotle: Introduction', in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, i, 1987, pp. 229-30.

85 Aristotle, 'Physics', Book VIII, Ch. 7, 260a, in Sachs, *Aristotle's Physics*: New Brunswick, London, 2001, p. 212.

86 Drabkin, 'Notes on the Laws of Motion in Aristotle', *The American Journal of Philology*, Baltimore, 1938, <http://links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, pp. 75-6, 79, accessed 14/9/2006.

to the weight the musicians apply to their instruments. I affirm that the perception of *nearer to* and *further from* is intrinsic to the musical scale. In a phenomenological account of hearing, weight imports loudness to a tone; but loudness is peripheral to the music itself. It is also secondary to the subject of music theory and the scale.

Motion as the effects of causes is viewed in terms of loco-motion or *topos* as the shifts and changes of surface of a body. To Aristotle, motion is related to, but not caused by, the internal demands of the weight of the object. We can assume an imitation of motion in the case of music. His use of proportions joins the relations of weight, impulse/potentiality, direction, and time, all of which concern the motion of a material body. For example, a substance *A* with weight has the potential to move substance *B*, also weighted, a distance *C,* in time *D*. The potential in *A* to *initiate* motion is a dynamic (δυναμιζ).[87] A different term arises when we consider that *A* moves only *half* of *B*, distance *C,* in *half* the time *D*. This is the term ισχυζ or 'impulse'.[88] In general, the proportions reflect a relative view of space - from the relation of cause and effect in the power of a substance to act to the relations of the properties of a substance in which motion occurs in only parts of the body.

As the quantification of a moving body is primarily dependent upon the senses in this approach, the medium in which a body moves is also dependent upon the senses. Broadly speaking, Aristotle tended to view air and water as media of motion, rather than material elements underpinning forms; hence musical matter is not a typical element of the material substrate in Aristotle's view. A musical tone is

87 Drabkin, 'Notes on the Laws of Motion in Aristotle', *The American Journal of Philology,* Baltimore, 1938, <http://links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, p. 62, accessed 14/9/2006.

88 Drabkin, 'Notes on the Laws of Motion in Aristotle,' *The American Journal of Philology,* Johns Hopkins, Baltimore, 1938, <http://links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, p. 62, accessed 14/9/2006. In these simple proportions, Aristotle is assuming that bodies move at an average speed, although it must have been obvious that things speed up as they fall.

'enformed' *air* and is unlike his preferred substantial elements of earth and fire.[89] An explanation of musical motion, that is, motion of enformed air, would be slightly puzzling. This may explain his single remark concerning the nature of music: 'It is not easy to determine the nature of music, or why anyone should have a knowledge of it.'[90]

Typically Aristotle explained motion, such as falling, by the *relations* of elements in a substance, that is, the elements of earth, air, fire, and water. In Aristotelian physics, if the substance or object contained a large component of earth, its *natural* motion, explained by the final cause as that which is intuitively sound, would be to fall towards the centre of the earth in the conjunction of like/like. Similarly, an object constituted mainly of fire would tend to rise towards the heavens.

Whereas the experience of motion and change of objects occurs in three dimensions, upon reflection, Aristotle addresses only *two* dimensions in the explanation of the proportional relations of motion. For Aristotle, motion is rectilinear and in two dimensions, that is, either up, down, to the left or the right.[91] Motion occurs when bodies act due to the four causes as they rise, fall, or move laterally in a medium. He writes: 'Any process of change must have an end; it must be able to arrive.' [92] Aristotle supports his argument for the rectilinear motion of objects as he notes that objects tend to fall or rise to their *natural* place.[93]

The places of the four natural elements are independent of our situation. Fire *always* goes up towards the heavens, and a clump of earth *always* goes down towards

---

89 Dijksterhuis, *The Mechanization of the World Picture*, Oxford, 1961, p. 25.

90 Aristotle, 'Politics', Book VIII, 1380a18-2, in *Contemplating Music,* Katz & Dalhaus eds., 4 vols., Stuyvesant, i,1987, p. 252.

91 Aristotle, *De Caelo*, Book 1, 2, <http://classics.mit.edu/Aristotle/heavens.mb.txt>, accessed 24/3/2003, p. 2. Aristotle is noted as the earliest classical philosopher to instigate scalar measurement.

92 Aristotle, *De Caelo,* Book 1, part 7, <http://classics.mit.edu/Aristotle/heavens.mb.txt>, accessed 24/3/2003, p. 9.

93 Aristotle, 'Physics' Book IV, Ch.1, 208a27, 10-20, in Sachs, *Aristotle's Physics*: New Brunswick, London, 2001, p. 95.

the centre of the universe, irrespective of our position. Water and air are the media in which such natural motions tend to occur. Natural place is ultimately independent of the viewer and the phenomenal body that occupies it. Natural place is a final cause, and an end product of the unimpeded, invisible agency of cause and effect. (This is an early conception of a natural law of gravitation that would not be adequately explained until some 2,000 years later by Newton.)

The density of the medium through which a body or substance moves is an important element of Aristotle's construal of motion. Whether a body moves in a natural, falling motion, or a violent, projectile motion, the body moves in proportion to the density of the surrounding medium, or its 'place'. He affirms that the time taken for a body to travel a certain distance in varying media is proportional to the *density* of the medium.[94]

Aristotle's theory of motion is generated initially by the intrinsic characteristic of weight, that is, $p = mv$, in which p is momentum, m is mass and v is velocity.[95] Aristotle's formula served as a basic tool of analysis for physics some 2,000 years later in the conception of force in the physics of Descartes. This formula answers Zeno's Arrow paradox and the infinite divisibility of space. In Aristotle's response to this paradox, whether motion is natural or projectile, motion has an external cause. The arrow moves as its trajectory changes and the surrounding medium loses its power. According to Aristotle, when a body is thrown, the thrower is in contact with the body in the first instance. Upon release, the thrower transfers the energy of release to the surrounding medium along with the body. He communicates the power of

94 Drabkin, 'Notes on the Laws of Motion of Aristotle', in *The American Journal of Philology*, Baltimore, 1938, <http://links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, p. 66, accessed 14/9/2006.

95 The term 'velocity' is used in this equation in response to the principle of cause and effect. By this principle, motion is directed.

projection onto the surrounding medium. This surrounding layer then repeats that action of transference to the next layer of the surrounding medium. And so the pattern goes. In this way, every point of motion in the path of a projectile is caused. Finally, as the power to project weakens, the body assumes its direction towards its natural place.[96] The actual cause of the change in the arrow's trajectory is the weight of the arrow. Dependent upon the degree of force with which the arrow is released, its weight in a uniform motion will be inversely proportionate to that force.[97]

To consider the variables of weight, density of the medium, average speed, and initial force as Aristotle hoped to do was to attempt too much. What was lacking in his discussion of motion was the valuable contribution of experimentation on motion in a non-resistant medium or a void.[98] Aristotle affirmed that nature abhors a vacuum. But he believed that weight was *intrinsic* to a substance, and as such, his theory of motion revolves around the idea of momentum, and not force as the term came to be understood. Hence Aristotle makes a blunder that was not challenged for centuries, that is, that, to an Aristotelian, substantial bodies fall naturally in relation to their momentum or weight, rather than due to gravitational force.

The limited degree to which Aristotle was prepared to abstract weight and place from a sensible body is at the core of his misconstrual of the motion of falling bodies. When Aristotle discusses weight, he does so in the light of abstraction and an associated notion of an exact proportionality. Unwittingly, he observes the role of

96 Aristotle, 'Physics' Book VIII, ch.10, 267a-10, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 225. Also, see Dijksterhuis, *The Mechanization of the World Picture*, Oxford, 1961, pp. 27-8.

97 Dijksterhuis, *The Mechanization of the World Picture*, Oxford, 1961, p. 28.

98 Drabkin, 'Notes on the Laws of Motion in Aristotle' in *The American Journal of Philology,* Baltimore, 1938, <http://links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>,p. 69, accessed 14/9/2006.

weight in two separate ways.[99] The weight of a body *relative to a medium* determines the rate of fall or rise. Here he is thinking of density per unit of volume; but at other times he is thinking of the total weight, as in the comparison of the ratios of velocities of *two bodies in a medium in which both are known to fall*. In the first instance, he is looking at volume as a phenomenon of a medium. In the second instance, he is looking at weight as that which offers Aristotelian substantial form, and natural place, and therefore constitutes a substance.

The strictly musical imitation of intrinsic power or 'weight' has its material cause in the confinement of air or pressure on an instrument and the resulting vibration, and its release as a tone with a certain density or loudness of sound. Ordinarily the loudness of a pitch is perceived as *nearer to* or *further from* a listener. In this thesis I claim that loudness is secondary to the spatial relations inherent in the musical scale, and, in particular, the Pythagorean intervals that offer depth to perception. To endow the loudness of a pitch with distance relations is to depend closely upon the senses to address music perception, rather than a coherent grasp of space.

In a broader scope, the corresponding dialogue between Aristotle and Plato is between the notions of *chora* and *topos*. The proposal of this thesis is that an account of music perception includes an account of space (*chora*) and spatial dimensions of motion. A spatial account of music easily distinguishes between an abstract conception of space and a causal account of place. As I have shown, Aristotle posits a sensible grasp of place in contrast to Plato's intelligible approach to space.

---

99 Drabkin, 'Notes on the Laws of Motion in Aristotle', in *The American Journal of Philology,* Baltimore, 1938, <http://www.links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, p. 79, accessed 14/9/2006.

Aristotle presents his critique of Plato by posing a question of identity; he notes that place cannot be body or an outline of body.[100] Place must be present to the senses prior to any geometric description.[101] And thus we view the external world as a multitude of contiguous/continuous surfaces with length and breadth, but not depth, in which 'place' offers 'being' - with or without bodies in it.[102] Aristotle argues that place as *topos* has the power of an explanation of the nature of substance, as follows:

> Therefore, if it is necessary that there always be motion, there must also always be *change of place* as the primary one of the motions, and of kinds of change of place, if one is primary and the others derivative, the primary one.[103]

He finds that this sensory approach is a more apt description of human experience than the conceptual, infinite, choric space of geometry. Unlike *chora*, place does not require a body to fill it, for it remains even when the body has moved away. The place of an object remains present to the mind due to its causal relations. To Aristotle, place is *not* intrinsic to the body; it is a *container* that is separate from the body, at rest or in motion. Place is the inner limit of that which surrounds a body.[104]

Aristotle's notion of place concerns the musical surface. In this topographical approach of the relation to change over time, the musical surface is of primary interest to the listener. Motion as change of place is indicated by changes in timbre. For the interested listener, however, the scope of his imagination will be described by the

---

100 Aristotle, 'Physics' Book IV, 209a, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 96.

101 Aristotle, 'Physics' Book IV, ch.1, 209a17, in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, p. 96.

102 Aristotle, 'Physics', Book IV, 209a11, in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, p. 96.

103 Aristotle, 'Physics' Book VIII, ch.7, 260a in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 213.

104 Aristotle, 'Physics' Book IV, ch.3, 210a25, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 99.

characterising limits of the musical place, and the experience of infinite depth will be unavailable to him.

3.7 Music and Its Medium

According to Aristotle, through whatever medium a body moves, its motion is due to a cause. The following quotation from *Physics* addresses the problem of bodies in motion through air and other containers. The following supports my position that Aristotle did not consider music in his physics. His emphasis remains strictly empirical.

> When we say we are in the heavens as in a place, it is because we are in the air and this is in the heavens; and we are in the air but not in all of it, but on account of the innermost surrounding part of it we say we are in the air. (For if all the air were a place, each thing and its place would not be equal, but they seem to be equal, and that in which something is primarily is of this sort.) Then whenever what surrounds is not divided but is continuous, a thing is said to be in it not as a place but as a part in a whole, but whenever it is divided and touching, the thing is first of all in the innermost part of what surrounds it, which is neither part of the thing in it not greater than its extension but equal to it, for the extremities of things which touch coincide. If the surrounding thing is continuous, a thing is moved not in it but with it, but if the surrounding thing is divided, a thing is moved in it, and no less so whether the surrounding thing is moved or not. Examples of things not divided, but spoken of as parts in wholes, are the eyeball in the eye and the hand in the body, and of things divided, the water in the jar and the wine in the jug, for the hand is moved with the body, but the water is moved in the jar.[105]

The opening sentence adopts common language practice, which is typical of Aristotle's philosophical method. Part of where we are is in the air, and part of us is on the ground. Hence, part of our place is in the air, unlike a fish, for example, whose whole place is in the water. Then Aristotle considers rival claims. If *all* the air were a surrounding limit and none was left over to inhabit the rest of the sublunar realm, then

105 Aristotle, 'Physics' Book IV, ch.4, 211a25-211b5, in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, p. 101.

it would seem that unequal sized things would take up unequal parts of air, but this does not appear to be the case. There seems to be an excess of air to account for all manner of physical shapes. When a medium such as air fully surrounds a bird, or water fully surrounds a fish, the bird or the fish is a part in a whole. A different situation occurs in a container such as a jug, whose limits are divided by and touching the water within it. In this case the water is in the innermost part of the jug, and this innermost part is neither the jug itself, nor the extension of the water, but equal to both as the extremities of both. This is the *place* of the water in the jug, but it can only be 'said' that there is a limit between the jug and the water, for it cannot be distinguished by the senses.

Aristotle follows this with a brief reference to the air. When a thing is contained to its extremities in the air, it is continuous with the air. This appears to be the dimensions of heard music. If a thing divides the weakly resistant air, such as the bird, then the bird is moving in the air, whether or not the air is moved. Similarly, the fish divides the water when it moves, whether or not the water itself has been moved. Neither the fish nor the bird leaves a vacuum behind it. Aristotle claimed that the medium swirled about and filled in the space vacated by the moving object.[106] Finally Aristotle gives examples to clarify his discussion. The eyeball in the eye and the hand in the body exemplify the relation of parts to the unified whole. The water in the jug exemplifies the relation of surface extremities and containers.

How does this account for music? Aristotle was not aware that tones *alter* the particles or waves constitutive of air, before they eventually fade. In Aristotle's account it seems that music would not be affected by an unequal apportioning of air, for music does not have a visible or touchable body that can be added to the available

106 Aristotle, 'Physics', Book IV, ch.7, 213b39, in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, p. 109

air. Music has a relation to air of like/like. It travels through the air, but might travel on the surface of the air, if air were to have an extremity; but this does not appear to be the case. Air does not appear to have a fixed limit or surface if music can travel through it at one moment, and not in the next. Yet Aristotle claims that air does have a limit, for the nature of objects is to move in certain ways in this sublunar realm, and other ways in the heavenly realms. But even if music is an object that is added to the air, then it need not divide the air for it has no magnitude or weight, only density. It is possible that Aristotle believes that music is added to the surface of the air in this sublunar realm, for in *De Caelo* he claims that there is not a harmony of the spheres because there is no *place* where it could be added.[107] If we are Aristotelians, then music is 'enformed' air; the nature of tones is not to be positioned in the air as a part in a whole. It is 'said of' music that it has a surface, but that is all. We must, in the end, note that music is neither added to nor divides the air. Neither does music as sound seem to be specifically dependent upon air, for sound can travel in different media, such as water.

We might then say that music is dependent upon a medium, but not any specific sort. Hence music does not have any magnitude; it is medium-dependent, and thus does not qualify for consideration as a substance in Aristotelian philosophy. It is, in the end, substantival.

In understanding a musical concept of place, according to Aristotle, timbre communicates information of surfaces in a place. Music is the 'emplacement' of sensible form, including the composer's musical ideas, 'enformed' air, and imitations of substance and motion. But timbre travels in all directions, and does not solely mark out surfaces. We must, in the end, have some general account of spatial location, for

107 Aristotle, *On the Heavens,* Bk. 2, 9. <http://classics.mit.edu/Aristotle/heavens.mb.txt>, accessed 22/2/2004.

this is a demand of place and surface in an Aristotelian account of music. But the possibility of spatial location has already been ruled out as an appropriate account of hearing in a sound-only world, devoid of vision or touch, as suggested by Strawson. A world without spatial location is overly abstract for the Aristotelian model. Hence as Aristotelian listeners, we are not so much hearing sounds as we are forming an imagined, caused, visual or tactile landscape constituted by images of directed forms, and louder or softer magnitudes of sound as places. This arises as a 'language' of images of place and associated expectations. By using Aristotelian principles of place and *topos*, a spatial account of music is not possible, for we cannot integrate an explanation of music by its phenomena without including the geometric nature of its foundations.

3.8 Aristoxenus

It was left to Aristotle's student, Aristoxenus, to make an account of music that embraced Aristotelian principles of matter, form, motion, and place. In this section I will present the multiple relations of music and form with regard to Aristotle's *Metaphysics* and an outline of the work of Aristoxenus. This discussion precedes an inquiry into music and perception with reference to Aristotle's *De Anima*.

Although the work of Aristoxenus flows on directly from the teachings of Aristotle, his account of music as an aural phenomenon was lost to subsequent theorists and a serious approach to harmony and musical function was not re-examined until studies by Rameau in 1722.[108] This discussion of Aristoxenus is

108 The following abstract situates the metaphysics of Aristotle and Aristoxenus in relation to modern harmony and theories of motion. This abstract is quoted from David E. Cohen, ' "The Imperfect Seeks Its Perfection": Harmonic Progression, Directed Motion, and Aristotelian Physics', *Music Theory Spectrum*, Berkeley, 2001, URL = <http://mc1litvip.jstor.org/stable/745984>, pp. 139-169, accessed 4/9/2006.

placed in its direct account of music and function flowing from Aristotle's *Metaphysics*.

Aristotle's *Metaphysics* is a search for a precise answer to the question of 'being *qua* being', that is, the nature or essence of the function of producing 'being' attributed to substance comprised of matter and form. To find an essence of a substance is to name an identity relation between the substance and the system of engagement of matter and form. To name an object as a substance is to be able to discuss the manner in which the object systematically and independently produces itself. The essence of an object is its method of production or its 'function' as well as the explanation of that method. Both the essence and the function fall under the term 'form'.[109]

In his book, *Harmonic Elements,* Aristoxenus adopts the method of his teacher Aristotle, and searches for the substance and essence in music, and in particular, melody.[110] Aristoxenus' concern is not to do with musical expression or a Platonic ethos, but the transference of structure, or the ordinary representation of musical form, from the musical sounds to the listener. In order for a cognitive listener to *understand* the essence of music, the listener should grasp the function of notes, and hence the

---

"The modern theoretical concept of harmonic progression was first clearly articulated by Rameau. Yet in his Traite, this concept is still demonstrably linked (via Zarlino) with an older notion of harmonic progression: the late-medieval contrapuntal doctrine that 'imperfect' dyadic sonorities "seek" or "require" resolution to specific "perfect" dyads. This doctrine first appears in Marchetto of Padua's Lucidarium (1317-18). Its explanation, the general principle that "the imperfect seeks its perfection," is a scholastic formulation of a basic principle of Aristotelian physics: natural motions are directed toward a predetermined goal or "end" (telos), which is the "perfection" of the moved thing. The late-medieval application of this principle to counterpoint thus emerges as the probable origin of the concept of harmonic progression and, more broadly, of the widely accepted view of music as embodying "Directed Motion."

109 Cohen, S. Marc, "Aristotle's Metaphysics", *The Stanford Encyclopedia of Philosophy (Winter 2003 Edition),* Edward N. Zalta (ed.), URL=<http://plato.stanford.edu/archives/win2003/entries/Aristotle-metaphysics/>, pp. 5-8, accessed 12/5/2006.

110 Aristoxenus, 'Harmonic Elements', in *Source Readings in Music History,* ed. O. Strunk, New York, Norton, 1950, pp. 25-33, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, i, 1987, pp. 274-281. See also, Barker, 'Music and Perception: A Study in Aristoxenus' in *The Journal of Hellenic Studies*, vol. 98, London, 1978, pp. 9-16.

structure. The debate in which Aristoxenus couches his terms is Aristotelian metaphysics, i.e., substance/essence or form/function.

Aristoxenus is concerned firstly with the perception of song as opposed to speech as the most general question. He asserts that we hear speech quite differently to the way we hear music. Speech moves up and down in pitch continuously, whereas song moves by intervals, 'remaining stationary at the points of arrival between leaps'.[111] Thus musical motion appears to happen in a space unlike the seamless, causal continuum that Aristotle affirms for ordinary space. Yet Aristoxenus affirms that the music listener should consider the musical continuity as a temporal and formal whole in two dimensions.[112]

Aristoxenus argues from a cognitive point of view: human intelligence and a trainable ear is all that is necessary to become a competent musician. [113] He writes in *Harmonic Elements*: 'The sense of hearing judges the magnitudes of the intervals; the intellect judges the functions of the notes.' [114] It is a mistake to superimpose mathematical relations on to musical intervals as the Pythagoreans had done. Quite simply, we simply hear an octave, fifth, or fourth as a distance and a concord. Taking this empirical position, he asks: what is a melody? How does it go on? What does a melody require for a listener to recognise it?[115] A discussion of this kind is sorely lacking in Pythagorean theory, he claims.

The tetrachord is the musical unit or *individual* substance consisting of matter and form that constitutes melodic invention. The two outer notes of the tetrachord, the

111 Barker, 'Music and Perception: A Study in Aristoxenus' in The *Journal of Hellenic Studies*, vol. 98, London, 1978, p. 10.
112 Katz & Dalhaus, 'Aristoxenus: Introduction', in *Contemplating Music*, Katz & Dalhaus (eds.), 4.vols, Stuyvesant, i, 1987, p. 272.
113 Aristoxenus, 'Harmonic Elements', in *Contemplating Music*, Katz & Dalhaus, (eds.), 4 vols., Stuyvesant, i,1987, p. 275. See also, Barker, 'Music and Perception: A Study in Aristoxenus', in *The Journal of Hellenic Studies*, v. 98, London, 1978, p. 9.
114 Aristoxenus, 'Harmonic Elements', in *Contemplating Music*, Katz & Dalhaus, (eds.), 4 vols., Stuyvesant, i, 1987, p. 275.
115 Barker, 'Music and Perception: A Study in Aristoxenus', in *The Journal of Hellenic Studies,* v. 98, London, 1978, p. 10.

mese and *hypate*, are the unchanging elements, and the two internal notes are the moving elements. The perception of these elements requires a trained ear. He writes: 'Such, then, being the nature of music, we must in matters of harmony also accustom both ear and intellect to a correct judgement of the permanent and changeable element alike.'[116]

The role of the intellect in music is to discern the function of a note. The understanding of the function of a note turns on a discussion of modulation. Based on the function of the two middle notes of the tetrachord, the scales are grouped in distinct genera of tuning, the enharmonic, chromatic, and diatonic scales.

Modulation occurs when a note holds one position in one tetrachord, and a related position in another tetrachord.[117] It signals the use of another scale; but may only be useful in modes whose middle point is a distance of a perfect consonance from another similar point.[118] With the development of modulation, the ability of the musical substance to 'act', that is, to self-produce as an imitation of a substance, is immeasurably increased. The musical surface stood to gain in complexity throughout the Middle Ages as noted by St. Augustine in his famous statement: 'Music is the art of modulating (measuring) well.' [119]

In Aristoxenus' description of the tetrachord and the musical scale one can perceive an analogy to the discussion of local motion and place as a separate container as mentioned above. Analogous to the explanation of motion and place, the listener's perception of the difference in the scales, that is, their 'shades' or 'colours', relies on

116 Aristoxenus, 'Harmonic Elements', in *Contemplating Music,* Katz & Dalhaus (eds.), 4 vols., Stuyvesant, i, 1987, p. 276.
117 Barker, 'Music and Perception: A Study in Aristoxenus' in *The Journal of Hellenic Studies,* v. 98, London, 1978, pp.12-13. See also, Aristoxenus, 'Harmonic Elements' in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, i, 1987, p. 278.
118 Barker, 'Music and Perception: A Study in Aristoxenus', in *The Journal of Hellenic Studies,* v. 98, London, 1978, p.14.
119 St. Augustine, in O'Connell, *Art and The Christian Intelligence in St. Augustine,* Cambridge, 1978, p. 72.

the 'permanence of the containing and the variation of the intermediate notes'.[120] In short, melodies appear to be or to imitate substances by virtue of three related criteria: relations of place within the fixed limits of the tetrachord; motion in the shading of the internal tones of the tetrachord; and modulation or the function of a tone in the integration of related scales into a piece of music. In this way, Aristoxenus successfully imports Aristotelian substance and metaphysics into an account of music and sense perception.[121]

The unstated requirement in an Aristoxenian account of a metaphysics of music and hearing is that the listener is trained to hear the functional tones in musical modulation. That is, he understands and may point out the places in which modulation, tonal shading, and standard modal statements are made in the music. The listener in this model is a trained musician, familiar with the use of scalar and harmonic devices. These conditions presented by Aristoxenus do not answer Aristotle's fundamental question: 'What is it that makes music pleasurable and how can we judge it without becoming musicians ourselves?'[122]

3.9 Marr on Time: Mapping and Conceptualising Motion

In this discussion I aim to give the reader more reason to consider an alternative account of hearing. This discussion includes a further reference to Marr and the importance of sustaining mental motion in hearing music.

Hearing in the human body occurs across two ears situated on either side of the head, so in a normal situation there is a lag in perception of sound. We tend to

120 Barker, 'Music and Perception: A Study in Aristoxenus', in *The Journal of Hellenic Studies*, v. 98, London, 1978, p. 10
121 This does not include the form of the 'round', whose expression is circular, and thus imitative of celestial, not terrestrial, motion.
122 Aristotle, 'Politics', Book VIII, 5, 1338b, in *Contemplating Music,* Katz & Dalhaus (eds.), 4 vols., Stuyvesant, 1987, i, p. 253.

hear most easily that which is to the front, to the left, or to the right of us. What is heard above or below us is less easy to hear. The pinna, the external capturing mechanism of the ear, produces echoes. In *De Anima*, Aristotle maps out sound in air and the act of hearing.[123] He notes that the air external to the ear is moving due to a blow that creates a sound. The air internal to the ear, by which he might mean the Eustachian tube, does not move. We now know that the inner ear is filled with fluid and that the vibrations in the air are transferred to the inner ear via the middle ear. The cochlea in the inner ear converts sounds into nerve signals that are conducted along the auditory portion of the eighth cranial nerve to higher brain centres. The interaction between the neural pathways of both ears makes sound location possible.[124]

The above paragraph concerns the transformation of vibrations of sound into auditory information. Do any findings in Marr's theory of sight map onto hearing? In his chapter 'From Images to Surfaces' Marr discusses several approaches to the complex phenomenon of processing visual motion. In his review of previous theories of vision, he notes that an early approach to vision was the Gestalt theory that concerns the figure and ground as well as eye movements.[125] One theorist noted by Marr, Braddick, shows the vision of motion divided into two groups in a method analogous to methods of playing a musical instrument, that is, a random-dot display of separate, staccato points, and smooth apparent motion, or seemingly connected, legato lines.[126] A further experiment in the nature of seeing motion concerns the mapping of one line on to other lines (Ullman). As Marr notes, the emphasis on

123 Aristotle, *De Anima* Book II, 8, 420a, translation, introduction, and notes by Lawson-Tancred, London, 1986, p. 177.

124 'Your Sense of Hearing' Oracle ThinkQuest, <http://library.thinkquest.org/3750/hear/hear.html>, accessed 10/9/2006.

125 Marr, p. 159.

126 Marr, p. 160.

smooth lines and apparent motion in this theory is cause to be wary; nevertheless, the technique of mapping is valuable.[127] In summing up his overview, Marr writes:

> Perhaps the key to the puzzle is that in the analysis of motion – more so, perhaps, than any other aspect of vision - time is of the essence. This is not only because moving things can be harmful, but also because, like yesterday's weather forecast, old descriptions of a state of a moving body soon become useless.[128]

Marr's theory is valuable in its account of seeing objects in motion. Yet, there are two contra-indications in Marr's theory of pursuit-tracking as applied to hearing music. First, Marr's account of a phenomenology of vision is studied as an aid for survival, including the ability to flee from harm and to find food. Ordinary spatial location is a survival mechanism that is not required in listening to music.[129] To be able to detect harm and be prepared to flee is not necessary in hearing music in an indoor concert venue, although it may be the highly valuable when hearing a growl in the bushes outside. Survival is not in question in Strawson's account of hearing; further, listening to music in a concert venue does not require ordinary survival mechanisms.

And second, my purpose in exploring this section on sound perception and Marr's theory of vision is to emphasise the substantial differences between perceptions of visible and heard, musical motion. Fundamentally, a cognitive listener simply *requires* 'old descriptions of the state of a moving body' to be stored in his memory in order to engage in the activity of hearing music well. Such descriptions are

127 Marr, p. 161.

128 Marr, p. 162

129 Cook quotes Roger Scruton in his book *Music, Imagination, and Culture.* Scruton claims in relation to musical motion, "We may find ourselves at a loss for an answer to that question (What is a moving musical line?): for, literally speaking, nothing does move. There is one note, and then another; movement, however, demands one thing, which passes from place to place." Roger Scruton, *The Aesthetics of Architecture*, London, 1979, in Nicholas Cook, *Music, Imagination, and Culture*, Oxford, 1990, p. 24.

an important element in his overall cognitive account of a musical work. In support of my point, in his article 'What is Abstract about the Art of Music?' author Kendall Walton writes a footnote concerning the usefulness of 'old descriptions' in hearing music:

> It also suggests another line of thought…that music treats not only particular concepts, a particular way of organising experience, but the very process of organizing and reorganising it, the *process* of adopting systems of classification and replacing one with another, of reconceptualizing things, of adjusting one's "conceptual scheme"…There are in music constant reorganisations and reclassifications and reconceptualisations of musical materials: thematic ideas, rhythmic motives, harmonic progressions, and formal structures are combined, fragmented, recombined, made to look like or unlike others, placed in new contexts, etc. Listening, then, is perhaps an exercise in the techniques by which we reconceptualise our extra-musical experience - whether in the development of scientific theories or in everyday thought…[130] (Candidate's italics)

3.10 Aristotle and The Soul: *De Anima*

In Aristotle's list of categories that constitute a substance, the emotions arise in his study of the soul as substance. Often listeners look to the emotions to explain music experience. Aristotle has an explanation for the role of sense perception, the soul, and its motion from being unlike an object of its perception towards that which it is like. Musical expectations are clearly present in Aristotle's theory of potentiality/actuality. However an emphasis on expectation does not address the problem of simply hearing; it increases the mental weight of knowledge and appreciation of process the listener brings to hearing music, but it does not address ways in which a listener may hear well.

130 Walton, 'What Is Abstract about the Art of Music?' in The Journal of Aesthetics and Art Criticism, v. 46, No. 3, (Spring 1988), <http://links.jstor.org/sici?sici=0021-8529%28198821%2946%3A3%3C351%3AWIAATA%3E2.0.CO%3B2-N>, accessed 22/4/2005, p. 358.

To Plato, the soul in motion is determined by fixed quantitative relations. Aristotle asserts that Plato was wrong to assign ratios to the movement of the soul. Aristotle writes: 'And it is clear to what material he refers when he explains how ideas are related to things perceived by sense and how unity is related to ideas; namely, that this material is a duality, the 'great-and-small' of quantity.'[131] To Aristotle, Plato's theory of Forms is aligned with his own theory of *choriston*. Plato's theory considers things themselves as having Ideal Forms of qualities, such as table-ness, straight-ness, or reflective-ness. Aristotle argues that Plato's quantitative account keeps pertinent information hidden. In *De Anima* he formulates his argument in an analogy of a tangent to a circle. A tangent to a circle has many attributes, one of which is touching a circle. If we consider only the Ideal Form of the tangential line, its straight-ness, then it is conceptually separate (*chorismos*) and lacks a function, which is touching the circle. Aristotle asserts that we cannot know that the line is straight without its relating to a body in some way. Things touch, and there is no void between points. In order for a form to *function*, it must relate.[132]

The seat of sensory perception in Aristotle's *De Anima* is the soul. The soul is a substance whose form is perception via the faculties of the senses.[133] In the case of music, the ear is touched directly by the sound waves whose form is a succession of points or a musical surface.[134] According to my argument, the function of the tetrachord is to imitate place with a particular appeal to the senses. In line with the metaphysical account already provided, the substance of the musical tetrachord, the forms of changing/not-changing or place/context, appeals to the listener's soul as

131 Aristotle, *Metaphysics* Bk. 1, 7, trans. Richard Hope, Ann Arbor, 1960, p. 21.

132 Aristotle, *De Anima,* trans. Hugh Lawson-Tancred, London, 1986, p. 128.

133 Christopher Shields, 'Aristotle's Psychology', *Stanford Encyclopedia of Philosophy (Winter 2005 Edition),* Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/win2005/entries/aristotle-psychology/>, accessed 12/5/2006.

134 Aristotle, *De Anima*, trans. Lawson-Tancred, London, 1986, p. 176.

substance. The active, perceptive soul of the listener is altered by the formal, material, and final arrangements of the melodic organisation of the music.

This system of perception or theory of soul relies on the capacity of the listener to become isomorphic with the music as change *within* place, that is, within the tetrachord, and change *of* place by modulation.[135] In an *entelechia* of this musical kind, the systematic production of place and modulation, that is, the two elements of a single musical function, relate to the listener's soul like the tangent and the circle.[136] Without a function, music and the listener do not relate.

Representation

A representational theory of perception is used to explain the faculty of hearing in Aristotelian natural science. This section will discuss what it is in music that serves as 'representational' material.[137] When a listener experiences music, the mental function is called '*aesthesis'*. Both Plato and Aristotle described '*aesthesis'* metaphorically as pressure on the mind.[138] Aristotle takes this function to be an identity relation. We understand the music when we grasp aurally the essence and function in the order of the notes, changes in key or tonal centre, and rhythmic variations. In short, as Aristoxenus asserts, we understand music when we can analyse the contained places on its surface.

135 Aristotle, ‹Politics› Book VIII, 1340a, in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols. Stuyvesant, i, 1987, p. 255.
136 Please see the Glossary of Terms for a definition of entelechia
137 Sorbom, "Aristotle on Music as Representation", in *Journal of Aesthetics and Art Criticism*, The American Society for Aesthetics, v. 52, no. 1, University Park, 1994, in *Musical Worlds: New Directions*, Alperson (ed.), University Park, Pennsylvania, 1994, pp. 37-45.
138 Sorbom, "Aristotle on Music as Representation", in *Journal of Aesthetics and Art Criticism*, The American Society for Aesthetics, v. 52, no. 1, University Park, 1994, in *Musical Worlds: New Directions*, Alperson (ed.), University Park, Pennsylvania, 1994, p. 37.

Aristotle would push this model even further, for the purpose or *telos* of the tetrachord is to relate to the soul of a cognitive being. The form of the music contains two higher principles of motion, unlike-to-like and desire, that relate specifically to cognitive, receptive beings. The soul searches for knowledge through perceptions of form unlike itself. [139] Musical motion, intrinsic to musical composition, is indicative of the manner in which music is perceived, through an entelechy of the motion of the soul and the moving substance of the music. In this way, there is motion between soul and place in a relation of unlike/like - to soul and place towards a relation of like/like.[140]

One of the problems of an account of entelechy in music is the problem of language. By seeking to familiarise himself with a musical place, the listener seeks out attributes or places in the music that he finds in himself. These places 'in' the music are containers of substantival timbres or colours that change in three ways: by virtue of relations to other objects, by their nature of *aesthesis* to achieve their place, and in a path towards the achievement of form. In this way the listener or his soul is led to project an identity relation between himself and the music, and it is difficult to keep such a relation at bay. This relation is dependent on spatial location by metaphor, the projection of identity, or by an imagined three-dimensional space. I claim that none of the above is applicable to the experience of hearing that, by its nature, does not spatially locate in three dimensions or relate causally to the listener.

3.11 Music and Grammar: Another Functionalist Approach

Sense perception, the construction of meaning therein, and the cognitive elements of that process concern both philosophy and psychology. One method of

139 Aristotle, *De Anima* Book II, 5, trans. Lawson-Tancred, London, 1986, pp.170, 172.

140 Aristotle, *De Anima*, Book II, 5, trans. Lawson-Tancred, London, 1986, p. 172.

aligning these fields is through a functionalist approach to perception associated with language. In this last section I will discuss this approach to music and the shortcomings of its account.

Aristotle's functionalist theory of perception is still relevant some 2,500 years after *De Anima*. In a modern conception of the theory, the claim is that we are 'hard-wired' to understand musical structures, as we are to grasp language structures. In his book *Listening*, the author Stephen Handel adopts a functionalist approach to the perception of music. He is concerned with the way in which linguistic theory and music theory might be aligned: 'For both linguistic and music theory, the goal might be to mirror the intuitions of an educated listener (Chomsky 1965; Lerdahl and Jackendoff 1983.) …The intuitions represent a grammar, a model of the listener's knowledge of language and music.'[141]

It is not exactly clear what Handel means by the intuition. That is, are there musical intuitions of melody, harmony, and rhythm? Handel does not specify. In addition, it should be noted that the intuitions Handel and several other psychologists use are those of a trained musician. As has already been noted in the introduction to this thesis, listeners do not share the same experience of music as musicians. If an ordinary listener chooses to expose himself to more and more music, but desires to *remain* a listener only, does this necessarily make him an intuitive, trained musician? In addition, a listener may become adept at comparing performances, but this does not imply a capacity to judge the performance as successful or unsuccessful. Handel's approach is similar to Aristoxenus'; his aim is for better-trained ears, not smarter listeners. What is lacking in psychological investigations into music is an inquiry into the grasp of music by every-day listeners. In his book *Exploring The Musical Mind*

141 Handel, *Listening*, Cambridge Mass., London, 1989, p. 324.

author John Sloboda presents this as a shortcoming in research at this point in time.[142] Modern research relies on trained musicians, not ordinary listeners. If we seek to highlight the ordinary listener's experience, then a different account from that of a trained musician ought to be made.

The aim of a functionalist approach to perception in the case of music is to make reductions to a position of surface analysis that accounts for the smallest elements of structure and the function of notes. In this way, the surface of the music represents what the listener hears. As Lerdahl and Jackendoff write in the opening chapter of their book, *A Generative Theory of Tonal Music*, concerning the form of knowledge they are pursuing:

> Rather we are referring to the largely unconscious knowledge (the 'musical intuition') that the listener brings to his hearing - a knowledge that enables him to organise and make coherent the surface patterns of pitch, attack, duration, intensity, timbre, and so forth. In our view a theory of musical idiom should characterise such organisation in terms of an explicit formal grammar that models the listener's connection between the presented musical surface of a piece and the structure he attributes to the piece… (I)t is no longer obvious how the listener obtains evidence for his structures from the musical surface. Thus a theory of a sufficiently intricate musical idiom will be a rich source of hypotheses about psychological musical universals.'[143]

The discrete phenomena of musically 'distinguishable sounds', e.g., pitch, attack, duration, intensity and timbre mentioned immediately above is reminiscent of Aristoxenus' concern with the musical surface, as previously noted. Concomitant with this approach to musical phenomena is a topographical account of music and place, which Lerdahl and Jackendoff also support. In reference to musical 'universals', the authors assert that their method is to examine the sort of knowledge an experienced musician has, from its basis in metre, motive, and pitch, to increasingly elaborate

142 Sloboda, *Exploring the Musical Mind,* Oxford, 2005, pp.127-9

143 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, pp. 3-4.

forms. They seek to understand to what extent this knowledge is learned, and to what extent it is innate. In constituting their search for the innate content of a musician's knowledge, they aim to present this innate element as a musical 'universal'. Their premise is that innate musical knowledge cannot have been learned, but, like acquiring a language, must have been gained unconsciously.[144]

Interestingly, Lerdahl and Jackendoff discuss rhythm as one of several possible examples of an innate understanding of music. Yet rhythm is the *only* example of innateness that is discussed extensively in their book. A discussion of other examples such as melody and harmony would have been welcome to flesh out their argument.

In this book Lerdahl and Jackendoff adapt the analytical technique of reduction instigated by Heinrich Schenker to suit the terms of their investigation. They also provide a word of caution: a generative grammar of music, they note, concerns the structure assigned to musical phrases, sections, and complete works, and *not* the judgement of pleasing or effective musical/ grammatical construction.[145]

In Schenkerian analysis, there is a hierarchy of complexity, from the very simplest harmonic and rhythmic reduction, for example, tonic-dominant-tonic and crotchet-crotchet-minim structures (quarter note – quarter note – half note), to considerable elaboration including dissonance and free rhythms.[146] The process of a linguistic understanding of music is founded upon the grasp of effective grammar or rules of construction of phonemes or units of sound. Lerdahl and Jackendoff achieve a complexity to their analysis of musical structures and perception that is considerably

144 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, pp. 279-285.

145 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, p. 7.

146 Cook, *Music, Imagination & Culture*, Oxford, 1990, pp. 71-2.

more detailed and complex than Schenker's, although the hierarchical structure is not abandoned.[147]

Handel also uses the Schenkerian method of analysis, but claims that these levels of analysis should be viewed as functioning interdependently. He notes that at the very basic 'background' (Ursatz) level of understanding the surface elements of interest to the musical grammarian include intensity, duration, pitch, vibrato, and frequency.[148] The middle ground (Mittelgrund) includes pitches of melodic importance. At this second level, according to Handel, we hear textures or combinations of timbres, i.e., warmth, roughness, brightness, hollowness.[149] And finally, at the foreground level is the 'heard' musical surface in its full elaboration. At the third level, he claims, we hear *objects*. We hear objects such as 'Brewery Lane-ness', 'mountain-ness', drunken-ness', and 'Queen-ness'.[150] Handel believes that the levels are interrelated, not hierarchical. He writes: 'Each level represents an abstraction, an after-the-fact attempt to specify the characteristics of that event.'[151] At each level, '…sounds yield meanings, and these meanings represent abstractions, reflections, or translations of the actual physical energies.'[152]

According to Handel, the meaning of music comes from the relation of notes. In music, he writes, a perceived pattern arises from both the notes and the listener. Lerdahl and Jackendoff are in accord with Handel in a commitment to the hard-wired nature of musical perception, but are careful to note that a musical 'universal' or

147 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music,* Cambridge, 1983, pp. 125-45.

148 Handel, *Listening*, Cambridge, Mass., London, 1989, p.181.

149 Handel, *Listening,* Cambridge, Mass., London, 1989, p. 181.

150 Handel, *Listening*, Cambridge, Mass., London, 1989, p. 181.

151 Handel, *Listening*, Cambridge, Mass., London, 1989, p. 181

152 Handel, *Listening*, Cambridge, Mass., London, 1989, p. 181.

archetype is a matter of preference rules, and not a case of melody being in any way archetypically 'well-formed'.[153]

Problems

Yet Handel is not thoroughly at ease with this approach to music and listening, that is, that the perception of place is related to the perception of music, and further, that laws of motion and functional relations explain the musical surface. He regularly expresses hesitations at taking a full-blown functionalist approach and the hierarchy it employs. He concludes his book with the following statement:

> Because of the complexity of the acoustic signal, a relatively static organisation into centres would be inadequate and inappropriate. A *flexible* organisational system, able to capitalise on the regularities in the acoustic signal caused by the constraints of production, would be necessary. Giving up the concept of a hierarchical organisation leaves the problem of how the multiple representations yield a coherent percept. That is still a mystery.[154]

In the third chapter of their book, entitled 'Grouping Structure', Lerdahl and Jackendoff emphasise the 'well-formed-ness' in a musical theme that is related to a listener's intuition. Such 'well-formed-ness' is based, at first, on what the grouping of written notes looks like, and not how the music sounds. In a later part of this chapter concerning the preferences of a listener, the first emphasis is upon boundaries, or in Marr's terms, terminations. The first examples are metrical examples that create boundaries between groups of slurred or smoothly connected notes rising in a sequential order. Further examples concern additional ways of creating boundaries that are less adapted to a listener's preferences. I note the emphasis on surface and the temporal nature of their argument. Also included in the section on preferences are

153 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, p. 9.

154 Handel, *Listening*, Mass., London, 1989, p. 545.

preferences of dynamics, articulation, and register.[155] Each of these conceits is aimed at defining the boundaries of a musical surface. Overall, the emphasis in this chapter is on the preferences by the 'intuition' to select boundaries of place in the musical surface, and balancing those boundaries with global, structural considerations, such as the perception of large-scale sequencing and repetition.[156] The authors admit that they are faced with a '…more formidable conceptual problem' in this latter endeavour, and note that parallelism in music is also a general problem in psychology itself. [157]

It is my claim that a spatial account of music answers Handel's problem. Marr's 2-1/2 dimensional sketch improves on this, by allowing for the less powerful preferences to become clear. That is, we ought to accept that in music, motion is a category of space related to perception, and that the perception of musical sounds is not a category of language. Lerdahl and Jackendoff are also hesitant to extend their theory of musical perception beyond a single melodic line.[158] They affirm that the thrust of their work applies to homophony, or a single melodic line with a chordal accompaniment. Hence they note that at this time their theory is inadequate to contrapuntal music.

Parsing and Musical 'Levels'

The use of a functional approach to musical perception as being akin to musico/linguistic analysis is not wholly acceptable. While it is beyond the scope of this thesis to criticise psychological methods, a reason for this problem can be suggested. If we accept that there are levels of listening to music, then we can imagine that the listener wants to change listening methods from, for example, the timbre of

155 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, pp. 44-46.
156 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music,* Cambridge, 1983, p. 55.
157 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, pp. 52-3.
158 Lerdahl & Jackendoff, *A Generative Theory of Tonal Music*, Cambridge, 1983, p. 37.

the flutes to the fugal form of the work. To make this transition and to continue to concentrate on the musical surface, particularly in an unfamiliar work, is a problem.

Tracking musical motion seems to be a problem that linguist theorists make no account of except by the method of parsing. Marr's theory of 2 1/2-dimensional space provides a viable solution to the problem of language function and music. Whereas parsing allows the listener to distinguish the sound he wants to hear among all others, it does not account for conceptualising musical motion. Ordinarily, some internal chatter or interruption to the concentration of the listener occurs as he adjusts and changes his limited, topographical focus from the production of individual notes to a larger overall structure. One way or the other, the listener misses the music as his idea of what is 'in' the music changes from timbre, for example, to structure. But given the theory of musical 'levels' and facts that constitute understanding music, this is what the listener ought to be able to do. That is, in a substance-based theory of listening, the listener can account for hearing music by communicating to others the elements or levels he has listened 'for' and subsequently identified 'in' the music. My contention is that the assumption of place and substance in music limits the perception of the listener to only what he can listen 'for', and not to the full panoply of what 'there-is' in music.

3.12 Music and *Telos*

In this final section I will return to a discussion of motion and cause, and focus in particular on the relation of the perfect intervals and the final cause. In the category of musical motion and a final cause, things must be able to arrive or 'end', with a sense of purpose or *telos*. If the final cause is that about which we do not deliberate, if it is that which is clearly intuitive, then how are we to situate such knowledge or understanding in terms of the causes? For example, are the perfect consonances such as the D major chord at the finish of J.S. Bach's *Mass in B minor* subject to an account of final cause?

A teleological account of musical motion might not distinguish these cadences as requiring a separate discussion from other elements of music. That is, as Leibniz might claim, that music as a whole, inclusive of consonances and dissonances, is purposeful. But the consonant cadences are an element of musical motion and ought not to be dismissed so perfunctorily. If we are in search not only of the nature of music, but the nature of the Good, then the consonances themselves are worthy of inquiry, for in Western classical music, the consonances appear to sound good. What initiates the experience of good sounds when hearing the consonances? That is, is there a relation between the actuality of the perfect consonance, such as the perfect fifth, sounding good and the potential of sounding good? According to Aristotle, there is an initiating cause in such cases, which he names the Unmoved Mover.[159]

In the duration of the process of listening to music, it is clearly possible to affirm that, for example, until the final cadence of Chopin's *Ballade #1 in A- flat*, there has been a chain of movers, either harmonic progression, melody, rhythm, or combinations therein. In G. F. Handel's *Water Music* or Bach's fugues in *The Well-tempered Clavier,* there are numerous cadences, such as the final, dominant, interrupted, or deceptive cadences. Is it possible that we judge that the music is good due to a surfeit of consonant cadences perceived as final or pseudo-final causes?

If we accept that a cadence is not moving perceptibly, and yet we accede to the way it sounds as sounding 'good', then we require the services of the final cause as to what *initiates* our perception. The final cause is applicable to a substance, that is, that

159 Aristotle, 'Physics', Chapter 7, 260a, 20, in Sachs, *Aristotle's Physics*, New Brunswick, London, 2001, p. 212.

which is self-producing. In the case of sound, the element that suits the criterion is timbre and form, as has been previously argued in this chapter. According to Aristotle, we ought to be able to make an account of sound that affirms an underlying organisation to music as a substance dependent on sound.

The argument for the Unmoved Mover as the ultimate cause of motion turns on time and infinity. The Unmoved Mover is ultimately responsible for the self-producing, perpetual motion of the universe in infinite time as follows.[160]

> 1 Something is in motion
> 2 If something is in motion, then it is moved by another.
> 3 Whatever is moved by another is either: (i) moved by something which is itself moved by another, or (ii) by something which is not moved by another.
> 4 If 3(ii), there exists an unmoved mover.
> 5 If 3(i), then either: (a) the chain carries on to infinity, or (b) it ends, in which case we arrive at an unmoved mover.
> 6 It is not possible that the chain carries on to infinity.
> 7 If 3(i), we arrive at an unmoved mover.
> 8 Hence, if something is in motion, there exists an unmoved mover.
> 9 Hence, there is an unmoved mover. [161]

Shields affirms that the Aristotelian final cause is, in the end, motion with respect to time, not space. Aristotle's argument for the final cause as motion is most often interpreted in a temporal sense as follows:

> 1 Entities in all categories of being other than substance depend upon substance for their existence.

160 Aristotle, 'Physics', Chapter 8, 265b10, in Sachs, *Aristotle's Physics,* New Brunswick, London, 2001, p. 222.
161 Shields, *Aristotle*, London, New York, 2007, p. 222.

2 If (1), then if substances are perishable (as a class), entities in all other categories of being must also be perishable.

3 Hence, if substances are perishable, time, which is in the category of quantity, can perish.

4 If time can perish, then time can also come into being.

5 If time can come into being and perish, then it is possible that there was time before time, and that there will be a time after time.

6 This is absurd.

7 Hence, time cannot come into being and perish.

8 Time can come into being and perish if change can come into being and perish.

9 Hence, change cannot come into being and perish.

10 Hence, there always was and always will be change.[162]

This conclusion is unsatisfactory. It affirms Aristotle's method that the causes turn on change, but does not make any further inroads into an understanding of the nature of the final cause.[163] In music, this conclusion with respect to time does reinforce one kind of illusion that music presents, that is, of a persistent rhythmic element or metric stroke that unifies perception. Yet rhythm is only one of four elements of music that include harmony, melody, and timbre. In this account of the final cause the fundamental, substantial element of sound, does not apply. There are two solutions to this problem.

The first response concerns spatial location. If we refigure the argument for the final cause spatially, we encounter the question of spatial location. In his book *Individuals*, Strawson discusses spatial location in a comparison of the elements of sound as opposed to those same elements in sight. He writes that to look for the underlying organisational mechanism of a painting, we may look to the three

162 Shields, *Aristotle*, London, New York, 2007, p. 226.

163 Shields, *Aristotle*, London, New York, 2007, p. 228.

fundamental elements of colour, brightness, saturation, and hue. These can be seen as comparable to the musical elements of pitch, loudness, and timbre.[164] The persistent element in painting is hue, explained by a dominant wavelength. The persistent element in music is timbre, as has been previously affirmed. We may visually cite hue, and we may note its whereabouts spatially, in language such as ‘to the left’, or ‘beneath the centre point’. Yet given two sorts of timbre in an enclosed space we cannot distinguish them spatially by hearing alone. That is, unlike vision in which we can indicate spatially what we see in three-dimensional space, we cannot even begin to indicate sounds by separating into two distinct parts of three-dimensional space two concurrent timbres by hearing only.

The argument for the Unmoved Mover and the primacy of change is neither spatially nor temporally adequate for music as it stands, for the perception of timbre and the final cadence is outside an explanation of space and time in a three-dimensional universe. As previously stated, a 2-1/2 dimensional account of space as the computational account of hearing music serves to answer this sticking point.

By way of a second response, Shields suggests an appealing spatial account of final cause, in which the causes are ‘stacked up’. His example is a bicycle wheel that is turning; the handlebars dictate direction to the motion under the control of the cyclist. The cyclist in motion is the final cause and ultimate referent of the motion.[165] This construction of the cosmological argument of final causes in relation to music suggests that the listener is also in motion. This is not to claim that the cyclist, or the listener, or the Unmoved Mover is moving from one point to another. The Unmoved Mover, the cyclist, and the listener are in motion *intransitively* without an end or purpose.

164 Strawson, pp. 79-80.

165 Shields, *Aristotle*, London, New York, 2007, p. 227.

In conclusion, arising from a four-fold conjunction of Aristotle's and Plato's metaphysics, Marr's phenomenology of vision, and Strawson's metaphysics of hearing is the question of the nature of the musical surface. Strawson's account is the most apt for hearing. To Aristotle, the changing surface of an object indicates change of place and motion. As previously stated, Plato presents a topological account of matter by describing qualities and their changeable nature, and the surface texture and the boundaries of objects is made up of triangles. Marr, too, presents his theory of perception as the process of increasing clarity in grasping the surface of an object, that is, by the perception of zero-crossings as continuities and discontinuities in the depth of a surface and its orientation.[166]

It is Strawson who makes the clearest account of the faculty of hearing sounds in a musical context and environment. Strawson constructs a world of hearing sounds that completely fills the world, thereby defusing sight, touch, and associations of spatial location; he includes complex musical unities, but excludes the very concept of metaphors and numerical dimensions of space, and hence constructs a world without surface.

What if there was no surface to experience? Marr defines the relation of vision and surface in the following way: '…the visible world can be regarded as being composed of smooth surfaces having reflectance functions whose spatial structure may be elaborate.'[167] Strawson's response to a world without surface, in which the listener compensates for its absence by his emotions, is that the listener is a non-solipsist, that is, the listener has no use for the distinction between events in the world and what happens to him. In this hypothetical world of sound only, there is no service

166 Marr, p. 97.

167 Marr, p. 44.

in explaining experience in the terms of *my* individual experience. The listener hears at an internal level perception, and his experience reflects on nothing other than the faculty of hearing sounds that constitute the sort of music world he briefly inhabits. He reports on hearing objects from an intrinsic, internal analogy of distance that is an element in his own conceptual scheme.

The following chapters in this thesis will concern surface, depth, and motion. Concerning an Aristotelian ultimate referent of motion, I will discuss the way in which Newton and Leibniz respond to the requirement of an ultimate referent in space. I will also look at the perceptions of the listener as a solipsist in Descartes' *Meditations*.

CHAPTER 4

DESCARTES (1596-1650)[168]

4.1 Co-ordinate Space

My claim throughout this thesis is that theories of music and theories of space are correlative. I also make the further claim that the perception of music and the perception of space are complementary. The way we philosophise about space is important to the way in which we perceive the world; a metaphysical account of Western music suggests that infinite depth is a dimension of space we would otherwise be unaware of. If Socrates encouraged philosophers to affirm an intuition of geometric space in an ascent to the Ideal Forms, then Descartes may be seen to engage in an analysis of that relationship. In his early work *Compendium Musicae* Descartes argues that a single tone imports spatial extension to the normally functioning ear by the harmonic series that includes the Pythagorean intervals. Whereas in the work of Plato and Aristotle, space 'alone' is difficult to conceptualise, in the work of Descartes, space is for the first time conceptualised as *separate* from the perceiver. The model of that relationship is generated by equations that solve for unknown points formulated in a graph of motion in the form of a co-ordinate system, and co-ordinate systems within co-ordinate systems. Space is extension and the site of mechanical interactions that occur in a part of space, or place.

In this chapter I will present Descartes' metaphysics; in particular, I focus upon his geometric method on thought, perception, and space. What is present to the senses, particularly concerning music and his *Compendium Musicae*, will constitute

168 Please note that unless otherwise footnoted, all references to the works of Descartes arise from *Descartes: Key Philosophical Writings*, Chavez-Arvizo (ed.), translated by E. S. Haldane and G. R. T. Ross, Ware, 1997.

the first section. This will be followed by a discussion of the importance of the harmonic series to Descartes' thought on rational extension and the body. The next section will look to Descartes' mathematics, physics, and motion, and the final section concerns the role of the music listener as suggested by Descartes' *Meditations*. I contend that Descartes presents a nascent understanding of a spatial approach to hearing music, although his emphasis on spatial location restricts the flexibility required for a full-blown account.

The import of Descartes' studies in music and mathematics is a reinforcement of the rational nature of space that can be recognised as timbre in relation to music. This was a crucial finding, for it led Descartes to affirm that both the intuitive and deductive processes of thought lead to new information about a particular object. This approach is captured in the idea of Cartesian extension. Repeated musical phrases, as well as repeated beginnings and endings of phrases give the listener information about a musical system, in a way that is parallel to Marr's theory of developing the 2-1/2 dimensional sketch. In addition to the linear development of a musical work, there is also a vertical development in the harmonic progression of a work.

From Plato to Descartes the principal, underlying function of perception of space was transformed from hearing to sight. In Descartes' early career he situated the imagination as a key to understanding the co-ordinate axis as a rational approach to the measurement of motion in the world. In a Cartesian format, the history of theories of space now includes a visible co-ordinate axis system. By the later period of his career, he was not inclined to view the imagination so positively. In *Meditations* he claims that the imagination turns to the body, and is not necessary to the function of the immaterial, unextended mind whose limit is the thought of God.

Throughout his career Descartes was known to be a talented mathematician. His legacy in this area is powerful. Descartes challenged the Scholastic method that had been prevalent throughout universities. Descartes promoted and published the method of analytic geometry, having inherited a legacy of findings in the fields of algebra and geometry.[169] Experiment, mathematics, and observation of the lived world, thanks to Galileo and Kepler amongst others, became a priority over and above speculation on a hidden reality. In his short monograph entitled *Geometrie* he shows that empirical measurements can be systematised on the co-ordinate graph.[170] With a concept of space as systematic extension in mind, numerical patterns and functions could be derived therein. The method of analytic geometry revolutionised systems of measurement and information, and projected the world into an age of modern mathematics and science.

Descartes was also a champion of philosophical method. Philosophy was no longer the highest kind of music, as Socrates had claimed. Descartes described philosophy as a tree, the roots of which are metaphysics, the trunk physics, and the branches the disciplines of mechanics, medicine, and morals.[171] In a reduction of this simile, the metaphysical root of the tree is the mathematised conception of space and objects conjoined with a normalised concept of the function of perception guaranteed by the omnipotence of God.

To Descartes, physics is the measurement of the proper, local motion of objects in mathematised space, and the three so-called branches from the trunk of the tree are extensions of proper motion. Descartes' physics was influenced by the work

169 Boyer, *The History of the Calculus and Its Conceptual Development*, New York, 1949, pp. 155-65.

170 Descartes, *The Geometry of Rene Descartes,* trans. Smith & Latham, New York, 1954, p. 2.

171 Descartes, 'Principles of Philosophy' p. 269.

of Galileo.[172] Galilean physics relied upon precise measurement of motion in experimental settings rather than explanation dependent upon Aristotelian syllogisms and teleological conceptions of cause and effect. Yet Galilean inertia was contentious to Descartes because it employed mathematically measurable trajectories of bodies in empty space; to Descartes, space was a corpuscular plenum. Although Descartes engaged with Galileo's law of inertia, he denied the possibility of a void and asserted the mathematical extension of space and the omnipotence of God. Without an experimental void, Galileo's measurement of gravitational acceleration ($a_g = 10m/sec^2$) cannot be performed. Descartes also believed that the quantity of motion or momentum in the universe, p, was a constant in which $p = mv$. The primary cause is God's conservation of momentum, so that the sum of all the products of mass and velocity remain constant.[173]

Extending the analysis of motion by Galileo, Descartes affirmed three laws of motion. Firstly, he asserted, in part, the Galilean law of inertia in which every body perseveres in its same state, either at rest or in motion. Secondly, every motion is rectilinear. Hence things that move in a circular motion tend to recede from the centre of the circle so described. Thirdly, if a smaller body collides with a larger body, the smaller will retain its own velocity but lose its direction; the larger body will not suffer any change. [174] However, Descartes was mistaken in this account of motion. The momentum of a body does change on impact for it changes direction *and* speed,

172 Descartes, through his association with Zarlino, was also familiar with the musical thought of Galileo's father, Vincenzo Galilei, who maintained that since music was an art of song, poetic and expressive, its nature should not be constrained by an abstract system of number. As such, his approach is aligned with Aristotle's pupil, Aristoxenus. Galilei also showed that the octave ratio was not limited to 2:1. By altering the tension of monochord string, he found that the octave was reached at 4:1. In an organ pipe, the octave ratio was found at 8:1. Blood, 'Physics of Musical Instruments' <http://www.dolmetsch.com/poshistory.htm>, accessed 12/8/2005.

173 Dijksterhuis, *The Mechanization of the World Picture*, Oxford, 1964, p. 410.

174 Author unacknowledged, 'Newton: His Life and Times', in *The Study of Space and Time*, ch.7, p. 2, <http://chandra.bgsu.edu/~god/Spacetime7.html>, accessed 11/10/2002.

and its momentum is thus a *vector* quantity. In addition, the body at rest also suffers impact and would only fail to do so if it were at absolute rest or of infinite mass.[175] These were errors discovered by Huygens, and were taken up by later physicists and philosophers, including Leibniz and Newton.

By the time of Descartes, in mid-seventeenth century Europe, formal rules of musical counterpoint were in place, although their formulation was not yet complete. Descartes' early work on music reflects an understanding of such rules conceived mathematically rather than geometrically. The emphasis in his understanding is upon harmonic 'agreement' in extended space. This approach will continue to hold sway in the work of the later philosopher to be explored in this thesis, Leibniz.

4.2 *Compendium Musicae*

The *Compendium Musicae* provides the reader with a view of Descartes' early work on method.[176] The overall argument in this work is that normally functioning human senses respond to music by way of 'automatic' reflex.[177] This can be explained by several factors: the simple mathematical nature of a tone and its dynamic level, rhythm and its repetition, the perfect intervals around which a scale or melody is built, and finally, the fundamental principle of consonance. To Descartes, pleasure in music falls under the domain of mechanics, for we are compelled to find pleasing that which is mathematically provable grounded in intuitions of consonance.

---

175 Dijksterhuis, *The Mechanization of the World Picture*, Oxford, 1961, p. 410-11.

176 Locke, "Descartes and Seventeenth-Century Music", in *The Musical Quarterly*, OUP, Vol. 21, No. 4, Oxford, Oct., 1935, <http://www.links.jstor.org/sici?sici=0027-4631(193510)21%3A4%3C423%3ADASM%3E2.0.CO%3B2-T>, accessed 15/8/2005, p. 429.

177 Augst, 'Descartes' Compendium on Music', in *Journal of the History of Ideas*, Vol. 26, No.1, Baltimore, Jan.-Mar. 1965, p.130, http://links.jstor.org/sici?sici=0022-5037(196501%2FO3)26%3A1%3C119%3ADCOM%3E2.0.CO%3B2-7, accessed 25/9/2006.

In *Compendium*, Descartes assumed that perception functioned 'normally', within the limits of the imagination, i.e., the ordinary perception of the dynamics of high and low tones, of long or short duration, and whether the music was played loudly or softly. From this position he embarked on a quantitative exploration of the musical scale.

When *Compendium Musicae* was written in 1618, Descartes had aligned his point of view with that of Zarlino who wrote on the nature of the perfect tones in a musical scale. According to Zarlino music should obey the rules of counterpoint, that is, the musical grammar derived from the Pythagorean perfect ratios. These rules accounted for the coherence of a musical work by establishing situations in which dissonances may be used, the intervals that may be played in parallel motion with a melody, and the roles of voicing and the protection of the 'final.'[178] In the *Compendium* Descartes also supported the use of the increasingly popular hexachord or six-tone scale, as presented by Guido'd'Arezzo and illustrated on the Guidonian Hand.[179] This six-tone scale includes the major third (5/4), the minor third, (6/5) and the major sixth (5/3). With the development of the six-tone scale, transposition and harmonic complexity grew by degrees; this was a huge boon to the scope of music.[180] In a distinctly rational manner, Descartes writes of music's increasing complexity: 'I believe all this can be easily derived from musical practice by calculation of the mathematical values of the steps, when this occurs, and of the pitches which form consonances with them.'[181]

178 Powers, 'Final' in *The New Grove Dictionary of Music and Musicians*, Stanley Sadie ed., 29 vols., London, viii, 2001, p. 817-18.

179 Descartes, 'Compendium Musicae', Rome, 1961, p. 35.

180 Claudius Ptolemy, 'Harmonics', in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, ii, 1987, p. 268.

181 Descartes, 'Compendium Musicae', Rome, 1961, p. 39.

4.2.1 Preliminary 1

Descartes' overall aim in the *Compendium* is to apply a structure to musical perception and to deduce the rules of composition and scale construction from the Pythagorean ratios. His notions of the intuitive and deductive faculties of the mind are implicit even in this early work. At the simplest level, he seeks to answer the question: what is a tone? He begins by observing two fundamental attributes of sound: relative height or depth, and duration. Here we can see the influence of Oresme and Galileo in the conceptualisation of a co-ordinate system (*x, y* axes) measuring distance and time.[182] In his further preliminary remarks, Descartes states that pleasure is the broad aesthetic aim in music; it is evidenced by the clear, mathematical division between tones, an interest in musical variety, and a pleasurable proportion between the music and the listener. Thus, the kind of mind that enjoys music - enjoys music geometrically and mathematically.

4.2.2 Preliminary 2

In Preliminary 2, Descartes writes: " For this pleasure a proportional relation of some kind between the object and the sense itself must be present."[183] Such proportions include the proportion of music to listener, of parts to wholes, and of complexity to understanding. For example, there is a proportion between the music and the listener in understanding the tonic or tonal centre of the musical work. The 'final' is the tonic or tonal centre of a work of music; it is the particular unity from which proportions as perfect ratios are derived. Provided that the listener experiences an intuitive grasp of the 'final' throughout a work of music, his intuition is 'almost' immediate and his pleasure is 'nearly' guaranteed even though he does not have a

182 Boyer, *The History of the Calculus and Its Conceptual Development*, New York, 1949, pp. 88, 165.

183 Descartes, 'Compendium Musicae', Rome, 1961, p. 11.

grasp of the Pythagorean mathematics. For the listener who struggles to perceive the tonal centre, pleasure will probably be remote. We may surmise that, in a way yet to be defined, music, an exact science of fixed proportions and rhythm, is connected in an appropriate way to 'the affects'. Thus the relation of music to sense perception is a mechanical relation as well as an intuitive/deductive relation.

4.2.3 Preliminaries 3 - 5

In Preliminary 3, he states that, in the interests of the listener and the conceptual mathematics he is appealing to, the nature of the 'information' that passes from the music to the hearing ought not to be too complex. Using an example of theme and variations in Preliminaries 4 and 5, we can discern the proper kind of music for normal sense perception. Preliminary 4 concerns the theme and the unity of the musical work: "An object is perceived more easily by the senses when the difference of the parts is smaller."[184] In Preliminary 5 Descartes writes "…the parts of a whole object are less different when there is greater proportion between them." In order to present as clear an overall picture as possible to the mind of the listener, the parts of a single musical work ought to broadly resemble each other. If we consider 'greater proportion' here as variations to a musical theme, the listener can perceive more clearly the relations between the theme and variations if the differences are clear and distinct. According to this model, the variations will be most clear when they are constructed proportionally.

184 Descartes, 'Compendium Musicae', Rome, 1961, p.12

4.2.4 Preliminary 6

In Preliminary 6 we turn to the role of the intuition. I will include *Rule 5* and *6* from *Rules for the Direction of the Mind* for a discussion of the terms of this problem.[185] In Preliminary 6 Descartes presents the Pythagorean intervals set out as geometric proportions of 2:1, 3:1, and 4:1, rather than mathematical measurements of 2, 4, and $\sqrt{8}$. Their relations are clear and simple, as opposed to the strictly mathematical example that includes an incommensurable. He is making a case for an intuitive grasp of proportion per *Rule 5*. *Rule 5* directs the mind to reduce complex relations to simpler parts in an attempt to achieve a primary intuition. In this instance proportion is a simple, for it is not subject to enumeration to anything simpler. In addition, *Rule 6* claims that the distance measurement or 'the geometry' of every relation from the simple should be noted. Further to an example of *Rule 6*, Descartes also notes that there is a difference in thought between objects identified by number and number itself. For example, whereas a perfect fifth, the typical interval played in a musical 'hunt' theme, is an instance of a number relation of 3/2, we cannot know what the interval is without its sound as an instance of its proportionate nature.

Most importantly to Descartes, it is *intrinsic* to our intellect that we find that the Pythagorean proportions sound good, for they are clear whole number ratios, verifiable to be in perfect mathematical proportion, and are principles from which musical figures can be derived. These three aspects of a Pythagorean interval are pleasing to the mind.

In the body of the *Compendium*, Descartes is concerned with deductive matters. The rules of counterpoint he expands upon are a guide to composition within the parameters of mathematical reason. Consonances are the paradigm and intuitive

185 Descartes, 'Rules for the Direction of the Mind', pp. 17-21.

principle upon which whole tones, semi-tones, and finally, dissonances and step-wise motion, are built. Melodic material was of some interest to Descartes, but step-wise movement had minimal value. He writes, "Clearly, therefore, the steps are only a means to an end; they bridge the unevenness between the pitches of the consonant intervals."[186] He states that scales, chords, and melodies may be built according to three proportions within the overtone-based octave, that is, a line segment of the octave ratio 2:1 divided into two, three, or five parts. The intervals that these divisions designate are the three primary consonances of the overtone series. There are secondary consonances derived from the division of the octave into the fourth and fifth, and even more remote consonances derived from the fifth alone. He then considers the source and suitability of the fifth, fourth, and major and minor thirds and sixths in polyphonic music. The whole-tone and half-tone steps are then reviewed. Their use is to make transitions between consonances and to facilitate transposition into another mode.

The sequence of tones that Descartes is modelling is the six-tone scale or hexachord, as previously mentioned. The model he uses to outline the scalar relations is displayed graphically as a circle in which relations will be repeated from one octave to the next. For a complete overview of the mathematical table of tonal relations in the hexachord system, Descartes uses a table consisting of columns with tones inserted in their relative positions. The work concludes with a discussion of cultural conventions such as compositional fluency, variety, inconsistency, and expectations.

Descartes writes that the relationships deduced through algebraic analysis are "…rather the outer husk than the constituents" of his approach to science.[187] He developed algebraic geometry in a co-ordinate system in which a language of

186 Descartes, 'Compendium Musicae', Rome, 1961, p. 31.

187 Descartes, 'Rules for the Direction of the Mind 4', p. 13.

segments and their relations and dimensions are analysed by way of formulae. As such, there is a complex of methods of analysis; space is external to the perceiver; the arrangement of bodies in space is rule-bound; geometry determines the limits of a figure; mathematical analysis is the derivation and application of fundamental functions; and finally, algebraic method incorporates the rules of substitution, removing parentheses, and reduction of similar terms.[188] This constrains music into a formulaic, mechanical form of science, aligned with astronomy, optics, and mechanics.[189] Descartes saw no objection to such an approach to music, except that such slavishness to rule following could be quite boring.[190]

4.3 Intuition and Deduction

Descartes denied the importance of secondary elements of bodies, that is, smell, taste, colour or sound. He studied the primary qualities of size and shape. So it may seem that there is no means of gaining a philosophical account of music from Descartes. We may look to a brief reference to music in Descartes' *Rules for the Direction of the Mind* for affirmation of the role of music in his philosophy.[191] In this work Descartes claims that music is a 'styled part of mathematics'.[192] That is, music is known mathematically, via the intuition whose phenomena appear to the mind clearly and distinctly, and deduction as the methodical practice of inferring necessary facts from experience.[193] Music is worthy of his method as a science as well as a

188 I. G. Bashmakova, G. S. Smirnova, 'The Literal Calculus of Viete and Descartes' in *The American Mathematical Monthly*, Abe Shenitzer, ed., March, 1999, http://links.jstor.org/sici?sici=0002-9890%2819903%29106%3A3%3C260%3ATLCOVA%3E2.0.CO%3B2-2 p. 1, accessed 3/10/2006.

189 Descartes, 'Compendium Musicae', Rome, 1961, p. 15.

190 Descartes, 'Compendium Musicae', Rome, 1961, p. 13.

191 Descartes, 'Rules for the Direction of the Mind' p. 15.

192 Descartes, 'Rules for the Direction of the Mind', p. 15.

193 Gaukroger, 'Descartes' Early Doctrine of Clear and Distinct Ideas', in *Journal of the History of Ideas*, vol. 53, No. 4, Baltimore, 1992, p. 589. In this article Gaukroger claims that Descartes sought to emulate rhetorical practice in his method of

pleasurable activity. It is a science by virtue of its order and measurement, and intuitive by virtue of its consonant nature.

Similar to the Aristotelian final cause, intuition is immune from doubt and is "…the conception of an attentive mind…(that) springs from the light of reason."[194] His interest in the immediate nature of the intuition may precede what grew into a substantial interest in later physics and the calculus, that is, 'instantaneous velocity'.[195] Again like the Aristotelian final cause, the intuition is a temporal mode of thought. Descartes will seek to make the intuition spatio-temporal in *Meditations*.

Only the understanding of proportional consonances such as the octave or the perfect fifth is obtained through intuition; any further judgements are a matter of taste and habit according to Descartes. His descriptions of the intervals are designed to appeal to taste. For example, the ear is 'kept busier', and would easily realise for example, that 'the fourth is the unhappiest of all consonances…if one were to use the fourth above the bass, the fifth would always accompany it, and the ear would easily realise that the fourth had been displaced from its proper position…'[196] The sense of hearing finds greatest satisfaction in a mathematically appropriate language generated by consonances, i.e., the octave, major sixth, perfect fifth, fourth, and the major and minor third. [197]

In contrast to intuition, deduction involves deriving inferences from previously known facts. The two differ as deduction occurs by a succession of mental movements rather than immediate understanding, and the conclusions it achieves are

---

mathematical analysis. He suggests that in the time of Descartes' early work, the quality of vividness with which images could be suggested was of greater value than mathematical proof.

194 Descartes, 'Rules for the Direction of the Mind 3', p. 9.

195 Gaukroger, 'Descartes' Early Doctrine of Clear and Distinct Ideas' in Journal of The History of Ideas, vol. 53, No. 4, Baltimore, 1992, p. 589.

196 Descartes, 'Compendium Musicae', Rome, 1961, p. 24.

197 Descartes, 'Compendium Musicae', Rome, 1961, p. 20.

remote, as opposed to immediate intuitive conclusions.[198] Deduction itself is a linear process. Deduction is also described as conceptual distance or proportion from the original intuition. Hence we may gauge our distance from a tonal centre deductively. For example, a deductive process may direct attention either backwards to an opening theme, or forward to a cadence or the resolution of a pedal point. The more exhaustive the deductive process, the more accurate will be the image presented to the understanding for judgement. In the history of music and metaphysics the importance of points of agreement, cadences or terminations, all products of a musical deduction as well as experience at the 2-1/2 dimensional level of perception, to use Marr's terms, have held enormous significance. [199] The combined functions of the perceiver's intuition and deduction are a dynamic process of understanding. They served to reinstate achievable learning processes in place of the practice of Aristotelian Scholastic interests in language, logic, and syllogism.

4.4 Extension and the Overtone Series

What we do not see in this early work is any presentation on the role of extension as the proper unfolding or motion of a body. The notion of extension and its relation to motion and God did not arise until later in Descartes' thought. Nonetheless it can be argued that an early version of extension can be found in his discussion of the overtone series. This argument will be pursued in the following discussion of the *Compendium* and Descartes' *Meditations*. Extension will be discussed in two parts; firstly, the extended overtone series in the tone, and secondly, the notion of the extension of a body.

198 Descartes, 'Rules for the Direction of the Mind 7', pp. 23-5.

199 Here I understand terminations to be cadences and other points of agreement. Marr writes: "…(A)lthough edges, bars, and blobs are rather obvious things, terminations are much more symbolic and abstract. The reader may therefore need some additional persuasion that these things are created and at a rather low level." Marr, p. 78.

Firstly, Descartes can be said to view the musical tone like corpuscular space or a single point, that is, the tone is extended.[200] This assertion is supported by the discovery of the overtone series by Descartes' acquaintance, Marin Mersenne. Adopting the discovery of this series by Mersenne, Descartes reinforced his method of measurement in music by stating that a single, fundamental tone has extension, which can be proved by the existence of the overtone series.[201] The tone is a *fundamental* that contains all its consonances, consisting of the Pythagorean perfect intervals and progressively smaller intervals as the series continues. These sympathetic tones resonate above the tonic in an overtone series. Thus a musical tone has extension that can be measured over time and by virtue of the overtone series.[202] In keeping with his method of quantification, the unison is proportional to the consonances as the number 1 is proportional to the rest of the numbers. Thus we may look to the tone as a point that reveals its own deduction and the octave as that which contains this deduction. The deduction is the process of the generation of the tones of the scale.

Secondly, a musical theme has extension, for it can be laid out on a co-ordinate graph measuring height and depth, density of sound, and time. In *Rule* 14 Descartes elaborates on the notion of a tone or point:

> We shall understand that in it ('*…a common element in which…all things compared with each other should equally participate'*) there exists every dimension found in those widely sundered facts which are to be compared with each other, and we shall conceive it either (1) merely as something extended, omitting every other precise determination - and then it will be identical with the point of geometry, considered as generating a line by its movement…[203]
> (Italics are Descartes' words and qualify the primary quoted statement.)

200 Descartes, 'Compendium Musicae', Rome, 1961, p.16.

201 Descartes, 'Compendium Musicae', Rome, 1961, pp. 17-18.

202 Descartes, 'Compendium Musicae', Rome, 1961, p. 16.

203 Descartes, 'Rules for the Direction of the Mind 14', p. 68.

Descartes notes that it is easiest to conceive of extension in two, rather than three dimensions.[204] The figure is the outline of the extended body in two or three dimensions. A figure is bounded by a surface, whose modes or patterns of motion are measurable by analytic geometry. In an analogous fashion to the measurement of length and breadth of the surface of a two- dimensional object, a musical surface has length and breadth as well in rule-bound space. In all, the surface, either musical or physical, is universally perceived as that which is seen with the eye of thought or intuition.

4.5 Extension, Body, and Space

The following is a discussion of extension, body, and space as shared between three of Descartes' works: *Principles of Philosophy* 2, *The World*, and *Rules for the Direction of the Mind*. In *Rules for the Direction of the Mind*, Descartes includes the imagination in his discussion of intuition and deduction. He will not be so tolerant of the imagination by the time of writing *Meditations*. However, it seems that the imagination is important in an account of musical and spatial perception. The imagination has the capacity to make analogies and to separate unities into parts, including the mathematicisation of the figure and space. Hence the imagination is an important function that supports both the intuition and the deduction. He discusses the relationship between intuition, deduction, and his method of mathematical redescription made by the imagination in *Rules for the Direction of The Mind*, when he states: '…they (mathematical deductions) seem to grow into a single process by virtue of a sort of motion of thought which has an attentive and vision-like knowledge

204 Descartes, 'Rules for the Direction of the Mind 12', pp. 40-41.

of one fact and yet can pass at the very same moment to another.'[205] He goes on to state the following:

> But since henceforth we are to attempt nothing without the aid of the imagination, it will be worth our while to distinguish carefully the ideas…To this end we submit for consideration these three forms of expression: - extension occupies place, body possesses extension, and extension is not body.[206]

Cartesian space is of a broad scope in which the particular function of place is a part. Hence Cartesian extension occupies place. This first statement requires no conceptual shift between the phrases 'extension occupies place' and 'that which is extended occupies place'. What occupies place, such as a tone, a rest, or a theme is extended and can be measured. Likewise, modes of extension occupy place. Movement occurs, but by itself motion does not alter the constitution or locatability of either body or space, for motion is local motion. Extension is the Platonic notion of geometric *chora*, but visualised in three-dimensional co-ordinate axes, and thus objects, qualities, and space all possess extension or choric properties.

In addition, the secondary qualities of an object may also be deduced geometrically. In *Rule* 12 Descartes writes: 'All sensation can be represented by figure by what is given spontaneously and by deduction.'[207] He generates an example through the use of colour. The colour red, for example, can be seen as a complex series of quantifiable waves of light. The more saturated the colour, the more complex the figuration of light to the normally perceiving eye as extension in motion. Musical tones are also said to have 'colour' or timbre. This is the particular quality of an instrument's material construction in relation to its capacity to form a tone. The note

205 Descartes, 'Rules for the Direction of the Mind 11', p. 37.

206 Descartes, 'Rules for the Direction of the Mind 14 ', p. 63.

207 Descartes, 'Rules for the Direction of the Mind 12', p. 39.

'A' on a flute and a violin may have the same pitch to the normally functioning ear, although they are quantifiably different in terms of timbre or tone colour. Like colour waves in light, their particular sound waves may also be configured in a co-ordinate system.[208] Hence these tone colours, or more generally, timbre would have extension and would occupy place. In *Principles 2*, he echoes his earlier position that prior to any ascription of utility, body is physical, that is, it has size, shape, and motion in three dimensions.[209] In *The World* Descartes asserts that all qualities of an object, either primary or secondary, can be explained in terms of its extension, and that a full explanation of an object would thus be available using his method.[210]

The second statement, 'body possesses extension' is separate and distinct assertion from the first. Descartes claims that a body is a unity and does not have an identity relation with extension. [211] The principle *attribute* of body is extension. Descartes maintains the importance of the intuition as a primary source of knowledge, for the reason that *having* an essence such as extension is distinct from *being* something such as a unity. He warns that we should not construct two separate ideas, such as the Scholastic notions of substance and accident, to explain the relationship between body and motion. A tone's essence is extension, but a tone is not extension itself. There is no substance that form and matter ultimately achieve, for every space, either occupied or not, is simply corpuscular and extended.

Finally Descartes' third claim, that extension is not body, is a reinforcement of the connection between the physical body and the concept of extension, while stating

208 Johnston, Measured Tones: *The Interplay of Physics and Music*, Bristol, New York, 1989, pp. 20-1.

209 Descartes, 'Principles of Philosophy: Second Part: Of the Principles of Material Things', p. 310.

210 Descartes, *The World*, trans. Michael S. Mahoney, p.7.
<http://www.princeton.edu/~hos.mike/texts/descartes/world/world.htm> accessed 9/2/2007.

211 Descartes, 'Rules for the Direction of the Mind 14', p. 62.

that it is false to understand this relation as identical. [212] The context of the conceptual claim such as extension cannot be substituted by a context of the physical body and as such, this is a reiteration of the second claim.

4.6 Musical Space and Agreement

Descartes came under considerable attack for his particular version of extension; Newton claimed that Descartes did not fully comprehend the Galilean law of inertia. Leibniz resisted the separation of *res cogitans* from *res extensa* implied by Descartes' mechanics and the immateriality of the mind. Descartes' theory of extension relate closely to a theory of hearing music. Here it is important to note that the musical analogy of the idea of Cartesian extended space, that is, harmonic extension, is an acceptable and regular element of music. It is asserted that analogies of geometric extension are heard in the Pythagorean intervals and can be found in cadences in most classically composed music and that an analogy of regular, harmonic, mathematical relations is most often used in the concluding parts of a musical work, e.g., chord progressions of V-I [(3/2)-(2/1)], and IV–I [(4/3)-(2/1)]. Hence the central point that links Descartes' essential concept of extension and actual bodies can be seen in the overtone series from which such cadences are derived. One may speculate that it is from this notion of harmonic extension that Leibniz derived his concept of cosmic harmony, although it is in the Cartesian idea of proper mechanical motion of bodies that timbre in general and these harmonic relations, in particular, arise.

212 Descartes, 'Rules for the Direction of the Mind 14', p. 66.

This Cartesian view of tonal extension presents a somewhat limited idea of music. It is overly limited to cadential material. One may ask: what is the nature of motion in Descartes' philosophy such that it may only account for cadential material? Having established that the tone has a mathematical and pleasing nature in cadences, the onus remains to explain musical motion. In *Principles* 2, 25 he writes:

> But if, not looking to popular usage, but to the truth of the matter, let us consider what ought to be understood by motion according to the truth of the thing; we may say, in order to attribute a determinate nature to it, that it is the transference of one part of matter or one body from the vicinity of those bodies that are in immediate contact with it, and which we regard as in repose, into the vicinity of others…the motion is always in the mobile thing, not in that which moves…[213]

4.7 Doubting Music

To a music listener, this description of motion may not appear problematic. A particular tone in a melody endures until another, to which the former is loosely related, arises. It seems that the former has moved, and that the latter is now present to the mind of the listener. Such 'motion' may be easily charted on a co-ordinate system, or even by a simple glance at a notated score. Yet music is only an analogy of motion, not motion itself. The actual motion of music is in the air. It is necessary to delve more deeply into Descartes' philosophical position on intuition and deduction to discern how we might find common ground between the perception of musical motion and actual motion. We will then be in a position to state more confidently the nature of Cartesian space, music, and the perceptions of the listener.

If we are to employ Descartes' method of intuition and deduction, it is necessary to establish the grounds upon which these mental processes function. In this way we may be certain of the grounds upon which analogies and actual instances

213 Descartes, 'Principles of Philosophy 2, 25', p. 321.

of motion occur. Descartes explores the grounds of certainty by exercising doubt. Doubt is not a mental state that appears to occur often in music; the emotions are of greater interest to most listeners. Thinking rarely arises in discussions of musical aesthetics; feeling is more often the matter of discussion. However extreme doubt and constructive thought are the tools employed in Descartes' *Meditations*, and they will be further employed in this discussion.

4.8 *The Meditations*

The aim of this discussion is to outline the way in which a metaphysical account of music and space is warranted by the functioning Cartesian intellect. The following brief quote serves as an introduction to Descartes' *Meditations*:

> The project, then, is to build the entire world from the thinking self. It is important here that it is not just the mind that is the foundation, but *my* mind. In this way, the starting place of philosophy for Descartes was connected to the rejection of authority that is central to the Cartesian philosophy. In beginning with the cogito, we build a philosophy detached from history and tradition.[214]

The following discussion of Descartes' *Meditations* will not be exhaustive. Briefly, the dimensions of the *Meditations* will be reviewed, and each will be considered in relation to music listening and the mind of the listener. It is important to note the ordinary listening environment, for this will have some bearing on the outcome of this investigation. The ordinary listening environment in which orchestral concert music is played is inside a concert hall. An outdoor venue tends to lose the acoustic vibrations that an indoor venue can provide. The listener is seated, facing the stage and the orchestra.

---

214 Daniel Garber, 'Descartes, Rene: The Cogito Argument', in *The Shorter Routledge Dictionary of Philosophy,* Edward Craig (ed.), Oxon, New York, 2005, p. 181.

The aim of Descartes *Meditations* is to distinguish between perceptions of a phenomenon and the individual nature of the phenomenon. This position is echoed in Marr's study of vision when he claims that the '…representation of an object is stored in a different place and is therefore a quite different kind of thing from the representation of its use and purpose.'[215] A similar position was taken in the writing of the *Compendium Musicae*, in which the listener was viewed as a separate and distinct entity apart from the music. The *Meditations* may be viewed as an ideal mechanics of the interaction of mind and body in a search for the grounds of 'absolute' certainty in perception. The questions Descartes will discuss concern the smallest unit of thought, the perception, in isolation from any object. It is this unit that arises when the meditator 'withdraws from the senses', as Descartes proposes in the *First Meditation*. For Descartes, this goal should be achieved cognitively and independently, except in relation to God, rather than by unwarranted dependence on a resemblance theory of knowledge. The proper, cognitive analysis of thought and judgement, reminiscent of the proper, self-evident motion of corpuscles and bodies in Descartes' physics, leads to a clear and distinct understanding of the relation of the material world, God, and human beings.

One of my goals in this exploration of Descartes' *Meditations* concerns the nature of musical perception. In what way is an invisible, material body, available only to the senses, yet also subject to judgement? This is not subject to the mere assertion by the will, as if, for example, a theme is heard, and that therefore the listener claims that it exists. As Descartes notes, only the meditator's faculty of judgement may make such an assertion; the will is subject to error. Yet for Descartes

215 Marr, p. 35.

the judgement is an element of the primary substance, thought, and is limited in its function by its dependence on clear and distinct perceptions.

Finally, Descartes' solipsistic account of clear and distinct perception reinforces a spatio-temporal approach to perception by its immediacy, clarity, and freedom from doubt. By collapsing the distance between his perceptions and any unknown proportions or relations, Descartes is supremely confident in the form and content of his intuitions. It is as if Descartes were to claim that 'my-perceptions-are-true' is a *y*-axis in a mental co-ordinate system, at the centre is the 'cogito', and the *x*-axis is the existence of the external world. Further, both axes represent independent substances.

From the *First Meditation* Descartes' rigorous method of doubt will be presented. He begins by doubting the evidence of the senses. Further, he asks the reader to consider whether he can be confident that he is awake and not asleep. Whether one is dreaming or awake, objects still appear in three dimensions, and hence are subject to doubt. He also proposes that we may doubt God's goodness. God might be a deceiver and all our beliefs may be wrong. We may be deeply in error and do not know it.

In the *Second Meditation* Descartes seeks to show that the opposite has been proved to be true by virtue of the meditator's clear and distinct perceptions, that is, that God is no deceiver. Furthermore, the existence of the 'I' has been clearly and distinctly presented to the mind of the meditator. The problem of circularity arises in which we have a clear and distinct perception that both depends upon, and seemingly proves, the non-deceptive nature of God.

In the *Third Meditation* an analysis of ideas in the mind and their efficient cause is presented. Descartes performs this analysis with a view to proving the existence of God, for some ideas are innate, some adventitious, and some fictitious. Two further proofs for the existence of God are also presented.

The *Fourth Meditation* concerns God, errors of judgement, and the role of the intellect and the will. This meditation is central to the construction of a cognitive listener. As God is no deceiver, the possibility of error in our judgements influenced by an indefinite will is guaranteed to be only temporary.

In the *Fifth Meditation* Descartes presents his theory of extension as the essence of external objects. Also, the innate nature of *ideas* of essence is discussed in relation to extension.

Finally, in the *Sixth Meditation* Descartes asserts the distinction between mind and body is real and that external objects and their properties exist. The unextended, immaterial mind and the extended, material body are considered to be primary substances, and hence Descartes' final offering is a theory of substance dualism.

With some grasp of the *Meditations* in place, one might question why the faculty of hearing warrants study in an aim for metaphysical, non-sensory knowledge? My aim throughout this thesis has been a cognitive account of music. I have sought this account through close attention to the musical scale and harmony. I have not included an account of rhythm. The following situation may arise: in listening to music, the listener's body adapts to the rhythmic element of music. This imports a feeling of rhythm to the intellect. Put simply, rhythm often undermines cognition. That is, it reassures the listener of rhythmic duration at the expense of spatial perception, and hence does not warrant belief or lead to a grasp of spatial structures and relations in music. It is valuable, therefore, to explore a philosophical account of music that understates rhythm and promotes cognition.

A brief cautionary note: in *Meditations* the reader may find that Descartes uses the notion of the imagination in an unusual sense. For Descartes, the imagination is literally the act of bringing images to the mind, rather than the storehouse of thoughts, ideas, and possibilities as it is considered today. Further, the Cartesian notion of judgement in *Meditations* is a unified account of ideas that consist of images, thoughts, and experiences at their source.

4.8.1 First Meditation: *What Can Be Called Into Doubt* [216]

Descartes' opening gambit in the search for absolute certainty is to explore doubt by undermining unexamined knowledge of particulars.[217] In the Cartesian sceptical program, such beliefs that served us well are set aside, and not irrevocably abandoned.[218] He writes in his *First Meditation*:

> But inasmuch as reason already persuades me that I ought no less carefully to withhold my assent from matters which are not entirely certain and indubitable than from those which appear to me manifestly to be false, if I am able to find in each one some reason to doubt, this will suffice to justify my rejecting the whole.[219]

There are three arguments in support of the Cartesian method of doubt; the listener may suffer sensory deception; he may be dreaming; or there may be a powerful being well versed in broad-scale deception to the extent that the listener is deceived even in his cognition of himself.[220] Firstly, Descartes leads the meditator to doubt the information of the senses. We may be deceived by any of our sensory

216 Please note that all references to Hatfield are in reference to: Hatfield, *Routledge Philosophy Guidebook to Descartes and the Meditations*, London, 2003.

217 Hatfield, p. 80.

218 Hatfield, p. 2.

219 Descartes, 'First Meditation', p. 134.

220 Descartes, 'First Meditation', p. 137.

faculties. From a distance a square tower may appear round. In music, we may believe that the timbre of the oboe truly resembles a duck in Prokoviev's *Peter and the Wolf*. That is, we may believe that the quack of a duck and the timbre of an oboe constitute the same idea in the mind. This is a resemblance theory of perception that was widely held by Descartes' Aristotelian forbears.

Secondly, Descartes presents a dreaming argument. How is it that we can distinguish between waking and dreaming states? He affirms that objects appear to us in three dimensions with a durational element in both states. Further, ideas come to the mind unbidden in both states as well. In music this is a particularly vicious condition. We may find that the experience of attending to a piece of music is dysfunctional by virtue of this kind of doubt, to the point that internal chatter appears in the end to be a more familiar and comfortable companion and we fail to hear the music at all. Descartes writes:

> And just as a captive while in sleep enjoys an imaginary liberty, when he begins to suspect that his liberty is but a dream, fears to awaken, and conspires with these agreeable illusions that the deception be prolonged, so insensibly of my own accord I fall back into my former opinions…[221]

Thirdly, Descartes puts forth an argument in which the meditator is wrong in his perceptions due to God's possible plan that we should err in certain ways, if not in all ways. Descartes undermines the idea of a benevolent God with an evil genius in order to subvert any remaining habits of opinion or belief in the material world that have continued to arise:

221 Descartes, 'Second Meditation', p. 139.

> That is why I consider that I shall not be acting amiss, if, taking of set purpose a contrary belief, I allow myself to be deceived, and for a certain time pretend that all these opinions are false and imaginary…[222]

In this scenario, even the truths of mathematics are under scrutiny. Mathematics is seen as a part of a knowledge derived from sensory information, and is hence subject to attack. We may always be wrong in a belief that 2 + 3= 5.[223] We may always believe that the hiss of a tyre is the hiss of a snake. In listening to music we might believe that a dominant chord always resolves to a tonic; or, that once a tempo has been established, it remains at that pulse for the duration of a work or a single movement of a work. Finally, we might believe that a key signature determines the final chord of a work. These beliefs about music are subject to doubt in a music-based reading of the *First Meditation*. In his book *Music, Imagination, and Culture*, author Nicholas Cook presents findings from test cases of listeners' responses to music. Cook finds that listeners do not always prefer tonal closure in the key signature of a musical work. [224] He writes: '…there was, for example, a general preference for a version of Brahms' Intermezzo Op. 177 No. 3 in which the final section of the piece…had been transposed up a minor second from the composer's original score!' Hence, what we perceive and what we believe about music are not necessarily correspondent.

Descartes undermines remembered beliefs in this meditation as well. Memory may falter when we seek to whistle the tune or melody of a song a day or two after hearing it. Did that particular cadence come at this point, or at another? Was this the way in which the melody was extended, or was it different? He extends his sceptical

222 Descartes, 'Second Meditation', p. 138.

223 Hatfield, p. 80.

224 Cook, *Music, Imagination, and Culture*, Oxford, 1990, p. 53.

agenda even further to include his past opinions and beliefs, and thus undermines his self-understanding as an embodied, continuous being.[225]

4.8.2 Second Meditation*: The Nature of the Human Mind and How It Is Known Better Than The Body*

In the *Second Meditation* Descartes puts forth the foundational point from which his metaphysical position will grow. Our bodily existence may be undermined; our perception of objects may be misled; our senses may deceive us; an evil genius may successfully cause us to believe perceptions that are completely erroneous. Beyond this sceptical attack on particulars, the meditator may assert clearly and distinctly that she thinks. There is no attribute of the body or bodily processes included in this single assertion. What does not falter in the extended retinue of doubtful particulars is the single statement of the cogito, ‘I think, therefore I exist’.

This single claim joins two separate active statements. The former concerns mental activity, and the latter concerns extension or spatiality. According to Descartes, this claim can be made clearly and distinctly, as opposed to other claims to knowledge, belief, and their habits that have been reduced to doubt. Some commentators, including Descartes himself in his *Replies*, note that a middle term in this syllogism is lacking, i.e., a thinking thing necessarily exists.[226] Others claim that the two elements of his ‘cogito’ are so closely related that there is no room for a second or middle term. Once the activity of thought is asserted, they find no obvious requirement for a logical analysis, for the second term follows very closely from the first. That is, the statement is intuitively true rather than logically incomplete.[227] To

225 Descartes, ‘First Meditation’, p. 138.

226 Hatfield, p. 109.

227 Hatfield, pp. 112-15.

this reader the latter intuitive approach appears more likely in keeping with the analogous arguments in the 'Fifth Meditation'. That is, the idea of experience is the glue that connects these two statements.[228]

Accompanying thinking are the mental activities of understanding, affirming, conceiving, denying, willing, refusing, imagining, and feeling.[229] To account for music listening experience and claims of certainty that can be established therein, some commentators encourage listening with imagination.[230] It may appear that a response to Descartes' emphasis on cognition would be to look to the imagination, but Descartes rules this out. The imagination cannot have an image of the cognitive mind, and hence cannot picture the concepts of thought and existence clearly and distinctly.[231] The picture of things cannot constitute a perception. Further, as will be shown in the 'Sixth Meditation', the imagination cannot imagine an "I" without turning to the body. Reminiscent of the assent to the Ideal Forms in Platonic philosophy, to think of mind is not to think of how it is related to the body.[232]

Descartes supports his argument for the separation of imagination from thought by considering wax. While wax changes shape and consistency, we still make the judgement that the material is wax, and such judgement is made in the mind.[233] Thus, Descartes asserts that particular features of a body may change their appearance, yet spatial properties remain. As Descartes will argue, it is the persistence of spatial properties or extension that will constitute a proper judgement and

228 Hatfield, pp. 112-13.

229 Descartes, 'Second Meditation', p. 143.

230 E.g., Kendall Walton, 'Listening with Imagination: Is Music Representational?' in *Musical Worlds: New Directions in the Philosophy of Music*, Philip Alperson (ed.), University Park, Pennsylvania, 1998, pp. 47-61.

231 Hatfield, p. 120.

232 Hatfield, p. 120

233 Hatfield, p. 133.

intellectual understanding of a body.[234] Hence by a commitment to spatial perception, we may all be judges, and Descartes answers Aristotle's call for an effective method of judging music. On the other hand, Descartes claims that the act of perception tells us nothing reliable about an object for particulars are subject to radical doubt; hence perception is independent of the object. What perception achieves is to present the nature of the mind of the meditator in each act of judgement.

Ordinarily viewed as a passive presence, the specifically Cartesian cognitive listener is in a position of some mental power in listening to music. As the Cartesian meditator poses a challenge to the authority of the Schoolmen by emphasising cognitive perceptions in the mind, the same may be said of the cognitive listener. By applying Descartes' method, the cognitive listener may choose not to interrupt the music with inner chatter that reifies the body or points to an account of the music that values his sensory responses other than hearing - for his body is, at this point, in doubt. In this way listening can occur more clearly. The listener need only be capable of an assertion of his existence by the sheer fact of his cognitive awareness of being a thinking thing and of existing through the music.

4.8.3 Third Meditation: *The Existence of God*

Sound fades with a transience unequalled by most sensory phenomena; ideas arise nonetheless. Musical ideas for the listener arise as emotions and judgements. One of the aims of the *Third Meditation* is to begin to classify the dimensions of thought, that is, ideas and judgements. Descartes begins by making a claim paramount to a geometric axiom in a theory of clear and distinct perceptions.

234 Hatfield, p. 134.

> I am certain that I am a thing that thinks; but do I not then likewise know what is requisite to render me certain of a truth? Certainly in this first knowledge there is nothing that assures me of its truth, excepting the clear and distinct perception of that which I state, which would not indeed suffice to assure me that what I say is true, if it could ever happen that a thing which I conceived so clearly and distinctly could be false; and accordingly it seems to me that already I can establish as a general rule that all things which I perceive very clearly and distinctly are true.[235]

This may be unpacked as follows:

> 1. I know with certainty that I am a thinking thing.
> 2. This knowledge is based solely on a clear and distinct perception of its truth.
> 3. Clear and distinct perception would not be sufficient to yield such knowledge if it were in any way fallible.
> 4. Therefore, clear and distinct perception provides a sufficient ground for knowledge; whatever I so perceive is true.[236]

Descartes affirms that he is a fully functional being in the above claim; in fact, so much so that he dominates other functions that approach him. The spatial analogue of this approach reaffirms Descartes' claim that motion is local and physical space is relative. The opposite of this approach is non-solipsistic, in which the functions of the music dictate the ideas.

One way in which we may escape solipsism is by attention to experience at the expense of all extraneous thought.[237] It is at times of focus and concentration that the 'cogito' brings its full strength to bear. If the attention to a musical performance is complete, then doubts will not arise. Descartes treats this only briefly in this *Meditation*, yet it may be of some interest to readers, as musical works do not last for a long period of time. It is possible that the cogito may be employed directly in

---

235 Descartes, 'Third Meditation', p. 148.

236 Hatfield, p. 144.

237 Hatfield, p. 148.

listening to live concert music, and that the results will provide material for the intellect.

Descartes then proceeds with an analysis of ideas and the role of images and judgement in ideas. The role of judgement in music holds an important position, particularly in critical claims. A judgement is a complex of ideas made into a unified form, such as the judgement on wax in the *Second Meditation*. A judgement points to the workings of the intellect to a greater extent than the sensory faculties. In this *Meditation* Descartes seeks out the possibility of false judgements, for it is possible that if we assume a completely benevolent God, we are subject to an equally great and powerful deceiving God.[238] In this case we may be consistently applying false judgements.

To support his approach to judgement, Descartes doubts ordinary perception and resemblance theory. The external world is subject to a sceptical attack since it presents illusions of resemblance to the senses. Descartes seeks to emphasise a cognitive account of perception in place of a resemblance theory. The resemblance theory of ideas contains three serious flaws.[239] Firstly, whereas we may believe that it is best to follow the teachings of nature, in situations where we make judgements concerning rainbows, virtue, or vice, we may be wrong.[240] Secondly, the unbidden nature of sensory ideas reveals that ideas may arise to the mind like dreams. That is, we have no way of distinguishing or correcting ideas. And finally, the great divide between our ideas of the sun's size in relation to the reasoned, astronomical calculation of its size shows the resemblance theory of objects to be in error. Therefore an unrevised resemblance theory of ideas requires rehabilitation.

---

238 Descartes, 'Third Meditation', p. 149.

239 Hatfield, pp. 154-55.

240 Descartes, 'Third Meditation', p. 151.

Descartes looks closely at the elements of judgements, that is, the ideas. Ideas may be images of objects, motivations to act, or concepts that contain a complex of elements of images, thoughts, and experience.[241] Descartes analyses ideas into three categories with two functions. He performs this analysis with a view to limits and a proof of the idea and the existence of God. This is a cosmological argument that produces a causal account of the idea of God that argues to the effects.

Descartes divides ideas into three classes: innate ideas, adventitious ideas, and fabricated or invented ideas. Innate ideas are ideas that are independent of the external world, such as ideas of geometry and infinite space, or ideas of God. Adventitious ideas appear to 'come from' outside the meditator. Fabricated ideas are fictitious ideas that have no relation to the mind of the meditator.[242]

Descartes' analysis of ideas concerns the relations of the objective reality of content and the formal reality of thought. (The terms 'objective' and 'formal' describe the modes or 'ways of being' of ideas. An analogy of a mode is: vermilion as a mode of red.) The formal reality can be likened to the formal cause in Aristotelian philosophy. A formal element of an idea is the cause of the effect of the idea. In the mode of formal reality of an idea, all ideas are a mode of and dependent upon the primary *substance*, thought.[243] Formal reality is the notion of the 'about-ness' of music. To grasp prior to hearing music that the Pythagorean ratios of the 'perfect' intervals import a geometrical approach to sound is to have a formal idea of musical space. That formal idea is closely related to the innate idea of 'agreement'.

The element of objective reality in ideas is their content and complexity. Those ideas with a higher degree of objective reality are ideas whose representation in

241 Descartes, 'Third Meditation', p. 149. Also Hatfield, pp. 150-1.

242 Garber, 'Descartes, Rene', in *The Shorter Routledge Dictionary of Philosophy*, Edward Craig (ed.), London, New York, 2005, p. 182.

243 Descartes, 'Third Meditation', p. 152.

the mind have a high degree of organising patterns, such as a richness of timbre or complex inter-relations of themes.[244] Thus the objective reality is reminiscent of Marr's study of vision and the surface orientations of an object. According to Descartes, a work has greater objective reality if it is about that which is infinite and perfect as opposed to that which is finite and imperfect.[245]

The ordinary listener is constructed as bringing little, if any, formal reality to music listening. The problem for music for some, and its glory for others, is that the objective reality of music is invisible and cannot be touched. As if this impasse were too hard to reconcile, the ordinary listener is seen to be passive, and contributing little to the event of music-making. In my account of hearing music spatially, the listener brings an interest in formal and objective reality as an interest in the degree to which parts and whole musical themes in motion are realised within the terms of motion established by the nature of music. A spatial account of music does not depend solely upon a substance such as thought in infinite space for its formulation. In music, space is perceived in a dimension that accounts for the moving, yet invisible nature of music. Ordinarily, the objective reality supervenes on the formal reality in the experience of listening to music, but in a spatial account, these relations are reversed. That is, the formal qualities supervene on the objective.[246]

In the *Third Meditation* Descartes solves the problem of adventitious ideas, that is, ideas that arise from the external world, by separating the judgements of such ideas from their origin, or from an 'efficient cause'. This is a very sound move to make in a spatial account of music, for the listener will not look to the local, object-

244 Hatfield, p. 159.

245 Descartes, 'Third Meditation', p. 152.

246 Blackburn, 'Supervenience', in *The Shorter Routledge Dictionary of Philosophy*, Edward Craig (ed.), London & New York, 2005, pp. 1007-8.

centred neighbourhood of motion, the instrumentalists and the conductor, to explain the parts of his ideas. This is not to deny that they are the causes of the *production* of sound. The instruments, players, and conductor do not constitute the idea or ideas that arise in the mind of the listener.

The idea that is constituted by the music has a degree of surface complexity in accordance with the dimensions of size, shape, and motion of the music that are distinct from the performers. Complexity is bound up in the musical object or theme that represents an image/idea. Its repetition increases the complexity of the way in which the music is judged. The perception of harmonic complexity has a greater objective reality to the mind of the listener. Hence one may not remark so much that 'The music is sad'; rather a listener might remark, for example, that the music communicated an extended feeling of exhaustion. We may ask how it is that a composer communicates an emotion of sadness or grief when he does not experience that feeling himself when composing? According to a Cartesian model of perception, we would judge only superficially if we were to judge simply that the composer was sad, for we would have failed to fully observe the formal component of the material.

To communicate and share ideas is part of what it is to be a social being. It is also a major requirement of coherent and consistent thought as claimed by Parmenides. To report the intellectual content of experience in accordance with Descartes' distinction of ideas would be to report with minimal dependence on material substances, yet the report would be solipsistic. The experience of listening to music spatially is well aligned with an act of non-solipsistic report, if we accept that the sounds that we hear do not arrive at our ears directly from the instruments; that is, if we accept that such sounds are not audio-visually locatable. This is in stark contrast to a Cartesian account of perceptions that are clearly and distinctly located in relation to the spatially extended material world. As previously mentioned, Descartes collapses any distance between external events and what happens to him in the truth rule of the perceptions.

The classification of ideas into formal and objective kinds puts forth a causal argument for ideas in general, and, in particular, an idea of God. Ideas that are within the limits of the meditator to cause are ideas of animate and inanimate corporeal bodies, including lizards, books, himself, as well as angels. If the meditator is aware of a formal idea that he himself could not cause, then he realises that it cannot belong to him; it belongs to another being, God, who also exists.[247]

Following the discussion of ideas, Descartes asserts that mind and body are *substances*.[248] The bodily substance may possess modes, that is, size, shape, and motion, or the substance may be unextended, such as the mind. Both are finite substances, and are within the limits of that which he is able to conceive. God is also a substance, but is '…infinite, independent, all-knowing, all-powerful…'[249] Unlike the idea of finite causes and substances previously discussed, the idea of God requires an 'infinite cause'.[250]

How exactly does the Cartesian meditator configure an infinite cause? My interest is the way in which Descartes distinguishes the idea of infinite cause, as the idea of infinite space is central to geometry. He considers the relation of the finite to the infinite in three arguments, two of which will be presented here. Descartes states that the infinite is not the mere opposite of the finite, for the meditator asserts, ' …there is manifestly more reality in infinite substance than in finite, and therefore

247 Hatfield, p. 154.

248 Hatfield, pp. 155-6.

249 Descartes, 'Third Meditation', p. 156

250 Hatfield, p. 163

that in some way I have in me the notion of the infinite earlier than the finite...'[251] Whenever we consider finite objects, we do so by limiting infinite space, or, by implication, unlimited being. That is, the idea of a finite substance presupposes infinite space, the Pythagorean interval presupposes timbre, or, in the Platonic terms of geometry, the proportion presupposes *chora*.[252]

Descartes proceeds to investigate another proof of the existence of God by a process of elimination as to the responsibility of the idea of God in the mind of the meditator. Assuming that the idea of God is an infinite cause, how is the meditator to grasp its effect in the corporeal world? The result of the argument is Descartes' theory of God's conservation of energy at every moment. This is a clear reference to his scientific theory in physics of the conservation of momentum. God is a creator and a conserving being. In this world no energy is lost in the creation or conservation of all the parts of the life of the meditator, as Descartes writes, '…from the fact that I was in existence a short time ago it does not follow that I must be in existence now, unless some cause at this instant, so to speak, produces me anew, that is to say, conserves me…so that the light of nature shows us that the distinction between creation and conservation is solely a distinction of reason'.[253]

4.8.4 Fourth Meditation: *Of the True and False*

This is a short meditation; its content concerns human behaviour and its foibles to a greater extent than the previous meditations. In the *Fourth Meditation* Descartes reaffirms that the mind is immaterial, unextended, and better suited to matters of the intellect than corporeal bodies and the senses. Having previously

251 Descartes, 'Third Meditation', p. 156.

252 Descartes, 'Third Meditation', p. 157. Also Hatfield, p. 164.

253 Descartes, 'Third Meditation', p. 159.

established the content of ideas and their functions in the mind of the meditator, Descartes examines the role of judgement. In the previous Meditation he had affirmed that a judgement is constituted by ideas, images, and concepts; here he analyses the relation of the judgement, the intellect, and the will. In his attempt to uncover the problem of error and false judgement, Descartes makes several positive claims concerning the will and its agreement with the other faculties just mentioned.

The will is indefinite and God-like in its unlimited scope, Descartes claims.[254] The will '…consists alone in our having the power of choosing to do a thing or choosing not to do it…' The role of the will in the act of judgement is to choose and to act 'without constraint'. [255] Whereas the will may appear listless in a condition of indifference, in its most positive manifestation, the will freely follows the intellect in assenting to clear and distinct ideas. For example, the will freely assents to the clear and distinct idea of consonance and the harmonic agreement of tones in a major or minor chord. Thus the judgement may assign 'accord' to the unity of the will and the intellect upon hearing such a chord.

It is contended that the judgement, supported by the will and the intellect, assesses the general success of a musical performance in this approach; this includes the clarity of the intervals, the calculated purpose of transitional material, and the unity of sectional playing of the orchestra. In a musical context the role of the judgement is not directed at the truth or falsity; rather it is attuned to the success or failure of the presentation of clear musical ideas to the mind.

Yet Descartes notes that the will and the intellect are not without error in themselves that may lead to false judgement. Neither the will nor the intellect enjoys

254 Descartes, 'Fourth Meditation', p. 165.

255 Descartes, 'Fourth Meditation', p. 166.

perfection; they are finite and susceptible to a resemblance theory of perception in which secondary qualities create a sensory idea that is materially false.[256]

Descartes does not rule out indifference as a direction of the will, and hence we may make a cognitive choice to act one way or another, despite the *tendency* of the will to act in a specific direction.[257] A judgement of the role of rhythm in music is an example of the directions the free, cognitive listener may adopt. For example, it has been suggested that the Cartesian will would comfortably assent to the dance-like rhythm of a Chopin ballade, such as *Ballade No. 3 in A-flat*. The rhythmic pattern is continuous and easily assimilated. A pleasing sense of expectation is gratified in its continuance. But the listener may assert his free will, choose indifference to rhythm, and thus refuse to participate in the expectations that the music's rhythm imports. He finds that such expectations hinder his cognitive grasp of the music. This is a constraint that the listener may impose upon his will, as he has freely chosen to limit his exposure to musical rhythm. He may choose to risk indifference with the confidence that this direction will also lead to judgement.

The risk of choosing indifference is that the 'cogito' will disappear. Descartes writes; ' ... I here suppose that I do not yet know any reason to persuade me to adopt the one belief (that mind and body are separate and distinct) rather than the other. From this it follows that I am entirely indifferent as to which of the two I affirm or deny, or even whether I abstain from forming any judgement in the matter.'[258] Thus Descartes claims that the choice of indifference is not a perfect or desirable condition. The possibility of judgement, and hence clarity, is probably lost in the grey areas of indifference.

---

256 Descartes, 'Fourth Meditation', p. 168.

257 Hatfield, p. 195.

258 Descartes, 'Fourth Meditation', p. 167.

Yet we ought not to ‘throw out the baby with the bath water’. In musical terms, at times the will may be coloured by the timbre of the music; at others, the listener may be unaware of his body. Overall, as affirmed in the opening discussion of these meditations, the listener ought to exercise the ‘cogito’ as well as he can in order to maintain his cognitive capacities; here it is asserted that he may exercise those capacities in a condition of indifference.

4.8.5 Fifth Meditation: *Of the essence of material things, and, again, of God, that He exists*

Descartes' agenda in the Fifth Meditation concerns the coherence and consistency of innate ideas, and reflects the metaphysics of Parmenides. His focus is on the mental relations that constitute ideas of the external world and its essence. This essence, he argues, reduces to extension. He writes that he is easily able to imagine objects in three dimensions as well as the division of objects into parts, and the measurable motion therein, over time. The thought of a tone's extension is coherent and consistent. Its properties can be demonstrated, and are deducible from the primary innate idea or intuition of consonance guaranteed by clear and distinct perception. Thus the extended nature of the tone is discoverable per the conditions of Parmenidean objectivity. This approach to objects in the external world is a geometric, analytic approach that Descartes claims is innate.

The qualities of an idea that are innate to the mind are describable in four ways. They include the richness of information that flows from an objective analysis of the idea; the idea is formally harmonious with the meditator's nature; the idea appears to arise from the memory; and finally, that such ideas were always in the mind or innate, without the meditator being aware. Furthermore, a meditator's ideas pertain or belong consistently to the thought of the object. Descartes seeks to prove the existence of God by this argument. His claim is that the formal reality of an idea of God is on a par with an idea of a figure. What can be deduced from either God or the geometric figure truly pertains to its respective ideas. He writes: '…because I can draw the idea of something from my thought, it follows that all I can know clearly and distinctly as pertaining to this object really does belong to it… [259] For example, by

259 Descartes, 'Fifth Meditation', p. 171.

referring to a C major chord's spatial extension and consonance as its essence, Descartes will argue that we do have a clear and distinct idea of it, and that it exists per the truth rule of the 'cogito'.

As Descartes had stated in the *Compendium*, when we hear a tone, its overtone series is present whether or not we hear it. The overtone series is an immutable truth of a tone. Under the aegis of consonance, the will assents to the idea. Its intervallic relations may be seen as a hidden assertion of extension. That is, we think clearly and distinctly of the C major chord, and hence it exists. Secondly, an idea of God's essence, eternal and infinite, is as clear and distinct as the thought of the consonance of the chord or tone, or a shape such as a triangle. Its immutable nature is innate to the meditator's intellect and compels cognitive acknowledgement. In fact Descartes claims that as these ideas are something, they are not nothing, and therefore are true. Hence God, the chord, and the triangle exist ideally. Finally, on *close* attention to this thought, Descartes asserts that the ideas of God, of a triangle, or of a chord are ideas that cannot be separated from their essences, that is, extension. That is, we cannot separate the idea of God from infinite extension, or consonance as a proportion from infinite depth.

According to Descartes, understanding extension does not derive from the senses, for the ideas in extension arise to the mind whether or not the will assents to them. In this way, the ideas of extension are true. Further, it is not the activity of the mere meditator's thought that unites essence and extension; the unity of essence and extension pertains to the necessary *existence* of God, the triangle, or the major chord. The immutable properties of an object such as its geometric proportions point to its existence.[260]

260 Descartes, 'Fifth Meditation', p. 173.

4.8.6 Sixth Meditation: *Of the existence of material things, and of the real distinction between the soul and body of man*

In the *Fifth Meditation*, Descartes established that extension is an essence of matter that arises in the mind clearly and distinctly, as well as an indication of a body's existence in three dimensions. This is an ontological argument that serves to establish a central point in the *Sixth Meditation*, that is, that mind and body are separate substances. The essence/existence argument supports Descartes' affirmation that the unextended, immaterial mind and the extended, material body are the two primary substances capable of existing independently in the world. He writes:

> First, I know that everything which I clearly and distinctly understand is capable of being created by God so as to correspond exactly with my understanding of it. Hence the fact that I can clearly and distinctly understand one thing apart from another is enough to make me certain that the two things are distinct, since they are capable of being separated, at least by God. The question of what kind of power is required to bring about such a separation does not affect the judgement that the two things are distinct. Thus, simply by knowing that I exist and seeing at the same time that absolutely nothing else belongs to my nature or essence except that I am a thinking thing, I can infer correctly that my essence consists solely in the fact that I am a thinking thing. It is true that I may have (or, to anticipate, that I certainly have) a body that is very closely joined to me. But nevertheless, on the one hand I have a clear and distinct idea of myself, in so far as I am simply a thinking, non-extended thing; and on the other hand I have a distinct idea of body, in so far as this is simply an extended, non-thinking thing. And accordingly, it is certain that I am really distinct from my body, and can exist without it. [261]

In this final *Meditation* Descartes seeks to account for the role of the senses and the imagination in distinguishing possible experiences of health and harm to the body. It is not simply a case of the intellect sorting the information from the senses rationally. Often the information is confused and misleading. That is, the senses do not merely alert the meditator to distance relations between himself and experiences

261 Descartes, 'Sixth Meditation', p. 176.

of pleasure or pain; the union of the mind and the body arrives at more complex information than this.

He reminds the reader that at the beginning of this meditation process, the information of the senses was subject to doubt from the dreaming argument and the deceiving genius argument. He then invokes the rule of truth gleaned from clear and distinct perception, as well as God's role as a non-deceiving creator. He reminds the reader that false judgements can be made but that the errors therein will not persist if the meditator analyses her thoughts and beliefs. The fundamental' cogito' provides him with the tools to make the necessary distinctions to gain certainty.

Descartes considers ideas derived from the senses. In the independent substance of the mind, that is, the intellect, there is no imagery, only innate ideas and cognitive activity such as spatial and structural relations. Descartes then presents an extended discussion of the imagination and sense perception. He writes that imagination and sense perception are *modes* of the intellect, but are not necessary to it. Their essential definition is an act of the intellect that turns to the body.[262]

The sensory perception is a passive faculty that receives ideas.[263] Sense perception brings ideas to the mind, including impressions of colours, sounds, smells, and tactile information. He reminds the reader that at times sensory ideas arise against the will of the meditator. In the associated active mode of making sense of these somewhat confused ideas, sensory ideas are identified with patterns contained in the body. As Descartes writes: 'But this faculty cannot be in me, since clearly it presupposes no intellectual act on my part, and the ideas in question are (often)

262 Descartes, 'Sixth Meditation', p. 177.
263 Descartes, 'Sixth Meditation', p. 182.

produced without my cooperation…'[264] Thus a substance must exist objectively that is responsible for the formal ideas the meditator now contains.

The mind also turns to the body in the act of imagining. The imagination brings to mind images of corporeal substances that are otherwise absent from the intellect. Hence there must be something distinct to which it looks. Descartes argues here that the act of turning the mind to the body in imagining shows that the body is distinct from the mind.

The imaginings and sense perceptions of the meditator may appear confused. Yet Descartes affirms that the ideas arise from existing corporeal bodies, for God is no deceiver. Further, we can be certain of the properties of such bodies as derived from extension. There is intermingling between the mind and the body, and together they act as a unit. The relation is complex, but the quest to both maintain health and avoid harm is the important function of the sense perceptions, the imagination, and the information from the material world of extended objects and space (*res extensa*). On the other hand, the intellect persists in maintaining cognition, that is, the faculties of deduction, intuition, and clear and distinct perception (*res cogitans*).

Descartes asserts at the end of this final *Meditation* that he is certain of the distinction between being asleep and awake, for his cognitive memory links his experiences when he is awake, but does not do so when he is asleep. In being awake, he can learn the source and limit of ideas that come to him. Further, when he is awake he can verify his perceptions or correct them as the need arises.

264 Descartes, 'Sixth Meditation', p. 182.

4.9 Space, Extension, and Thought

A considerable wealth of ideas arises in Descartes' overall philosophy and metaphysics. Here the concepts of the overtone series, extension, mechanics, and, more specifically, the role of the cadence, receive their strongest clarification as shown in *Compendium* and *Rules for the Direction of the Mind*. Yet in the *Meditations*, the circular nature of the 'cogito' that both depends upon and proves God is problematic in his analysis of perception and his metaphysics in general.

In *Meditations* Descartes makes a close study of perception, its internal relation to knowledge and certainty, and its role in ideas of the external world. His conclusion is that the immaterial, unextended mind is separate from the material, extended body. Descartes' account of perceptions concern the meditator's overall functioning mental capacity. His account of the true nature of his perceptions depends upon spatial location. As hearing sounds does not involve spatial location, Descartes' account of perception is contentious. During the course of hearing music, the relations of music to space become clearer by the action of thought that derives its judgements and ideas from infinite extension.

The focus for music in the style of Cartesian philosophy and metaphysics shifts to the rational listener's perceptions more completely than ever before in the history of philosophy. If we are Cartesians, then the ideas in the music serve to enhance and possibly mirror the supposed function of the intellect rather than to promote any independent musical material or ideas. In reflecting upon the style of early Baroque music that was popular at the time of Descartes, my claim is that popular Baroque music is an expression of the way the mind was perceived to function. The early Baroque style does not require or reward close listening, for its style is only intended to enhance and reflect the internal experience of the intellect that receives it. In most early Baroque music, the musical phrases are brief, repetitive, and not difficult to process.

Finally, Descartes finds that he knows innately those ideas that incorporate a spatial component, such as the relation of God and infinite extension. What can be known by an analysis of the substance and function of thought in the immaterial, unextended mind is that which has extension. Although his solipsistic account of perception cannot be supported, Descartes affirms that the perception of infinite mechanical, extended space is valid, alongside the perception of tones, chords, and the harmonic series. The history of space is aligned with the history of timbre. By making this account of space, the Cartesian approach permits mechanical motions in space that recommence an inquiry into the ineffability of music.

CHAPTER 5

LEIBNIZ (1646-1716) [265]

5.1 Music and Dynamics

The influence of Leibniz's metaphysics on music has not been widely commented upon in philosophical accounts of Western art music. Yet two familiar aesthetic theories of music are present in his philosophy; first, the notion of 'expression', that music 'expresses' emotion, and second; causation, that music causes emotions, both of which feature prominently in Leibniz's metaphysics. The notion that music is expressive is a thorny problem in musical aesthetics. We conceive of music as expressive of something; hence music is 'about' something to be understood. How are listeners to understand 'absolute', wordless, untitled music? The important question that arises is whether solely instrumental music is a 'language' subject to understanding and reference or if, on the other hand, 'absolute' music is a sound-only world that embraces a reconsidered construction of space. In this chapter I will consider Leibniz's account of motion and expression. I conclude that the unfolding musical surface must be expressive in Leibniz's account. My argument is that the emphasis on surface in his account of 'spatiality' precludes the inclusion of timbre in the listening experience.

Descartes' legacy in the time of Leibniz incorporated the ideas of spatial extension, measurement, and function in a co-ordinate system. These ideas led to huge advances in mathematics and engineering in the period of the Enlightenment. Principles of mechanical motion were transformed into a reality, engineered by levers,

265 Please note that unless otherwise indicated, all references to works written by G. W. Leibniz are found in the following edition of Leibniz's collected works: *Leibniz: Philosophical Papers and Letters*, selected, translated, introduced and edited by Leroy E. Loemker, 2 vols., University of Chicago Press, Chicago, 1956.

hydrostatics, and pulleys, subject to mechanical laws and the law of inertia. In this period, the universe came to be seen as the product of mechanical patterns and interactions subject to mathematical analysis. To Leibniz, in a mechanical universe such as this one, all bodies achieve a limit, suffer a collision, and then move at a new velocity or regain their previous velocity.

To Leibniz, all things are in a process of becoming in a mechanical universe. His position on the individual nature of every substance focuses his discussion on particular attributes of individual bodies. Although every body is unique according to Leibniz, the temporal and spatial relations of bodies all participate in an ongoing public expression of a universal cosmic harmony that reflects God's pre-established view of this actual world as the best of all possible worlds.[266] In his view on collision, Leibniz claims that it is impossible to single out the precise moment at which motion is transferred from one body to another due to the *elastic* nature of bodies.[267] From his observation of the elastic nature of bodies, Leibniz surmises that 'motion' itself does not exist.[268] Dynamic relations of momentum and resistance, active and passive principles of force, and the elasticity of substances on impact constitute the attributes of all substances in Leibniz's metaphysics.

Dynamics was central to Leibniz's theory of explanation. All bodies in inertial motion maintain such inertial motion by a dynamic of momentum and resistance. In relation to music, one aspect of dynamic relations is the vibration of the tone. Every tone has an individual timbre constituted by the vibration of the string, surface, or air in a tube, and the particular nature of the instrument and the instrumentalist. Leibniz's spatial model is mathematical and dynamic. There is not an emphasis on the

266 Leibniz, 'Radical Origination of Things', ii, p. 796.

267 Leibniz, 'A New System of the Nature and the Communication of Substances', ii, pp. 729-730.

268 Leibniz, 'On Nature Itself', ii, pp. 820-1; 'Correspondence with De Volder', ii, p. 869.

Pythagorean theory of proportions underlying the notion of fixed, infinite space, for this would deny God's ongoing interest in this world. In a dynamic model, the timbre, perceived to be what is 'behind' the music, is directed 'forward', towards a participation in the 'cosmic harmony' that God has set in motion. In this way Leibniz's goal of a three-dimensional approach to space, musical space in particular, and a dynamic account of motion that imports a further dynamic of science and perception is guaranteed. Ultimately spatiality is a function of God's complex, rational arrangement of matter and thought in the universe; it serves to enhance a picture of the interconnectedness of all things and their expression in a cosmic harmony.

The cognitive faculty is explained by dynamics, in which the possible contradictory nature of 'truths of fact' and immutable 'truths of reason' are the dynamic elements that relate to form a concept. Further, hearing music is a dynamic event between the cognitive listener, the performers, conductor, enclosed venue, and the sounds produced. The listener's own personal background also mediates what he hears. I remind the reader of Ridley's brief allusion to music and causality, in which he notes that a causal account of hearing music emphasises an expectation or past experience-based account of listening.[269] Leibniz's account of listening would promote the latter approach.

Contrary to Descartes, Leibniz does not take understanding to be internal to the mind only; he takes seriously the idea of a cognitive element in each substance.[270] His approach to the nature of a concept or understanding is inherently public and fully accountable. He supports the re-identification of particulars that, in turn, makes music listening an act of cognition.

269 Cf., p. 30

270 Leibniz, 'Discourse on Metaphysics', i, p. 494

Leibniz views God's creation of this world as His most economical creation. In this best of all possible worlds, a maximal number of elements are related for the greatest profit and best outcome for all.[271] Whereas Descartes asserted that the immaterial mind was separate from the material, extended world, Leibniz affirms that the functions of minds and matter are all interconnected, contained only by a rational God. Things are as we see them to be, for human perception is a part of God's nature.

5.2 The Concatenation of All Things: Spatiality

In a general overview of Leibniz's physics and metaphysics, his approach is *topological* and three-dimensional. Internal information arises to the surfaces of things; the interaction of surface information in a mechanical system is charted by spatial location and the elasticity of bodies in a cosmically ordered 'spatiality'. To Leibniz, spatiality is a *diffusion* of elements that constitute a locality.[272] 'Space', is a term that Leibniz did not condone. The conventional use of the word 'space' is a mere convenience, based on appearances that humans observe as 'well-founded' phenomena.[273] Descartes had viewed both space and body as modes of corpuscular extension.

Timbre is a close analogy of Leibniz's idea of spatiality. It is the organising concept 'behind' the music. Leibniz used the term 'spatiality' as a most apt designation of geometric/functional relations and a diffusion of the locality or surface relations of a multitude of substances, '…resolvable into plurality, continuity, and coexistence…of parts at one and the same time…'[274] Spatiality is neither strictly

271 Leibniz, 'Two Dialogues on Religion', i, p. 335.

272 Leibniz, 'Metaphysical Foundation of Mathematics', ii, p. 1084. Leibniz writes: 'Situs is a mode of coexistence.'

273 Leibniz, 'Letters to Nicolas Redmond', ii, p. 1071.

274 Leibniz, 'Correspondence with De Volder', ii, p. 838. In his mathematics of instantaneous velocity, that is, the calculus, these relations were notated $f(x)$.

relative nor proportional; it is the site of mechanical relations, inertia, and an ultimate harmony of logic, free will, and the laws of physics. The continuously changing nature of this diffusion constitutes a continuum.

In addition, spatiality is aligned with Leibniz's primary metaphysical principle, the Principle of Sufficient Reason (see §5.3, p. 132). The Principle of Sufficient Reason is Leibniz's claim that whatever happens does so for a reason. His method of determining the nature of thought and matter by the Principle of Sufficient Reason, as will be discussed, aims to eliminate mystery, for *all* concepts are available to the truths of fact or reason and are essentially public. By the Principle of Sufficient Reason, Leibniz claims:

> And there is no created substance…whose complex concept as this exists in the divine mind does not contain the whole universe, with all that ever is, has been, and will be. And there is no truth of fact or of individual things which does not depend upon an infinite series of reasons… [275]

Spatiality denotes the interconnectedness of all things both nominal and physical. This interconnectedness is a property of a reasoned order of co-existents that includes its relations, motions, and limits. The Principle of Sufficient Reason recalls to the mind a *particular* spatial order to be a final cause to the cognition, whereas previously the final cause had only been subject to discussion of an Aristotelian temporal order.

275 Leibniz, 'On Freedom', i, p. 406. To Leibniz understanding seems to be infinite per the notion of an infinite regress. Hence there is no account of evil in Leibniz's philosophy as a limit at which understanding ceases.

5.3 Expression

To Leibniz, facts are as expressive and rich in information as fictions. Music presents an expressive fiction of motion; no individual tone 'moves' in the illusion of buzzing bees, such as in Rimsky-Korsakoff's *Flight of the Bumble Bee*. Musical lines and harmonic progression create only a sense or perception of motion. This does not discount any reason why such a fictional approach is not possible. Whether a work is fictional or non-fictional, it has an essence, that is, an explanation prior to natural law. To Leibniz, the metaphysics of 'force' as an explanation of the essence of a substance prior to laws of motion presents that substance as an *expression* of God's rationality. In his view, substances are expressive of their past, present, and future, of which an omnipotent God is both the efficient and final cause, as parent, fixed referent, and *telos*.

The primary focus that Leibniz offers to an understanding of a musical work is a close attention to the notion of the dynamics of expression. This grasp of the topological complexity of an expressive, substantial form increases the information available to an inquiring mind. Expression suggests an impressive substance or substantial form as that which music is expressive 'of '. To bring what is private and previously unexplored to the public surface is the aim of a dynamic understanding of expression. Understanding in the sense in which Leibniz uses the term concerns a grasp of the interrelatedness of all things.

Leibniz claimed the following definition of music: 'Music is the hidden pleasure of a mind unconscious it is calculating.'[276] This definition of music joins the mathematical activity of the mind with the ongoing nature of harmony, melody, and rhythm. It is indicative of his philosophical position, that is, that all substances,

276 Quote from Leibniz, in *Musikalische Bibliothek*, Lorenz Misler (ed.), in *The Cambridge Companion to Bach*, John Butt (ed.), Cambridge, 1997, p. 60.

concepts, and events in the world are interrelated by virtue of their mechanical and dynamic relations. Leibniz uses an umbrella term ‘force’ to discuss these relations, underpinned by the calculus that measures the rate of change of a function.

Fundamental to each and every body and part of a body is his notion of *force*, a principle of action and becoming. Descartes had not been successful at isolating and explaining force and motion other than to note that motion is separate from our perception of it, and both are dependent on God. Leibniz claims that ‘force’ is not only measurable as a natural physical cause; it is a metaphysical cause of motion as an *active* principle of substance as well. He emphasises an inner active force, endowing it with direction, appetite, and the independence of a monad.

Although Leibniz held an account of force as innate to a body, supported by his theory of the dynamic of active and passive principles, this remains a theory subject to Ockham’s Razor. That is, the principle of force is employed to explain too much, and ultimately loses an objective, scientific function. Ultimately, the term ‘force’ does not enjoy precise definition until the work of Isaac Newton.

5.4 Truths of Fact, Truths of Reason, and the Principle of Sufficient Reason

Descartes’ examination of geometry and the axiomatic method in philosophy reinvigorated the limits of philosophical description and explanation. With geometric method and analysis returned to the Western philosophical agenda, theories, axioms, and laws were included in the building blocks of philosophy once more. Philosophical inquiry was not merely a case of arguing well; science and accurate measurement could be used to support the actual nature of phenomena. Although absolute music does not make any claim to truth, in this chapter I will consider the question if our understanding of it is subject to Leibniz’s distinguishing claims about truth.

Unlike Descartes, to Leibniz, facts were not granted an unconditional truth status. He proposed two classes of truth: truths of fact, and truths of reason. Leibniz's Principle of Sufficient Reason contained both sorts of truth within the single principle. As previously stated, by this principle Leibniz asserted that everything that happens does so for a reason. In tracing back the reason for any event or substance, there will be a combination of these two different kinds of truth. In this way Leibniz affirms that there is a dynamic relation of truth in any given concept that is not a law. Not only does God act according to this principle in all of his creations, this principle can be applied to the arts, the sciences, and to understanding the actual world.

Truths of fact were subject to the possibility of their contradiction also being true. For example, my cat is named Aztec. This is a fact about my cat, and also about me. But were her name not Aztec but Daffodil, this would not imply a contradiction about either of us. On the other hand, truths of reason are not subject to contradiction. Truths of reason include mathematical statements such as 3 + 2 = 5, or the Pythagorean theorem of the square of the hypotenuse. They are separate and distinct from the mutable field of truths of fact. A truth of *fact* is that frequency relations that sound harmonious are theoretically necessary. A truth of *reason* is that frequencies themselves are logically necessary.

Leibniz used the Principle of Sufficient Reason to support his notion of spatiality against Newton's theory of absolute space in the following way. According to the Principle of Sufficient Reason, the choices God makes of the ways in which the world 'goes on' are subject to the dynamic relations of truths of fact and truths of reason. If absolute space were perfectly uniform, distinct from objects, and homogeneous as Newton claimed it to be, then, Leibniz argued, God would have no sufficient reason to situate things in one order as opposed to another. That is, the complex of relations between substances would have no meaning against a backdrop that did not, in some way, participate in or reflect in these relations as 'spatiality'.

5.5 Instantaneous Velocity, the Infinitesimal, and Intuition

In the previous chapter I wrote: 'One may speculate that it is from the Cartesian notion of harmonic extension that Leibniz derived his concept of cosmic harmony, although it is in the Cartesian idea of proper mechanical motion of bodies that these harmonic relations arise' (p.97). Further, I argued that Descartes made good account of the principles of harmonic extension and cadences in music. In addition, Descartes presented a three-dimensional co-ordinate system of space and bodies that was constructed by rational principles of analytic geometry and precise measurement. What was lacking was an account of the immediacy of perception other than by intuition. Theorists such as Marr have taken this position very seriously. Perception is an important element in music; immediacy of perception is a primary factor of music listening experience. According to Gaukroger, the immediate manner in which images arose to the intuition was of considerable interest in Descartes' early theory of perception. He suggests that the notion of immediacy or the 'instantaneous' quality was included in Descartes' understanding of intuition, but ultimately Descartes lacked a mathematical account of immediacy that could support his projection of intuition's immediate nature.[277] Leibniz incorporated the calculation of the *instantaneous* velocity of a persistent material or immaterial thing, including spontaneous thought or intuition, into his notion of spatiality. Instantaneous velocity and its measurement were deduced mathematically by the invention of the infinitesimal calculus. The

277 Gaukroger, 'Descartes' Early Doctrine of Clear and Distinct Ideas', in *Journal of the History of Ideas*, Baltimore, 1992, pp. 595-6.

mathematical symbols that Leibniz developed to effect calculated solutions of instantaneous velocity is still in use today.

The calculus, to which both Leibniz and Newton laid claim, measures instantaneous change in a region, even in a fragment, as a matter of proportion and a limit, such as the secant or slope of the tangent to the line of motion configured on a co-ordinate axis (§5.8, p. 140). As Descartes viewed the entire material world as constituted by the medium of extension, it was not possible to discuss the actual nature of a moving body instant by instant. Thus it seemed incumbent on Leibniz to extend Descartes' account to include motion, and, by extension, musical motion. Leibniz would achieve this by incorporating a more detailed account of bodies and motion. In *Discourse on Metaphysics* Leibniz asserts that although motion may not be attributable to one particular body amongst bodies, the *cause* of motion is to be found in his metaphysics as follows in the next section.[278]

5.6 Dynamics and Substance: Force

Leibniz accounts for cause and effect by a dynamic approach that institutes a theory of active and passive principles essential to his concept of substance, thereby conjoining his physics to his metaphysics under the aegis of a single term, *force*. Leibniz assumes Aristotle's language of matter and causal relations in the achievement of 'substantial form'. He adapts the basic principles of cause and effect to Galilean mechanics, taking these to be equivalent in a mechanical universe. That is, that the extent of an effect is equal to the extent of the cause.

In a Leibnizian version of a mechanical universe, space is relative. It is constituted by three elements: inertia, a multitude of collisions of bodies, and

278 Leibniz, 'Discourse on Metaphysics', i, p. 484.

subsequent changes in shape.[279] As such, no body is at absolute rest; each body maintains its own inertial state independently. In Galilean mechanics, resistance in a body is the first effect of collision. To Leibniz, this passive principle of resistance is essential to the sub-stratum of matter at its most fundamental level.[280] He seeks the cause of this resistance effect, which he designates to be an active principle.

To Leibniz, there is a unique, rational essence or dynamic of active/passive principles at work in every individual substance. The incorporation of a *principle* of action into primary, passive, resistant matter constitutes the transition from mere matter into an individuated, unique substance. The presence of active and passive modes of being in one substance or dynamic unity individuates a simple, basic substance or monad and explains its motion as *appetite*.[281]

Leibniz presents a law of calculating appetite as a law of continuity. [282] The law of continuity states that in tracing the trajectory of a moving body, one must include the limit *in* the calculation. [283] Thus, according to the law of continuity, 'nature has no gaps'. 'Motion' or appetite is a seamless, mechanical process that includes all intermediate phases from one collision to the next. A composer who provides an abundance of musical examples of this point is a contemporary of Leibniz, J. S. Bach. An example of ongoing, seamless music can be instanced in *The Brandenburg Concertos* or fugues from both books of *The Well-Tempered Clavier*.

According to Leibniz, rest ought to be seen as a relative rather than an absolute state. Rest is the furthest elimination of error in the calculation of the incomparably small as a vanishing or minimal motion. 'Equality is the smallest

279 Leibniz, 'Correspondence with De Volder', ii, p. 839.

280 Leibniz, 'Specimen Dynamicum', ii, p. 714.

281 Leibniz, 'On Nature Itself', ii, p. 821.

282 Leibniz, 'Specimen Dynamicum', ii, p. 731.

283 Boyer, *The History of the Calculus and Its Conceptual Development*, New York, 1949, p. 217. 'In any supposed transition, ending in any terminus, it is permissible to institute a general reasoning, in which the final terminus may also be included.'

inequality,' Leibniz asserts.[284] Taken together, the combined laws of inertia and continuity broadly assert that the mechanical nature of motion and rest is a dynamic of inertial motion and collision within a seamless continuum.

Leibniz abstracts from the dynamics of substance and mechanics constructed above to present a metaphysical account of force. In his *Specimen Dynamicum* he claims that this force is present in a substance whether or not it is perceived by the senses, and therefore force is a rational principle of substance prior to an empirical account.[285]

5.7 *Specimen Dynamicum*

Leibniz presents his argument for the elasticity of substance and force in the analysis of motion in *Specimen Dynamicum*. His theory is that force is *innate* to the body. It may be seen as appetite, rather than energy.[286] To place this into a correct physical format, Leibniz finds that the altitude achieved by a body is proportional to the *square* of the velocity of its ascent, hence $f = mv^2$, in which f is the force of the falling body, m is its mass, and v is its velocity.[287] Leibniz writes: '…when two bodies collide, there is conserved after the collision, not the same quantity of motion

284 Leibniz, 'Metaphysical Foundations of Mathematics', ii, p. 1090.

285 Leibniz, 'Specimen Dynamicum', ii, p. 721.

286 Consider A of four units of mass, to be replaced by B, of a single unit. Descartes would affirm that B would simply arise four units. Leibniz asserts that the force inherent in B is what is to be measured, not the relative velocity. Hence B would only expend two units to rise to the height of A. The effect of B's innate force is the square of its velocity.

287 The problem with the approach to force in this document is the lack of any temporal measurement. It makes little sense to compare B to A if it takes A one minute to fall a distance of one unit and it takes an hour for B to achieve its relative height. Leibniz ignores a discussion of the perception of time and yet imports it into his system of measurement. Newton rectifies Leibniz's problem in his equation of force that includes acceleration, not velocity. Leibniz revisited this problem in his later letter 'Correspondence with De Volder', in 1699. Here he redescribes the problem in terms of velocity and inertia, which must necessarily include a slope or rate of change with respect to time. Yet he sees no error in his description of force that excludes time.

Leibniz, 'Thoughts on the Principles of Descartes', ii, p. 651.

or impetus but the same quantity of force'[288] Neither motion nor impetus can be conserved as neither can be measured, according to Leibniz; on the other hand, force can be measured by the calculus. Thus within every substance, and in the broader category of Galilean mechanics and collision, there is a dynamic of principles of resistance/mass, and velocity/ rate of change of speed.[289]

Force is an innate principle of bodies as well as a principle of interaction between bodies and their extension. To Leibniz, force is a genus divisible into two species, active and passive, or kinetic and potential (energy). These two species of force are individually divisible into primitive and derivative subspecies. In general, Leibniz's primitive force is viewed as on a par with energy, or the work involved in coherence or centrifugal force. The first subspecies of active primitive force is the motivation to act per the principle of inertia. Passive primitive force is Aristotelian primary matter, and is the tendency of an elastic body to resist motion. Derivative force, seen as rate of change of the active, primitive force, is viewed as the continuous local motion or change of bodies over time. Active derivative force categorises the collisions of primitively active forces. Passive derivative force is the stuff of the laws of mechanics, resistance, and the effect of levers, pulleys, hydrostatics, etc. [290] This latter view is the perception of space in the Cartesian mechanical universe.

The motion of a reasonably coherent rotating body, such as a planet, is both tangential and centrifugal. According to Leibniz, these two kinds of motion explain the circumstances of the dynamics of force. On a curve tracing the motion of a regularly rotating body, the active derivative force in a body moves it in a straight, inertial line as a tangent to a point on a curve. If we imagine a coherent rotating body,

288 Leibniz, 'A Brief Demonstration of a Notable Error of Descartes and Others Concerning a Natural Law, 1686', i, p. 462.
289 Leibniz, 'Specimen Dynamicum', ii, p. 730.
290 Leibniz, 'Specimen Dynamicum', ii, p. 713-5.

a part or parts of the body will tend to fly off at a tangent to the curve of the rotation. This is the active principle of force at work. This inertial tendency upsets the equilibrium of the rotating body, and thus the parts are drawn in towards the centre of the rotating body, which is the passive principle at work. Hence innumerable straight lines constitute the dynamics of active force interacting with the passive force of resistance to produce a curve. It is this principle that underpins the calculus.

Whereas according to Leibniz a substance is that which acts, its essence or 'force field' is modified by the mechanical interaction with other objects in the continuum, that is, by what is spatial through collision.[291] Only in a field undisturbed by collisions will a substance express directly the nature of its internal processes. In a region defined by spatial relations of substances, expression will always be modified by external conditions.

The reader might note that there exists some irregularity in Leibniz's use of the term 'force'. In one sense, force was understood as the relation of pressure to area, such as the force of wind on a set of sails. In the way Leibniz uses the term, force is more closely aligned with the notion of energy. The definition of the term was loose until Newton clarified it in the equation $f = ma$.

5.8 Calculus

Leibniz and Newton are considered to be the two inventors of calculus. Newton discovered and used the calculus nine years prior to Leibniz, in 1666, but Leibniz published his findings using his version of the calculus before Newton, in 1684.

291 Leibniz, 'Correspondence with De Volder', in *Contemplating Music*, Katz & Dalhaus (eds.), 4 vols., Stuyvesant, iii, 1987, p. 439.

A calculated solution is the calculation of change of the path of a moving body that assumes a continuum in space and time. The calculus is used to measure motion in keeping with the concept of inertial, persistent motion and a vanishing point or limit. It employs the Cartesian co-ordinate system of measurement, that is, the conjunction of two axes of measurement, Cartesian geometric principles, and the relatively new concept of the fictional infinitesimal. In the calculus, the power of the system has been increased. As Descartes had shown, the dimensions of two points on a curve determine the slope of the curve at its position on the co-ordinate axis ($y = mx + b$). What cannot be determined by Cartesian geometry is the rate at which instantaneous change occurs. The calculus is used to determine the instantaneous rate of change of a quantity as it moves in relation to another quantity.

The calculus arose from inquiry into the quality of *intensity* of motion.[292] As late as the fourteenth century, force, or internalised impetus, was a kinematic *quality* only, not a quantity; velocity, whether constant or variable, could only be described, not measured. 'Internalised impetus', as mentioned in the third chapter on Aristotle, was attributed to bodies subject to projectile as well as gravitational motion. As such, the degree of 'force' was seen as a modern term for the degree of intensity of the qualities of an event.[293] Leibniz worked with this notion of intensity. He writes: 'But quantity is either extensive or intensive; extensive quantity exists in the number of actions, *intensive* in the magnitude or strength *required to impress* the habit.'[294] Also he writes in a letter to Arnold Eckhard in 1677, '…perfection is the degree or quantity of reality or essence, as *intensity is degree of quality* …[295]

292 Boyer, *The History of the Calculus and its Conceptual Development*, New York, 1949, p. 4.

293 Boudri, 'Force Like Water' in *What Was Mechanical about Mechanics? The Concept of Force between Metaphysics and Mechanics from Newton to LaGrange*, trans. Sen McGlinn, Dordrecht, 2002, pp. 36-7.

294 Leibniz. 'General and Common to All Faculties: On a Basis for Studies in General', ii, p. 136.

295 Leibniz, 'Letter to Arnold Eckhard', i, p. 272.

5.9 Pitch and Force

In Leibniz's approach to the intensity of qualities applied to music, sonic vibrations are primary, calculated as a dynamic force, and hence are conceived in relation to a primary substance. The intensity of the vibration must be in accord with a substantial approach to the concept of pitch. That is, sonic vibrations are constitutive of a pitch whereby infinitesimal changes that occur must remain within the designated area or limit of that pitch. Thus we can picture the particular pitch on an instrument as the interplay of opposing forces in the production of tone, or as the peak and trough of the period of a tone. For any given pitch there is a limit to the vibrations, i.e., the <u>relations</u> of *vis viva/mortua*, or kinetic and potential energy, which can be called that pitch. That is, the relations of *vis viva/mortua* are bounded by the material nature of the instrument and the conventional nature of the pitch. These vibrations must be marshalled and controlled by the instrumentalist in their ebb and flow to conform to that notion.

5.10 The Best of All Possible Worlds

What do the calculus and its associated infinitesimal bring to music? The question carries both a social and a physical/acoustical element. Acoustically, the calculus is a tool that, by measuring the derivative or rate of change of a period in the production of a pitch, may be used to ensure parity between instruments. The theory of the infinitesimal, as Leibniz asserts, does not propose to eradicate all error from the measurement of the derivative, only that the deviation or error will be harmless.

A social analogue to this approach to measurement may be found in the well-tempered scale; its construction by J. S. Bach is co-temporal with the period of

Leibniz's philosophical career. In the well-tempered scale the major third is no longer so sharp and, to the ears of many listeners, its brilliance is sacrificed.[296] But the alternative that arises from well-tempered tuning is that many instruments can be tuned to the same scale, and hence, a greater number of musicians can be employed in the making of music. To Leibniz, the development of the well-tempered instrument and the relative distance of the tones of the well-tempered scale assure a greater socio-economic gain over and above the purity of equal tempering and the restrictions it imposes. In this way the well-tempered scale is an indication of a God who scripts this world as the 'best of all possible worlds'.

5.11 Spatiality and No-Space: Objects, The Musical Surface, and Cognition

Objective Particulars

In the following section I will consider Strawson's account of a type/token method of perception and cognition in contrast with Leibniz's account of 'spatiality' and expression. First I will consider Strawson's account that organises fundamental distinctions in thought that join perception to cognition in the public domain.

Strawson affirms that to counter an ordinary, subjective position of the ordinary music listener, an account of musically 'objective' particulars that are public is required.[297] This requirement can be aligned with the Parmenidean account of objectivity, in which what cannot be thought, cannot be said. These particulars are heard and spoken about publicly, and hence are not particulars private to the listener only.

296 Apel, 'Temperament', *Harvard Dictionary of Music*, 2nd edition, Willi Apel (ed.), Cambridge, Mass., 1969, p. 836. Each of the 12 tones of the chromatic scale in equal temperament is separate by the twelfth root of two or 1.05946 cents.
297 Strawson, pp. 66-8.

The conceptual apparatus of hearing that Strawson is describing requires that listeners are able to distinguish particulars and universals. For example, the reader might imagine a fictional musical type such as Prokoviev's *Peter and the Wolf* in which instances of performances or thematic material in performances are specific instances or tokens. The various themes in *Peter and the Wolf* consist of a group of notes that are re-identifiable as tokens.

The theme itself is a type whose myriad performances are tokens. When we hear the quacking of the duck in the Prokoviev example, it is intended that we hear the tokens of the same type of duck every time in this fiction (it's that duck again!), whether it is in the tree or in the stomach of the wolf. In this common-sense world, the two instances of the duck quacking are merely of the same type.

To extend this example, if the same piece of music is played in two separate venues at the same time, two proposed listeners hear tokens of the same type, Prokoviev's *Peter and the Wolf*, for example, for they are in separate venues hearing separate orchestras.[298] This is a case of separate particulars as tokens. But in the case in which two listeners attend to the same orchestra in a shared venue, they have experienced the same, single type. They should, according to Strawson, be able to discuss the 'objective' particulars of their experience.

The Re-identification of Particulars

There are two elements to the token-type description of hearing. The capacity to re-identify a material particular or token entails the capacity to conceive of a universal type. For example, a performance of a musical work such as *Peter and the Wolf* conducted by Stokowski and played by the Philadelphia Orchestra in June 1971

298 Strawson, pp. 67-8.

is a (hypothetically re-identifiable) token of the universal type that is the written musical work *Peter and the Wolf.*

In applying this distinction to hearing music, the listener's ability to re-identify tokens as belonging to a type is essential. Composers and performers are often generous in the supply of re-identifiable tokens. Repetition of thematic material is often adequate to meet the requirement of re-identification of particulars, in which re-identification is a part of the listener's cognitive apparatus. And in the context of Strawson's account of No-Space, re-identification is a central element in the concept of distance, position, and memory in a world of sound only.

To support his claim that No-Space is subject to cognition, Strawson seeks to account for *unheard* particulars in a discussion of a world of sound only, that is, tones that have escaped detection by the listener. The problem arises in the following scenario. Having heard an opening subject A and a counter-subject D of music type N, we then hear subject A but only parts of counter-subject D towards the close of the work. Some sounds may have occurred very loudly so we miss parts of the repeated subject. We say that parts of D were unheard. Thus we are aware that some particulars may have occurred but were unheard by us. This cognitive condition of knowing, but not remembering, supports the objective nature of particulars in a sound world and the position of the listener in relation to those particulars.

Alternatively, according to Leibniz, if a sound particular escapes unheard by a listener, it would be forgotten and absent from any report he makes. The sound particulars that the listener *has* heard, although possibly incomplete, are the best possible ones to hear.[299] Clearly, in this two-pronged approach to experience, Leibniz puts a 'gloss' on the memory of his experience that would otherwise not be there.

Contrarily, Strawson's account of No-Space turns on unheard particulars, and depends upon such particulars to satisfy his account of the unique spatial dimensions of hearing only. First, because the listener is a non-solipsist, and, by definition, does not have a *use* for sound particulars whether heard or unheard, the sound world is logically separate from the listener.[300] Leibniz's theory of the interconnectedness of all things prohibits the listener from forming such a separate, abstracted world. Second, unheard particulars in No-Space are indicative of a '…systematic kind of relationship' between the listener and the master-sound.[301] If a sound particular goes unheard by the listener, the conclusion is drawn that the listener is not in a position in relation to the master-sound. Strawson writes:

> The pitch of the master-sound at any moment would determine the auditory analogue of *position* in the sound-world at that moment. The sound-world is then conceived of as containing many particulars, unheard at any moment, but audible at other positions than the one occupied at that moment….[302]

That is, the listener's perception is a projection of his position at a given moment. That perception is indicative of his position at that time, yet it is not indicative of his perception for all time.

5.12 Leibniz and Aesthetics

Leibniz sought to create an account of aesthetic value by means of his Principle of Sufficient Reason, the equivalence of cause and effect, and his account of

299 I ask the reader to note that the unheard particulars in this discussion are not the same as the hidden elements of the ratios in Barker's discussion of the Pythagorean intervals in the first chapter.

300 Strawson, p. 72.

301 Strawson, p. 75.

302 Strawson, pp. 77-8.

substances as containing both efficient and final causes. For example, if the instrumentalists play high staccato notes, and the listener feels happy at that time, Leibniz will view those sounds as the cause of the equivalent effect of happiness. The listener may or may not realise the role of the general nature of Leibniz's Principle of Sufficient Reason in explaining the cause of his happiness. In other words, although the timbre of the music may have sounded generally major, in the musical sense of the term, the musical surface and particular instruments contributing to that surface are the dominant influences on the listener at the time.

If we are Leibnizians, then the musical surface the listener hears is an expression of God's rationality in this best of all possible worlds. Further, musical accounts of evil such as *Sonata No. 9 for Piano* by Prokoviev would be incomprehensible to him, for, according to Leibniz, everything that happens does so for a reason, and evil occurs, by definition, without reason. According to Leibniz, what is heard has maximal value and is the most appropriate and best suited to that space and time in the best of all possible worlds.

5.13 Another Metaphysical Approach

I contend that a spatial account of absolute music informs the listener from a comprehensive, 'philosophical' point of view. What is the nature of perception if there is no visual means of locating objects? What are the limits of a world of hearing only? By the action of hearing music without the added faculty of visual location, a considerably different account of music as opposed to the other arts ought to be generated. By exploring the phenomena of this world, philosophers stand to be less confounded by the appearances of music, or polarised in their accounts of music as *either* a language of aesthetic emotion *or* an acoustical science. The aim of listening to music spatially is not to understand musical facts (by this I mean intervals and musical forms) but *to experience aurally the spatial dimensions of a world closely related to, but not sponsored by, the faculty of sight*.

Firstly, I contend that a cognitive, algorithmic account of perceiving musical motion is correlative to a cognitive, algorithmic account of visual perception. The algorithmic process is not complete until the music or the object in view is finished or complete. Secondly, vision is a process informed by surface and light reflection as terminal points; absolute musical space is without reflective surface, and, by the definition of absolute music, that is, composed music free from reference or narrative, absolute musical space is increasingly liberated from surface and contained by timbre as the music unfolds. The cognitive account, that is, an account whereby we can share the particulars of listening experience, is not complete until the listener is satisfied that, by his own judgement, the external spatial dimension has been addressed. That is, that the combined experience of the musical surface, structure, and timbre has been sufficiently incorporated into the listener's experience. It is only then that myriad aesthetic properties such as 'reflective', 'driven', or 'sprightly' can be applied.
Although the experience is shared with others by language, it is not founded on language but on the experience of hearing within the limits of music itself.

5.14 Space and the Diatonic Scale

To bring this discussion of hearing into the realm of the Western diatonic tradition, an explanation of music perception might work in the following way. Per Leibniz, we may *substitute* a tonic and scale system built on integer-based frequency relations in the geometric language of ratios for the Strawsonian master-sound. The analogy of distance, i.e., the system of spatial relations of musical/mathematical bodies in relation to a listener's internal master-sound is externalised as a key signature, although key signature is not a fixed component of a listener's 'hardware'. The intrinsic changes in those bodies or themes over time constitute the experience of music. Listeners pick out sequences of particulars in music and re-identify them in the course of listening. For the duration of a musical work, the analogy of distance from a tonic, and the possible world of changing musical bodies in relation to that tonic constitute the experience of music. Finally, the Pythagorean intervals import infinite depth in the music to that experience.

If we were to seek an even more vivid analogy of hearing music, we could say that music is the spatial relations of human beings or bodies *prior* to speech, when song was an indication of 'how things are'. That is, music is the *internal* position of the listener in relation to a continuous master-sound or tonic. Music is, at the same time, an *external* position as an indication of his relation to a coherent harmonic system or scale, or 'where things are' in an unfolding, geometric, and kinematic space.

CHAPTER 6

NEWTON (1642-1727)[303]

6.1 Theorising Geometry

In this chapter I will present an extended overview of Newton's scientific account and theories and apply these to music. Newton describes his scientific method as 'experimental philosophy' or the derivation of general laws from the facts of experience.[304] The language of geometry in which Newton couched his findings implied a persistent geometric structure to motion in the universe. This structure in no way implies a substance to his argument; what Newton reveals is space as the primary site of rational mechanics. My interest lies in the nature of Newtonian 'absolute' and 'relative' space. I contend that Newton's theory of absolute and relative space presents a Pythagorean universe of fixed geometric relationships conceived as prior to an everyday, lived reality. I will pursue a possible relation between music and space in this model. Further, I will show that such an account can be linked to the perception of music.

Prior to Newton, as has been shown in the studies on Plato, Aristotle, Descartes and Leibniz, two broadly differing assertions had been made on the nature of space. Unlike his immediate predecessor Leibniz, the Newtonian concept of space is not an order of co-existents; Newton reserves the idea of *place* for the ascription of that which is 'ordered' in, and a part of, theoretical absolute and relative space. Newton makes space a priority, taking a particularly spatial approach to metaphysics.

---

303 Unless otherwise indicated, direct quotations from the written works of Newton are referenced from the following edition of Newton's works, *Newton: Philosophical Writings,* Andrew Janiak (ed.), CUP, Cambridge, 2004.
304 Newton, 'Principia', Cambridge, 2004, p. 89.

In a sound-only framework in a Newtonian context, timbre will take precedence as the explanatory medium in theoretically 'absolute' space.

Platonic thought supports geometric laws in absolute space: Aristotelian thought concerns the relative nature of motion in a continuum. The history of metaphysics and the philosophy of science are a history of the analysis and synthesis of these two approaches. Newton shows that both methods are correct in his *Principia* in his theory of gravitational force. This force is an underlying principle of motion, whether in the relations of planets and the Sun, the motion of the tides, or the varieties of motion on the surface of the Earth. Gravitational attraction is a natural phenomenon, subject to definition in space and time, which attracts bodies in planetary motion.

The general theory of gravitational force dispels the super-natural speculations of metaphysics. Newton did not seek an ultimate purpose or limit to what exists such as a *telos* or God. That is, Newton remained unfettered by the substance/accident form of argument. His method was to study the phenomena first and foremost. He chose the method of geometric proportion and its implication of infinite space above algebraic equation and its identifying system of agreement. He preferred to employ a geometric method of construction centred on the construction of curves in a plane rather than algebraic curves centred on the construction of equations. Newton asserts that geometry is united with the study of motions, not constructibility. As he writes:

> For geometry postulates that a beginner has learned to describe lines and circles exactly before he has reached the threshold of geometry, and then it teaches how problems are solved by these operations. To describe straight lines and circles are problems, but not problems in geometry. Geometry postulates the solutions of these problems from mechanics and teaches the use of the problems thus solved. And geometry can boast that with so few principles obtained from other fields, it can do so much. Therefore, geometry is founded on mechanical practice and is nothing other than that part of

universal mechanics that reduces the art of measuring to exact proportions and demonstrations.[305]

That is, by observing mechanical interactions between two or three bodies, Newton claims that an abstract geometric definition best and most lucidly explains these interactions. A Newtonian approach to phenomena and motion does not seek a harmony or concord of thought and experience, as Descartes' emphasis on intuition had claimed. Newton's method is not to make the physical world intuitively rational; it is his interest to perceive the world to be mechanically rational in relative and absolute space.

Although his theory of force transformed natural philosophy into a stronger form of natural science, Newton's findings were not without precedent. From Galileo, Newton adopted the law of inertia as a natural state of motion; from Kepler he adopted the finding that within a system of elliptical rotation such as planetary rotation, a central force will map out equal areas of the circumference in equal times. From dynamical systems that are a causal method of explanation from Aristotle and Leibniz, Newton adopts the notion of attraction and repulsion of planets. The parallelogram law shows us that although planets maintain a reasonably regular path around a central gravitational point of attraction, there is also a natural tendency for a planet to recede from that central force, and to recede from other planets as well.

6.2 Newton and Music

According to Newton's method, it is fitting that the musical scale can be derived mathematically, but heard spatially, for this unites relative and absolute space. After the findings of Galileo, the universe was conceived mathematically. Although

305 Newton, 'Author's Preface to the reader, First Edition: Principia' Cambridge, 2004, pp. 40-1.

Newton's most influential text, *The Principia*, was written in a geometric style, it is clear that the mathematics of the calculus is instrumental in his findings. As noted in the previous chapter, the $\sqrt[12]{2}$ was used to generate a musical scale and to determine the measurements of incremental change in instruments themselves. To the present day there is a mathematical rather than a Pythagorean basis for most, but not all, instrumental tuning. In his article, 'Aesthetics of Music: Limits and Grounds', author Francis Sparshott asserts '…the ratios between frequencies are systematically prior to the absolute magnitude of the frequencies related…to learn music is largely to come to hear tones in terms of this system, as complying with or deviating from these ideal positions.' [306] That is, the ratio 2:1 is prior to a performed octave, and hence a geometric account of sound is a suitable account of musical intervals, rather than the empirical measurement of intervals in cents.

6.3 Geometry and Abstraction

For Newton, geometry is the language of abstraction. In *The Principia* (1687) Newton presents the laws of motion in the language of geometry and mathematics, without an intervening step concerning variables and line segments as Descartes had done. By employing variables and equations, Newton claims that the Cartesian advocate has merely achieved a mechanical aptitude, harmony, or 'agreement' with the use of tools of construction and the concept of extension. Newton's astounding achievements are tempered by his own acknowledgement that the laws he determined are *idealisations* of the motions of terrestrial and planetary phenomena. Newton wrote in his Preface to the First Edition of *The Principia* (1687):

---

306 Sparshott, 'Aesthetics of Music: Limits and Grounds', in *What is Music?,* Alperson (ed.), University Park, Pennsylvania, 1987, p. 46.

> Therefore geometry is founded on mechanical practice and is nothing other than that part of the universal mechanics which reduces the art of measuring to exact propositions and demonstrations…Geometry is commonly used in reference to magnitude, and mechanics in reference to motion…In this sense *rational mechanics* will be the science, expressed in exact propositions and demonstrations, of the motions that result from any forces whatever and of the forces that are required for any motions whatever.[307]

Domski notes that Descartes had limited analytic geometry to algebraic curves with a corresponding closed, equation-based polynomial. Non-algebraic, 'transcendental' curves were beyond the scope of study for Descartes.[308] That is, although Descartes' analytic geometry goes to some length, as it were, to understand clearly and distinctly the nature of phenomena, the Cartesian method does not go far enough. The problem is perhaps better elucidated in a musical format as follows.

As discussed in the fourth chapter, harmonic agreement as evidenced in the overtone series of a given tone is an example of the Cartesian concept of the extended structure of space. According to Descartes, the intuition grasps clearly and distinctly a consonant chord such as a D major chord, built on the extension of the tone of 'D', that is constituted by the initial few elements of the harmonic series (D, A, and F#). The chord is easily assimilated by the intuition as it is consonant and in harmonic agreement with the fundamental tone. The full extent of a tone's harmonic series is the timbre and the 'proper motion' of a tone guaranteed by God. Hence the primary function that relates the intuition to extended space is 'agreement'. An analogous point may be made concerning Descartes' method of analytic geometry. Descartes' study of space is limited to points of agreement on a graph rather than based on observations of motion in a framework of infinite space.

307 Newton, 'Author's Preface to the Reader, First Edition: Principia', Cambridge, 2004, p. 41.

308 Domski, 'The Constructible and the Intelligible in Newton's Philosophy of Geometry', Dept. of History and Philosophy of Science, Bloomington, <http://www.philsci-archive.pitt.edu/archive/00001063/>, accessed 3/10/2006.

6.4 Newton's Laws of Motion: Absolute Space and Extension [309]

First Law: The Law of Inertia: Every body perseveres in its state of being at rest or of uniform motion in a right (straight) line, unless it is compelled to change that state by forces impressed upon it.

Second Law: The Definition of Force: The change of motion is proportional to the motive force impressed; and is made in the direction of the right (straight) line in which the force is impressed.

Third Law: The Action-Reaction Principle: To every action there is always opposed an equal reaction; or the mutual actions of two bodies on each other are always equal, and directed to contrary parts.[310]

The Newtonian theory of absolute space rests upon these laws of motion. In terms of an absolute space, the theory suggests that there is a realm of infinite space that is planetary in which the motions of the planets is persistent, regular, and explicable by reason. Briefly transferring his thought to a relation of music and space, Newton reinstates Plato's views of Pythagorean geometry and the foundation of the musical scale that delineate proportions in the infinite depth of *chora*.[311]

Newton asserts that absolute space is present to the understanding in an ascent to his definition of space. Citing a familiar argument from the atomist Leucippus, Newton claims that although we cannot imagine infinite space, we can understand an ever-increasing extent of space.[312] Further, in an assertion reminiscent of Descartes' *Third Meditation* (§4.6.3, p. 110), he claims we might understand an infinite being or

309 The formulation of Newton's laws has been quoted from the following address: Author unacknowledged,' The Transition From Aristotle to Newton' in *The Study of Space and Time*, <http://chandra.bgsu.edu/~God/Spacetime6.html>, accessed 11/10/2002.

310 Wolfe, 'Gravity, Newton's laws of motion and the orbits of the planets', < http://www.phys.unsw.edu.au/~jw/gravity.html>, accessed 15/10/2006.

311 Bowman, *Philosophical Perspectives on Music*, Oxford, 1998, p.37.

312 Newton, 'De Gravitatione', Cambridge, 2004, p. 24.

space as a site of unlimited attributes unfettered by negative constraints or limits. By these statements Newton brings to the mind an idea of infinite geometric space.[313]

It is a part of Newton's theory that geometrically abstract, absolute, ethereal space is theoretically divisible into surfaces of shapes, lines, and points, all of which are contiguous in absolute space. That is, space is 'full' and 'revealed' in the motion of bodies. Recalling Plato, there is 'enough room' for bodies that already occupy space and those that are yet to come to be. Absolute, choric space exists prior to the bodies that enter it. Newton writes:

> We firmly believe that the space was spherical before the sphere occupied it, so that it could contain the sphere; and hence as there are everywhere space that can adequately contain any material sphere, it is clear that space is everywhere spherical. And so of other figures.[314]

In the metaphysical account of 'absolute' space by Isaac Newton, we arrive at a conception of a realm that is reminiscent of the Platonic, geometric *chora*. That is, Newton posits a theoretical 'absolute' that suggests a rational structure to the flurry and chaos of motion on earth. The absolute space in which earthly and planetary motions occur is an infinite aether, limited by the demands of rational thought and the laws of Euclidean geometry.[315] Like the Platonic *chora*, Newton's theoretical absolute space is an ideal medium that conforms to the shape of the body that enters it, prior to its entry. All manner of figures are *of* space; infinite, absolute space is harmonious because it is rational. Yet this description of space also runs a line very close to Aristotle's theory of function and his argument from *choriston*. The listener

313 Newton, 'De Gravitatione', Cambridge, 2004, p. 23.

314 Newton, 'De Gravitatione', Cambridge, 2004, p. 23.

315 Huggett, Nick and Carl Hoefer, "Absolute and Relational Theories of Motion", *The Stanford Encyclopedia of Philosophy (Fall 2006 edition),* Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/fall2006/entries/spacetime-theories/, accessed, 30/1/2007.

need not take Newton's position to the point at which musical space is locatable, as if there were something sensible *in* music that can be located *in* space. Space is not rational because it is related to geometric shapes. Space is rational *prior* to its relation to bodies.

6.5 Absolute and Relative Space

There are two important levers to Newtonian 'absolute' space. The first is an erasure of the role of impressed force. There is neither a force of attraction nor a constant acceleration at which objects fall.[316] In his theory of absolute, infinite space, 'absolute' places as regions of absolute space are fixed. They are parts of space that have duration and position.[317] The order of position of places in absolute space is immutable. The second lever in his theory of absolute space is his assertion of inertia. The 'absolute' motion of bodies in relation to Newtonian absolute space is an ideal and abstract situation. The idea of the motion of bodies in absolute space itself is misguided, for Newton has affirmed that the absolute is fixed, immutable, and unchanging. Therefore, *relative* to 'absolute' space, bodies move without interference, at their 'true' acceleration.[318]

Relative space, according to Newton, is a mathematical and physical assumption we make whereby measurements of rest and motion are calculated relative to a moving body such as the earth.[319] Such measurements are adequate for every-day use that pertains to observable phenomena, such as the surfaces of bodies.

---

316 DiSalle, 'Newton's Philosophical Analysis of Space and Time', in *The Cambridge Companion to Newton*, I. Bernard Cohen & George E. Smith (eds.), Cambridge, 2002, p. 35.

317 Newton, 'De Gravitatione', Cambridge, 2004, p. 25.

318 Newton, 'Fundamental Principles of Natural Philosophy', in *Theories of the Universe*, Milton Munitz (ed.), New York, 1957, p. 205-6.

319 Newton is shown to have invented the infinitesimal calculus. His method was informed by the 'fluents' and 'fluxions' of moving bodies. Leibniz published his method of the calculus before Newton.

There is a further justification for Newton's approach from the highly abstract to the phenomenal, or his accounts of absolute and relative space. As much as the geometer theorises on the abstract, at the same time he exists in the phenomenal world, likewise, absolute and relative space both exist concurrently as well. Bodies move in relative space. Bodies also move relative to absolute space. For example, the reader might imagine a region of air that moves in relation to the earth's surface and the motion of that planet, perhaps due to changes in the earth's temperature. That same region of air also moves in relation to absolute space. This is the relation that Newton's theory of force addresses geometrically.

The challenge Newton sets himself is to show that absolute and relative spaces are two frameworks adequate to the laws of motion of bodies. These two frameworks have no immediate impact upon those bodies, and therefore do not explain the surface of bodies; yet they affect all existing things.[320] The success of his argument shows that gravitational force is a universal law throughout the universe.

6.6 The Globe Experiment

Newton offers proof of the existence of absolute space in two famous experiments, the rotating bucket and the two globes. [321] I will focus on the second proof of absolute space in the two-globe thought experiment, and how it may apply to music, listening, and absolute space. Newton proposes the following thought experiment in his *Scholia to The Principia*:

320 Stein, 'Newton's Metaphysics' in *The Cambridge Companion to Newton*, I. Bernard Cohen, George E. Smith (eds.), Cambridge, UK, 2002, p. 272.

321 Huggett, Nick and Carl Hoefer, "Absolute and Relational Theories of Space and Motion", *The Stanford Encyclopedia of Philosophy (Fall 2006 Edition),* Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2006/entries/spacetime-theories/>, p. 5, accessed 30/1/2007.

> For it is possible to draw evidence partly from apparent motions, which are the differences between the true motions, and partly from the forces that are the causes and effects of the true motions. For example, if two globes, at a given distance from each other with a cord connecting them, were revolving about a common centre of gravity, the endeavour of the globes to recede from the axis of motion could be known from the tension of the cord, and thus the quantity of circular motion could be computed. Then, if any equal forces were similarly impressed upon the alternate faces of the globes to increase or decrease their circular motion, the increase or decrease of the motion could be known from the increased or decreased tension of the cord, and thus, finally, it could be discovered which faces of the globes the forces would have to be impressed upon for a maximum increase in the motion, that is, which were the posterior faces, or the ones that are in the rear of the circular motion. Further, once the faces that follow and the opposite faces that precede were known, the direction of the motion would be known. In this way both the quantity and the direction of this circular motion could be found in any immense vacuum, where nothing external and sensible existed with which the globes could be compared.[322]

This thought experiment involves absolute motion or acceleration in which the centre of the cord is the centre of gravity; it connects the two globes and does not move. Further, the globes are not subject to gravitational attraction as they would be in relative space; that is, there is no relative measurement or up and down in this experiment, only circular paths. In absolute space, the centre of gravity would be the reference point of the 'absolute' motions.

The experiment is measurable as the tension and relaxation of inertial bodies and forces in absolute space. At the centre of the cord, measurements are made of the forces of acceleration and inertia exerted by the globes as they recede from one another. With the application of a very slight increase in weight, the direction of the globes may be discerned through the increase or decrease in the acceleration.

322 Newton, 'Scholium to The Principia', Cambridge, 2004, p. 70.

6.7 Music and The Globe Experiment

An analogy of this experiment may be made in a musical format. The setting of the experiment is an enclosed concert venue, a fixed frame in this experiment, in which sounds travel at speed and reverberate off the walls of the venue. The speed at which this happens is beyond the capacity of the listener to grasp; hence we may say simply that the sounds travel at speed. The dimensions of the enclosed space have some bearing on the density of the sound, or degree of reverberation; but here we may say that the dimensions are adequate for the sounds to be heard completely without overwhelming the listener. Were some sounds to adapt fully to the density of the venue, they would be seemingly without pitch or impenetrability. Likewise, some sounds may be so low they might only reverberate through the floor. These descriptions of pitch are analogous to the experiments of increase and decrease of acceleration in the globe experiment. That is, in ordinary circumstances the pitch would be accelerating at the speed of sound or decelerating in a negative direction. We may assume that the sounds are accelerating at a speed at which they are audible for the ordinary listener. Our perception of music is this dynamic of the tension and relaxation of increasing and decreasing acceleration.

The musical bodies or globes have weight proportional to the centre of gravity at the mid-point of the cords. At the centre of cord that connects the globes or bodies of sound we may project the listener. The listener is at the centre of gravity; he is the *cognitive* arbiter of the tension or relaxation of the cords that connect the globes or the pitch weight and acceleration of the musical bodies. The total impressed force of the music may be simply the relation of pitch/timbre and mass/acceleration in two moving bodies around a fixed centre.

6.8 *De Gravitatione*

In *De Gravitatione*, Newton proposes a metaphysical substrate to the theory of force. He outlines the attributes of infinite, rational geometric space that are immediate to the senses as bodies. That is, Newton invests in an account of bodies without reference to 'being a substance'. Beyond this structural approach to space Newton is unwilling to venture, for he is decisive in making an account of only the 'substantiality' of spatial attributes.[323] Here Newton considers a hypothetical body as created by God in a system of absolute and relative motion. Such a non-substantial body is identifiable in space from the evidence of the senses; it is has the quality of impenetrability; it is visible, opaque, coloured due to reflection of light, and is subject to percussion. Extension is viewed here as a field of impenetrability or surface. Newton writes:

> 'It is unnecessary to feign some unintelligible substance to be given in which as in a subject a substantial form should inhere; extension and an act of the divine will suffice. Extension takes the place of the substantial subject in which the form of the body is conserved by the divine will…'[324]

To support this position, Newton makes a veiled reference to the calculus, in which he notes that we can determine finite quantities of infinite surfaces and solids.[325] That is, by employing the infinitesimal calculus we can gain a grasp of the infinite within the limits of the finite.

In *De Gravitatione* Newton also addresses his opponents' theories, in particular, Descartes'. His most searing criticism of Cartesian extension and purely

323 Stein, 'Newton's Metaphysics' in *The Cambridge Companion to Newton*, I. Bernard Cohen, George E. Smith (eds.), Cambridge, UK, 2002, p. 281.

324 Stein 'Newton's Metaphysics' in *The Cambridge Companion to Newton*, I. Bernard Cohen, George E. Smith (eds.), Cambridge, 2002. p. 278.

325 Newton, 'De Gravitatione', Cambridge, 2004, p. 24.

local motion is that we cannot re-identify particulars. Once a body, or a part of a body, has engaged in motion in Cartesian extension, Newton claims that we cannot identify where its origin is, for the surrounding bodies have moved and the originating position is no longer present.[326] Accompanying the loss of origin is the loss of the body's length of extension traversed. Hence the body has no velocity. Further, there would be no parts to the space traversed, for there was no beginning to the observed motion. Newton writes; 'It follows indubitably that Cartesian motion is not motion, for it has no velocity, no determination, and there is no space or distance traversed by it.'[327] In his estimation, Descartes has created a theory of motion around a concept that has only a purely mental content. Newton himself claims that his own theory is based in reality, for the calculus can identify the source, the motion, and the path of the body.[328]

In his article 'Newton's Metaphysics', author Howard Stein attests to Newton's point of view: 'As approaching a substance, space needs no 'subject' to 'support' its existence.' [329] Marr's theory of 2 1/2-dimensional space is linked to this notion of space 'approaching' a substance. A drama *unfolds* scripted by the laws of motion rather than static geometric Forms. Space is real: it is the site of forces and bodies in the universe. Space, Newton claims, is neither substance nor accident. [330] It is not a substance, for a substance acts. It is not an accident, for it does not perish with

326 Newton, 'De Gravitatione', Cambridge, 2004, p. 19.

327 Newton, 'De Gravitatione', Cambridge, 2004, p. 20.

328 Stein, 'Newton's Metaphysics', in *The Cambridge Companion to Newton*, I. Bernard Cohen & George E. Smith (eds.), Cambridge, 2002, p. 266.

329 Stein, 'Newton's Metaphysics', in The Cambridge Companion to Newton, I. Bernard Cohen, George E. Smith (eds.), Cambridge, 2002, p. 267.

330 Newton, 'De Gravitatione', Cambridge, 2004, p. 21.

a body that formerly occupied it. Space is certainly no accident, but more importantly, it is not 'nothing'.[331]

In the following section I will consider Newton's notion of gravity, mass, and acceleration as a method of conceiving of a body and motion of attraction and repulsion in absolute and relative space. This will then lead us to Newton's experiments that he believed supported the notion of absolute space. My interest is to note the way in which music may be viewed in these ways. Finally, a further investigation of the idea of the absolute will conclude this chapter.

Body, Space, Force, and Motion

In *De Gravitatione* Newton makes clear and concise statements concerning space, place, force, and motion. He spells out as clearly as possible the relation of body to space as follows. Parts of bodies adhere to the body as a whole. When a body moves, its parts move with it in relation to its surface. Hence, surfaces of planets don't peel away as they move in an inertial motion around the Sun. He writes further:

> Definition 1. Place is a part of space which something fills completely.
> Definition 2. Body is that which fills place.
> Definition 3. Rest is remaining in the same place.
> Definition 4. Motion is change of place.
> Definition 5. Force is the causal principle of motion and rest. And it is either an external one that generates, destroys, or otherwise changes impressed motion in some body, or it is an internal principle by which existing motion or rest is conserved in a body, and by which any being endeavours to continue in its state and opposes resistance. [332]

331 Newton, 'De Gravitatione', Cambridge, 2004, p. 22.
332 Newton, 'De Gravitatione' Cambridge, 2004, p. 13.

‘Force is a cause of motion’ is echoed in various guises in Aristotle, Leibniz, Descartes, Galileo, and many others. Newton echoes their position in Definition 5 in which he affirms that the dynamics of resistance and momentum explain inertia. Newton viewed inertia as a force rather than a state of affairs.[333] Assuming that space and impenetrable bodies are the sites of forces that cause motion, Newton’s laws of motion are definitive of the mechanical relations between bodies, and between bodies and space. Newton’s crowning achievement was to discover gravity in this theory and present its role in terrestrial and planetary motion. He integrated gravity as a force of attraction between bodies and as a force in the relations of the mass of a body in rotation around another body into a greater framework of universal mechanics. That is, the force of the motion of a planet circling the sun is discoverable by multiplying its mass by acceleration. There is a tendency in a planet to recede from this centripetal action by virtue of the parallelogram law. He related force to distance by a theory of a gravitational centre and the law of the inverse square.[334] Nonetheless, Newton could only appeal for the existence of gravity as it was conceived in absolute space. He supposed it to be an element of an enveloping aether, for he did not hold a theory of action-at-a-distance.

6.9 Music in Three Dimensions

Having established that Newton’s metaphysics, that is, his account of space and geometry, models the Pythagorean intervals and a ‘harmony of the spheres’, there is a further question that may be considered. Does Newton’s three-dimensional account of space that accounts for the qualities of a body serve music perception? Concerning perception, Newton affirms that God’s nature is an allegory of human

333 Cohen, ‘Newton’s Concepts of Force and Mass’, in The Cambridge Companion to Newton, Cambridge, 2002, pp. 60-1.
334 Cf., p. 143.

nature in a mechanical universe. [335] The world of phenomena and change is a lesser version of God's 'sensorium', that is, the 'place in the head where we see images produced by the brain'.[336] It appears that God does not require a developing internal image in order to perceive phenomena. As Newton writes:

> …does it not appear from phenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite space, as it were in his Sensory, perceives things intimately, and thoroughly perceives them, and comprehends them wholly by their *immediate* presence to himself; of which things the images only carried through the organs of sense into our little sensoriums, are there *seen* and beheld by that which in us perceives and thinks.[337]

According to the argument of this thesis, to explore perception is to find analogies of Newtonian mechanics in musical sound. It is simple enough to explore the production of sound on an instrument using Newtonian mechanics. Newton himself noted that sound travelled in waves. He studied sound in the last section of the Third Book of the *Principia* in which he devised a theory of the speed of sound very close to the generally accepted version.[338] This will be considered firstly. Secondly, the perception of sound and Newton's theory of absolute space will be considered.
In order to remain aligned with the body of Newton's thought, I will view the music in general as analogous to an interaction of forces. We may look to the first two laws of motion for the necessary analogies.

As previously noted, the first law of motion concerns inertia, and is founded upon resistance and momentum. While these are not spatial qualities, they are

335 Newton, 'Book Three: The Systems of the World, Rule 4, in Principia', Cambridge, 2004, p. 92.
336 Tamny, 'Newton, Creation, and Perception' in *Isis,* v. 70, No. 1, March 1979, <http://links.jstor.org/sici?sici=0021-1753(197903)70%3A1%3C48%3ANCA%3E2.0.CO%3B2-O>, accessed 7/1/2008, p. 55.
337 Newton, 'Queries to the Opticks: Query 28', Cambridge, 2004, p. 130.
338 S. Chandrasekhar, *Newton's Principia for the Common Reader*, Oxford, 1995, p. 592. In the Third Edition of The Principia Newton noted that the speed of sound was 1142 English feet or 1070 French feet per second. The modern measure of the speed of sound is 1100 feet or 340 metres per second.

dynamic elements that can be measured spatially. We may further consider timbre to consist of inertial particles in the everyday world. If we imagine a bullroarer, then by the action of twirling and thus exerting a force upon air, particles are compressed and released in patterns of momentum and resistance. This mimics the effect of an impressed force on an inertial object. If the music is a non-stop event, then the force may not be impressed but continuous. Nevertheless, per the parallelogram rule, the dynamic motion or frequency of the sound is still a factor in its overall motion.[339] If we consider the bullroarer again, when the force causes a body to rotate continuously, then the body accelerates constantly in the direction of that force in a right straight line tangential to the curved line of rotation. Also, the rate of acceleration is proportional to the strength of the force exerted. As the bullroarer spins faster, its acceleration is positive, and as it slows, its acceleration is negative. Hence in a friction-free environment, the acceleration is proportional to the force.

In the next step we can more fully account for musical motion. We can abandon the bullroarer and adopt an enclosed tube such as a flute in which we consider the mass of a sound as an analogue of the mass of a body. The mass is the density of a volume of a material body or the amount of material it holds; its analogue in sound is pitch and is measured by frequency vibrations.[340] The patterns of frequency that form the pitch are inversely proportional to the length of the vibrating string or pipe. That is, there is a certain mass of air that escapes as pitch. If too much or not enough air is blown through the tube, the pitch will not present.

In a Newtonian framework, timbre and pitch correlate to inertia, acceleration, and mass. Let the inertial quality be reduced to an infinitesimally small limit. The force applied to produce a pitch also causes the acceleration of the timbre, or $f = ma$.

339 Cohen, 'Newton's Concepts of Force and Mass', in The Cambridge Companion to Newton, Cambridge, 2002, p. 66.
340 Johnston, Measured Tones, Bristol, New York, 1989, pp. 30-31.

The timbre consists of the proportion of the basic pitch and the particular harmonic overtones that occur at that given pitch. In addition to timbre, there is a degree of volume or density of sound due to the amplitude of the sound waves. It seems that as sounds become louder, the music is approaching, and conversely, as the sounds soften, the music is receding. But this account of *nearer to* and *further from* answers only the perception of sound, and not a concept of distance in the theory of the musical scale.

6.10 Timbre and The Pythagorean Intervals

Again the question arises, what do the Pythagorean intervals import to the theory and perception of music? My contention is that they import infinite depth to the perception of musical motion.

In his article 'Newton, Creation, and Perception', author Martin Tamny writes that Newton held the opinion that absolute perception was possible if one accepted that God was all-powerful, and could manipulate both space and time.[341] However a problem arises in this notion of absolute perception. One would be mistaken in his perception if he believed that a space was inextricably linked to God's will and immune from forces of motion. In Newton's scenario, God becomes the composer of the moment-to-moment flow of events *and* the way they are perceived. For example, one can imagine a group of people who worship a mountain that is believed to capture the sacred. Such a sacred place explained by Newton's theory of perception would invent sacred space and place from one moment to the next. But this is impossible, for the surface of the earth itself is in motion; continents are pushing into each other and changing the surface of the planet. A seemingly sacred mountain may be believed to

341 Tamny, 'Newton, Creation, and Perception' in *Isis*, v. 70, No. 1, March 1979, <http://links.jstor.org/sici?sici=0021-1753(197903)70%3A1%3C48%3ANCA%3E2.0.CO%3B2-O>, accessed 7/1/2008, p. 50.

be singular and unaffected by ordinary forces; yet it is subject to the same shifts and upheavals as other places on the earth's surface. A place may be a part of space, but the laws of motion are prior to our perception or beliefs 'about' it.

In the reconciliation of theories of music and space with theories of perception, I contend that the Pythagorean intervals import not only the distance relation upon which the musical scale is constructed, but also the perception of an analogy of infinite depth in the vanishing limit of that pitch. That is, in a Newtonian framework, we can allow the pitch to vanish to zero and note the timbre that remains. In focussing on timbre, the listener takes note of what lingers in the moments after the passing of tones. The relationships the listener perceives are spatial; the dynamics of the pitch, the clarity of the intervals and their relation to what has gone before, and most importantly, the way in which the timbre of the sounds forges an infinite, geometric, sound world.

6.11 Galilean Relativity

In this chapter, as throughout the rest of the thesis, I have chosen to focus upon the experience of the listener. My claim is that the listener ought to be a non-solipsist if he is to hear music in a construction of infinite depth. Ultimately, in the accounts of listening either spatially or causally, whether the listener is non-solipsistic or a solipsist, the accounts are similar. This is explained by a further facet of Newton's spatial theory, that is, the Galilean theory of the relativity of inertial frames. We cannot know the absolute nature of inertial frames, such as this 4-dimensional frame that we inhabit. The construction of two separate, inertial frames of reference, absolute and relative space, created problems for Newton. Any frame of inertial motion will contain the same physical interactions as another frame whether that frame is in uniform rectilinear motion or at 'absolute' rest, and hence there are an infinite number of frames that may suit Newton's requirements. [342] Newton admits the role of theory and abstraction in his thought is contestable, yet unavoidable. We *cannot know* for a fact from this regional vantage point and the evidence of the positions of phenomenal bodies if there exists in this universe a single body that *is* at absolute rest that may serve as a reference point. As Newton writes:

> For from the positions and distances of things from any body considered as immovable we define all places; and then, with respect to such places, we estimate all motions, considering bodies as transferred from some of those places into others. And so, instead of absolute places and motions, we use relative ones, and that without any inconvenience in common affairs; but in philosophical disquisitions, we ought to abstract from our senses and consider things themselves, distinct from what are only sensible measures of them. For it may be that there is no body really at rest to which places and motions of others may be referred.[343]

6.7 Strawson

In this section I will discuss Newtonian theories of space and gravity in relation to Strawson's view of a master-sound, and the analogy of distance. In Strawson's framework, pitch is the conscious continuum and the gravitational equivalent of the mental motions of the conscious listener, that is, the dynamic motions of attraction and repulsion. Strawson suggests that it is the master-sound as pitch that permits the analogy of distance in the case of perception, and the explanation of heard and unheard particulars in the broader framework of a workable system of particulars and universals.

342 Janiak, Andrew, "Newton's Philosophy", *The Stanford Encyclopedia of Philosophy (Winter 2006 Edition),* Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/win2006/entries/newton-philosophy/, p. 3, accessed 24/2/2007.

343 Newton, 'Fundamental Principles of Philosophy', in *Theories of the Universe*, Milton Munitz (ed.), London, 1957, p. 204.

Applying a Newtonian theory of bodies and motion to Strawson's hypothetical account, it is clear that the master-sound is constituted by pitch and timbre, and defined by a law of inertia. It persists in its state of motion, changes speed and direction due to impressed forces, but is central in maintaining the *analogy* of position of the listener relative to an object in a world without spatial location (see quote from Strawson, §5.10, p. 146).

Concomitant to the problem of relative frames of reference in Newton's mechanics, there is no ultimate referent in Strawson's account of hearing. The master-sound is an analogy of the conscious listener who re-identifies particulars repeatedly, grasps a system in which some particulars occur without his hearing them, and in that way, gauges space as distance between himself and the music, as well as between thematic bodies themselves.

My claim concerning music's ineffability is that a perception of the infinite depth of space is correlative to a perception of timbre in Western classical orchestral music in the resonance of naturally fading Pythagorean intervals. It is because we as listeners gain a phenomenological experience of infinite, geometric, and kinematic space that music is described as ineffable. In a framework of Newtonian mechanics, what remains as a pitch fades is timbre. Timbre presents the positive acceleration of a shape that vanishes to the infinitesimally small as it approaches zero. Further, if we apply Strawson's criteria of a distance analogy to musical sound perception, timbre is the interest of the listener who would seek to 'position' his experience in relation to depth of the timbre of the music.

CONCLUSION

In this thesis I have addressed the moment and the timbre of Western orchestral music in the diatonic tradition. My approach has culminated in the claim that a spatial account of music points to the ineffability of music. A spatial account is complex, including perception in 2 1/2 and 3 dimensional space of objective, immaterial particulars whose timbre is, at times, of infinite depth. The sound indicative of the greatest depth is the sound of the Pythagorean intervals heard in an orchestral setting in an enclosed concert venue. A spatial account of hearing is persuasive as it addresses the ineffability of music. The process of hearing is aimed towards a formal grasp of a group of tones, but may never *fully* achieve that goal due to the transient nature of music. I have argued that the phenomenological process of hearing that brackets out language and the peripheral elements of musical sound are spatial in an intermediate dimension of 'coming-to-be'. My further claim is that an internal perception of the infinite depth of space is correlative to a perception of timbre in the resonance of naturally fading Pythagorean intervals. I hold that this connection of music and infinite space qualifies as metaphysical and ineffable, as it is internal to music, as well as a unique experience of inner spatial perception.

The aim of this thesis has been to build the conditions whereby this is revealed to the ordinary listener. Hence my account of listening has not sought an extra-musical explanation of hearing music, nor have I restructured what the listener hears in the first instance. Instead I have focussed upon the nature and process of hearing and the result of that process. By the criteria of depth, and infinite depth, I have aimed to achieve Aristotle's desire for 'correct' judgements of music that assess 'true pleasure…from hearing others…' under conditions that are sound and persuasive.

I have traced opposing physical and metaphysical accounts of the structure of space, of space and place, *chora* and *topos*, function and dynamics, and the gradual development of fundamental laws of physical motion, culminating in Newton's theory of 'absolute' and relative space and gravitational force. The parallel argument in music has concerned the possibility of a rational substrate that gives depth to the surface motion of music. I have argued that this is the role of timbre. The timbre of a perfect interval is geometrically and mathematically sound. The frequency of vibration over one period in an octave is inversely proportional to its geometric construction on the monochord. The vibrations import a persistent function of depth, even infinite depth according to Plato and the Pythagoreans, to otherwise transient music.

Further I have argued that the nature of the listener is cognitive. Although I have not ruled out the presence of the emotions in hearing music, I have chosen to emphasise cognition to a greater extent. A cognitive account of hearing music insures that a listener assesses similarities in a musical work as 'that again', that he groups tones into wholes, perceives changes in those wholes, and re-identifies particulars. I have stipulated that the sort of music that is subject to my inquiry is absolute music. The challenge in hearing this kind of music cognitively is that the information in hearing the music is not processed by spatial location. In a world that is increasingly devoted to the data of sight, an emphasis on hearing alone serves to heighten interest in the *full* capacity of the human mind.

In making these claims about music perception and space, I have explored the claims of others concerning these areas, including Aristotle, Descartes, Leibniz, Newton, and Plato.

What Plato brings to this topic is the importance of distance, not only the conceptual distance one must travel to grasp a concept or a Form, but also the practice of geometry, the method of measuring distances on the surface of shapes and between shapes; finding patterns amongst shapes; and deriving conclusions, axioms, or laws from those relations. Plato's theory of Ideal Forms imports 'structure' to space. His concept of *chora* both contains and presents qualities in infinite space that are described by geometry. Plato employed metaphorical language in his claim that philosophy is the highest music, and made no connection between *harmonia* and hearing the Pythagorean intervals. For Plato, music performed by musicians was about human gestures. Thus the theory of the Pythagorean intervals remained an elusive theory.

Aristotle originally applied the term 'natural philosophy' to inquiries about the everyday world. A fundamental question in his philosophy concerned an intelligible empirical reality that was centred on the term 'substance' and the causes of motion. Aristotelian motion was understood to be sensible, that is, it could be sensed on the surface of a thing and further explained by a dynamic of cause and effect. Motion or change of place situates a substance relative to an Unmoved Mover and is central to Aristotle's account of 'being'. Such an approach to music leads to two problems, the like/like nature of soul in relation to the music, and the theory that understanding and expressing oneself musically is like understanding and expressing oneself in language. Generally I have argued that a substantival account of music leads the listener to an impasse in which he searches for 'place' as a goal he listens 'for' in the music. In so doing, the listener finds a cause for his emotional experience. I argue that he fails to hear the complexity in the music in parts that he hasn't listened 'for', and has not heard the music as a whole, spatially designed world.

Further, in a functional approach to the relation of music and the use of language that is derived from an Aristotelian account of cause and effect, I find that the proposed relation does not address hearing music due to its emphasis on the trained musician's intuition, instrument experience, and sense of rhythm. A functional account does not adequately address the listening experience of an ordinary listener, who does not have the benefit of a music education to bring to listening experience.

Both Aristotle and Descartes conceived motion as *local* motion. Descartes viewed motion as a geometric function that can be mapped onto a co-ordinate system of points. The overtone series presents timbre as an internal relation of a tone, and thus the tone is available to the intellect by both intuition and deduction. Descartes finds that even an immaterial body such as a musical tone has spatial extension that is internal to it subject to description by laws of geometry and algebra. Such joint physical and conceptual versions of space are further explored in the dynamics and spatiality of Leibniz, and dynamics in 'absolute' space in Newton.

Descartes argues in *Meditations* for the 'cogito', that is, that only thought is a persistent substance that is true; the external world is subject to radical doubt. The circular argument then unfolds. The intellect is a function of thought that is unextended, immaterial, and guaranteed in the infinite nature of a Cartesian God; the intellect is distinct from the body whose essence is material, extended, and under the influence of God as the conservator of energy. Hence the only things that we are duly cognisant of as evidence of our true perceptions are those things in the world with extension. Unfortunately for music this led Descartes to emphasise tones that 'agree' as a reflection of true perception in space; and further, his method of spatial location is a strong argument for a Cartesian co-ordinate system of identifying music.

Nevertheless, Descartes' solipsistic approach shows that the perceptions of space and objects in space are a function of 'my' intellect, and, provided that such an account is offered of the geometric nature of space, space and infinite depth is intrinsic to a study of the musical scale.

I have argued that Leibniz's account of dynamics and spatiality directed inner perception outwards towards a 'cosmic harmony' expressive of his view of the nature of God. That is, there is a limit even to the extent to which Leibniz will allow the inner perception of depth before that perception is externalised on the surface, and thus becomes another element in the spatial order of things. During Leibniz's lifetime, the full 12-tone, well-tempered musical scale was scripted by mathematical relations ($\sqrt[12]{2}$), rather than the previously held geometric relations. With the advent of precise measurement of scalar relations also came the modern form of key signature, as well the precise construction of musical instruments. Clearly the pleasure of music gained strength in the Enlightenment period.

Binary systems of language and concept formation, the calculus, and the fundamentally mathematical nature of the universe are three predominant modes of explanation for Leibniz. I have argued that what was lacking in Leibniz's notion of spatiality and its relation to music was the depth and complexity imported by geometry and its system of theorems, axioms, and proofs.

Newton adopted geometry as the language of motion in the universe. In this thesis I have shown that the Newtonian model of 'absolute' space describes music. Beginning with a basic model of motion around a central point, Newton was able to formulate the theory of gravitational force and planetary motion around the Sun. As such, the 'harmony of the spheres' was vindicated by Newton in the original language of geometry set forth by Plato and the Pythagoreans. Music is described by analogy with the physical elements of force, mass, and acceleration in three-dimensional space, as well as by Newton's metaphysical theory of 'absolute', infinite, immutable space.

Throughout this thesis I have looked at music with a view to clarifying what is reliable and effective about music in order to devise an adequate analytic account suitable for further philosophical inquiry. In a study of the history of physics, metaphysics, and philosophy I have shown that the relation of music and space is pivotal in making sense of music, that is, music is the internal ordering of sounds that define and describe theoretically and phenomenologically intelligible, multi-dimensional space.

Glossary of Terms

Absolute music: In the Western tradition; composed music that is non-representational, without words, and without any extra-musical meaning; music composed and performed without the addition of any external narrative or drama external to the assembly of tones themselves.

Causal account of music: A causal account of music makes one of two assumptions: either there is something 'in' the music that causes listeners' effects or emotions, or; there is something in the listener that is 'hard-wired' to understand and respond to music as a cause of certain effects, such as emotions.

Consonance: A harmonious sounding of two or more tones in a simple ratio of small whole numbers.

Contrapuntal: Music that features the interplay of melodic lines in the system of counterpoint.

Diatonic: Music composed within the Western major-minor tone system, i.e., the five tones and two semitones as produced on the white keys of the keyboard, excluding chromatic tones.

Entelechia: An out-coming or unfolding of purpose or *telos*.

Ineffable: beyond words; eluding expression.

Interval: A relationship between two pitches, determined in the modern period by the number of scale degrees included. The ancient Greeks determined intervals by ratios of string lengths on the monochord.

Key Signature: An arrangement of sharps or flats notated at the beginning of each staff that determine a diatonic scale in either a major or a minor mode.

Material element of music: In an Aristotelian system of explanation, opposed to a formal element in music, in which the material element of music is the 'stuff' of music; 'enformed' air.

Modulation: The process of changing key within a composition, made feasible by equal temperament, and often established by a cadence in the original key as well as in the new one.

Non-solipsist: One who has no *use* for experience as solely the projection of his own mind.

Perfect interval: The interval of an octave, fifth, or fourth that is neither augmented nor diminished.

Timbre: The particular frequency relations that distinguish instrument and vocal groupings determined by the degrees of presence of harmonics; tone colour.

Topological: Pertaining to the qualities of a surface; qualities of place.

Bibliography

Alperson, Philip, (ed.), *Musical Worlds: New Directions in the Philosophy of Music*, University Park, Pa., Pennsylvania State University Press, 1998.

Alperson, Philip, (ed.), *What Is Music? An Introduction to the Philosophy of Music*, University Park, Pa., Pennsylvania State University Press, 1987

Apel, Willi, (ed.), *Harvard Dictionary of Music*, 2nd Edition, Cambridge, Mass, Harvard University Press, 1969.

Apel, Willi, 'Temperament', *Harvard Dictionary of Music*, 2nd edition, Cambridge, Mass., Harvard University Press, 1969, pp. 835-36.

Aristotle, *De Anima*, translated, with an introduction and notes by Hugh Lawson-Tancred, London, Penguin, 1986, p. 128.

Aristotle, *On the Heavens*, Bk. 2, 9. <http://classics.mit.edu/Aristotle/heavens.mb.txt>, accessed 22/2/2004.

Aristotle, *Politics*, reprinted from Oxford translation, W.D. Ross (ed.) by permission Oxford University Press, in *Contemplating Music: Source Readings in the Aesthetics of Music*, Stuyvesant, N.Y., i, Pendragon Press, 1987.

Aristotle, *Metaphysics*, trans Richard Hope, Ann Arbor, The University of Michigan Press, 1960.

Augst, Bertrand, 'Descartes' Compendium on Music', in *Journal of the History of Ideas*, Baltimore, Johns Hopkins University Press, vol. 26, No.1, Jan-Mar 1965, <http://www.links.jstor.org/sici?sici=0022-5037(196501%2FO3)26%3A1%3C119%3ADCOM%3E2.0.CO%3B2-7> , accessed 25/9/ 2006.

Barker, Andrew, 'Music and Perception: A Study in Aristoxenus' in *The Journal of Hellenic Studies*, vol. 98, London, The Council of the Society for the Promotion of Hellenic Studies, 1978.

Barker, Andrew, 'Plato and Aristoxenus on the Nature of μελος' in *The Second Sense: Studies in Hearing and Sound from Antiquity to the Seventeenth Century*, Charles Burnett, Michael Fend, Penelope Gouk, eds. London, The Warburg Institute, University of London, 1991.

Bashmakova, I.G. & G. S. Smirnova, 'The Literal Calculus of Viete and Descartes', in *The American Mathematical Monthly*, vol. 106, No. 3 (Mar.1999), URL = http://links.jstor.org/sici?sici=0002-9890%28199903%29106%3A3%3C260%3ATLCOVA%3E2.0.CO%3B2-2, accessed 3/10/2006.

Beaney, Michael, "Analysis", *The Stanford Encyclopedia of Philosophy (Fall 2007 Edition),* Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/fall2007/entries/analysis, accessed 16/5/2008.

Bernardi, L., Porta, C., Sleight, P., 'The Sound of Silence is Music to the Heart', in *Heart*, 92, no.4, http://www.google.com/search?client=safari&rls=en-us&q=The+Sound+of+silence+is+Music+to+the+Heart&ie=UTF-8&oe=UTF-8, accessed 19/2/2009.

Blackburn, Simon, 'Supervenience', in *The Shorter Routledge Encyclopedia of Philosophy*, Edward Craig (ed.), Oxon, New York, Routledge, 2005.

Blauert, Jen, *Spatial Hearing*, Cambridge, Mass., London, MIT Press, 1983.

Blood, Brian, *Physics of Musical Instruments,* <http://www.dolmetsch.com/poshistory.htm> accessed 12/8/2005.

Boudri, J. Christiaan, *What was Mechanical about Mechanics: The Concept of Force Between Metaphysics and Mechanics from Newton to LaGrange*, trans. Sen McGlinn, Boston Studies in the Philosophy of Science, vol. 224, Boston, Kluwer Academic Publishers, 2002.

Bowman, Wayne D., *Philosophical Perspectives on Music*, Oxford, Oxford University Press 1998.

Boyer, Carl B., *The History of the Calculus and Its Conceptual Development*, New York, Dover Publications, 1949.

Brown, Kevin, 'Platonic Solids and Plato's Theory of Everything', http://www.mathpages.com/home/kmath095.htm, accessed 14/2/2003.

Burnett, Charles, Michael Fend, Penelope Gouk, eds., *The Second Sense: Studies in Hearing and Sound from Antiquity to the Seventeenth Century*, London, The Warburg Institute, University of London, 1991.

Butt, John, 'A Mind Unconscious that It Is Calculating'?', in *The Cambridge Companion to Bach*, John Butt (ed.), Cambridge, UK, Cambridge University Press, 1997.

Butt, John (ed.), *The Cambridge Companion to Bach*, Cambridge, UK, Cambridge University Press, 1997.

Capek, Milic (ed.), *The Concepts of Space and Time*, Synthese Library, v. 22, Boston Studies in the Philosophy of Science, Dordrecht, Boston, D. Reidel Publishing Co., 1976.

Capleton, Brian, 'The Circle of Pythagoras', http://www.amarilli.co.uk/piano/theory/pythcrcl.asp, accessed 17/3/2004.

Casey, Edward S., *The Fate of Place: A Philosophical History*, Berkeley, University of California Press, 1997.

Chandrasekhar, S., *Newton's Principia for the Common Reader,* Oxford, Clarendon Press, 1995.

Cohen, David E., '"The Imperfect Seeks Its Perfection": Harmonic Progression, Directed Motion, and Aristotelian Physics', in *Music Theory Spectrum*, vol. 23, No.2, (Fall 2001), University of California Press on behalf of The Society for Music Theory, URL = <http://www.mc1litvip.jstor.org/stable/745984>, accessed 4/9/2006.

Cohen, I. Bernard, George E. Smith (eds.), *The Cambridge Companion to Newton,* Cambridge, UK, Cambridge University Press, 2002.

Cohen, I. Bernard, 'Newton's Concepts of Force and Mass', *The Cambridge Companion to Newton*, I. Bernard Cohen & George E. Smith (eds.), Cambridge, UK, CUP, 2002.

Cohen, S. Marc, "Aristotle's Metaphysics", *The Stanford Encyclopedia of Philosophy (Winter 2003 Edition),* Edward N. Zalta (ed.) URL=<http://plato.stanford.edu/archives/win2003/entries/Aristotle-metaphysics/>, accessed 12/5/2006.

Cook, Nicholas, *Music, Imagination, and Culture*, Oxford, Clarendon Press, 1990.

Cooper, John M., 'Socrates', in *The Shorter Routledge Dictionary of Philosophy*, Edward Craig, (ed.), Oxon, New York, Routledge, 2005.

Cornford, F. M., "The Invention of Space" in *The Concepts of Space and Time: Their Structure and Development*, Milic Capek (ed.), Synthese Library, v. 22, Boston Studies in the Philosophy of Science, Dordrecht, Boston, D. Reidel Publishing Co., 1976.

Cornford, F. M., *Plato's Cosmology*, London, Routledge, 1948.

Cornford, F. M., *The Republic of Plato*, Oxford, Clarendon Press, 1941.

Craig, Edward, 'Solipsism', in *The Shorter Routledge Encyclopedia of Philosophy,* Edward Craig (ed.), Oxon, New York, Routledge, 2005.

Crocker, Richard, 'Pythagorean Mathematics and Music', in *The Journal of Aesthetics and Art Criticism*, vol 22, No.2 (Winter, 1963), <http://www.links.jstor.org/sici?sici=0021-8529(196324)22%3A2%3C189%3APMAM%3E2.0.CO%3B2-8>, accessed 12/3/2002.

Dempster, Douglas, 'Review of Peter Kivy's *The Fine Art of Repetition'*, in *Music Theory Online*, The Online Journal of the Society for Music Theory, vol. 2.3, 1996, www.societymusictheory.org/mto/issues/mto.96.2.3/mto.96.2.3.dempster.html, accessed 21/3/2008.

Descartes, Rene 'Compendium Musicae', in *Musicological Studies and Documents,* Rome, American Institute of Musicology, 1961.

Descartes, Rene, *The Geometry of Rene Descartes*, trans. David E. Smith & Marcia A. Latham, New York, Dover Publications, 1954.

Descartes, Rene, *Key Philosophical Writings,* ed. Enrique Chavez-Arvizo, trans. Elizabeth S, Haldane and G. R. T. Ross, Ware, Wordsworth Editions Ltd., 1997.

Descartes, Rene, *The World*, trans. Michael Mahoney, http://www.princeton.edu/~hos.mike/texts/descartes/world/world.htm, accessed 9/2/2007.

Dijksterhuis, E. J., *The Mechanization of the World Picture,* trans. C. Dikshoorn, Oxford, Oxford University Press, 1961.

Drabkin, Israel E., 'Notes on the Laws of Motion in Aristotle' in *The American Journal of Philology*, v. 59, No. 1, Baltimore, Johns Hopkins University Press, 1938, <http://www.links.jstor.org/sici?sici=0002-9475(1938)59%3A1%3C60%3ANATOLOM%3E2.0.CO%3B2-U>, accessed 14/9/2006.

Domski, Mary, '*The Constructible and Intelligible in Newton's Philosophy of Geometry'*, Dep't of History and Philosophy of Science, Bloomington, <philsci-archive.pitt.edu/archive/00001063/>, accessed 3/10/2006.

Encyclopaedia Britannica, 15th edition, 30 vols, Chicago, University of Chicago, 1982.

Euclid, *The Thirteen Books of the Elements,* 2nd edition., trans Sir Thomas L. Heath, 2 vols., New York, Dover Publications, 1956.

Flew, Anthony, *An Introduction to Western Philosophy*, Indianapolis, New York, Bobbs-Merrill, 1971.

Garber, Daniel, 'Descartes, Rene: The Cogito Argument', in *The Shorter Routledge Dictionary of Philosophy*, Oxon, New York, Routledge, 2005.

Gaukroger, Stephen, 'Descartes' Early Doctrine of Clear and Distinct Ideas' in *Journal of The History of Ideas,* Baltimore, Johns Hopkins University Press, 1992.

Guthrie, Kenneth Sylvan, *The Pythagorean Sourcebook and Library*, Grand Rapids, Michigan, Phanes Press, 1987.

Handel, Stephen, *Listening: An Introduction to the Perception of Auditory Events*, Cambridge, Mass., London, MIT Press, 1989.

Hanslick, Eduard, *On the Musically Beautiful: A Contribution Towards the Revision of the Aesthetics of Music,* trans. and ed. Geoffrey Payzant, Indianapolis, Hackett Publishing Company, 1986.

Hatfield, Gary, *Routledge Guidebook to Descartes and The Meditations*, London, Routledge, 2003.

Henderson, Isobel, 'Greece', in *Harvard Dictionary of Music*, Willi Apel (ed.), 2nd Edition, Cambridge, Mass., Harvard University Press, 1970

Huffman, Carl, 'Pythagoreanism", *The Stanford Encyclopaedia of Philosophy (Summer 2006 Edition),* Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/sum2006/entries/pythagoreanism/>.

Huggett, Nick and Carl Hoefer, " Absolute and Relational Theories of Motion", *The Stanford Encyclopedia of Philosophy (Fall 2006 edition),* Edward N. Zalta (ed.), URL = <http://plato.stanford.edu/archives/fall2006/entries/spacetime-theories/>, accessed 30/1/2007.

Janiak, Andrew, "Newton's Philosophy", *The Stanford Encyclopedia of Philosophy (winter 2006 Edition),* Edward N. Zalta (ed.), URL= http://plato.stanford.edu/archives/win2006/entries/newton-philosophy/, accessed 24/2/2007.

Janiak, Andrew, *Newton: Philosophical Writings*, Cambridge, UK, Cambridge University Press, 2004.

Jesseph, Douglas M., ‘Leibniz on the Foundations of Calculus: The Question of the Reality of the Infinitesimal Magnitudes’, *Perspectives on Science*, Spring-Summer, 1998, <muse.jhu.edu/demo/perspectives_on_science/v006/6.1jesseph.html>, accessed 30/5/2005.

Johnston, Ian, *Measured Tones: The Interplay of Physics and Music*, Bristol, New York, Adam Hilger Press, 1989.

Jourdain, Philip E. B., *The Nature of Mathematics*, Mineola, New York, Dover Publications, 1956.

The Journal of The History of Ideas, Baltimore, Johns Hopkins University Press.

Katz, Ruth & Dalhaus, Carl, (eds.), C*ontemplating Music: Source Readings in the Aesthetics of Music*, 4 vols, Stuyvesant, New York, Pendragon Press, 1987.

Leibniz, G. W., *Philosophical Papers and Letters*, Leroy Loemker (ed.), 2 vols., Chicago, University of Chicago Press, 1956.

Leibniz, G. W., and Clarke, S., ‘Discussion on the Nature of Space and Time’, in *The Concepts of Space and Time: Their Structure and Development,* Milic Capek (ed.), Synthese Library, v. 74, Boston Studies in the Philosophy of Science, Dordrecht, Boston, D. Reidel Publishing Co., 1976.

Lerdahl, Fred & Jackendoff, Ray, *A Generative Theory of Tonal Music*, Cambridge, Mass., The MIT Press, 1983.

Lippmann, Edward A., *Musical Thought in Ancient Greece*, New York, Columbia University Press, 1964.

Lippmann, Edward A., *The Philosophy and Aesthetics of Music*, Lincoln, University of Nebraska, 1999.

Locke, Arthur W., "Descartes and Seventeenth-Century Music", in *The Musical Quarterly*, OUP, Vol. 21, No. 4, Oct. 1935, <http://www.links.jstor.org/sici?sici=0027-4631(193510)21%3A4%3C423%3ADASM%3E2.0.CO%3B2-T>, accessed 15/8/2005.

A Loeb Classical Library Reader, trans. Howard N. Fowler, Cambridge, Mass., London, Harvard University Press, 2006.

Marr, David, *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*, New York, W. H. Freeman Press, 1982.

Morison, Benjamin, *On Location: Aristotle's Concept of Place,* Oxford, Clarendon Press, 2002.

Munitz, Milton, ed., *Theories of the Universe: From Babylonian Myth to Modern Science*, London, Macmillan, 1957.

The New Grove Dictionary of Music and Musicians, Stanley Sadie (ed.), 2nd Edition London, 29 vols. Grove-Macmillan, 2001.

Newton, Isaac, *Philosophical Writings,* Andrew Janiak (ed.), Cambridge, Cambridge University Press, 2004.

Nudds, Matthew, "Experiencing the Production of Sounds', *European Journal of Philosophy,* vol. 9, No. 2, August 2001, www.ingentaconnect.com/content/00000009/00000002/art0004, pp. 210-229, accessed 13/7/2006.

O'Connell, Robert J., *Art and The Christian Intelligence in St. Augustine*, Cambridge, Mass., Harvard University Press, 1978.

Plato, *Timaeus and Critias,* trans. Desmond Lee, London, Penguin, 1977.

Plato, *The Republic*, trans. by F. M. Cornford, London, Routledge, 1945.

Plato, 'Republic', in *The Dialogues of Plato*, trans. B. Jowett, 3rd Edition, Oxford, 1882 in *Contemplating Music: Source Readings in the Aesthetics of Music*, Ruth Katz & Carl Dalhaus (eds.), Stuyvesant, New York, Pendragon Press, 1987.

Plato, *Laws*, trans. by Benjamin Jowett. <http://www.classicallibrary.org/plato/dialogues/laws/book2.htm> Accessed 3/14/2007.

Plato, 'Phaedo', in *A Loeb Classical Library Reader*, Loeb Classical Library, Boston, Harvard University Press, 2006.

Powers, Harold, 'Final' in *The New Grove Dictionary of Music and Musicians*, 2nd Edition, 29 vols., Stanley Sadie (ed.), vol. 8, London, Grove-McMillan, 2001.

Ptolemy, Claudius 'Harmonics', in *Contemplating Music Source Readings in the Aesthetics of Music,* 4 vols., Ruth Katz & Carl Dahlhaus (eds.), Stuyvesant, Pendragon Press, ii,1978.

Randall, Allan F., 'Parmenides' Principle', http://www.elea.org/Parmenides/Parm-comment.html, accessed 5/3/2005.

Ridley, Aaron, *The Philosophy of Music: Theme and Variations*, Edinburgh, Edinburgh University Press, 2004.

Sachs, Joe, *Aristotle's Physics: A Guided Study*, Masterworks of Discovery: Guided Studies of Great Texts in Science, New Brunswick, London, Rutgers University Press, 2001.

Salmon, Wesley, (ed.), *Zeno's Paradoxes*, The Library of Liberal Arts, Bobbs-Indianapolis and New York, Merrill Co., Inc., 1970.

Sharpe, R.A., *Music and Humanism*, Oxford, Oxford University Press, 2000.

Shields, Christopher, *Aristotle*, London, New York, Routledge, 2007.

Shields, Christopher, "Aristotle's Psychology", *The Stanford Encyclopedia of Philosophy (Winter 2005 Edition),* Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/win2005/entiries/Aristotle-psychology/>, accessed 12/5/2006.

The Shorter Routledge Encyclopedia of Philosophy, Edward Craig, (ed.), Oxon, New York, Routledge, 2005.

Sloboda, John, *Exploring The Musical Mind: Cognition, Emotion, Ability, Function*, Oxford, Oxford University Press, 2005.

Smith, George E., 'The Methodology of the Principia', in *The Cambridge Companion to Newton*, I. Bernard Cohen & George E. Smith eds., Cambridge, UK, Cambridge University Press, 2002.

Snyder, Dave 'Gravity, Part 2: Newton, Hooke, Halley and the Three Body Problem', Ann Arbor, University of Michigan, 2006, http://www.umich.edu/~lowbrows/reflection/2006/dsnyder.17.html, accessed 11/6/2008.

Sorbom, Goran, “Aristotle on Music as Representation”, The American Society for Aesthetics, 1994, in *Musical Worlds: New Directions in the Philosophy of Music*, Philip Alperson ed., University Park, Pa., Pennsylvania State University Press, 1998.

Sparshott, Francis, ‘Aesthetics of Music: Limits and Grounds’, in Philip Alperson ed., *What Is Music? An Introduction to the Philosophy of Music*, University Park, Pa, Pennsylvania State University Press, 1987, pp. 35-98.

‘The Speed of Sound’, Tom Benson, (ed.), <http://www.grc.nasa.gov/WWW/K-12/airplane/sound.html>, accessed 30/6/2007.

Stein, Howard, ‘Newton’s Metaphysics’ in *The Cambridge Companion to Newton,* I. Bernard Cohen, George E. Smith, (eds.), Cambridge, UK, Cambridge University Press, 2002.

Strawson, P. F., *Individuals: An Essay in Descriptive Metaphysics*, London, Methuen, 1959.

‘The Study of Space and Time’, 7 chapters, <http://chandra.bgsu.edu/~God/Spacetime2.html>, accessed 11/10/2002.

Tamny, Martin, ‘Newton, Creation, and Perception’, in *Isis*, v. 70, No. 1, University of Chicago Press for The History of Science Society March, 1979, <http://links.jstor.org/sici?sici=0021-1753(197903)70%3A1%3C48%3ANCA%3E2.0.CO%3B2-O>, accessed 7/1/2008.

Van der Waerden, ‘Eudoxus of Cnidus’, *Encyclopaedia Britannica*, 15th edition, 30 vols., Chicago, University of Chicago, 1982.

Waterfield, Robin, *The First Philosophers: The Pre-Socratics and the Sophists*, Oxford, Oxford University Press, 2000.

Wenckel, Fritz, *Music, Sound, and Sensation*, New York, Dover Publications, 1967.

Wolfe, Joe, ‘ Gravity, Newton’s Laws of Motion and the Orbits of the Planets’, http://www.phys.unsw.edu.au/~jw/gravity.html, accessed 15/8/2007.